MEMO

Date: 8/5/2024
To: Energy Trust Board of Directors
From: Cody Kleinsmith, Project Manager - Evaluation

Subject: Billing Analysis of Residential Ductless Heat Pump Installations

Executive Summary

Energy Trust analyzed the energy impacts of ductless heat pumps (DHPs) installed in Oregon using Energy Trust incentives from 2020 to 2022. This analysis was conducted using our in-house Residential Energy Billing Analysis (REBA) tool. Energy Trust's DHP measures underwent significant changes in 2020 and 2022 through both measure development and program design processes. As such, this analysis into DHP savings was conducted for the following reasons:

- DHPs are a high impact and high volume measure for Energy Trust's Residential program, both in terms of meeting savings and equity goals.
- Energy Trust has not evaluated DHP savings since a 2019 study and would like to assess the effectiveness of the changes the Residential program made in 2020 and 2022 to DHP measures.
- These results will inform 2025 DHP measures and offers.
- Regular billing analysis of measures is a significant method for Energy Trust to fulfill our mission, strategic goals and values, especially "We are Transparent."

On average, Energy Trust claimed 2,307 kWh of annual electricity savings per DHP installed during this study period. Evaluated savings were found to be 1,032 kWh (±308 kWh) annually, or roughly 7% of whole home electricity usage. This is 45% of the claimed savings per DHP and was statistically different from the average claimed savings value. In addition to this overall result, we analyzed the population of DHP installations during this study period in many different sub-samples, detailed in Table 1 below. Realization rates for these sub-samples ranged from as low as 3% to as high as 63%, and all but one of them[1] was statistically different from the average claimed savings value of their sample. Due to available sample sizes, we have moderate to very low confidence in the results of these sub-samples.

Based on the findings of this analysis, we will undertake the following actions:

The Residential measure development and engineering teams will incorporate these results into the 2024 measure approval document (MAD) update process for DHPs. The DHP measures were previously modified by these teams in the 2020 and 2022 MAD update process to incorporate recommended

[1] This one instance where evaluated savings was not statistically different from the claimed savings was for homes between 2,000 and 2,499 square feet in area. This was primarily driven by low sample sizes causing low precision.

changes from a 2019 DHP Study conducted by Energy Trust and Cadmus[2]. The results of this billing analysis may be combined with other trusted sources of information available in the market, such as the Regional Technical Forum, in a similar fashion to the 2020 and 2022 update processes to determine appropriate savings claims for DHP measures in 2025 and beyond.

In addition to updates to the existing measures, the Residential program will explore program design changes in response to these results. This is particularly relevant in terms of unconditioned spaces in a homes' baseline and how they impact DHP savings. This issue was previously identified in the 2019 Cadmus DHP study and was partially addressed through added measure requirements for locating the primary indoor unit. Additional units beyond the first are not, however, subject to the same requirements to be placed in a portion of a home that was previously conditioned by an electric resistance heating source. The Residential program will explore collecting this information on forms or other avenues to allow future research to identify and account for this issue and its impact on efficiency savings. The Residential program is also expecting to incorporate these results into the 2025 measures in ways that recognize the impact of unconditioned spaces on DHP savings to continue to allow the program to have the necessary installation flexibility to serve these homes.

Lastly, Energy Trust will perform additional research into DHPs to further contextualize, understand and determine recommendations to address these results. As expressed throughout this report, there are many cases where the limitations of stand-alone billing analysis or limited sample sizes are constricting our ability to understand what is driving the results. Energy Trust's ongoing no-cost DHP pilot will be one place where Energy Trust will learn more information about several of these elements, such as thermal comfort and behavior changes resulting from DHP installations in low-income customer segments. Beyond this research, the Residential program and evaluation engineering teams will work together to identify additional research opportunities from these findings and conduct them as either stand-alone research projects or incorporate them into upcoming or ongoing research efforts, such as Fast Feedback or a Residential Process Evaluation. Areas of interest for future research activities include supplemental heating equipment, suboptimal customer behavior post-installation, using a future-participant comparison group for future billing analysis projects and conducting billing analysis more frequently, the seasonality of DHP savings, and evaluating the impact of program design changes.

Despite the realization rates and evaluated savings of this research, DHPs will continue to be an important measure for Energy Trust. DHPs are a popular space conditioning choice for customers in homes without ducting and will continue to be a part of the solution to displacing electric resistance heat in Oregon, especially as new federal and state programs and other funding sources or programs enter the market. DHPs are also a significant equity measure due to the housing stock that many of Energy Trust's priority customer segments occupy. As Energy Trust takes the above next steps, we will continue to improve our DHP measures and outcomes for our utility stakeholders and customers we serve.

[2] That report can be found on Energy Trust's website: https://www.energytrust.org/wp-content/uploads/2019/10/Residential_Ductless_Heat_Pump_Study_Report.pdf

Sample Description	Sample Years	Sample N[3]	Annual Baseline Usage[4]	Average Claimed Savings[5]	Average Evaluated Savings	Realization Rate	90% Confidence Interval[6]	% Savings[7]	Reliability Rating[8]
Overall	2020-2022	2,054	13,917	2,307	1,032	45%	724, 1,339	7%	Moderate
Overall, 2017 to 2019	2017-2019	2,318	14,510	2,222	726	33%	421, 1,031	5%	Moderate
Overall, 2022 Only	2022	792	12,516	2,326	1,206	52%	611, 1,801	10%	Moderate
Overall, with Supplemental Heating Equipment	2022	159	14,006	1,485	320	22%	-779, 1,419	2%	Very Low
Overall, without Supplemental Heating Equipment	2022	628	12,368	2,373	1,494	63%	824, 2,164	12%	Moderate
Market Rate Offers	2020-2022	1,182	14,168	2,277	798	35%	389, 1,208	6%	Low
Income Qualified Offers	2020-2022	549	13,979	2,308	1,216	63%	648, 1,784	9%	Moderate
Site Built Homes	2020-2022	1,687	14,151	2,271	918	40%	578, 1,259	6%	Moderate
Manufactured Homes	2020-2022	250	13,478	3,335	2,084	62%	1,296, 2,872	15%	Moderate
Site Built Homes, 2022 Only	2022	640	14,437	2,244	1,003	45%	446, 1,560	7%	Low
Site Built Homes, with Supplemental Heating Equipment	2022	132	13,979	1,452	205	14%	-1,012, 1,421	1%	Very Low
Site Built Homes, without Supplemental Heating Equipment	2022	491	14,629	2,303	1,180	51%	549, 1,811	8%	Low
Heating Zone 1	2020-2022	1,831	13,943	2,296	1,104	48%	781, 1,426	8%	Moderate
Heating Zone 2/3	2020-2022	221	14,331	2,609	359	14%	-592, 1,309	3%	Very Low
One Indoor Unit	2020-2022	1,046	13,218	2,384	1,195	50%	792, 1,597	9%	Moderate
Two Indoor Units	2020-2022	571	13,604	2,302	709	31%	173, 1,244	5%	Low
Many Indoor Units	2020-2022	436	15,989	2,281	980	43%	264, 1,695	6%	Low
Replacing an Electric Forced Air Furnace	2020-2022	455	13,399	3,569	1,436	40%	688, 2,184	11%	Low
Replacing a Zonal System	2020-2022	1,414	13,820	2,205	826	37%	470, 1,182	6%	Low
Replacing a Zonal System, 2022 Only	2022	535	14,240	2,185	1,000	46%	406, 1,594	7%	Low
Replacing a Zonal System, with Supplemental Heating Equipment	2022	113	13,636	1,417	49	3%	-1,180, 1,278	<1%	Very Low
Replacing a Zonal System, without Supplemental Heating Equipment	2022	407	14,381	2,246	1,259	56%	579, 1,939	9%	Low
Homes <1,000 Square Feet	2020-2022	409	11,404	2,350	1,360	58%	835, 1,886	12%	Moderate
Homes between 1,000 and 1,499 Square Feet	2020-2022	966	13,575	2,299	1,080	47%	690, 1,471	8%	Moderate
Homes between 1,500 and 1,999 Square Feet	2020-2022	428	15,454	2,319	888	38%	169, 1,607	6%	Low
Homes between 2,000 and 2,499 Square Feet	2020-2022	157	16,827	2,291	1,118	49%	-82, 2,318	7%	Very Low
'Ideal' Installation Scenario	2022	135	13,477	2,228	1,087	49%	5, 2,169	8%	Low
Overall, without Natural Gas Service	2020-2022	1,754	14,342	2,312	1,121	48%	792, 1,450	8%	Moderate

Table 1 - Findings Summary

[3] Final treatment group sample size available for analysis. Comparison group Ns are 10 times the treatment group Ns.
[4] Annual Electricity usage for treatment sites in the one year prior to their participation in a DHP measure with Energy Trust.
[5] Mean weather normalized annual energy usage in kWh.
[6] Confidence interval of evaluated savings value at 90% confidence level.
[7] Electricity savings as a percentage of baseline annual use.
[8] Reliability rating of savings estimate based on relative precision and sample size.

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Introduction

Energy Trust developed a Residential Energy Billing Analysis (REBA) tool to evaluate energy savings from efficiency measures it funds in residential buildings. This report summarizes the results of the REBA tool analysis of ductless heat pump (DHP) installations in a range of scenarios and settings in the state of Oregon.

Energy Trust's Residential program provides incentives to homeowners, owners of rental properties, and other home occupants through various pathways to support the installation of energy efficient DHP systems in homes, primarily to replace electric resistance heating systems. The Residential program maintains a variety of different offers for DHPs which include market rate offers for single family homes, manufactured homes, accessory dwelling units (ADUs), and small multifamily homes[9], and income qualified offers for low to moderate income customers through the Savings Within Reach (SWR) track, Community Partner Funding (CPF) track, and the No-Cost Pilot track, as well as other regional or customer type focused promotions.

DHP savings were most recently evaluated by Energy Trust in a 2019 study conducted by Cadmus. To follow up from and build upon that study, this analysis focuses on DHPs installed between 2020 and 2022. In this period Energy Trust claimed a variety of savings values per DHP based on several conditions including heating zone[10], type of heating system being displaced, if supplemental heating equipment[11] was used in the dwelling prior to installation, and dwelling type. Average claimed savings in this study was 2,307 kWh annually per DHP, with individual installations claiming between roughly 450 kWh and 3,900 kWh annually.

Methods

The REBA tool establishes energy savings using monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. First, the tool selects treated homes that received the measures of interest. Energy usage data are weather normalized through an automated process using site-level weather regression models and typical meteorological year data,[12] similar to the methods established by CalTRACK.[13] Normalized annual energy usage is computed for each treated site in both the year prior to measure installation (baseline) and the year following installation (post-installation). The site-level change in annual energy usage is simply computed as the difference in weather normalized

[9] "Small multifamily" is defined as multifamily properties with are between 2-4 units or non-stacked attached units, such as rowhouses. Small multifamily dwellings were not included in the scope of this analysis or report.

[10] Heating zones are geographic areas defined by the Regional Technical Forum, based on the number of heating degree-days during a typical winter. Heating zone 1 represents areas of the state with relatively mild winters, such as Western Oregon. Heating zones 2 and 3 represent areas of the state with cold winters, like the mountains and Central and Eastern Oregon.

[11] "Supplemental heating equipment" or "supplemental fuels" is defined as non-electricity and non-gas powered heating equipment that is used to condition a space. These supplemental fuels may include wood, pellets, propane, oil, or other heating solutions. Supplemental heating equipment has been captured on incentive applications by Energy Trust starting in 2022, and only captures supplemental heating equipment, not cooling equipment.

[12] TMYx data files are typical meteorological data derived from hourly weather data through 2021 from NOAA's Integrated Surface Database using the TMY/ISO 15927-4:2005 methodologies. https://climate.onebuilding.org/

[13] CalTRACK methods describe a process of arriving at a calculation of avoided energy use related to the implementation of one or more energy efficiency measures, such as an energy efficiency retrofit, using monthly billing data, as well as interval data from smart meters. https://www.caltrack.org/

usage between the baseline and post-installation periods. The average change in annual energy usage among homes that received treatment is then evaluated against the average change in energy usage during the same period in a comparison group of similar homes. This analytical process compares DHP installations to the pre-existing condition in a home, which in most, but not all, cases is a zonal electric heat system, electric furnace, or one of these two types of systems alongside non-utility supplemental heating fuels such as wood, oil, or propane. This aligns with the assumptions that Energy Trust uses to estimate DHP savings[14].

The REBA tool selects a comparison group of untreated homes that did not receive any Energy Trust-funded upgrades during the analysis period using a site-level, nearest neighbor matching technique. So, for each treated home, matched non-participant homes are selected from within the same geographic area that had very similar monthly electric usage patterns during the baseline period to the treated home. For this analysis, only electric usage data was used to match treatment and comparison homes. The weather normalized annual energy usage and change in annual energy usage for comparison group homes are estimated using the same procedures as for treated homes. For this analysis, ten matched comparison homes were selected for each treated home. The REBA tool estimates annual energy savings attributable to the DHP installed in the treated homes as the difference in the average change in annual energy usage between the treatment and comparison group homes (difference-in-differences).

Overall, these methods resulted in strong matched treatment and comparison group samples in their baseline period, as seen in Figure 1 below for the Overall sample. Individual sub-sample model fit statistics are available in Appendix A.

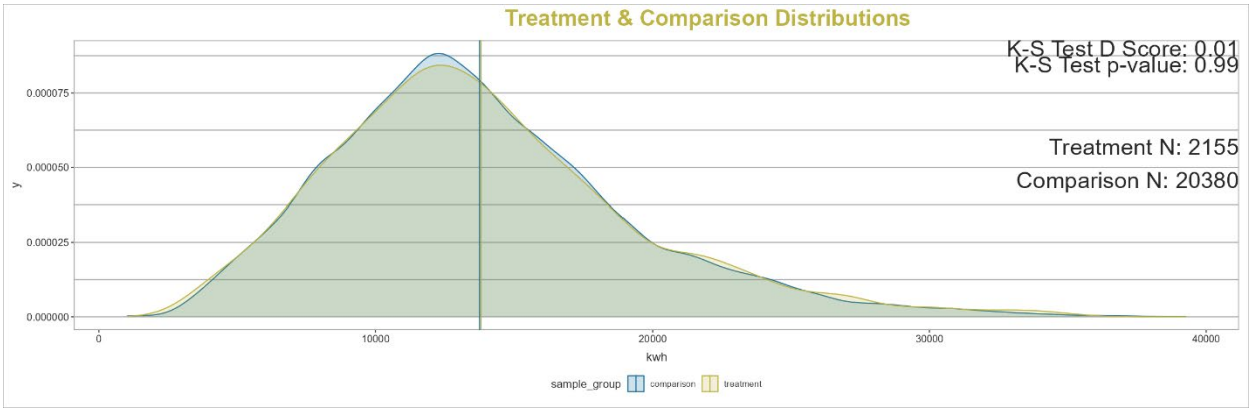


Figure 1 - Annual kWh Distribution of Overall Sample Treatment and Comparison Group Sites

Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. We also restricted the analysis to homes whose participation in other Energy Trust measures was limited to under 100 kWh in claimed savings. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found for site.

[14] Energy Trust's baseline assumptions for DHPs are informed by the 2019 Cadmus DHP Study.

- Less than 9 months of valid billing data available for either baseline or post-install year.
- Weather normalization process failed for either baseline or post-install year.
- Baseline electric usage in the top or bottom 1 percent of treated sites.
- Post-install annual electric usage is more than double or less than half of baseline year.
- Weather regression model has R-square value <0.25 for either baseline or post-install year.
- Other measures installed during analysis period with aggregate deemed electricity savings >100 kWh per year.

We analyzed electric savings for DHPs both overall and along several key variables of interest including heating zone, market rate or specialized offers, housing type, number of indoor units, utility territory, type of system being replaced, presence of supplemental heating equipment in the baseline, and home square footage.

Limitations of Billing Analysis for DHP Measures

While the REBA tool follows industry best practices for billing analysis, there are some key limitations of the methodology, and billing analysis in general, that should be highlighted to contextualize these results.

The first thing to highlight is that this analysis uses real-world installations that may not behave in an expected manner once installed in households due to behavioral patterns. For example, DHP participants may lack the necessary understanding of how to operate the new DHP, may be installing their DHP system for increased thermal comfort from their baseline conditions instead of as a replacement measure, continue to use non-utility supplemental heating equipment, continue to use their previous utility fuel heating equipment, or even revert to using their previous system(s) entirely. Energy Trust's DHP savings assumptions are based on prior research activities and incorporate adjustments for these scenarios based on how frequently they were observed during those research projects. However, without additional customer data collection to accompany this billing analysis we are unable to verify if these behaviors are occurring at lower, similar, or higher rates than the previous research and resulting assumptions, which may bias these results.

The next thing to note is that indoor units (or heads) of DHP projects may be installed in previously unconditioned spaces in a home. This is a known issue that was observed and noted for having an impact on savings in the 2019 Cadmus DHP study. As a result of that study, the program implemented requirements that the first indoor unit is installed in the primary living space and in a previously conditioned space. This requirement was not, however, implemented for additional units beyond the first. These additional units can result in lower savings estimates in billing analysis when they are installed in unconditioned spaces as units installed in these spaces are not offsetting any baseline heating or cooling load and instead build load to condition those portions of a home. Without additional data collection to accompany this billing analysis, it is unclear how large the impact of unit installations in unconditioned spaces may have on these results.

A final thing to note is the matching performed by REBA between treatment and comparison groups. This matching is based on monthly energy use patterns and geographic proximity, but does not include other factors which may contribute to the effectiveness of installed measures in different participant and household settings. The REBA tool is unable to match treatment sites with comparison sites that align on customer income levels, number of residents in the home, the square footage or layout of comparison households, and other household characteristics.

Results

This section presents summary results for DHP installations overall and along the various sub-sample variables of interest. Throughout this section, we will refer to the savings expected and specified in the measure approval document(s) for the sample as the *claimed savings* and the savings output of the REBA tool analysis as the *evaluated savings*. Both the claimed and evaluated savings values are presented as averages and represent a wide range of specific measure applications. All results will be presented in kWh and refer to a decrease in energy use in the home unless otherwise specified.

2017-2019 Overall Results; REBA Tool Testing

To test the methodology and results of the REBA tool we first ran the population of DHPs installed by the Residential program from 2017-2019 through the tool. The purpose of this analysis was to compare the evaluated savings of DHP installations during this time period in the REBA tool to the evaluated savings results of the 2019 Cadmus DHP study, which included these years in its analysis. The 2019 Cadmus DHP study is used as a benchmark for this analysis because it is the most recent DHP billing analysis completed by Energy Trust, used extensive customer data collection through surveys, and is a significant data source for DHP measure assumptions currently used by Energy Trust.

Households that participated in a DHP offer from 2017-2019 with Energy Trust had a mean evaluated savings of **726 kWh** (±305 kWh) or 5% of whole home baseline electricity usage. After attrition there were 2,318 households available for this analysis with a mean baseline electricity usage of 14,510 kWh per year. This evaluated savings result is moderately certain, and the claimed savings value of 2,222 kWh falls outside of the 90% confidence interval, as shown in Figure 2.

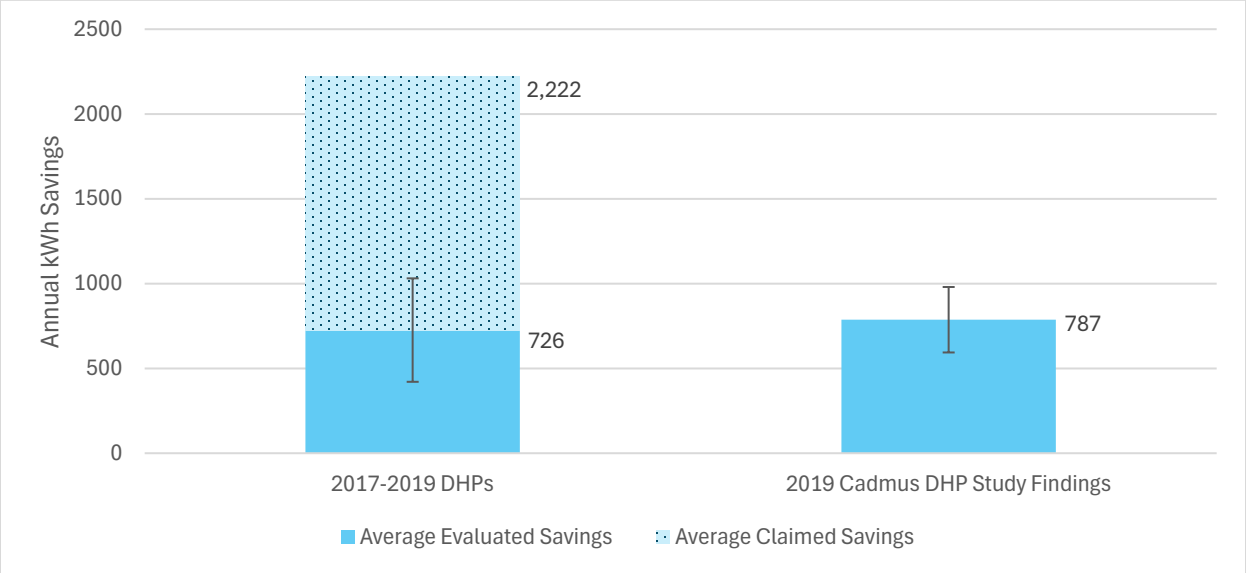


Figure 2 - 2017-2019 REBA Results Testing

These results closely mirror the results of the 2019 Cadmus DHP study, which found an evaluated savings per DHP of 756 kWh (±185 kWh), or 5.8% of whole home baseline electricity usage among 1,589 dwellings with a mean baseline electricity usage of 13,879 kWh per year. These minor differences in the evaluated savings values are small and could be explained by differences in the study samples (i.e., the 2019 Cadmus DHP study had a wider year range of installs and did not include manufactured homes) and slight

methodological differences, but are similar enough to maintain confidence in the use of the REBA tool as a follow-up to the 2019 Cadmus DHP study in the following analyses.

2020-2022 Overall & 2022 Overall Results

Following the Cadmus 2019 DHP study, the Residential program incorporated findings and made several changes to both the program design and measure assumptions. The remaining segments of this study focus on these years to gain the most up-to-date understanding of Energy Trust incentivized DHP savings. In cases where data is available for 2020-2022, all of those years are included in the analysis to preserve sample sizes and strengthen statistical confidence. In some analyses we restrict the years to just 2022 due to the availability of data around supplemental heating equipment. In this overall results section both the 2020-2022 overall findings and 2022 findings are included.

Households that participated in a DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **1,032 kWh** (±308 kWh) or 7% of whole home baseline electricity usage. After attrition there were 2,054 households available for this analysis with a mean baseline electricity usage of 13,917 kWh per year. The evaluated savings equate to a realization rate of 45% of the mean claimed savings of 2,307 kWh. This estimate is moderately certain, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 3.

Households that participated in a DHP offer during 2022 with Energy Trust had a mean evaluated savings of **1,206 kWh** (±595 kWh) or 10% of whole home baseline electricity usage. After attrition there were 792 households available for this analysis with a mean baseline electricity usage of 12,516 kWh per year. The evaluated savings equate to a realization rate of 52% of the mean claimed savings of 2,326 kWh. This estimate is moderately certain, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 3.

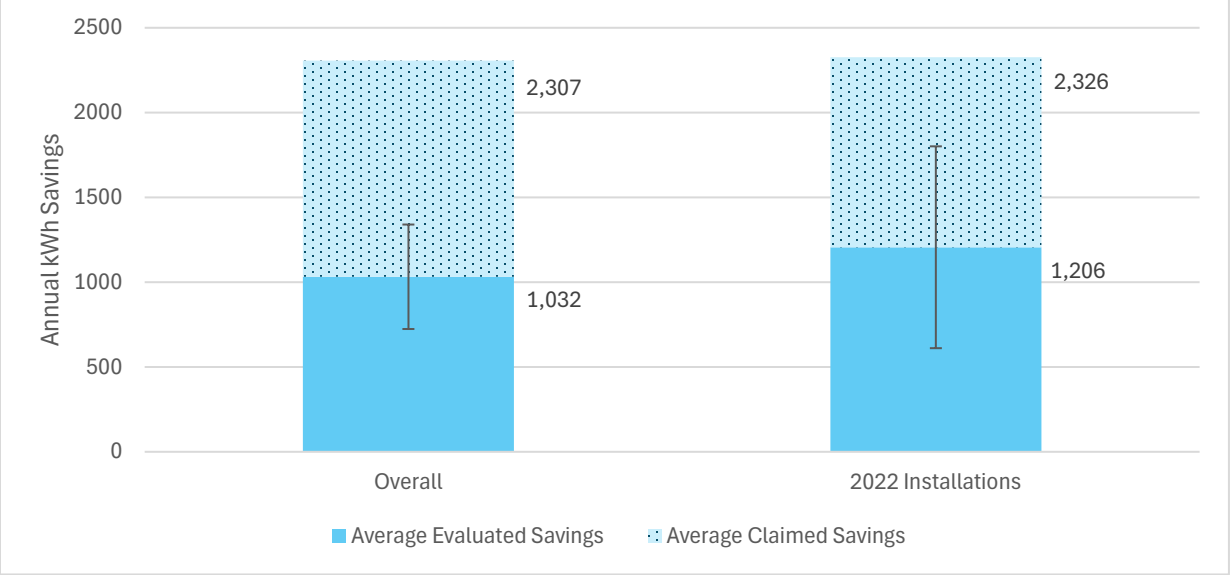


Figure 3 - 2020-2022 Overall & 2022 Overall Results

While these overall results show lower-than-expected savings for DHP installs during the study period, it is hard to interpret the primary drivers behind this finding. These samples of DHP installations included in the overall analyses contain a myriad of differences in measure, household, and geographical

characteristics. These differences include ones that will be explored throughout the following results sections as well as those discussed in the *Limitations of Billing Analysis for DHP Measures* section above. These overall findings will be used as a point of reference and comparison throughout the following results and in the *Findings & Recommendations* section below.

Worth noting from these findings is the increased average evaluated savings from the 2017-2019 findings. The 2020-2022 overall evaluated savings mean is 306 kWh higher than 2017-2019 and the 2022 overall evaluated savings mean is 480 kWh higher. These higher results indicate some level of increased realized savings in recent years, but should be taken with a grain of salt as the 2017-2019 estimate falls within the 90% confidence intervals of both values indicating that they are not statistically different from one another.

Another piece of information that can help us understand the usage patterns and subsequent savings of DHPs is the distribution of electric load by month. Figure 4, below, provides the average monthly kWh load of sites in the 2020-2022 overall sample for both the treatment and comparison groups. This graph illustrates that DHP installations generally occur in homes with a high winter heating load and lower summer cooling load in their baseline year. To preserve the readability of this memo, this chart is not included in the main body for the subsequent analyses and can instead be found in Appendix A for each analysis run.

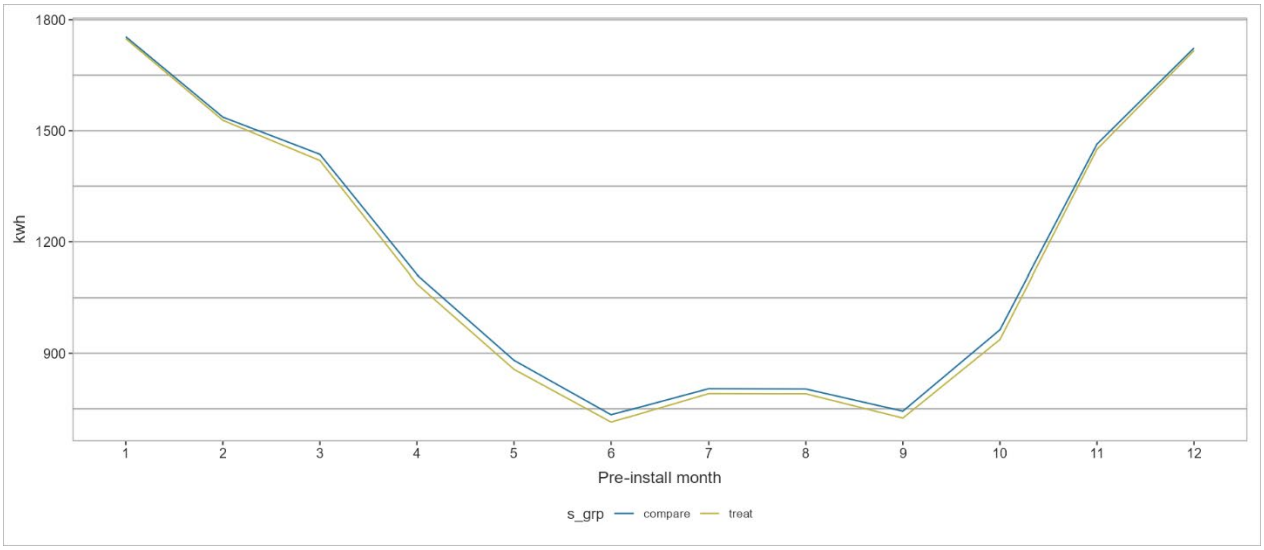


Figure 4 - Baseline Average Monthly kWh of 2020-2022 Overall Sample Homes

Overall Results with and without Supplemental Heating Equipment

As an outcome of the 2019 Cadmus DHP study, Energy Trust began collecting and tracking information related to supplemental heating equipment present in a home's baseline conditions when installing a DHP. Beginning in 2022, the Residential program began tracking both the presence and type of supplemental heating fuel present in a home on incentive application forms and maintaining that information in Energy Trust's database. The types of supplemental fuels collected include wood, pellets, oil, propane, and other forms of heating solutions. For this analysis we broke up the 2022 DHP installations into two categories; those that installed a DHP and were confirmed to have no supplemental fuels present in their baseline period and those that installed a DHP and were confirmed to have one or more

supplemental fuels present in any magnitude in their baseline period. Energy Trust's assumes that DHPs installed in homes with supplemental heating equipment will result in less energy savings than those installed in homes without any supplemental heating equipment, as illustrated by their 1,485 kWh and 2,373 kWh average claimed savings values in this sample respectively.

