MEMO

Date: August 20, 2020
To: Board of Directors
From: Dan Rubado, Evaluation Project Manager
Subject: **Summary of Recurve Analysis of Manufactured Homes Air and Duct Sealing Impacts**

EXECUTIVE SUMMARY

Energy Trust used an impact analysis tool built by Recurve Analytics to evaluate electric savings from free manufactured home air and duct sealing services delivered by a network of trade ally contractors from 2013 to 2018. Weather normalized annual energy usage prior to installation was compared with the year immediately following installation. The change in annual energy usage was evaluated against changes in energy usage during the same time period in two comparison groups.

The Recurve snapshot reports that follow this memo, and the summary or results below, show the detailed findings from this analysis. Overall electricity savings for duct sealing were lower than expected but statistically significant (480 kWh per year, +/- 80 kWh, or 3% savings). Combined air and duct sealing projects had similar savings to duct sealing only projects (470 kWh per year, +/- 90 kWh, or 3% savings). We did not find any evidence of energy savings associated with air sealing alone (30 kWh per year, +/- 530 kWh, or 0% savings). The similarity in overall savings between duct sealing alone and combined air and duct sealing project corroborates the finding that air sealing had little to no impact on energy usage.

Duct sealing savings appeared to increase somewhat with home size and baseline energy usage. Baseline energy usage in single-wide homes was very low, making it more difficult to achieve savings. Savings were slightly higher in heating zone 2, although this finding was not conclusive. Heating zone 2 appears to be considerably underserved, based on the low volume of projects. Duct sealing savings were dramatically higher for complex duct sealing projects. The impact of project complexity strongly outweighed home size as a factor influencing duct sealing savings. The highest savings were in double-wide homes completing complex duct sealing, while the lowest savings were in single-wide homes receiving standard duct sealing. We observed a slight decreasing trend in energy savings over time for duct sealing alone. Combined air and duct sealing project savings followed similar patterns across all dimensions.

We recommend either conducting a thorough review of the free air sealing service being provided or ending this service altogether. We recommend adopting new, deemed, electric savings values for manufactured home duct sealing services, based on these findings, and focusing on scenarios where energy savings were the highest. That said, from an equity perspective, it is important to continue providing services to single-wide homes, which represent the lowest-income households among manufactured home residents. It may be possible to bundle other more cost-effective services together with free duct sealing services to improve the overall economics of the delivery method. We also recommend that free duct sealing services be expanded in heating zone 2, since this region currently appears to be underserved and energy savings may be higher with the colder climate.

Introduction

Energy Trust used an impact analysis tool built by Recurve Analytics to evaluate electric savings from free manufactured home air and duct sealing services delivered by trade ally contractors from 2013 to 2018. Energy Trust's Residential program has provided incentives to a network of contractors since 2006 to provide duct sealing services to eligible manufactured homes in Oregon free of charge. Later, in 2013, the program began to offer free air sealing services as well. The focus has been on repairing and sealing leaky duct work in homes with ducted forced air furnaces, which are primarily electric resistance systems, although a small minority have gas furnaces. Homes with leaky building shells may also qualify to receive air sealing, where a contractor applies sealant to gaps and cracks in the floor, walls, or around windows and doors. This this service has not provided as frequently as duct sealing. The contractors identify eligible homes, assess the potential energy savings of air and duct sealing through pressure testing, and perform any needed work. In cases where the duct work is in disrepair, additional incentives are provided for the contractors to make needed repairs. Duct sealing projects involving significant repairs are known as "complex duct sealing" and tracked as a distinct service. Complex duct sealing projects require pre-approval by the program, have higher quality assurance standards, and require more documentation from the contractor, including submission of photos of the duct work.

The Recurve impact analysis tool uses monthly utility billing data to conduct pre/post analyses of whole home energy usage. Energy usage data are weather normalized using typical meteorological year data. Normalized annual energy usage in the year immediately preceding the installation is compared with that of the year immediately following installation. The change in normalized annual energy usage is then evaluated against changes in energy usage during the same time period in two comparison groups—a site-level, matched, non-participant comparison group and a group of homes that received the same services in later years (future participants). These calculations provide two estimates of the average annual energy savings resulting from the measures, given typical weather conditions. If both estimates are based on sufficient sample sizes, we simply take the average as our best estimate of energy savings and note cases where that was not possible. Lastly, several standard data screens are applied to remove atypical homes from the analysis.

The Recurve snapshot reports that follow this memo, and the summary or results below, show that overall electricity savings for duct sealing were lower than expected, but statistically significant. We did not find any evidence of energy savings associated with air sealing alone. Combined air and duct sealing projects had similar savings to duct sealing only projects. We analyzed each of these project types along several dimensions, including heating zone. 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. Most of our analyses spanned across heating zones because projects in heating zone 2 were relatively rare, and so that we could identify other factors that may be more important. We also analyzed the results by size of manufactured home, project type (whether complex or standard duct sealing was completed), the interaction of home size and project type, and project year.

Duct Sealing Results

Overall savings. There were 1,596 electrically heated manufactured homes analyzed that received duct sealing and no other measures. These homes had average annual baseline electricity usage of 14,200 kWh.

From 2013 to 2018, overall electric savings averaged 480 kWh per year (+/- 80 kWh) or 3% of baseline electricity usage. The expected savings for this measure was 600 kWh per home per year, so the overall realization rate was 80%. These homes were distributed across Energy Trust's electric service territory in Oregon but concentrated in the Portland Metro, Salem, Roseburg, and Medford areas.

Heating zone impact. For heating zone 1, across all years, duct sealing in electrically heated homes saved an average of 470 kWh per year (+/- 80) or 3% of baseline electricity usage. There were 1,537 duct sealing projects analyzed in heating zone 1, which had average annual baseline electricity usage of 14,200 kWh. These homes were distributed across heating zone 1 but concentrated in the Portland Metro, Salem, Roseburg, and Medford areas. Heating zone 1 results were nearly identical to the overall results because 96% of homes in the treatment group were in heating zone 1.

For heating zone 2, average electric savings were 600 kWh per year (+/- 620) or 4% of baseline electricity usage. There were just 59 duct sealing projects analyzed in heating zone 2, which had average annual baseline electricity usage of 16,000 kWh. We have low confidence in the savings estimate for heating zone 2, which is not statistically different from heating zone 1, due to the relatively small sample size and low precision. In addition, there were not enough future participants to create a reliable comparison group, so zone 2 savings are based only on the matched comparison group. Although the estimate is not reliable, this result indicates that duct sealing may achieve slightly higher electric savings in heating zone 2, which we would expect for homes in a colder climate.

The results by heating zone are shown in Chart 1, below.

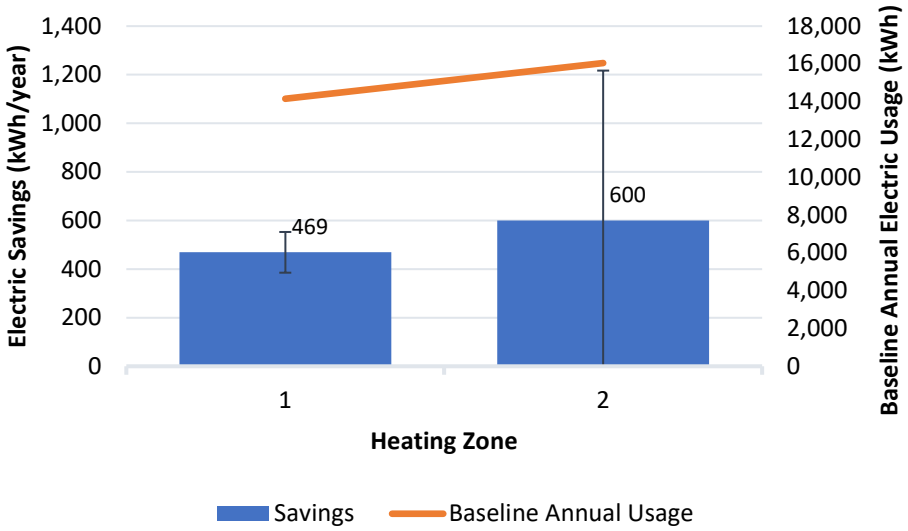


Chart 1: Manufactured home duct sealing electric savings by heating zone

Home size impact. For single-wide manufactured homes, across all years, duct sealing in electrically heated homes saved an average of 300 kWh per year (+/- 150) or 2% of baseline electricity usage. There were 494 duct sealing projects analyzed in single-wide homes, representing 31% of the sample, which had average annual baseline electricity usage of 12,700 kWh.

For double-wide manufactured homes, average electric savings were 520 kWh per year (+/- 120) or 3% of baseline electricity usage. There were 970 duct sealing projects analyzed in double-wide homes, representing 61% of the sample, which had average annual baseline electricity usage of 14,900 kWh.

For triple-wide manufactured homes, average electric savings were 1,160 kWh per year (+/- 1,080) or 6% of baseline electricity usage. There were just 49 triple-wide duct sealing projects analyzed, representing 3% of the sample, which had an average annual baseline electricity usage of 19,000 kWh. There were an insufficient number of triple-wide homes to create a reliable matched comparison group, so these savings are based only on the future participant group. Although we have low confidence in the savings estimate for triple-wide homes, due to the small sample size and low precision, there does appear to be a correlation between home size and savings.

Duct sealing in double wide manufactured homes saved 220 kWh per year more than in single-wide homes, and savings in triple-wide homes, although uncertain, appear to be higher than double-wide homes. The results by home size are shown in Chart 2, below.

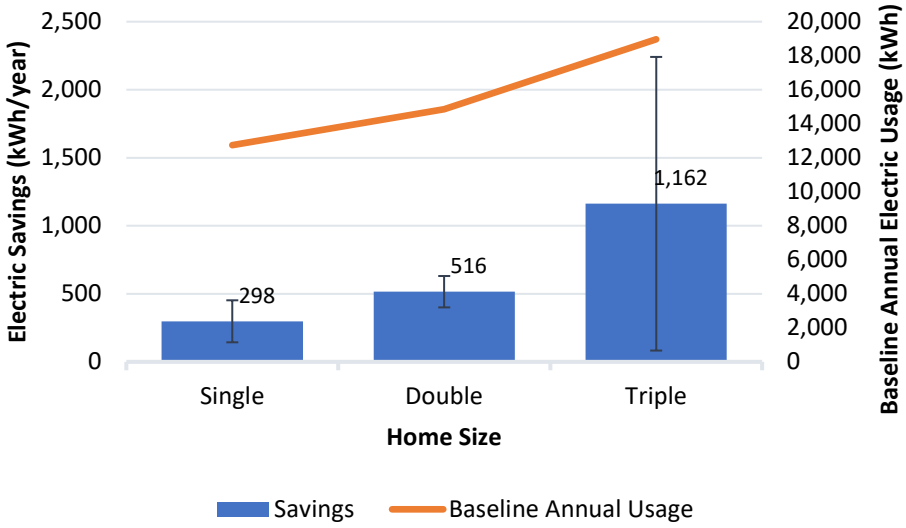


Chart 2: Manufactured home duct sealing electric savings by home size

Project type impact. For complex duct sealing projects, across all years, electrically heated manufactured homes saved an average of 1,040 kWh per year (+/- 210) or 6% of baseline electricity usage. There were 331 complex duct sealing projects analyzed in manufactured homes, representing 21% of the sample, which had average annual baseline electricity usage of 16,000 kWh. For standard duct sealing projects, average electric savings were 330 kWh per year (+/- 90) or 2% of baseline electricity usage. There were 1,266 standard duct sealing projects analyzed, representing 79% of the sample, which had average annual baseline electricity usage of 13,800 kWh. The 710 kWh per year difference in savings between complex and standard duct sealing projects was statistically significant. The results by project type are shown in Chart 3, below.

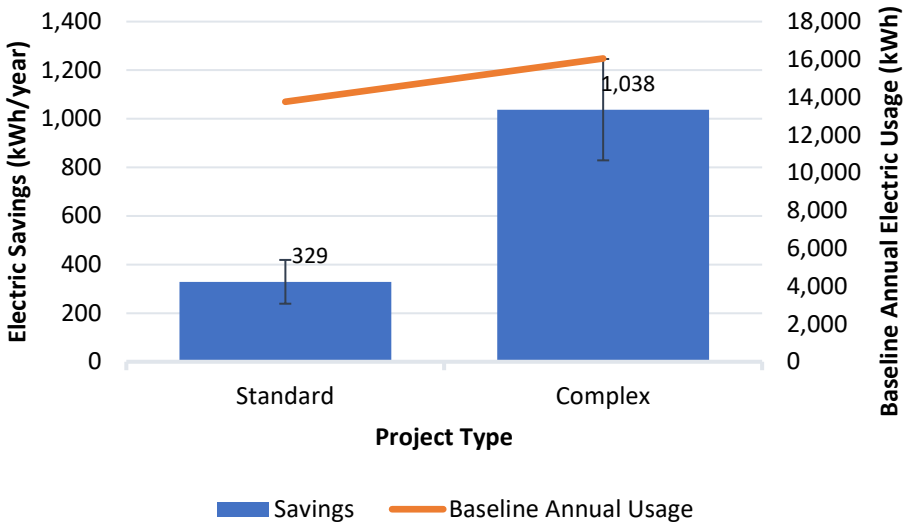


Chart 3: Manufactured home duct sealing electric savings by project type

Project type impact in single-wide homes. Within single-wide manufactured homes, complex duct sealing saved an average of 1,038 kWh per year (+/- 514), or 7% of baseline electricity usage. There were just 54 complex duct sealing projects in single-wide homes, representing 3% of the sample and 11% of single-wide homes, which had average annual baseline electricity usage of 14,700 kWh.

By comparison, single-wide homes with standard duct sealing projects saved an average of just 218 kWh per year (+/- 161), or 2% of baseline electricity usage. There were 440 standard duct sealing projects in single-wide homes analyzed, representing 28% of the sample and 89% of single-wide homes, which had average annual baseline electricity usage of 12,500 kWh. The average difference between complex and standard duct sealing electric savings in single-wide homes of 820 kWh was statistically significant, although slightly smaller than in double-wide homes.

Project type impact in double-wide homes. The highest duct sealing electric savings were observed in double-wide manufactured homes with complex duct sealing projects, at 1,210 kWh per year (+/- 250) or 7% of baseline electricity usage. There were 247 complex duct sealing projects in double-wide homes analyzed, representing 15% of the sample and 25% of double-wide homes, which had average annual baseline electricity usage of 16,300 kWh.

By comparison, electric savings for double-wide homes with standard duct sealing projects saved an average of just 270 kWh per year (+/- 130), or 2% of baseline electricity usage. There were 723 standard duct sealing projects in double-wide homes analyzed, representing 45% of the sample and 75% of double-wide homes, which had average annual baseline electricity usage of 14,400 kWh. The average difference between complex and standard duct sealing electric savings in double-wide homes was 940 kWh, which was statistically significant.

The results by home size and project type, combined, are shown in Chart 4, below.

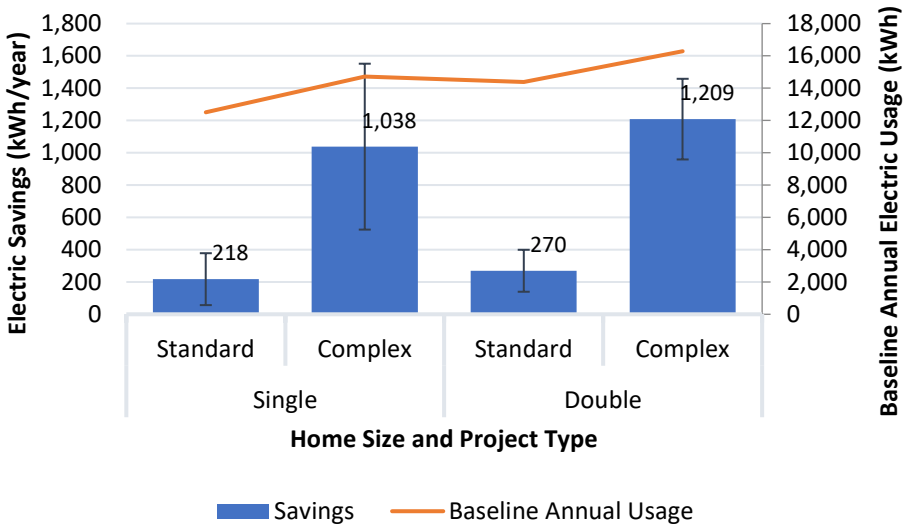


Chart 4: Manufactured home duct sealing electric savings by home size and project type

Trend over time. We analyzed electric savings for each year individually, from 2013 to 2018, to see if there were any changes in savings occurring over time. While there is not a consistent trend, it appears that electric savings for duct sealing has decreased somewhat over time. This decline in savings was associated with a decline in project volumes and baseline annual electricity usage. The trend over time in savings is shown in Chart 5, below.

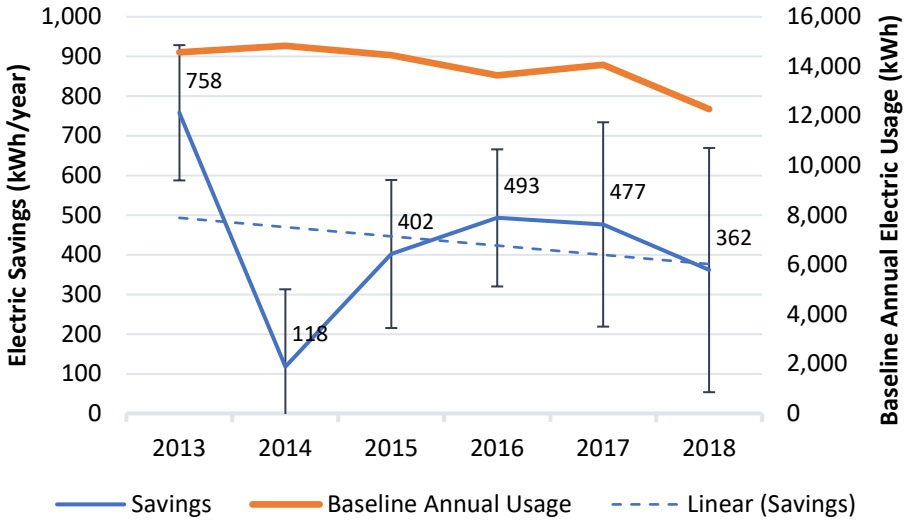


Chart 5: Manufactured home duct sealing electric saving by year, 2013-2018

Reliability of results. For the overall analysis of duct sealing electric savings, and most of the subgroups discussed above, both the matched comparison groups and future participant comparison groups provided relatively good representations of the baseline electricity usage in the treatment group. There were some cases where one of the comparison groups did not fit the treatment group as well as the other, and there were two cases where only one of the comparison groups had a large enough sample to be used. In all cases, the comparison groups provided a reasonable point of comparison, as similar manufactured homes, that did not receive free duct sealing services. Many of the groups analyzed had

relatively large sample sizes and moderate levels of precision which gives us confidence in these results. We assessed the results for each analysis scenario, based on sample size, level of agreement between comparison groups, magnitude of savings, and relative precision, and provided a confidence rating. While we have high or moderate confidence in many of the results, there are eight scenarios where we have low confidence in the value of the point estimate. However, in most cases, these point estimates seem to fit roughly into a larger trend.

Summary of results. In Table 1, below, we summarize the results of the various duct sealing scenarios analyzed. Results are provided in annual kWh savings for electrically heated homes that received duct sealing from 2013 to 2018. For most analyses, we combined the two heating zones to preserve sample sizes. We present the midpoint savings estimate of the two comparison group methodologies (matched non-participants and future participants).

Table 1: Summary of manufactured home duct sealing electric savings results, 2013-2018

Heating Zone	Home Size	Project Type	Years	N*	Baseline Energy Usage	Average Savings**	Absolute Precision**	Percent Savings**	Conf. Level
All	All	All	All	1,596	14,217	476	+/- 84	3.3%	High
1	All	All	All	1,537	14,157	469	+/- 84	3.3%	High
2	*All*	*All*	*All*	*59*	*16,046*	*600†*	*+/- 617†*	*3.7%†*	*Low*
All	Single	All	All	494	12,741	298	+/- 154	2.3%	Moderate
All	Double	All	All	970	14,859	516	+/- 115	3.5%	Moderate
All	*Triple*	*All*	*All*	*49*	*18,965*	*1,162‡*	*+/- 1,079‡*	*6.1%‡*	*Low*
All	All	Standard	All	1,266	13,758	329	+/- 90	2.4%	Moderate
All	All	Complex	All	331	16,049	1,038	+/- 209	6.5%	Moderate
All	Single	Standard	All	440	12,508	218	+/- 161	1.7%	Low
All	Double	Standard	All	723	14,377	270	+/- 130	1.9%	Moderate
All	*Single*	*Complex*	*All*	*54*	*14,725*	*1,038*	*+/- 514*	*7.0%*	*Low*
All	Double	Complex	All	247	16,289	1,209	+/- 250	7.4%	Moderate
All	All	All	2013	464	14,573	758	+/- 171	5.2%	Moderate
All	All	All	2014	335	14,829	118	+/- 195	0.8%	Low
All	All	All	2015	292	14,446	402	+/- 187	2.8%	Moderate
All	All	All	2016	281	13,638	493	+/- 173	3.6%	Moderate
All	All	All	2017	140	14,065	477	+/- 258	3.4%	Low
All	All	All	2018	87	12,275	362	+/- 308	2.9%	Low

Note: results based on less than 60 treatment sites may be unreliable and are displayed in *italics*.

* N is the final treatment group sample size in the analysis.

** The average savings, absolute precision and percent savings values represent the midpoint estimates between the two comparison group methodologies used, except where otherwise noted.

† These savings, precision, and percent savings values are based on the matched comparison group alone. There were not enough future participants to create a separate comparison group.

‡ These savings, precision, and percent savings values are based on the future participant comparison group alone. There were not enough non-participant triple-wide homes to create a separate comparison group.

Air Sealing Results

Overall savings. There were 62 electrically heated manufactured homes analyzed that received air sealing and no other measures. These homes had average annual baseline electricity usage of 11,870 kWh. These homes were spread along the I-5 corridor in Western Oregon and concentrated in the Portland Metro and Medford areas. From 2013 to 2018, overall electric savings averaged just 30 kWh per year (+/- 530 kWh) or 0% of baseline electricity usage. The expected savings for this measure was 585 kWh per home per year, so the overall realization rate was 5%. These results were not statistically different from zero, so provide no evidence of energy savings for air sealing. There were an insufficient number of homes that received air sealing alone to conduct further analysis. We provide further assessment of air sealing savings below in the section on air and duct sealing combined.

Reliability of results. For the overall analysis of air sealing electric savings, the matched comparison groups and future participant comparison groups provided relatively good representations of the baseline electricity usage in the treatment group. Thus, the comparison groups provided a reasonable point of comparison, as similar manufactured homes, that did not receive free air sealing services. However, the two comparison groups yielded wildly different results, one resulted in a savings estimate of 290 kWh per year and the other resulted in an estimate of -230 kWh per year. When taken together, these two estimates averaged out to essentially zero. Our confidence in the savings estimate for air sealing is low, given the relatively small sample size, disagreement between the two comparison groups, small magnitude of savings, and low precision.

Summary of results. In Table 2, below, we summarize the results of the air sealing analysis. Results are provided in annual kWh savings for electrically heated homes that received air sealing from 2013 to 2018. We present the midpoint savings estimate of the two comparison group methodologies (matched non-participants and future participants).

Table 2: Summary of manufactured home air sealing electric savings results, 2013-2018

Heating Zone	Home Size	Project Type	Years	N*	Baseline Energy Usage	Average Savings**	Absolute Precision**	Percent Savings**	Conf. Level
All	All	All	All	62	11,870	31	+/- 535	0.3%	Low

* N is the final treatment group sample size in the analysis.

** The average savings, absolute precision and percent savings values represent the midpoint estimates between the two comparison group methodologies used, except where otherwise noted.

Air and Duct Sealing Results

Overall savings. There were 1,333 electrically heated manufactured homes analyzed that received both air and duct sealing services. These homes had average annual baseline electricity usage of 14,100 kWh. From 2013 to 2018, overall electric savings averaged 470 kWh per year (+/- 90 kWh) or 3% of baseline electricity usage. The expected savings for this measure was 760 kWh per home per year, so the overall realization rate was 62%. This estimate is nearly identical to the overall savings for duct sealing alone and is statistically indistinguishable. This provides further evidence that air sealing services in manufactured homes did not save energy. These homes were distributed across Energy Trust's electric service territory in Oregon but concentrated in the Portland Metro, Salem, Roseburg, and Medford areas.

Heating zone impact. There were an insufficient number of homes available in heating zone 2 to analyze energy savings for air and duct sealing combined. For heating zone 1, across all years, air and duct sealing combined in electrically heated homes saved an average of 470 kWh per year (+/- 90) or 3% of baseline electricity usage. There were 1,319 air and duct sealing projects analyzed in heating zone 1, which had average annual baseline electricity usage of 14,000 kWh. These homes were distributed across heating zone 1 in Western Oregon but concentrated in the Portland Metro, Salem, Roseburg, and Medford areas. Heating zone 1 results were identical to the overall results because 99% of homes in the treatment group were in heating zone 1. This savings estimate is also identical to the heating zone 1 results for duct sealing alone, again reinforcing that the air sealing component of this service did not save energy.

Home size impact. For single-wide manufactured homes, across all years, air and duct sealing combined in electrically heated homes saved an average of 420 kWh per year (+/- 130) or 3% of baseline electricity usage. There were 657 air and duct sealing projects analyzed in single-wide homes, representing 49% of the sample, which had average annual baseline electricity usage of 13,000 kWh.

For double-wide manufactured homes, average electric savings were 610 kWh per year (+/- 140) or 4% of baseline electricity usage. There were 567 air and duct sealing projects analyzed in double-wide homes, representing 43% of the sample, which had average annual baseline electricity usage of 15,200 kWh.

There were not enough triple-wide homes that received air and duct sealing available to analyze energy savings.

The difference in estimated savings between single- and double-wide homes is 190 kWh, which seems non-trivial, but is not statistically significant. However, it makes intuitive sense with the higher baseline electric usage of double-wide homes and the trend is similar to duct sealing only projects.

Air and duct sealing project savings for both single- and double-wide homes are slightly higher than with duct sealing alone, although the differences are not statistically significant. While these differences may be attributable to the addition of air sealing, they may also be due to differences in the distribution of complex duct sealing projects or other factors, or simply random variability in energy usage or housing stock. The results by home size are shown in Chart 6, below.

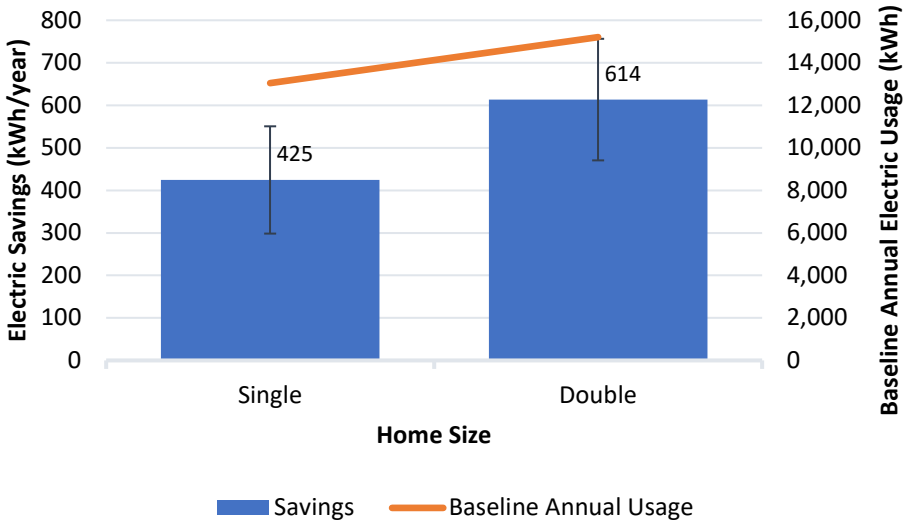


Chart 6: Manufactured home air and duct sealing combined electric savings by home size

Project type impact. For air and duct sealing projects with complex duct sealing, across all years, electrically heated manufactured homes saved an average of 750 kWh per year (+/- 180) or 5% of baseline electricity usage. There were 303 complex duct sealing projects analyzed in manufactured homes, representing 23% of the sample, which had average annual baseline electricity usage of 15,200 kWh.

For air and duct sealing projects with standard duct sealing, average electric savings were 380 kWh per year (+/- 100) or 3% of baseline electricity usage. There were 1,030 standard duct sealing projects analyzed, representing 77% of the sample, which had average annual baseline electricity usage of 13,700 kWh. The 370 kWh per year difference in savings between complex and standard duct sealing projects was statistically significant.

The savings for standard air and duct sealing projects was similar to that of standard duct sealing only projects. In addition, estimated savings for complex air and duct sealing projects was nearly 300 kWh less than for complex duct sealing only projects. As a result, the difference between complex and standard projects is somewhat smaller for air and duct sealing than for duct sealing alone. In this scenario, the addition of air sealing services appears to make little difference. The results by project type are shown in Chart 7, below.

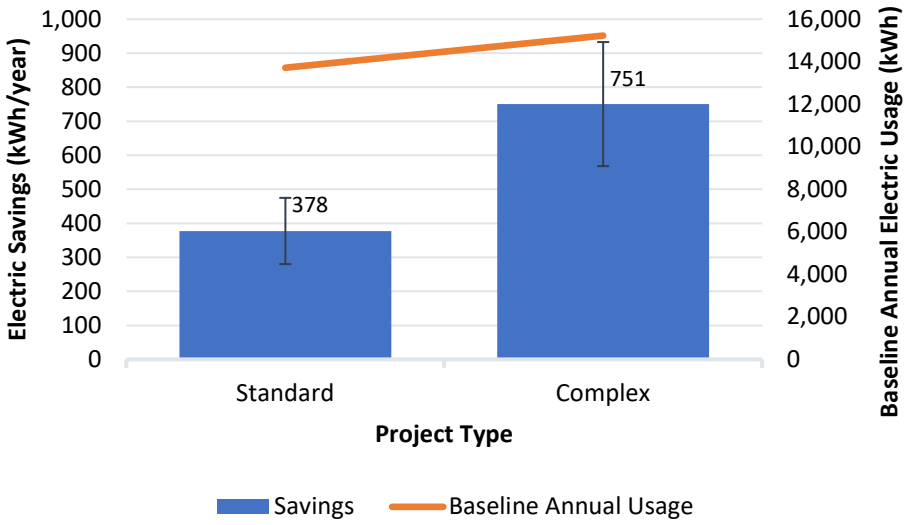


Chart 7: Manufactured home air and duct sealing combined electric savings by project type

Project type impact in single-wide homes. Within single-wide manufactured homes, air and duct sealing projects with complex duct sealing saved an average of 560 kWh per year (+/- 420), or 4% of baseline electricity usage. There were just 54 projects with complex duct sealing in single-wide homes, representing 4% of the sample and 8% of single-wide homes, which had average annual baseline electricity usage of 14,800 kWh.

Single-wide homes with standard air and duct sealing projects saved an average of 410 kWh per year (+/- 130), or 3% of baseline electricity usage. There were 600 standard air and duct sealing projects in single-wide homes analyzed, representing 45% of the sample and 91% of single-wide homes, which had average annual baseline electricity usage of 12,900 kWh. The average difference between complex and standard project electric savings in single-wide homes of 150 kWh was not statistically significant.

Project type impact in double-wide homes. The highest air and duct sealing combined electric savings were observed in double-wide manufactured homes with complex duct sealing projects, at 900 kWh per year (+/- 230) or 6% of baseline electricity usage. There were 219 projects with complex duct sealing in double-wide homes analyzed, representing 16% of the sample and 39% of double-wide homes, which had average annual baseline electricity usage of 15,500 kWh.

By comparison, electric savings for double-wide homes with standard air and duct sealing projects saved an average of just 380 kWh per year (+/- 180), or 3% of baseline electricity usage. There were 348 standard air and duct sealing projects in double-wide homes analyzed, representing 26% of the sample and 61% of double-wide homes, which had average annual baseline electricity usage of 15,000 kWh. The average difference between complex and standard project electric savings in double-wide homes was 520 kWh, which was statistically significant.

The results by home size and project type, combined, are shown in Chart 8, below.

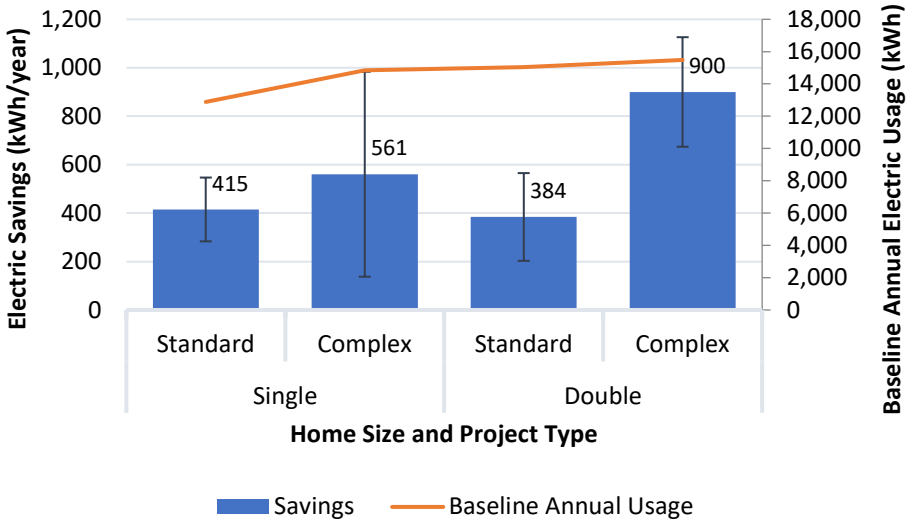


Chart 8: Manufactured home air and duct sealing combined electric savings by home size and project type

Trend over time. We analyzed electric savings for each year individually, from 2013 to 2018, to see if there were any changes in savings occurring over time. While there is not a consistent trend, it appears that electric savings for air and duct sealing has decreased somewhat over time. This decline in savings was associated with a decline in project volumes and baseline annual electricity usage. The trend over time in savings is shown in Chart 9, below.

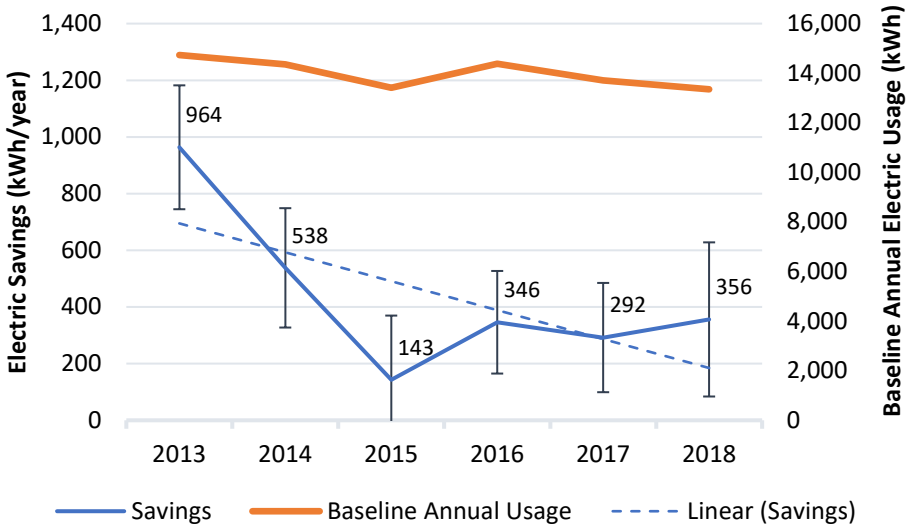


Chart 9: Manufactured home air and duct sealing combined electric saving by year, 2013-2018

Reliability of results. For the overall analysis of air and duct sealing combined electric savings, and most of the subgroups discussed above, both the matched comparison groups and future participant comparison groups provided relatively good representations of the baseline electricity usage in the treatment group. There were some cases where one of the comparison groups did not fit the treatment group as well as the other, and there was one case where only one of the matched comparison group had a large enough sample to be used. In all cases, the comparison groups provided a reasonable point of comparison, as similar manufactured homes, that did not receive free duct sealing services. Many of the groups analyzed had relatively large sample sizes and moderate levels of precision which gives us confidence in these results. We assessed the results for each analysis scenario, based on sample size, level of agreement between comparison groups, magnitude of savings, and relative precision, and provided a confidence rating. While we have high or moderate confidence in many of the results, there are eight scenarios where we have low confidence in the value of the point estimate. However, in most cases, these point estimates seem to fit roughly into a larger trend.

Summary of results. In Table 3, below, we summarize the results of the various air and duct sealing scenarios analyzed. Results are provided in annual kWh savings for electrically heated homes that received air and duct sealing from 2013 to 2018. For most analyses, we combined the two heating zones to preserve sample sizes. We present the midpoint savings estimate of the two comparison group methodologies (matched non-participants and future participants).

Table 3: Summary of manufactured home air and duct sealing electric savings results, 2013-2018

Heating Zone	Home Size	Project Type	Years	N*	Baseline Energy Usage	Average Savings**	Absolute Precision**	Percent Savings**	Conf. Level
All	All	All	All	1,333	14,061	469	86	3.3%	High
1	All	All	All	1,319	14,024	469	87	3.3%	High
2	*All*	*All*	*All*	*14*	--	--	--	--	--
All	Single	All	All	657	13,045	425	126	3.3%	Moderate
All	Double	All	All	567	15,208	614	143	4.0%	Moderate
All	*Triple*	*All*	*All*	*5*	--	--	--	--	--
All	All	Standard	All	1,030	13,718	378	97	2.8%	Moderate
All	All	Complex	All	303	15,230	751	182	4.9%	Moderate
All	Single	Standard	All	600	12,884	415	132	3.2%	Moderate
All	Double	Standard	All	348	15,037	384	181	2.6%	Moderate
All	*Single*	*Complex*	*All*	*54*	*14,844*	*561*	*423*	*3.8%*	*Low*
All	Double	Complex	All	219	15,483	900	226	5.8%	Moderate
All	All	All	2013	268	14,732	964	219	6.5%	Moderate
All	All	All	2014	262	14,349	538	211	3.7%	Moderate
All	All	All	2015	154	13,415	143	227	1.1%	Low
All	All	All	2016	267	14,386	346	181	2.4%	Low
All	All	All	2017	245	13,706	292	193	2.1%	Low
All	All	All	2018	139	13,350	356†	272†	2.7%†	Low

Note: results based on less than 60 treatment sites may be unreliable and are displayed in *italics*.

* N is the final treatment group sample size in the analysis.

** The average savings, absolute precision and percent savings values represent the midpoint estimates between the two comparison group methodologies used, except where otherwise noted.

† These savings, precision, and percent savings values are based on the matched comparison group alone. There were not enough future participants to create a separate comparison group.

Conclusions and Recommendations

The Recurve analysis of free duct sealing services provided to electrically heated manufactured homes found that electric savings were significant, but lower than expected in many scenarios. Duct sealing savings appeared to increase somewhat with home size and baseline energy usage. Savings also appeared to be slightly higher in heating zone 2, although, due to the low sample size, this finding is indicative of a trend rather than conclusive. Based on the low volume of projects completed in heating zone 2, it appears that this region may be significantly underserved. Baseline energy usage in single-wide homes was very low, on average, making it much more difficult to achieve significant energy savings from duct sealing.

Duct sealing project savings were dramatically higher for complex versus standard duct sealing projects. Complex duct sealing projects involved significant repairs to duct work, including reconnecting disconnected ducts, and have more rigorous quality assurance and documentation requirements. These homes tended to use substantially more energy prior to work being performed, and thus had higher energy savings potential, most likely because there was significant leakage of conditioned air from the

duct work prior to the project. Single-wide homes requiring complex duct repairs had baseline energy usage similar to that of typical double-wide homes. Also, of note, the complex duct sealing projects were much more common in double-wide manufactured homes than single-wide homes—complex duct sealing was completed 2.3 times more frequently in double-wide homes.

When duct sealing savings were analyzed by home size and project complexity together, the impact of project complexity strongly outweighed home size. The large effect of project complexity on savings was not significantly modified by home size and the difference in savings by home size persisted across project types. The largest savings were observed in double-wide homes completing complex duct sealing, while the lowest savings were observed in single-wide homes receiving standard duct sealing.

We observed a slight decreasing trend in energy savings over time for duct sealing projects, which was accompanied by a decrease in average baseline energy usage. There were also lower numbers of duct sealing projects completed over time, suggesting a possible decrease in the number of manufactured homes most in need of these services. Whatever the cause, energy savings for these services appear to be on the decline.

We found no evidence of independent electric savings from free air sealing services provide to electrically heated manufactured homes. Although the number of air sealing only projects was relatively small and the certainty of the savings estimate was low, the null result was corroborated by the analysis of combined air and duct sealing projects. The electric savings results for combined air and duct sealing projects were similar, across many dimensions, to the results for duct sealing only projects. This suggests that there are no incremental electric savings due to air sealing as a component of the combined air and duct sealing projects, at least that could be detected through billing analysis. The trends in savings described above, for duct sealing projects, were very similar for combined air and duct sealing projects.

We recommend either conducting a thorough review of the free air sealing service being provided, to determine why the energy savings are so poor, or ending this service altogether. There may be comfort or health benefits created through air sealing, associated with reducing drafts or noise, but it does not appear to be a good energy investment. We were not able to investigate comfort or health benefits through this analysis.

We recommend adopting new, deemed, electric savings values for manufactured home duct sealing services, based on these findings, and focusing on scenarios where energy savings were the highest. That said, from an equity perspective, it is important to continue providing services to single-wide homes, which represent the lowest-income households among manufactured home residents. It may be possible to bundle other more cost-effective services together with free duct sealing services to improve the overall economics of the delivery method. For instance, installation contractors could provide whole home LED changeouts, direct installation of smart thermostats, or other efficiency measures. We also recommend that free duct sealing services be expanded in heating zone 2, since this region currently appears to be underserved and energy savings may be higher with the colder climate.