Households with supplemental heating equipment in their baseline period that participated in a DHP offer during 2022 with Energy Trust had a mean evaluated savings of **320 kWh** (±1099 kWh) or 2% of whole home baseline electricity usage. After attrition there were 159 households available for this analysis with a mean baseline electricity usage of 14,006 kWh per year. The evaluated savings equate to a realization rate of 22% of the mean claimed savings of 1,485 kWh. This estimate has very low certainty, but the claimed savings value still falls outside the bounds of the 90% confidence interval, as shown in Figure 4.

Households without supplemental heating equipment in their baseline period that participated in a DHP offer during 2022 with Energy Trust had a mean evaluated savings of **1,494 kWh** (±670 kWh) or 12% of whole home baseline electricity usage. After attrition there were 628 households available for this analysis with a mean baseline electricity usage of 12,368 kWh per year. The evaluated savings equate to a realization rate of 63% of the mean claimed savings of 2,373 kWh. This estimate is moderately certain, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 4.

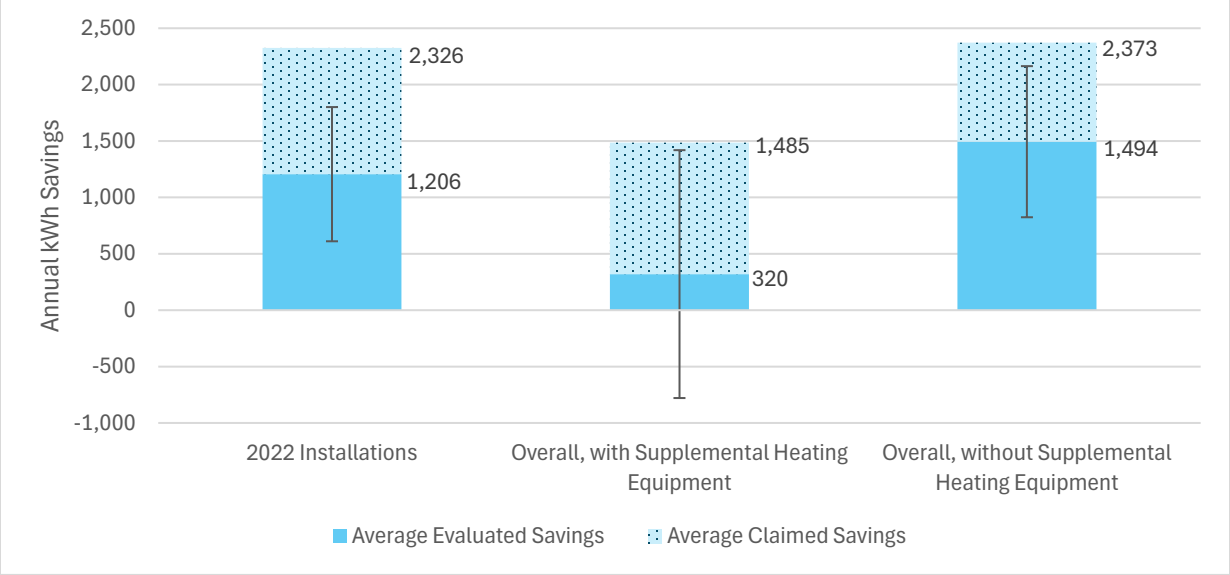


Figure 5 - Overall Samples, With and Without Supplemental Fuels

From this analysis, we are able to more directly see the impact that supplemental heating equipment may be having on the savings of DHP measures. This analysis, specifically the evaluated savings of households that did have supplemental heating equipment in their baseline, should be considered with caution given the wide confidence interval and very low certainty.

The mean evaluated savings of households without supplemental heating equipment was over 1,100 kWh more than the mean evaluated savings of households that had supplemental heating equipment. The difference in the claimed savings values of these two categories was 888 kWh annually. Thus, the evaluated difference between supplemental heating measure savings and non-supplemental heating

measure savings was 286 kWh greater than the claimed difference in savings, indicating that the Residential program may be underestimating the impact of supplemental fuels on DHP savings. Beyond the difference in savings, it is also worth noting that installations that occurred in homes with supplemental heating equipment contain zero (and negative savings) within their confidence interval. This indicates that these installations may be resulting in zero savings or load growth as customers utilize electricity to take on a higher percentage of their conditioning load.

In addition to these savings values, we are also able to see differences in the baseline electricity consumption of these two groups. Households that had supplemental heating equipment had a higher annual baseline electricity usage than households that did not, by over 1,600 kWh. This higher level of baseline electricity usage indicates that despite these homes using supplemental heating equipment, other factors are still driving up their electricity consumption. It is unclear what these factors are, though they may be a combination of existing home conditions, home size or layout, different behavioral characteristics among residents, additional electricity using equipment associated with homes with supplemental heating equipment, or other factors. Supplemental heating equipment is often associated with homes that are in more rural locations, which in Oregon often correlates to homes in heating zones two and three. Homes in these heating zones typically have higher energy loads due to weather conditions which place a higher demand on space condition equipment. In this analysis the sample of homes with supplemental heating equipment was made up of approximately 80% homes in heating zone one and 20% homes in heating zone two, a moderate increase from the overall sample of 90% heating zone one and 10% heating zone two. See Figure 6 below for a map of the distribution of sites in the sample of homes with supplemental heating equipment. This increase in homes in heating zone two in the supplemental heating equipment sample may be partially responsible for the increased baseline electricity load found in that group compared to homes without supplemental heating equipment.

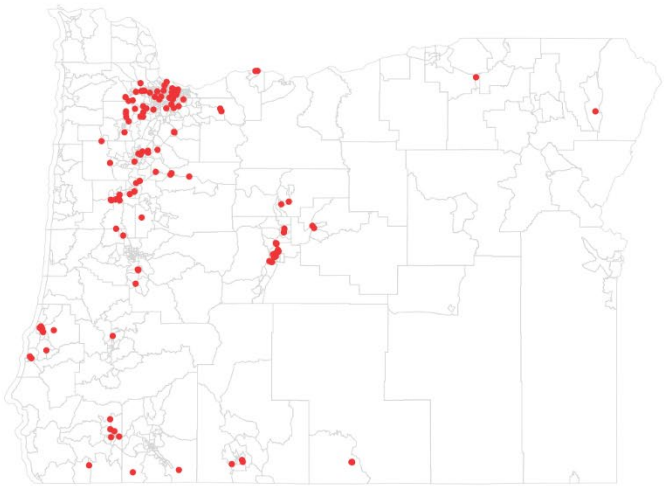


Figure 6 - Map of Homes with Supplemental Heating Equipment

Results by Income Stratified Measures

Energy Trust maintains several offers for DHPs and other measures that target low- and moderate-income households. These offers typically offer a higher incentive level to support customers who have been historically underserved by Energy Trust and often do not have access to the capital resources necessary

to participate in Energy Trust measures. Energy Trust also recognizes that the customers that participate in the low- and moderate-income offers often have different characteristics than customers that participate in market-rate, or standard, offers. Differences may include baseline heating loads, home weatherization and efficiency levels, home size, number of occupants, etc. Despite these differences, Energy Trust does not claim different savings values for market rate and income qualified measures. The marginal difference in average claimed savings in this analysis of 2,277 kWh for market rate offers and 2,308 kWh for income qualified offers is driven by the mix of individual measures in the samples that have different claimed savings values for reasons other than income track. We conducted an analysis of both "market-rate" and "income-qualified" offers to determine whether DHPs perform differently when installed through these different tracks.

Market-rate measures included all offers with no income requirements attached. Income-qualified measures included offers in Energy Trust's moderate-income track (Savings Within Reach), community partner funding offers, and no-cost to consumer pilot offers. For a full list of the individual measures included in each analysis group, refer to Appendix A.

Households that participated in a market-rate DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **798 kWh** (±409 kWh) or 6% of whole home baseline electricity usage. After attrition there were 1,182 households available for this analysis with a mean baseline electricity usage of 14,168 kWh per year. The evaluated savings equate to a realization rate of 35% of the mean claimed savings of 2,277 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 7.

Households that participated in an income-qualified DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **1,216 kWh** (±568 kWh) or 9% of whole home baseline electricity usage. After attrition there were 549 households available for this analysis with a mean baseline electricity usage of 13,979 kWh per year. The evaluated savings equate to a realization rate of 53% of the mean claimed savings of 2,308 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 7.

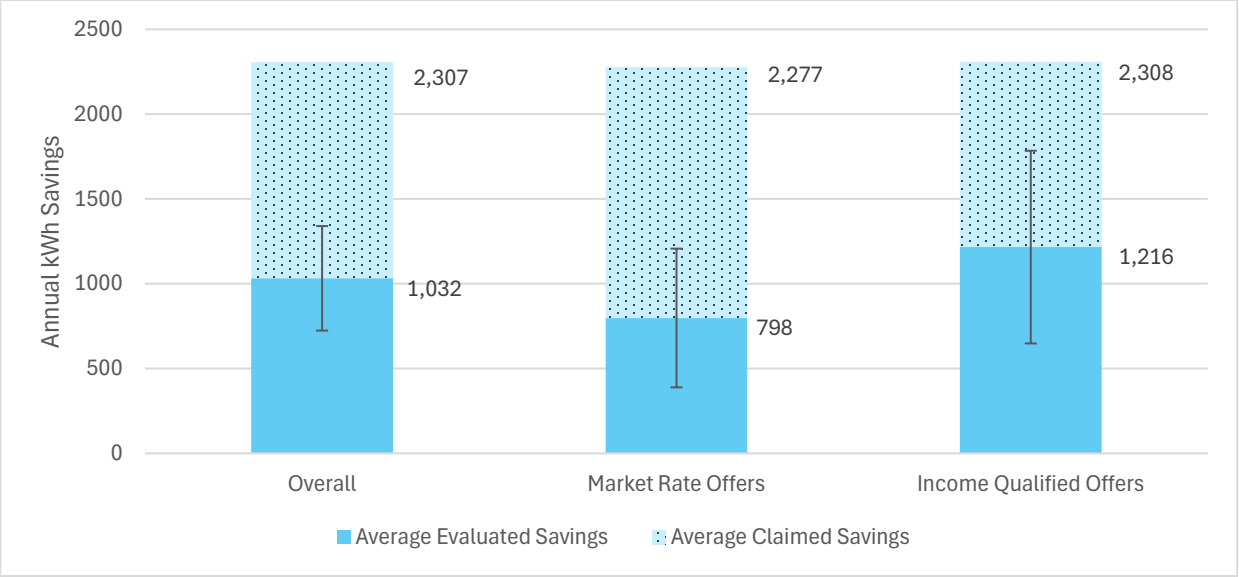


Figure 7 - Income Stratified Measures

When analyzing by income stratification we see several differences in both the baseline and analysis outcomes. Homes participating in market-rate offers have an average evaluated savings of roughly 400 kWh lower than income qualified offers. Despite this difference, it should be interpreted with caution due to the significant overlap between the confidence intervals of these two categories. Claimed savings values for these two categories were very similar, with only a 30-kWh difference, on average, which results in the income-qualified offers experiencing a much higher realization rate than the market-rate offers. There are several potential explanations for this difference which include both program design and participant characteristic factors.

A program design factor that could be contributing to higher average savings in income qualified offers is the more hands-on approach that these households receive compared to market-rate installations. This hands-on approach allows the resident more opportunities to ask questions, become more familiar with how to operate their equipment, and allows program representatives and installation contractors to ensure setpoints, sizing, and other equipment specifications are fine tuned for the unique customer.

Participant factors which could be contributing to these findings in income qualified offers are the size, layout, and existing condition of a participating home compared to market rate homes. Income qualified homes are frequently smaller, have fewer rooms, and/or have a simpler existing HVAC system layout. These factors can all contribute to creating an ideal DHP installation scenario for realizing energy efficiency savings and lead to the higher average evaluated savings. On the other hand, income qualified customers often reside in homes that may be less weatherized than market rate participant homes, which could easily counter any efficiency benefits gained by home layout or size.

While we see this difference in evaluated savings, a place where we see only marginal differences is in the mean baseline electricity use between these two groups. Market-rate and income-qualified customers are experiencing baseline electricity usage levels that are only 189 kWh apart annually. This result indicates that despite different demographic characteristics between these two groups, they are using similar levels of electricity. Similar to the difference in average evaluated savings, this finding could be

informed by differences in the housing stock or behavioral characteristics of customers participating in each group. One of the assumptions often made between the income qualified and market rate participants is the size of homes that each population resides in. In the case of these samples, the income qualified participants had an average home square footage of 1,290 while the market rate participants had an average home square footage of 1,438. This modest difference of only 148 square feet between groups indicates that in DHP participants this difference is marginal.

Results by Household Building Type

Energy Trust maintains different measures with distinct savings assumptions and claims based on building type. The Residential program distinguishes building type and tracks DHP installations in two main categories: site-built homes and manufactured homes. The distinct claimed savings values in each of these building types are driven by previous evaluations of DHP savings, primarily the 2019 Cadmus DHP study. The savings values found in the previous research and incorporated into the program design are a result of a number of observed differences between the average manufactured and site-built home, including things like building weatherization levels, square footage, layout, etc. In the sample of homes included in this analysis, the average claimed savings of manufactured homes was 3,370 kWh. The respective sample of site-built homes had a considerably lower average claimed savings value of 2,271 kWh.

Site-built homes that participated in a DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **918 kWh** (±340 kWh) or 6% of whole home baseline electricity usage. After attrition there were 1,687 households available for this analysis with a mean baseline electricity usage of 14,151 kWh per year. The evaluated savings equate to a realization rate of 40% of the mean claimed savings of 2,271 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 8.

Manufactured homes that participated in a DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **2,084 kWh** (±788 kWh) or 15% of whole home baseline electricity usage. After attrition there were 250 households available for this analysis with a mean baseline electricity usage of 13,478 kWh per year. The evaluated savings equate to a realization rate of 62% of the mean claimed savings of 3,335 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 8.

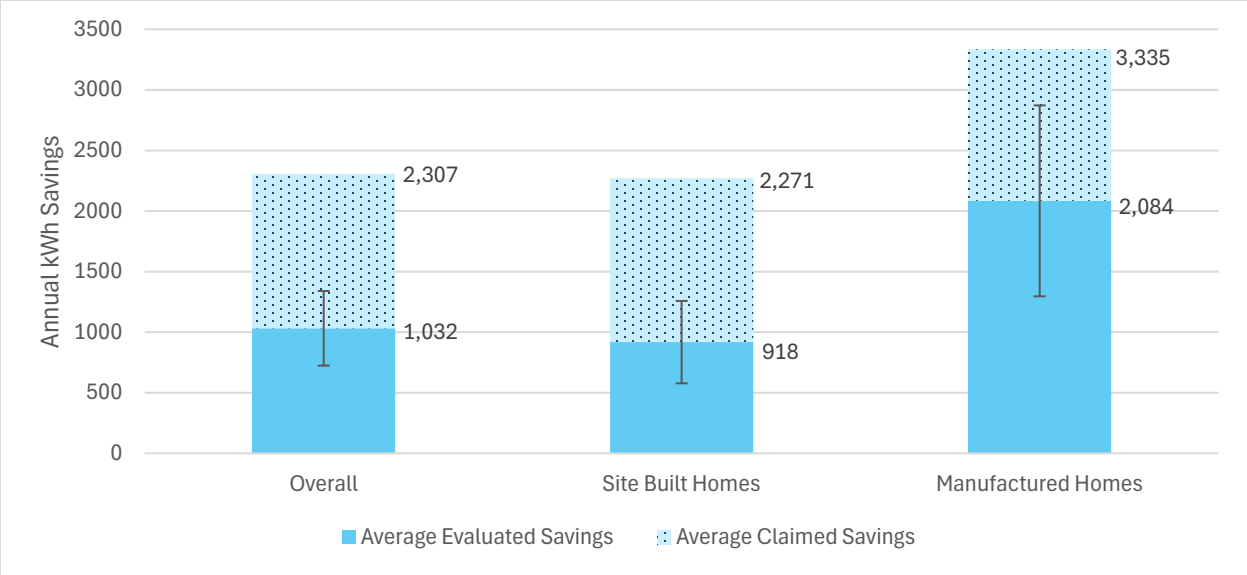


Figure 8 - Housing Type

Several interesting findings come from this analysis. The first is the large difference in savings between site-built and manufactured homes. Site-built homes had a mean evaluated savings value that was 1,166 kWh lower than the mean evaluated savings value of manufactured homes, and these differences are statistically different from one another. The mean evaluated savings of the manufactured homes sample is also the only sub-sample that is statistically different from the overall sample. This aligns very closely with the difference in claimed savings, which is 1,106 kWh lower for site-built homes than for manufactured homes. This illustrates that the ratio of evaluated savings to claimed savings is quite different, as is seen by the difference in their realization rates, but the magnitude of that difference closely aligns with the claimed savings values in the measures. This suggests that while the claimed savings values may be high, the program is correctly account for the differences between these two housing types.

These two home types also had different baseline electricity use levels, with manufactured homes using an average of 13,478 kWh annually compared to site-built homes' 14,151 kWh annually, or a 673 kWh difference. This difference is relatively modest, especially when we compare it to the 1,166 kWh difference in mean evaluated savings between these two samples. This finding indicates that the savings seen in the evaluated manufactured home sample are being driven by other factors than a higher space conditioning load available to be offset by the installed DHP.

Result in Site-Built Homes, With & Without Supplemental Heating Equipment

The following analysis analyzes the interaction of site-built homes and supplemental heating equipment. Similar to the overall sample, site-built homes with supplemental heating equipment have lower mean claimed savings values (1,452 kWh) than those without supplemental heating equipment (2,303 kWh). This is a result of the findings of previous evaluation studies into DHPs, primarily the 2019 Cadmus DHP study, and is driven by homes with supplemental heating equipment in their baseline using electricity to provide a smaller portion of their space conditioning in their baseline period. This results in a moderate load building effect in their post-participation period as they shift more of their space conditioning load to electric based sources. This same load building effect is not present in homes without supplemental heating equipment. In addition to segmenting by homes with and without supplemental heating

equipment, Figure 9 below also includes the 2022 Overall sample and 2022 Overall Site-Built homes sample for comparison purposes.

Site-built homes that participated in a DHP offer during 2022 with Energy Trust had a mean evaluated savings of **1,003 kWh** (±557 kWh) or 7% of whole home baseline electricity usage. After attrition there were 640 households available for this analysis with a mean baseline electricity usage of 14,437 kWh per year. The evaluated savings equate to a realization rate of 45% of the mean claimed savings of 2,244 kWh. This estimate has low, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 9.

Site-built homes that had supplemental heating equipment in their baseline and participated in a DHP offer during 2022 with Energy Trust had a mean evaluated savings of **205 kWh** (±1,217 kWh) or 1% of whole home baseline electricity usage. After attrition there were 132 households available for this analysis with a mean baseline electricity usage of 13,979 kWh per year. The evaluated savings equate to a realization rate of 14% of the mean claimed savings of 1,452 kWh. This estimate has very low, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 9.

Site-built homes that did not have supplemental heating equipment in their baseline and participated in a DHP offer during 2022 with Energy Trust had a mean evaluated savings of **1,180 kWh** (±631 kWh) or 8% of whole home baseline electricity usage. After attrition there were 491 households available for this analysis with a mean baseline electricity usage of 14,629 kWh per year. The evaluated savings equate to a realization rate of 51% of the mean claimed savings of 2,303 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 9.

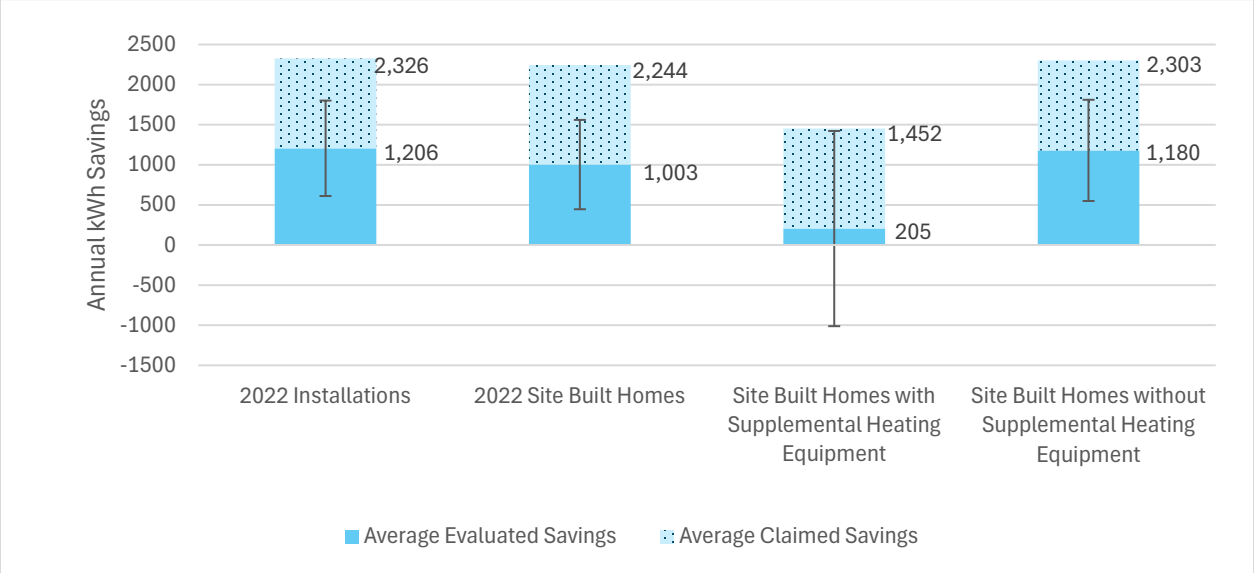


Figure 9 - Site-Built Homes With and Without Supplemental Heating Equipment

From these analyses we can see that site-built homes with supplemental heating equipment are performing relatively worse than site-built homes without supplemental heating equipment. The confidence interval for site-built homes with supplemental heating equipment is quite wide, largely as a function of the small sample size, so caution should be used when interpreting these results. These results are not statistically different due to their confidence intervals. It is, however, still worth comparing the

differences between these two groups and understanding their effect on the overall 2022 site-built home sample.

Homes with supplemental heating equipment saw a much lower mean evaluated savings at only 205 kWh, compared to those without supplemental heating equipment at 1,180 kWh. This difference in evaluated savings values of 975 kWh is moderately larger than the difference in mean claimed savings between these two groups of 851 kWh. This 124 kWh difference-in-differences between the mean claimed and mean evaluated savings values indicates that the program may be underestimating the impact of supplemental heating equipment in site-built homes. This result is similar to, but smaller than, the overall supplemental heating analysis above and further illustrates this underestimation of the impact of supplemental heating equipment.

One of the things that is worth noting about this analysis regardless of its sample size is the effect that homes with supplemental heating equipment has on the overall site-built sample. When the 132 households with supplemental heating equipment are included in the analysis it brings the mean evaluated savings of the overall sample down. This is illustrated by the difference between the mean evaluated savings of the site-built homes without supplemental heating equipment and the mean evaluated savings of the 2022 overall site-built homes sample. These samples have a difference in their means of 177 kWh, or roughly 15% of the mean evaluated savings of the site-built homes without supplemental heat point estimate. Due to low sample sizes, including for manufactured homes which results in the omission of a parallel analysis to the above, we are unable to analyze the effect of supplemental heating equipment on many of the other variables of interest in this study, but a similar effect may be present.

Results by Heating Zone

Energy Trust divides its DHP offers by heating zone to account for different climates and the resulting impacts on heating loads and energy savings. Most of the population of Oregon and, as a result, most of the participants in Energy Trust DHP offers, fall within heating zone one. Heating zone one is primarily in the western part of the state in the Willamette Valley and coastal regions and is characterized by more moderate winter temperatures. Heating zone two makes up much of the rest of the state, in Central, Eastern, and Southern Oregon, and contains all of the DHP installations that the program did outside of heating zone one between 2020 and 2022. A small part of Oregon is heating zone three, in the northeast corner of the state, but no installations of DHPs occurred in heating zone three between 2020 and 2022 with Energy Trust incentives. Heating zone two and three are both characterized by more extreme winter temperatures, which results in a higher heating load than heating zone one. Due to the more extreme winter temperatures in heating zone two, Energy Trust claims higher savings values for those installations as the DHP offsets a larger baseline load. This difference is illustrated in this analysis, as the heating zone one sample had a mean claimed savings of 2,296 kWh annually compared to heating zone two's mean claimed savings of 2,609 kWh annually.

Homes that participated in a DHP offer from 2020-2022 in heating zone one with Energy Trust had a mean evaluated savings of **1,104 kWh** (±323 kWh) or 8% of whole home baseline electricity usage. After attrition there were 1,831 households available for this analysis with a mean baseline electricity usage of 13,943 kWh per year. The evaluated savings equate to a realization rate of 48% of the mean claimed savings of 2,296 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 10.

Homes that participated in a DHP offer from 2020-2022 in heating zone two with Energy Trust had a mean evaluated savings of **359 kWh** (±951 kWh) or 3% of whole home baseline electricity usage. After attrition there were 221 households available for this analysis with a mean baseline electricity usage of 14,331 kWh per year. The evaluated savings equate to a realization rate of 14% of the mean claimed savings of 2,609 kWh. This estimate has very low certainty and is not statistically distinguishable from zero. The claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 10.

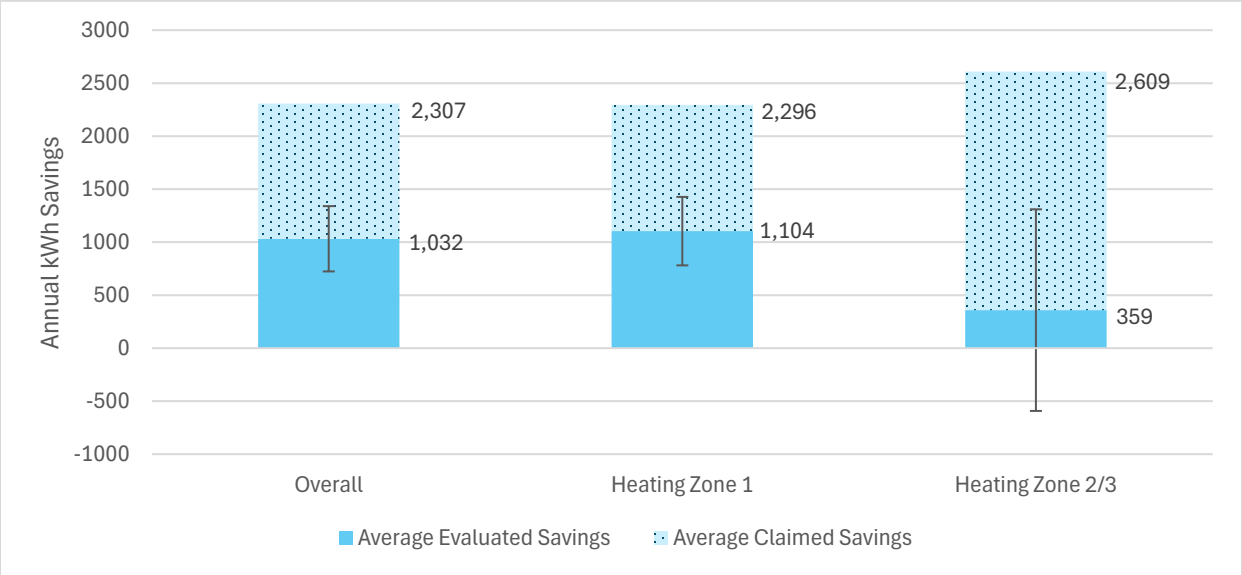


Figure 10 - Heating Zone

While there is very low certainty in the evaluated savings value associated with heating zone two DHP installations, it is still worth discussing what this low value may be telling us. Evaluated savings from heating zone one installations generally align with the overall evaluated savings, which is to be expected since they make up the bulk of the overall sample. However, the heating zone two installations are seeing evaluated savings well below the claimed savings value.

The first thing to note about the findings of the heating zone two installations is the low evaluated savings of only 359 kWh annually. The confidence interval is also wide enough that zero savings does fall within the 90% confidence interval. This indicates that it is possible that no savings or even negative savings (load growth) are resulting from these measures. While this results in a poor realization rate of only 14%, it is worth comparing this value to the 2019 Cadmus DHP study, which found an evaluated savings of -337 kWh annually in heating zone two installations, or an overall 337 kWh increase in electricity use after DHP installation. While this 2019 value does still fall within the 90% confidence interval, the positive mean evaluated savings estimate for installations from 2020-2022 indicates that DHP installations in heating zone two have potentially increased in effectiveness since the 2019 study. Despite this wide confidence interval, the claimed savings value still sits well outside of the 90% confidence interval. Several things could be driving this lower evaluated savings value in heating zone two installations. As referenced above, a slightly higher proportion of installations where supplemental heating equipment was present in the baseline conditions occurred in heating zone two than the overall sample which could be a driver of these lower evaluated savings results. In addition, heat pumps in heating zone two may be frequently

experiencing temperatures below their capabilities of conditioning and are switching into electric resistance mode for a larger portion of the time. These, and other factors, could be drivers of this low result compared to the overall sample and heating zone one sample and warrant additional study and data collection to understand.

The second thing to note about heating zone two DHP installations is the baseline electricity usage of homes. This analysis indicates a higher electric load in heating zone two than in heating zone one, as the baseline electricity usages are 14,331 kWh and 13,943 kWh, respectively, or roughly 400 kWh apart. Despite this higher load, it is unclear if this additional load is being used to condition households, as homes in heating zone two could have other characteristics or usage patterns that result in a higher demand for electricity.

Results by Indoor Unit Quantity

Energy Trust collects information about the number of indoor units (or 'heads') installed to condition a household when a DHP is installed through the Residential program. These indoor units provide heating and cooling capabilities to different areas of a home, and typically more units are necessary to condition larger homes or homes with many interior walls or isolated dwelling spaces. Additional indoor units beyond the first do not increase Energy Trust's claimed savings values, and despite higher costs for additional units Energy Trust does not offer increased incentives to projects with multiple indoor units[15].

Despite Energy Trust not using the number of indoor units to claim different savings values, we still performed this analysis to provide additional context as to what may be happening in homes under different installation circumstances and to follow up on analysis performed in the 2019 Cadmus DHP study. To maintain statistical power and sample sizes, we grouped and analyzed homes that installed a DHP with one, two, or more than two indoor units.

Homes that participated in a DHP offer from 2020-2022 with a single indoor unit had a mean evaluated savings of **1,195 kWh** (±403 kWh) or 9% of whole home baseline electricity usage. After attrition there were 1,046 households available for this analysis with a mean baseline electricity usage of 13,218 kWh per year. The evaluated savings equate to a realization rate of 50% of the mean claimed savings of 2,384 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 11.

Homes that participated in a DHP offer from 2020-2022 with two indoor units had a mean evaluated savings of **709 kWh** (±536 kWh) or 5% of whole home baseline electricity usage. After attrition there were 571 households available for this analysis with a mean baseline electricity usage of 13,604 kWh per year. The evaluated savings equate to a realization rate of 31% of the mean claimed savings of 2,302 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 11.

Homes that participated in a DHP offer from 2020-2022 with three or more indoor units had a mean evaluated savings of **980 kWh** (±716 kWh) or 6% of whole home baseline electricity usage. After attrition there were 436 households available for this analysis with a mean baseline electricity usage of 15,989

[15] The No-Cost DHP Pilot offer which began in 2022 is the exception to this incentive rule. DHPs with one indoor unit in this pilot are eligible for up to $5,200 in total incentives, while DHPs with two indoor units are eligible for up to $7,800 in total incentives.

kWh per year. The evaluated savings equate to a realization rate of 43% of the mean claimed savings of 2,281 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 11.

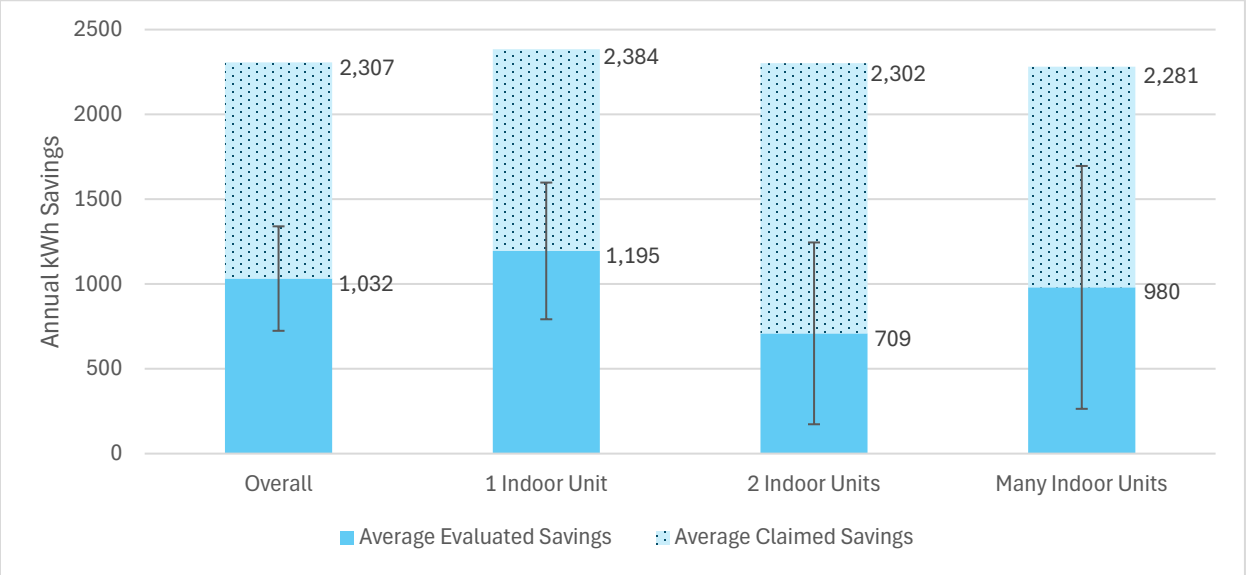


Figure 11 - Indoor Unit Quantity

The most interesting finding from this analysis is the trend of evaluated savings values by number of indoor units. It is worth noting that none of the point estimates are mutually statistically significant from one another and there is considerable overlap between their confidence intervals. Despite that, the average evaluated savings for installations with two indoor units and many indoor units are lower than one indoor unit installations. While it is uncertain what is the cause of this lower average estimate for the multi-head systems in this analysis, it is possible that there are a number of installations in which the units beyond the first are being installed in previously unconditioned spaces in homes, are being used to offset supplemental heating fuels that are conditioning portions of a home, or are being installed for air conditioning and building summer cooling load but not offsetting winter heating loads. This seems especially likely for one-to-two indoor unit installations due to two factors:

1. The two indoor unit installations saw the lowest mean evaluated savings and lowest realization rate of the three analyses and;
2. The two indoor unit baseline electricity energy usage was only 400 kWh higher than the one indoor unit baseline electricity energy usage.

Another factor that is likely influencing these results is the homes that participate in each of these three categories. Each increase in the number of indoor heads resulted in an increase in average baseline electricity usage, from 13,218 kWh for one indoor unit, to 13,604 kWh for two indoor units, to 15,989 kWh for many indoor unit installations. This increase indicates that the number of indoor units often increases in homes that are larger, have layouts that require more electricity to condition, or have behavioral/other characteristics that result in higher energy consumption. One of the interesting findings that comes from these different baseline electricity usage levels is the low performance of installations with many indoor units. These installations are occurring in homes that have a significant electricity load

which likely indicates that they have a larger space conditioning that could be offset by a DHP installation than the one or two indoor unit samples. Despite this larger load, the DHP installations in this sample do not result in higher or lower evaluated savings estimates, and due to the lack of statistical significance between these groups, are essentially performing the same.

Results by Baseline System Replaced

One of the primary drivers of different claimed savings values for Energy Trust DHP installations is the baseline heating system that is being replaced. Most Energy Trust DHP installations are used to replace electric resistance heating systems, which are classified for the purpose of this analysis into two types: electric furnaces and zonal heating systems. These baseline heating systems create different claimed savings values based on assumptions of their energy usage and ability to condition the home, resulting in higher claimed savings for a DHP replacing an electric furnace and lower claimed savings for a DHP replacing a zonal heating system. Within this sample, the average claimed savings when replacing an electric furnace was 3,569 kWh, which was nearly 1,400 kWh higher than the average claimed savings when replacing a zonal system, which was 2,205 kWh.

Homes that participated in a DHP offer that replaced an electric furnace from 2020-2022 with Energy Trust had a mean evaluated savings of **1,436 kWh** (±748 kWh) or 11% of whole home baseline electricity usage. After attrition there were 455 households available for this analysis with a mean baseline electricity usage of 13,399 kWh per year. The evaluated savings equate to a realization rate of 40% of the mean claimed savings of 3,569 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 12.

Homes that participated in a DHP offer that replaced a zonal heating system from 2020-2022 with Energy Trust had a mean evaluated savings of **826 kWh** (±356 kWh) or 6% of whole home baseline electricity usage. After attrition there were 1,414 households available for this analysis with a mean baseline electricity usage of 13,820 kWh per year. The evaluated savings equate to a realization rate of 37% of the mean claimed savings of 2,205 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 12.

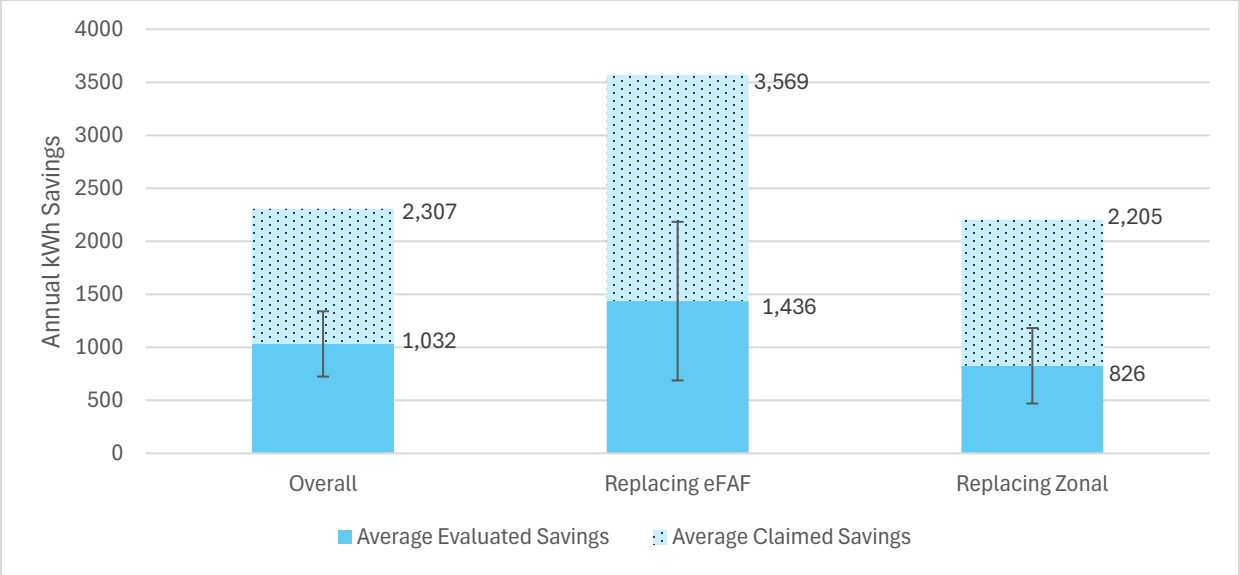


Figure 12 - Baseline System Replaced

There are several interesting findings from these analyses of the baseline heating system being replaced. Once again, it is worth noting that while the average point estimates do appear to be different, these results are not statistically significant from one another and there is considerable overlap between their confidence intervals. With that in mind, the average evaluated savings of installations replacing an electric furnace are considerably higher than the average evaluated savings of installations replacing a zonal system. This difference of 610 kWh along with the confidence intervals indicates that it is likely that electric furnace replacements are saving more than zonal replacements. However, when we account for the average claimed savings of these two samples and compare their realization rates, we can see that they are realizing a similar proportion of their claimed savings. The electric furnace realization rate of 40% is only marginally higher than the zonal system realization rate of 37%. This small difference indicates that this higher average evaluated savings for electric furnace replacements is largely being captured and correctly calculated in the savings claims used by Energy Trust for these different baseline scenarios.

Homes replacing an electric furnace had a baseline electricity usage of 13,399 kWh annually while homes that replaced a zonal heating system had a baseline electricity usage of 13,820 kWh annually, which both are fairly similar, thought slightly lower than the overall sample baseline usage of 13,917 kWh annually[16]. These similar findings help further contextualize the mean evaluated savings values between the two groups, as electric furnace baseline homes are experiencing those higher evaluated savings values despite having a similar electricity baseline load to offset. It is possible that, despite this similar overall load, the space conditioning load may be different between these two groups and that the overall baseline looks similar due to other electricity usage patterns, weatherization levels or other infrastructure, or other energy using equipment. Additional research could be conducted to compare the space conditioning load directly between these two groups.

[16] Both samples being lower than the overall sample is due to sites with missing "System Replaced" attributes being removed from this analysis. The impact of this can be seen in the different Ns, as the two samples in this analysis combined are roughly 200 sites smaller than the overall sample.

Results in Homes Replacing Zonal Systems, With and Without Supplemental Heating Equipment

In addition to the previous analysis comparing evaluated savings across different baseline equipment scenarios, the following analysis examines the zonal system replacement group[17] and the impact of supplemental heating equipment on their savings. Included in the following analysis for comparison is the overall 2022 installation sample, 2022 zonal replacement sample, and the 2022 zonal replacement sample with and without supplemental heating equipment.

Homes that participated in a DHP offer that replaced a zonal heating system during 2022 with Energy Trust had a mean evaluated savings of **1,000 kWh** (±594 kWh) or 7% of whole home baseline electricity usage. After attrition there were 535 households available for this analysis with a mean baseline electricity usage of 14,240 kWh per year. The evaluated savings equate to a realization rate of 46% of the mean claimed savings of 2,185 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 13.

Homes that participated in a DHP offer that replaced a zonal heating system and did have supplemental heating equipment during 2022 with Energy Trust had a mean evaluated savings of **49 kWh** (±1,229 kWh) or <1% of whole home baseline electricity usage. After attrition there were 113 households available for this analysis with a mean baseline electricity usage of 13,636 kWh per year. The evaluated savings equate to a realization rate of 3% of the mean claimed savings of 1,417 kWh. This estimate has very low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 13.

Homes that participated in a DHP offer that replaced a zonal heating system and did not have supplemental heating equipment during 2022 with Energy Trust had a mean evaluated savings of **1,259 kWh** (±680 kWh) or 9% of whole home baseline electricity usage. After attrition there were 407 households available for this analysis with a mean baseline electricity usage of 14,381 kWh per year. The evaluated savings equate to a realization rate of 56% of the mean claimed savings of 2,246 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 12.

[17] A parallel analysis of electric furnace baseline replacements is not included due to a lack of sample size available for electric furnace baseline homes with supplemental heating equipment.

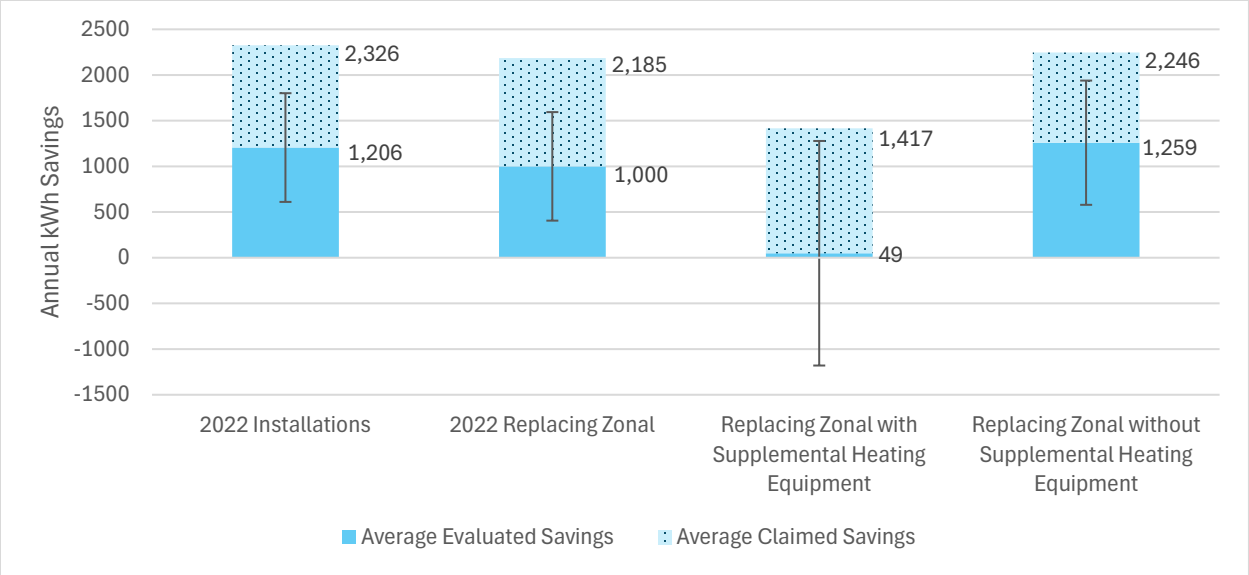


Figure 13 - Zonal Baseline Systems & Supplemental Heating Equipment

This analysis provides us with several interesting pieces of information. One piece of information that stands out is the average evaluated savings of homes with zonal systems and supplemental heating equipment. This average evaluated savings of 49 kWh annually and 3% realization rate indicates that little efficiency benefits are being realized in these homes. It is worth noting that the sample size is small and the precision is very low because of that, as is illustrated by the very wide confidence interval. With this low precision, this value should be considered with caution. As more years of data become available, which could improve confidence and precision through larger sample sizes, this analysis should be a prioritized sample to review again.

Outside of the evaluated savings values, another difference we see in this analysis is in the baseline electricity usage. Homes with supplemental heating equipment had an average annual baseline electricity usage of 13,636 compared to homes without supplemental heating equipment which had an average annual baseline electricity usage of 14,381 kWh. This difference of over 700 kWh shows that site-built homes without supplemental heating equipment are using more electricity. This is likely in part because they are fulfilling a larger portion of their space conditioning needs through electric equipment, though it is likely that it is also influence by other factors such as different home sizes and layouts, different behavioral characteristics, different infrastructure such as weatherization levels or other energy using equipment, or other factors.

Results by Home Size

Energy Trust offers for DHPs are not limited based on home size, resulting in a wide range of home sizes and layouts participating in DHP offers. Energy Trust also does not claim different savings values for DHP installations based on the size of home. To align with Residential program implementation practices, and to preserve sample sizes, this analysis looked at homes in groups of 500 square foot increments. Homes were grouped together if they were less than 1,000 square feet, 1,000 to 1,499 square feet, 1,500 to 1,999 square feet, and 2,000 to 2,499 square feet in area. During the analysis years of 2020 to 2022, no homes larger than 2,500 square feet installed a DHP with Energy Trust.

Homes that were smaller than 1,000 square feet in area that participated in a DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **1,360 kWh** (±525 kWh) or 12% of whole home baseline electricity usage. After attrition there were 409 households available for this analysis with a mean baseline electricity usage of 11,404 kWh per year. The evaluated savings equate to a realization rate of 58% of the mean claimed savings of 2,350 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 14.

Homes that were between 1,000 and 1,499 square feet in area that participated in a DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **1,080 kWh** (±390 kWh) or 8% of whole home baseline electricity usage. After attrition there were 966 households available for this analysis with a mean baseline electricity usage of 13,575 kWh per year. The evaluated savings equate to a realization rate of 47% of the mean claimed savings of 2,299 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 14.

Homes that were between 1,500 and 1,999 square feet in area that participated in a DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **888 kWh** (±719 kWh) or 6% of whole home baseline electricity usage. After attrition there were 428 households available for this analysis with a mean baseline electricity usage of 15,454 kWh per year. The evaluated savings equate to a realization rate of 38% of the mean claimed savings of 2,319 kWh. This estimate has low certainty, but the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 14.

Homes that were between 2,000 and 2,499 square feet in area that participated in a DHP offer from 2020-2022 with Energy Trust had a mean evaluated savings of **1,118 kWh** (±1,200 kWh) or 7% of whole home baseline electricity usage. After attrition there were 157 households available for this analysis with a mean baseline electricity usage of 16,827 kWh per year. The evaluated savings equate to a realization rate of 49% of the mean claimed savings of 2,291 kWh. This estimate has very low certainty, and the claimed savings value falls inside the bounds of the 90% confidence interval, as shown in Figure 14.

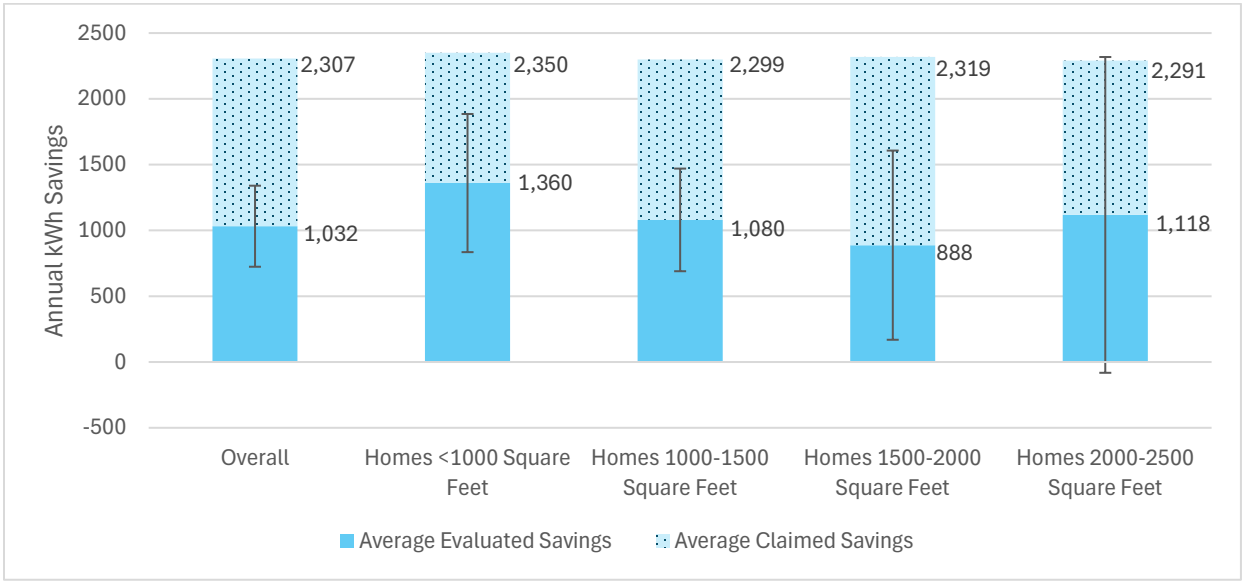


Figure 14 - Home Size (Square Feet)

The first pattern to note across these different home size brackets is the evaluated savings trend. Similar to many of these analyses, caution should be used in attributing differences to these results. While the average evaluated savings estimates are different, none of them are statistically significant from one another and contain a large amount of overlap in their confidence intervals. With this in mind, we can still see that the smallest homes have the highest average evaluated savings, and homes between 1,500 and 1,999 square feet have the lowest evaluated savings. The overall trendline of the mean evaluated savings of each bin indicates a few things. The first is that smaller homes are likely realizing more savings. This may be due to physical patterns of the homes and behavioral patterns of the residents of these homes. Some of these influences may include things analyzed elsewhere in this report, such as the number of indoor units or the type of heating system replaced. On the other hand, the largest homes in the sample also had higher mean evaluated savings than the middle two bins, though there is very low certainty in that estimate. One of the things driving this result could be the available heating load in the baseline that the DHP could offset.

In addition to this evaluated savings trend, these bins of home sizes saw significant increase in baseline electricity usage in each step up in size. Between each of the smallest three categories this difference amounted to roughly 2,000 kWh per bin, with a slightly smaller step between the largest two categories of 1,400 kWh. This upward trend indicates that home size has a strong correlation with baseline electricity usage and could, in future research, be used as an adjustment factor to help determine the baseline heating and cooling load a home might have that could be displaced by a DHP.

Results in the 'Ideal' Scenario

In addition to all of the above results that analyzed one or two parameters of interest, we tested an 'ideal' DHP installation scenario. This ideal scenario controlled for much more than just one or two parameters and allows us to test some of the assumptions that are used to determine claimed savings values. To preserve some level of significance and sample sizes, this ideal scenario does not include all of the possible parameters that could have been chosen, but includes those that are more significant in the current measure savings claim methodology. The full list of parameters applied to this analysis are a DHP that is:

- Replacing a zonal heating system.
- In a home that does not include supplemental heating equipment in its baseline conditions.
- Is in a site-built home.
- Is in heating zone one.
- Is installed with a single indoor unit.

Homes that participated in a DHP offer from 2022 with Energy Trust within these 'ideal' scenario parameters had a mean evaluated savings of **1,087 kWh** (±1,082 kWh) or 8% of whole home baseline electricity usage. After attrition there were 135 households available for this analysis with a mean baseline electricity usage of 13,477 kWh per year. The evaluated savings equate to a realization rate of 49% of the mean claimed savings of 2,228 kWh. This estimate has low certainty, but the claimed savings value falls just outside the bounds of the 90% confidence interval, as shown in Figure 15.

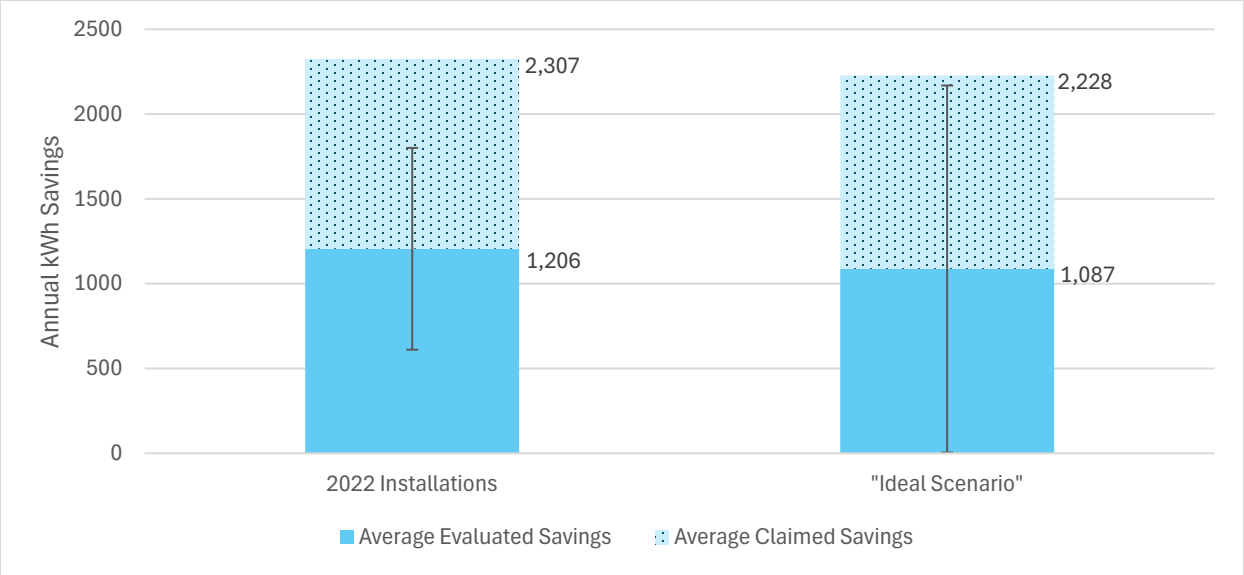


Figure 15 - 'Ideal' Scenario

Despite controlling a range of variables in this analysis, the mean evaluated savings value is very close to our 2022 overall sample value and is statistically indistinguishable from it. With the small sample size available for this analysis we are much less certain of the mean, as seen in our 90% confidence interval width, but the point estimate is quite similar. This lack of difference suggests that there are additional drivers behind these evaluated savings values that Energy Trust is not currently capturing and accounting for both in our savings claims and in our in-field installations. Significant to note is this small sample size. The Residential program has worked to attempt to target these types of installations in market rate offers through the measure design and program implementation process. However, through 2022 these ideal scenarios still make up less than a fifth of the total installations available for this analysis. As the Residential program continues to install more DHPs that fit into this ideal scenario, this result should be revisited to assess this ideal circumstance with more sites available for analysis.

Results in Homes without Natural Gas Service

Energy Trust is a fuel-neutral organization and does not encourage customers to select one fuel over another or switch from one fuel to another. DHP measures offered by Energy Trust are explicitly not offered to homes that use a natural gas furnace or other natural gas-powered heating systems to condition their spaces. However, as found in the 2019 Cadmus DHP study, participants in Energy Trust DHP offers do occasionally have central gas systems as their primary baseline heating equipment or have isolated gas systems (i.e., a gas fireplace) as their primary baseline heating equipment. While this information was not captured in DHP incentive applications or other forms, especially in the more frequent case of gas fireplaces, we do capture and store if a home has a gas utility connection. For this analysis, we removed all sites that had gas service to remove any that may be using natural gas as a primary or supplemental baseline heating system.

Homes that participated in a DHP offer from 2020-2022 with Energy Trust and did not have a gas utility connection had a mean evaluated savings of **1,121 kWh** (±329 kWh) or 8% of whole home baseline electricity usage. After attrition there were 1,754 households available for this analysis with a mean baseline electricity usage of 14,342 kWh per year. The evaluated savings equate to a realization rate of

48% of the mean claimed savings of 2,312 kWh. This estimate has moderate certainty, and the claimed savings value falls outside the bounds of the 90% confidence interval, as shown in Figure 16.

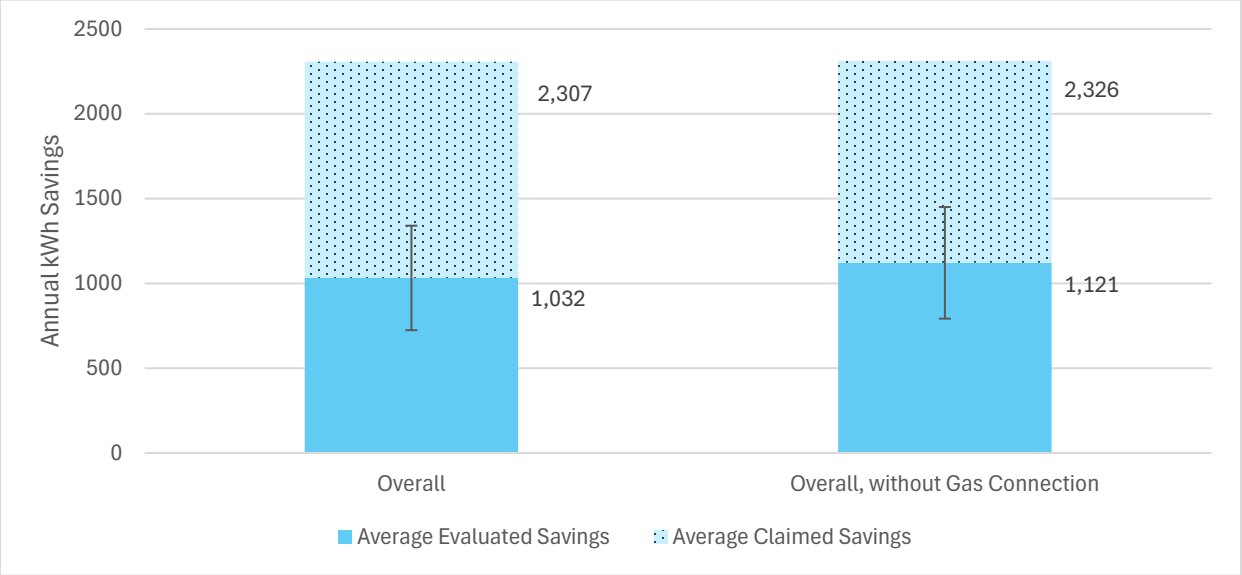


Figure 16 - Natural Gas Connections

When removing all sites with natural gas utility connections from the overall sample of DHP installations, roughly 300 sites are removed from the sample. This results in an increase of about 90 kWh in mean evaluated savings. This difference is well within the 90% confidence intervals for both of these estimates, and they are statistically indistinguishable from one another.