Appendix A: Recurve Impact Analysis Reports
Duct Sealing Alone

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

1,596 Treatment Meters	386 +/- 93 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,217 Mean Baseline Consumption (Electricity)	47% Realization Rate
7,868 Site-level Matched Meters	467 +/- 99 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	13,755 Mean Baseline Consumption (Electricity)	57% Realization Rate
1,091 Future Participant Meters	484 +/- 148 kWh Average Savings Relative to Future Participant Group	3 +/- 1% Savings Relative to Future Participant Group	13,509 Mean Baseline Consumption (Electricity)	59% Realization Rate

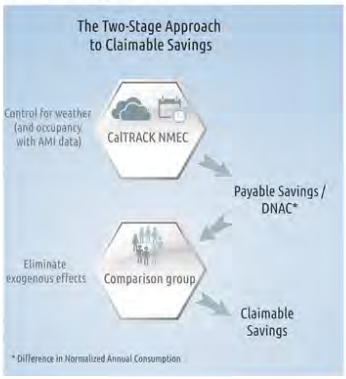
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group

The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

133.9 miles

80% of projects lie within this distance from treatment group centroid

1,596
Meters

14,217
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group

This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

2.2 miles

Distance between treatment and comparison group centroids

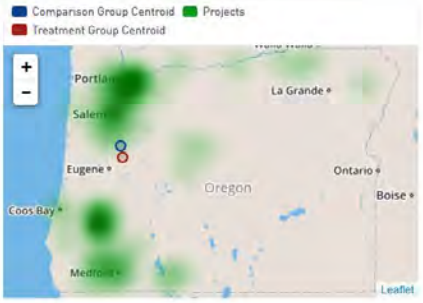
7,868
Meters

13,755
Mean Baseline Consumption (Electricity)

Future Participant Group

The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations

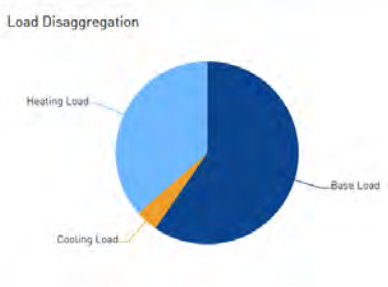


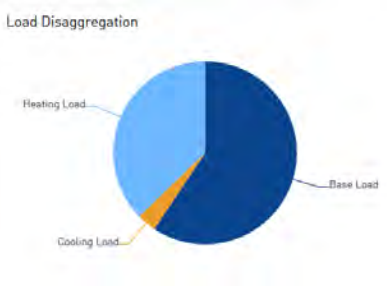
13.6 miles

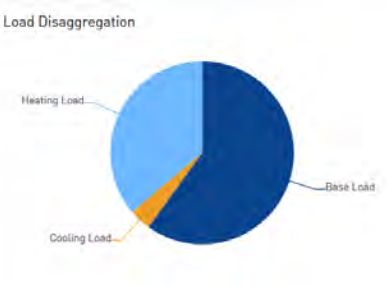
Distance between treatment and future participant group centroids

1,091
Meters

13,509
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	1,596	29%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

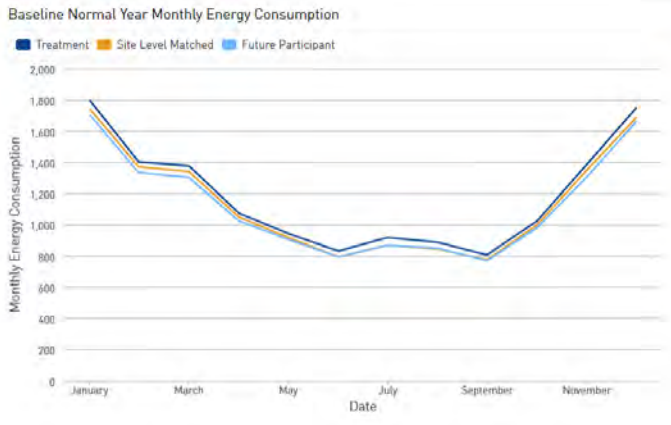
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- ... Measure: Airduct -- Year: 2014, 2013, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

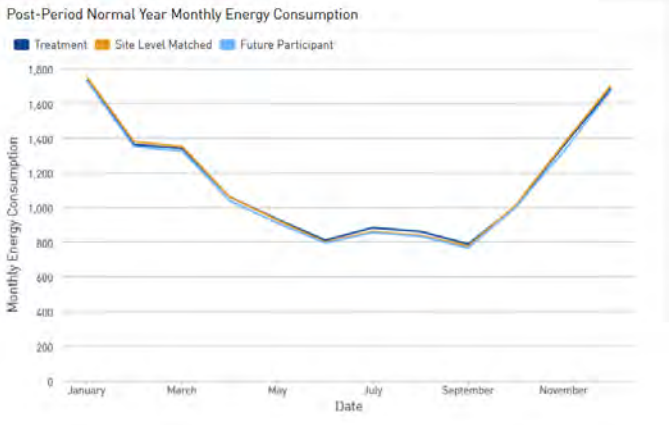
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,993
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	2,993
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	1,397	1,596
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	1,596

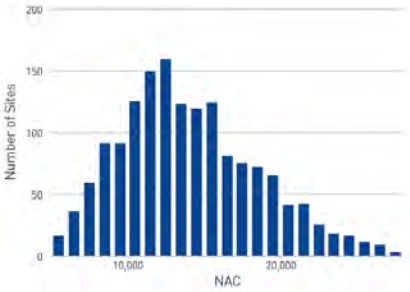
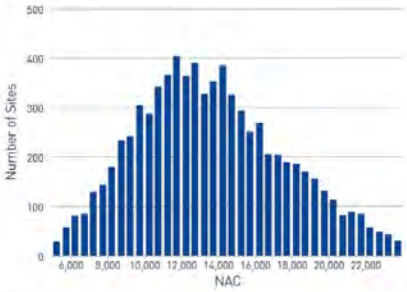
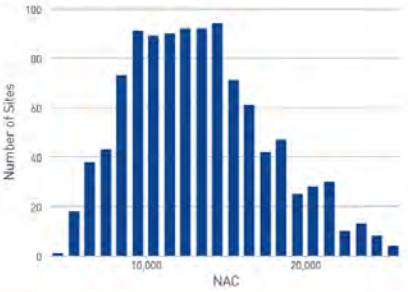
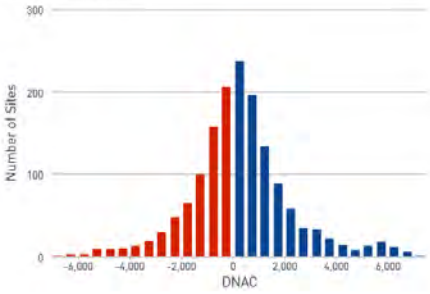
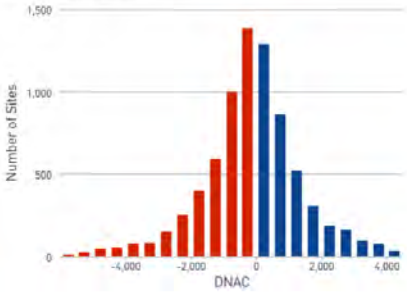
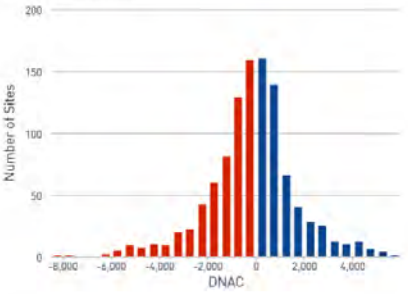
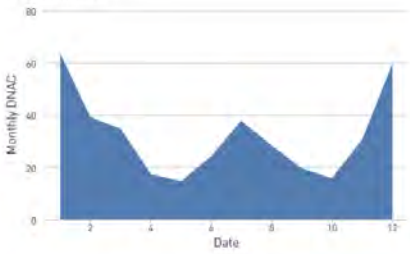
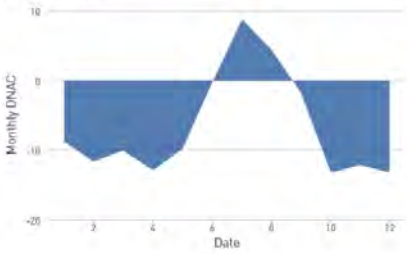
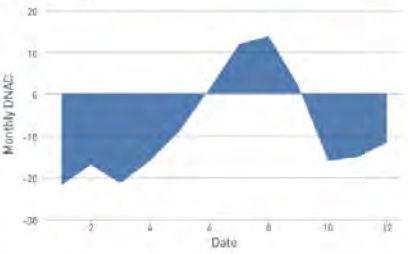
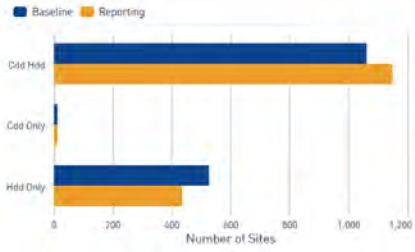
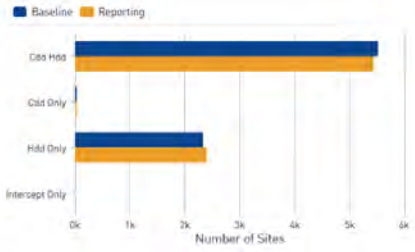
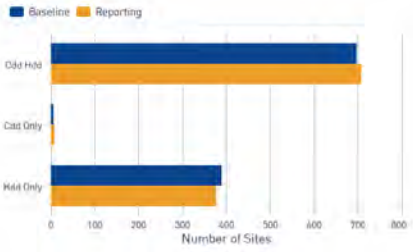
3. Modeling Results

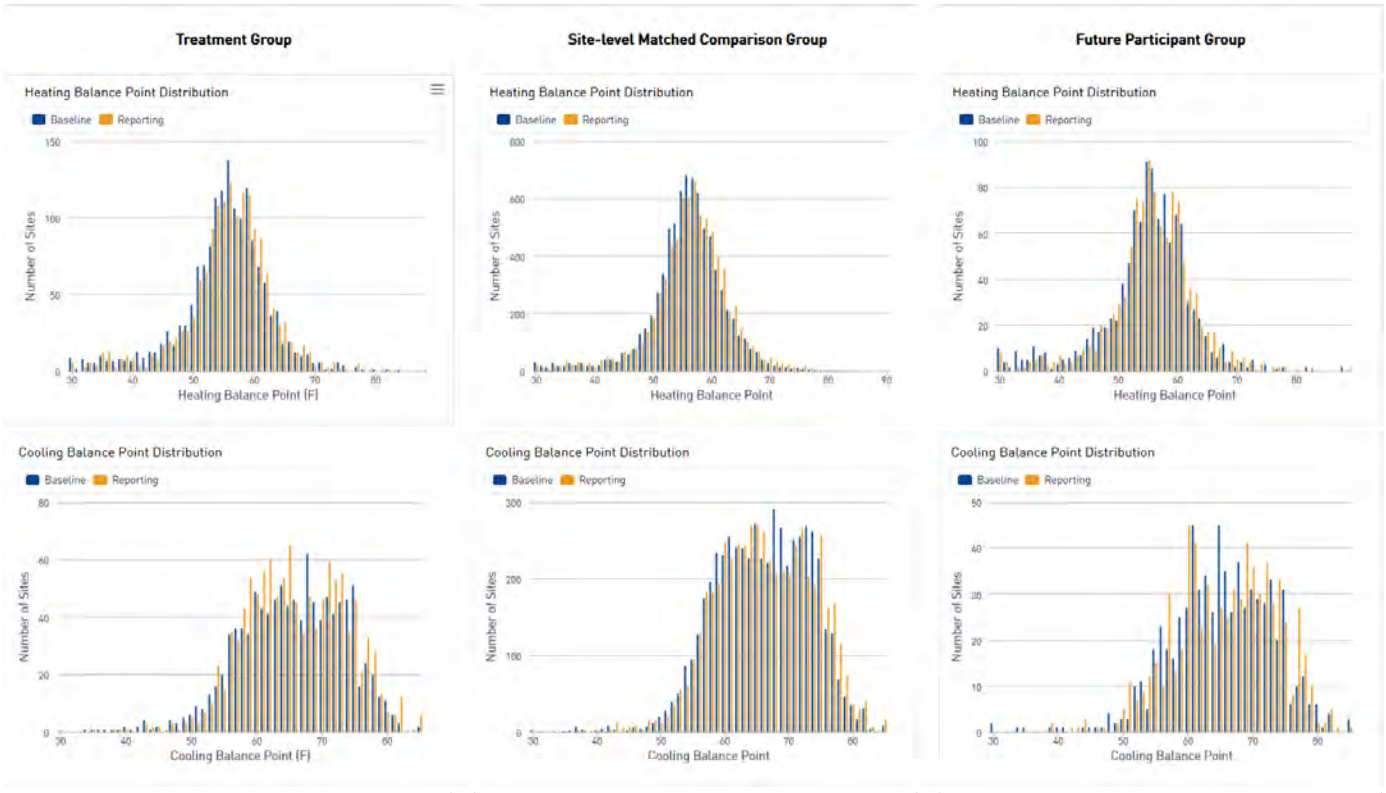
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.0736 Annual Consumption p-value	0.145 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
386 +/- 93 kWh Average Difference in Normalized Annual Consumption per Participant	3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-81 +/- 34 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 0 % Difference in Normalized Annual Consumption as a Percent of Baseline	-98 +/- 116 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		



4. Methodology

CalTRACK and Comparison Group Methods
Documentation: docs.caltrack.org
Code: https://github.com/energy-market-methods/caltrack

Data Preparation

Baseline period: Since the predicted baseline may be unstable with different baseline period lengths, which may, in turn, affect calculated savings, the consensus of the CalTRACK 2.0 working group was to set the maximum baseline period at 12 months, since the year leading to the energy efficiency intervention is the most indicative of recent energy use trends and prolonging the baseline period increases the chance of other unmeasured factors affecting the baseline. In addition, CalTRACK uses a minimum 12-month baseline by default.

Blackout period: The blackout period refers to the time period between the end of the baseline period and the beginning of the reporting period. In this analysis, it is specified to coincide with the project installation time period, meaning that the billing period that contains the project installation date is dropped from the analysis.

Analysis periods: Different portions of the analysis used different time periods of consumption data, therefore, it is useful to clearly define these time periods and where they were used. Consider a project with an installation date on a particular day d in a particular month m in a particular program year y. The year before the program year is labelled as y-1, the year prior to that as y-2 and so on, while the years following the program year are labelled y+1, y+2 etc. In all cases, the billing period that contains the project installation was dropped from the analysis. Other sections of the analysis use the following time periods:
- *Treatment and site-level matched groups:* Baseline period includes the 12 months preceding the installation billing period. Reporting period includes the 12 months following the installation billing period.
- *Future participant group:* Baseline period is the calendar year preceding the program year (Year *y-1*). Reporting period is the program year itself (Year *y*).
- Site-level consumption matching was performed using the 12 months of data immediately prior to the project installation date.
- Equivalence tests were performed using data from the previous calendar year (y-1).

Modeling

Weather Normalization: Weather normalization of billing data in CalTRACK follows certain model foundations in literature (PRISM, ASHRAE Guideline 14, IPMVP Option C and the Uniform Methods Project for Whole Home Building Analysis). Building energy use is modeled as a combination of base load, heating load, and cooling load. Heating load and cooling load are assumed to have a linear relationship with heating and cooling demand, as approximated by heating and cooling degree days, beyond particular heating and cooling balance points. A number of candidate OLS models are fit to the consumption data using different combinations of heating and cooling balance points (ranging from 30 to 90 F) and different sets of independent variables. The model with the highest adjusted R-squared that contains strictly positive coefficients is selected as the final model and used to calculate normalized energy usage.

Model Types: CalTRACK specifies a linear relationship between energy use and temperature as reflected in the building consumption profile. In the most generic case, a model would include an intercept term, a heating balance point and heating slope coefficient, and a cooling balance point and a cooling slope coefficient. Depending on the fuel a building uses for heating or cooling or its consumption patterns, models with a single temperature coefficient and balance point (i.e., heating or cooling) may be more appropriate.

Difference in Normalized Annual Consumption (DNAC): The DNAC is calculated by using two CalTRACK regression models in conjunction with Typical Meteorological Year (TMY3) weather data, as follows:
- Two models are fit to the consumption data - one model for the baseline (pre-intervention) period and one for the reporting (post-intervention) period.
- Long-term heating and cooling degree days based on TMY3 data are substituted in both regression equations to calculate the Normalized Annual Consumption (NAC) for each period. TMY3 data is maintained by NREL and includes weather averages for 1020 locations in the US between 1991-2005.
- DNAC is determined by subtracting the two NACs (DNAC = Baseline NAC - Reporting NAC).

Disaggregation: Disaggregated loads are calculated from the different components of the statistical model fit. The weather sensitive components (heating and cooling load) are calculated by multiplying the relevant model coefficients (beta_hdd or beta_cdd) by the total degree days in a normal weather year (total HDD or CDD). For each site, the total HDD or CDD can be calculated using that site's estimated degree day balance points (also an output of the model) and the temperature for its closest weather station. The base load is estimated by multiplying the intercept of the statistical model by the number of days (365 for a full year).

Savings calculation: Savings are calculated by subtracting the DNAC for either comparison group from the DNAC for the treatment group.

Savings Uncertainty: Uncertainty presented in this analysis is calculated using the ASHRAE Guideline 14 formulation for aggregating the prediction uncertainty of point estimates in a time series. It is calculated at a 90% confidence level. The total uncertainty at the site-level is calculated using the sum of squares of the baseline and reporting models. Other aggregate uncertainty values (e.g. for a portfolio or for a difference-in-differences estimate) are also aggregated using the square root of the sum of squares.

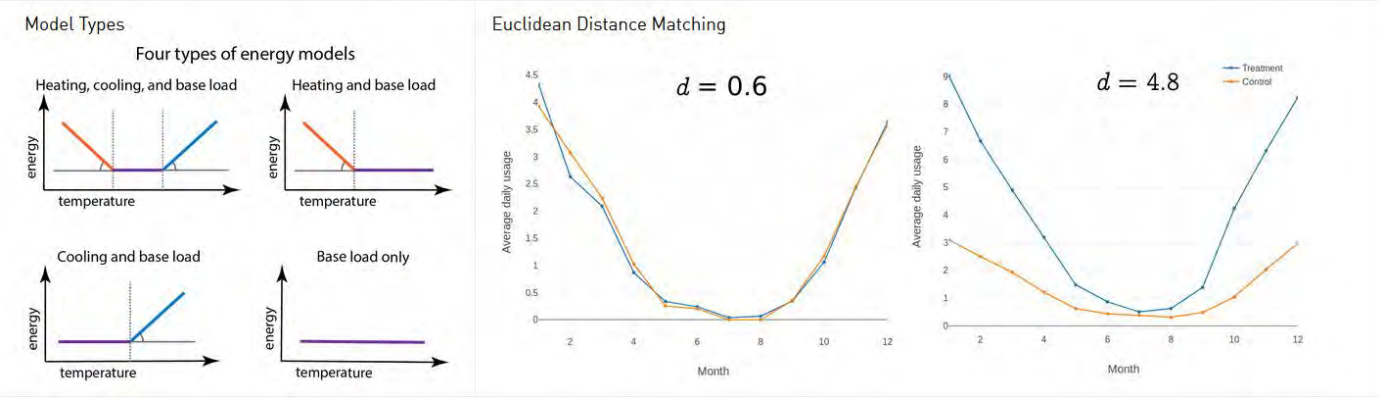
Comparison Group Generation

Site-level Matching: In monthly consumption matching, a comparison group is constructed by selecting 20 matches from the comparison group pool with the shortest distance d to the treatment group customer under consideration. After applying the selected filters on the comparison group, the comparison group is filtered down to the closest 5 matches to each treatment group member. The pool is limited to non-participants within the same zipcode as the treatment group customer. The distance d is, in essence, a way to reduce 12 monthly consumption differences between any two customers to one metric (see Figure). In the present analysis, we selected twenty nearest neighbors for each treatment site based on the Euclidean distance of monthly consumption.

Future Participant Groups: Comparison groups comprising future participants are considered to be representative of participants in most aspects (observable and non-observable). For example, future participants are known to be eligible to receive the measure, and for some measures, they may have the same baseline equipment as the participants. Future participants have the same propensity to participate in the program as participants, thus reducing or eliminating self-selection bias, something that is otherwise difficult to control for in a quasi-experimental study. More comprehensive data is typically collected for future participants, allowing for potentially better matching and more insightful analysis. From a practical perspective, future participant groups may be difficult to construct for all measures, unless a program has been running for multiple years and is considered stable with sufficient data collection over the analysis period. Sample sizes for the comparison group may also be constrained if using future participants.

Stratified sampling is applied to future participant groups to attempt to replicate the distributions of the underlying variable (annual consumption) in the comparison group. Annual consumption of all treatment sites is first split into deciles, then a random sample is selected from within each corresponding bin in the comparison group pool of future participants.

Sampling method: In all cases where sampling was required from the comparison group, sampling was performed without replacement.



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Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: 1 - Hdd <= 6000	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

1,537 Treatment Meters	385 +/- 93 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,157 Mean Baseline Consumption (Electricity)	47% Realization Rate
7,581 Site-level Matched Meters	464 +/- 99 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	13,681 Mean Baseline Consumption (Electricity)	57% Realization Rate
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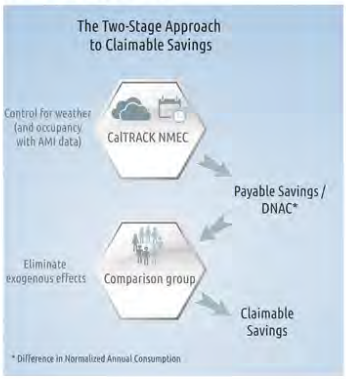
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

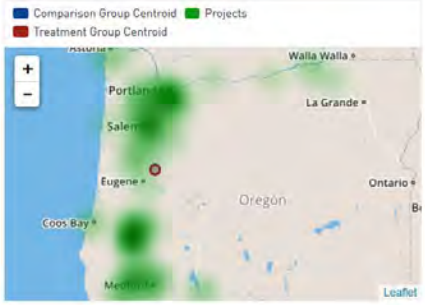
134.2 miles
80% of projects lie within this distance from treatment group centroid

1,537
Meters

14,157
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



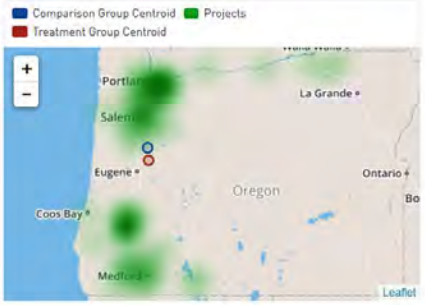
2.1 miles
Distance between treatment and comparison group centroids

7,581
Meters

13,681
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

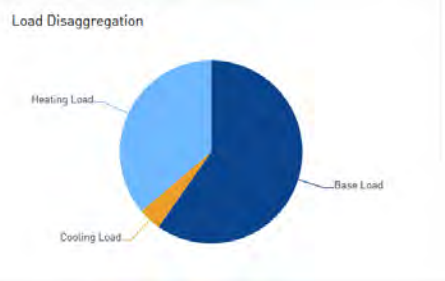
Future Participant Site Locations

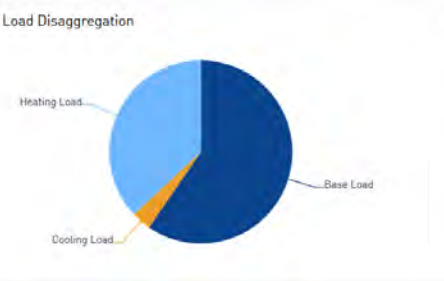


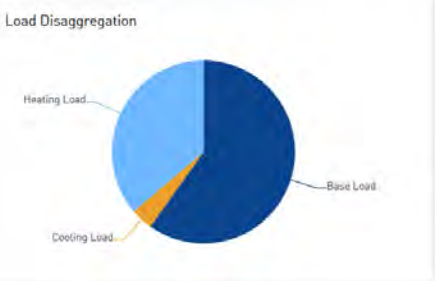
13.7 miles
Distance between treatment and future participant group centroids

1,074
Meters

13,488
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	1,537	28%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

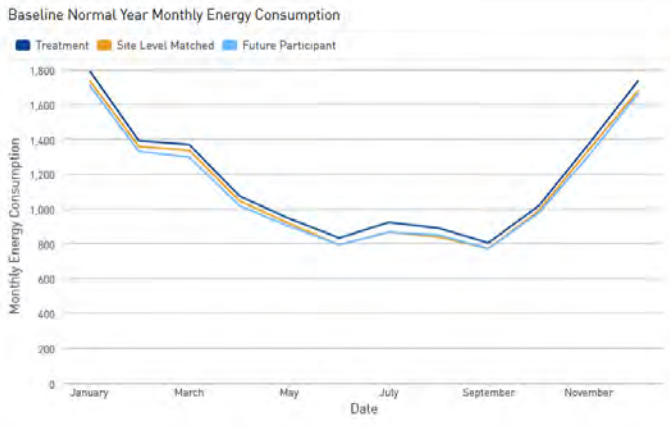
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: 1 - Hdd <= 6000 -- Cooling Zone: All	152	4,774
Other measure-specific filters.	--	0	4,774
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,414	3,360
Meters with at least 5 site-level matched meters from the comparison group pool.	--	72	3,288

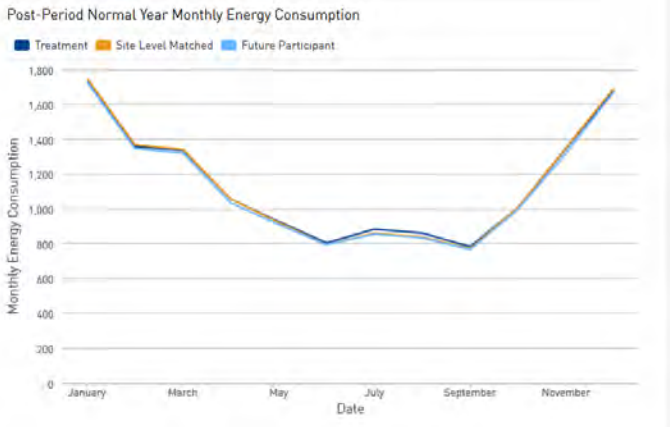
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	23	3,265
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,265
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,249
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	329	2,920
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,920
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,920
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	2,920
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	1,383	1,537
likely_gas_water_heating: Meters with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	1,537

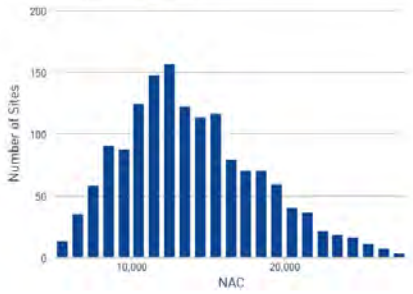
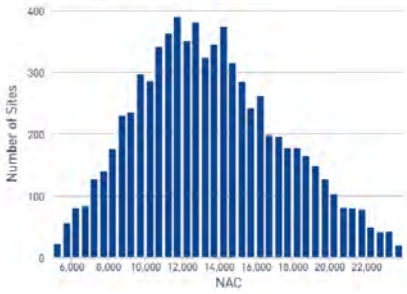
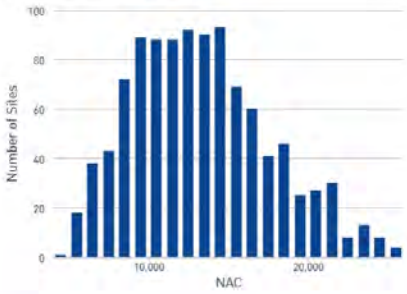
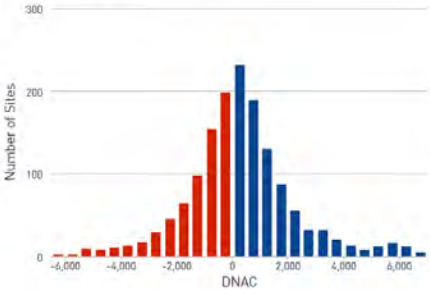
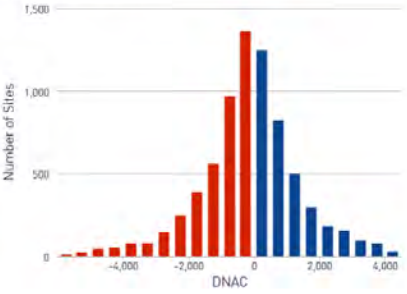
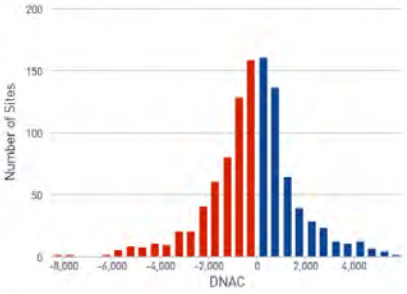
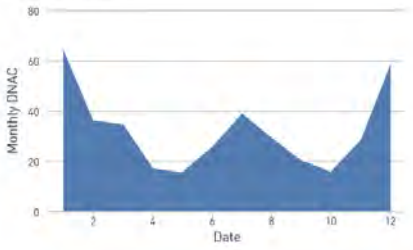
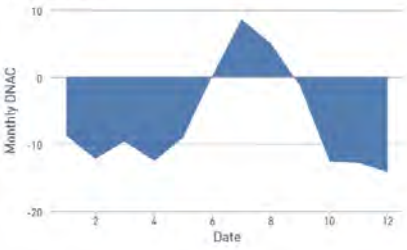
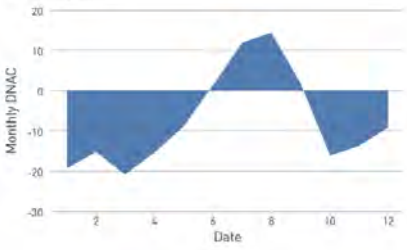
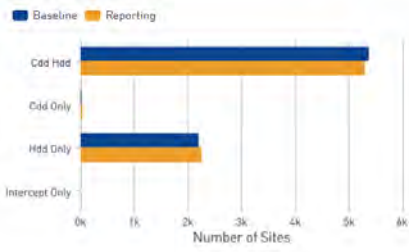
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution
		
	ⓘ 0.121 Annual Consumption p-value	ⓘ 0.159 Annual Consumption p-value
ⓘ DNAC Distribution	ⓘ DNAC Distribution	ⓘ DNAC Distribution
		
385 +/- 93 kWh Average Difference in Normalized Annual Consumption per Participant 3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-78 +/- 34 kWh Average Difference in Normalized Annual Consumption per Participant -1 +/- 0 % Difference in Normalized Annual Consumption as a Percent of Baseline	-89 +/- 116 kWh Average Difference in Normalized Annual Consumption per Participant -1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
ⓘ Monthly DNAC	ⓘ Monthly DNAC	ⓘ Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018	Fuel: Electricity		
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* Q1 2020 *Last Participation Data Update:* Q1 2020 *CalTRACK Version:* 2.0
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): 2 - 6000 < Hdd < 7500, 3 - Hdd >= 7500	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: All	Complex Duct Sealing: All	LikelyGasWaterHeating: All
Electric Provider: All	Contractor: All	Baseline Heating System: All	Water Heating Fuel: All	Home Size (SqFt): All	Ducted heat pump type: All

59 Treatment Meters	418 +/- 573 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 4 % Percent Normal Year Pre-Post Difference in Consumption per Participant	16,046 Mean Baseline Consumption (Electricity)	43% Realization Rate
289 Site-level Matched Meters	600 +/- 617 kWh Average Savings Relative to Site-level Matched Comparison Group	4 +/- 4% Percent Savings Relative to Site-level Matched Comparison Group	15,679 Mean Baseline Consumption (Electricity)	62% Realization Rate
17 Future Participant Meters	1117 +/- 1275 kWh Average Savings Relative to Future Participant Group	7 +/- 8% Savings Relative to Future Participant Group	14,866 Mean Baseline Consumption (Electricity)	115% Realization Rate

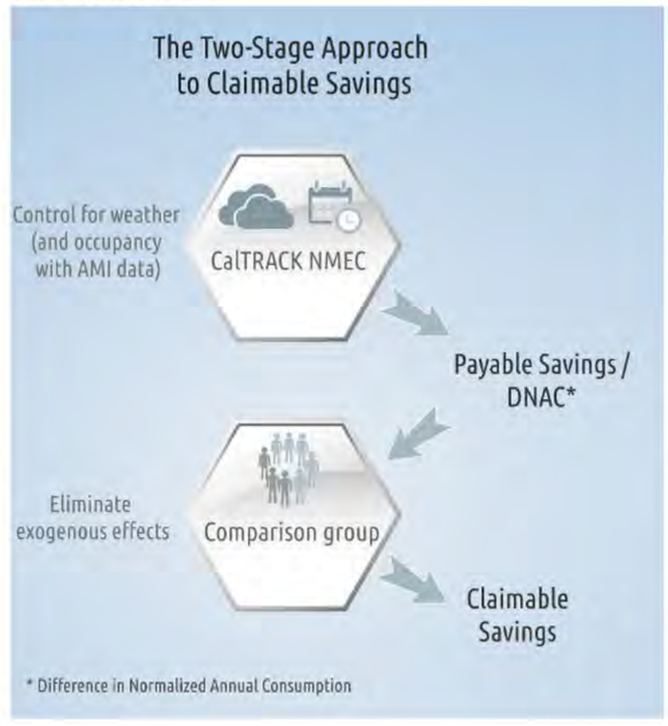
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

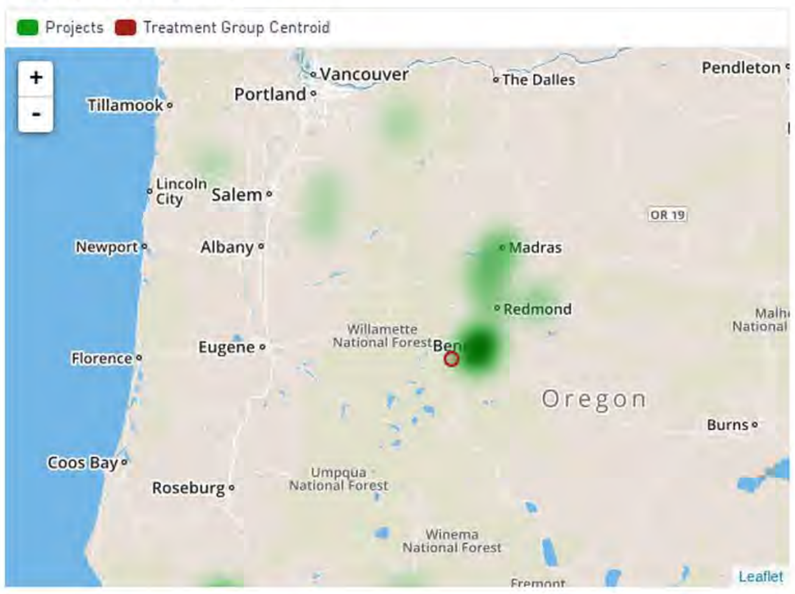
Two-Stage Approach



Treatment Group

The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



138.1 miles

80% of projects lie within this distance from treatment group centroid

59
Meters

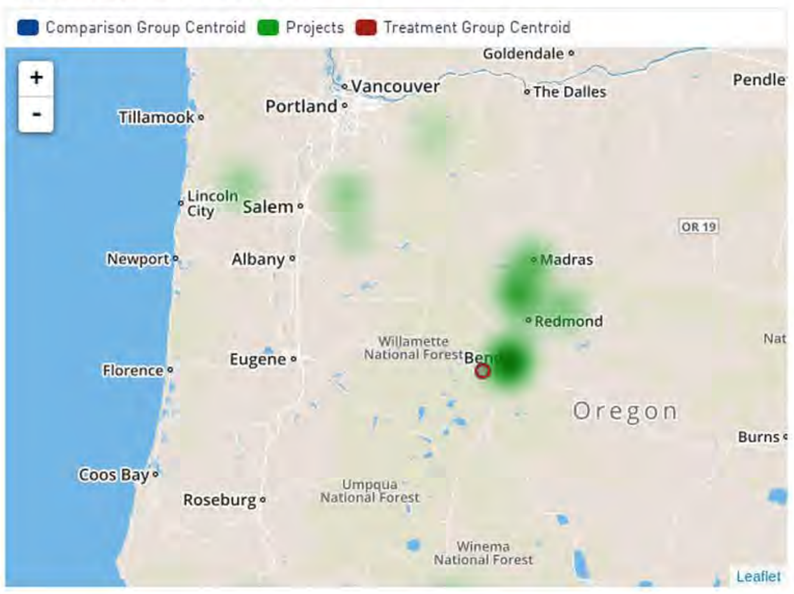
16,046
Mean Baseline Consumption (Electricity)

Load Disaggregation

Site-level Matched Comparison Group

This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



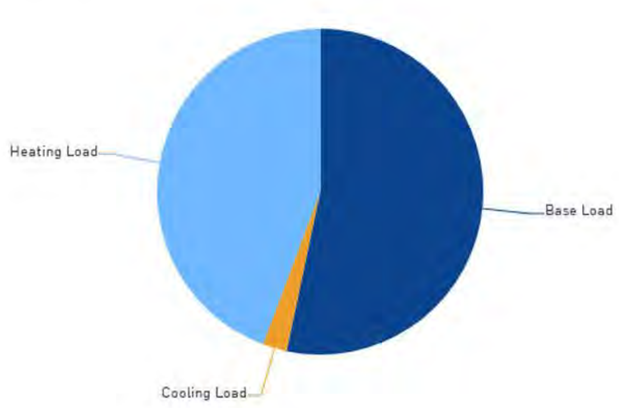
6.7 miles

Distance between treatment and comparison group centroids

289
Meters

15,679
Mean Baseline Consumption (Electricity)

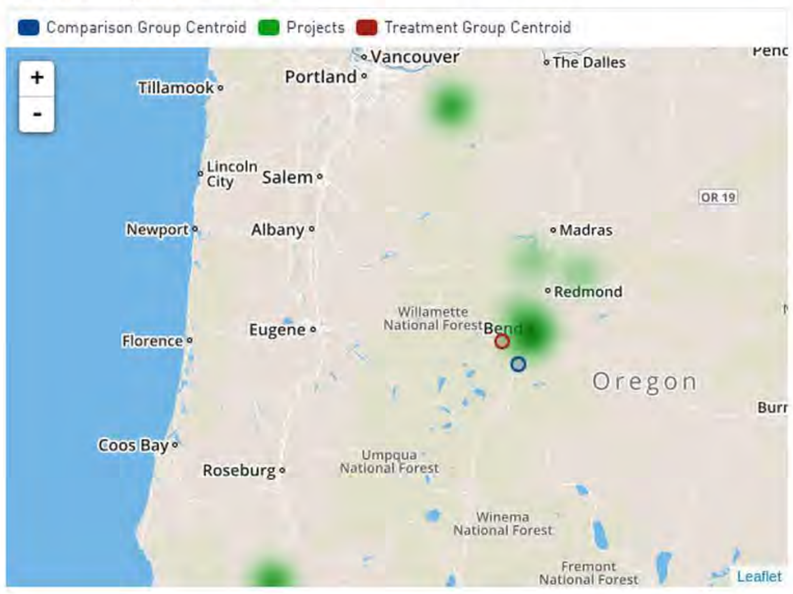
Load Disaggregation



Future Participant Group

The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations



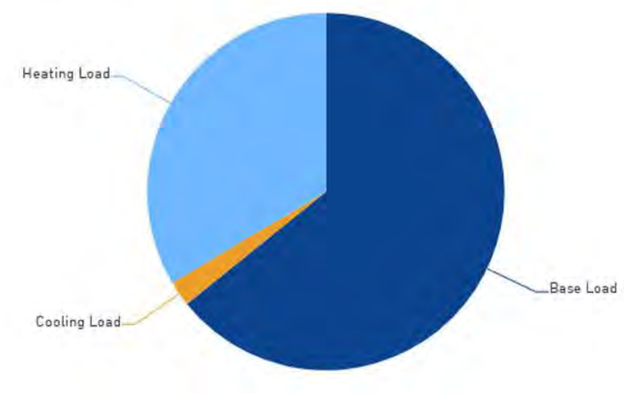
11.7 miles

Distance between treatment and future participant group centroids

17
Meters

14,866
Mean Baseline Consumption (Electricity)

Load Disaggregation



2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	59	1.1%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

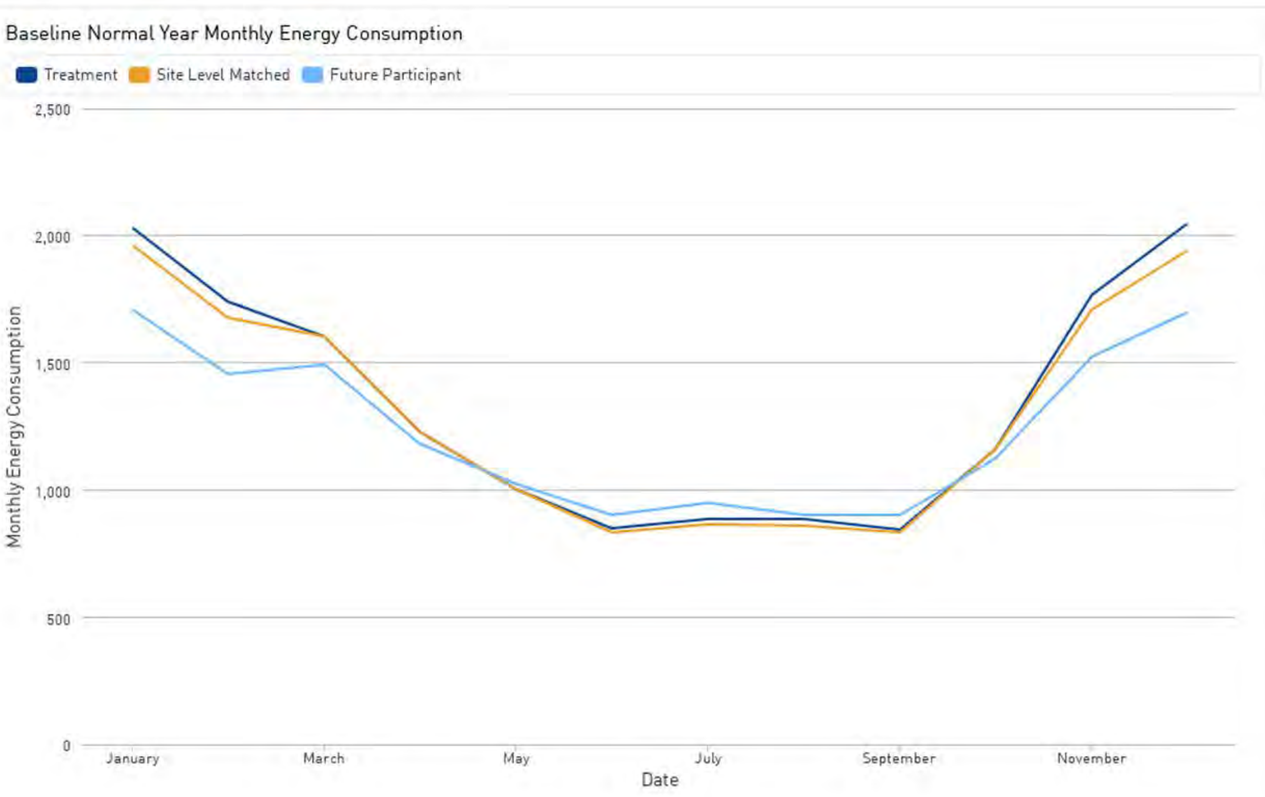
Sample Attrition Table

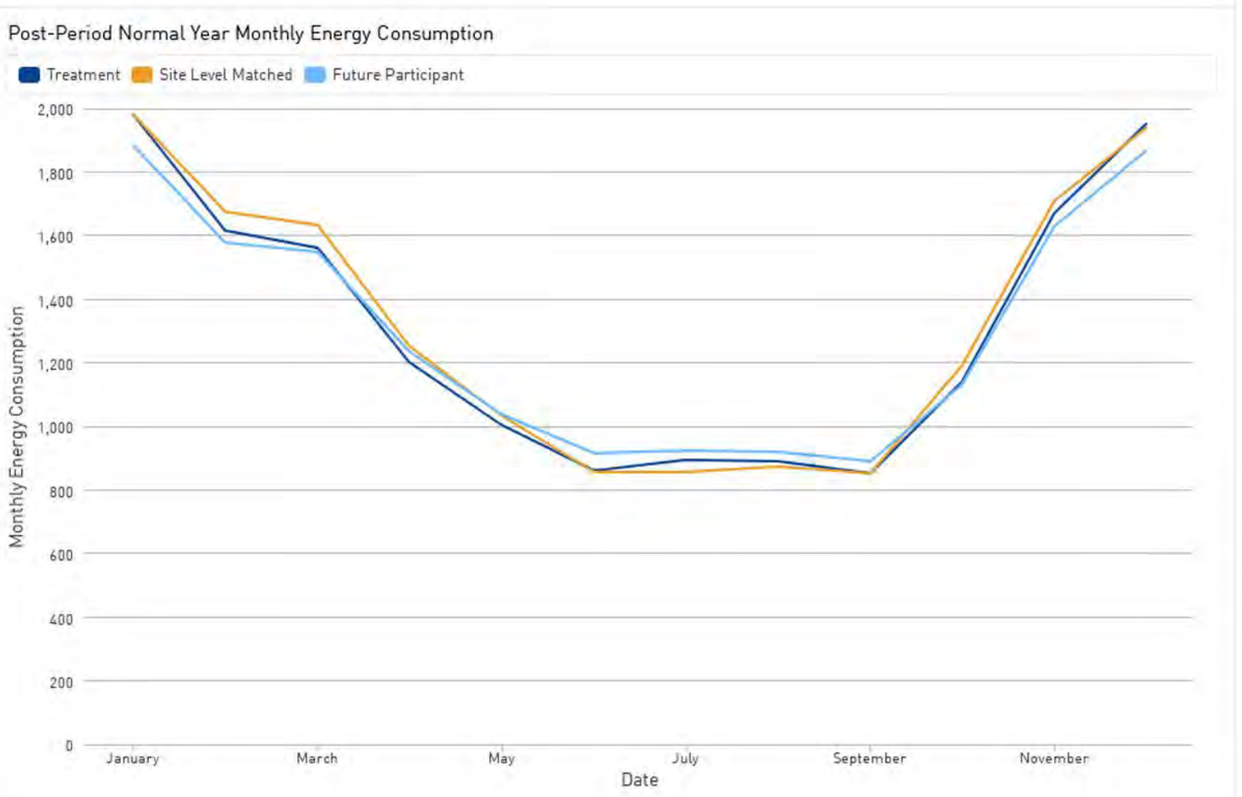
	FILTER NAME	FILTER VALUE	TREATMENT METERS DROPPED	TREATMENT METERS REMAINING
1	Initial treatment population			96096
2	Measure	AIRDUCT	90442	5654
3	Year	2013, 2014, 2015, 2016, 2017, 2018	0	5654
4	Fuel	Electricity	432	5222
5	Valid consumption data in baseline and reporting periods	valid data	0	5222
6	MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods	Is not null	0	5222
7	HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	='ELE'	296	4926
8	HeatingZone: Meters in selected heating climate zone.	2, 3	4778	148
9	CoolingZone: Meters in selected cooling climate zone.	--		148
10	PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	>=11	59	89
11	Meters with at least 5 site-level matched meters from the comparison group pool		6	83
12	DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold	<1	2	81
13	DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption	--	0	81
14	ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Between 0.5 and 99.5	0	81
15	R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. ...	> 0.5	8	73
16	CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshol...	< 1	0	73
17	home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide)	--	0	73
18	complex_duct_sealing: Meters with the 'MH Complex Add-On' measure	--	0	73
19	airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs	="ele_duct"	14	59
20	likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	--	0	59
21	Electricity Provider	--	0	59
22	Home Size [Sq Ft]	--	0	59
23	Water heating fuel type	--	0	59
24	Heat pump type	--	0	59
25	Contractor	--	0	59
26	Baseline heating system	--	0	59
27	Thermostat name	--	0	59
28	Heat pump baseline equipment	--	0	59
29	Heat pump manufacturer	--	0	59
30	Heat pump comissioning	--	0	59
31	Multi-measure flag	Is not null	0	59
32	Final treatment population			59

3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

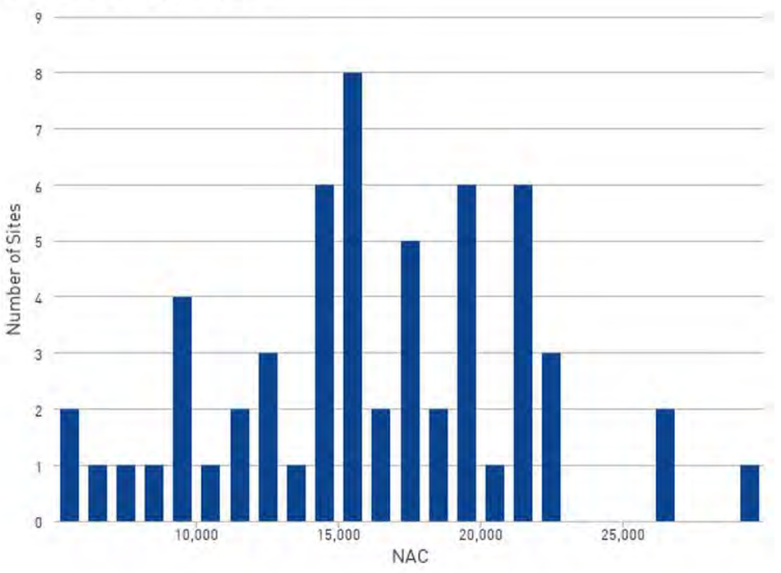
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.



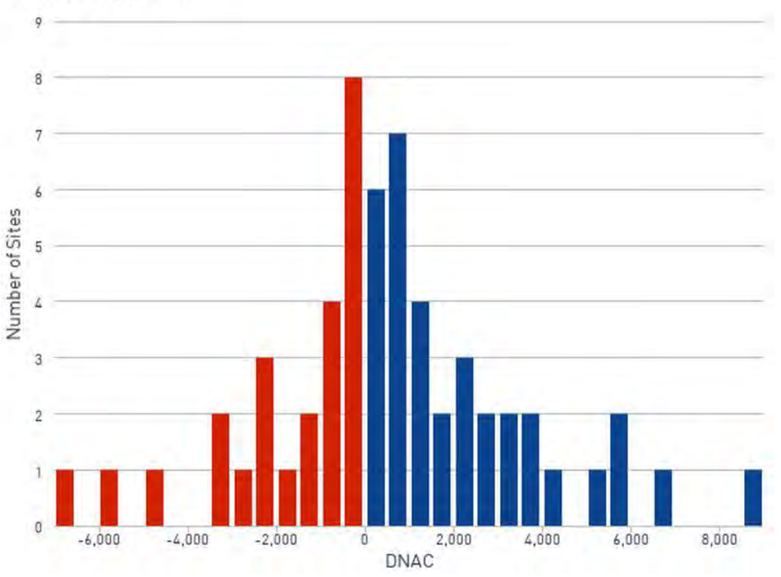


Treatment Group

Baseline NAC Distribution



DNAC Distribution



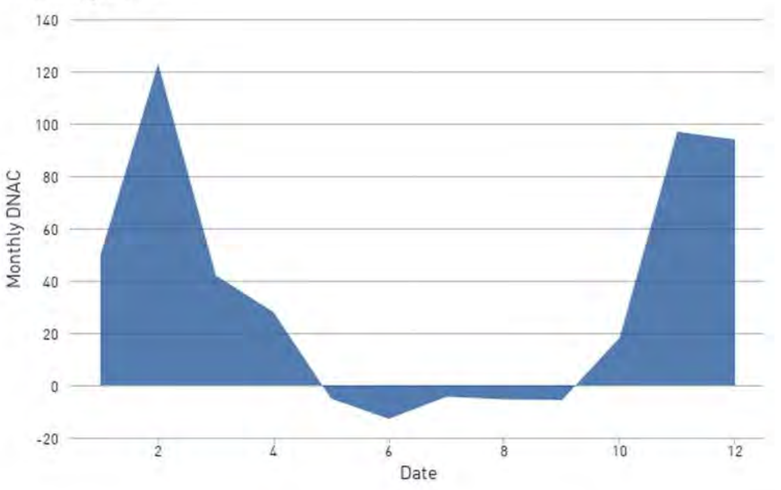
418 +/- 573 kWh

Average Difference in Normalized Annual Consumption per Participant

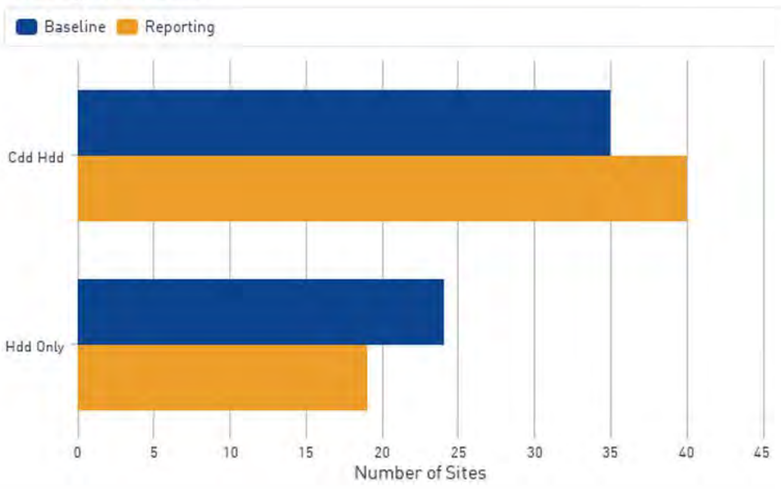
3 +/- 4 %

Difference in Normalized Annual Consumption as a Percent of Baseline

Monthly DNAC

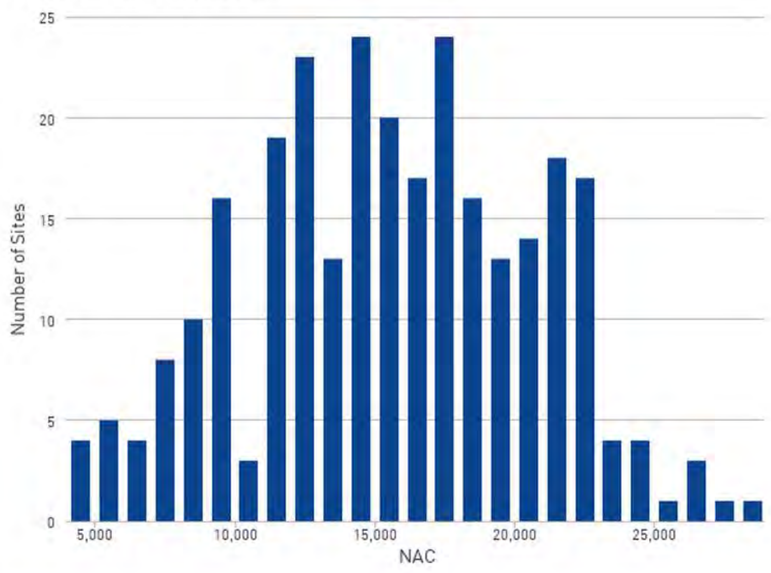


Model Type Distribution



Site-level Matched Comparison Group

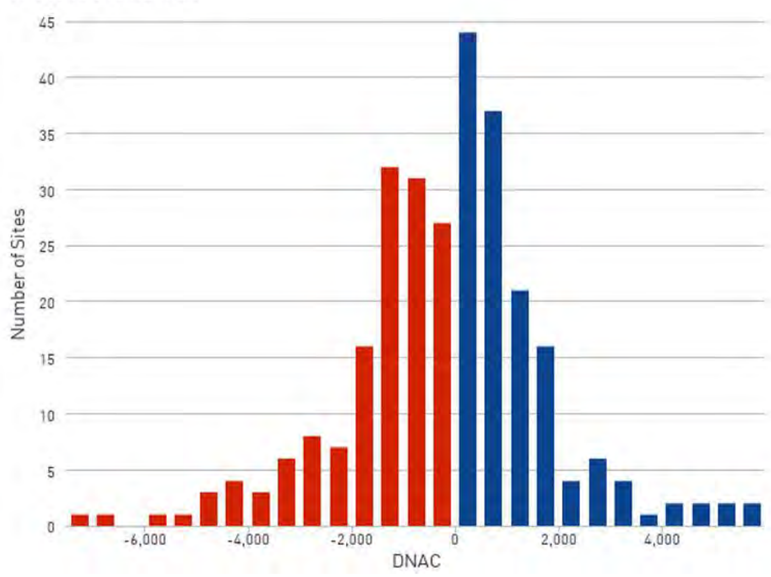
Baseline NAC Distribution



0.272

Annual Consumption p-value

DNAC Distribution



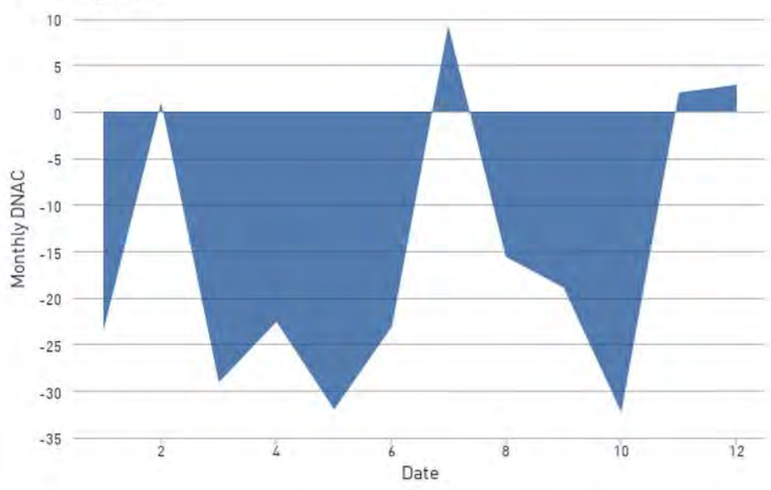
-182 +/- 229 kWh

Average Difference in Normalized Annual Consumption per Participant

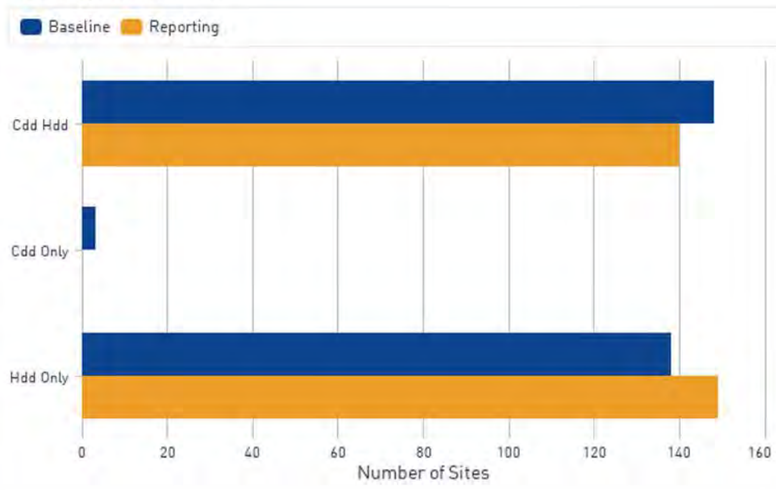
-1 +/- 1 %

Difference in Normalized Annual Consumption as a Percent of Baseline

Monthly DNAC

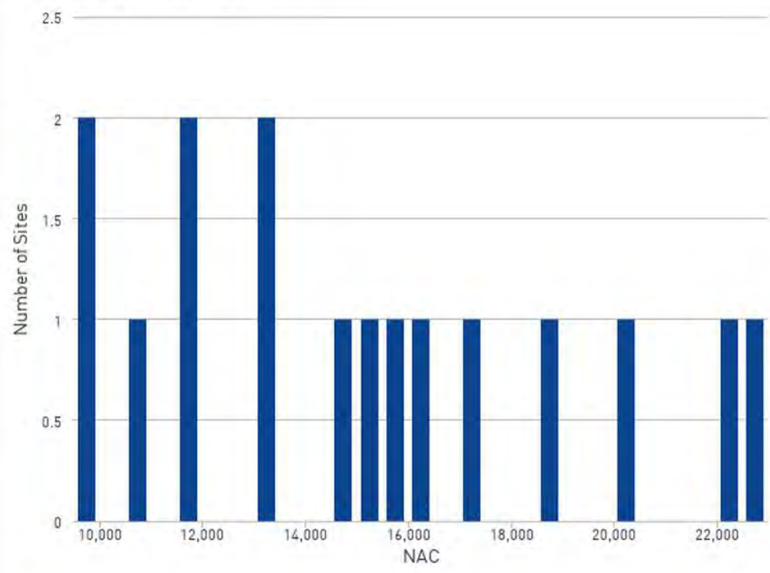


Model Type Distribution



Future Participant Group

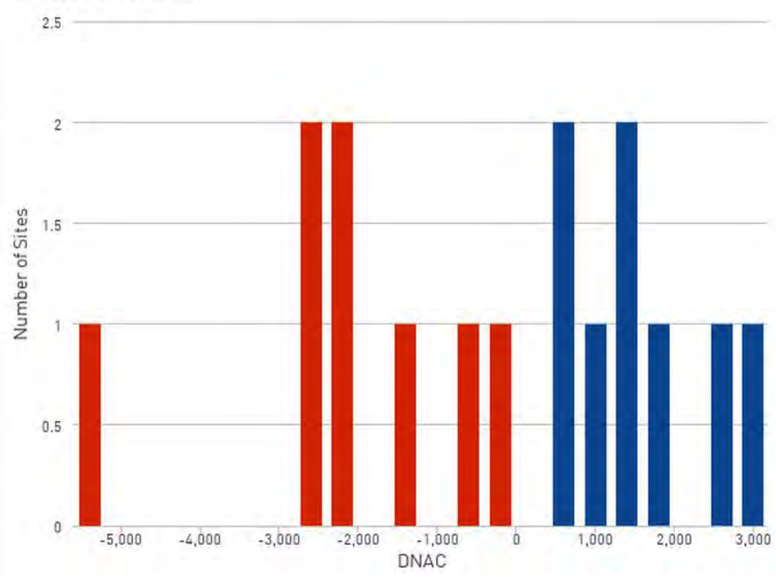
Baseline NAC Distribution



0.338

Annual Consumption p-value

DNAC Distribution



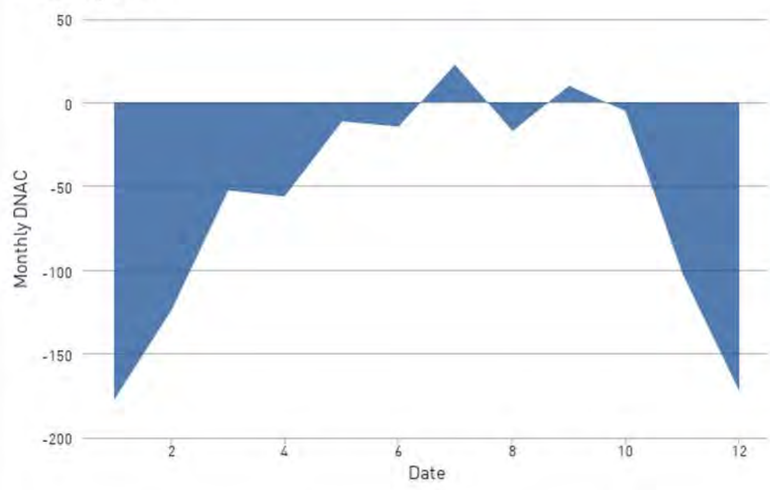
-698 +/- 1138 kWh

Average Difference in Normalized Annual Consumption per Participant

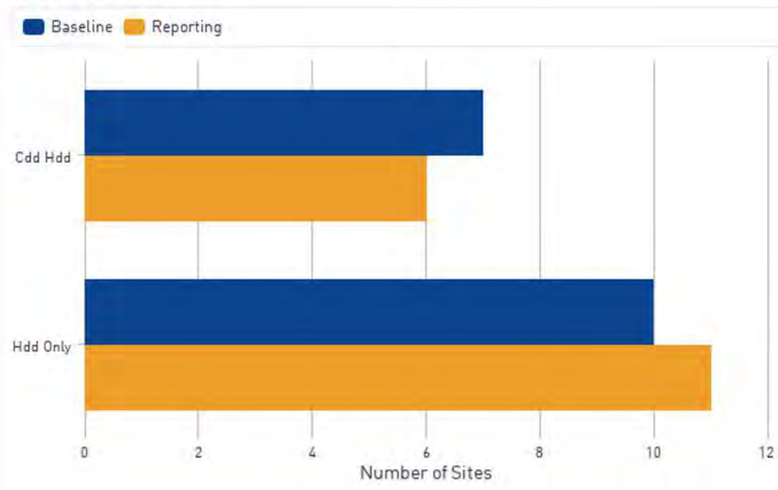
-5 +/- 8 %

Difference in Normalized Annual Consumption as a Percent of Baseline

Monthly DNAC



Model Type Distribution



Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: Single-Wide	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

494 Treatment Meters	188 +/- 162 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	1 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	12,741 Mean Baseline Consumption (Electricity)	23% Realization Rate
740 Site-level Matched Meters	342 +/- 187 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	11,896 Mean Baseline Consumption (Electricity)	42% Realization Rate
308 Future Participant Meters	254 +/- 266 kWh Average Savings Relative to Future Participant Group	2 +/- 2% Savings Relative to Future Participant Group	12,085 Mean Baseline Consumption (Electricity)	31% Realization Rate

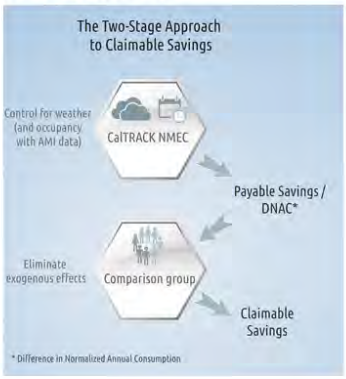
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

137.5 miles
80% of projects lie within this distance from treatment group centroid

494
Meters

12,741
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

6.4 miles
Distance between treatment and comparison group centroids

740
Meters

11,896
Mean Baseline Consumption (Electricity)

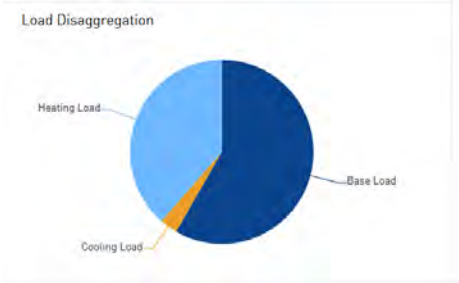
Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

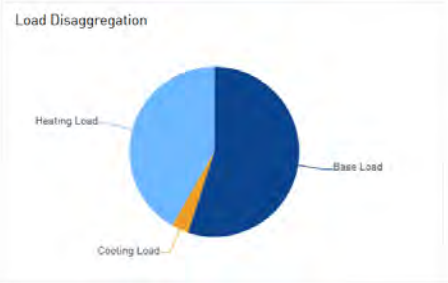
Future Participant Site Locations

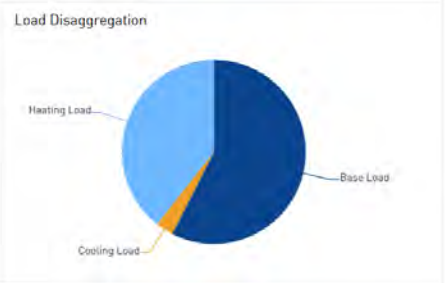
17.7 miles
Distance between treatment and future participant group centroids

308
Meters

12,085
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	494	9%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

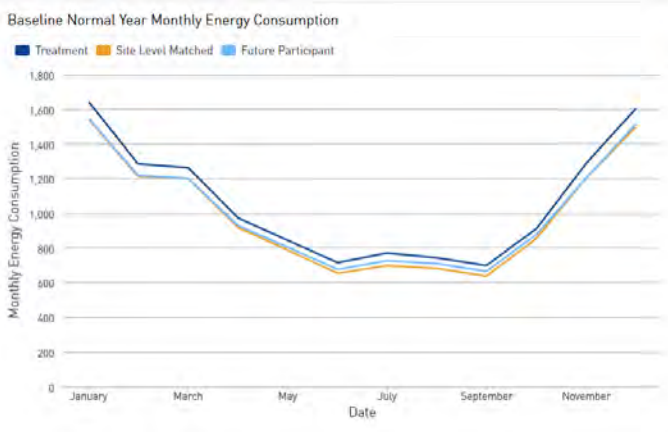
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

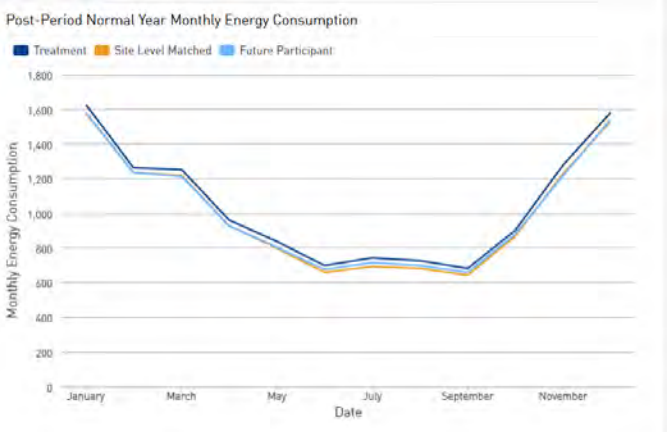
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: Single-Wide	1,796	1,197
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	1,197
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	703	494
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	494

3. Modeling Results

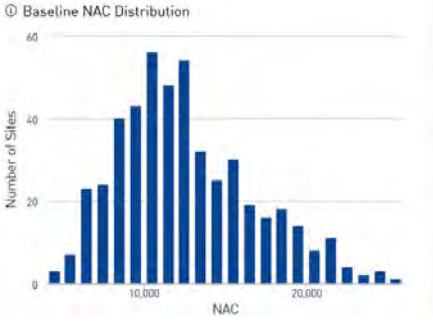
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

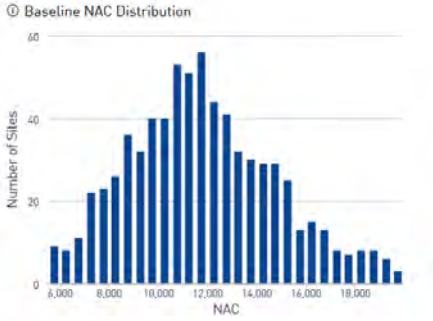
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.

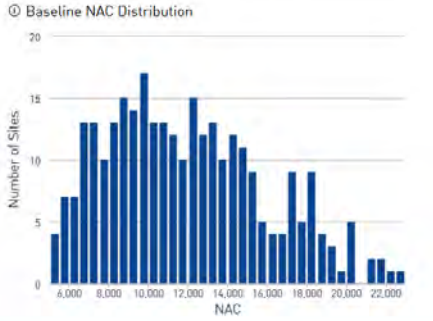


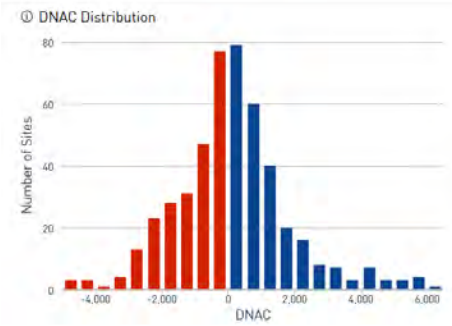


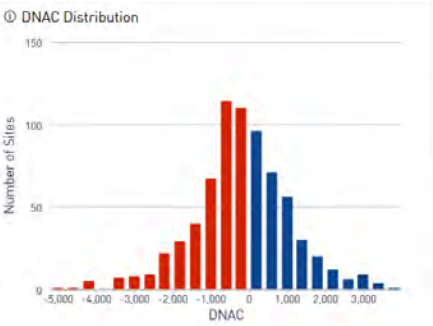
Treatment Group	Site-level Matched Comparison Group	Future Participant Group

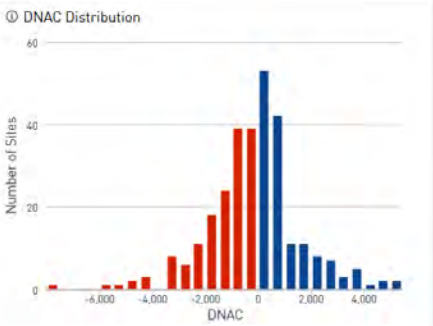




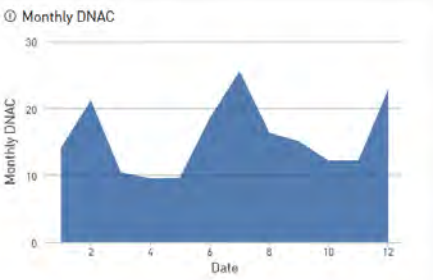


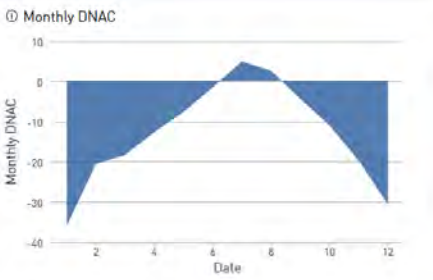


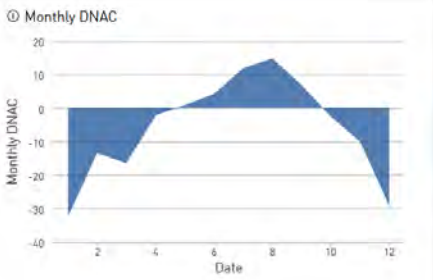


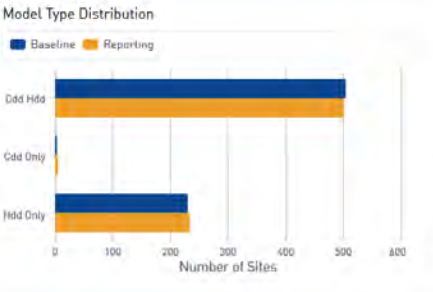


188 +/- 162 kWh	2 +/- 1 %	-154 +/- 93 kWh	-1 +/- 1 %	-66 +/- 211 kWh	-1 +/- 2 %
Average Difference in Normalized Annual Consumption per Participant	Difference in Normalized Annual Consumption as a Percent of Baseline	Average Difference in Normalized Annual Consumption per Participant	Difference in Normalized Annual Consumption as a Percent of Baseline	Average Difference in Normalized Annual Consumption per Participant	Difference in Normalized Annual Consumption as a Percent of Baseline









Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: Double-Wide	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

970 Treatment Meters	452 +/- 123 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,859 Mean Baseline Consumption (Electricity)	54% Realization Rate
2,158 Site-level Matched Meters	528 +/- 143 kWh Average Savings Relative to Site-level Matched Comparison Group	4 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	14,577 Mean Baseline Consumption (Electricity)	63% Realization Rate
648 Future Participant Meters	503 +/- 195 kWh Average Savings Relative to Future Participant Group	3 +/- 1% Savings Relative to Future Participant Group	14,048 Mean Baseline Consumption (Electricity)	60% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
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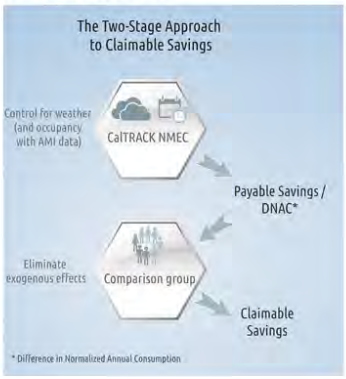
Two-Stage Approach



Treatment Group

The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

131.0 miles

80% of projects lie within this distance from treatment group centroid

970	14,859
Meters	Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group

This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

15.2 miles

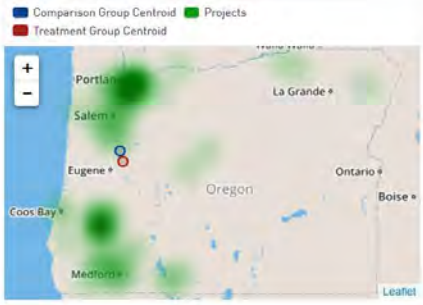
Distance between treatment and comparison group centroids

2,158	14,577
Meters	Mean Baseline Consumption (Electricity)

Future Participant Group

The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

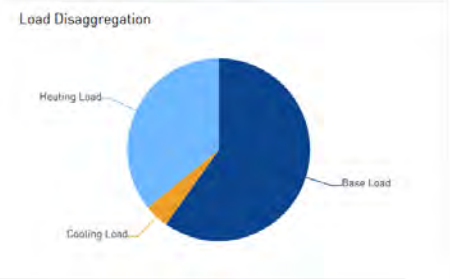
Future Participant Site Locations

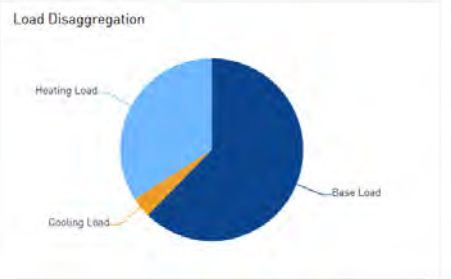


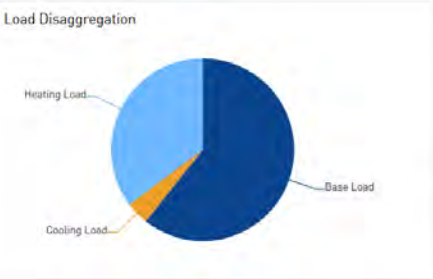
11.7 miles

Distance between treatment and future participant group centroids

648	14,048
Meters	Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	970	18%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

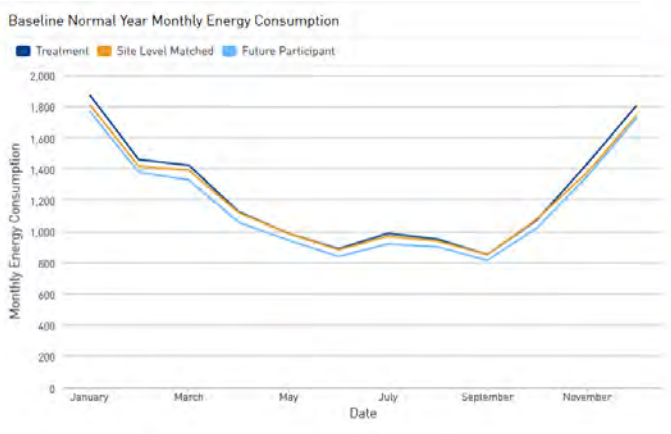
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

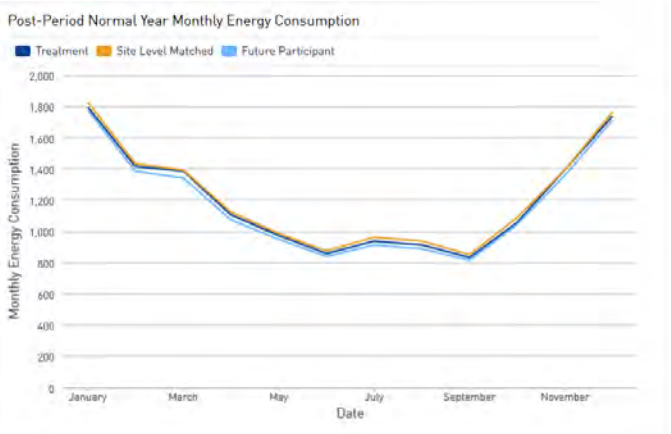
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: Double-Wide	1,445	1,548
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	1,548
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	578	970
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	970

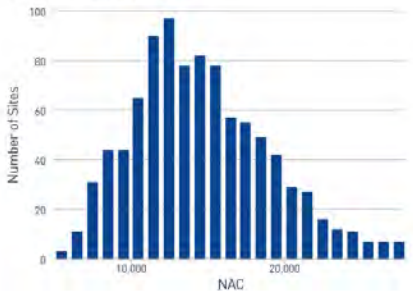
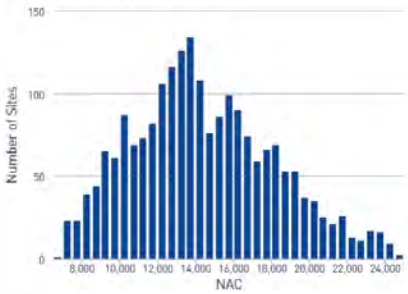
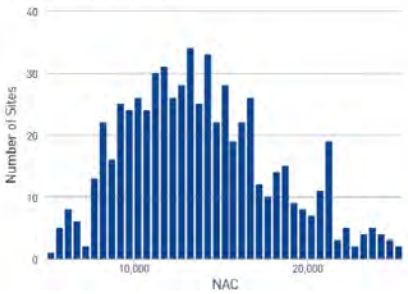
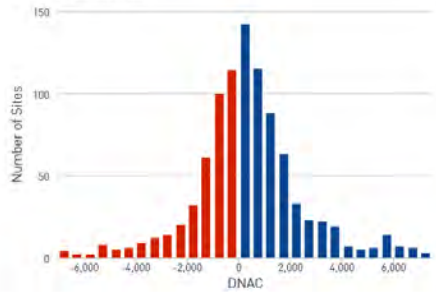
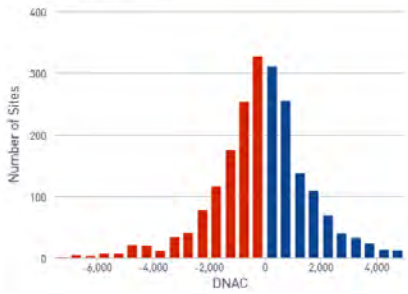
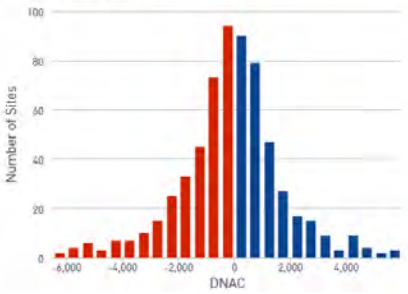
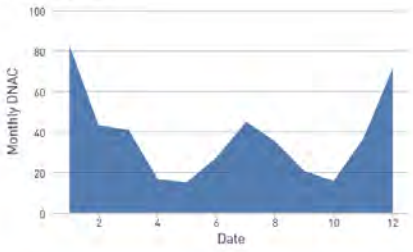
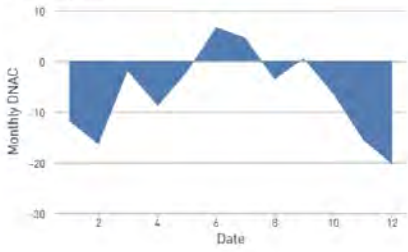
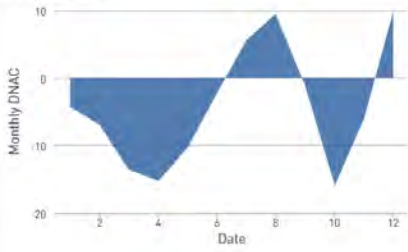
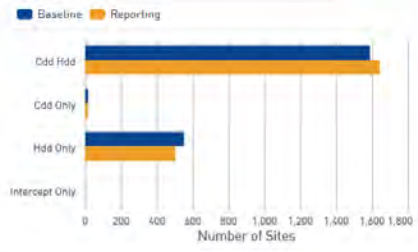
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.164 Annual Consumption p-value	0.157 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
452 +/- 123 kWh Average Difference in Normalized Annual Consumption per Participant	3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-76 +/- 73 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-50 +/- 151 kWh Average Difference in Normalized Annual Consumption per Participant	-0 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: False	LikelyGasWaterHeating: All

1,266 Treatment Meters	232 +/- 100 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	2 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	13,758 Mean Baseline Consumption (Electricity)	30% Realization Rate
6,236 Site-level Matched Meters	357 +/- 106 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	13,367 Mean Baseline Consumption (Electricity)	45% Realization Rate
868 Future Participant Meters	301 +/- 163 kWh Average Savings Relative to Future Participant Group	2 +/- 1% Savings Relative to Future Participant Group	13,189 Mean Baseline Consumption (Electricity)	38% Realization Rate

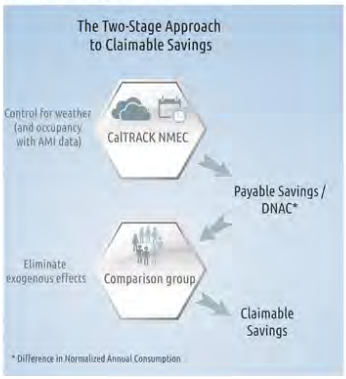
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

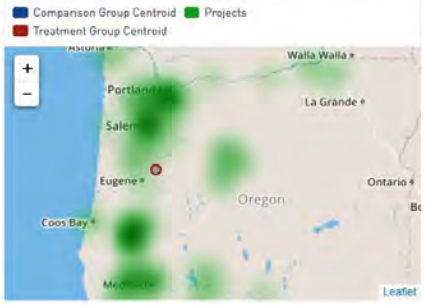
134.0 miles
80% of projects lie within this distance from treatment group centroid

1,266
Meters

13,758
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



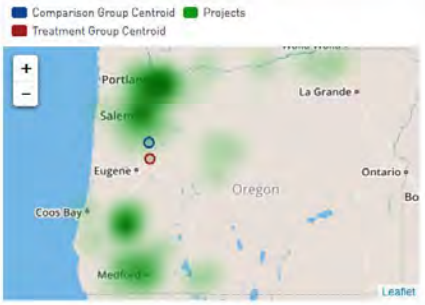
1.9 miles
Distance between treatment and comparison group centroids

6,236
Meters

13,367
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

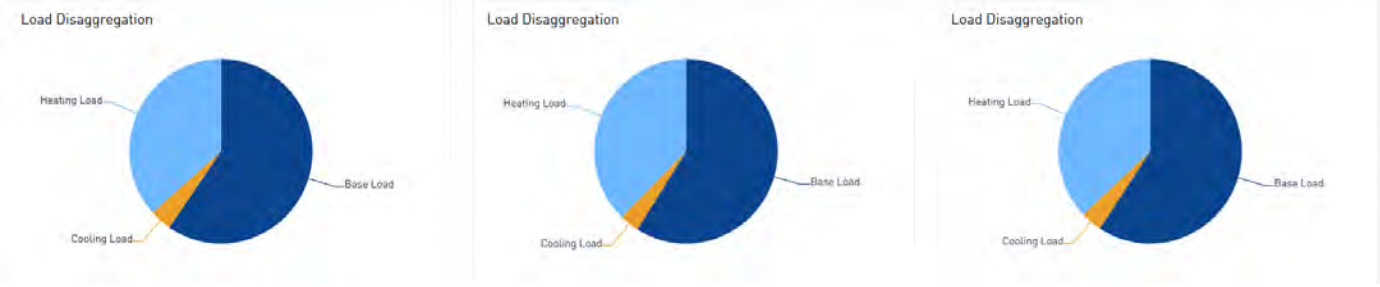
Future Participant Site Locations



18.7 miles
Distance between treatment and future participant group centroids

868
Meters

13,189
Mean Baseline Consumption (Electricity)



2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	1,266	23%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

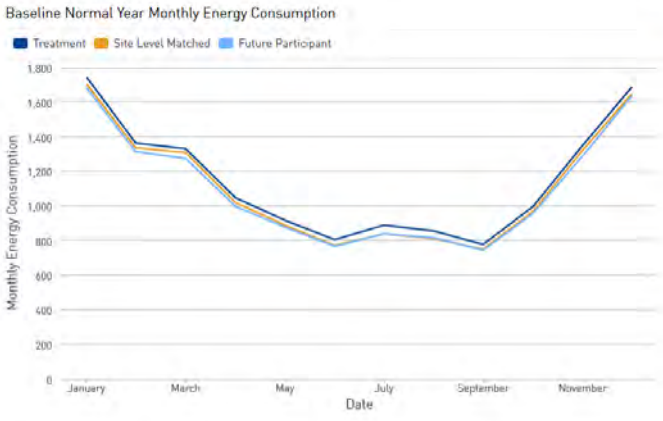
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

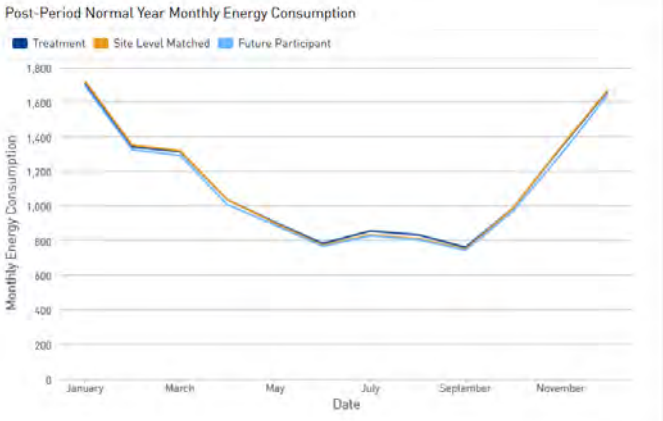
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,993
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: False	633	2,360
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	1,094	1,266
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	1,266