The baseline electricity usage in homes without natural gas utility connections is roughly 400 kWh higher than in the broader sample. This difference is much smaller than the heating load of a home, which results in limited utility from this analysis. With this small of a difference, it is likely that many of these participating homes within the Overall sample that did have natural gas service are not using it for all of or even a signification portion of their space conditioning needs. Without further data collection and with this similar of estimates and confidence intervals it is difficult to indicate any real difference in this sample of homes without gas connections from the overall sample.

Findings & Recommendations

Results of this DHP billing analysis found that DHP installations between 2020 and 2022 had an overall mean evaluated savings realization rate of 45% of claimed savings values. While less than half of claimed savings, this result did show an improvement over installations that took place between 2017 and 2019 which had an evaluated savings realization rate of 33% of claimed savings. This improvement indicates that the Residential program's changes made in response to the 2019 Cadmus DHP study have increased the savings realized by DHPs, but also indicates that there is still room for improvement.

Several subsets of the sample of 2020 to 2022 DHP installations had evaluated savings and realization rates above or below this overall finding. While these individual subsets can indicate a general relationship between the variable(s) of interest and the evaluated savings it is important to note that **only one of the individual samples were statistically different from the overall evaluated savings:** the manufactured home sample. This finding is crucial to contextualizing and understanding these results. Overall evaluated

savings are roughly half of claimed savings, and while there are several variables and scenarios which may indicate higher or lower savings through their average evaluated savings point estimates, we are unable to say for sure that the analyzed variable(s) are responsible for the differences in those savings within the samples available to us for analysis.

As mentioned throughout this analysis, there are several limitations of the REBA tool and standalone billing analysis without additional customer data collection. This restricts our ability to understand what is driving these results. Many factors that are not collected by Energy Trust and stored in our database for analysis can impact how an installed DHP performs in practice. Two of these factors, supplemental heating equipment and location of the first indoor unit in a previously conditioned primary living space, were previously identified in the 2019 Cadmus DHP study, addressed by the program, and incorporated through the measure development and program implementation process. This has resulted in improved overall realization rates as seen in this analysis. This indicates that additional research into identifying the level of impact of other limiting factors, as well as implementing considerations for these factors into DHP offers and field installations could result in higher realized savings. Factors of interest from the 2019 Cadmus DHP study and these results that could be further researched, catalogued, and implemented in Energy Trust DHP measures include:

- The installation of indoor units beyond the first in previously unconditioned spaces.
- The continued use of non-efficient heating and cooling systems alongside the DHP.
- Increased or decreased thermal comfort via DHP use from baseline conditions.
- Customer motivations for installing DHPs as purely cooling equipment.

In addition to these strategies, additional research could be done to further evaluate the savings of DHP measures. As discussed throughout the report, certain characteristics of customers and their homes are not directly matched in this billing analysis due to incomplete information about non-participants used to construct comparison groups. Additional research, which is accompanied by the purchase of third-party datasets, participant and non-participant surveys, or that utilizes a future participant comparison group approach could help Energy Trust understand the impacts of things like income, number of occupants, home layout, and other characteristics which may be impacting the evaluated savings of DHP installations. Additional research could also take the shape of future REBA analyses as sample sizes continue to increase. Especially in cases where supplemental heating equipment was a variable of interest, we were limited in this analysis to DHP installations that occurred exclusively in the year 2022. As more installations from 2023 and beyond become available for analysis that may allow us to ascertain the impact of supplemental heating equipment with more certainty.

DHPs will continue to be an important option for customers looking to replace, update, or upgrade space conditioning systems in their homes. This is especially true as Federal incentives, tax rebates, and other programs continue to enter the marketplace to promote heat pumps. While these results suggest that DHP savings are lower than currently claimed by Energy Trust, continued evaluation of this technology should be conducted to allow Energy Trust to engage with this technology moving forward. These results should be revisited as the No-Cost Pilot evaluation results and other future follow-up studies are completed to further inform the savings of DHPs in real-world conditions.

Appendix A: REBA Output Results

The following pages include the REBA output summaries, which include the following information:

- A summary of methods.
- An attrition table.
- Model output values.
- Graphical comparison of pre-installation monthly energy use between treatment and comparison groups.
- Graphical comparison of post-installation differences in mean energy use and energy use distribution of treatment and comparison groups.
- Geographic distribution of treatment and comparison sites.
- Model fit statistics.
- Individual list of measures included in the analysis.

The output summaries are provided in the following order:

- Overall
- Overall (2017-2019)
- Overall, 2022 Only
- Overall, with Supplemental Heating Equipment
- Overall, without Supplemental Heating Equipment
- Market-Rate Offers
- Income-Qualified Offers
- Site-Built Homes
- Site-Built Homes, 2022 Only
- Site-Built Homes with Supplemental Heating Equipment
- Site-Built Homes without Supplemental Heating Equipment
- Manufactured Homes
- Heating Zone 1
- Heating Zone 2/3
- 1 Indoor Unit
- 2 Indoor Units
- Many Indoor Units
- Replacing an Electric Forced Air Furnace (eFAF)
- Replacing a Zonal Heating System
- Replacing a Zonal Heating System, 2022 Only
- Replacing a Zonal Heating System with Supplemental Heating Equipment
- Replacing a Zonal Heating System, without Supplemental Heating Equipment
- Homes <1,000 Square Feet
- Homes 1,000-1,499 Square Feet
- Homes 1,500-1,999 Square Feet
- Homes 2,000-2,499 Square Feet
- ‘Ideal’ Scenario
- Overall, Without Natural Gas Service

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** .

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,257	Initial list of all participants
4,257	Total participants with no other measures installed
4,257	Total participants filtered to selected measure combinations
4,257	Total participants filtered to selected measure attributes
4,015	Treatment sites matched to consumption data
3,088	Treatment sites with normalized consumption data
2,215	Treatment sites with R2 > 0.5
2,199	Treatment sites with full pre & post years of consumption
2,155	Treatment sites after removing top and bottom 1%
2,054	Final model treatment sites before filters
2,054	Final model treatment sites with filters

Expected Savings

2,307 kWh

Estimated Savings

1,032 kWh

Low Estimate

724 kWh

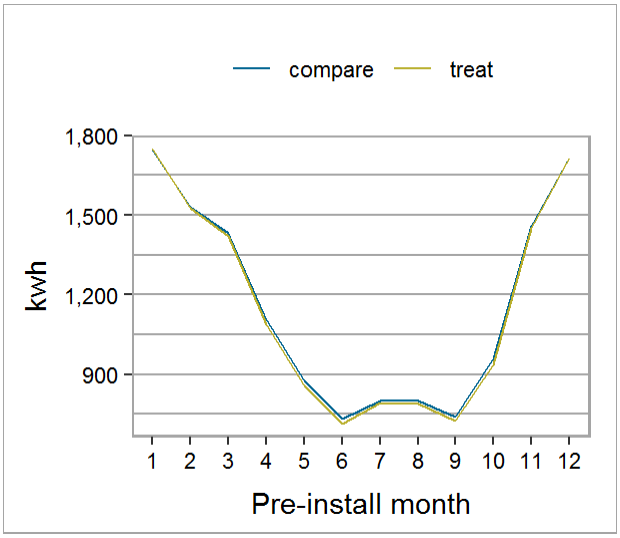
High Estimate

1,339 kWh

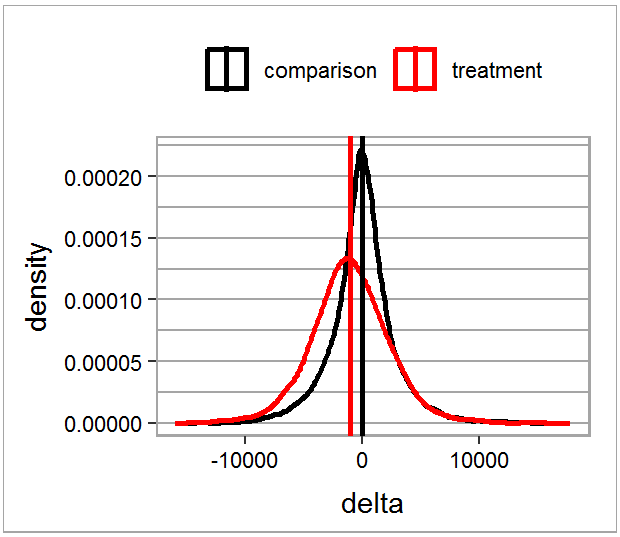
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,917	40	344	0	13,850	13,984
sample_period	−13	57	0	1	−107	82
sample_group	−153	132	−1	0	−371	64
sample_period:sample_group	**−1,032**	**187**	**−6**	**0**	**−1,339**	**−724**

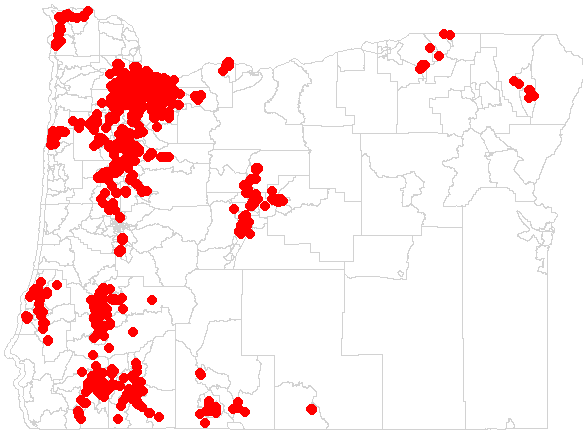
Baseline: Treatment and Comparison Group Mean Montly Consumption



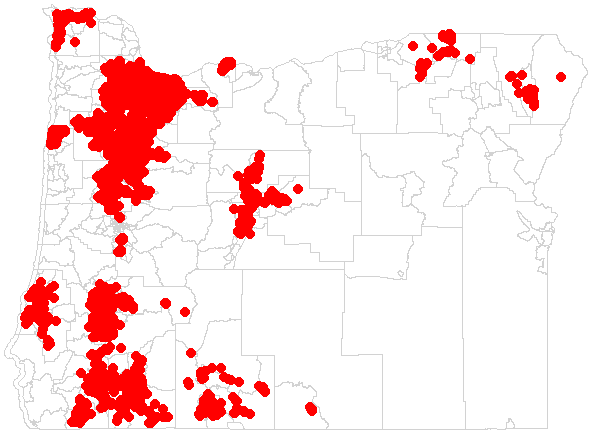
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0020921

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2017 and 2019

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2017 to 2019** .

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
5,619	Initial list of all participants
5,618	Total participants with no other measures installed
5,603	Total participants filtered to selected measure combinations
5,603	Total participants filtered to selected measure attributes
5,306	Treatment sites matched to consumption data
3,640	Treatment sites with normalized consumption data
2,526	Treatment sites with R2 > 0.5
2,478	Treatment sites with full pre & post years of consumption
2,428	Treatment sites after removing top and bottom 1%
2,318	Final model treatment sites before filters
2,318	Final model treatment sites with filters

Expected Savings

2,222 kWh

Estimated Savings

726 kWh

Low Estimate

421 kWh

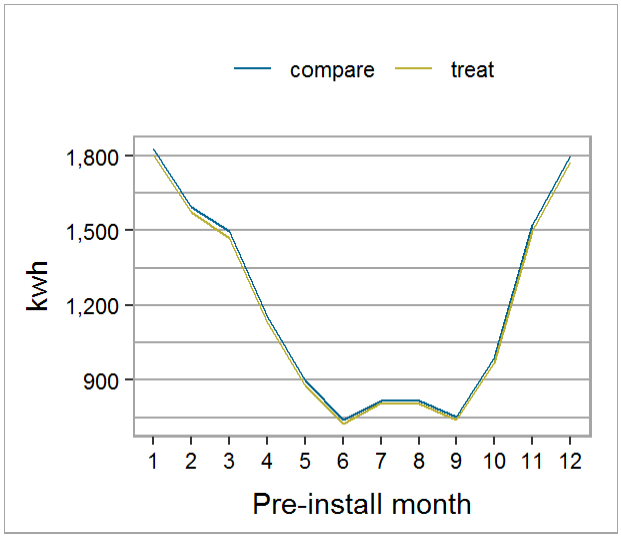
High Estimate

1,031 kWh

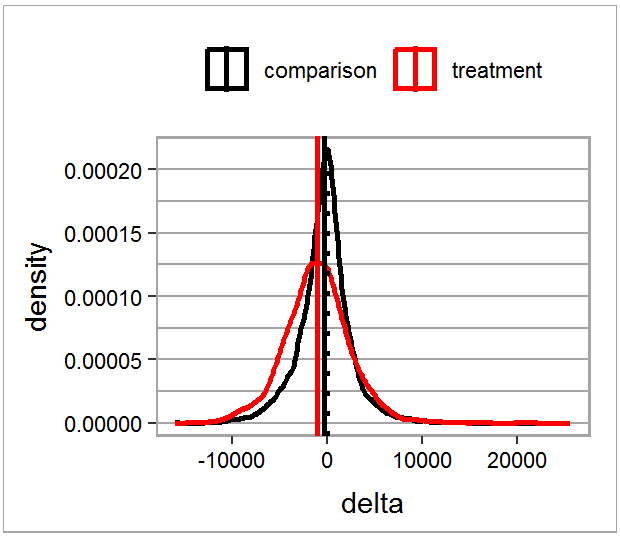
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,510	41	350	0	14,442	14,578
sample_period	−343	59	−6	0	−440	−247
sample_group	−333	131	−3	0	−548	−117
sample_period:sample_group	**−726**	**185**	**−4**	**0**	**−1,031**	**−421**

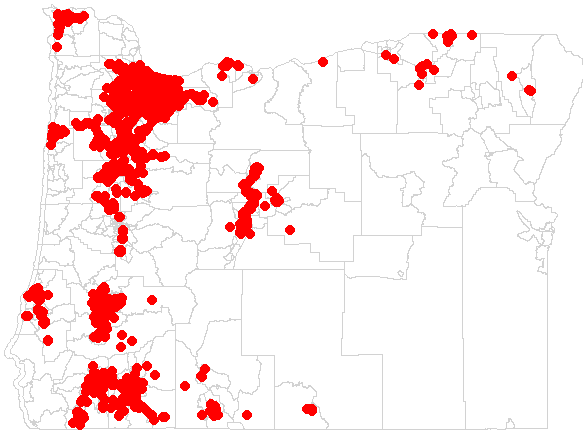
Baseline: Treatment and Comparison Group Mean Montly Consumption



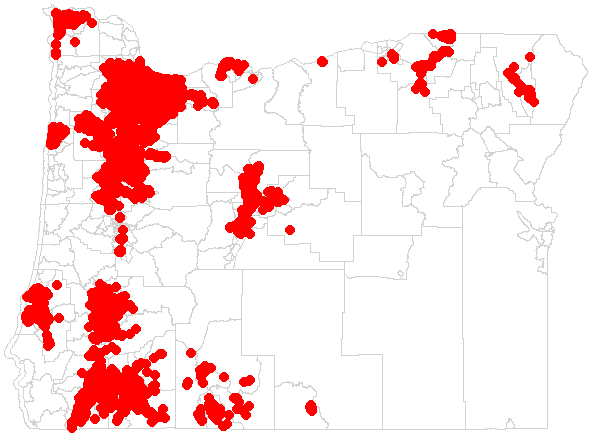
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0029698

Model p-value

0

List of Individual Measures in Analysis
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 2
DHP for Manufactured Homes Replacing eFAF, Zone 1
DHP for Manufactured Homes Replacing eFAF, Zone 2
DHP for Manufactured Homes w/ Zonal Heat, Zone 1
DHP for Manufactured Homes w/ Zonal Heat, Zone 2
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR w/ Ele Zonal Heat, Zone 1
DHP for SWR w/ Ele Zonal Heat, Zone 2
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 2
SWR DHP for XMH w/ Zonal Heat, Zone 1
SWR DHP for XMH w/ Zonal Heat, Zone 2
SWR DHP for XMH w/ eFAF, Zone 1
SWR DHP for XMH w/ eFAF, Zone 2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** .

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
1,446	Initial list of all participants
1,446	Total participants with no other measures installed
1,446	Total participants filtered to selected measure combinations
1,446	Total participants filtered to selected measure attributes
1,376	Treatment sites matched to consumption data
1,132	Treatment sites with normalized consumption data
857	Treatment sites with R2 > 0.5
853	Treatment sites with full pre & post years of consumption
835	Treatment sites after removing top and bottom 1%
792	Final model treatment sites before filters
792	Final model treatment sites with filters

Expected Savings

2,326 kWh

Estimated Savings

1,206 kWh

Low Estimate

611 kWh

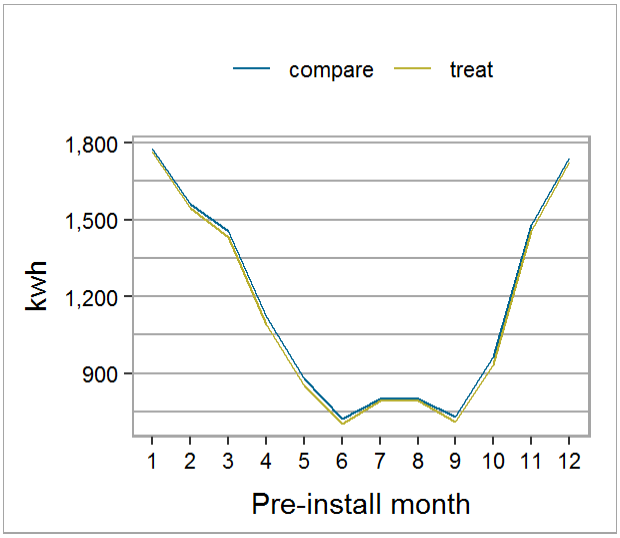
High Estimate

1,801 kWh

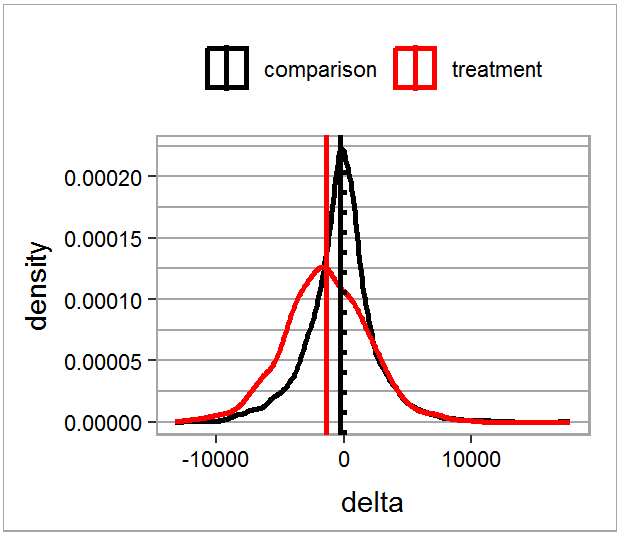
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	12,516	75	168	0	12,393	12,639
sample_period	−183	106	−2	0	−357	−9
sample_group	1,286	256	5	0	865	1,707
sample_period:sample_group	**−1,206**	**362**	**−3**	**0**	**−1,801**	**−611**

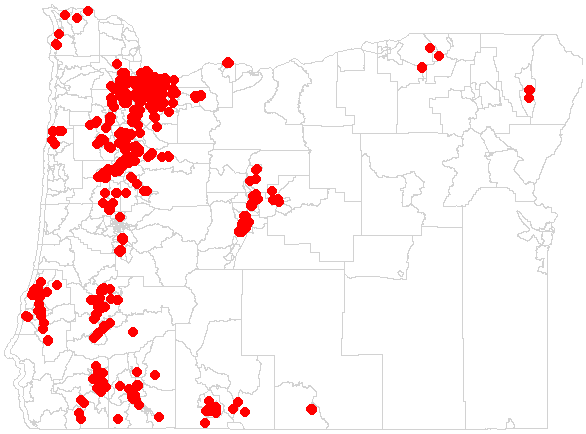
Baseline: Treatment and Comparison Group Mean Montly Consumption



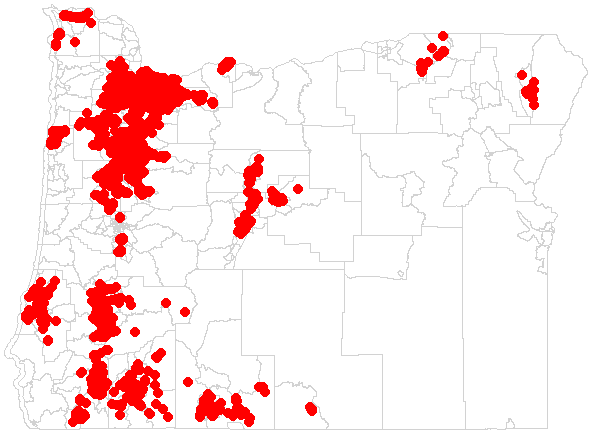
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0019989

Model p-value

0.0000003

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2

List of Individual Measures in Analysis
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** . Measures were included that shared the following characteristic(s): supplementalheatingequipment is ‘Wood Stove’,‘Pellet Stove’,‘Gas Fireplace’,‘Other’,‘Propane Heater’,‘Oil Heater’,‘Gas Stove’

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
1,446	Initial list of all participants
1,446	Total participants with no other measures installed
1,446	Total participants filtered to selected measure combinations
304	Total participants filtered to selected measure attributes
290	Treatment sites matched to consumption data
249	Treatment sites with normalized consumption data
172	Treatment sites with R2 > 0.5
172	Treatment sites with full pre & post years of consumption
168	Treatment sites after removing top and bottom 1%
159	Final model treatment sites before filters
159	Final model treatment sites with filters

Expected Savings

1,485 kWh

Estimated Savings

320 kWh

Low Estimate

-779 kWh

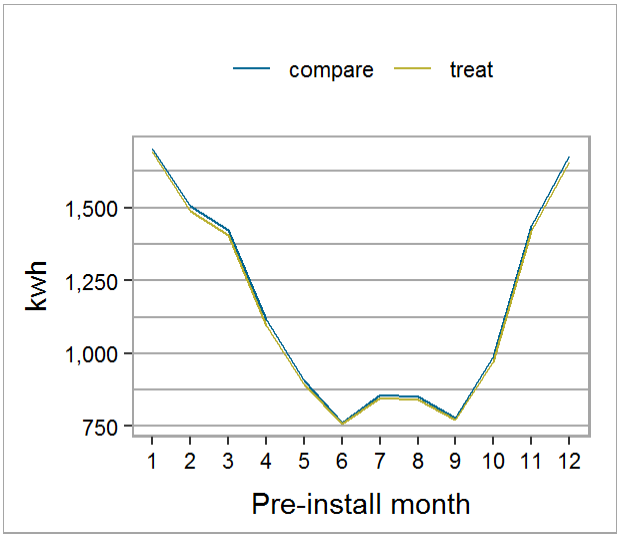
High Estimate

1,419 kWh

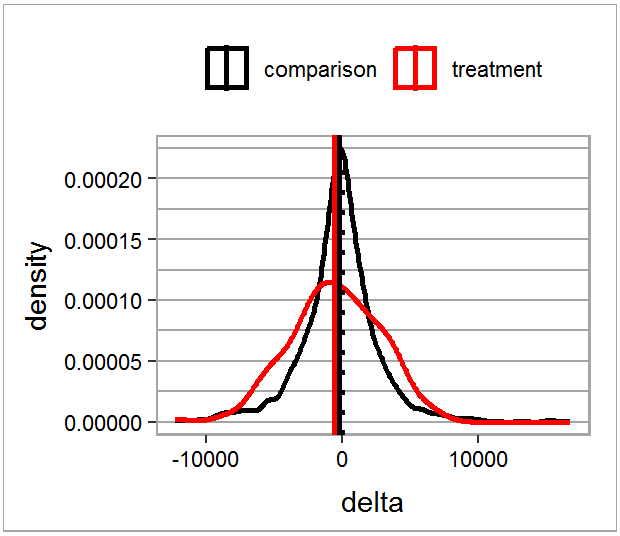
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,006	153	92	0	13,754	14,257
sample_period	−218	216	−1	0	−574	138
sample_group	−161	472	0	1	−938	616
sample_period:sample_group	**−320**	**668**	**0**	**1**	**−1,419**	**779**

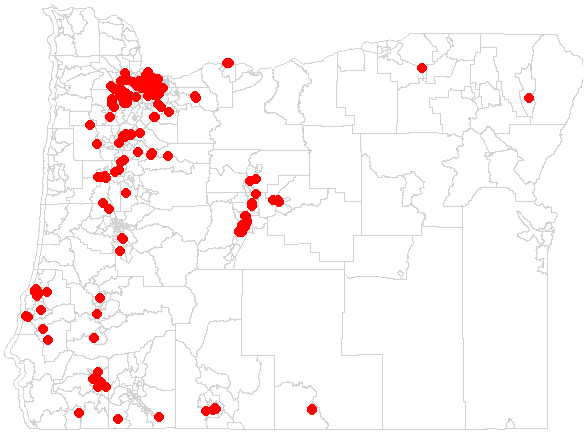
Baseline: Treatment and Comparison Group Mean Montly Consumption



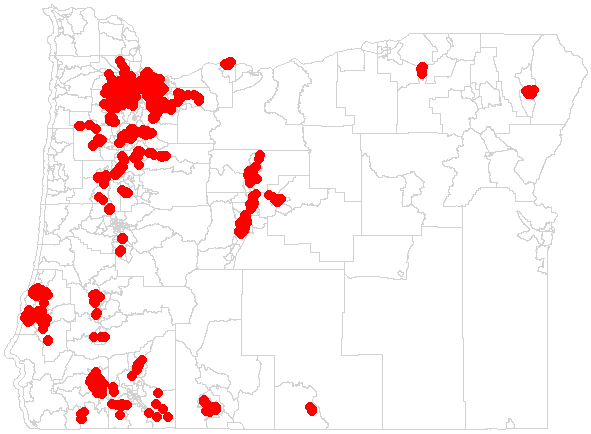
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

-0.0001105

Model p-value

0.4461897

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2

List of Individual Measures in Analysis
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** . Measures were included that shared the following characteristic(s): supplementalheatingequipment is 'None'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
1,190	Initial list of all participants
1,190	Total participants with no other measures installed
1,190	Total participants filtered to selected measure combinations
1,134	Total participants filtered to selected measure attributes
1,079	Treatment sites matched to consumption data
878	Treatment sites with normalized consumption data
681	Treatment sites with R2 > 0.5
677	Treatment sites with full pre & post years of consumption
663	Treatment sites after removing top and bottom 1%
628	Final model treatment sites before filters
628	Final model treatment sites with filters

Expected Savings

2,373 kWh

Estimated Savings

1,494 kWh

Low Estimate

824 kWh

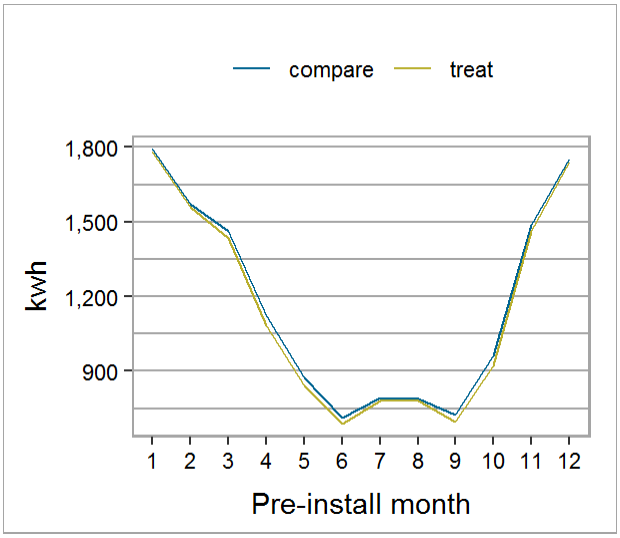
High Estimate

2,164 kWh

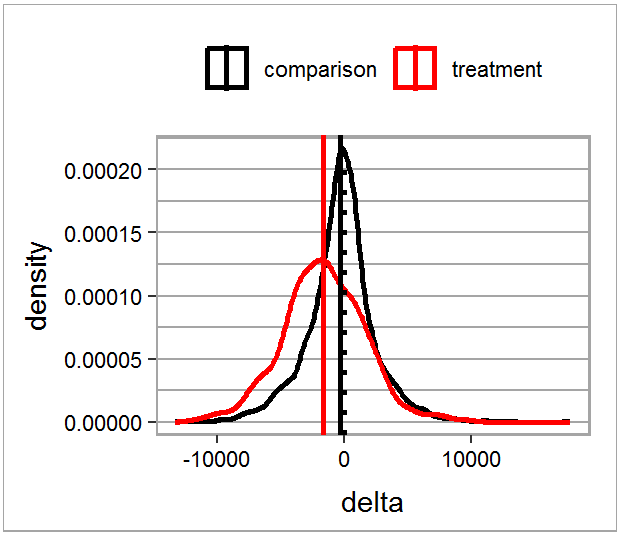
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	12,368	83	149	0	12,232	12,505
sample_period	−109	117	−1	0	−302	84
sample_group	1,407	288	5	0	934	1,881
sample_period:sample_group	**−1,494**	**407**	**−4**	**0**	**−2,164**	**−824**

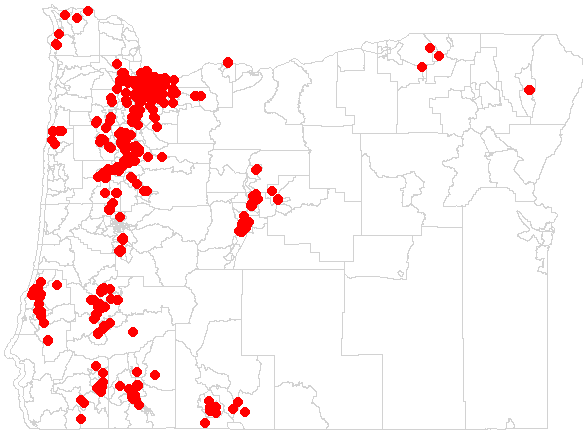
Baseline: Treatment and Comparison Group Mean Montly Consumption



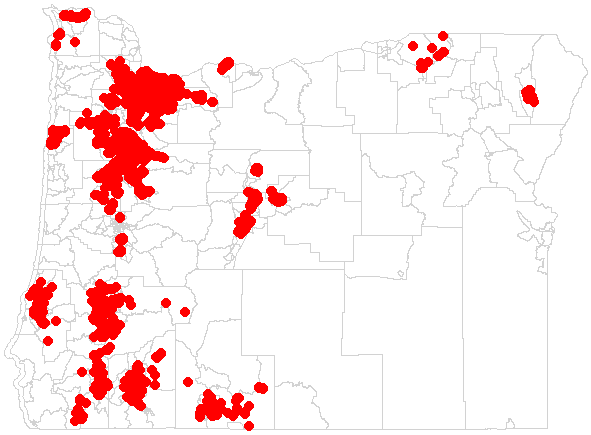
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0020892

Model p-value

0.0000033

List of Individual Measures in Analysis

CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 2
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 2 Regional Promotion
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 2
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** .