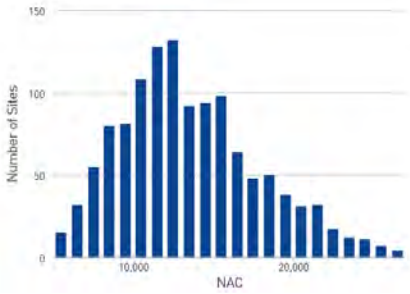
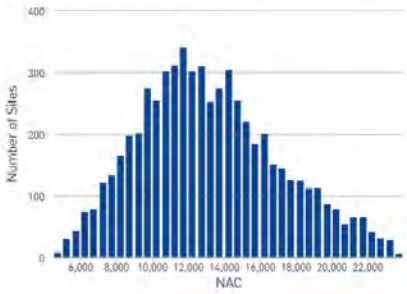
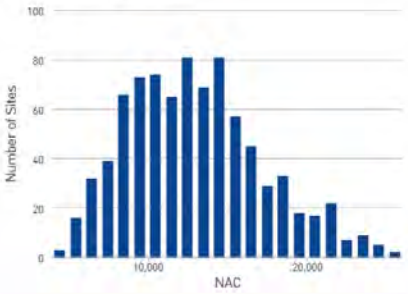
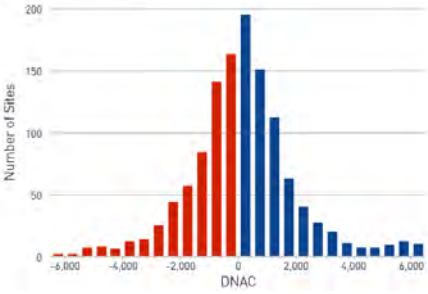
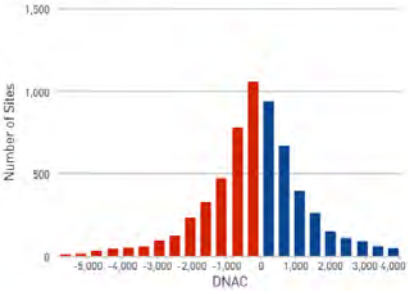
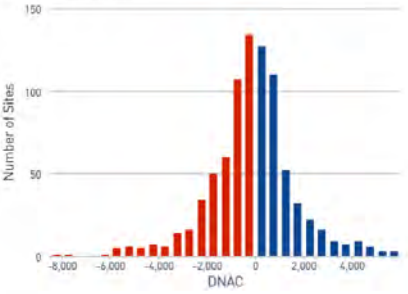
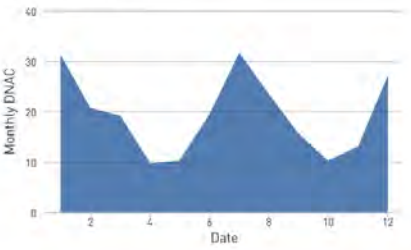
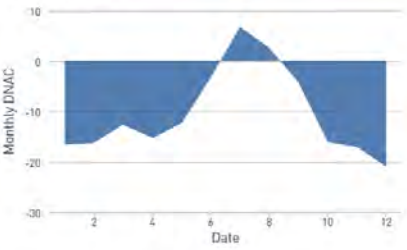
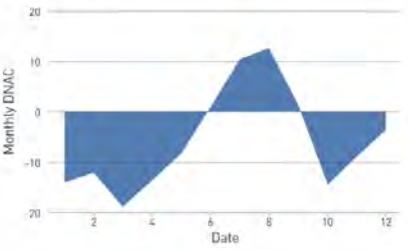
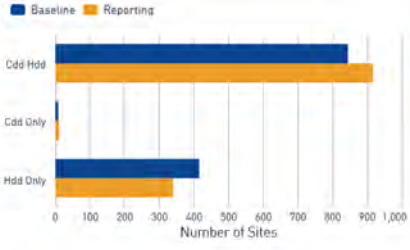
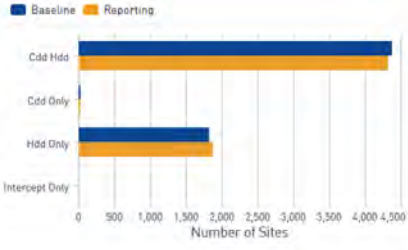
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.0000374 Annual Consumption p-value	0.126 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
232 +/- 100 kWh Average Difference in Normalized Annual Consumption per Participant	2 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-125 +/- 37 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 0 % Difference in Normalized Annual Consumption as a Percent of Baseline	-69 +/- 129 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: True	LikelyGasWaterHeating: All

331 Treatment Meters	978 +/- 233 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	6 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	16,049 Mean Baseline Consumption (Electricity)	103% Realization Rate
1,636 Site-level Matched Meters	884 +/- 248 kWh Average Savings Relative to Site-level Matched Comparison Group	6 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	15,261 Mean Baseline Consumption (Electricity)	93% Realization Rate
223 Future Participant Meters	1191 +/- 354 kWh Average Savings Relative to Future Participant Group	7 +/- 2% Savings Relative to Future Participant Group	14,756 Mean Baseline Consumption (Electricity)	126% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
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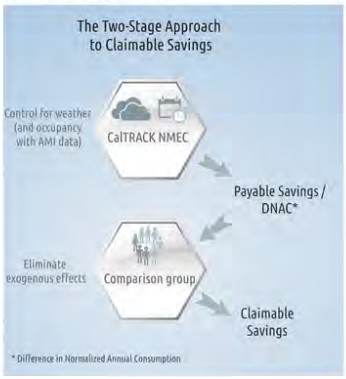
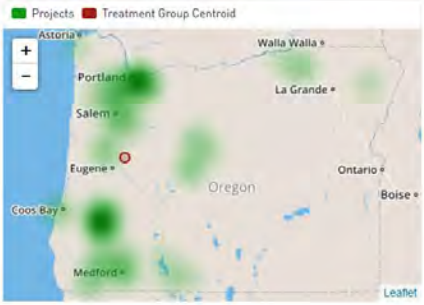
Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



130.9 miles
80% of projects lie within this distance from treatment group centroid

331
Meters

16,049
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

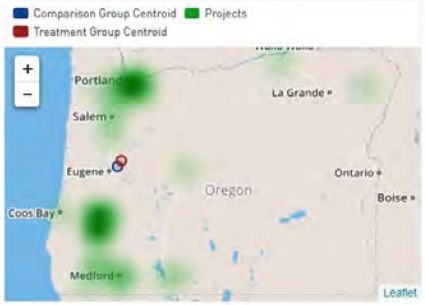
3.4 miles
Distance between treatment and comparison group centroids

1,636
Meters

15,261
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

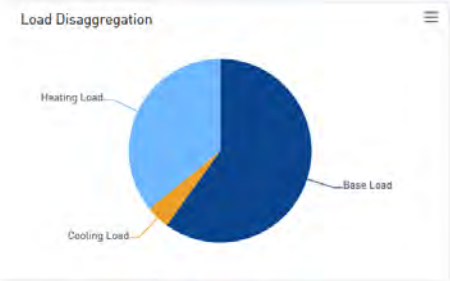
Future Participant Site Locations

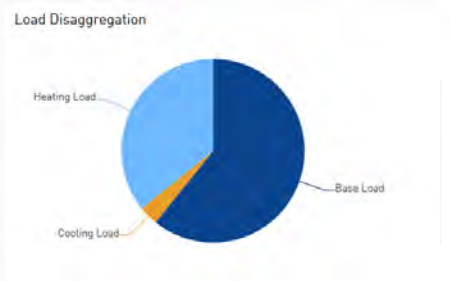


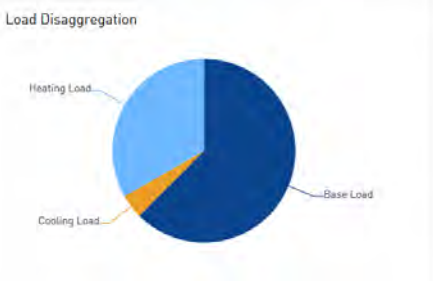
7.4 miles
Distance between treatment and future participant group centroids

223
Meters

14,756
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	331	6%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

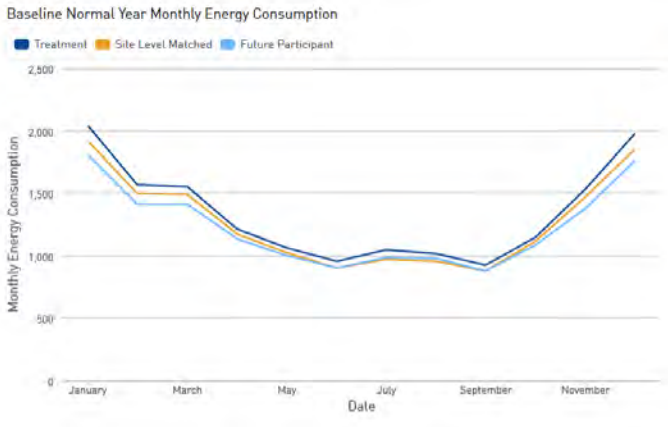
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

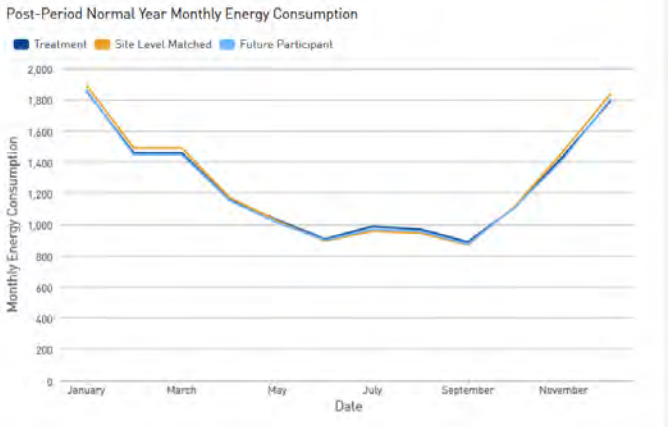
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,993
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: True	2,359	634
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	303	331
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	331

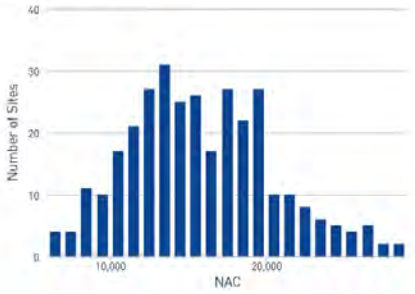
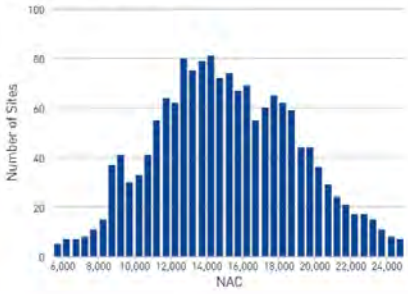
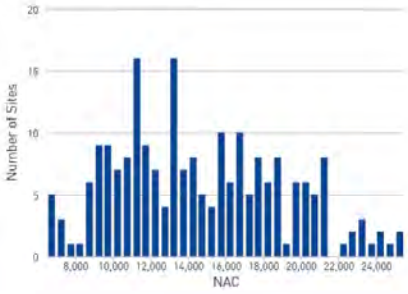
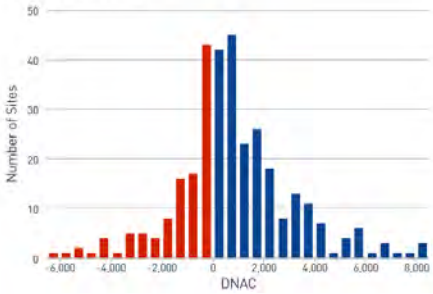
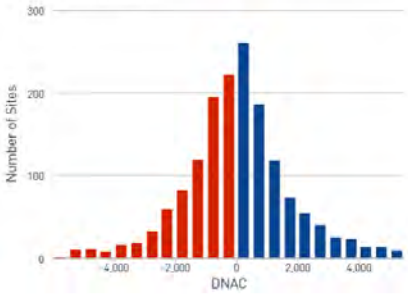
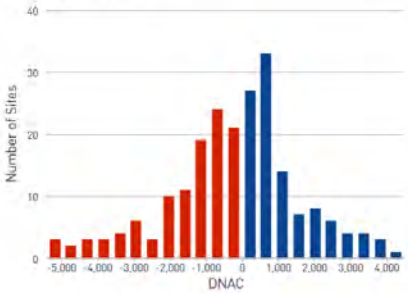
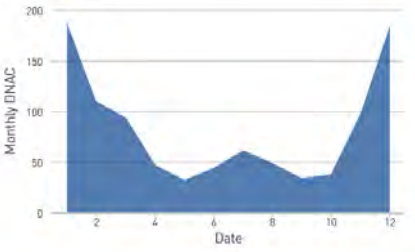
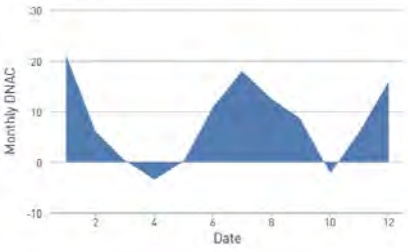
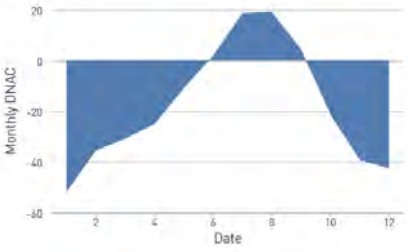
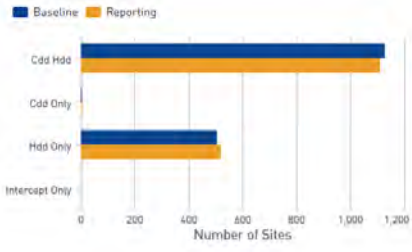
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.154 Annual Consumption p-value	0.115 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
978 +/- 233 kWh Average Difference in Normalized Annual Consumption per Participant 6 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	93 +/- 86 kWh Average Difference in Normalized Annual Consumption per Participant 1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-213 +/- 266 kWh Average Difference in Normalized Annual Consumption per Participant -1 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013

Result Summary

Measure: Airduct	Program Year: 2013	Fuel: Electricity		
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

464 Treatment Meters	576 +/- 186 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	4 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,573 Mean Baseline Consumption (Electricity)	57% Realization Rate
2,287 Site-level Matched Meters	727 +/- 198 kWh Average Savings Relative to Site-level Matched Comparison Group	5 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	14,043 Mean Baseline Consumption (Electricity)	72% Realization Rate
270 Future Participant Meters	789 +/- 324 kWh Average Savings Relative to Future Participant Group	5 +/- 2% Savings Relative to Future Participant Group	14,267 Mean Baseline Consumption (Electricity)	78% Realization Rate

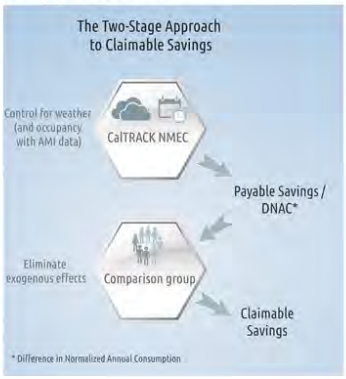
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

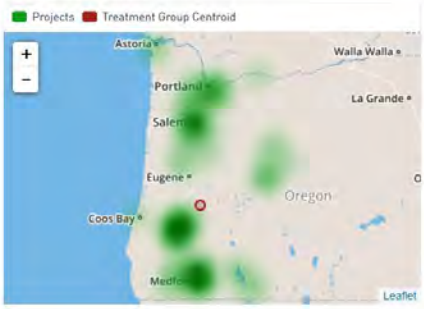
The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



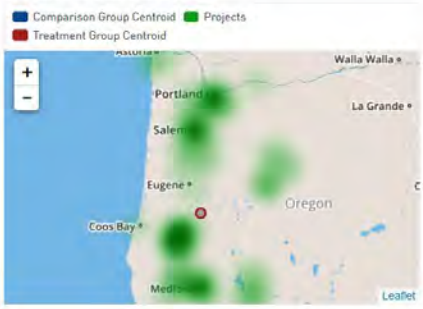
129.6 miles
80% of projects lie within this distance from treatment group centroid

464
Meters

14,573
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



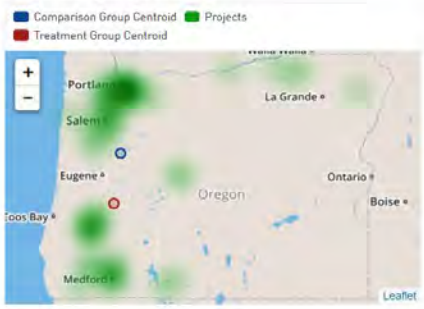
1.3 miles
Distance between treatment and comparison group centroids

2,287
Meters

14,043
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

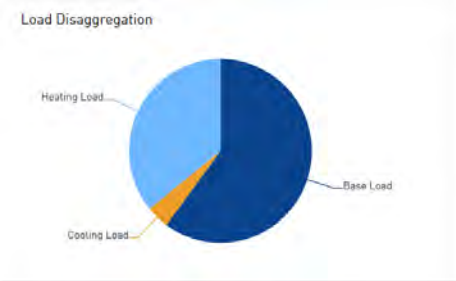
Future Participant Site Locations

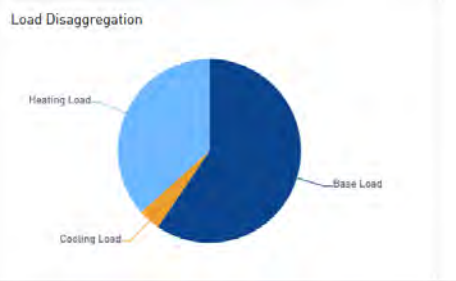


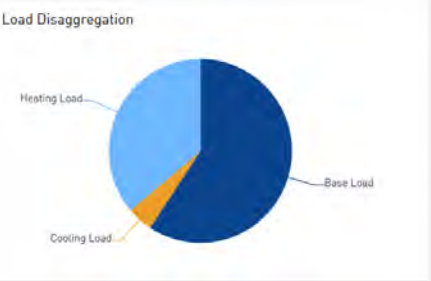
57.3 miles
Distance between treatment and future participant group centroids

270
Meters

14,267
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

1,402	464	33%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

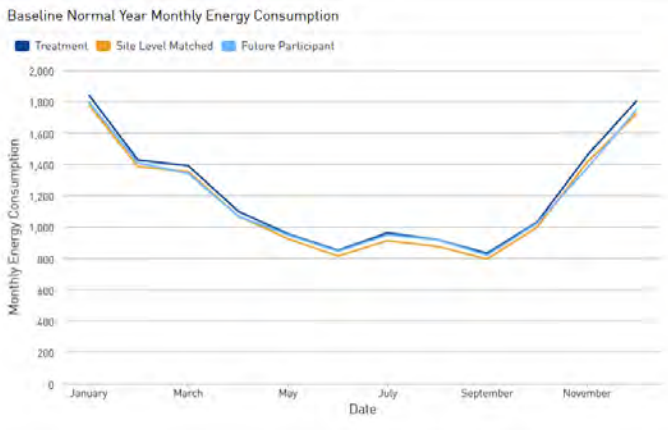
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013 -- Fuel: Electricity	--	1,402
Meters with valid consumption data in baseline and/or reporting periods.	--	80	1,322
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	1,322
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	52	1,270
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	1,270
Other measure-specific filters.	--	0	1,270
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	425	845
Meters with at least 5 site-level matched meters from the comparison group pool.	--	15	830

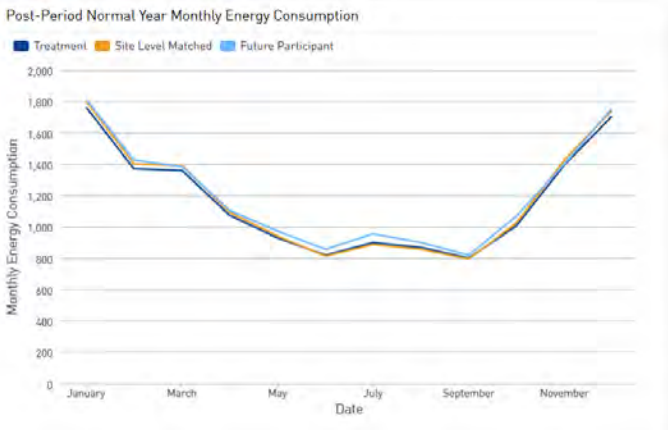
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	9	821
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	821
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	4	817
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	74	743
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	743
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	743
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	743
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	279	464
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	464

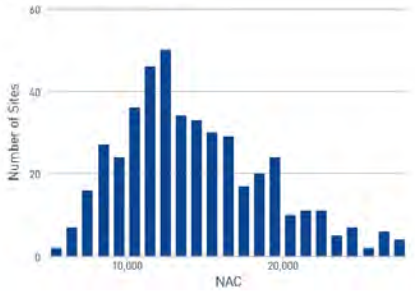
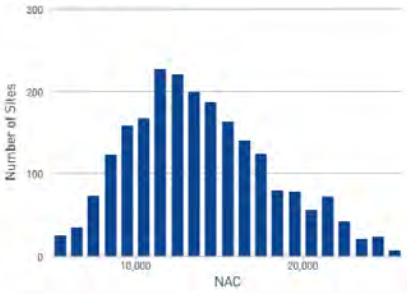
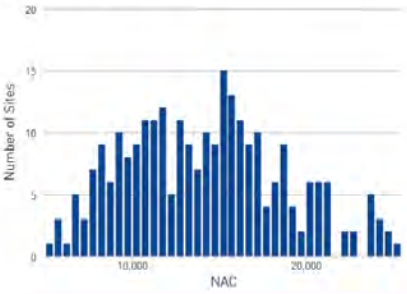
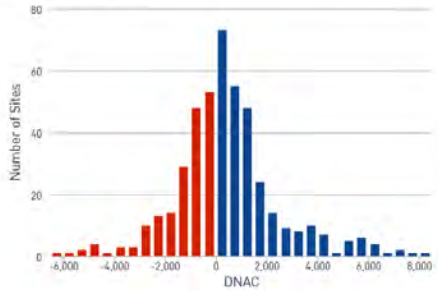
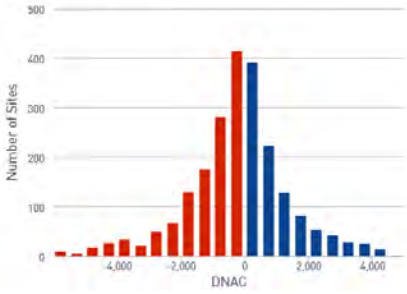
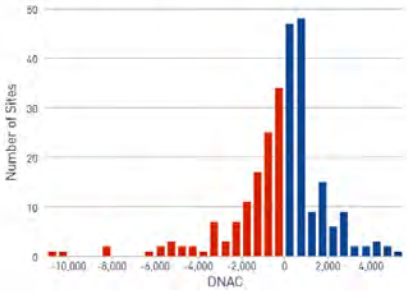
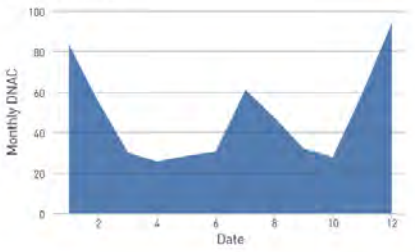
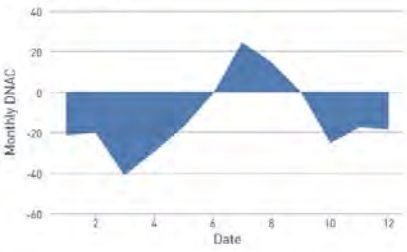
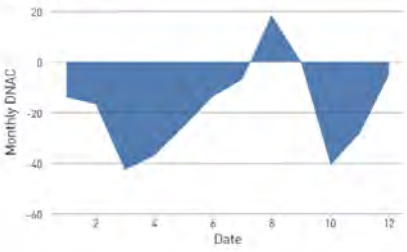
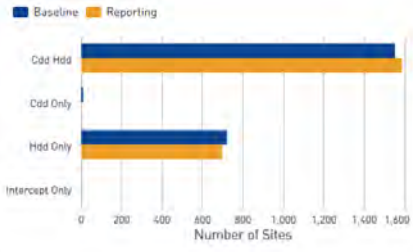
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.166 Annual Consumption p-value	0.2 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
576 +/- 186 kWh Average Difference in Normalized Annual Consumption per Participant	4 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-151 +/- 68 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 0 % Difference in Normalized Annual Consumption as a Percent of Baseline	-213 +/- 265 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2014

Result Summary

Measure: Airduct | Program Year: 2014 | Fuel: Electricity

Last Consumption Data Update: October 1, 2019

Last Participation Data Update: October 1, 2019

CalTRACK Version: 2.0

Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

335 Treatment Meters	97 +/- 220 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	1 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,829 Mean Baseline Consumption (Electricity)	11% Realization Rate
1,657 Site-level Matched Meters	186 +/- 234 kWh Average Savings Relative to Site-level Matched Comparison Group	1 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	14,205 Mean Baseline Consumption (Electricity)	20% Realization Rate
294 Future Participant Meters	50 +/- 334 kWh Average Savings Relative to Future Participant Group	0 +/- 2% Savings Relative to Future Participant Group	13,678 Mean Baseline Consumption (Electricity)	5% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
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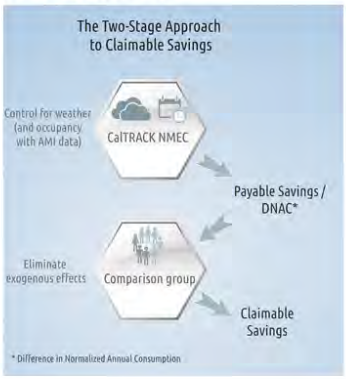
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

165.8 miles
80% of projects lie within this distance from treatment group centroid

335
Meters

14,829
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

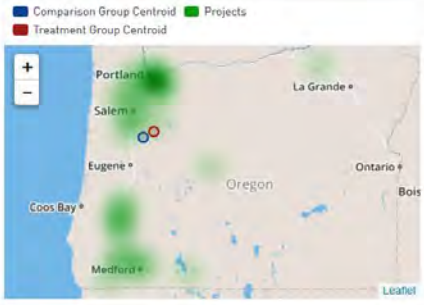
5.0 miles
Distance between treatment and comparison group centroids

1,657
Meters

14,205
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

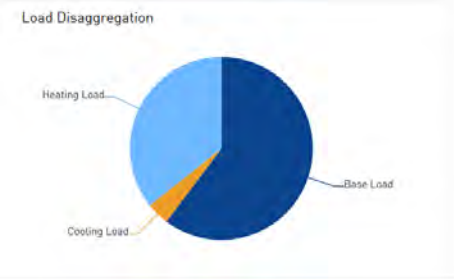
Future Participant Site Locations

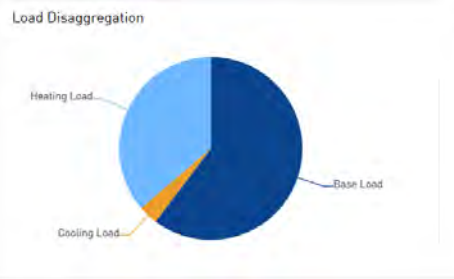


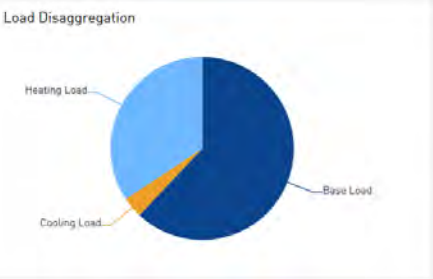
14.3 miles
Distance between treatment and future participant group centroids

294
Meters

13,678
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

1,132	335	30%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

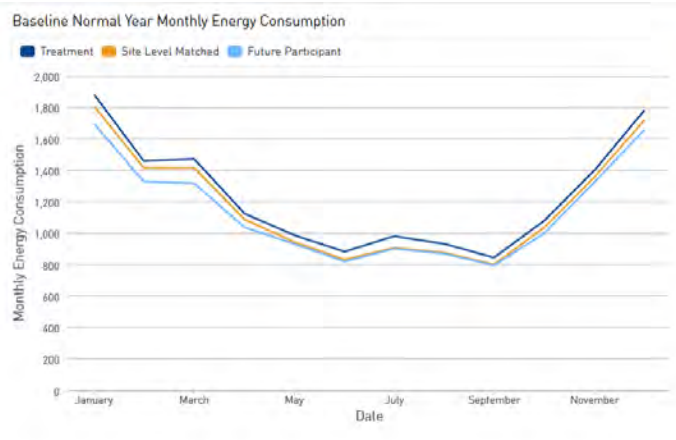
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2014 -- Fuel: Electricity	--	1,132
Meters with valid consumption data in baseline and/or reporting periods.	--	59	1,073
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	1,073
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	43	1,030
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	1,030
Other measure-specific filters.	--	0	1,030
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	289	741
Meters with at least 5 site-level matched meters from the comparison group pool.	--	18	723

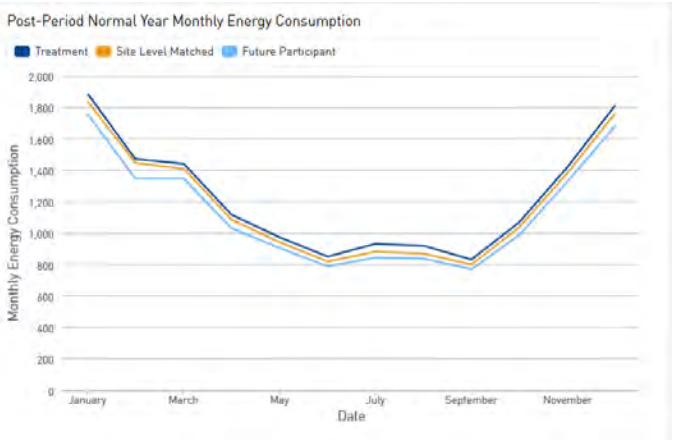
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	8	715
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	715
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	3	712
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	105	607
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	607
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	607
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	607
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	272	335
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	335

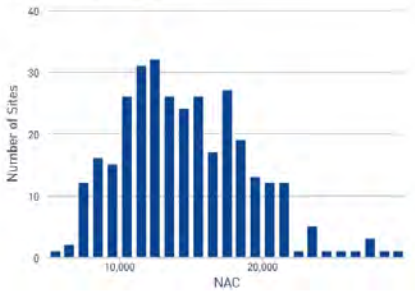
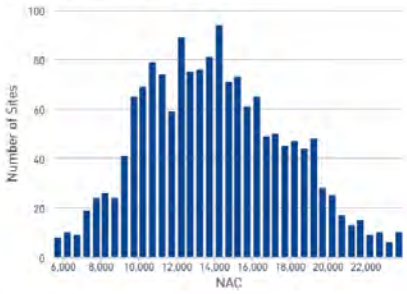
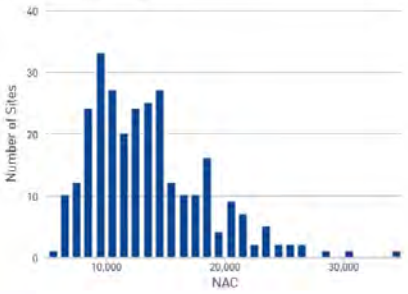
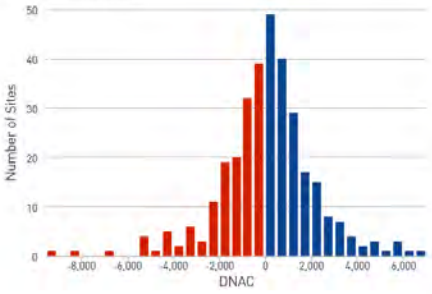
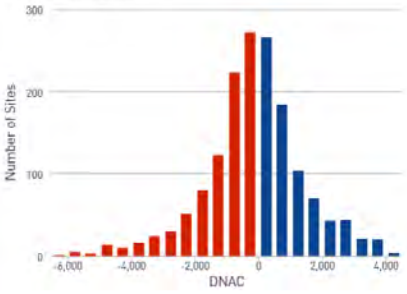
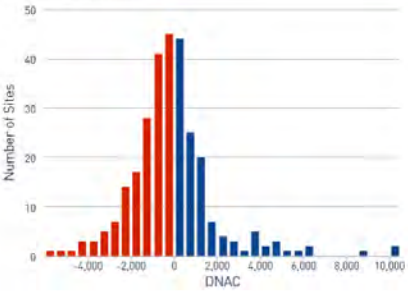
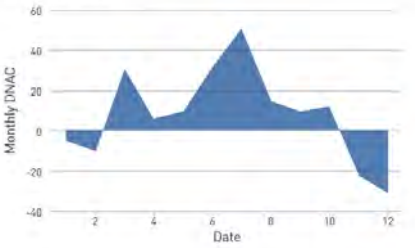
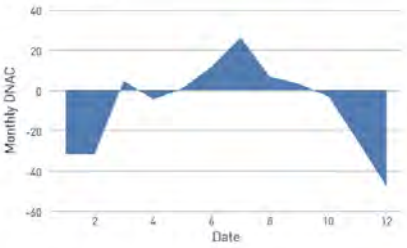
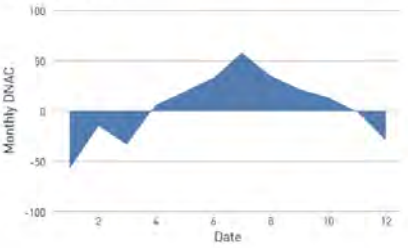
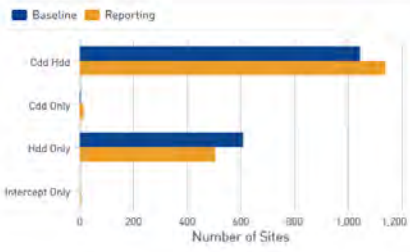
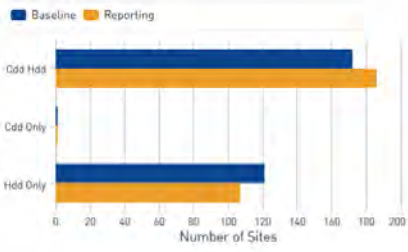
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution
		
	ⓘ 0.0859 Annual Consumption p-value	ⓘ 0.206 Annual Consumption p-value
ⓘ DNAC Distribution	ⓘ DNAC Distribution	ⓘ DNAC Distribution
		
97 +/- 220 kWh Average Difference in Normalized Annual Consumption per Participant	1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-89 +/- 81 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	47 +/- 252 kWh Average Difference in Normalized Annual Consumption per Participant	0 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline
ⓘ Monthly DNAC	ⓘ Monthly DNAC	ⓘ Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2015

Result Summary

Measure: Airduct	Program Year: 2015		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

292 Treatment Meters	417 +/- 212 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,446 Mean Baseline Consumption (Electricity)	58% Realization Rate
1,438 Site-level Matched Meters	499 +/- 224 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	13,796 Mean Baseline Consumption (Electricity)	69% Realization Rate
233 Future Participant Meters	305 +/- 312 kWh Average Savings Relative to Future Participant Group	2 +/- 2% Savings Relative to Future Participant Group	13,373 Mean Baseline Consumption (Electricity)	42% Realization Rate

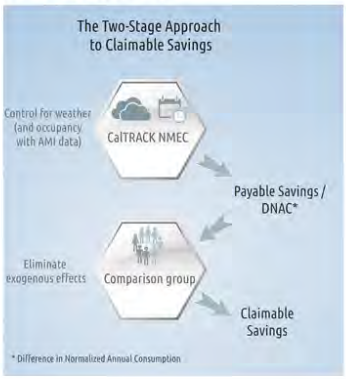
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group

The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

145.0 miles

80% of projects lie within this distance from treatment group centroid

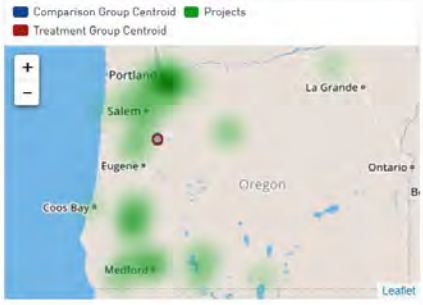
292
Meters

14,446
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group

This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



1.9 miles

Distance between treatment and comparison group centroids

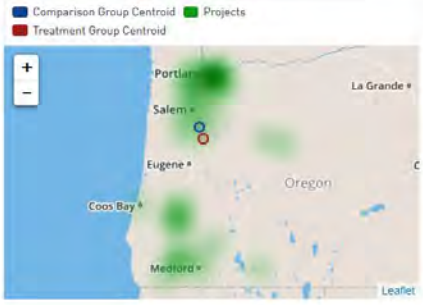
1,438
Meters

13,796
Mean Baseline Consumption (Electricity)

Future Participant Group

The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations

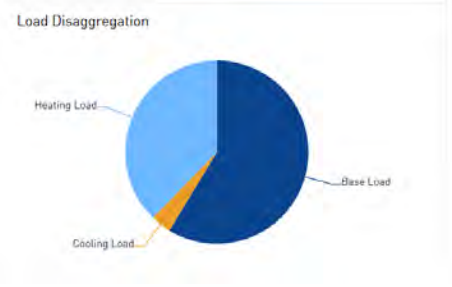


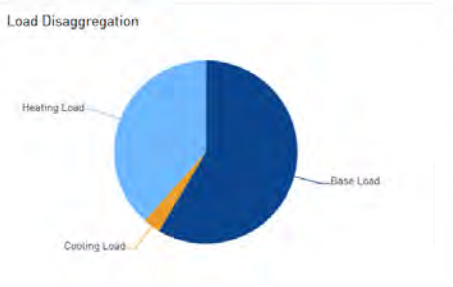
13.3 miles

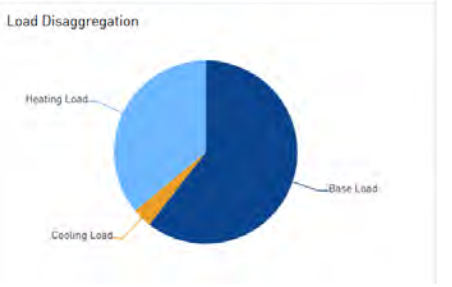
Distance between treatment and future participant group centroids

233
Meters

13,373
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

722	292	40%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

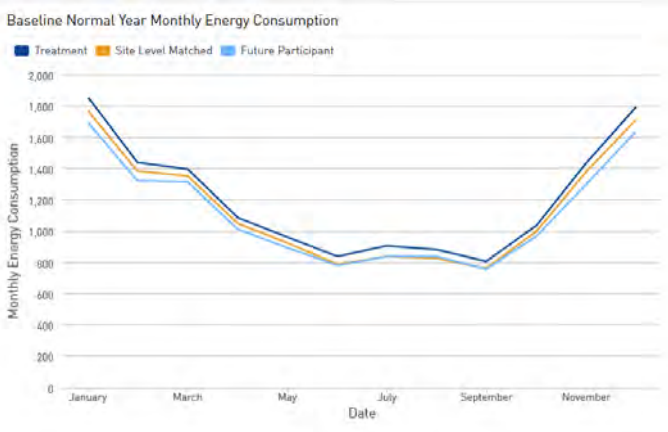
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2015 -- Fuel: Electricity	--	722
Meters with valid consumption data in baseline and/or reporting periods.	--	15	707
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	707
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	32	675
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	675
Other measure-specific filters.	--	0	675
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	172	503
Meters with at least 5 site-level matched meters from the comparison group pool.	--	9	494

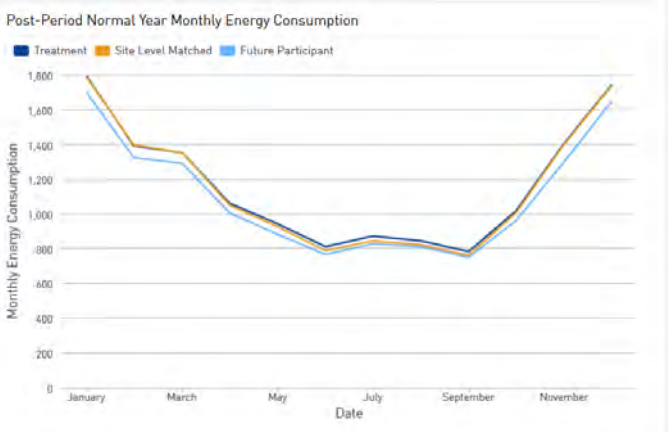
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	0	494
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	494
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	2	492
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	41	451
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	451
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	451
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	451
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct [electricity]	159	292
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	292

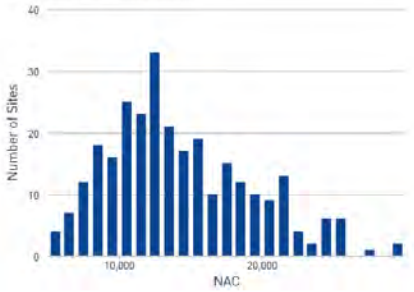
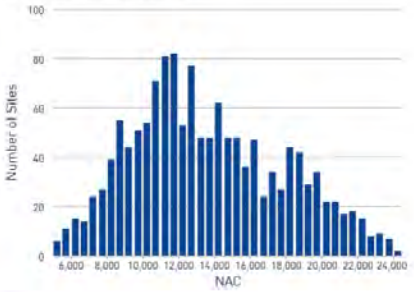
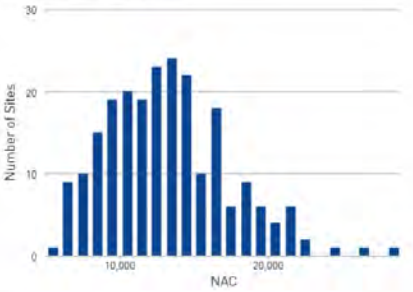
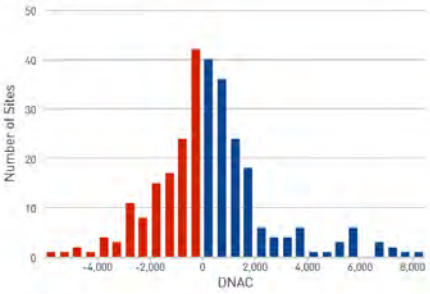
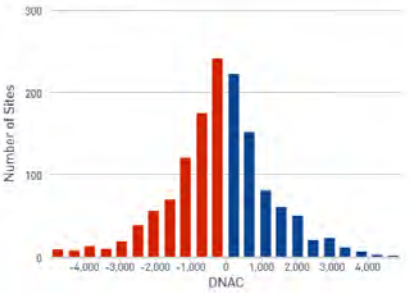
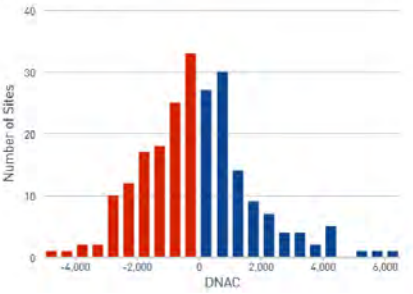
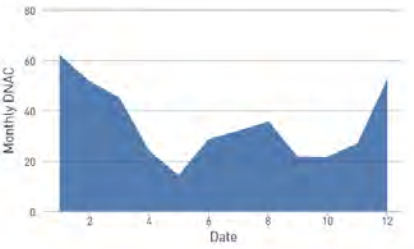
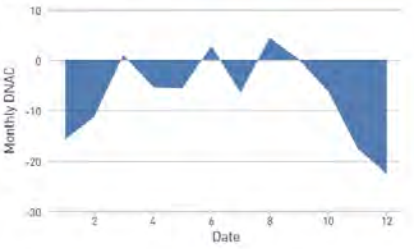
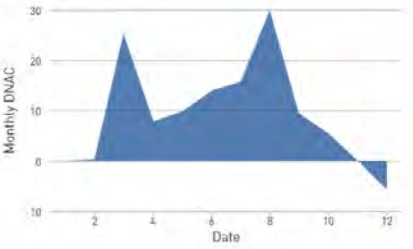
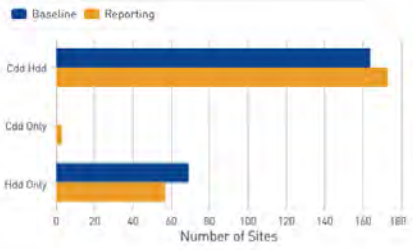
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.168 Annual Consumption p-value	0.163 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
417 +/- 212 kWh Average Difference in Normalized Annual Consumption per Participant	3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-82 +/- 71 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	112 +/- 228 kWh Average Difference in Normalized Annual Consumption per Participant	1 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2016

Result Summary

Measure: Airduct | Program Year: 2016 | Fuel: Electricity

Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

281 Treatment Meters	286 +/- 186 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	2 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	13,638 Mean Baseline Consumption (Electricity)	43% Realization Rate
1,393 Site-level Matched Meters	412 +/- 201 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	13,347 Mean Baseline Consumption (Electricity)	62% Realization Rate
152 Future Participant Meters	574 +/- 322 kWh Average Savings Relative to Future Participant Group	4 +/- 2% Savings Relative to Future Participant Group	12,773 Mean Baseline Consumption (Electricity)	86% Realization Rate

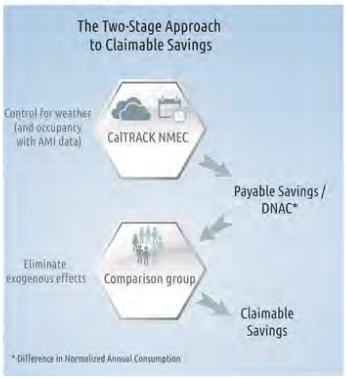
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

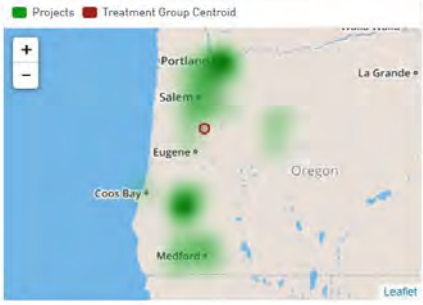
The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



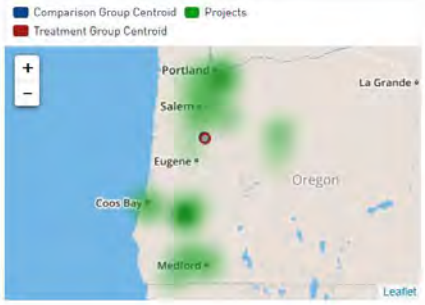
134.1 miles
80% of projects lie within this distance from treatment group centroid

281
Meters

13,638
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



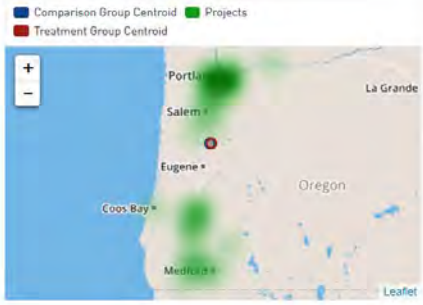
5.0 miles
Distance between treatment and comparison group centroids

1,393
Meters

13,347
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

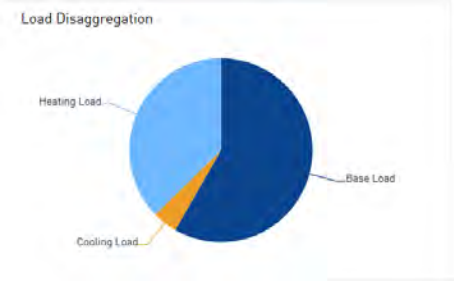
Future Participant Site Locations

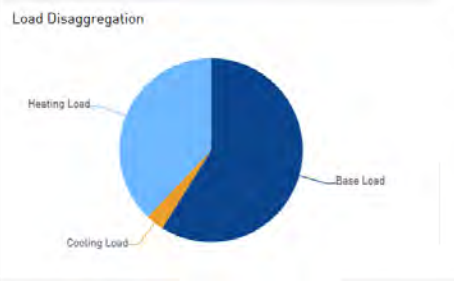


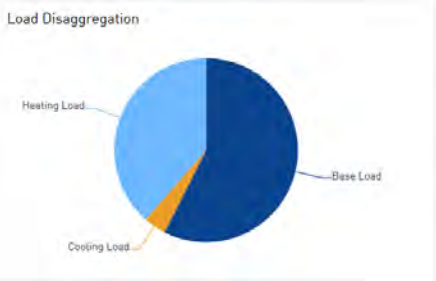
1.9 miles
Distance between treatment and future participant group centroids

152
Meters

12,773
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

903	281	31%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

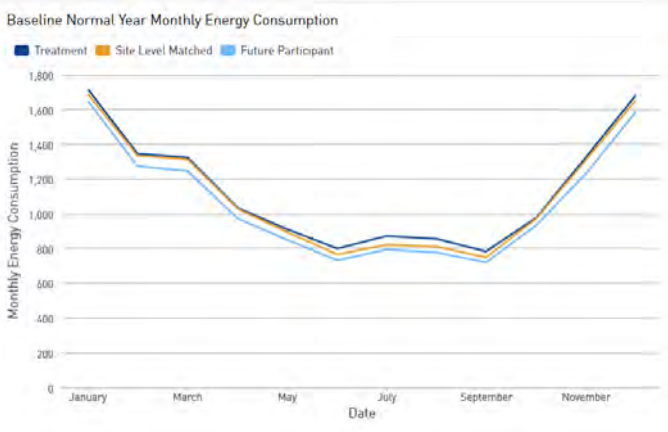
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2016 -- Fuel: Electricity	--	903
Meters with valid consumption data in baseline and/or reporting periods.	--	22	881
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	881
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	41	840
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	840
Other measure-specific filters.	--	0	840
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	211	629
Meters with at least 5 site-level matched meters from the comparison group pool.	--	12	617

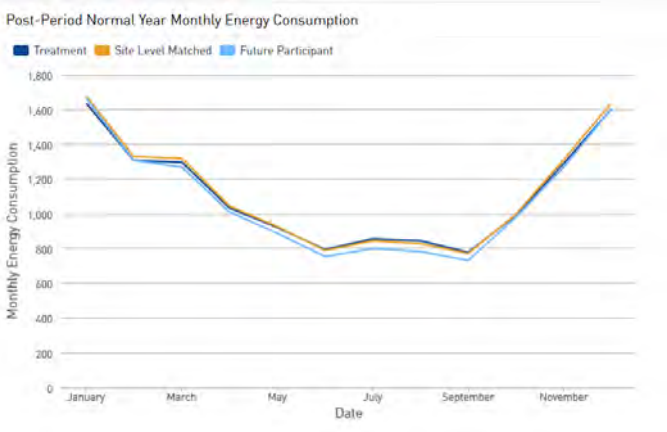
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	3	614
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	614
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	3	611
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	52	559
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	559
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	559
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	559
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	278	281
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	281

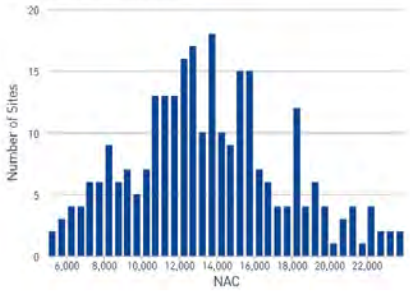
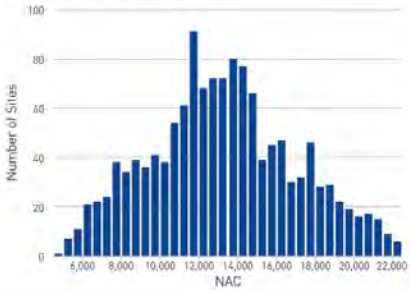
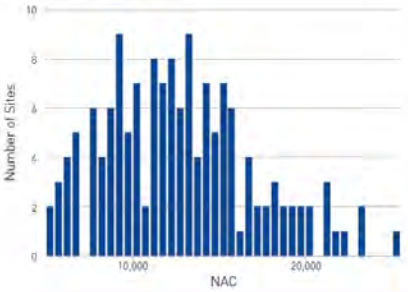
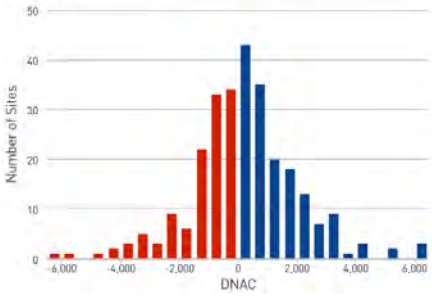
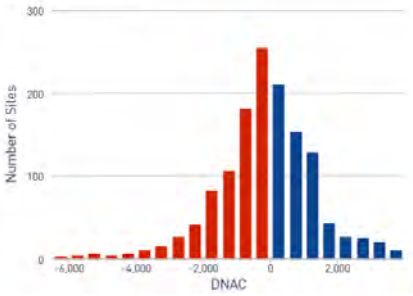
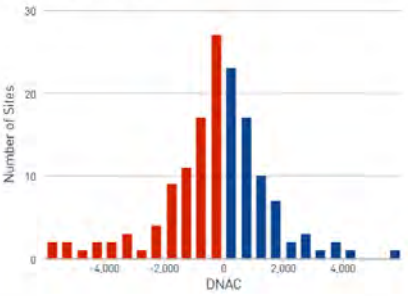
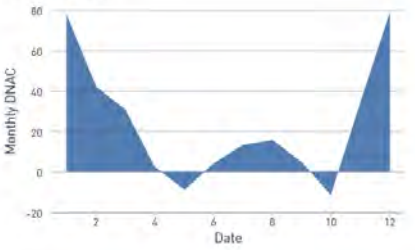
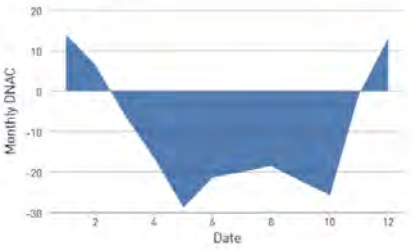
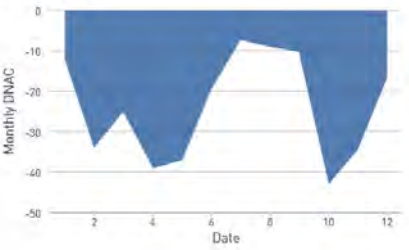
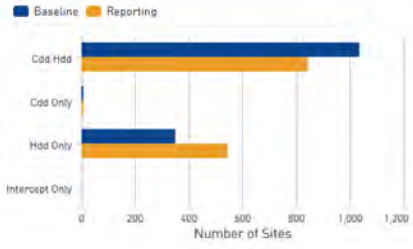
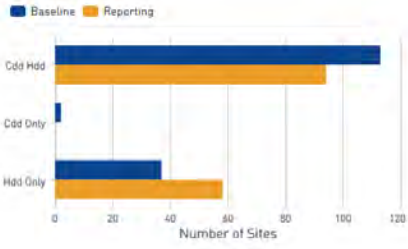
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.161 Annual Consumption p-value	0.105 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
286 +/- 186 kWh Average Difference in Normalized Annual Consumption per Participant	2 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-126 +/- 75 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-288 +/- 262 kWh Average Difference in Normalized Annual Consumption per Participant	-2 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2017

Result Summary

Measure: Airduct	Program Year: 2017		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

140 Treatment Meters	641 +/- 287 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	5 +/- 2 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,065 Mean Baseline Consumption (Electricity)	107% Realization Rate
Site-level Matched Meters 677 Site-level Matched Meters	400 +/- 307 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	13,718 Mean Baseline Consumption (Electricity)	67% Realization Rate
106 Future Participant Meters	553 +/- 447 kWh Average Savings Relative to Future Participant Group	4 +/- 3% Savings Relative to Future Participant Group	13,042 Mean Baseline Consumption (Electricity)	92% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
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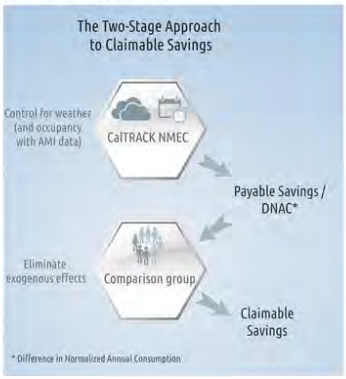
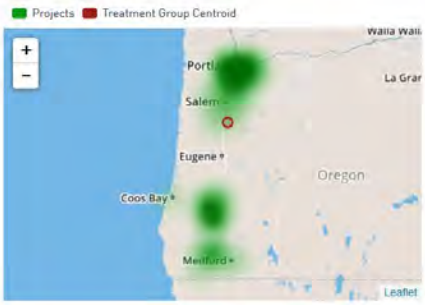
Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



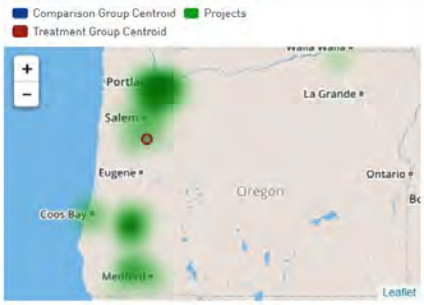
143.5 miles
80% of projects lie within this distance from treatment group centroid

140
Meters

14,065
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



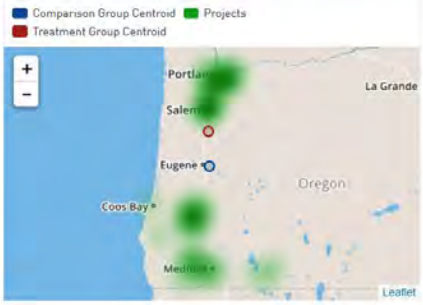
2.8 miles
Distance between treatment and comparison group centroids

677
Meters

13,718
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

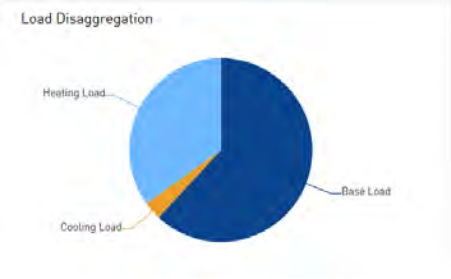
Future Participant Site Locations

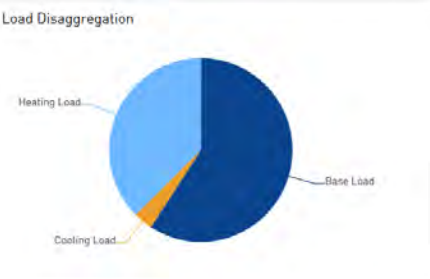


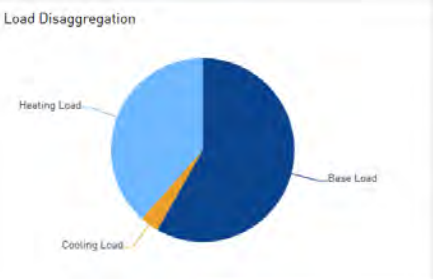
40.1 miles
Distance between treatment and future participant group centroids

106
Meters

13,042
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

780	140	18%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

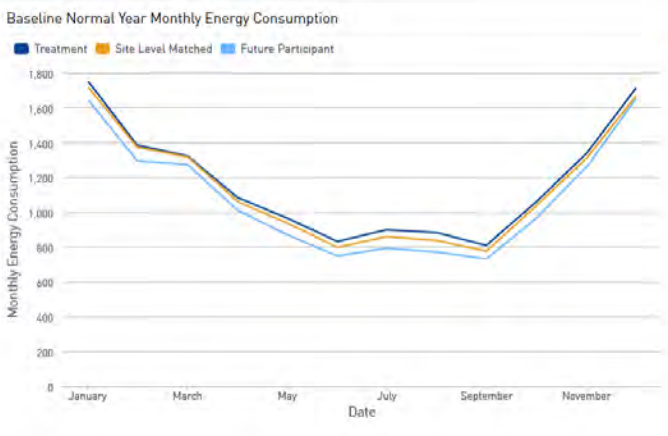
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2017 -- Fuel: Electricity	--	780
Meters with valid consumption data in baseline and/or reporting periods.	--	39	741
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	741
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	58	683
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	683
Other measure-specific filters.	--	0	683
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	229	454
Meters with at least 5 site-level matched meters from the comparison group pool.	--	5	449

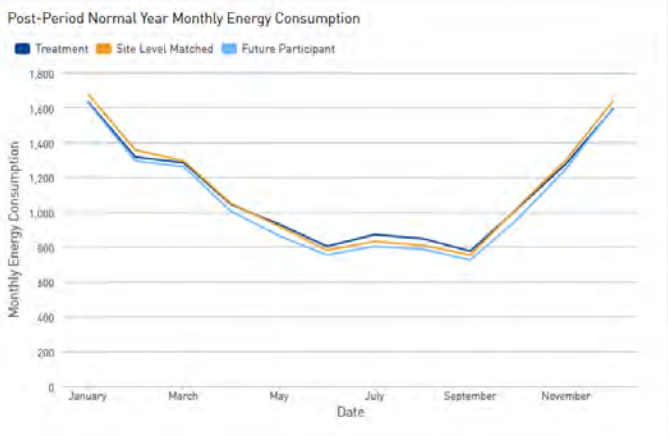
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	3	446
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	446
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	2	444
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	39	405
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	405
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	405
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	405
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	265	140
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	140

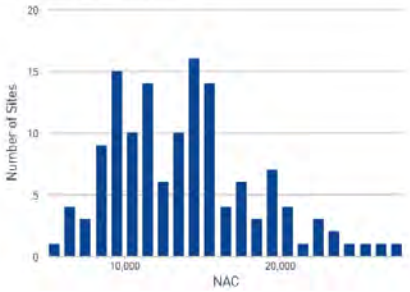
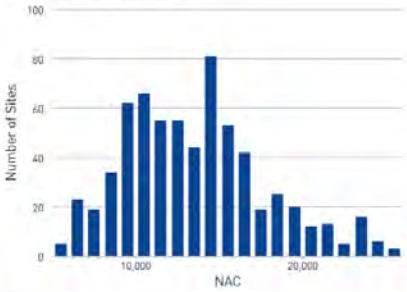
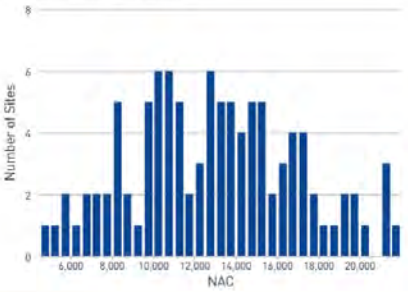
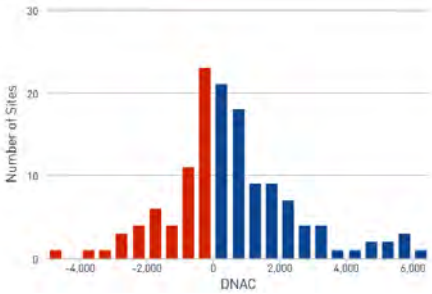
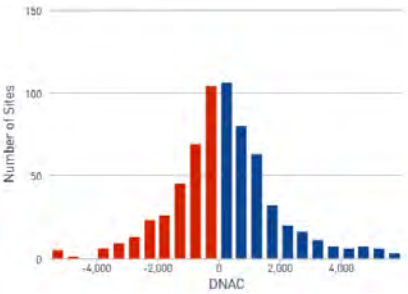
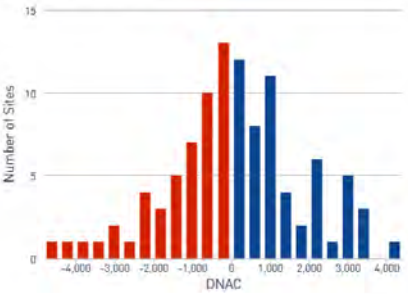
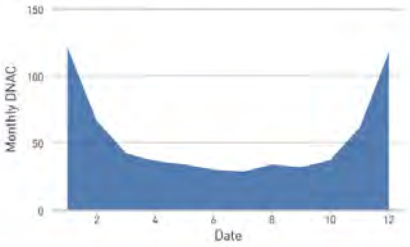
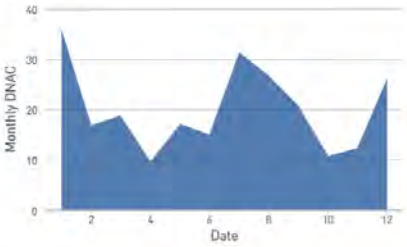
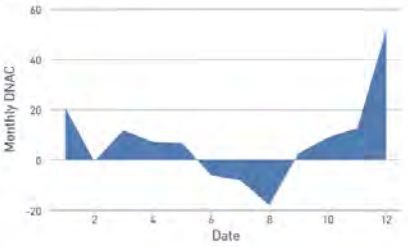
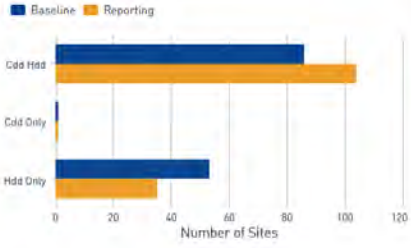
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.243 Annual Consumption p-value	0.233 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
641 +/- 287 kWh Average Difference in Normalized Annual Consumption per Participant	5 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline	241 +/- 110 kWh Average Difference in Normalized Annual Consumption per Participant	2 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	88 +/- 343 kWh Average Difference in Normalized Annual Consumption per Participant	1 +/- 3 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2018

Result Summary

Measure: Airduct	Program Year: 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

87 Treatment Meters	275 +/- 320 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	2 +/- 3 % Percent Normal Year Pre-Post Difference in Consumption per Participant	12,275 Mean Baseline Consumption (Electricity)	50% Realization Rate
430 Site-level Matched Meters	283 +/- 350 kWh Average Savings Relative to Site-level Matched Comparison Group	2 +/- 3% Percent Savings Relative to Site-level Matched Comparison Group	12,233 Mean Baseline Consumption (Electricity)	51% Realization Rate
38 Future Participant Meters	440 +/- 638 kWh Average Savings Relative to Future Participant Group	4 +/- 5% Savings Relative to Future Participant Group	13,231 Mean Baseline Consumption (Electricity)	80% Realization Rate

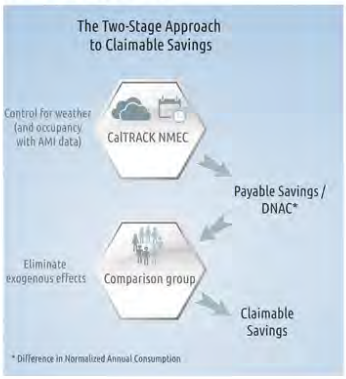
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

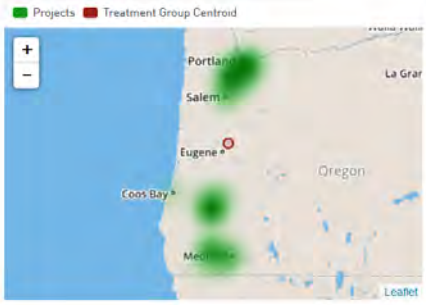
The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



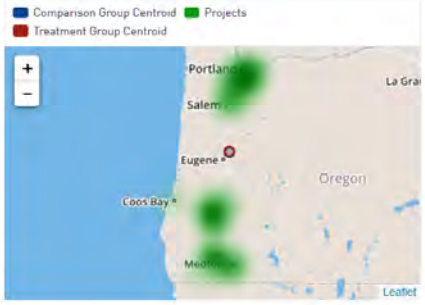
128.1 miles
80% of projects lie within this distance from treatment group centroid

87
Meters

12,275
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



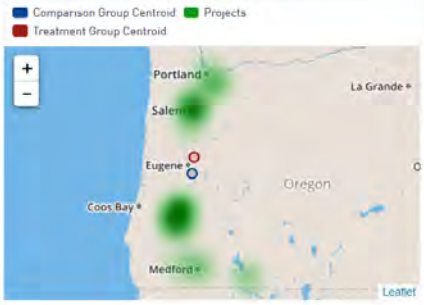
3.5 miles
Distance between treatment and comparison group centroids

430
Meters

12,233
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

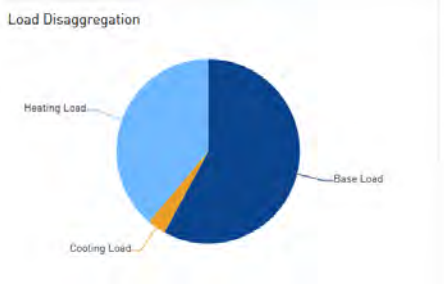
Future Participant Site Locations

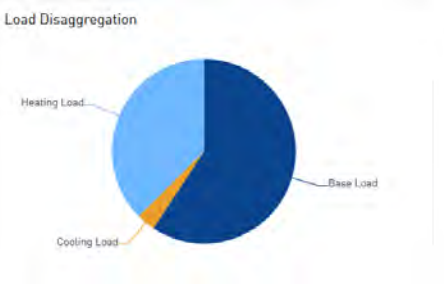


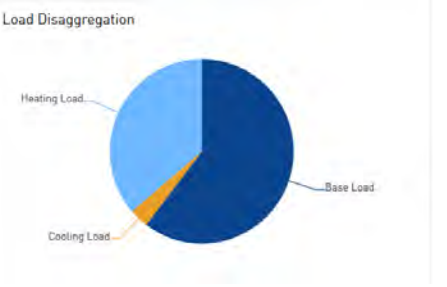
18.1 miles
Distance between treatment and future participant group centroids

38
Meters

13,231
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

555	87	16%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

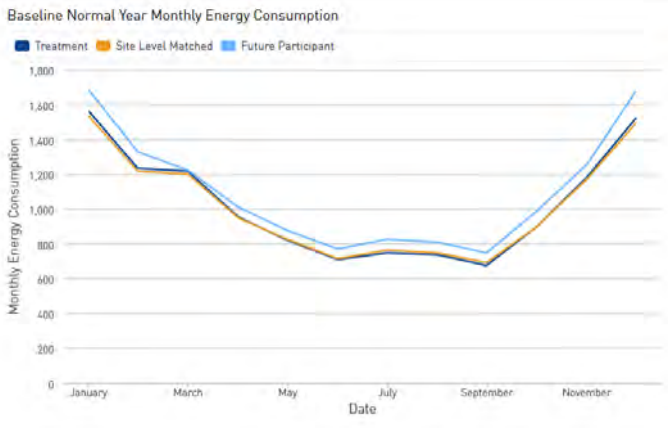
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2018 -- Fuel: Electricity	--	555
Meters with valid consumption data in baseline and/or reporting periods.	--	57	498
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	498
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	70	428
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	428
Other measure-specific filters.	--	0	428
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	149	279
Meters with at least 5 site-level matched meters from the comparison group pool.	--	19	260

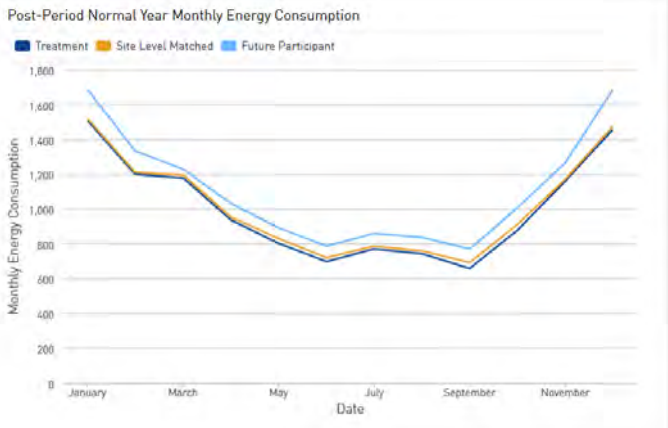
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	2	258
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	258
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	1	257
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	27	230
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	230
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	230
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	230
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Duct (electricity)	143	87
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	87

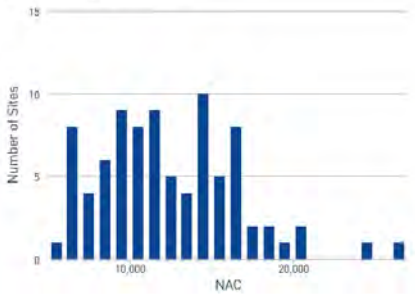
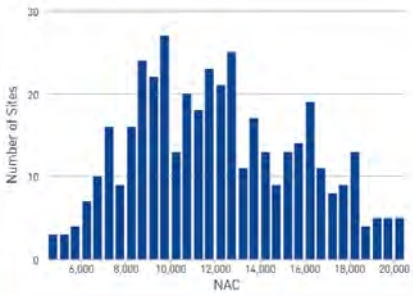
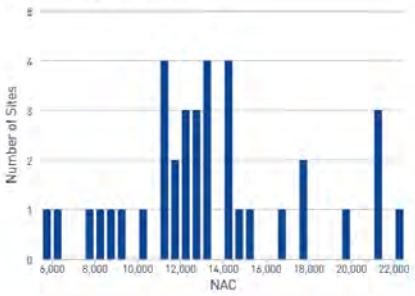
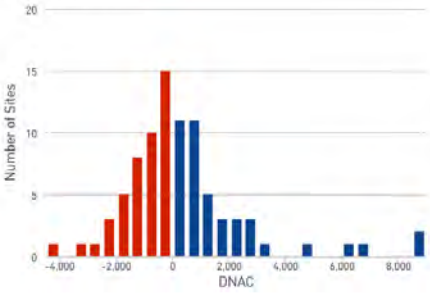
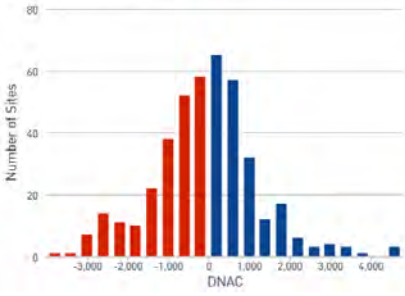
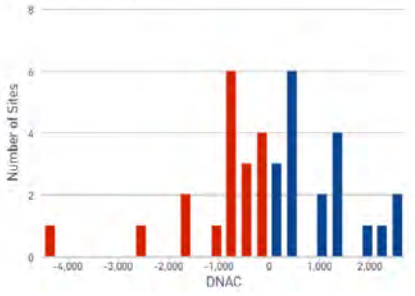
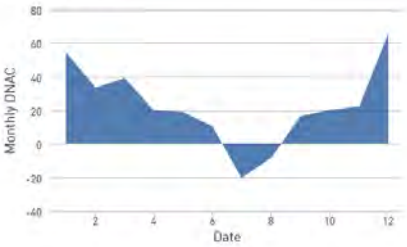
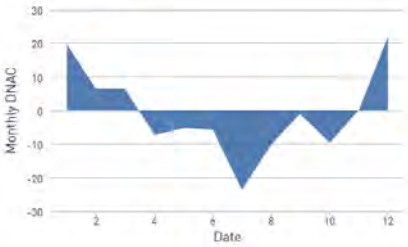
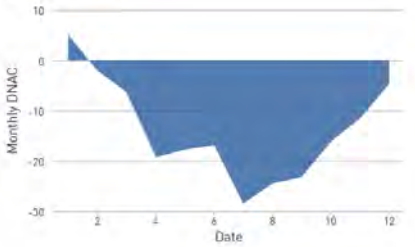
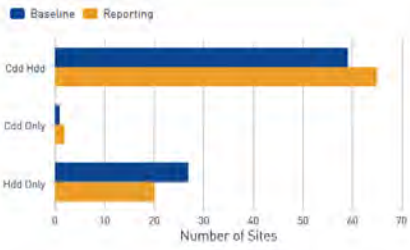
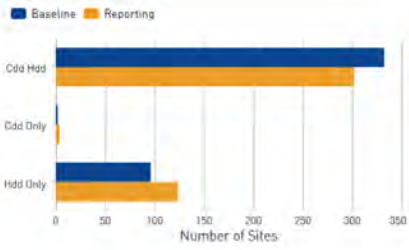
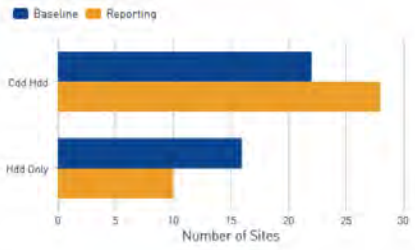
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.281 Annual Consumption p-value	0.332 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
275 +/- 320 kWh Average Difference in Normalized Annual Consumption per Participant	2 +/- 3 % Difference in Normalized Annual Consumption as a Percent of Baseline	-8 +/- 141 kWh Average Difference in Normalized Annual Consumption per Participant	-0 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-166 +/- 552 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 4 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Appendix B: Recurve Impact Analysis Reports
Air Sealing Alone

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

62 Treatment Meters	80 +/- 628 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	1 +/- 5 % Percent Normal Year Pre-Post Difference in Consumption per Participant	11,870 Mean Baseline Consumption (Electricity)	8.2% Realization Rate
301 Site-level Matched Meters	289 +/- 658 kWh Average Savings Relative to Site-level Matched Comparison Group	2 +/- 6% Percent Savings Relative to Site-level Matched Comparison Group	11,597 Mean Baseline Consumption (Electricity)	30% Realization Rate
64 Future Participant Meters	-228 +/- 848 kWh Average Savings Relative to Future Participant Group	-2 +/- 7% Savings Relative to Future Participant Group	12,176 Mean Baseline Consumption (Electricity)	-23% Realization Rate

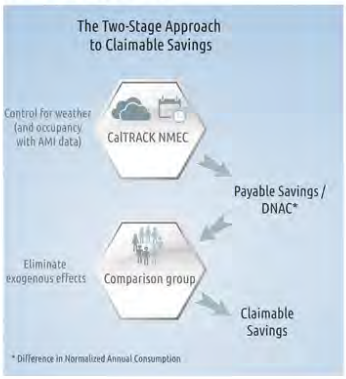
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

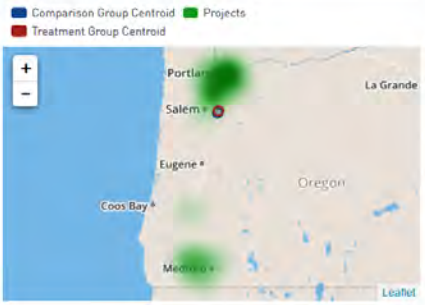
171.8 miles
80% of projects lie within this distance from treatment group centroid

62
Meters

11,870
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



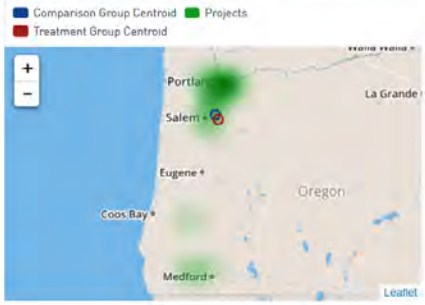
2.7 miles
Distance between treatment and comparison group centroids

301
Meters

11,597
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

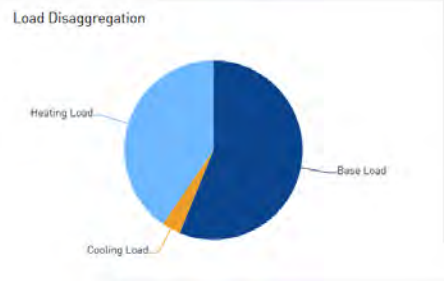
Future Participant Site Locations

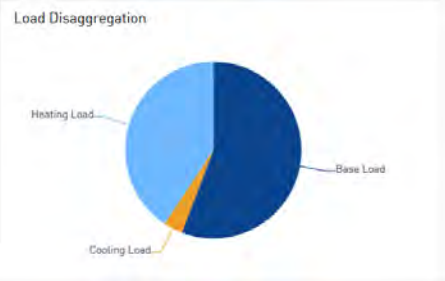


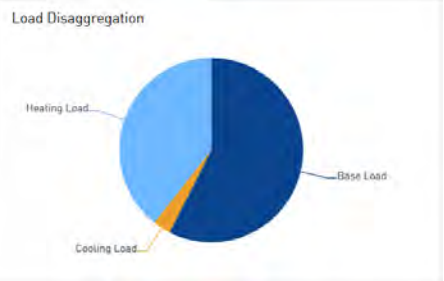
6.5 miles
Distance between treatment and future participant group centroids

64
Meters

12,176
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	62	1.1%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

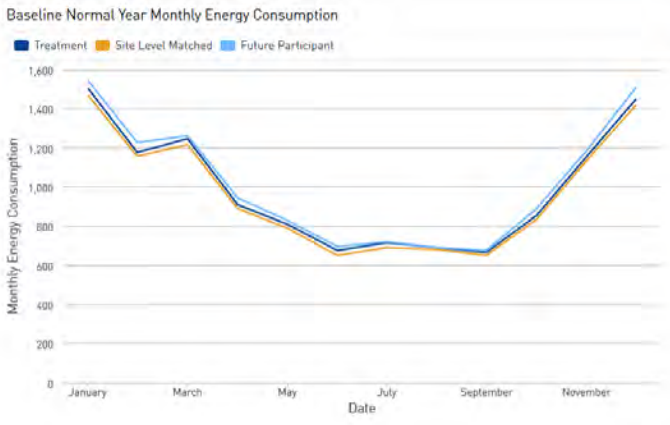
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

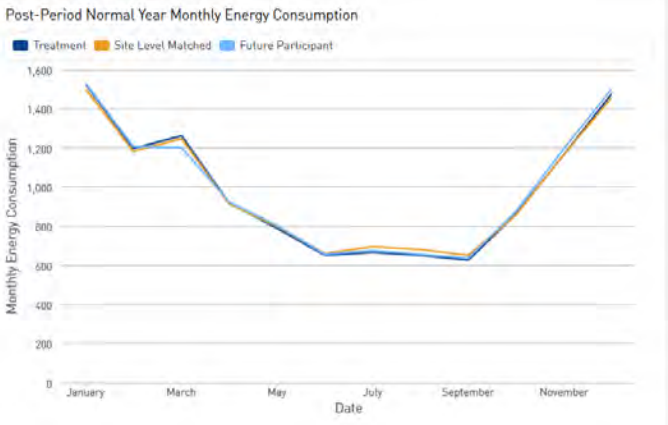
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,993
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	2,993
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air (electricity)	2,931	62
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	62

3. Modeling Results

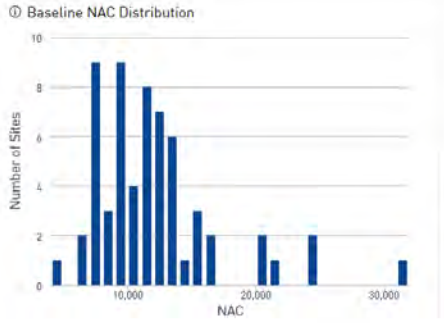
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

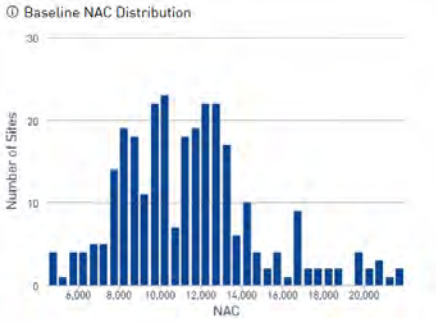
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.

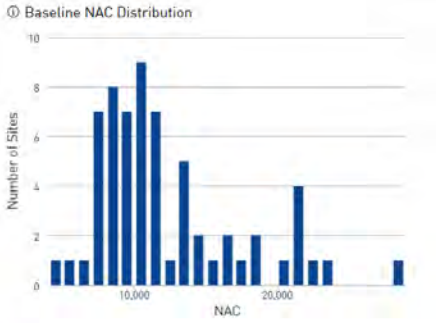




Treatment Group	Site-level Matched Comparison Group	Future Participant Group





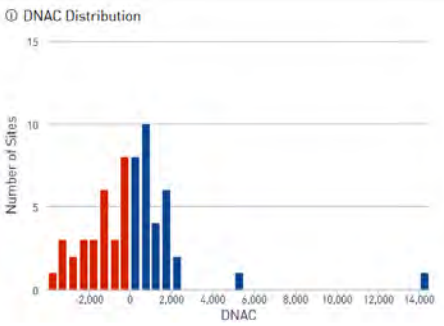


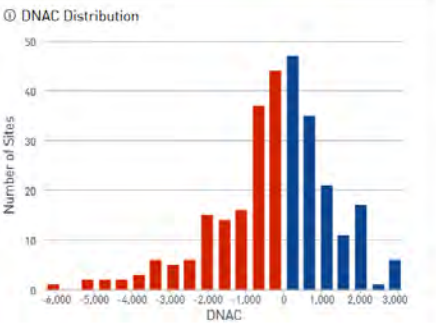
0.221

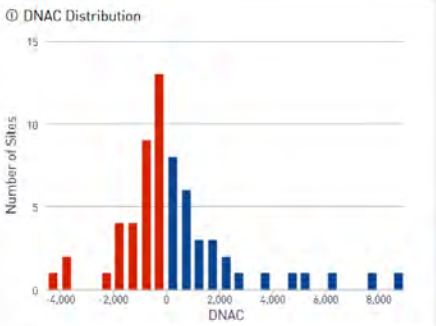
Annual Consumption p-value

0.297

Annual Consumption p-value







80 +/- 628 kWh

Average Difference in Normalized Annual Consumption per Participant

2 +/- 5 %

Difference in Normalized Annual Consumption as a Percent of Baseline

-209 +/- 197 kWh

Average Difference in Normalized Annual Consumption per Participant

-2 +/- 2 %

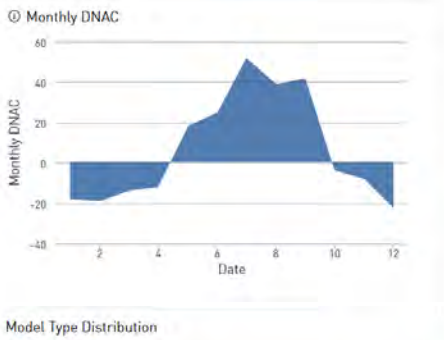
Difference in Normalized Annual Consumption as a Percent of Baseline

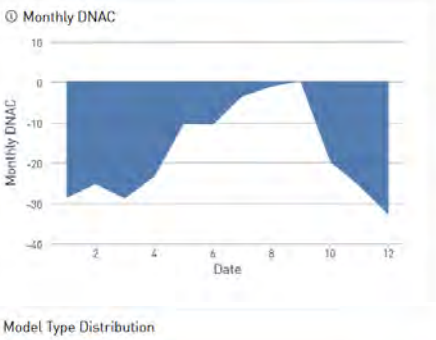
308 +/- 571 kWh

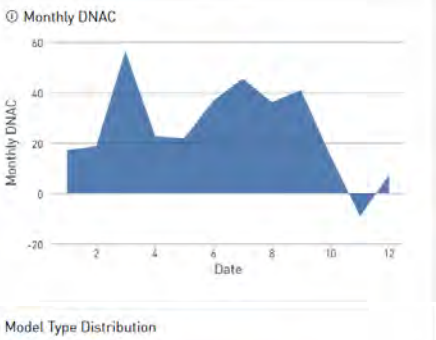
Average Difference in Normalized Annual Consumption per Participant

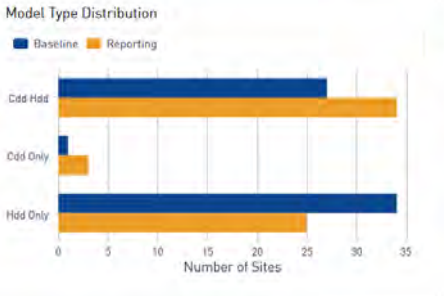
3 +/- 5 %

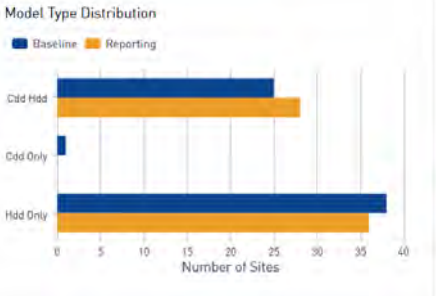
Difference in Normalized Annual Consumption as a Percent of Baseline











4. Methodology

CalTRACK and Comparison Group Methods
Documentation: docs.caltrack.org
Code: https://github.com/energy-market-methods/caltrack

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Baseline period: Since the predicted baseline may be unstable with different baseline period lengths, which may, in turn, affect calculated savings, the consensus of the CalTRACK 2.0 working group was to set the maximum baseline period at 12 months, since the year leading to the energy efficiency intervention is the most indicative of recent energy use trends and prolonging the baseline period increases the chance of other unmeasured factors affecting the baseline. In addition, CalTRACK uses a minimum 12-month baseline by default.