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
2,356	Initial list of all participants
2,356	Total participants with no other measures installed
2,355	Total participants filtered to selected measure combinations
2,355	Total participants filtered to selected measure attributes
2,223	Treatment sites matched to consumption data
1,763	Treatment sites with normalized consumption data
1,265	Treatment sites with R2 > 0.5
1,257	Treatment sites with full pre & post years of consumption
1,231	Treatment sites after removing top and bottom 1%
1,181	Final model treatment sites before filters
1,181	Final model treatment sites with filters

Expected Savings

2,277 kWh

Estimated Savings

798 kWh

Low Estimate

389 kWh

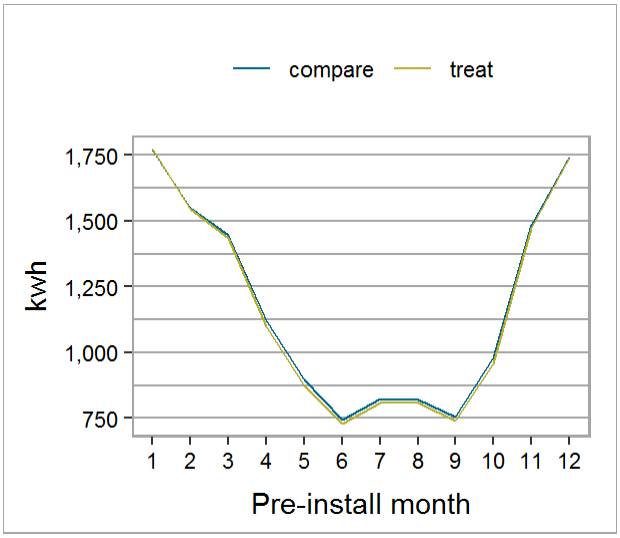
High Estimate

1,208 kWh

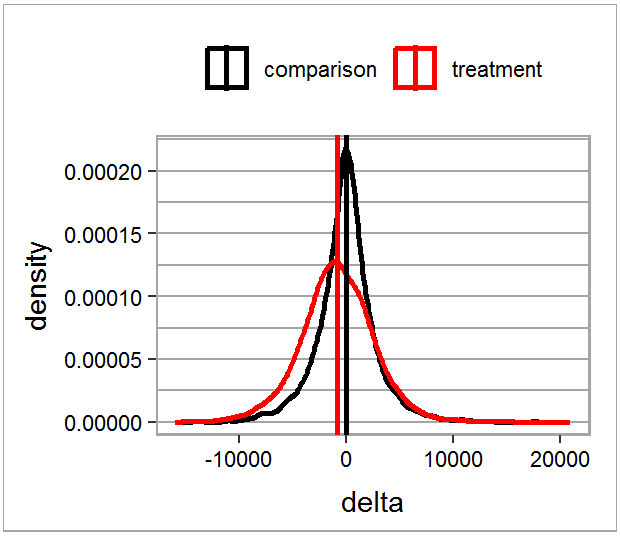
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,168	55	256	0	14,077	14,259
sample_period	−41	78	−1	1	−170	88
sample_group	−182	176	−1	0	−471	108
sample_period:sample_group	**−798**	**249**	**−3**	**0**	**−1,208**	**−389**

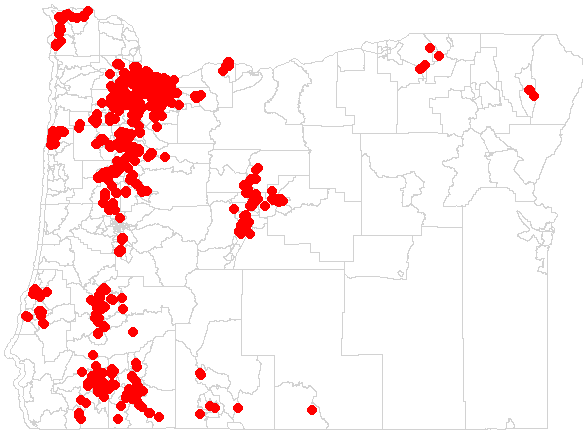
Baseline: Treatment and Comparison Group Mean Montly Consumption



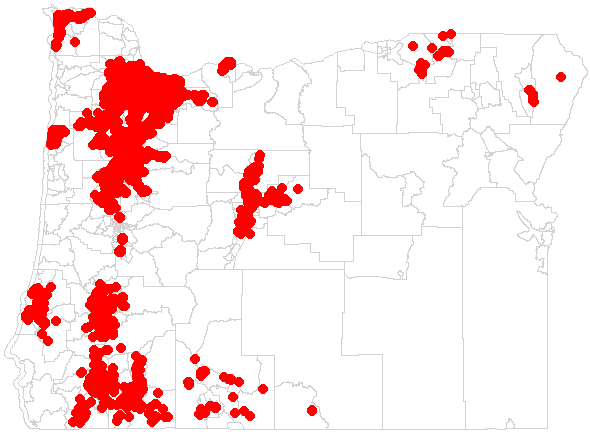
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0014027

Model p-value

0.0000001

List of Individual Measures in Analysis
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** .

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
1,017	Initial list of all participants
1,017	Total participants with no other measures installed
1,017	Total participants filtered to selected measure combinations
1,017	Total participants filtered to selected measure attributes
958	Treatment sites matched to consumption data
776	Treatment sites with normalized consumption data
584	Treatment sites with R2 > 0.5
581	Treatment sites with full pre & post years of consumption
569	Treatment sites after removing top and bottom 1%
549	Final model treatment sites before filters
549	Final model treatment sites with filters

Expected Savings

2,308 kWh

Estimated Savings

1,216 kWh

Low Estimate

648 kWh

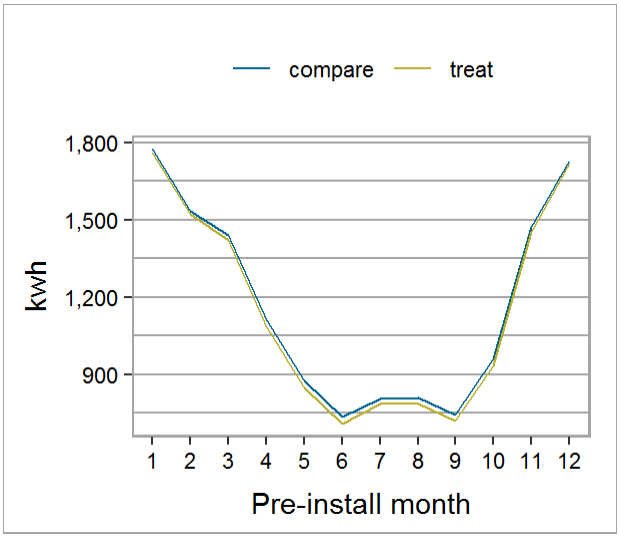
High Estimate

1,784 kWh

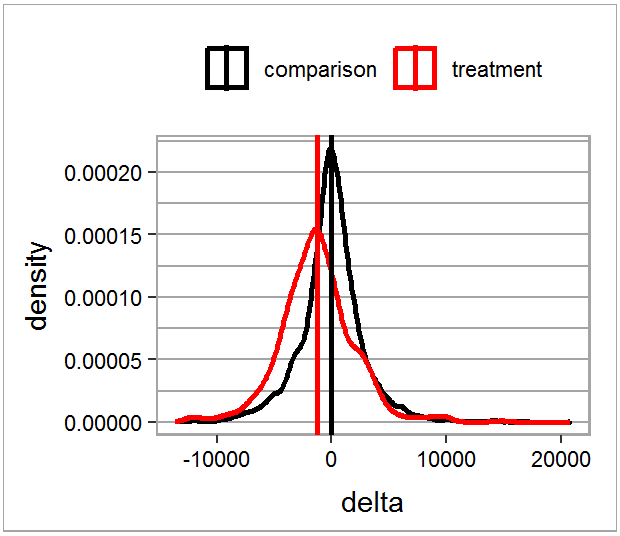
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,979	77	181	0	13,852	14,107
sample_period	−48	109	0	1	−228	132
sample_group	−239	244	−1	0	−640	163
sample_period:sample_group	**−1,216**	**345**	**−4**	**0**	**−1,784**	**−648**

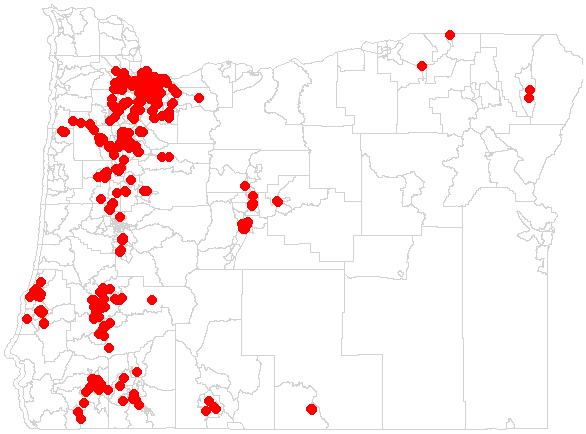
Baseline: Treatment and Comparison Group Mean Montly Consumption



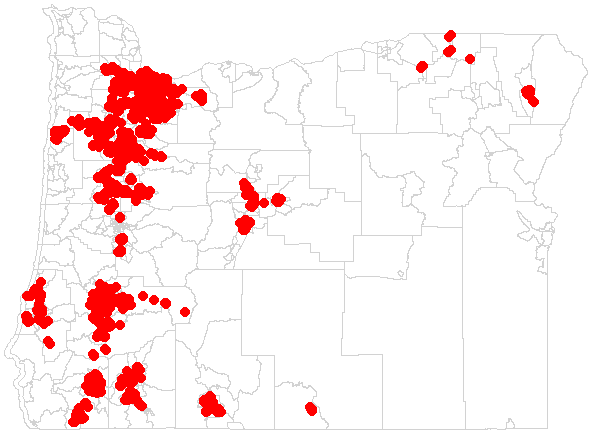
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0034541

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): MarketName is 'Site Built Home','Single Family Home'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
3,638	Initial list of all participants
3,638	Total participants with no other measures installed
3,638	Total participants filtered to selected measure combinations
3,638	Total participants filtered to selected measure attributes
3,433	Treatment sites matched to consumption data
2,685	Treatment sites with normalized consumption data
1,951	Treatment sites with R2 > 0.5
1,938	Treatment sites with full pre & post years of consumption
1,898	Treatment sites after removing top and bottom 1%
1,817	Final model treatment sites before filters
1,680	Final model treatment sites with filters

Expected Savings

2,271 kWh

Estimated Savings

918 kWh

Low Estimate

578 kWh

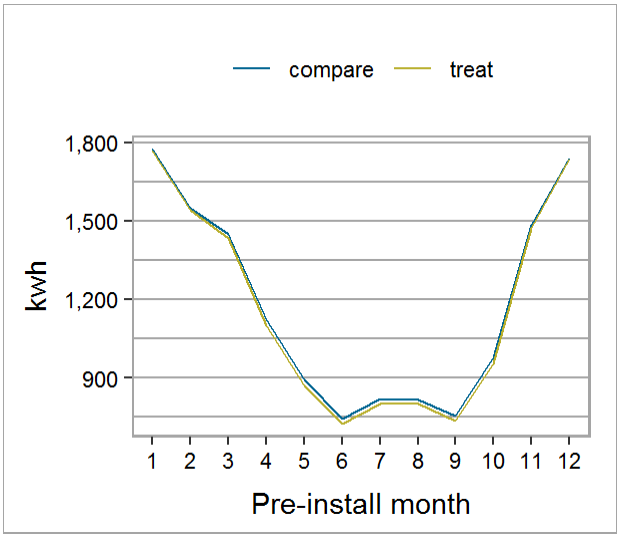
High Estimate

1,259 kWh

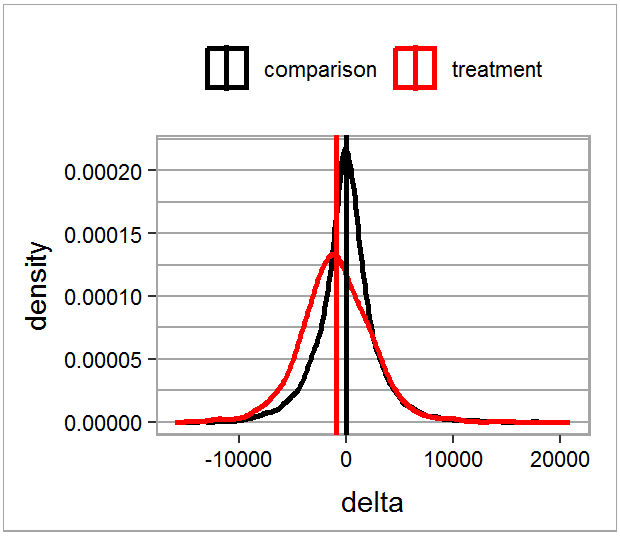
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,151	46	311	0	14,076	14,226
sample_period	−6	64	0	1	−112	100
sample_group	−213	146	−1	0	−453	27
sample_period:sample_group	**−918**	**207**	**−4**	**0**	**−1,259**	**−578**

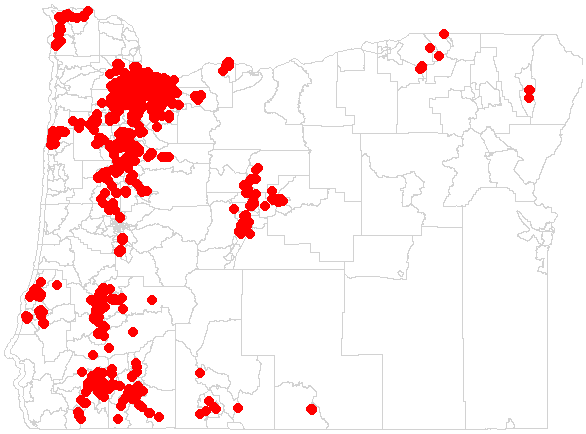
Baseline: Treatment and Comparison Group Mean Montly Consumption



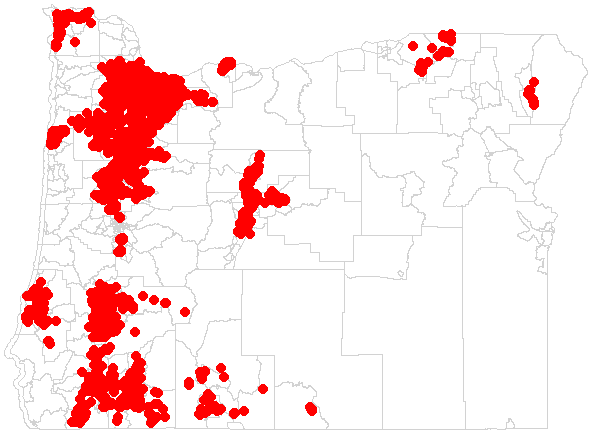
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0019144

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP w/ Ele Zonal Heat, Zone 1

List of Individual Measures in Analysis
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** in homes with the following shared characteristic(s): MarketName is 'Site Built Home','Single Family Home'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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- Baseline energy usage in the top or bottom 1 percent of treated sites
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- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
1,252	Initial list of all participants
1,252	Total participants with no other measures installed
1,252	Total participants filtered to selected measure combinations
1,252	Total participants filtered to selected measure attributes
1,190	Treatment sites matched to consumption data
985	Treatment sites with normalized consumption data
762	Treatment sites with R2 > 0.5
758	Treatment sites with full pre & post years of consumption
742	Treatment sites after removing top and bottom 1%
705	Final model treatment sites before filters
640	Final model treatment sites with filters

Expected Savings

2,244 kWh

Estimated Savings

1,003 kWh

Low Estimate

446 kWh

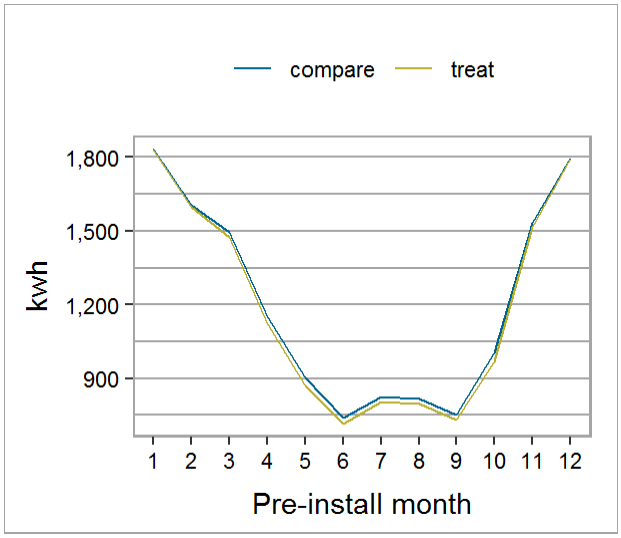
High Estimate

1,560 kWh

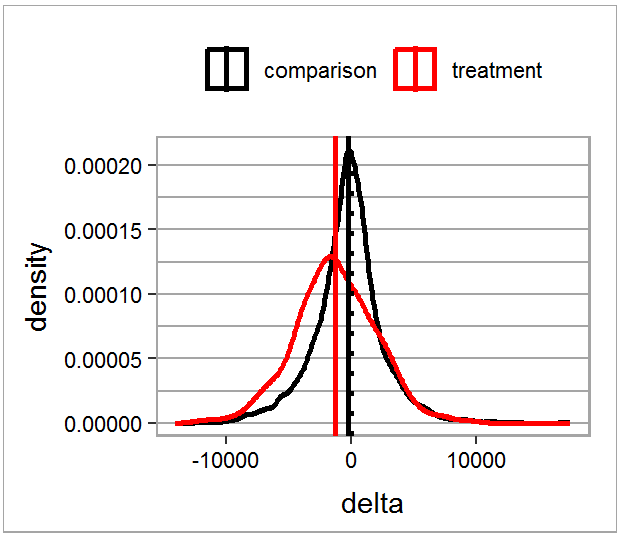
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,437	76	189	0	14,312	14,563
sample_period	−252	108	−2	0	−430	−75
sample_group	−219	239	−1	0	−613	175
sample_period:sample_group	**−1,003**	**339**	**−3**	**0**	**−1,560**	**−446**

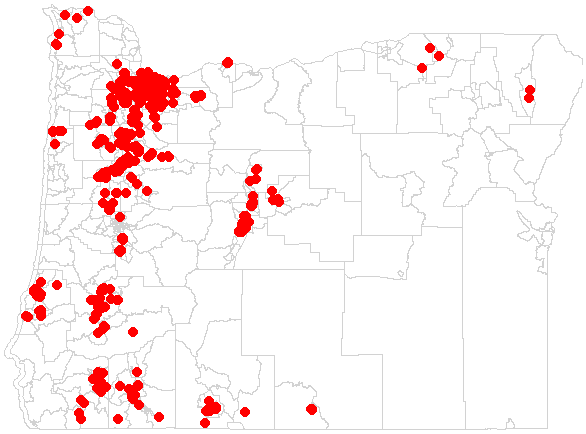
Baseline: Treatment and Comparison Group Mean Montly Consumption



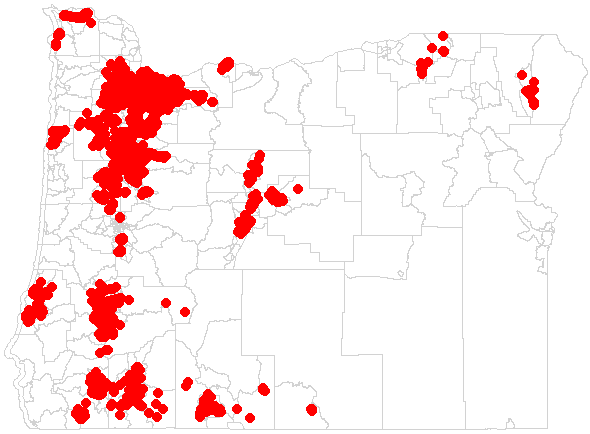
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0029181

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup

List of Individual Measures in Analysis
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** in homes with the following shared characteristic(s): MarketName is 'Site Built Home','Single Family Home'. Measures were included that shared the following characteristic(s): supplementalheatingequipment is 'Wood Stove','Pellet Stove','Gas Fireplace','Other','Propane Heater','Oil Heater','Gas Stove','Baseboard'

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- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
253	Initial list of all participants
253	Total participants with no other measures installed
253	Total participants filtered to selected measure combinations
250	Total participants filtered to selected measure attributes
241	Treatment sites matched to consumption data
206	Treatment sites with normalized consumption data
145	Treatment sites with R2 > 0.5
145	Treatment sites with full pre & post years of consumption
141	Treatment sites after removing top and bottom 1%
133	Final model treatment sites before filters
132	Final model treatment sites with filters

Expected Savings

1,452 kWh

Estimated Savings

205 kWh

Low Estimate

-1,012 kWh

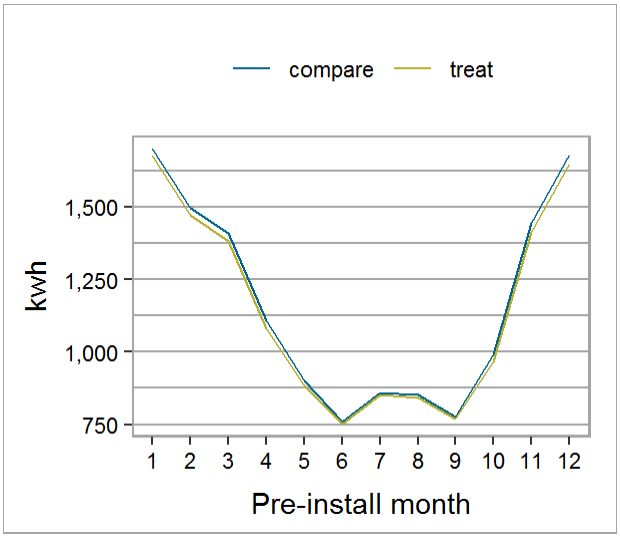
High Estimate

1,421 kWh

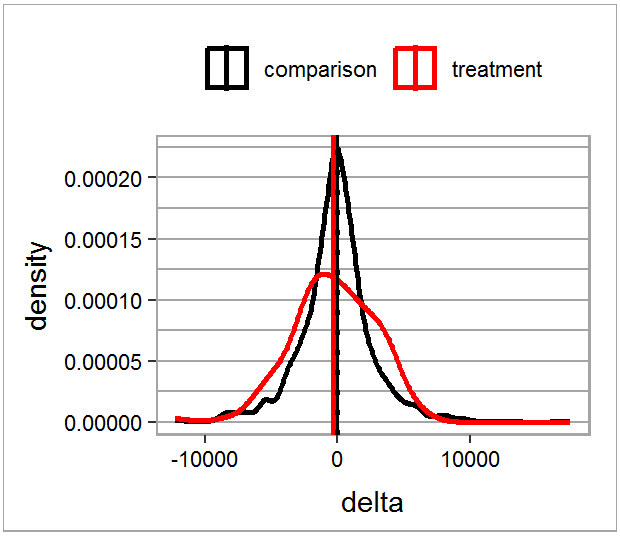
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,979	168	83	0	13,702	14,255
sample_period	−101	238	0	1	−492	290
sample_group	−248	523	0	1	−1,108	612
sample_period:sample_group	**−205**	**739**	**0**	**1**	**−1,421**	**1,012**

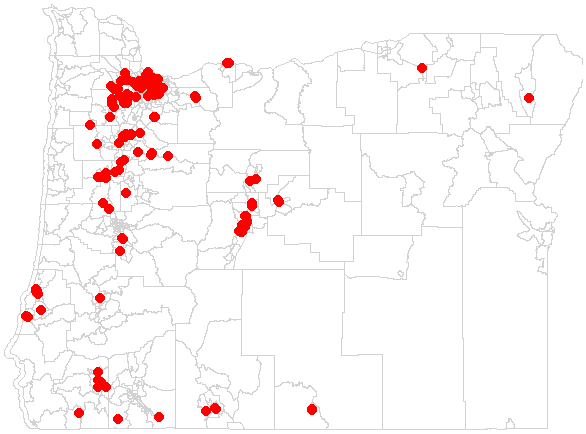
Baseline: Treatment and Comparison Group Mean Montly Consumption



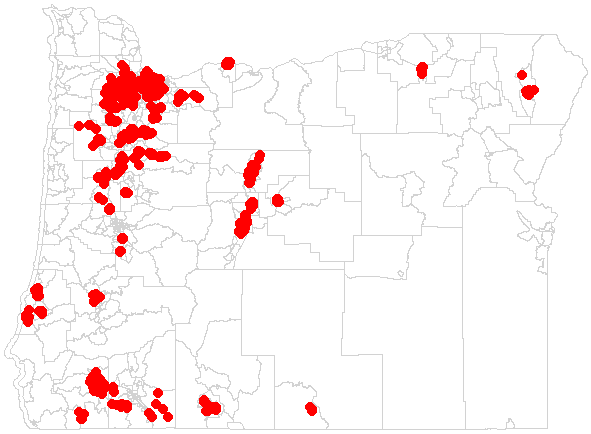
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

-0.0006769

Model p-value

0.7358907

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ1 Sup fuel

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** in homes with the following shared characteristic(s): MarketName is 'Site Built Home','Single Family Home'. Measures were included that shared the following characteristic(s): supplementalheatingequipment is 'None'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
1,026	Initial list of all participants
1,026	Total participants with no other measures installed
1,026	Total participants filtered to selected measure combinations
969	Total participants filtered to selected measure attributes
919	Treatment sites matched to consumption data
754	Treatment sites with normalized consumption data
598	Treatment sites with R2 > 0.5
594	Treatment sites with full pre & post years of consumption
582	Treatment sites after removing top and bottom 1%
553	Final model treatment sites before filters
491	Final model treatment sites with filters

Expected Savings

2,303 kWh

Estimated Savings

1,180 kWh

Low Estimate

549 kWh

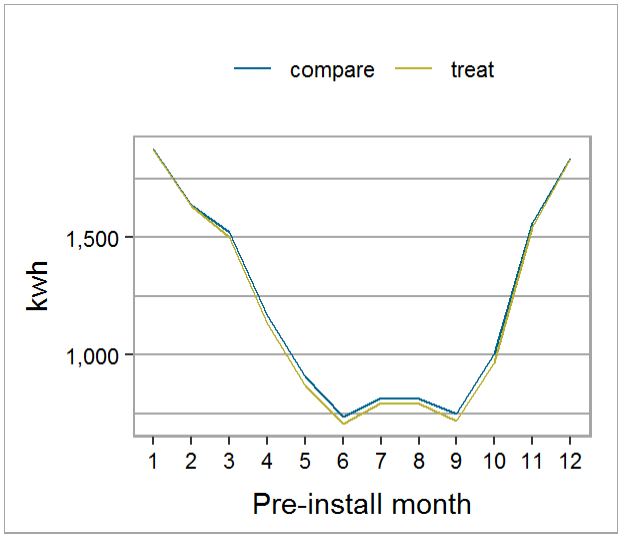
High Estimate

1,811 kWh

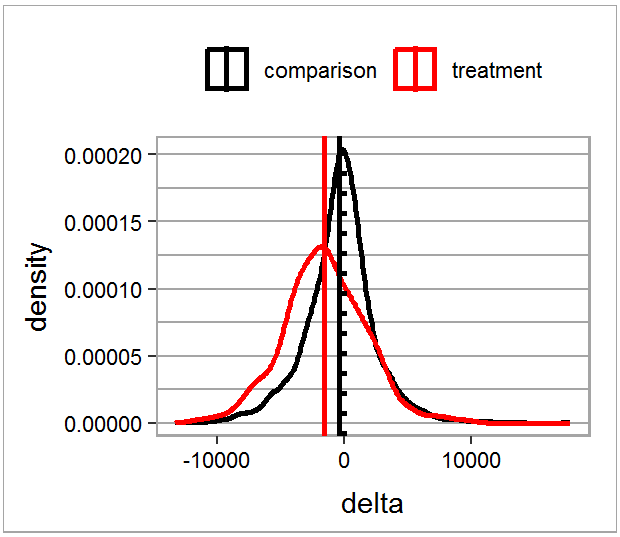
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,629	87	169	0	14,486	14,772
sample_period	−341	123	−3	0	−543	−139
sample_group	−266	271	−1	0	−712	181
sample_period:sample_group	**−1,180**	**384**	**−3**	**0**	**−1,811**	**−549**

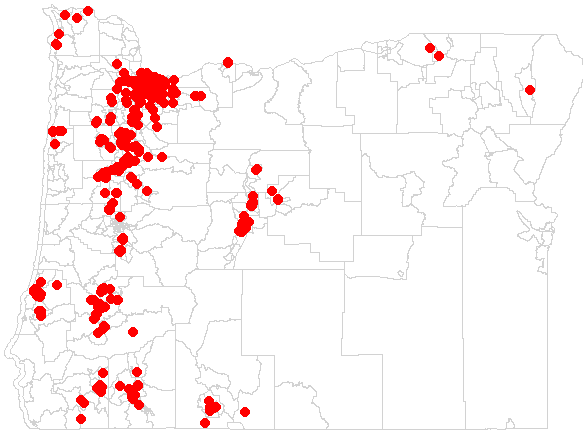
Baseline: Treatment and Comparison Group Mean Montly Consumption