Blackout period: The blackout period refers to the time period between the end of the baseline period and the beginning of the reporting period. In this analysis, it is specified to coincide with the project installation time period, meaning that the billing period that contains the project installation date is dropped from the analysis.

Analysis periods: Different portions of the analysis used different time periods of consumption data, therefore, it is useful to clearly define these time periods and where they were used. Consider a project with an installation date on a particular day d in a particular month m in a particular program year y. The year before the program year is labelled as y-1, the year prior to that as y-2 and so on, while the years following the program year are labelled y+1, y+2 etc. In all cases, the billing period that contains the project installation was dropped from the analysis. Other sections of the analysis use the following time periods:
- *Treatment and site-level matched groups:* Baseline period includes the 12 months preceding the installation billing period. Reporting period includes the 12 months following the installation billing period.
- *Future participant group:* Baseline period is the calendar year preceding the program year (Year *y-1*). Reporting period is the program year itself (Year *y*).
- Site-level consumption matching was performed using the 12 months of data immediately prior to the project installation date.
- Equivalence tests were performed using data from the previous calendar year (y-1).

Appendix C: Recurve Impact Analysis Reports
Combined Air and Duct Sealing

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

1,333 Treatment Meters	384 +/- 97 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,061 Mean Baseline Consumption (Electricity)	36% Realization Rate
6,582 Site-level Matched Meters	403 +/- 103 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	13,565 Mean Baseline Consumption (Electricity)	38% Realization Rate
1,232 Future Participant Meters	535 +/- 148 kWh Average Savings Relative to Future Participant Group	4 +/- 1% Savings Relative to Future Participant Group	13,661 Mean Baseline Consumption (Electricity)	51% Realization Rate

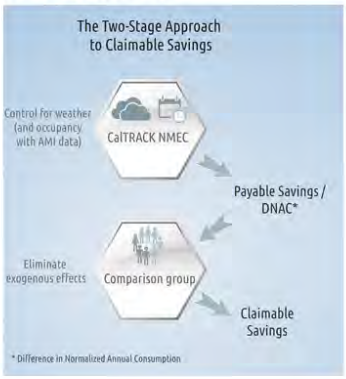
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

154.1 miles

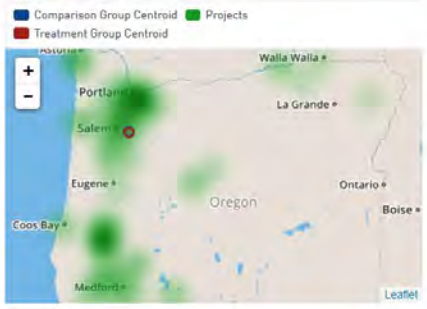
80% of projects lie within this distance from treatment group centroid

1,333
Meters

14,061
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



2.0 miles

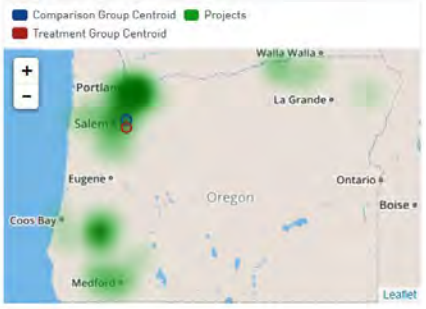
Distance between treatment and comparison group centroids

6,582
Meters

13,565
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations

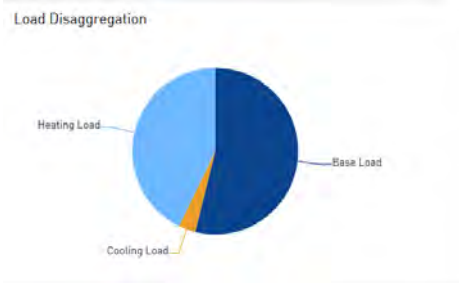


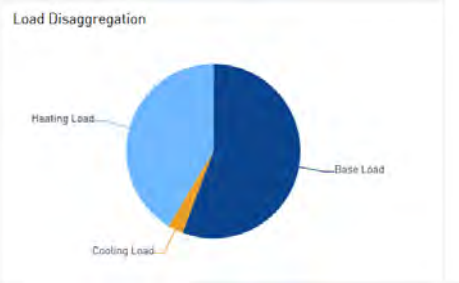
7.7 miles

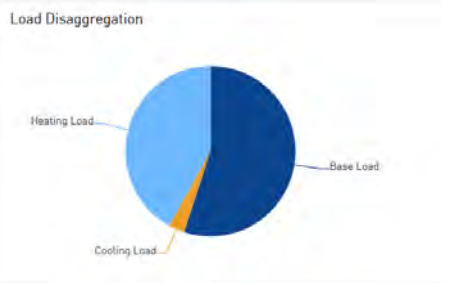
Distance between treatment and future participant group centroids

1,232
Meters

13,661
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	1,333	24%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

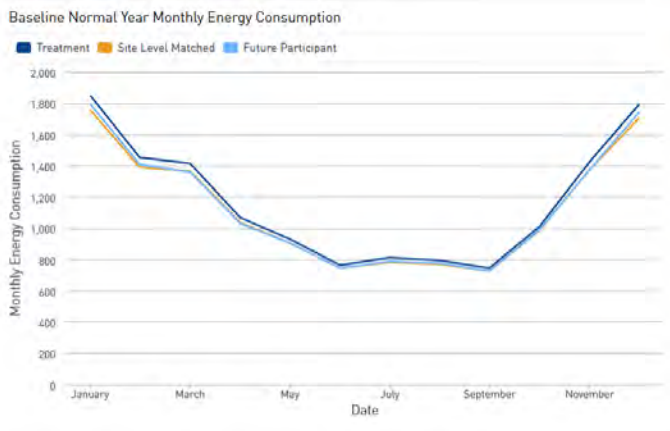
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

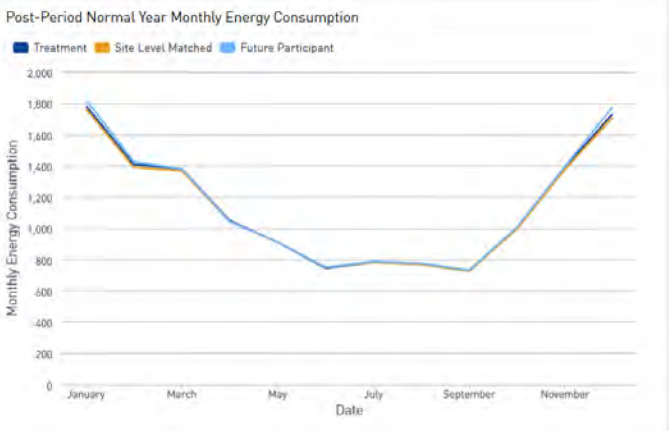
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,993
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	2,993
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	1,660	1,333
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	1,333

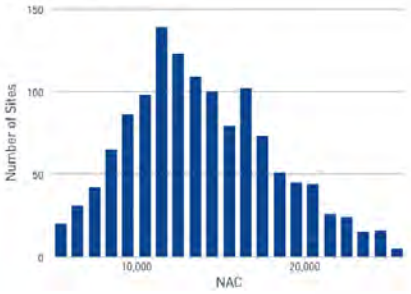
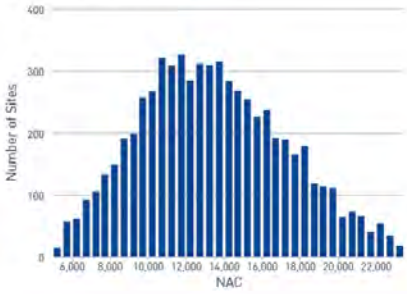
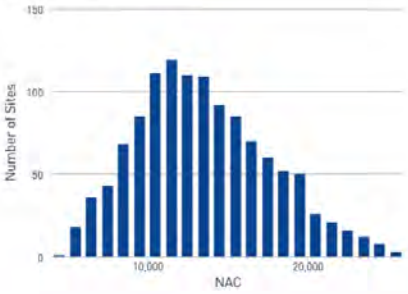
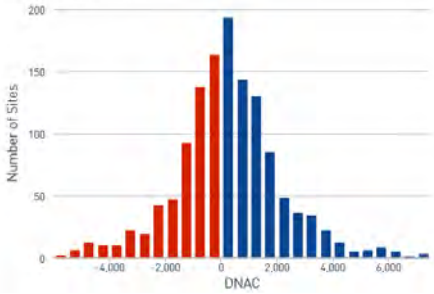
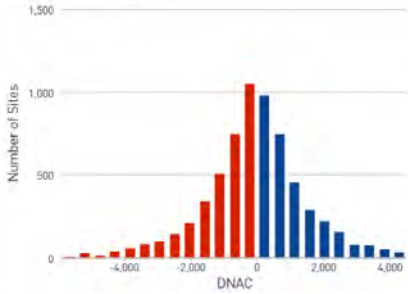
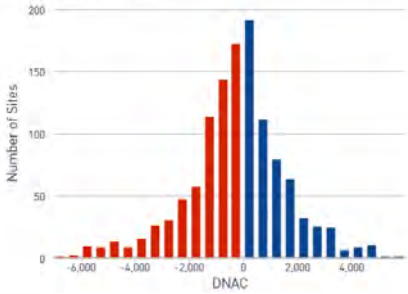
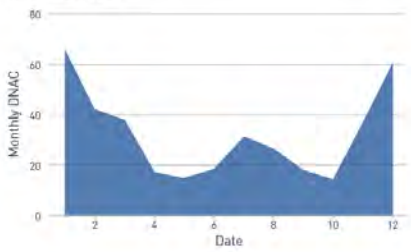
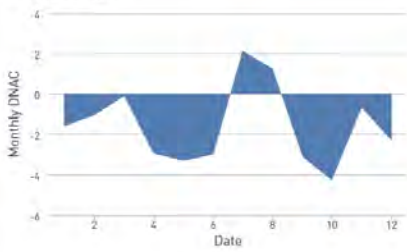
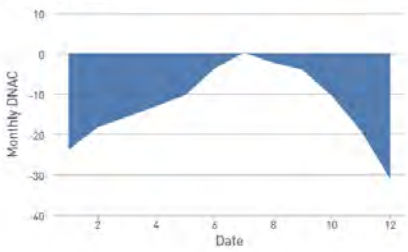
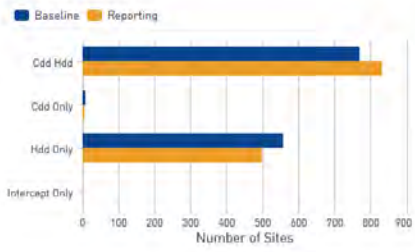
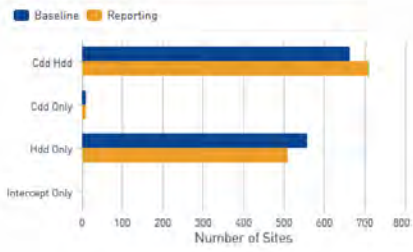
3. Modeling Results

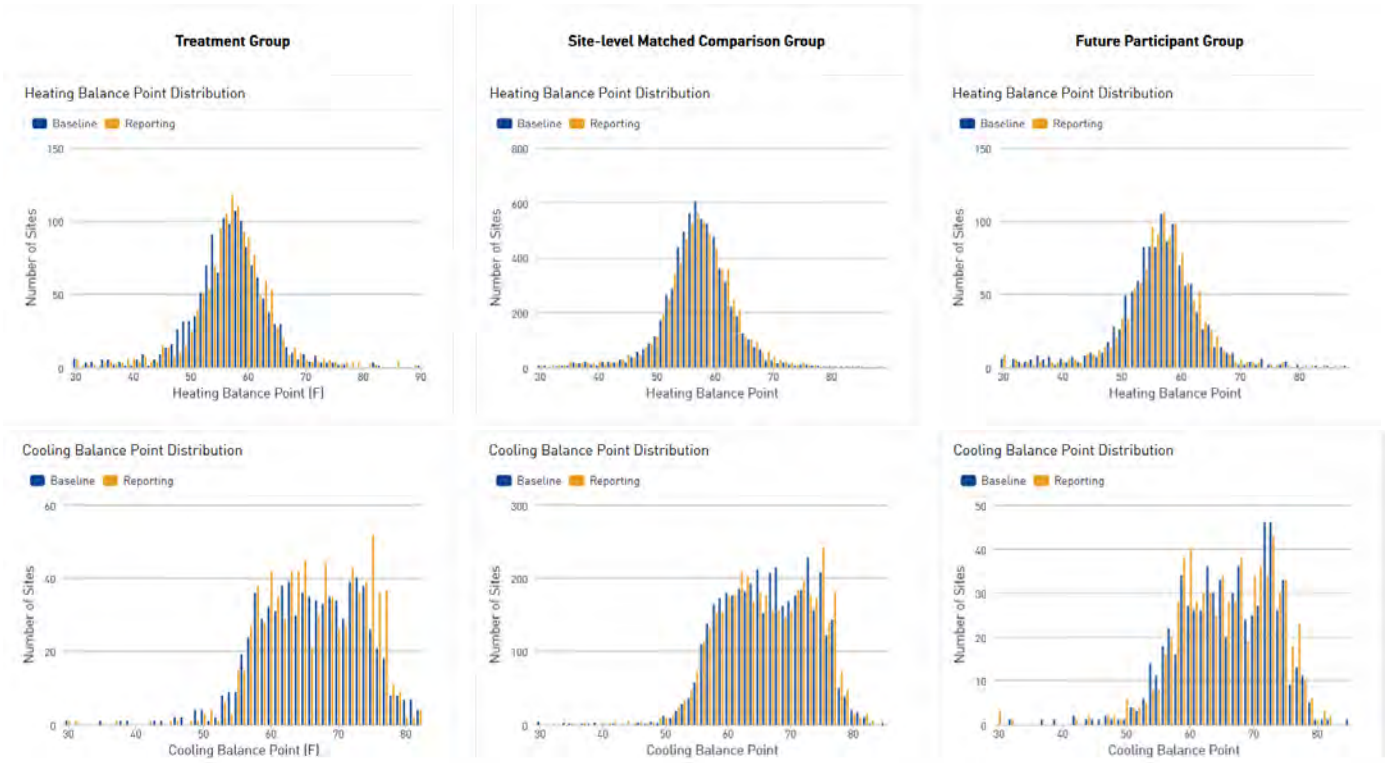
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.089 Annual Consumption p-value	0.147 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
384 +/- 97 kWh Average Difference in Normalized Annual Consumption per Participant 3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-19 +/- 35 kWh Average Difference in Normalized Annual Consumption per Participant -0 +/- 0 % Difference in Normalized Annual Consumption as a Percent of Baseline	-151 +/- 112 kWh Average Difference in Normalized Annual Consumption per Participant -1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		



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- *Future participant group:* Baseline period is the calendar year preceding the program year (Year *y-1*). Reporting period is the program year itself (Year *y*).
- Site-level consumption matching was performed using the 12 months of data immediately prior to the project installation date.
- Equivalence tests were performed using data from the previous calendar year (y-1).

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: 1 - Hdd <= 6000	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

1,319 Treatment Meters	383 +/- 97 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,024 Mean Baseline Consumption (Electricity)	36% Realization Rate
6,510 Site-level Matched Meters	400 +/- 104 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	13,528 Mean Baseline Consumption (Electricity)	38% Realization Rate
1,226 Future Participant Meters	537 +/- 149 kWh Average Savings Relative to Future Participant Group	4 +/- 1% Savings Relative to Future Participant Group	13,646 Mean Baseline Consumption (Electricity)	51% Realization Rate

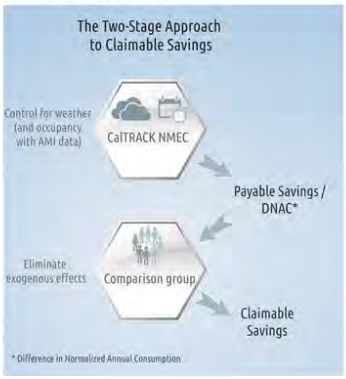
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

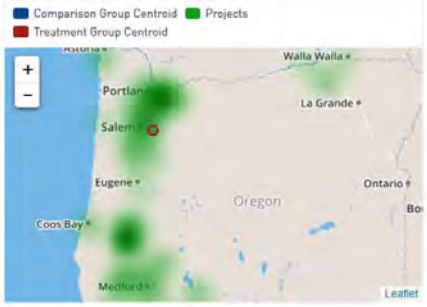
146.8 miles
80% of projects lie within this distance from treatment group centroid

1,319
Meters

14,024
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



1.9 miles
Distance between treatment and comparison group centroids

6,510
Meters

13,528
Mean Baseline Consumption (Electricity)

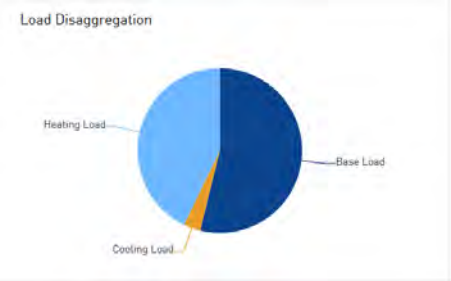
Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

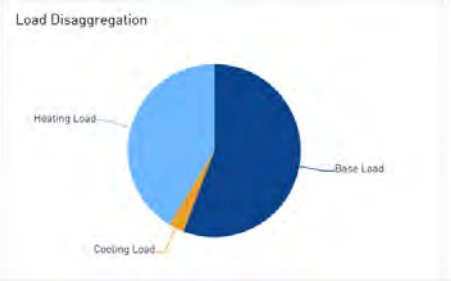
Future Participant Site Locations

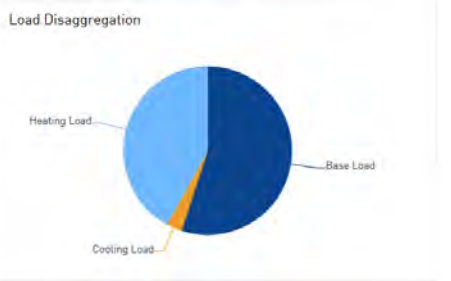
7.4 miles
Distance between treatment and future participant group centroids

1,226
Meters

13,646
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	1,319	24%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

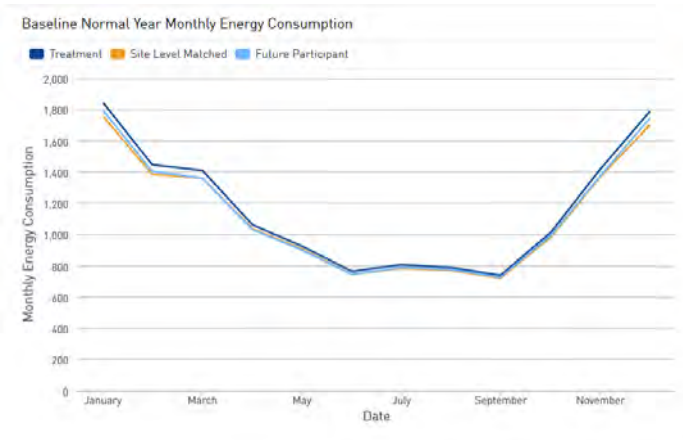
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: 1 - Hdd <= 6000 -- Cooling Zone: All	152	4,774
Other measure-specific filters.	--	0	4,774
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,414	3,360
Meters with at least 5 site-level matched meters from the comparison group pool.	--	72	3,288

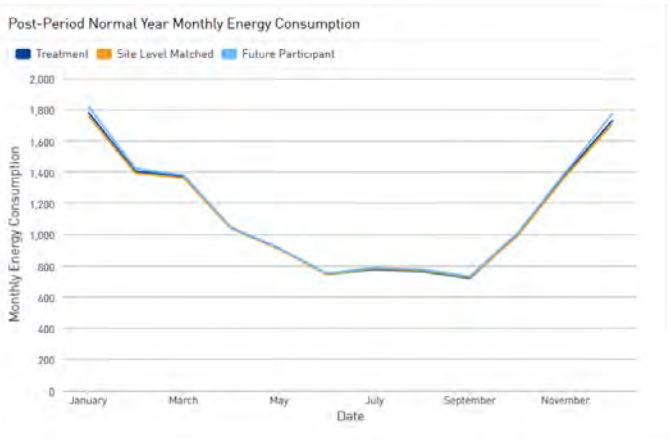
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	23	3,265
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,265
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,249
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	329	2,920
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,920
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,920
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	2,920
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	1,601	1,319
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	1,319

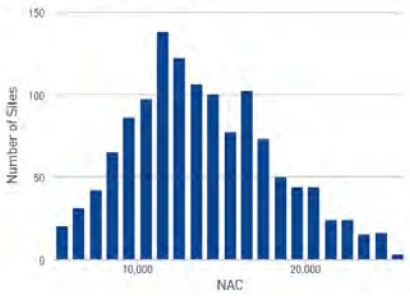
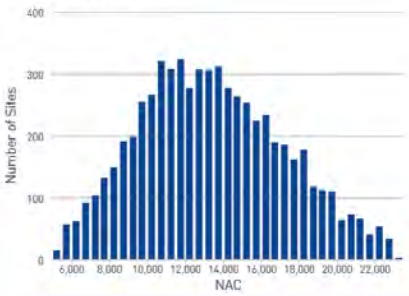
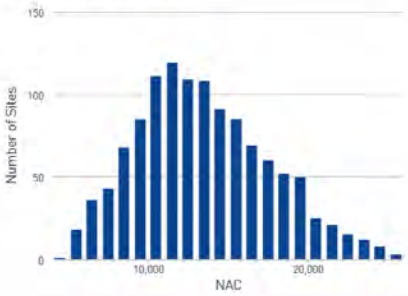
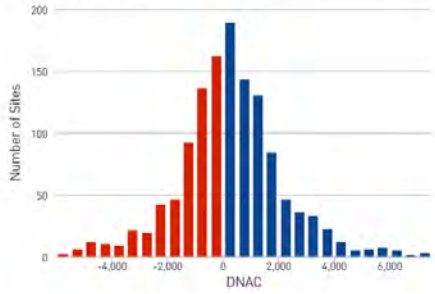
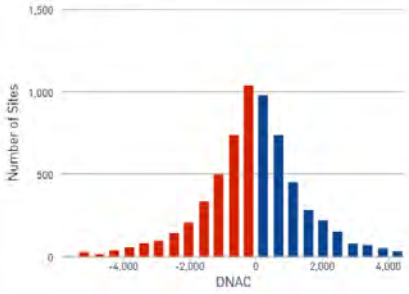
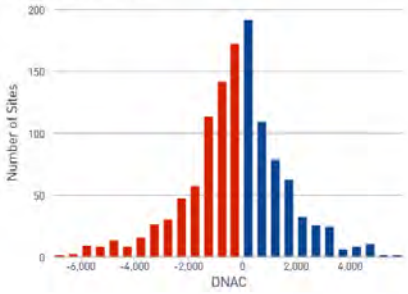
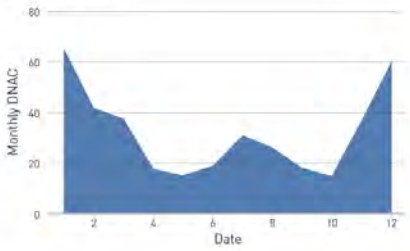
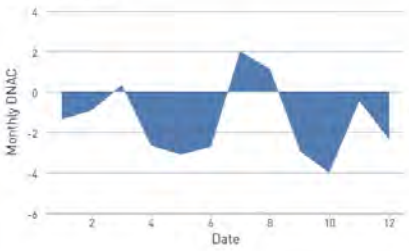
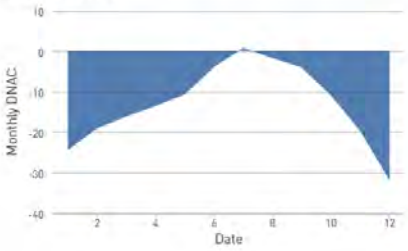
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution
		
	ⓘ 0.131 Annual Consumption p-value	ⓘ 0.147 Annual Consumption p-value
ⓘ DNAC Distribution	ⓘ DNAC Distribution	ⓘ DNAC Distribution
		
383 +/- 97 kWh Average Difference in Normalized Annual Consumption per Participant 3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-17 +/- 35 kWh Average Difference in Normalized Annual Consumption per Participant -0 +/- 0 % Difference in Normalized Annual Consumption as a Percent of Baseline	-154 +/- 113 kWh Average Difference in Normalized Annual Consumption per Participant -1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
ⓘ Monthly DNAC	ⓘ Monthly DNAC	ⓘ Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* Q1 2020
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*Last Participation Data Update:* Q1 2020 *CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): 2 - 6000 < Hdd < 7500, 3 - Hdd >= 7500	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: All	Complex Duct Sealing: All	LikelyGasWaterHeating: All
Electric Provider: All	Contractor: All	Baseline Heating System: All	Water Heating Fuel: All	Home Size (SqFt): All	Ducted heat pump type: All

14 Treatment Meters	473 +/- 1044 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 6 % Percent Normal Year Pre-Post Difference in Consumption per Participant	17,533 Mean Baseline Consumption (Electricity)	33% Realization Rate
70 Site-level Matched Meters	357 +/- 1151 kWh Average Savings Relative to Site-level Matched Comparison Group	2 +/- 7% Percent Savings Relative to Site-level Matched Comparison Group	16,885 Mean Baseline Consumption (Electricity)	25% Realization Rate
6 Future Participant Meters	-111 +/- 1523 kWh Average Savings Relative to Future Participant Group	-1 +/- 9% Savings Relative to Future Participant Group	16,724 Mean Baseline Consumption (Electricity)	-8% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

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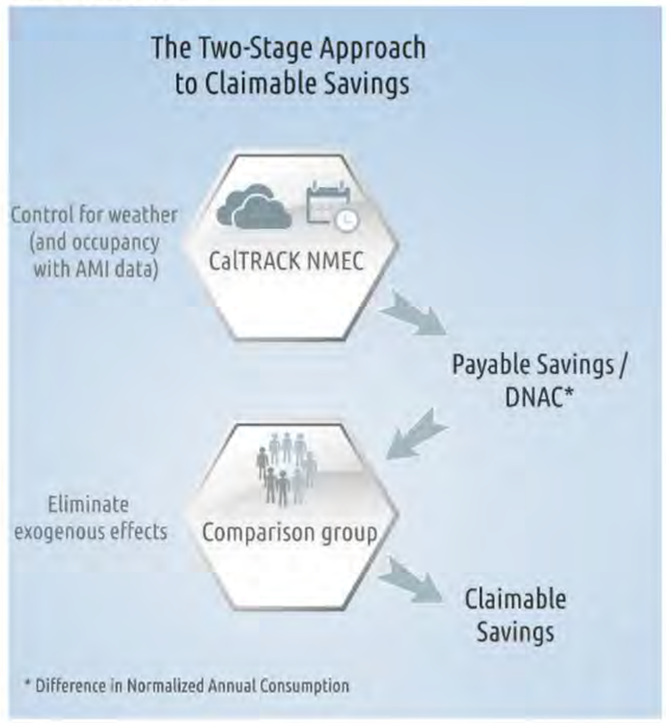
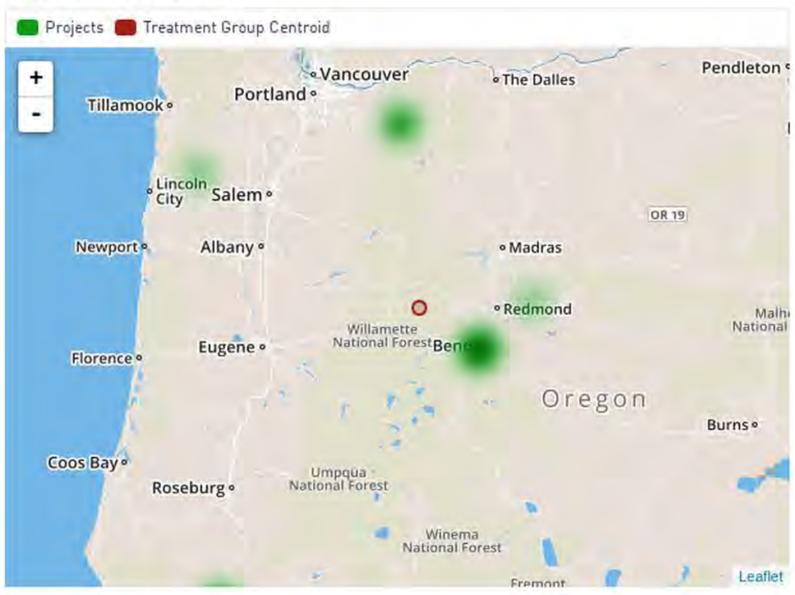
Two-Stage Approach



Treatment Group

The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

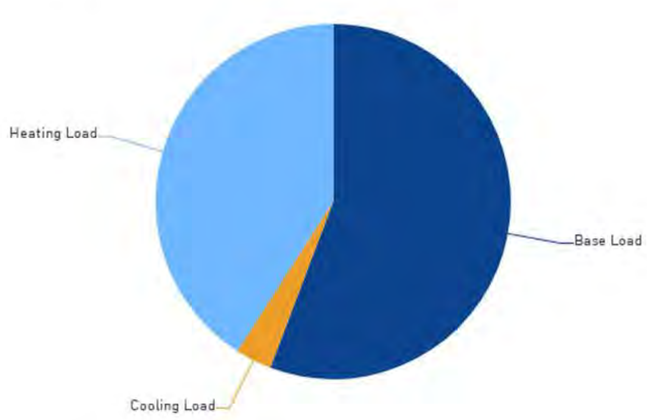


146.7 miles

80% of projects lie within this distance from treatment group centroid

14	17,533
Meters	Mean Baseline Consumption (Electricity)

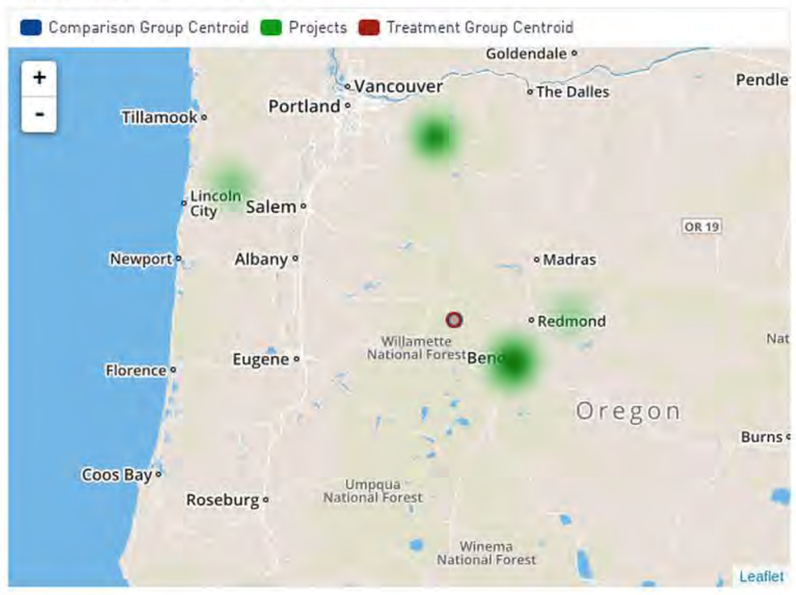
Load Disaggregation



Site-level Matched Comparison Group

This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

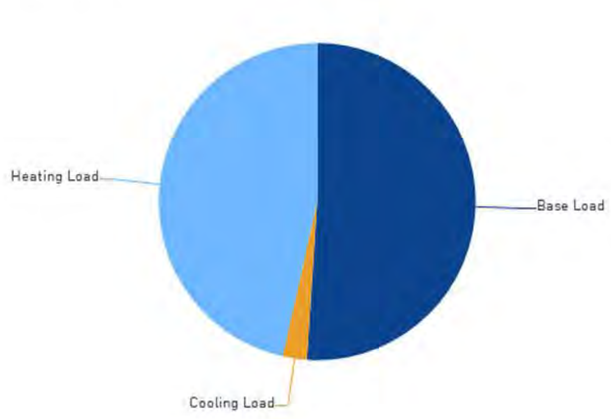


10.7 miles

Distance between treatment and comparison group centroids

70	16,885
Meters	Mean Baseline Consumption (Electricity)

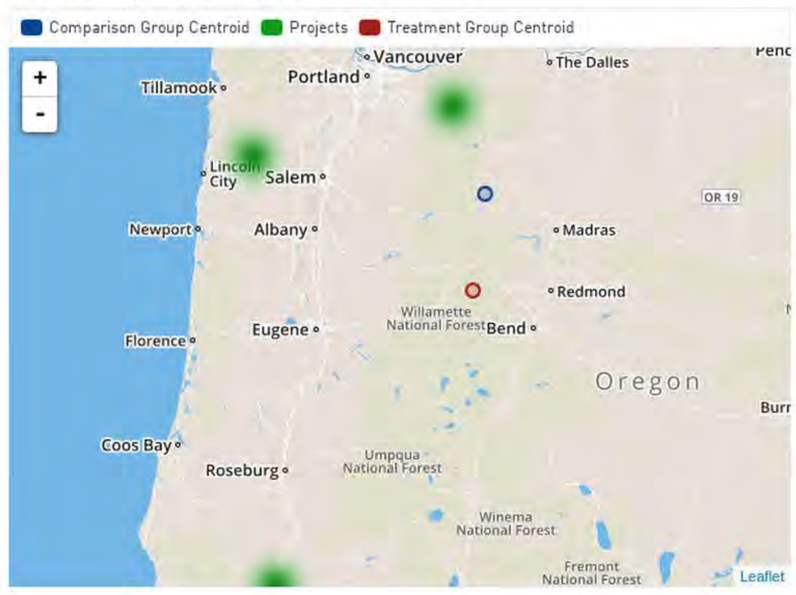
Load Disaggregation



Future Participant Group

The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations

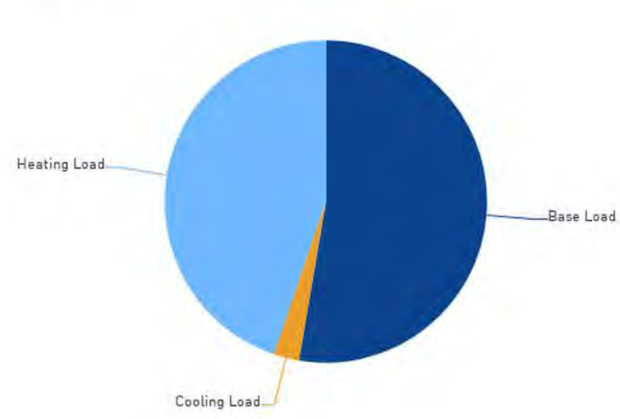


39.2 miles

Distance between treatment and future participant group centroids

6	16,724
Meters	Mean Baseline Consumption (Electricity)

Load Disaggregation



2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	14	0.25%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

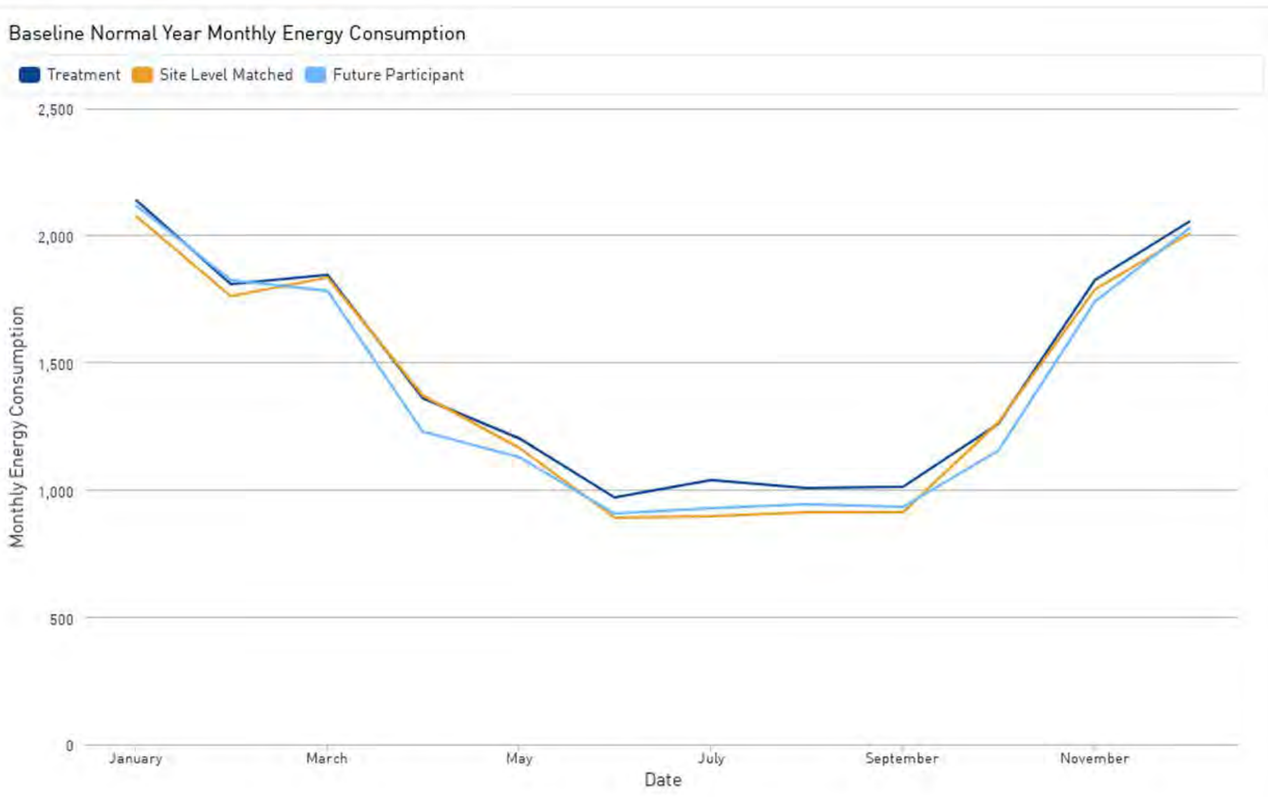
Sample Attrition Table

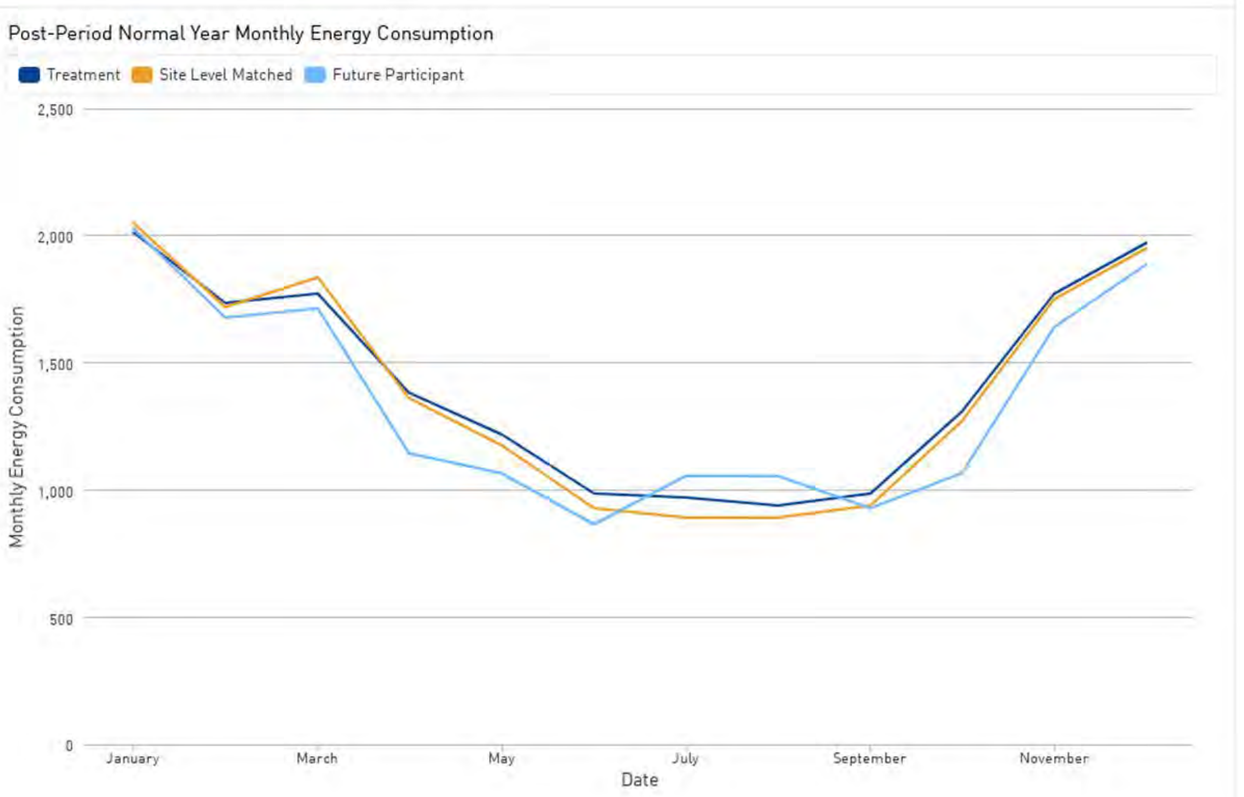
	FILTER NAME	FILTER VALUE	TREATMENT METERS DROPPED	TREATMENT METERS REMAINING
1	Initial treatment population			96096
2	Measure	AIRDUCT	90442	5654
3	Year	2013, 2014, 2015, 2016, 2017, 2018	0	5654
4	Fuel	Electricity	432	5222
5	Valid consumption data in baseline and reporting periods	valid data	0	5222
6	MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods	Is not null	0	5222
7	HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	='ELE'	296	4926
8	HeatingZone: Meters in selected heating climate zone.	2, 3	4778	148
9	CoolingZone: Meters in selected cooling climate zone.	--		148
10	PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	>=11	59	89
11	Meters with at least 5 site-level matched meters from the comparison group pool		6	83
12	DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold	<1	2	81
13	DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption	--	0	81
14	ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Between 0.5 and 99.5	0	81
15	R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. ...	> 0.5	8	73
16	CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshol...	< 1	0	73
17	home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide)	--	0	73
18	complex_duct_sealing: Meters with the 'MH Complex Add-On' measure	--	0	73
19	airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs	="ele_air_and_duct"	59	14
20	likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	--	0	14
21	Electricity Provider	--	0	14
22	Home Size [Sq Ft]	--	0	14
23	Water heating fuel type	--	0	14
24	Heat pump type	--	0	14
25	Contractor	--	0	14
26	Baseline heating system	--	0	14
27	Thermostat name	--	0	14
28	Heat pump baseline equipment	--	0	14
29	Heat pump manufacturer	--	0	14
30	Heat pump comissioning	--	0	14
31	Multi-measure flag	Is not null	0	14
32	Final treatment population			14

3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

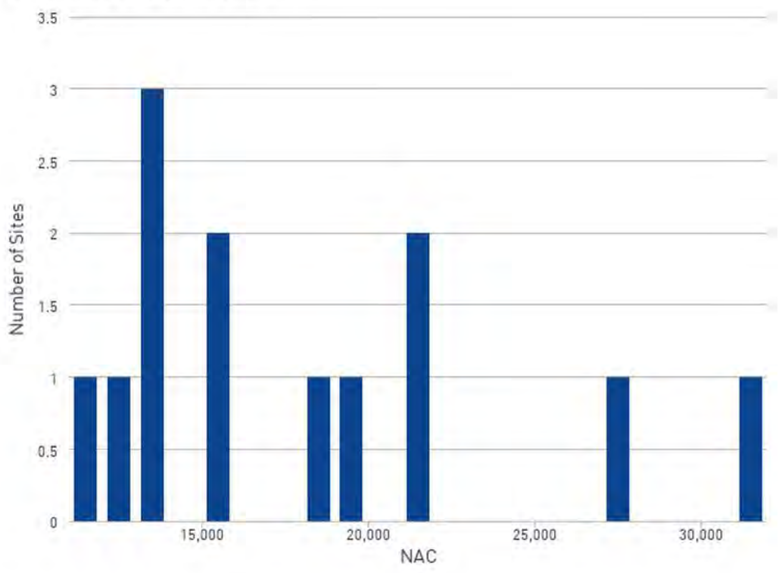
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.



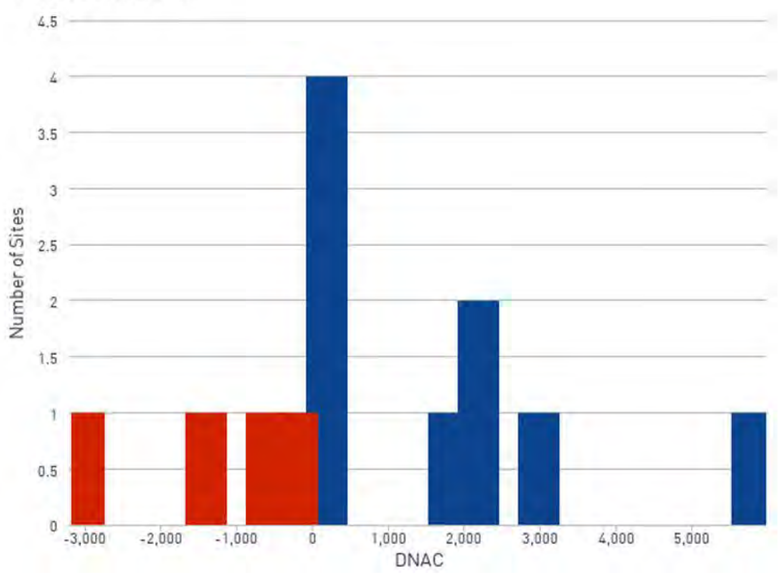


Treatment Group

Baseline NAC Distribution



DNAC Distribution



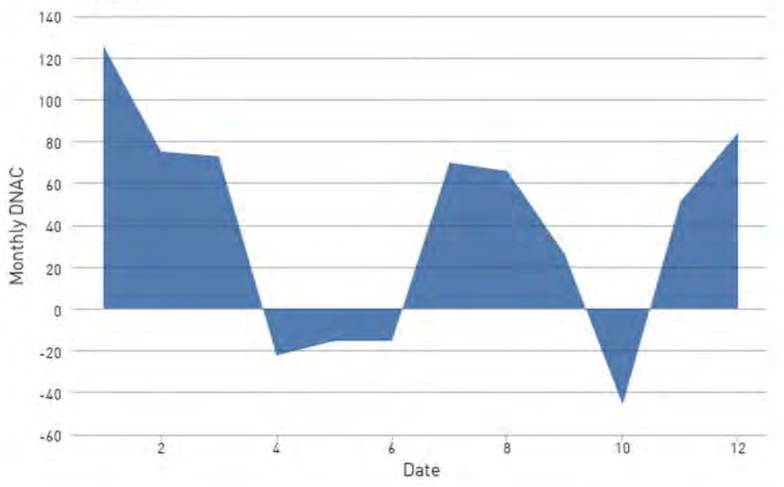
473 +/- 1044 kWh

Average Difference in Normalized Annual Consumption per Participant

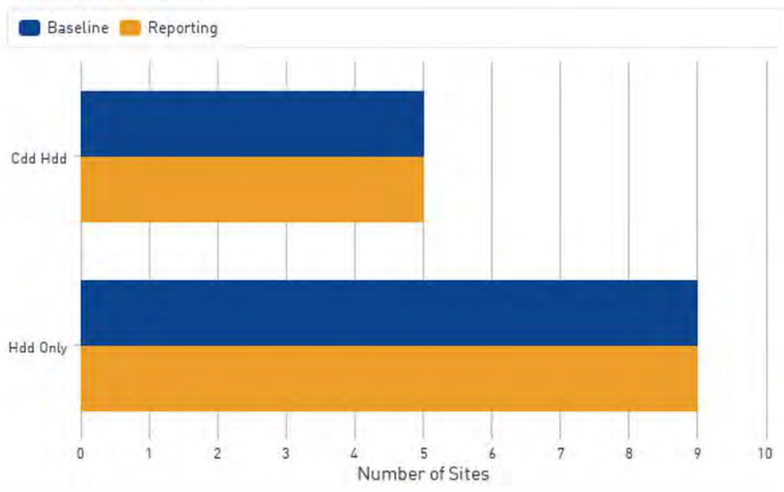
8 +/- 5 %

Difference in Normalized Annual Consumption as a Percent of Baseline

Monthly DNAC

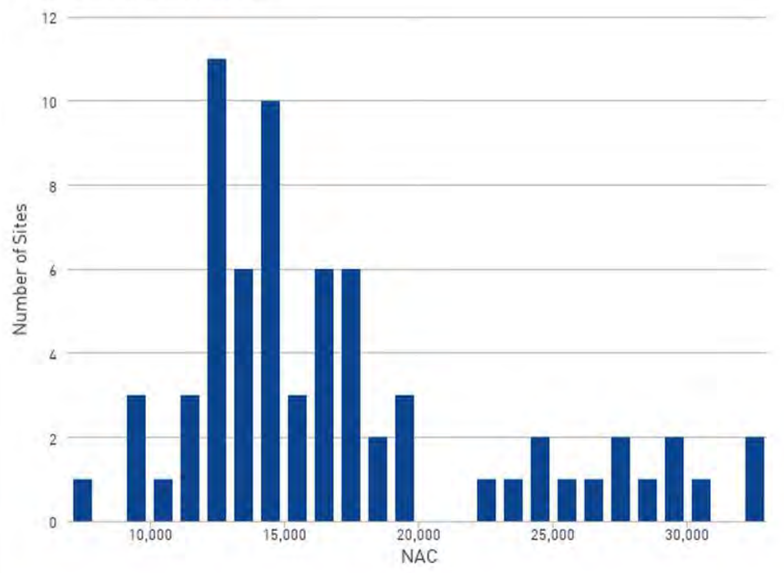


Model Type Distribution



Site-level Matched Comparison Group

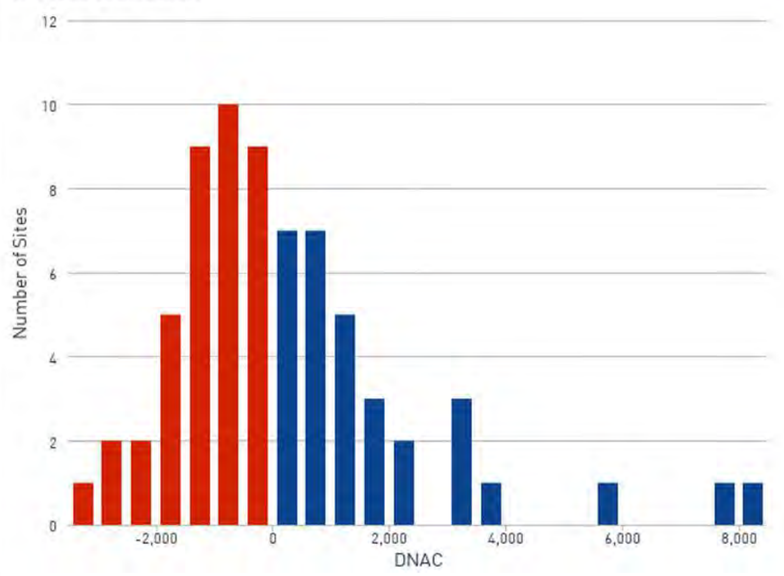
Baseline NAC Distribution



0.319

Annual Consumption p-value

DNAC Distribution



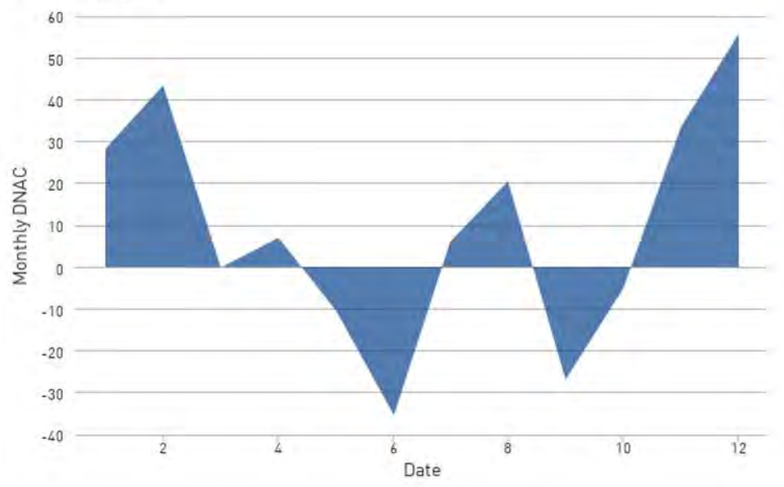
117 +/- 484 kWh

Average Difference in Normalized Annual Consumption per Participant

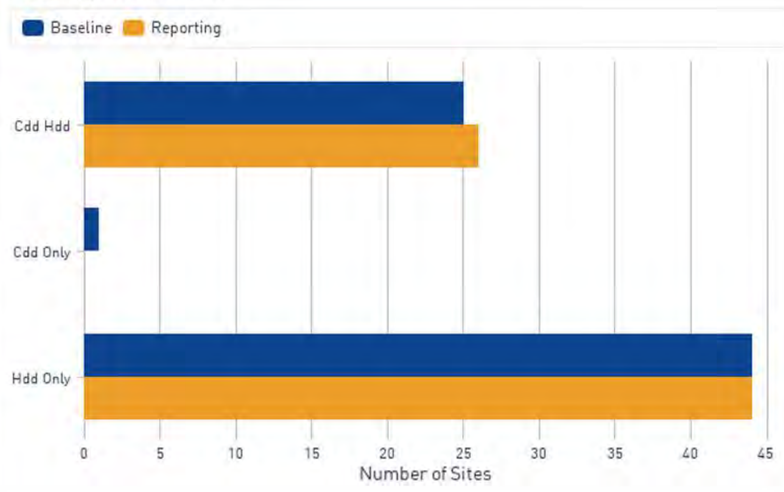
1 +/- 3 %

Difference in Normalized Annual Consumption as a Percent of Baseline

Monthly DNAC

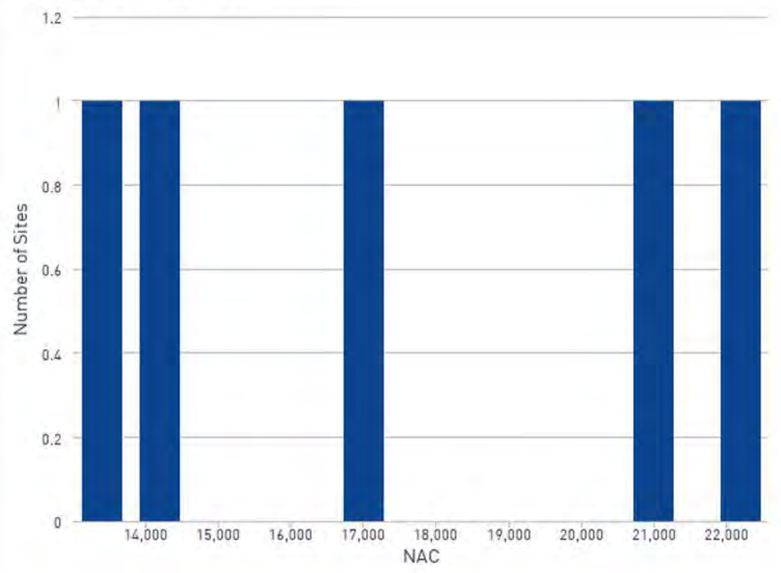


Model Type Distribution



Future Participant Group

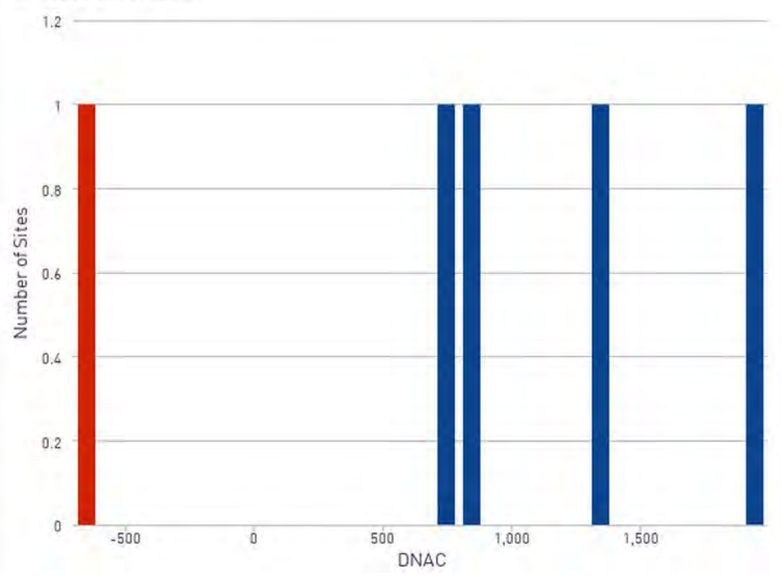
Baseline NAC Distribution



0.454

Annual Consumption p-value

DNAC Distribution



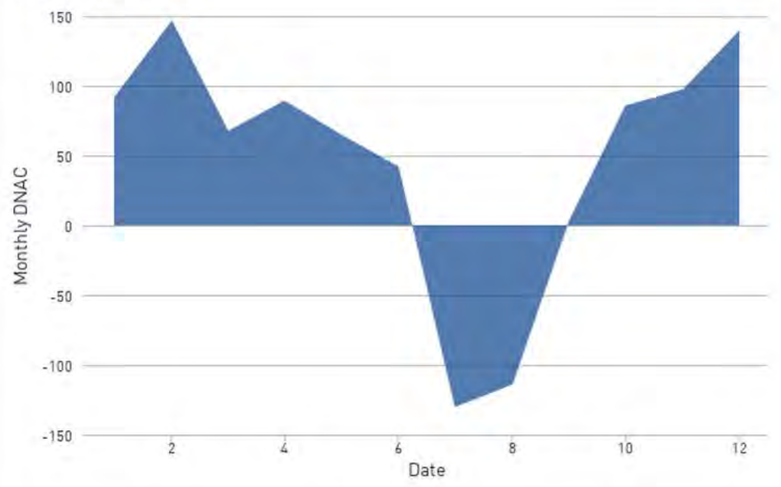
584 +/- 1109 kWh

Average Difference in Normalized Annual Consumption per Participant

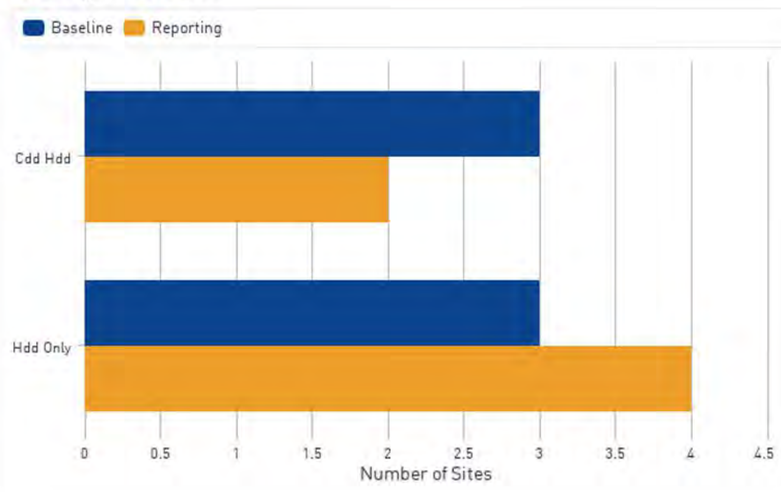
3 +/- 7 %

Difference in Normalized Annual Consumption as a Percent of Baseline

Monthly DNAC



Model Type Distribution



Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: Single-Wide	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

657 Treatment Meters	309 +/- 133 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	2 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	13,045 Mean Baseline Consumption (Electricity)	29% Realization Rate
1,198 Site-level Matched Meters	341 +/- 156 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	12,222 Mean Baseline Consumption (Electricity)	32% Realization Rate
550 Future Participant Meters	508 +/- 212 kWh Average Savings Relative to Future Participant Group	4 +/- 2% Savings Relative to Future Participant Group	12,557 Mean Baseline Consumption (Electricity)	48% Realization Rate

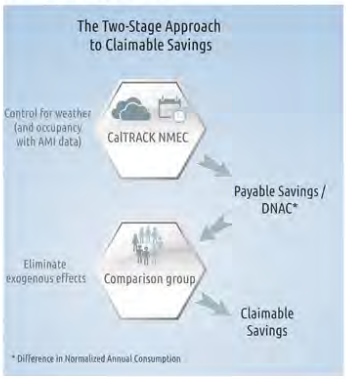
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group

The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

166.4 miles

80% of projects lie within this distance from treatment group centroid

657
Meters

13,045
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group

This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

7.0 miles

Distance between treatment and comparison group centroids

1,198
Meters

12,222
Mean Baseline Consumption (Electricity)

Future Participant Group

The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

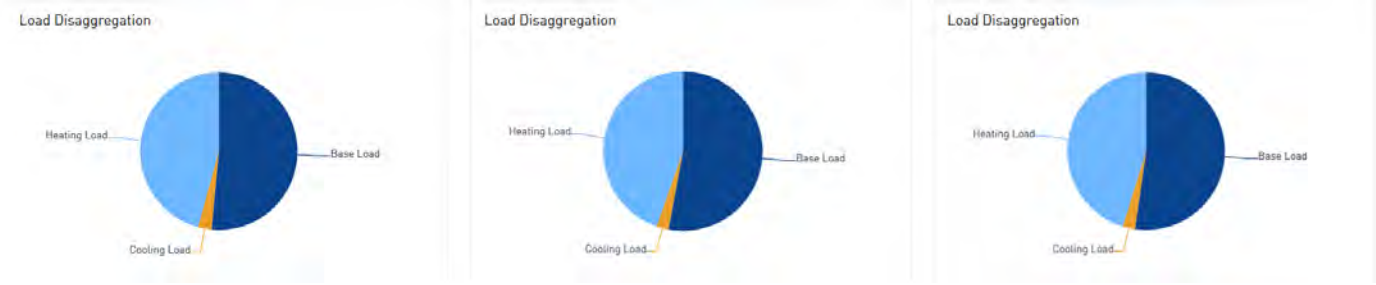
Future Participant Site Locations

5.1 miles

Distance between treatment and future participant group centroids

550
Meters

12,557
Mean Baseline Consumption (Electricity)



2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	657	12%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

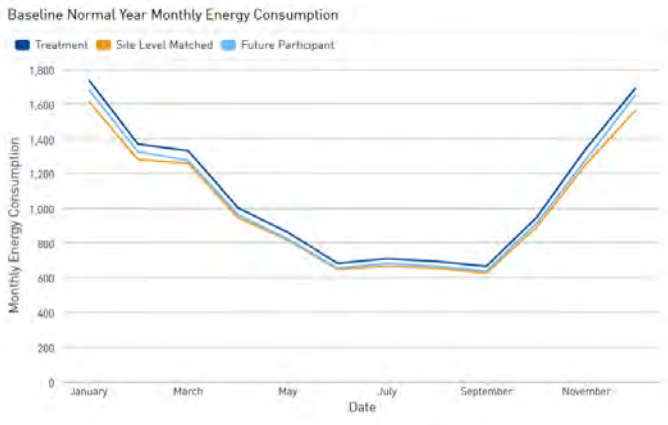
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

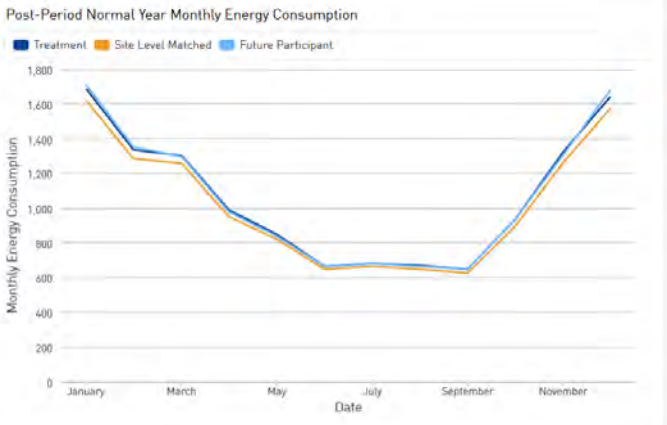
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: Single-Wide	1,796	1,197
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	1,197
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	540	657
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	657

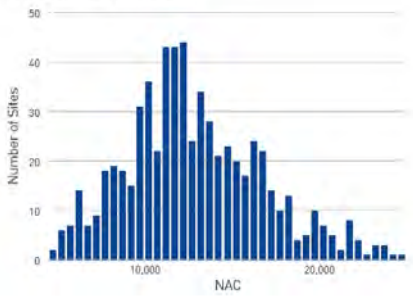
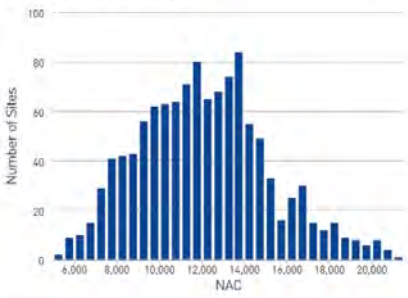
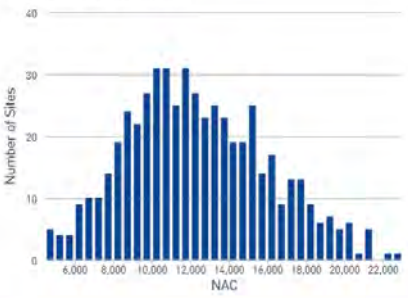
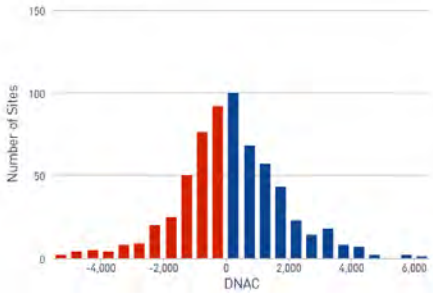
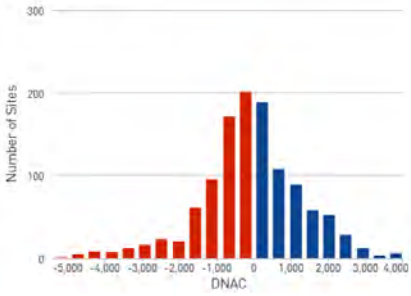
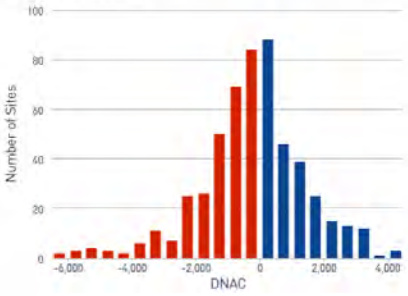
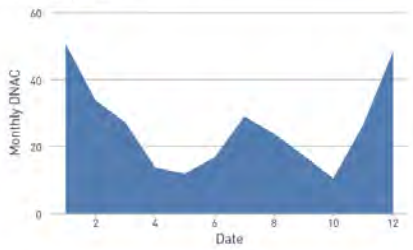
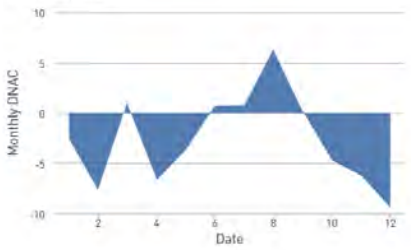
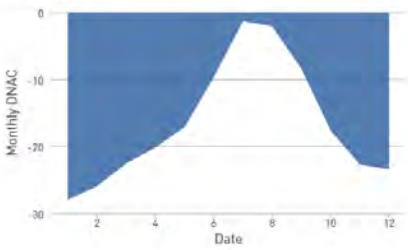
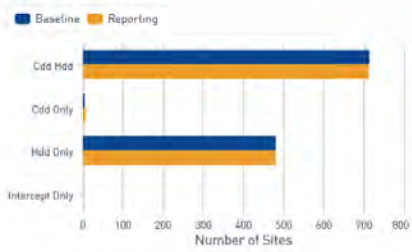
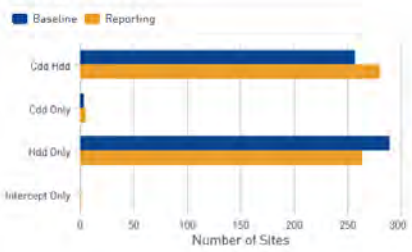
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.125 Annual Consumption p-value	0.165 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
309 +/- 133 kWh Average Difference in Normalized Annual Consumption per Participant 3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-32 +/- 81 kWh Average Difference in Normalized Annual Consumption per Participant -0 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-199 +/- 164 kWh Average Difference in Normalized Annual Consumption per Participant -2 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

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Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: Double-Wide	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

567 Treatment Meters	544 +/- 159 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	4 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	15,208 Mean Baseline Consumption (Electricity)	51% Realization Rate
1,233 Site-level Matched Meters	550 +/- 183 kWh Average Savings Relative to Site-level Matched Comparison Group	4 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	14,703 Mean Baseline Consumption (Electricity)	51% Realization Rate
558 Future Participant Meters	677 +/- 229 kWh Average Savings Relative to Future Participant Group	4 +/- 2% Savings Relative to Future Participant Group	14,545 Mean Baseline Consumption (Electricity)	63% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

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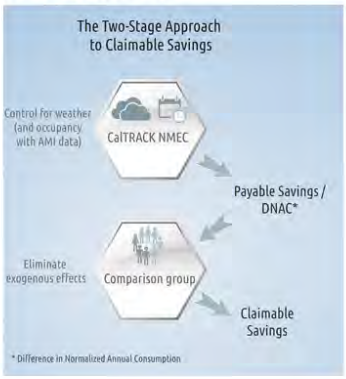
Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

160.2 miles

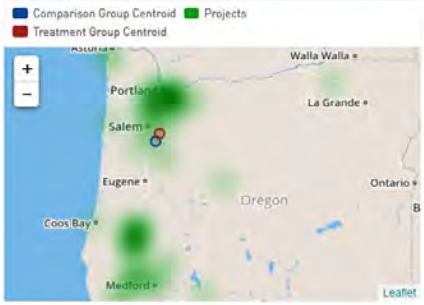
80% of projects lie within this distance from treatment group centroid

567
Meters

15,208
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



13.3 miles

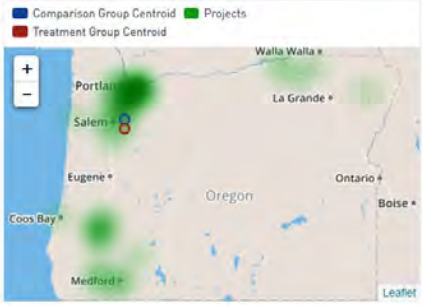
Distance between treatment and comparison group centroids

1,233
Meters

14,703
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations

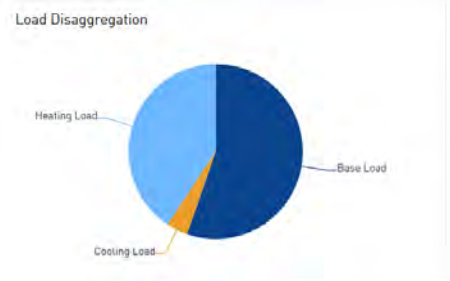


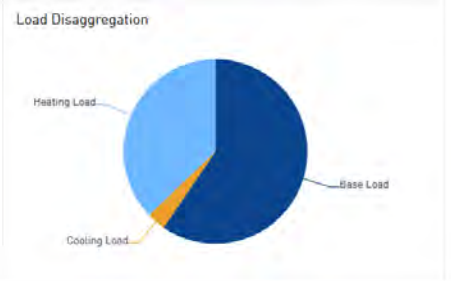
10.9 miles

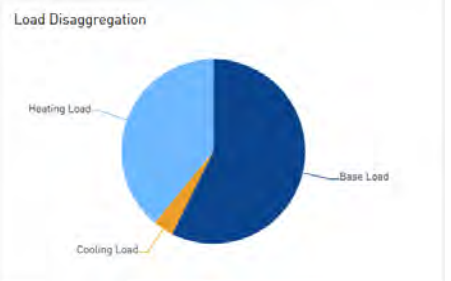
Distance between treatment and future participant group centroids

558
Meters

14,545
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	567	10%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

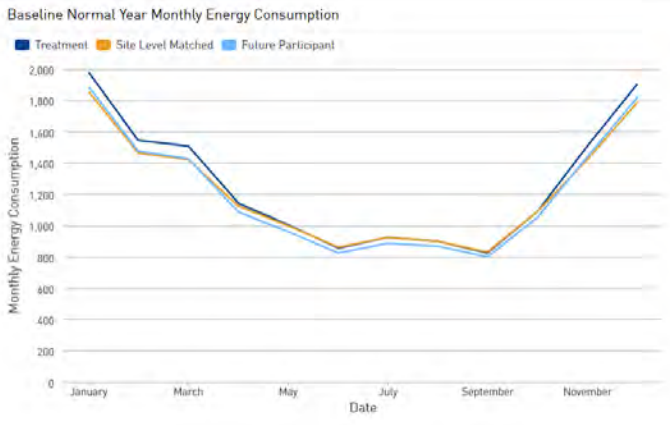
Measure: Meters associated with a particular measure in program participation data **Year:** Program year **Fuel:** Type of metered fuel	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

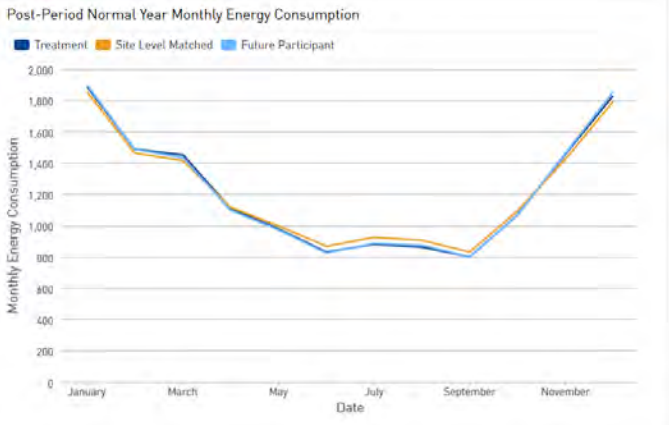
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: Double-Wide	1,445	1,548
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	1,548
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	981	567
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	567

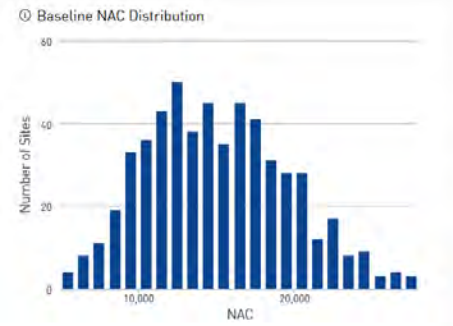
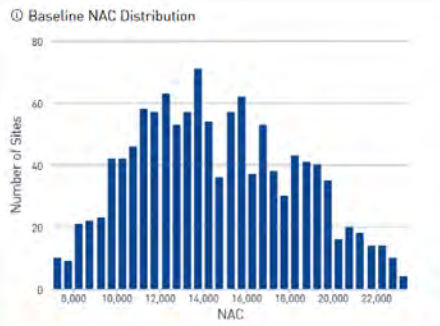
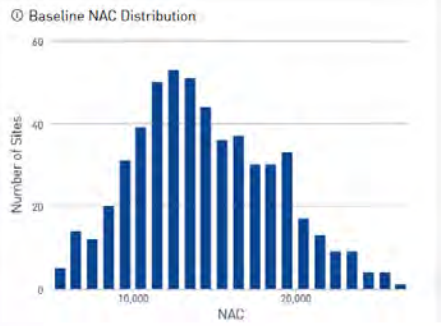
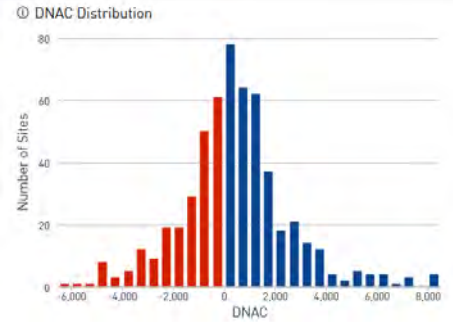
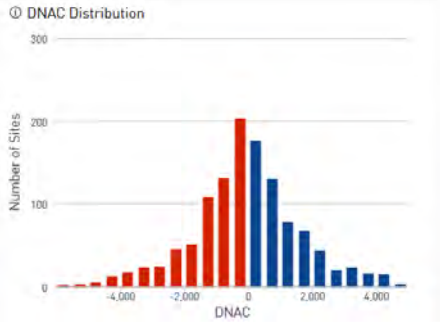
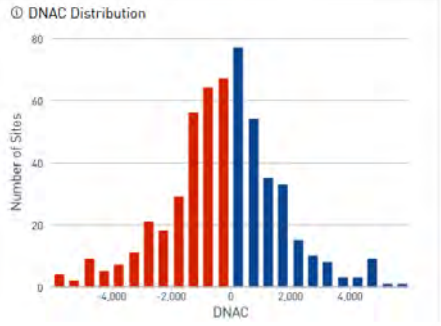
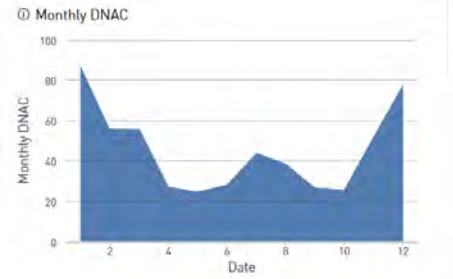
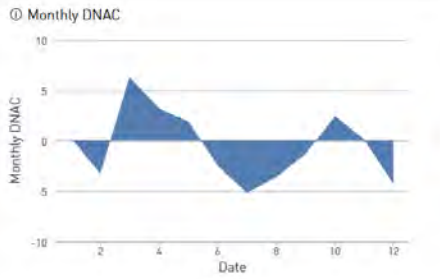
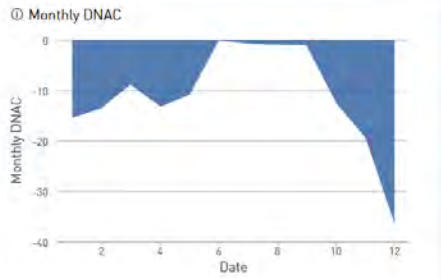
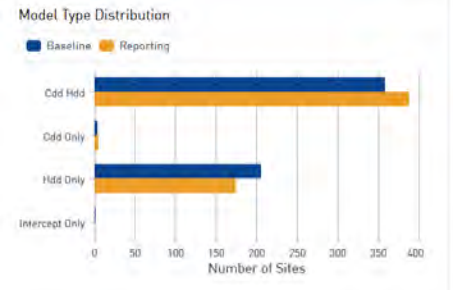
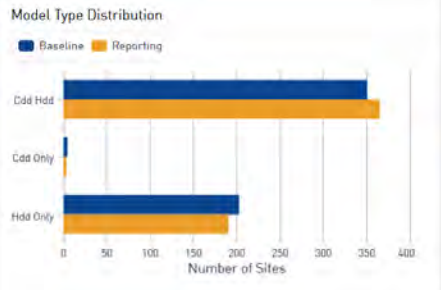
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
		
	0.168 Annual Consumption p-value	0.153 Annual Consumption p-value
		
544 +/- 159 kWh Average Difference in Normalized Annual Consumption per Participant 4 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-6 +/- 89 kWh Average Difference in Normalized Annual Consumption per Participant -0 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-133 +/- 165 kWh Average Difference in Normalized Annual Consumption per Participant -1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
		
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: False	LikelyGasWaterHeating: All

1,030 Treatment Meters	297 +/- 110 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	2 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	13,718 Mean Baseline Consumption (Electricity)	29% Realization Rate
5,091 Site-level Matched Meters	323 +/- 117 kWh Average Savings Relative to Site-level Matched Comparison Group	2 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	13,255 Mean Baseline Consumption (Electricity)	31% Realization Rate
951 Future Participant Meters	432 +/- 167 kWh Average Savings Relative to Future Participant Group	3 +/- 1% Savings Relative to Future Participant Group	13,306 Mean Baseline Consumption (Electricity)	42% Realization Rate

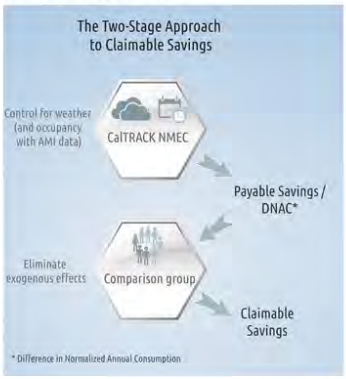
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

154.9 miles
80% of projects lie within this distance from treatment group centroid

1,030
Meters

13,718
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

1.8 miles
Distance between treatment and comparison group centroids

5,091
Meters

13,255
Mean Baseline Consumption (Electricity)

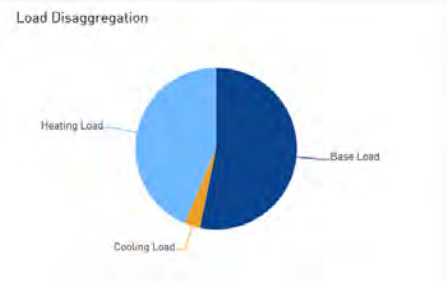
Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

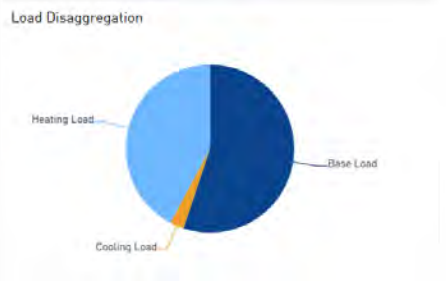
Future Participant Site Locations

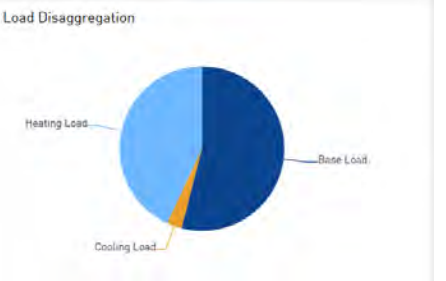
8.5 miles
Distance between treatment and future participant group centroids

951
Meters

13,306
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	1,030	19%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

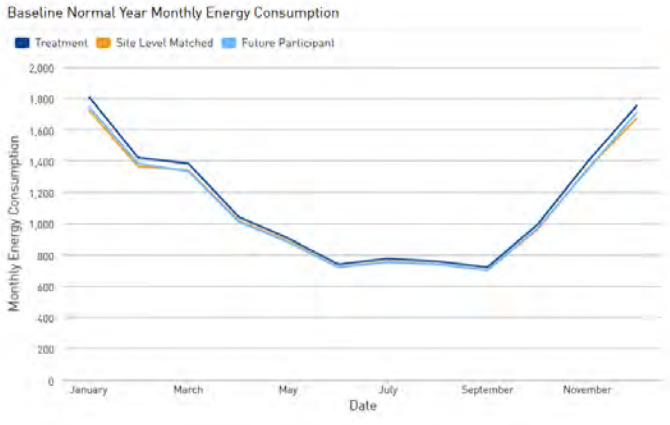
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

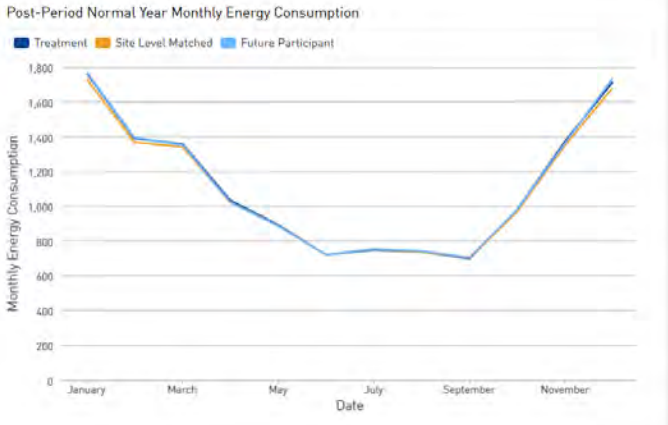
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,993
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: False	633	2,360
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	1,330	1,030
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	1,030

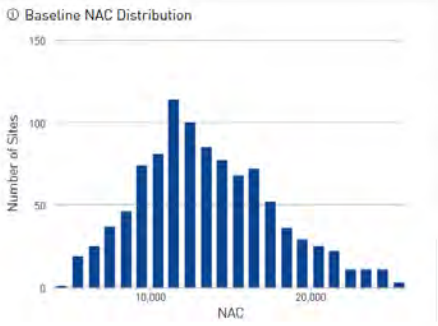
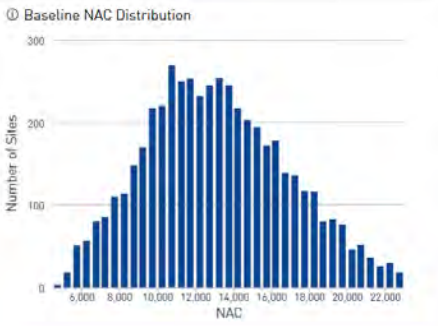
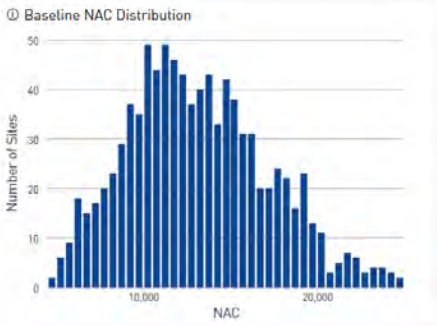
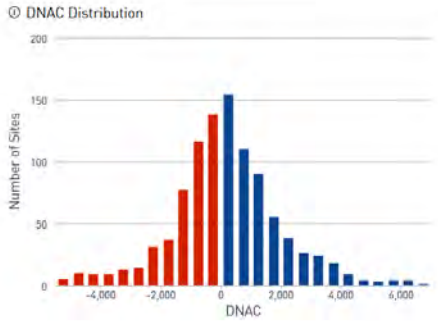
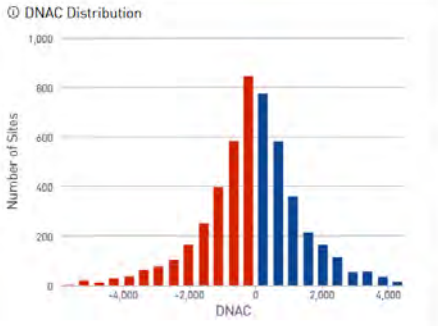
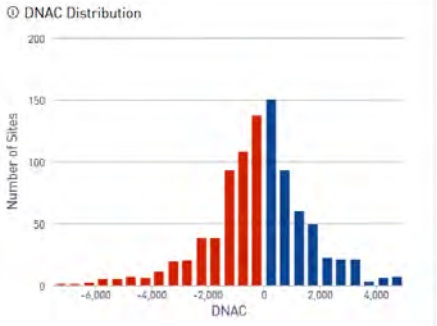
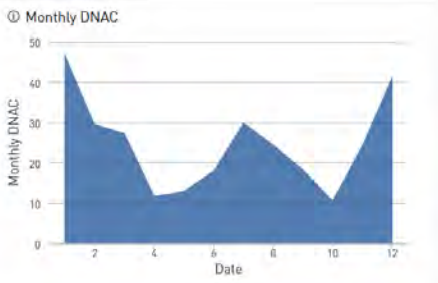
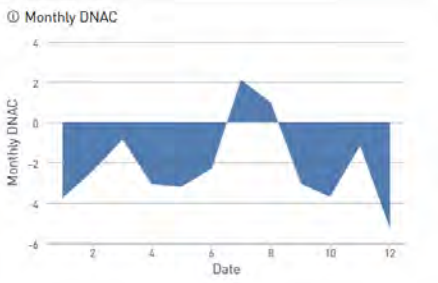
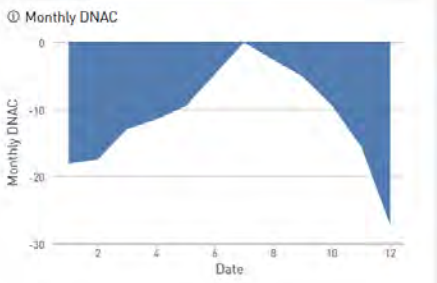
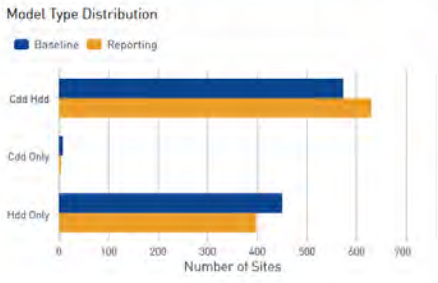
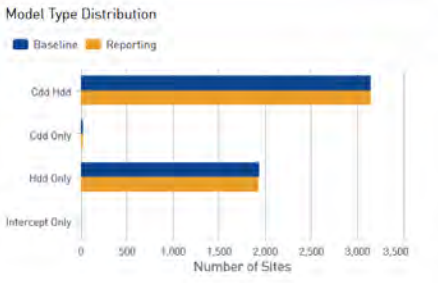
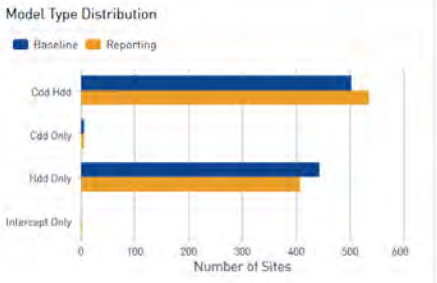
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
		