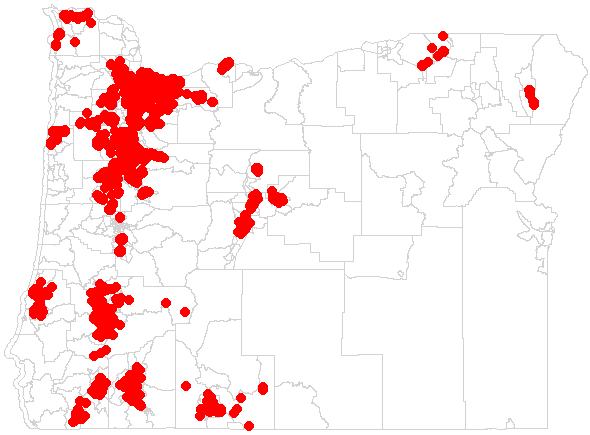
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0044485

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 2
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): MarketName is 'Manufactured Home'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,237	Initial list of all participants
4,237	Total participants with no other measures installed
4,237	Total participants filtered to selected measure combinations
4,237	Total participants filtered to selected measure attributes
3,996	Treatment sites matched to consumption data
3,079	Treatment sites with normalized consumption data
2,208	Treatment sites with R2 > 0.5
2,192	Treatment sites with full pre & post years of consumption
2,148	Treatment sites after removing top and bottom 1%
2,048	Final model treatment sites before filters
250	Final model treatment sites with filters

Expected Savings

3,335 kWh

Estimated Savings

2,084 kWh

Low Estimate

1,296 kWh

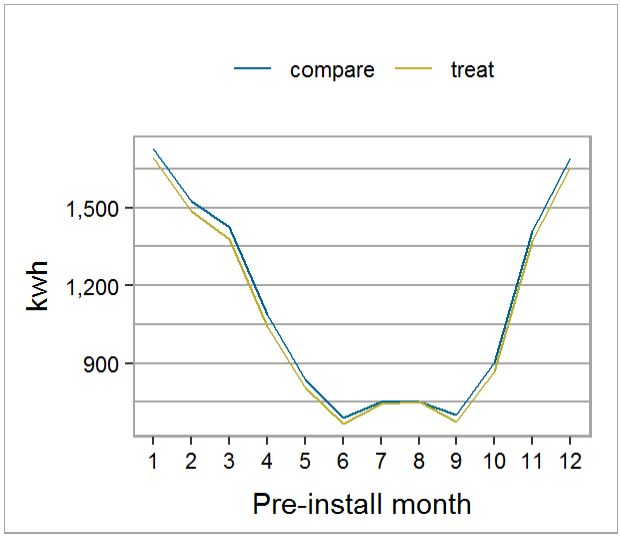
High Estimate

2,872 kWh

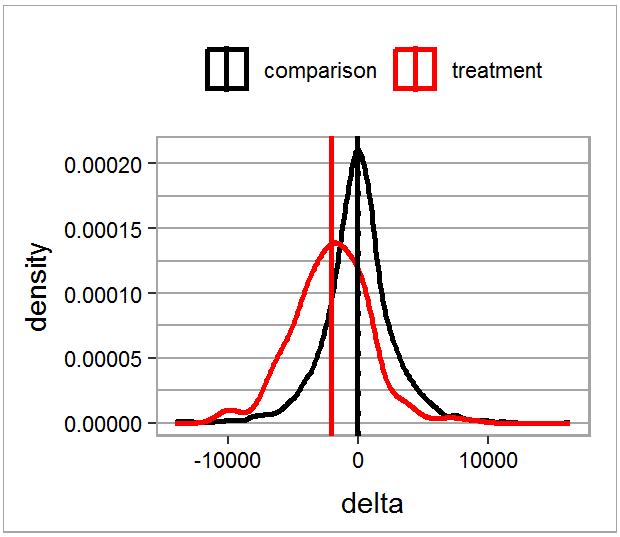
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,478	105	128	0	13,305	13,651
sample_period	−4	149	0	1	−249	240
sample_group	−342	339	−1	0	−899	215
sample_period:sample_group	**−2,084**	**479**	**−4**	**0**	**−2,872**	**−1,296**

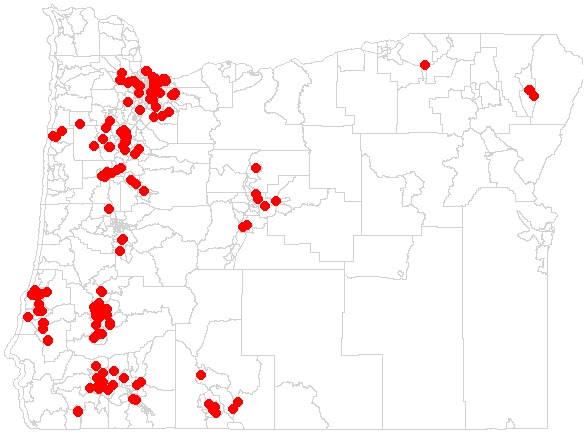
Baseline: Treatment and Comparison Group Mean Montly Consumption



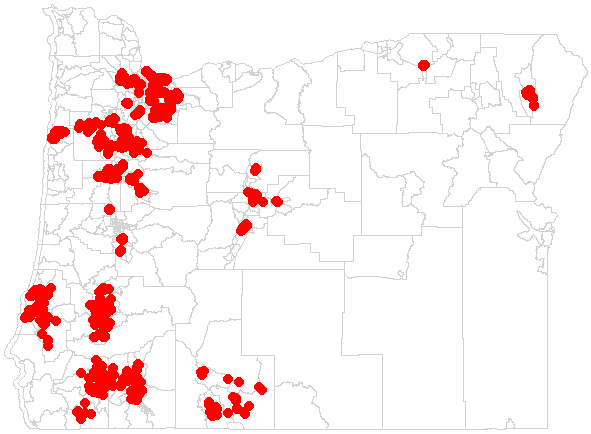
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0107548

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): HeatingZone is '1'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,257	Initial list of all participants
4,257	Total participants with no other measures installed
4,257	Total participants filtered to selected measure combinations
4,257	Total participants filtered to selected measure attributes
4,015	Treatment sites matched to consumption data
3,088	Treatment sites with normalized consumption data
2,215	Treatment sites with R2 > 0.5
2,199	Treatment sites with full pre & post years of consumption
2,155	Treatment sites after removing top and bottom 1%
2,054	Final model treatment sites before filters
1,831	Final model treatment sites with filters

Expected Savings

2,296 kWh

Estimated Savings

1,104 kWh

Low Estimate

781 kWh

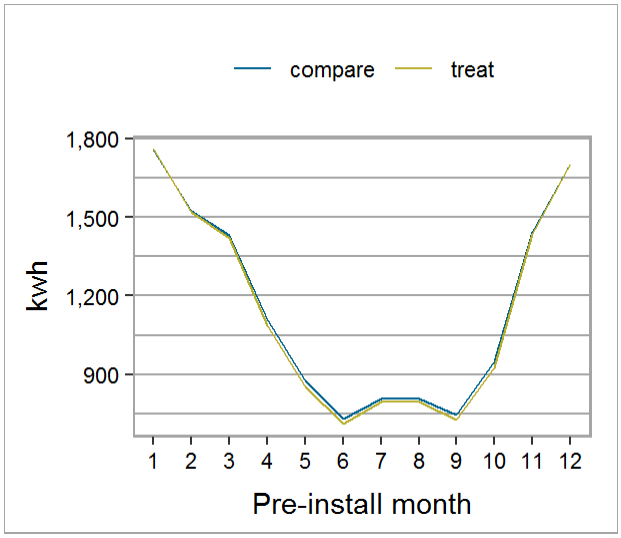
High Estimate

1,426 kWh

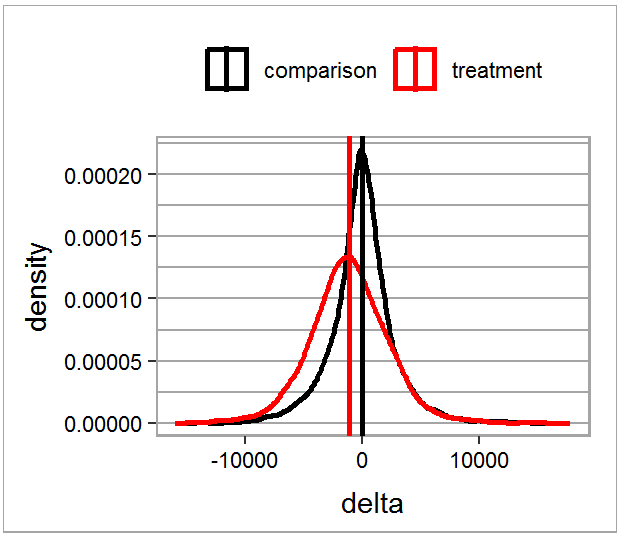
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,943	43	326	0	13,873	14,014
sample_period	−40	61	−1	1	−139	60
sample_group	−208	139	−1	0	−436	20
sample_period:sample_group	**−1,104**	**196**	**−6**	**0**	**−1,426**	**−781**

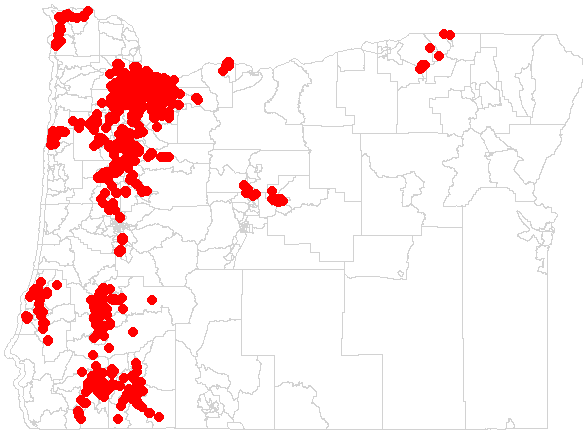
Baseline: Treatment and Comparison Group Mean Montly Consumption



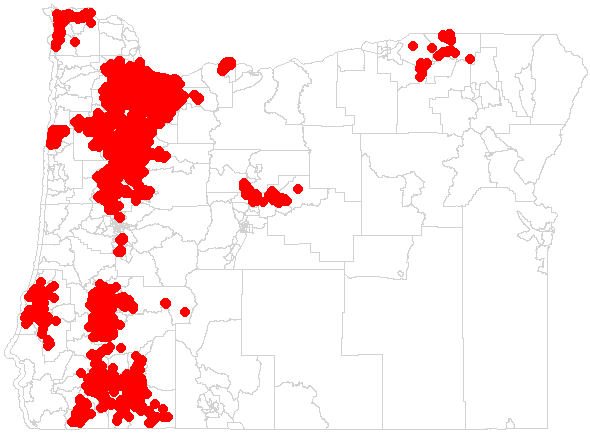
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0027089

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
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DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

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DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
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DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): HeatingZone is '2','3'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,257	Initial list of all participants
4,257	Total participants with no other measures installed
4,257	Total participants filtered to selected measure combinations
4,257	Total participants filtered to selected measure attributes
4,015	Treatment sites matched to consumption data
3,088	Treatment sites with normalized consumption data
2,215	Treatment sites with R2 > 0.5
2,199	Treatment sites with full pre & post years of consumption
2,155	Treatment sites after removing top and bottom 1%
2,054	Final model treatment sites before filters
221	Final model treatment sites with filters

Expected Savings

2,609 kWh

Estimated Savings

359 kWh

Low Estimate

-592 kWh

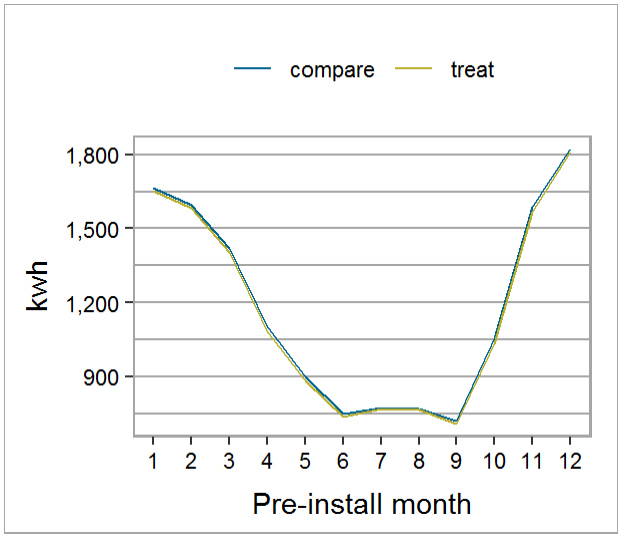
High Estimate

1,309 kWh

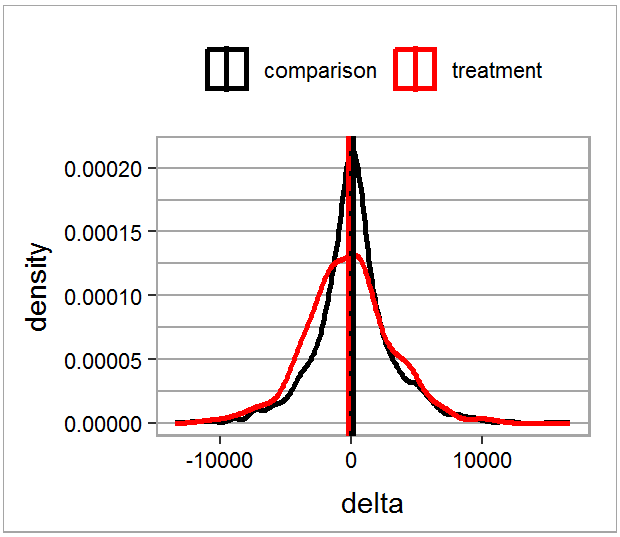
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,331	126	113	0	14,124	14,539
sample_period	130	179	1	0	−164	424
sample_group	−328	408	−1	0	−1,000	344
sample_period:sample_group	**−359**	**578**	**−1**	**1**	**−1,309**	**592**

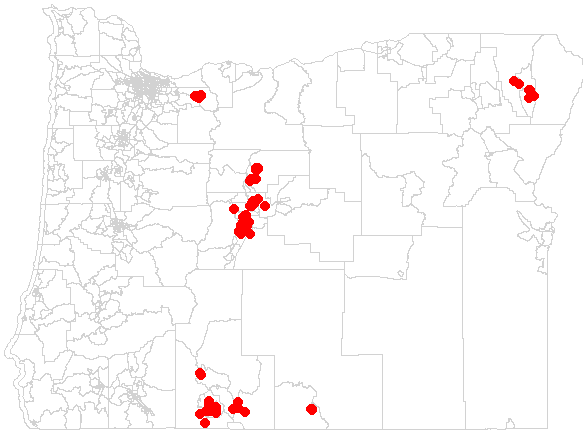
Baseline: Treatment and Comparison Group Mean Montly Consumption



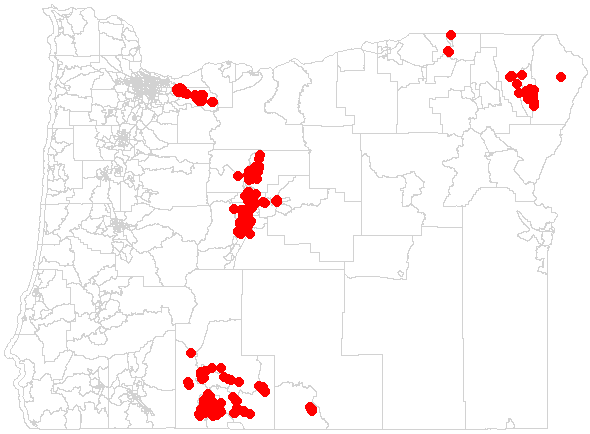
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0001852

Model p-value

0.2858638

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** . Measures were included that shared the following characteristic(s): indoorunits is '1'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,246	Initial list of all participants
4,246	Total participants with no other measures installed
4,244	Total participants filtered to selected measure combinations
2,383	Total participants filtered to selected measure attributes
2,232	Treatment sites matched to consumption data
1,668	Treatment sites with normalized consumption data
1,126	Treatment sites with R2 > 0.5
1,119	Treatment sites with full pre & post years of consumption
1,095	Treatment sites after removing top and bottom 1%
1,046	Final model treatment sites before filters
1,046	Final model treatment sites with filters

Expected Savings

2,384 kWh

Estimated Savings

1,195 kWh

Low Estimate

792 kWh

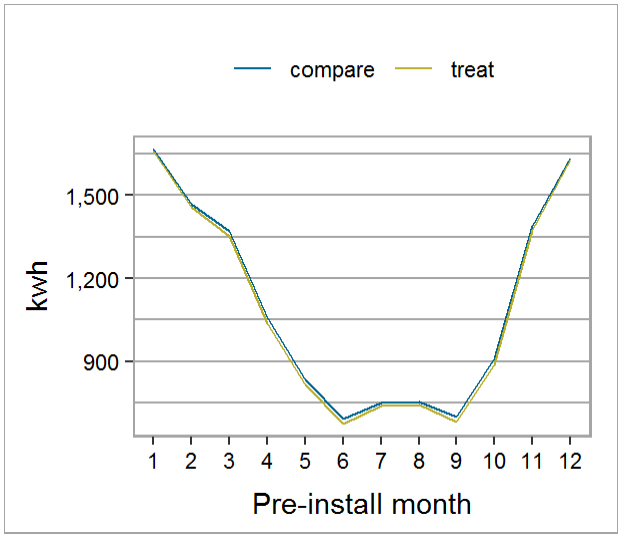
High Estimate

1,597 kWh

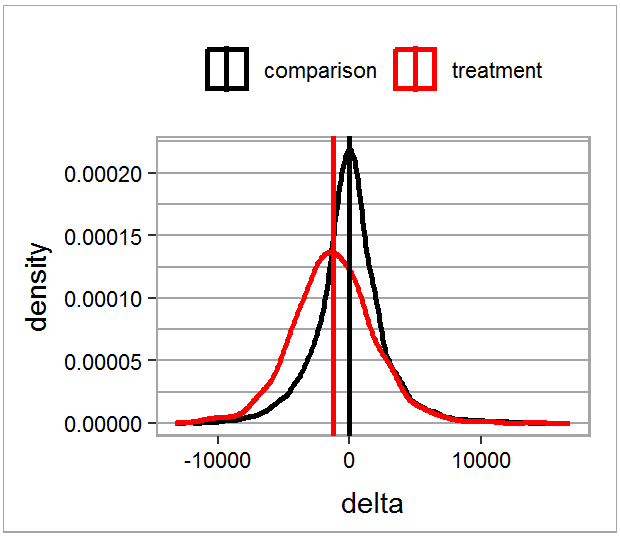
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,218	54	247	0	13,130	13,306
sample_period	−17	76	0	1	−142	108
sample_group	−162	173	−1	0	−446	123
sample_period:sample_group	**−1,195**	**245**	**−5**	**0**	**−1,597**	**−792**

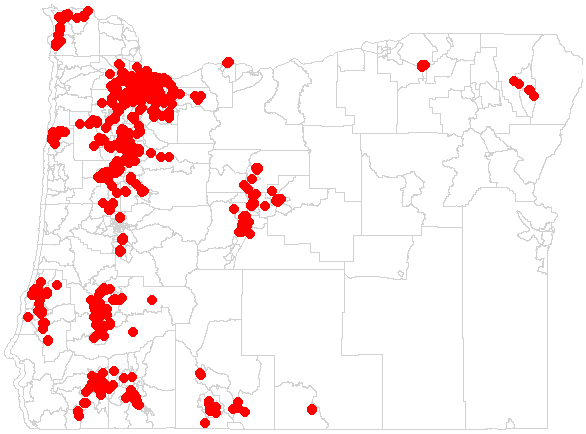
Baseline: Treatment and Comparison Group Mean Montly Consumption



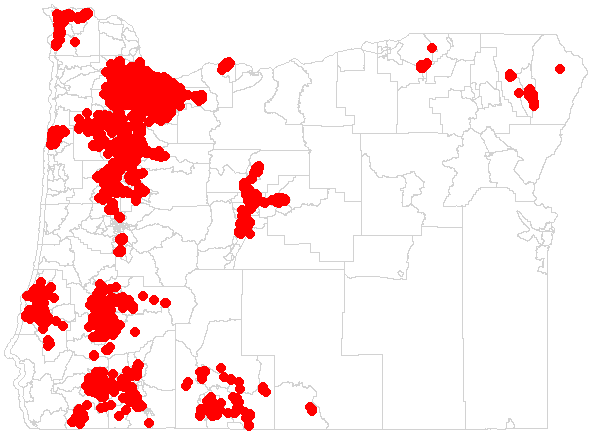
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0031191

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** . Measures were included that shared the following characteristic(s): indoorunits is '2'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,230	Initial list of all participants
4,230	Total participants with no other measures installed
4,230	Total participants filtered to selected measure combinations
1,029	Total participants filtered to selected measure attributes
976	Treatment sites matched to consumption data
790	Treatment sites with normalized consumption data
615	Treatment sites with R2 > 0.5
610	Treatment sites with full pre & post years of consumption
596	Treatment sites after removing top and bottom 1%
571	Final model treatment sites before filters
571	Final model treatment sites with filters

Expected Savings

2,302 kWh

Estimated Savings

709 kWh

Low Estimate

173 kWh

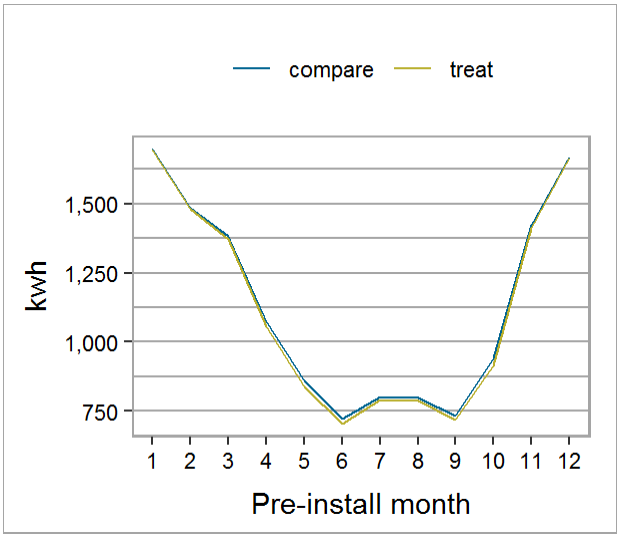
High Estimate

1,244 kWh

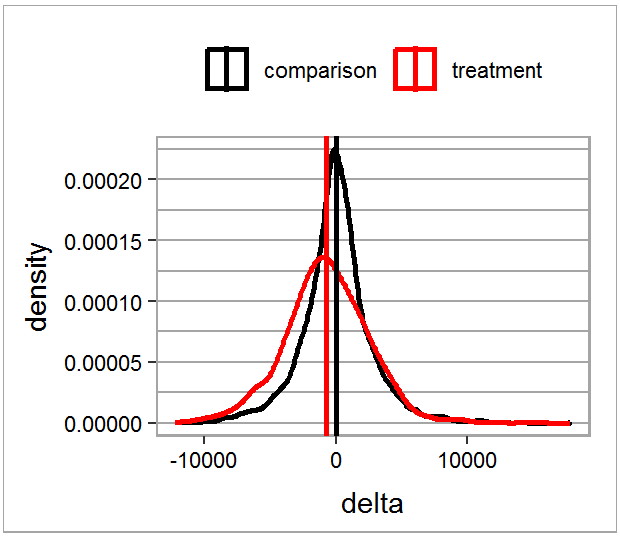
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,604	74	185	0	13,483	13,725
sample_period	−3	104	0	1	−174	169
sample_group	−169	230	−1	0	−548	209
sample_period:sample_group	**−709**	**326**	**−2**	**0**	**−1,244**	**−173**

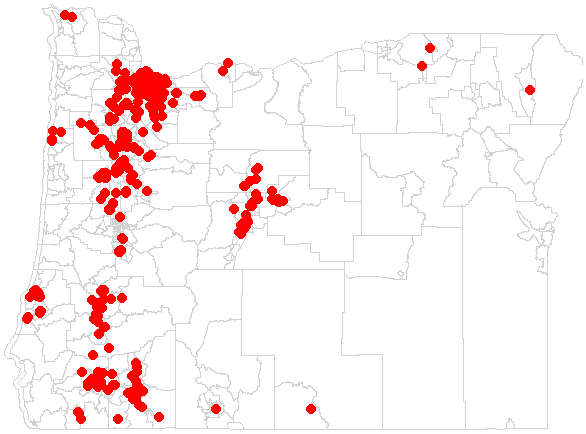
Baseline: Treatment and Comparison Group Mean Montly Consumption



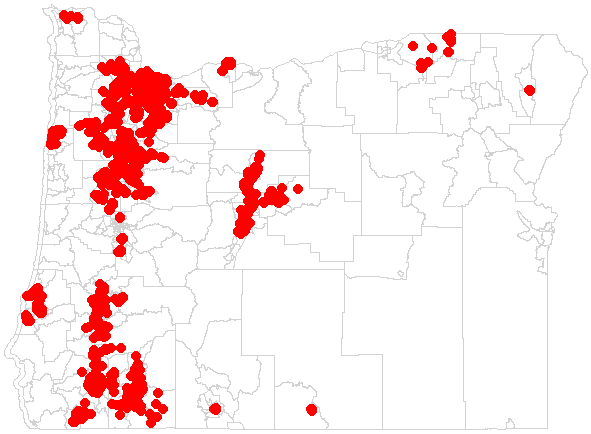
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0011592

Model p-value

0.0013359

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** . Measures were included that shared the following characteristic(s): indoorunits is ‘3’,‘4’,‘5’,‘6’,‘8’,‘7’

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,217	Initial list of all participants
4,217	Total participants with no other measures installed
4,217	Total participants filtered to selected measure combinations
839	Total participants filtered to selected measure attributes
802	Treatment sites matched to consumption data
627	Treatment sites with normalized consumption data
473	Treatment sites with R2 > 0.5
469	Treatment sites with full pre & post years of consumption
459	Treatment sites after removing top and bottom 1%
436	Final model treatment sites before filters
436	Final model treatment sites with filters

Expected Savings

2,281 kWh

Estimated Savings

980 kWh

Low Estimate

264 kWh

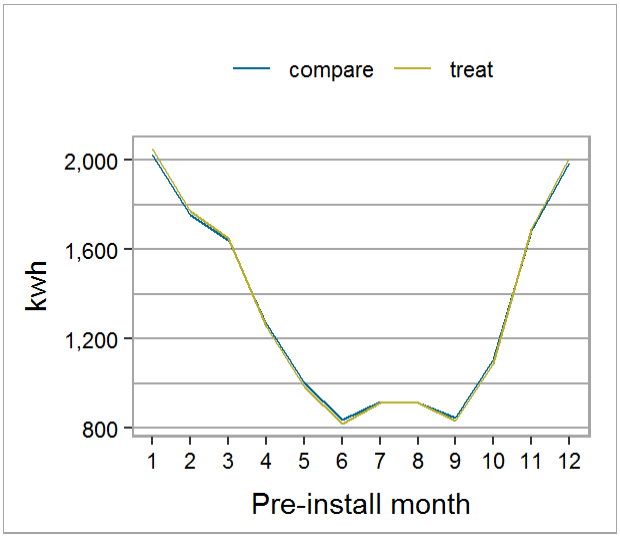
High Estimate

1,695 kWh

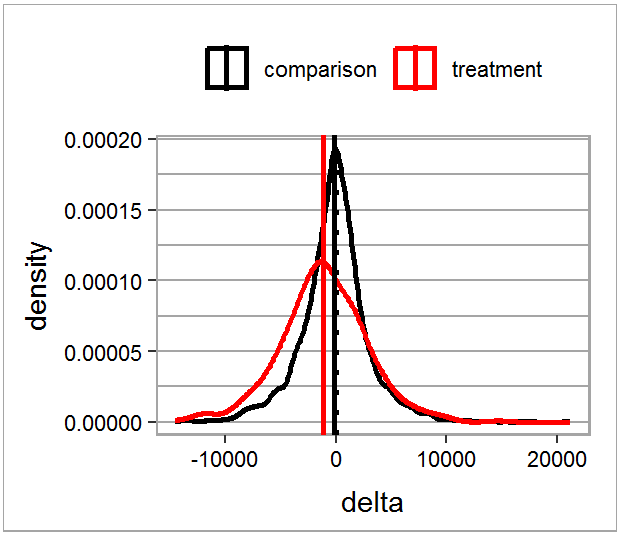
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	15,989	98	164	0	15,828	16,149
sample_period	−149	138	−1	0	−377	78
sample_group	−6	308	0	1	−513	500
sample_period:sample_group	**−980**	**435**	**−2**	**0**	**−1,695**	**−264**

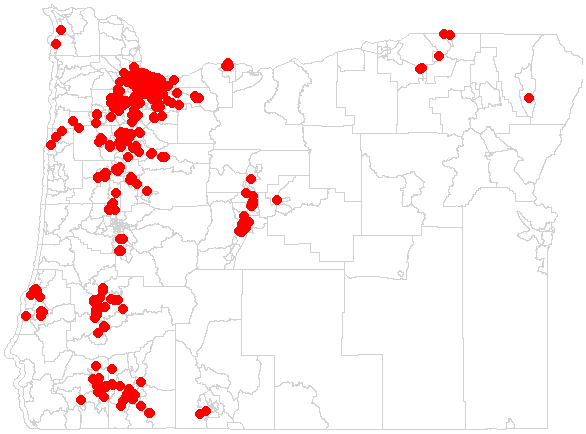
Baseline: Treatment and Comparison Group Mean Montly Consumption



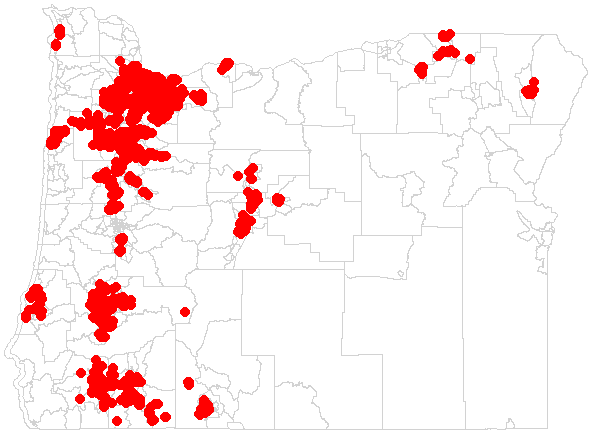
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0012839

Model p-value

0.0031191

List of Individual Measures in Analysis
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k

List of Individual Measures in Analysis
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** . Measures were included that shared the following characteristic(s): systemreplaced is 'Electric Furnace'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
1,136	Initial list of all participants
1,136	Total participants with no other measures installed
1,136	Total participants filtered to selected measure combinations
1,017	Total participants filtered to selected measure attributes
953	Treatment sites matched to consumption data
728	Treatment sites with normalized consumption data
491	Treatment sites with R2 > 0.5
487	Treatment sites with full pre & post years of consumption
477	Treatment sites after removing top and bottom 1%
455	Final model treatment sites before filters
455	Final model treatment sites with filters

Expected Savings

3,569 kWh

Estimated Savings

1,436 kWh

Low Estimate

688 kWh

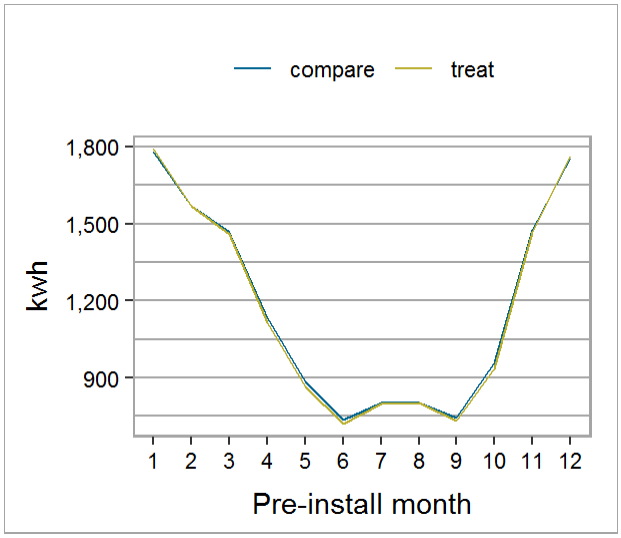
High Estimate

2,184 kWh

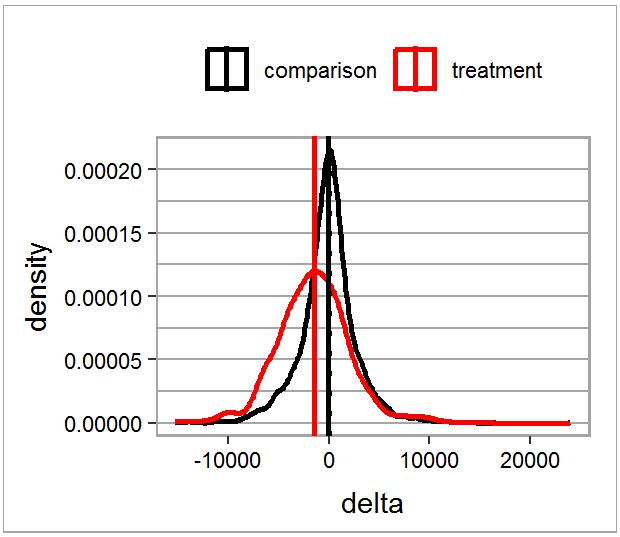
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,399	97	138	0	13,240	13,558
sample_period	−63	137	0	1	−288	162
sample_group	625	321	2	0	96	1,154
sample_period:sample_group	**−1,436**	**455**	**−3**	**0**	**−2,184**	**−688**

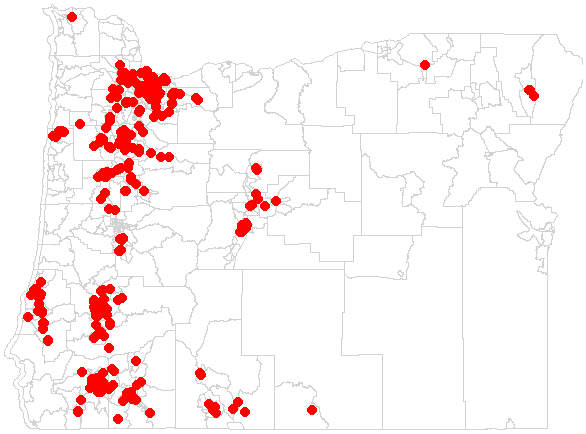
Baseline: Treatment and Comparison Group Mean Montly Consumption



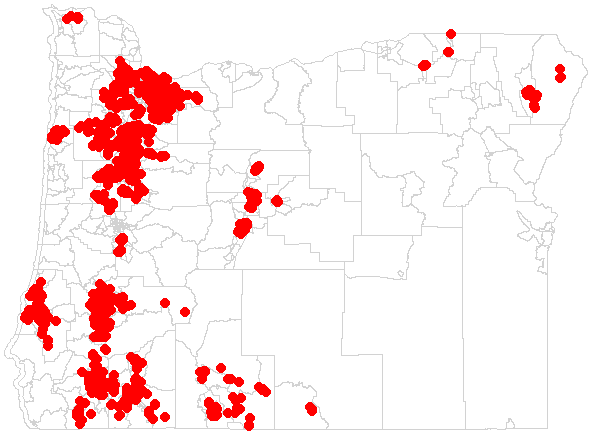
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0010666

Model p-value

0.0063432

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup
DHP for Rentals Replacing Forced Air, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** . Measures were included that shared the following characteristic(s): systemreplaced is 'Electric Wall Heater','Electric Baseboard Heat','Radiant Ceiling Heat'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
3,121	Initial list of all participants
3,121	Total participants with no other measures installed
3,121	Total participants filtered to selected measure combinations
2,884	Total participants filtered to selected measure attributes
2,726	Treatment sites matched to consumption data
2,094	Treatment sites with normalized consumption data
1,526	Treatment sites with R2 > 0.5
1,515	Treatment sites with full pre & post years of consumption
1,483	Treatment sites after removing top and bottom 1%
1,414	Final model treatment sites before filters
1,414	Final model treatment sites with filters

Expected Savings

2,205 kWh

Estimated Savings

826 kWh

Low Estimate

470 kWh

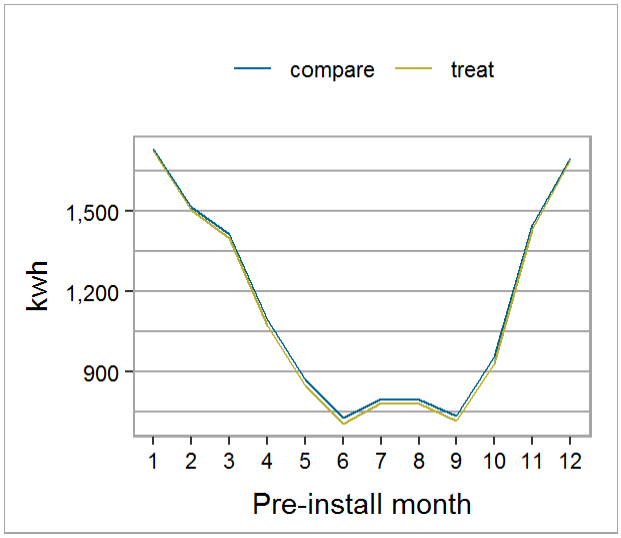
High Estimate

1,182 kWh

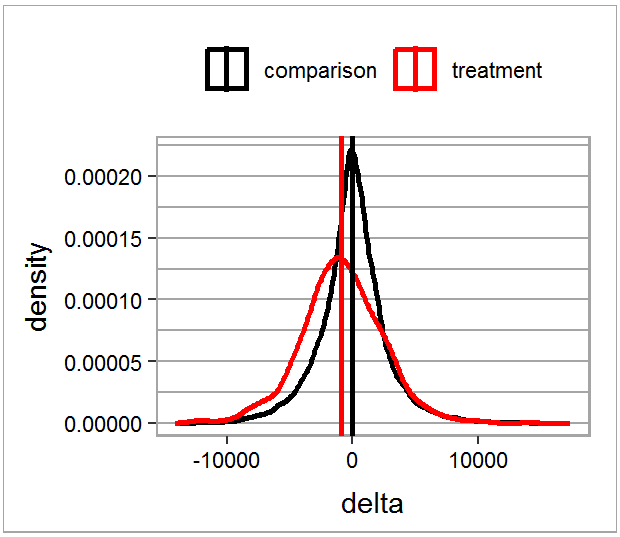
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,820	48	290	0	13,742	13,899
sample_period	−38	67	−1	1	−149	72
sample_group	−232	153	−2	0	−484	20
sample_period:sample_group	**−826**	**216**	**−4**	**0**	**−1,182**	**−470**

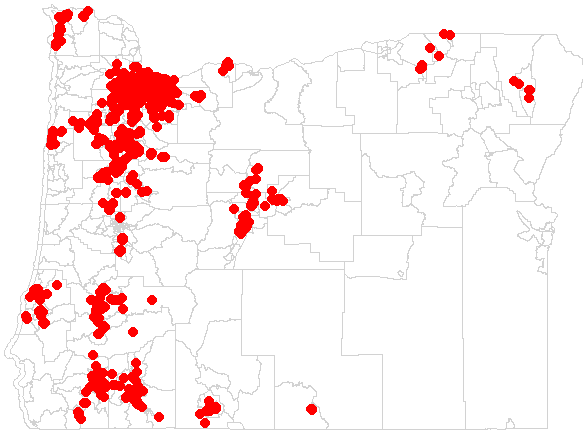
Baseline: Treatment and Comparison Group Mean Montly Consumption



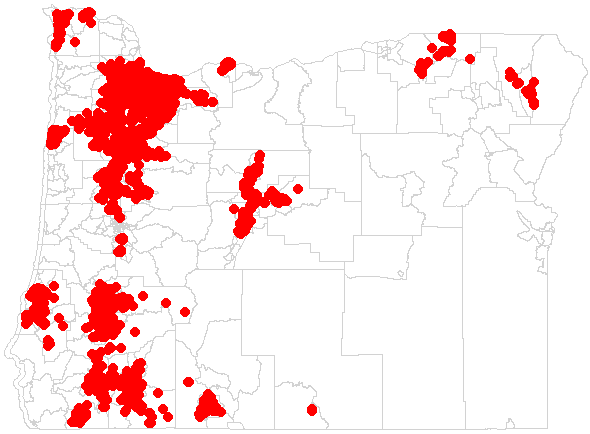
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.001852

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** . Measures were included that shared the following characteristic(s): systemreplaced is 'Electric Wall Heater','Electric Baseboard Heat','Radiant Ceiling Heat'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
992	Initial list of all participants
992	Total participants with no other measures installed
992	Total participants filtered to selected measure combinations
948	Total participants filtered to selected measure attributes
904	Treatment sites matched to consumption data
740	Treatment sites with normalized consumption data
581	Treatment sites with R2 > 0.5
578	Treatment sites with full pre & post years of consumption
566	Treatment sites after removing top and bottom 1%
535	Final model treatment sites before filters
535	Final model treatment sites with filters

Expected Savings

2,185 kWh

Estimated Savings

1,000 kWh

Low Estimate

406 kWh

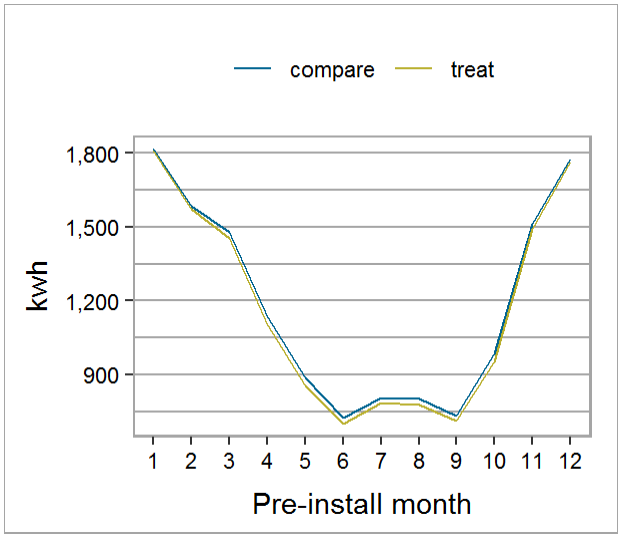
High Estimate

1,594 kWh

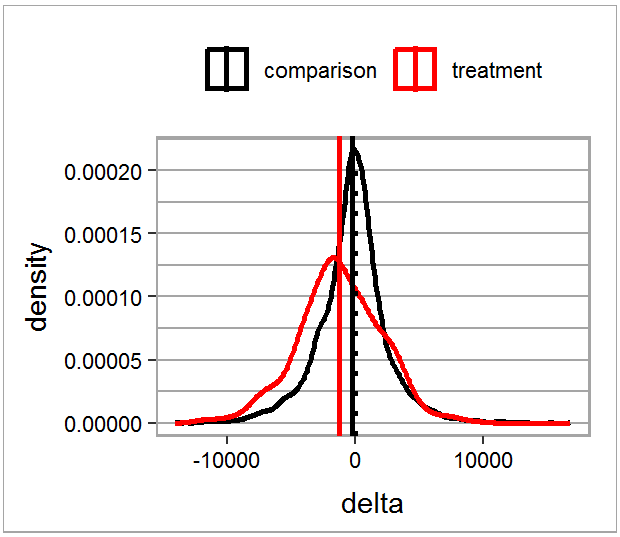
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,240	81	175	0	14,106	14,373
sample_period	−255	115	−2	0	−444	−66
sample_group	−271	255	−1	0	−691	149
sample_period:sample_group	**−1,000**	**361**	**−3**	**0**	**−1,594**	**−406**

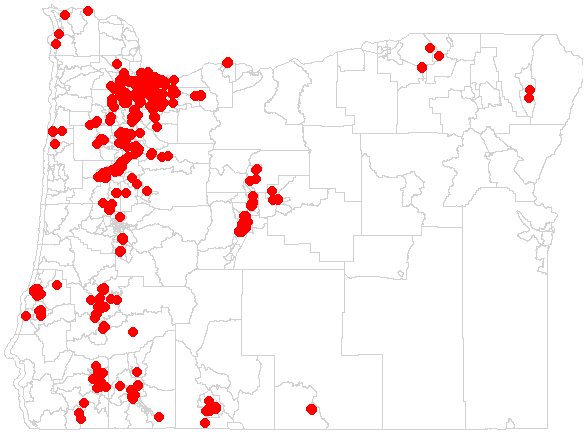
Baseline: Treatment and Comparison Group Mean Montly Consumption



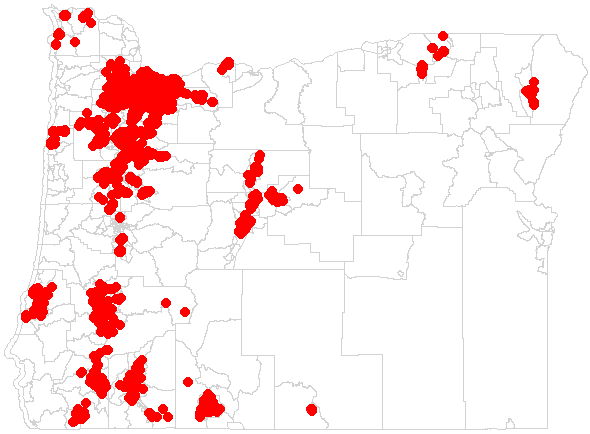
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0032428

Model p-value

0.0000001

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** . Measures were included that shared the following characteristic(s): systemreplaced is 'Electric Wall Heater','Electric Baseboard Heat','Radiant Ceiling Heat' & systemreplaced is 'Electric Wall Heater','Electric Baseboard Heat','Radiant Ceiling Heat' & supplementalheatingequipment is 'Wood Stove','Pellet Stove','Gas Fireplace','Other','Oil Heater','Gas Stove'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
220	Initial list of all participants
220	Total participants with no other measures installed
220	Total participants filtered to selected measure combinations
208	Total participants filtered to selected measure attributes
200	Treatment sites matched to consumption data
170	Treatment sites with normalized consumption data
124	Treatment sites with R2 > 0.5
124	Treatment sites with full pre & post years of consumption
120	Treatment sites after removing top and bottom 1%
113	Final model treatment sites before filters
113	Final model treatment sites with filters

Expected Savings

1,417 kWh

Estimated Savings

49 kWh

Low Estimate

-1,180 kWh

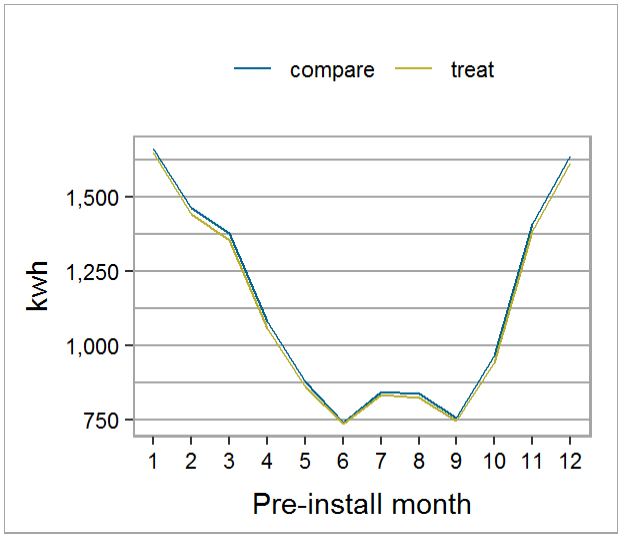
High Estimate

1,278 kWh

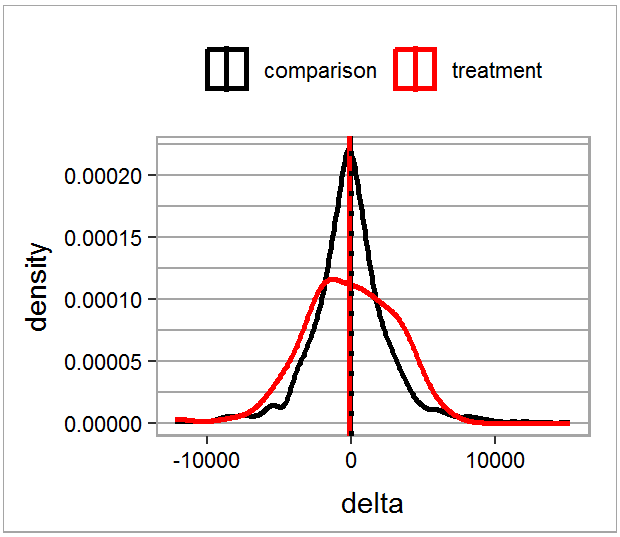
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,636	170	80	0	13,356	13,915
sample_period	−88	240	0	1	−484	307
sample_group	−190	528	0	1	−1,059	679
sample_period:sample_group	**−49**	**747**	**0**	**1**	**−1,278**	**1,180**

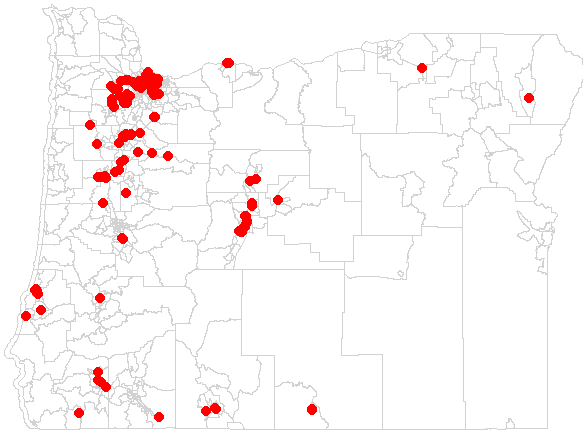
Baseline: Treatment and Comparison Group Mean Montly Consumption



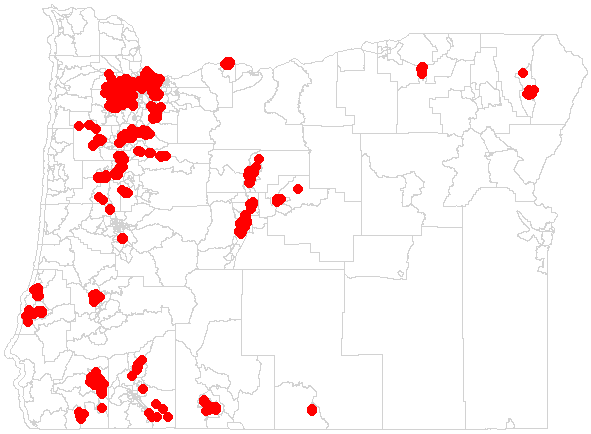
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

-0.0011478

Model p-value

0.9185011

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1 Sup fuel

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** . Measures were included that shared the following characteristic(s): systemreplaced is 'Electric Baseboard Heat','Radiant Ceiling Heat','Electric Wall Heater' & supplementalheatingequipment is 'None'

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
772	Initial list of all participants
772	Total participants with no other measures installed
772	Total participants filtered to selected measure combinations
716	Total participants filtered to selected measure attributes
683	Treatment sites matched to consumption data
553	Treatment sites with normalized consumption data
443	Treatment sites with R2 > 0.5
440	Treatment sites with full pre & post years of consumption
430	Treatment sites after removing top and bottom 1%
407	Final model treatment sites before filters
407	Final model treatment sites with filters

Expected Savings

2,246 kWh

Estimated Savings

1,259 kWh

Low Estimate

579 kWh

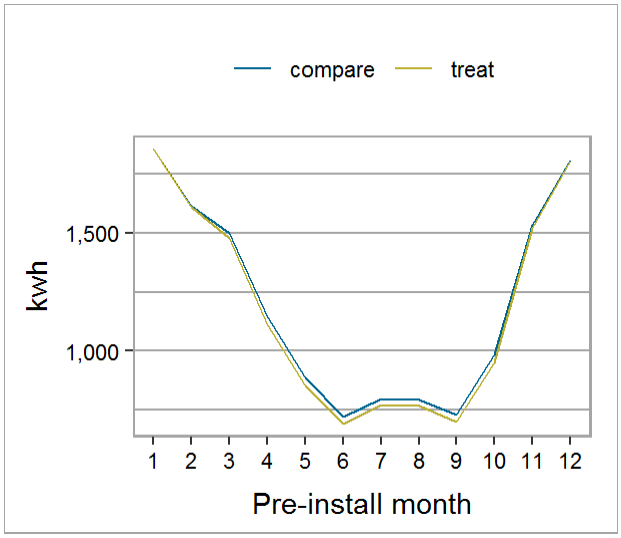
High Estimate

1,939 kWh

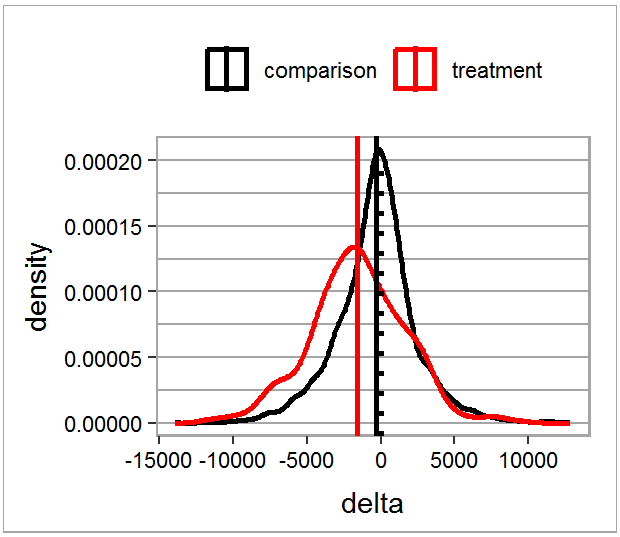
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,381	93	154	0	14,227	14,535
sample_period	−319	132	−2	0	−537	−102
sample_group	−260	292	−1	0	−741	221
sample_period:sample_group	**−1,259**	**413**	**−3**	**0**	**−1,939**	**−579**

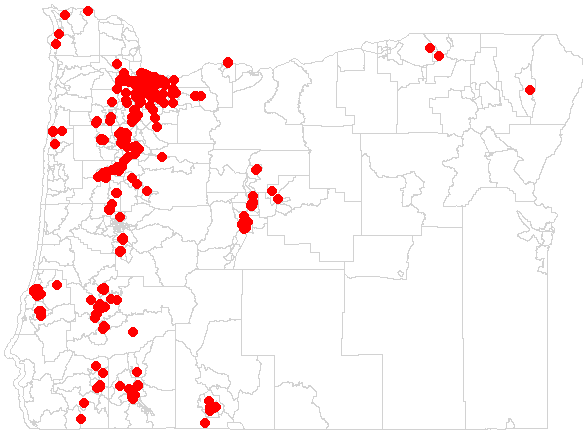
Baseline: Treatment and Comparison Group Mean Montly Consumption



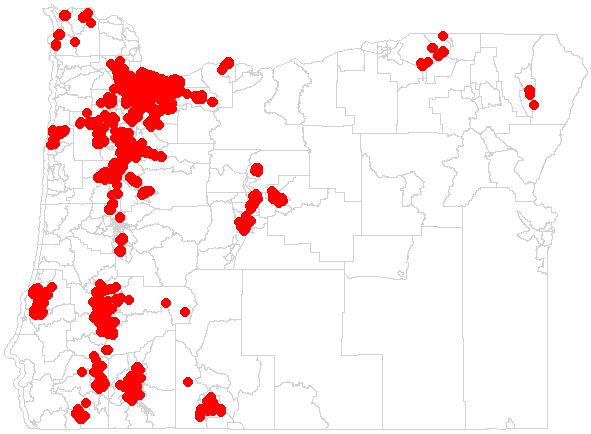
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0047974

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 2
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): SqFt is '[<1000]'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,257	Initial list of all participants
4,257	Total participants with no other measures installed
4,257	Total participants filtered to selected measure combinations
4,257	Total participants filtered to selected measure attributes
4,015	Treatment sites matched to consumption data
3,088	Treatment sites with normalized consumption data
2,215	Treatment sites with R2 > 0.5
2,199	Treatment sites with full pre & post years of consumption
2,155	Treatment sites after removing top and bottom 1%
2,054	Final model treatment sites before filters
409	Final model treatment sites with filters

Expected Savings

2,350 kWh

Estimated Savings

1,360 kWh

Low Estimate

835 kWh

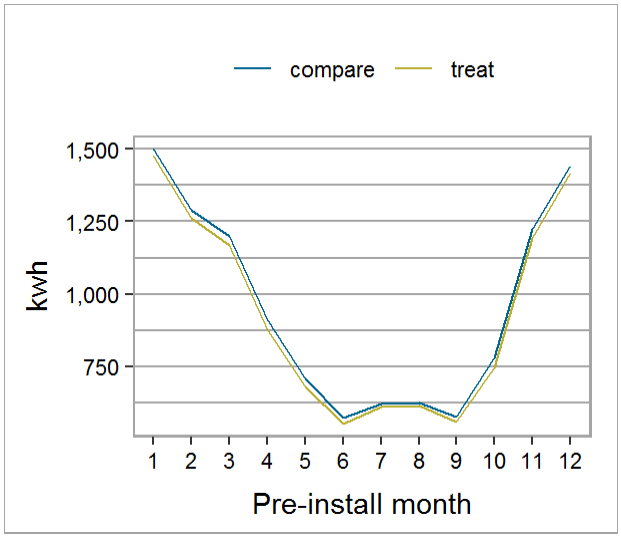
High Estimate

1,886 kWh

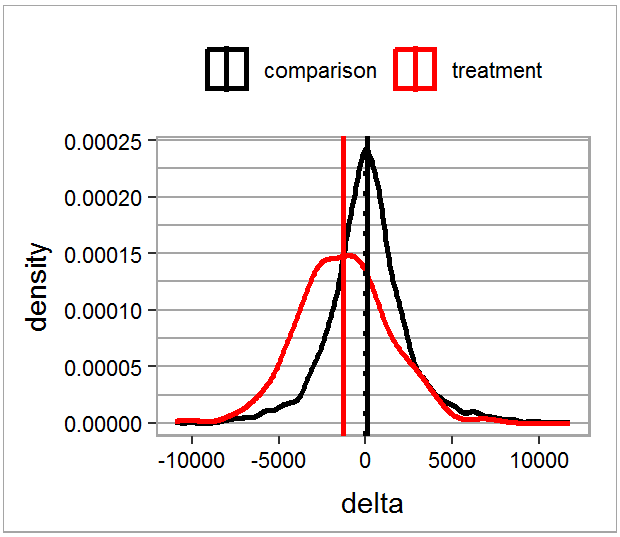
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	11,404	72	159	0	11,286	11,522
sample_period	95	102	1	0	−72	262
sample_group	−250	226	−1	0	−621	122
sample_period:sample_group	**−1,360**	**319**	**−4**	**0**	**−1,886**	**−835**

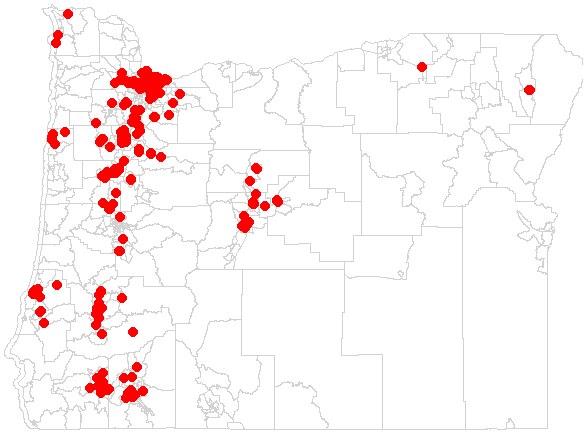
Baseline: Treatment and Comparison Group Mean Montly Consumption



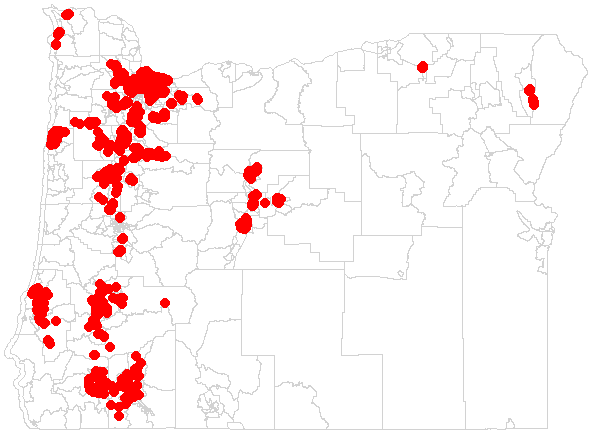
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0063243

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): SqFt is '[1000 - 1499]'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,257	Initial list of all participants
4,257	Total participants with no other measures installed
4,257	Total participants filtered to selected measure combinations
4,257	Total participants filtered to selected measure attributes
4,015	Treatment sites matched to consumption data
3,088	Treatment sites with normalized consumption data
2,215	Treatment sites with R2 > 0.5
2,199	Treatment sites with full pre & post years of consumption
2,155	Treatment sites after removing top and bottom 1%
2,054	Final model treatment sites before filters
966	Final model treatment sites with filters

Expected Savings

2,299 kWh

Estimated Savings

1,080 kWh

Low Estimate

690 kWh

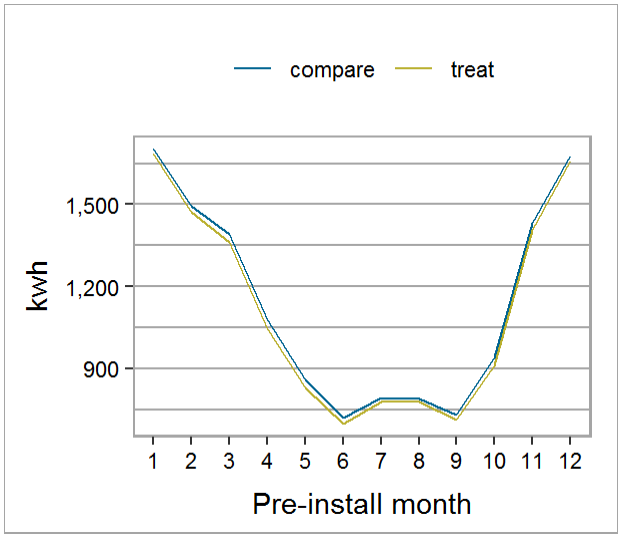
High Estimate

1,471 kWh

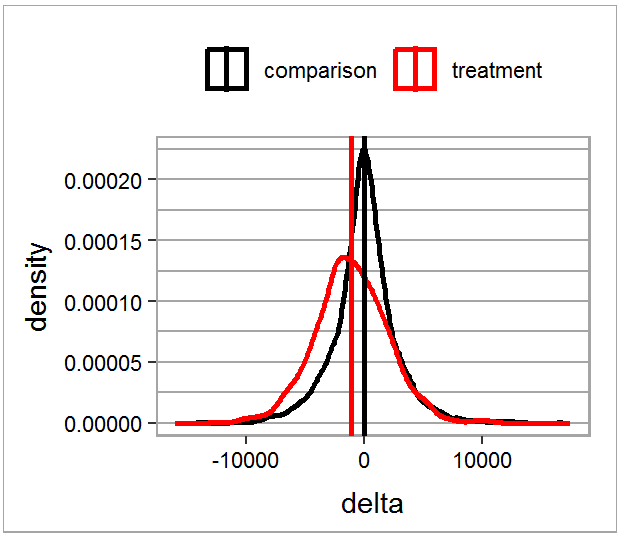
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,575	53	256	0	13,487	13,662
sample_period	7	75	0	1	−116	131
sample_group	−241	168	−1	0	−517	35
sample_period:sample_group	**−1,080**	**237**	**−5**	**0**	**−1,471**	**−690**

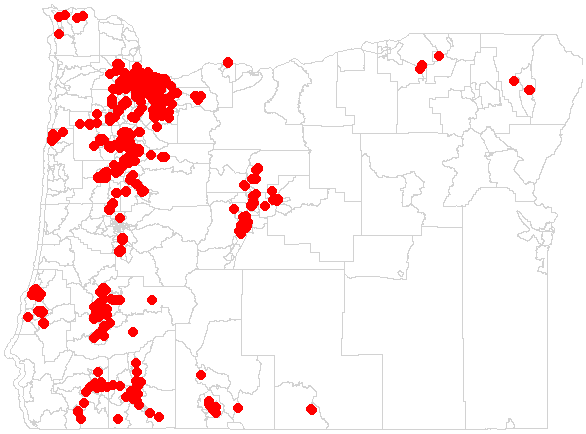
Baseline: Treatment and Comparison Group Mean Montly Consumption



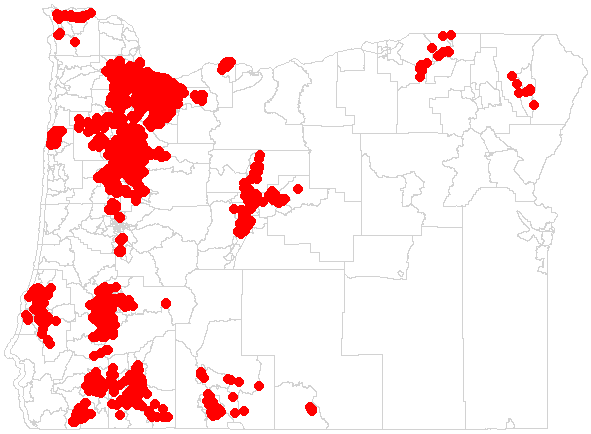
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0033963

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): SqFt is '[1500 - 1999]'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

- Utility billing data not found
- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
4,257	Initial list of all participants
4,257	Total participants with no other measures installed
4,257	Total participants filtered to selected measure combinations
4,257	Total participants filtered to selected measure attributes
4,015	Treatment sites matched to consumption data
3,088	Treatment sites with normalized consumption data
2,215	Treatment sites with R2 > 0.5
2,199	Treatment sites with full pre & post years of consumption
2,155	Treatment sites after removing top and bottom 1%
2,054	Final model treatment sites before filters
428	Final model treatment sites with filters

Expected Savings

2,319 kWh

Estimated Savings

888 kWh

Low Estimate

169 kWh

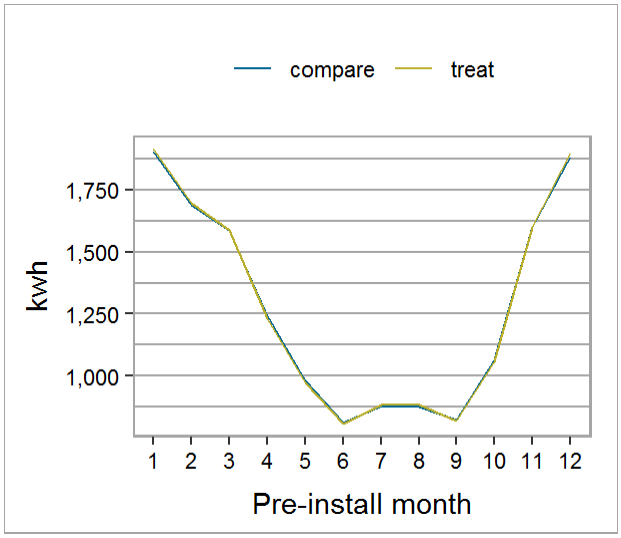
High Estimate

1,607 kWh

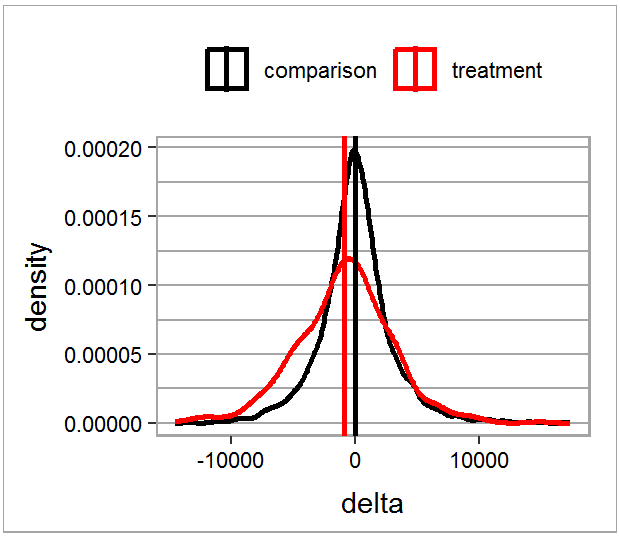
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	15,454	99	156	0	15,291	15,617
sample_period	−31	140	0	1	−261	200
sample_group	−104	309	0	1	−612	404
sample_period:sample_group	**−888**	**437**	**−2**	**0**	**−1,607**	**−169**

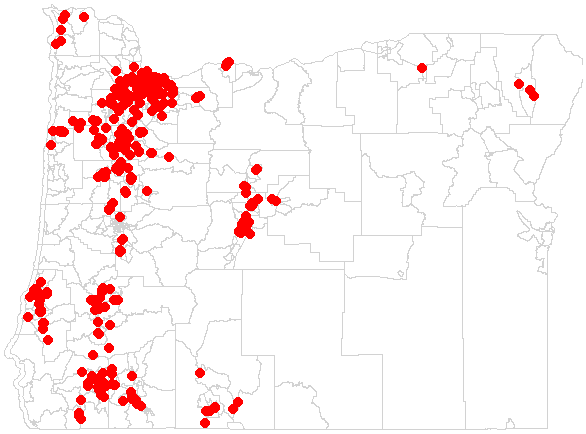
Baseline: Treatment and Comparison Group Mean Montly Consumption



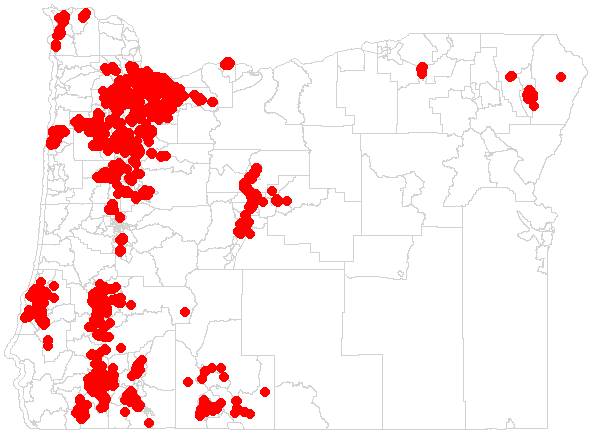
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0010097

Model p-value

0.0103624

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed between 2020 and 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump from 2020 to 2022** in homes with the following shared characteristic(s): SqFt is '[2000 - 2499]'.

The billing analysis tool uses monthly energy usage data from utility bills to conduct pre-post analysis of whole home energy usage. Energy usage data are weather normalized using site-level weather regression models and typical meteorological year data, similar to the methods established by CalTRACK. Normalized annual energy usage is computed for each site in both the year prior to measure installation (baseline) and the year following installation (post-install). The site-level change in annual energy usage is simply computed as the difference in usage between the baseline and post-install periods. The average change in annual energy usage among treated sites is then evaluated against the average change in energy usage during the same period in a comparison group of similar sites. The comparison group is selected from untreated homes using a site-level, nearest neighbor matching technique, based on baseline monthly energy usage of sites located in the same Census tract. The change in normalized annual energy usage for comparison group sites is arrived at using the same procedure as the treatment group. For this analysis, **10** matched comparison sites were selected for each treated site. The resulting difference in the change in annual energy usage (difference-in-differences) is the annual energy savings attributable to the measures installed at the treated sites. Several standard data screens are applied to remove homes from the analysis that are missing data, are outliers in energy usage, have inconsistent occupancy, have unusual usage patterns, or are otherwise unsuitable for billing analysis. These screens are applied symmetrically to all treatment and comparison sites. Sites are removed from the analysis for the following reasons:

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2,054	Final model treatment sites before filters
157	Final model treatment sites with filters

Expected Savings

2,291 kWh

Estimated Savings

1,118 kWh

Low Estimate

-82 kWh

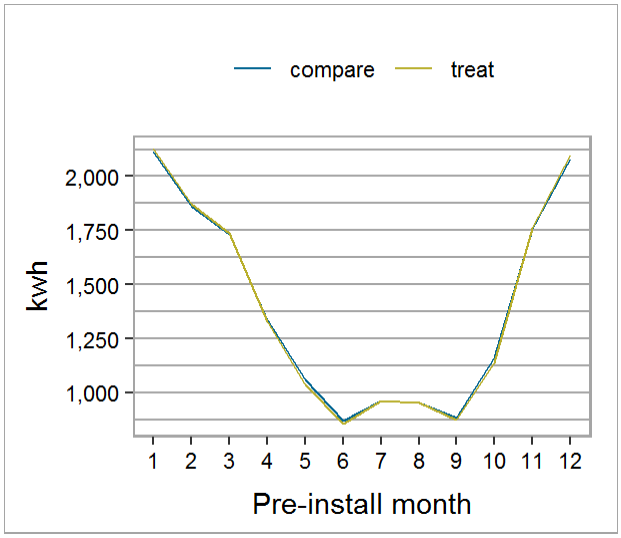
High Estimate

2,318 kWh

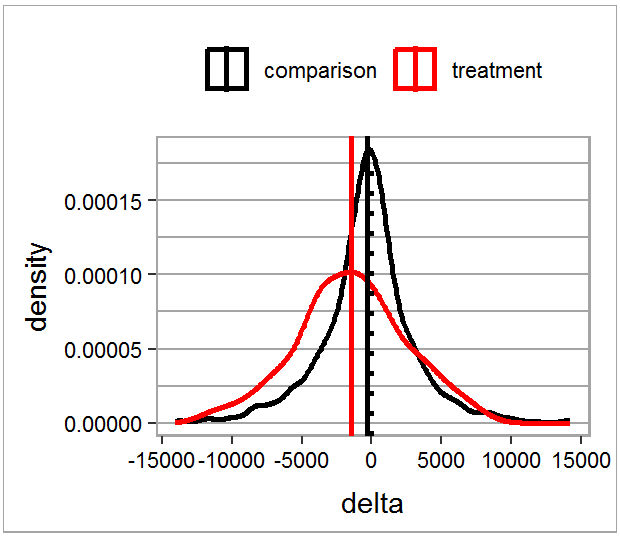
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	16,827	166	101	0	16,554	17,100
sample_period	−334	235	−1	0	−720	52
sample_group	−80	516	0	1	−928	769
sample_period:sample_group	**−1,118**	**730**	**−2**	**0**	**−2,318**	**82**

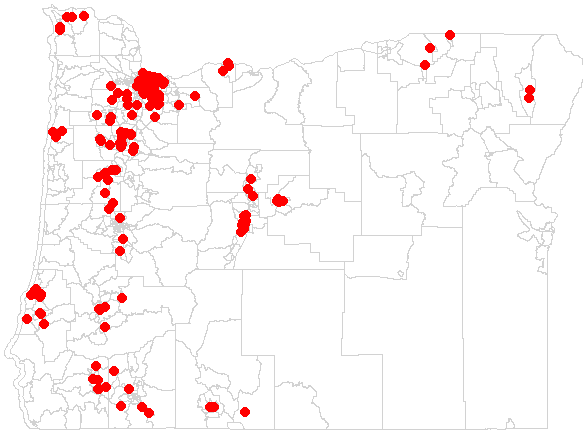
Baseline: Treatment and Comparison Group Mean Montly Consumption



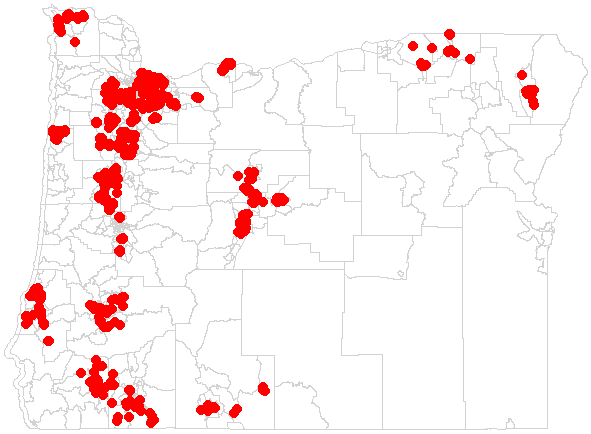
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0021696

Model p-value

0.0233919

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
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DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
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DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
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DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2

Ductless heat pump measures installed in 2022

Introduction

Energy Trust developed a billing analysis tool to evaluate energy savings from efficiency measures it funds that are installed in residential buildings. This report summarizes our analysis of electric savings conducted on treated homes that installed **Ductless heat pump in 2022** in homes with the following shared characteristic(s): MarketName is 'Site Built Home' & HeatingZone is '1'. Measures were included that shared the following characteristic(s): systemreplaced is 'Electric Baseboard Heat','Radiant Ceiling Heat','Electric Wall Heater' & supplementalheatingequipment is 'None' & indoorunits is '1'

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- Less than 9 months of valid billing data available for either baseline or post-install year
- Weather normalization process failed for either baseline or post-install year
- Other measures installed during analysis period with aggregate deemed electricity savings > **100** kWh per year
- Baseline energy usage in the top or bottom 1 percent of treated sites
- Post-install annual energy usage is more than double or less than half of baseline year
- Weather regression model has R-square value < **0.5** for either baseline or post-install year

Site Attrition

Treament Sites	Analysis Stage
656	Initial list of all participants
656	Total participants with no other measures installed
656	Total participants filtered to selected measure combinations
274	Total participants filtered to selected measure attributes
254	Treatment sites matched to consumption data
205	Treatment sites with normalized consumption data
157	Treatment sites with R2 > 0.5
157	Treatment sites with full pre & post years of consumption
153	Treatment sites after removing top and bottom 1%
143	Final model treatment sites before filters
135	Final model treatment sites with filters

Expected Savings

2,228 kWh

Estimated Savings

1,087 kWh

Low Estimate

5 kWh

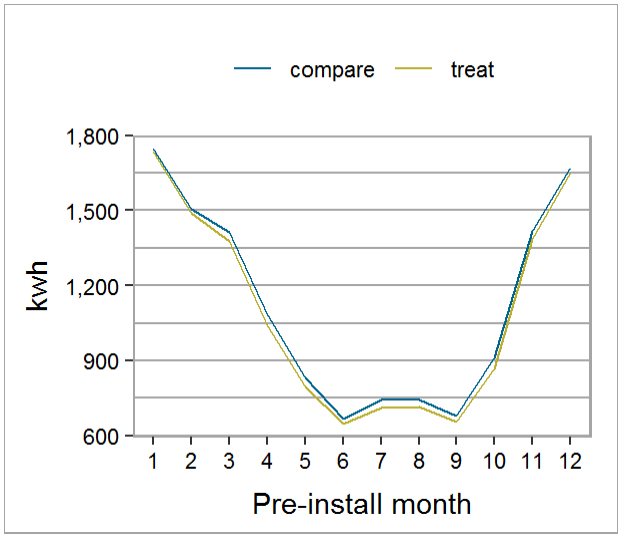
High Estimate

2,169 kWh

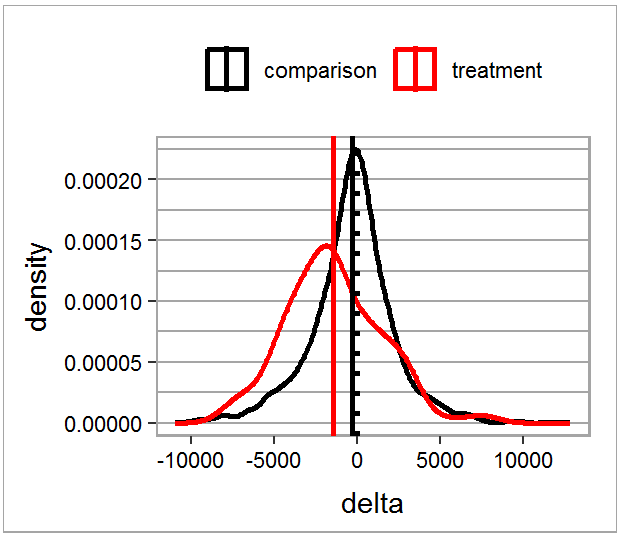
Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	13,477	148	91	0	13,234	13,720
sample_period	−366	209	−2	0	−709	−22
sample_group	−398	465	−1	0	−1,163	367
sample_period:sample_group	**−1,087**	**658**	**−2**	**0**	**−2,169**	**−5**

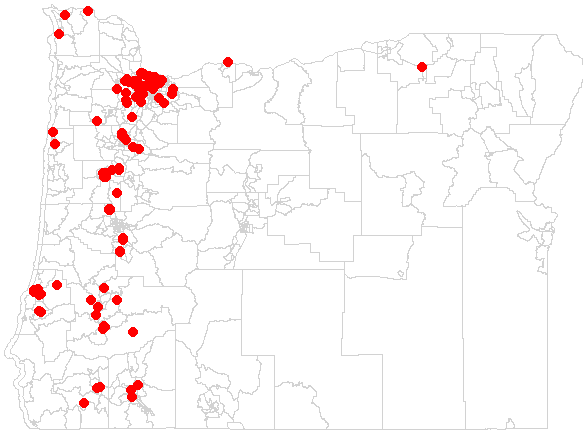
Baseline: Treatment and Comparison Group Mean Montly Consumption



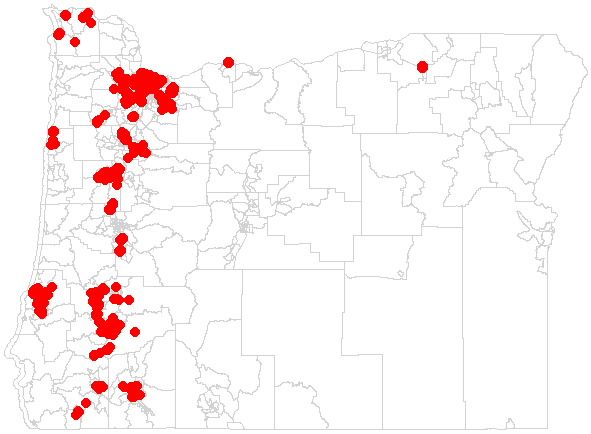
Post-install Consumption Change: Treatment & Comparison Groups



Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0051377

Model p-value

0.0008376

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP w/ Ele Zonal Heat, Zone 1
Single Family DHP Promotion for Zonal HZ1

Ductless heat pump measures installed between 2020 and 2022

Introduction

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2,054	Final model treatment sites before filters
1,754	Final model treatment sites with filters

Expected Savings

2,312 kWh

Estimated Savings

1,121 kWh

Low Estimate

792 kWh

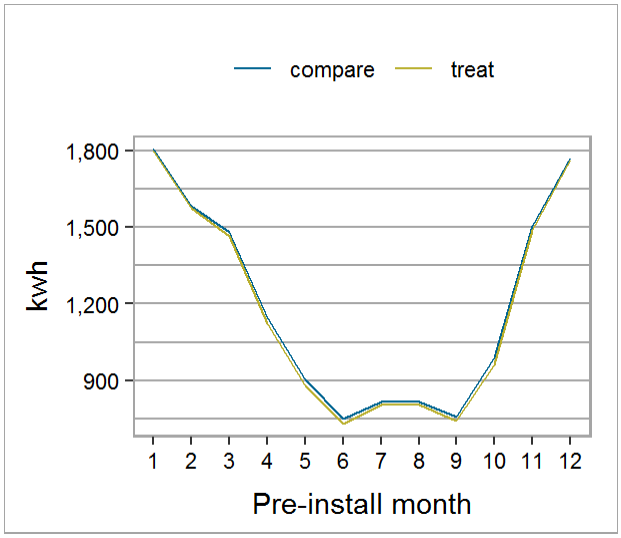
High Estimate

1,450 kWh

Analysis Results

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	14,342	44	328	0	14,270	14,414
sample_period	−31	62	−1	1	−133	70
sample_group	−204	141	−1	0	−436	29
sample_period:sample_group	**−1,121**	**200**	**−6**	**0**	**−1,450**	**−792**

Baseline: Treatment and Comparison Group Mean Montly Consumption



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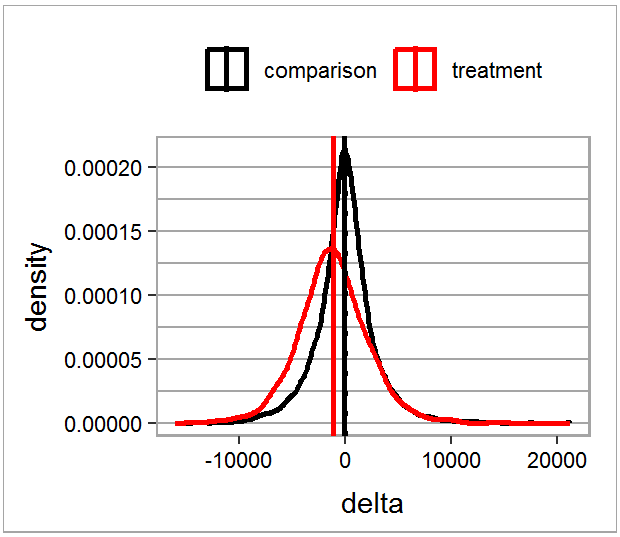
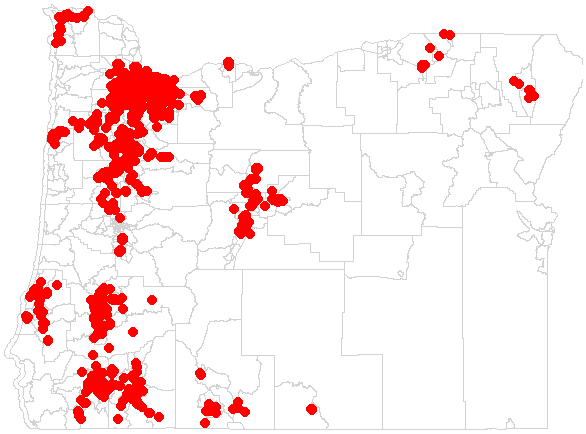
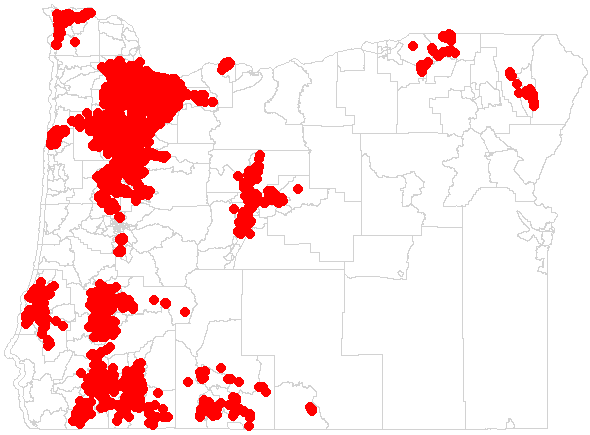


Treatment group spatial distribution



Comparison group spatial distribution



Model Adjusted r2

0.0027603

Model p-value

0

List of Individual Measures in Analysis
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:1
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2
CPF No Cost DHP Replacing Ele Zonal, Zone 1, 1:2 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:1 Sup
CPF No Cost DHP Replacing Ele Zonal, Zone 2, 1:2 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:1 Sup
CPF No Cost DHP Replacing Forced Air, Zone 1, 1:2
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1
CPF No Cost DHP Replacing Forced Air, Zone 2, 1:1 Sup
Community Partner Funded DHP Replacing Forced Air, Zone 1
Community Partner Funded DHP Replacing Forced Air, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 1 Sup
Community Partner Funded DHP w/ Ele Zonal Heat, Zone 2
DHP Replacing Forced Air, Zone 1
DHP Replacing Forced Air, Zone 1 Sup
DHP Replacing Forced Air, Zone 1 TLM
DHP Replacing Forced Air, Zone 2
DHP Replacing Forced Air, Zone 2 Sup
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 1 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion
DHP Replacing Zonal Heat, Zone 2 Fixed Price Promotion Sup
DHP Replacing Zonal Heat, Zone 2 Regional Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion
DHP Replacing eFAF Zone 1 Fixed Price Promotion Sup
DHP Replacing eFAF Zone 2 Regional Promotion
DHP Replacing eFAF Zone 2 Regional Promotion Sup
DHP for Rentals Replacing Forced Air, Zone 1
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 1 FPP 15-18k Sup
DHP for Rentals Replacing Forced Air, Zone 1 FPP 9-12k
DHP for Rentals Replacing Forced Air, Zone 1 Sup
DHP for Rentals Replacing Forced Air, Zone 2
DHP for Rentals Replacing Forced Air, Zone 2 FPP 15-18k
DHP for Rentals Replacing Forced Air, Zone 2 FPP 9-12k Sup

List of Individual Measures in Analysis
DHP for Rentals w/ Ele Zonal Heat, Zone 1
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 1 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 1 Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 15-18k Sup
DHP for Rentals w/ Ele Zonal Heat, Zone 2 FPP 9-12k
DHP for Rentals w/ Ele Zonal Heat, Zone 2 Sup
DHP for SWR Replacing Forced Air, Zone 1
DHP for SWR Replacing Forced Air, Zone 1 Sup
DHP for SWR Replacing Forced Air, Zone 2
DHP for SWR Replacing Forced Air, Zone 2 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1
DHP for SWR w/ Ele Zonal Heat, Heating Zone 1 Sup
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2
DHP for SWR w/ Ele Zonal Heat, Heating Zone 2 Sup
DHP for XMH Replacing eFAF Zone 1 Fixed Price Promotion
DHP for XMH Replacing eFAF Zone 2 Fixed Price Promotion
DHP w/ Ele Zonal Heat, Zone 1
DHP w/ Ele Zonal Heat, Zone 1 Sup
DHP w/ Ele Zonal Heat, Zone 1 TLM
DHP w/ Ele Zonal Heat, Zone 1 TLM Sup
DHP w/ Ele Zonal Heat, Zone 2
DHP w/ Ele Zonal Heat, Zone 2 Sup
Single Family DHP Promotion for Zonal HZ1
Single Family DHP Promotion for Zonal HZ1 Sup fuel
Single Family DHP Promotion for Zonal HZ2
Single Family DHP Promotion for eFAF HZ1 Sup fuel
Single Family DHP Promotion for eFAF HZ2