	0.15 Annual Consumption p-value	0.17 Annual Consumption p-value
		
297 +/- 110 kWh Average Difference in Normalized Annual Consumption per Participant	3 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-26 +/- 40 kWh Average Difference in Normalized Annual Consumption per Participant	-0 +/- 0 % Difference in Normalized Annual Consumption as a Percent of Baseline	-135 +/- 126 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline
		
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013, 2014, 2015, 2016, 2017, 2018

Result Summary

Measure: Airduct	Program Year: 2013, 2014, 2015, 2016, 2017, 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone(s): All	Heating Zone(s): All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: True	LikelyGasWaterHeating: All

303 Treatment Meters	620 +/- 205 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	4 +/- 1 % Percent Normal Year Pre-Post Difference in Consumption per Participant	15,230 Mean Baseline Consumption (Electricity)	56% Realization Rate
1,491 Site-level Matched Meters	624 +/- 218 kWh Average Savings Relative to Site-level Matched Comparison Group	4 +/- 1% Percent Savings Relative to Site-level Matched Comparison Group	14,598 Mean Baseline Consumption (Electricity)	56% Realization Rate
282 Future Participant Meters	877 +/- 321 kWh Average Savings Relative to Future Participant Group	6 +/- 2% Savings Relative to Future Participant Group	14,925 Mean Baseline Consumption (Electricity)	79% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

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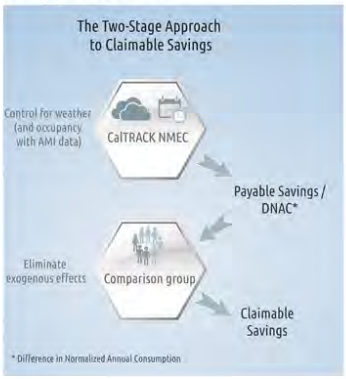
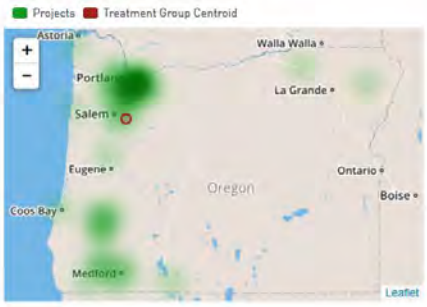
Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



160.3 miles

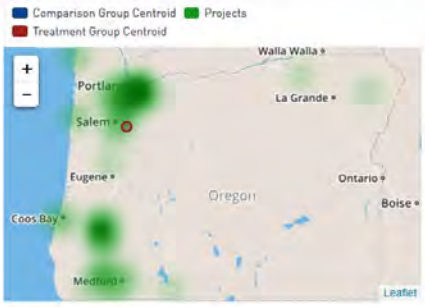
80% of projects lie within this distance from treatment group centroid

303
Meters

15,230
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



2.9 miles

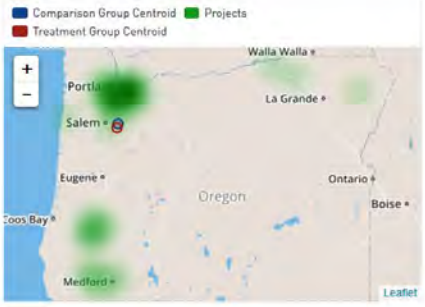
Distance between treatment and comparison group centroids

1,491
Meters

14,598
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations

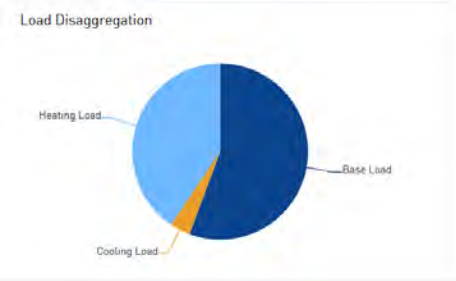


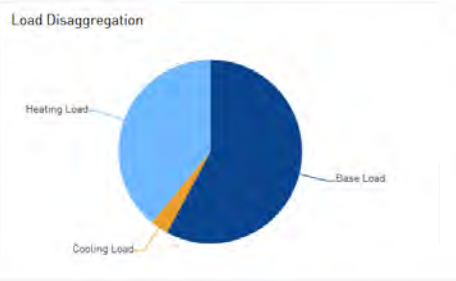
5.4 miles

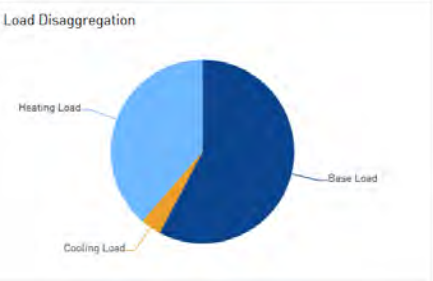
Distance between treatment and future participant group centroids

282
Meters

14,925
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

5,494	303	5.5%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

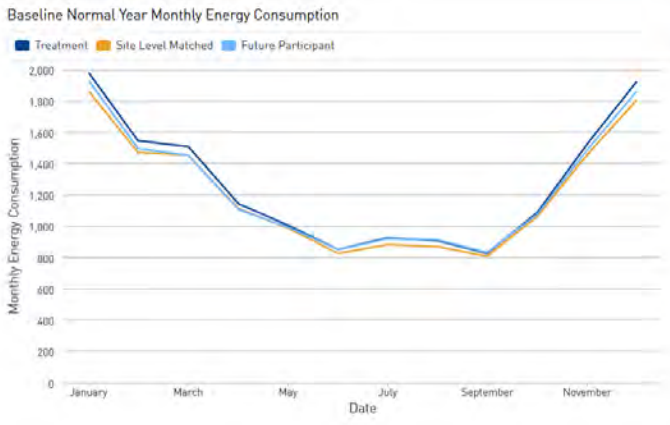
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013, 2014, 2015, 2016, 2017, 2018 -- Fuel: Electricity	--	5,494
Meters with valid consumption data in baseline and/or reporting periods.	--	272	5,222
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	5,222
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	296	4,926
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	4,926
Other measure-specific filters.	--	0	4,926
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	1,475	3,451
Meters with at least 5 site-level matched meters from the comparison group pool.	--	78	3,373

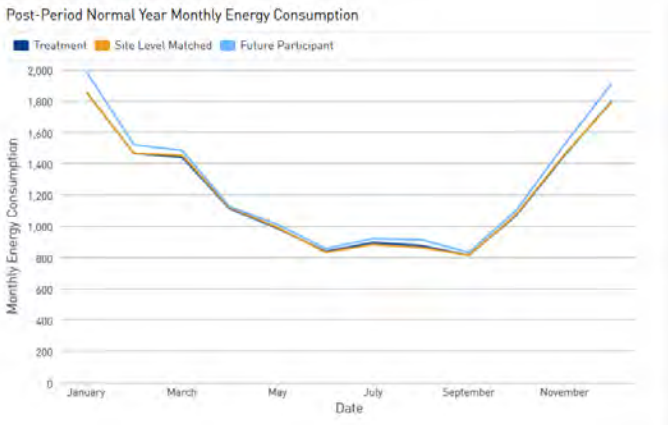
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	25	3,348
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	3,348
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	16	3,332
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	339	2,993
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	2,993
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	2,993
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: True	2,359	634
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	331	303
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	303

3. Modeling Results

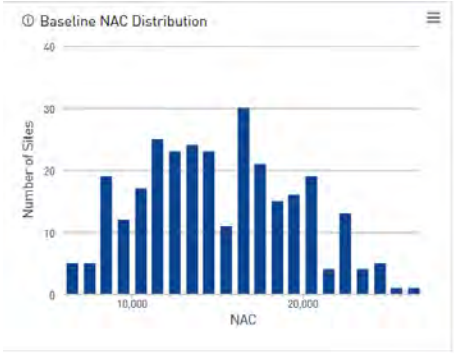
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

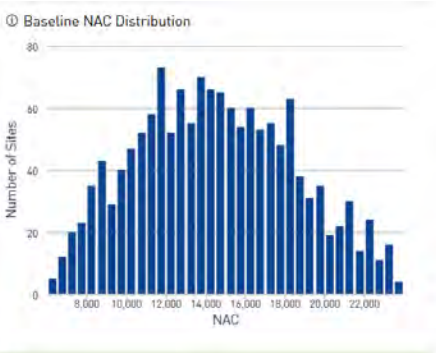
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.

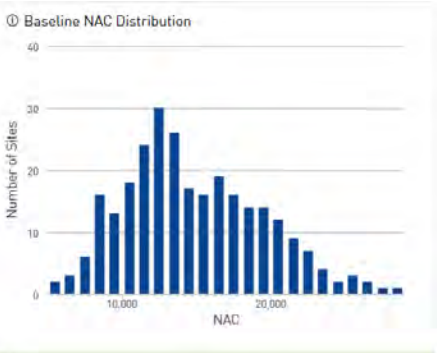




Treatment Group	Site-level Matched Comparison Group	Future Participant Group





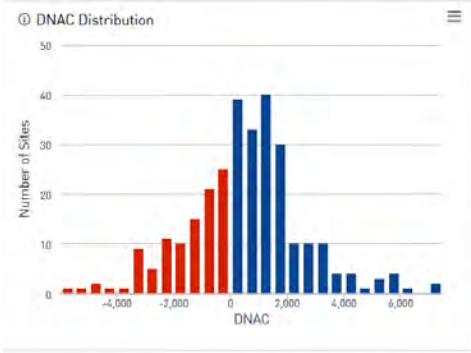


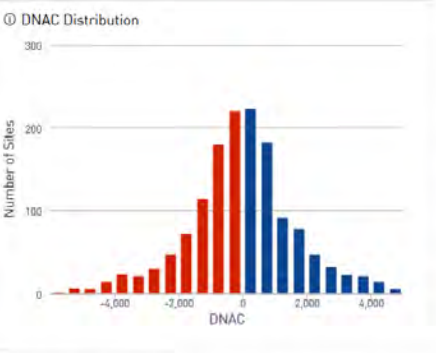
0.144

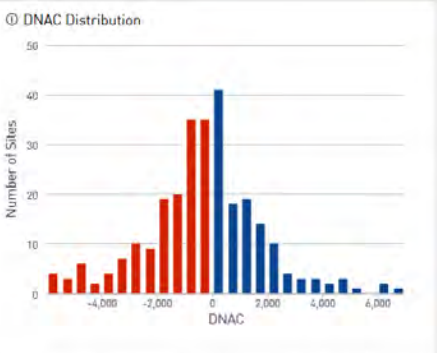
Annual Consumption p-value

0.235

Annual Consumption p-value







620 +/- 205 kWh

Average Difference in Normalized Annual Consumption per Participant

5 +/- 1 %

Difference in Normalized Annual Consumption as a Percent of Baseline

-4 +/- 76 kWh

Average Difference in Normalized Annual Consumption per Participant

-0 +/- 1 %

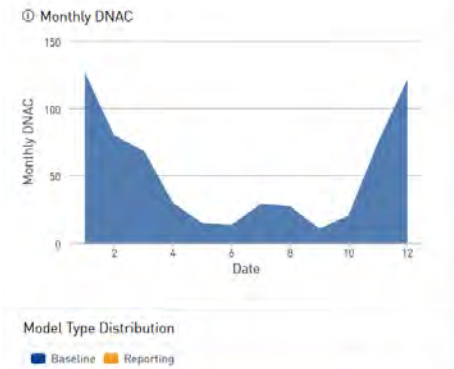
Difference in Normalized Annual Consumption as a Percent of Baseline

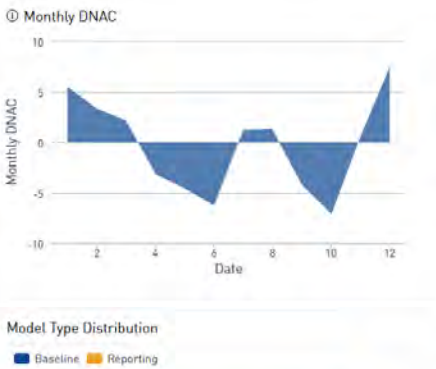
-257 +/- 248 kWh

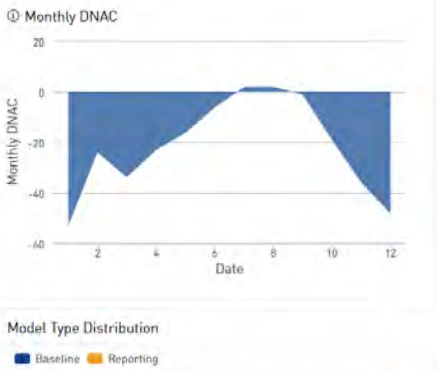
Average Difference in Normalized Annual Consumption per Participant

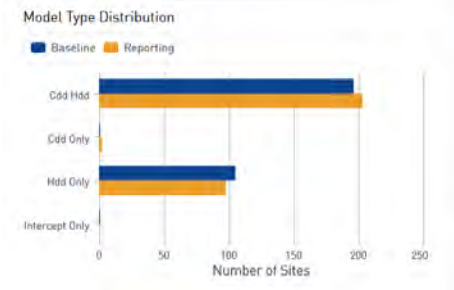
-2 +/- 2 %

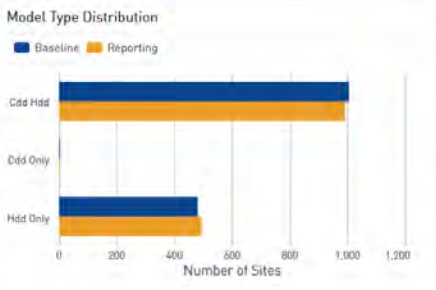
Difference in Normalized Annual Consumption as a Percent of Baseline

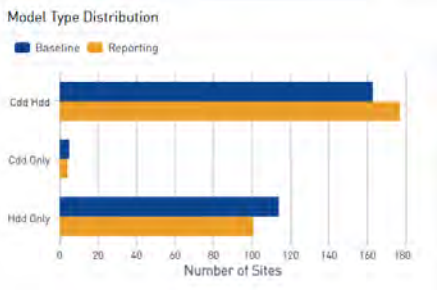












Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2013

Result Summary

Measure: Airduct	Program Year: 2013		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

268 Treatment Meters	670 +/- 239 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	5 +/- 2 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,732 Mean Baseline Consumption (Electricity)	51% Realization Rate
1,326 Site-level Matched Meters	676 +/- 256 kWh Average Savings Relative to Site-level Matched Comparison Group	5 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	14,192 Mean Baseline Consumption (Electricity)	51% Realization Rate
193 Future Participant Meters	1251 +/- 406 kWh Average Savings Relative to Future Participant Group	8 +/- 3% Savings Relative to Future Participant Group	14,220 Mean Baseline Consumption (Electricity)	95% Realization Rate

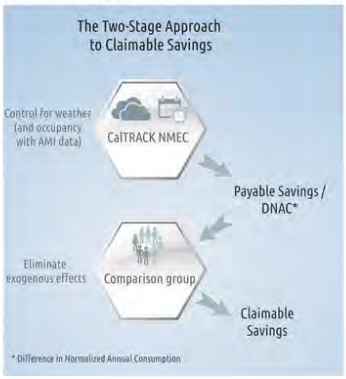
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

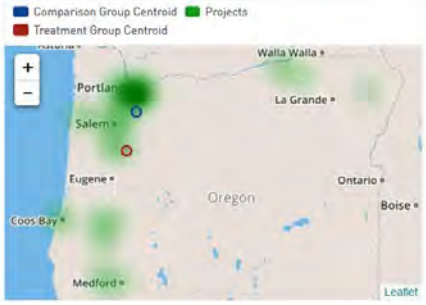
Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Treatment Site Locations

Site-level Matched Site Locations

Future Participant Site Locations

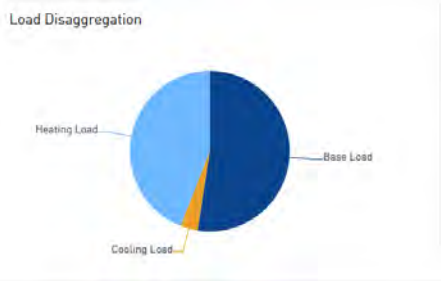


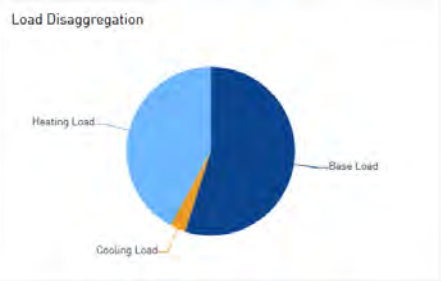
152.6 miles
80% of projects lie within this distance from treatment group centroid

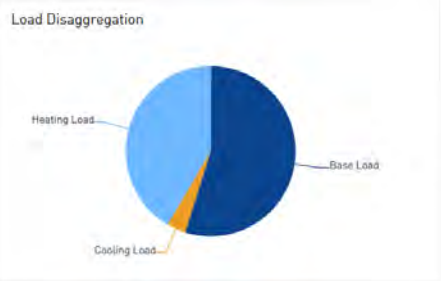
2.7 miles
Distance between treatment and comparison group centroids

45.0 miles
Distance between treatment and future participant group centroids

Treatment Group		Site-level Matched Comparison Group		Future Participant Group	
268	14,732	1,326	14,192	193	14,220
Meters	Mean Baseline Consumption (Electricity)	Meters	Mean Baseline Consumption (Electricity)	Meters	Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

1,402	268	19%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

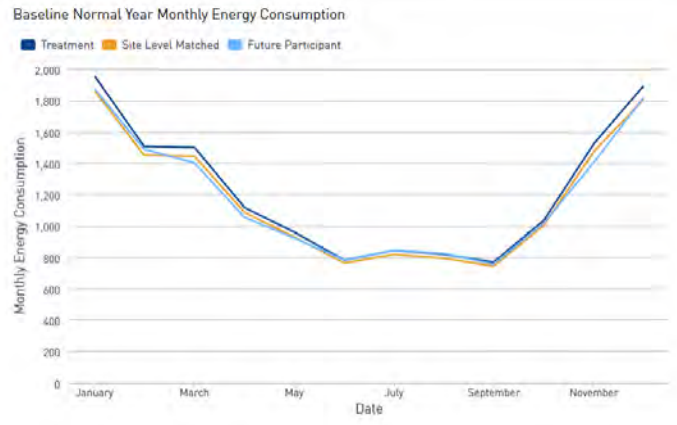
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2013 -- Fuel: Electricity	--	1,402
Meters with valid consumption data in baseline and/or reporting periods.	--	80	1,322
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	1,322
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	52	1,270
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	1,270
Other measure-specific filters.	--	0	1,270
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	425	845
Meters with at least 5 site-level matched meters from the comparison group pool.	--	15	830

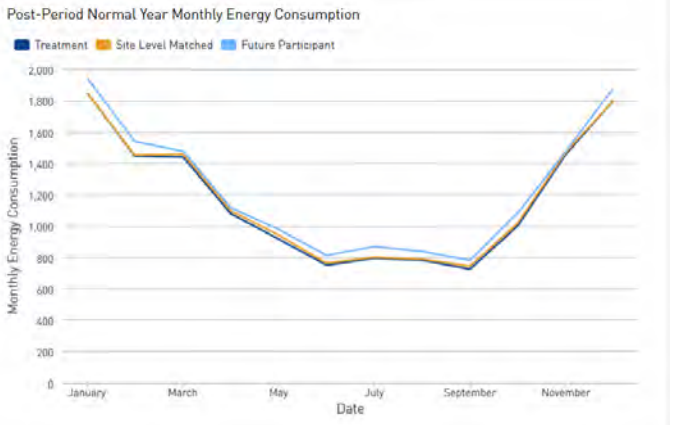
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	9	821
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	821
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	4	817
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	74	743
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	743
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	743
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	475	268
likely_gas_water_heating: Meters with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	268

3. Modeling Results

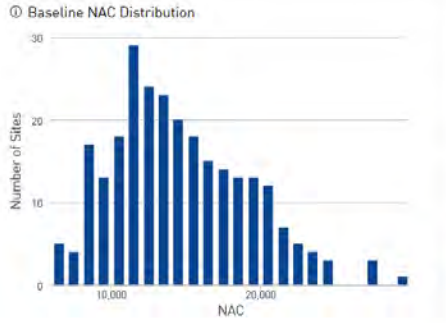
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

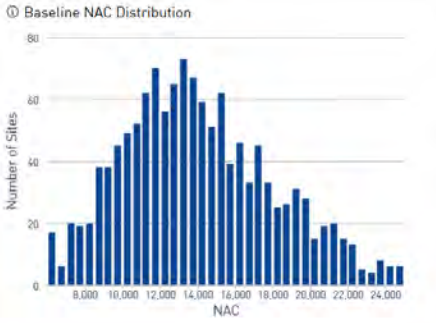
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.

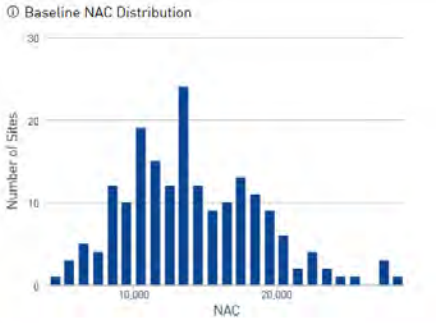


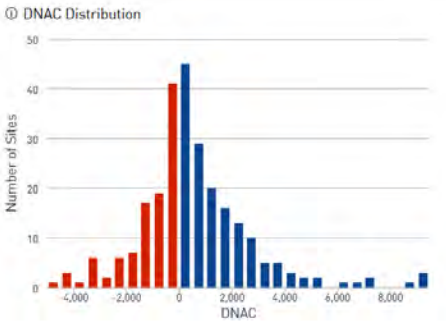


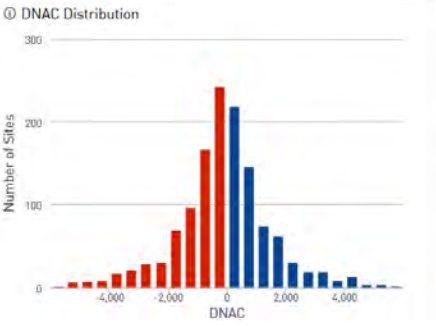
Treatment Group	Site-level Matched Comparison Group	Future Participant Group

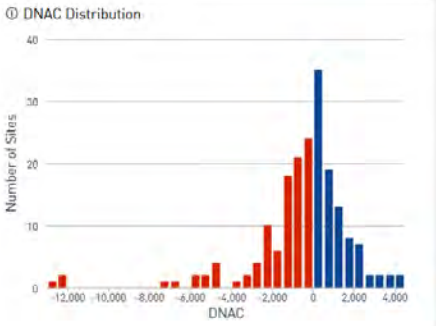


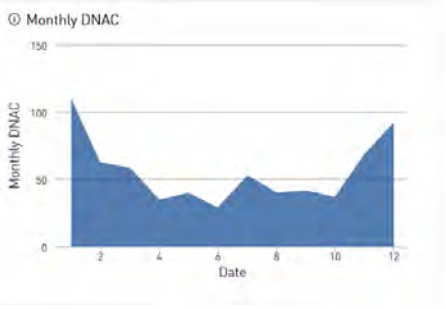


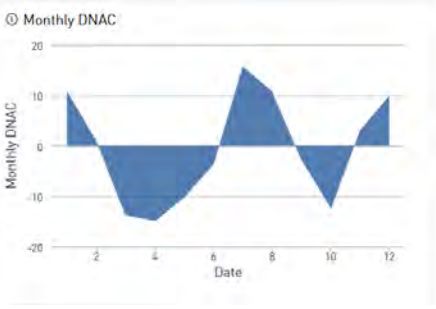


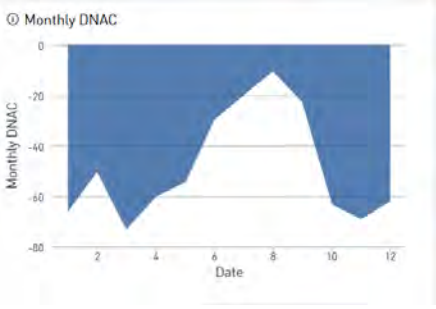












Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2014

Result Summary

Measure: Airduct	Program Year: 2014		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

262 Treatment Meters	379 +/- 242 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 2 % Percent Normal Year Pre-Post Difference in Consumption per Participant	14,349 Mean Baseline Consumption (Electricity)	32% Realization Rate
1,298 Site-level Matched Meters	512 +/- 255 kWh Average Savings Relative to Site-level Matched Comparison Group	4 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	13,721 Mean Baseline Consumption (Electricity)	44% Realization Rate
250 Future Participant Meters	564 +/- 351 kWh Average Savings Relative to Future Participant Group	4 +/- 2% Savings Relative to Future Participant Group	13,803 Mean Baseline Consumption (Electricity)	48% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

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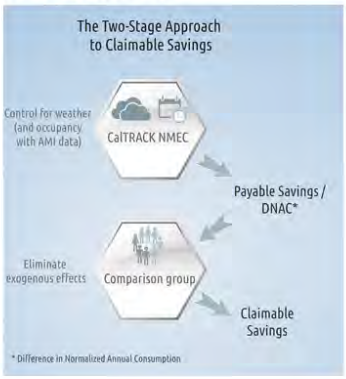
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations

139.3 miles
80% of projects lie within this distance from treatment group centroid

262
Meters

14,349
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations

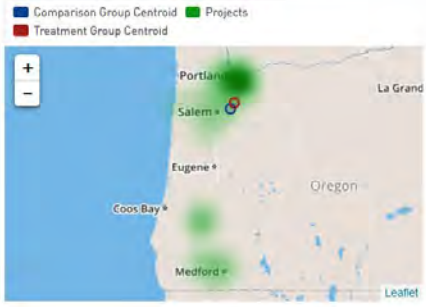
2.9 miles
Distance between treatment and comparison group centroids

1,298
Meters

13,721
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

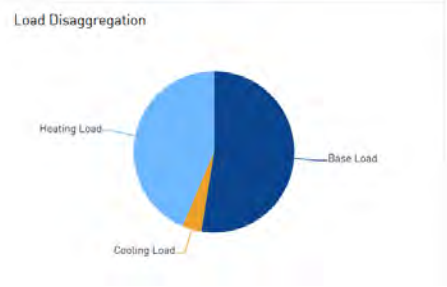
Future Participant Site Locations

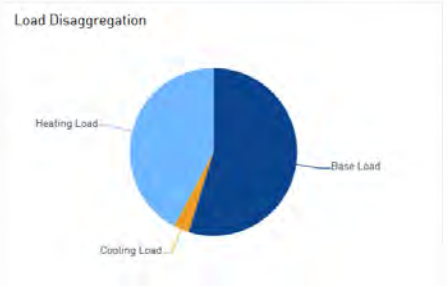


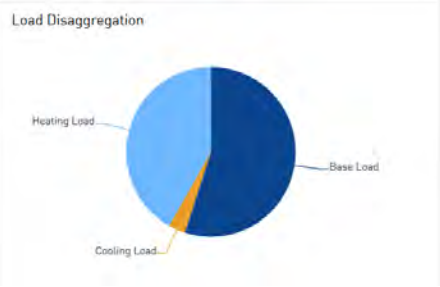
8.0 miles
Distance between treatment and future participant group centroids

250
Meters

13,803
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

1,132	262	23%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

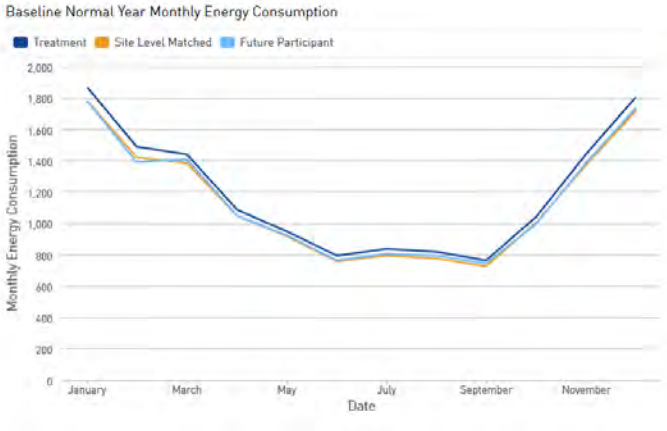
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2014 -- Fuel: Electricity	--	1,132
Meters with valid consumption data in baseline and/or reporting periods.	--	59	1,073
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	1,073
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	43	1,030
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	1,030
Other measure-specific filters.	--	0	1,030
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	289	741
Meters with at least 5 site-level matched meters from the comparison group pool.	--	18	723

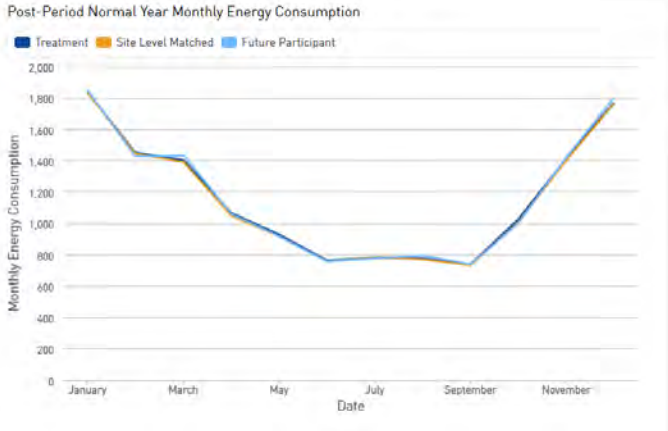
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	8	715
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	715
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	3	712
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	105	607
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	607
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	607
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	607
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	345	262
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August	Likely gas water heating: All	0	262

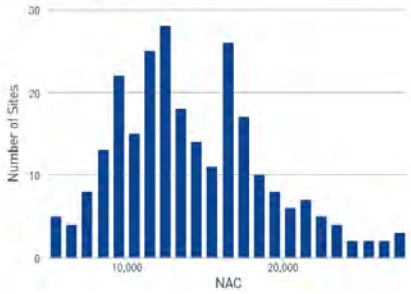
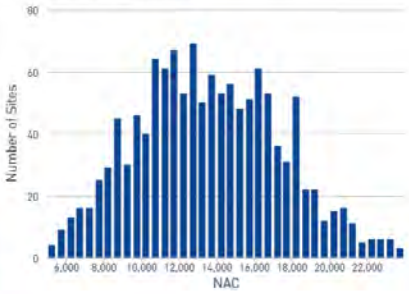
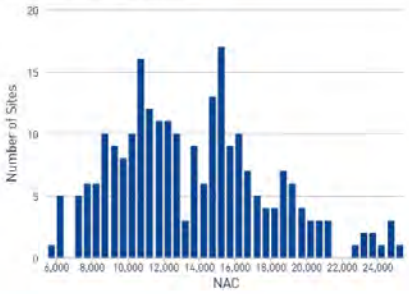
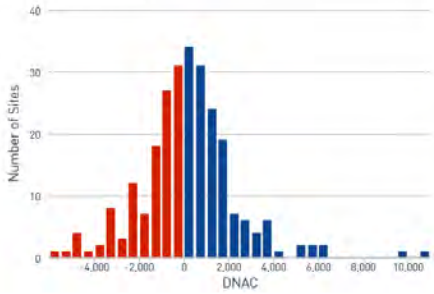
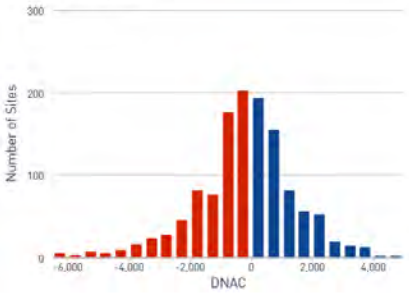
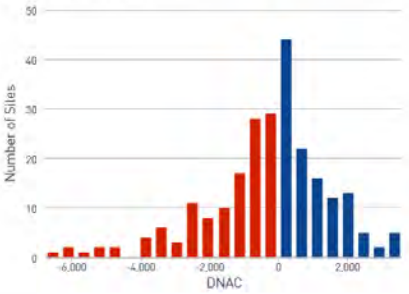
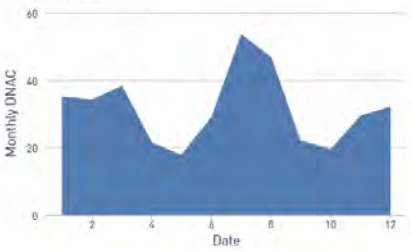
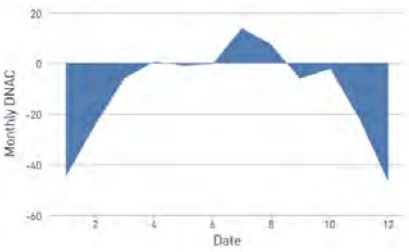
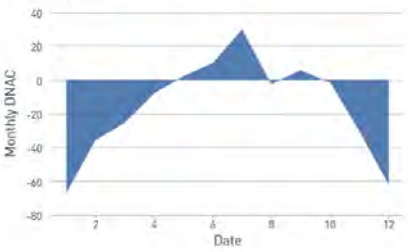
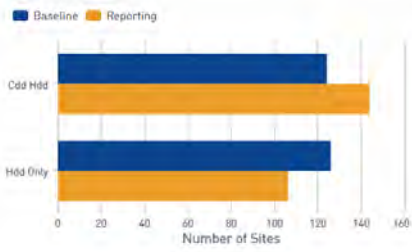
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.169 Annual Consumption p-value	0.00615 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
379 +/- 242 kWh Average Difference in Normalized Annual Consumption per Participant	4 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline	-132 +/- 82 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-185 +/- 254 kWh Average Difference in Normalized Annual Consumption per Participant	-1 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2015

Result Summary

Measure: Airduct	Program Year: 2015		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

154 Treatment Meters	201 +/- 273 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	1 +/- 2 % Percent Normal Year Pre-Post Difference in Consumption per Participant	13,415 Mean Baseline Consumption (Electricity)	22% Realization Rate
765 Site-level Matched Meters	206 +/- 289 kWh Average Savings Relative to Site-level Matched Comparison Group	2 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	13,055 Mean Baseline Consumption (Electricity)	22% Realization Rate
319 Future Participant Meters	80 +/- 360 kWh Average Savings Relative to Future Participant Group	1 +/- 3% Savings Relative to Future Participant Group	13,766 Mean Baseline Consumption (Electricity)	9% Realization Rate

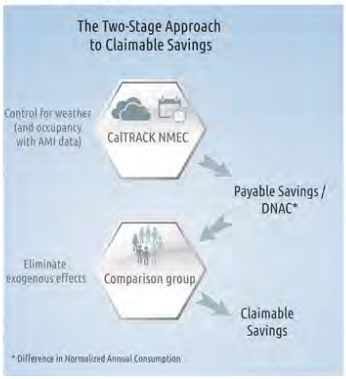
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

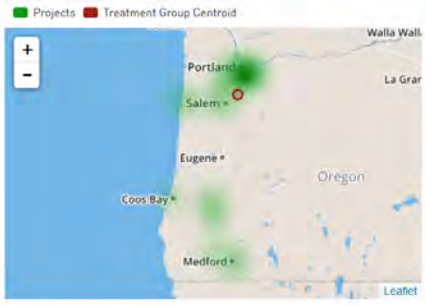
The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



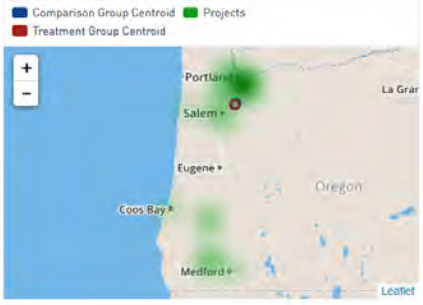
128.3 miles
80% of projects lie within this distance from treatment group centroid

154
Meters

13,415
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



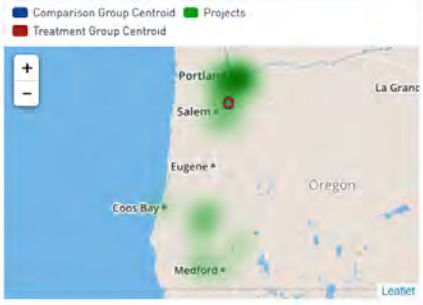
2.3 miles
Distance between treatment and comparison group centroids

765
Meters

13,055
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

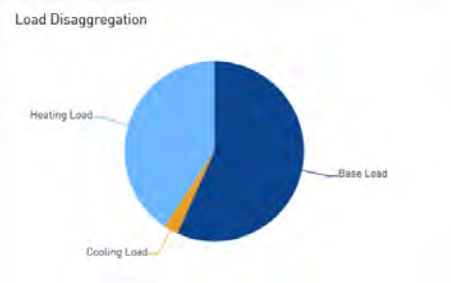
Future Participant Site Locations

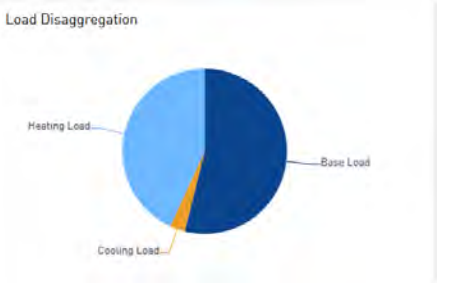


1.7 miles
Distance between treatment and future participant group centroids

319
Meters

13,766
Mean Baseline Consumption (Electricity)





2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

722	154	21%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

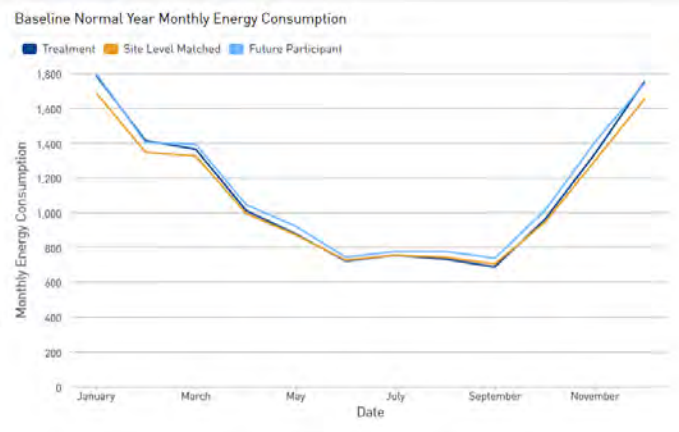
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2015 -- Fuel: Electricity	--	722
Meters with valid consumption data in baseline and/or reporting periods.	--	15	707
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	707
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	32	675
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	675
Other measure-specific filters.	--	0	675
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	172	503
Meters with at least 5 site-level matched meters from the comparison group pool.	--	9	494

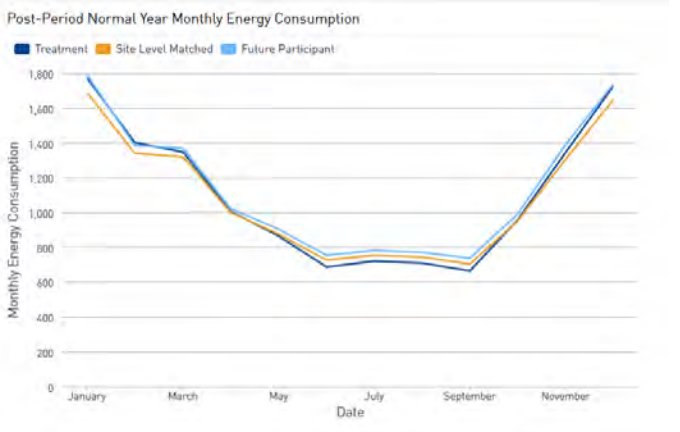
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	0	494
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	494
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	2	492
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	41	451
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	451
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide)	Home Size: No Filtering Based on Home Size	0	451
complex_duct_sealing: Meters with the "MH Complex Add-On" measure	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	451
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	297	154
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	154

3. Modeling Results

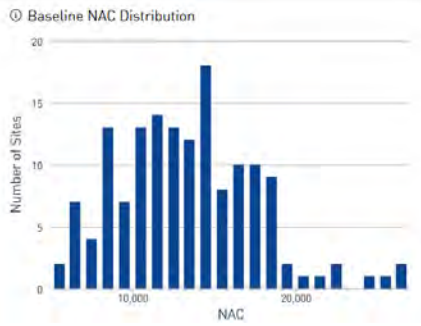
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

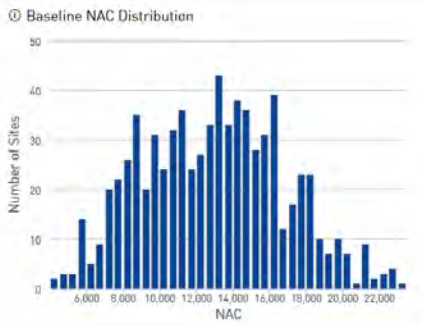
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.

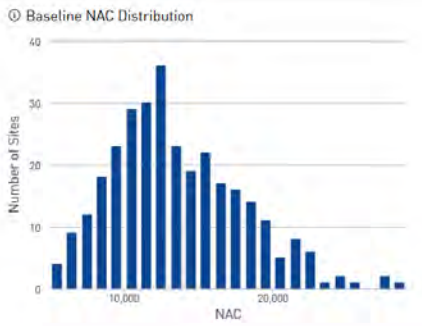




Treatment Group	Site-level Matched Comparison Group	Future Participant Group





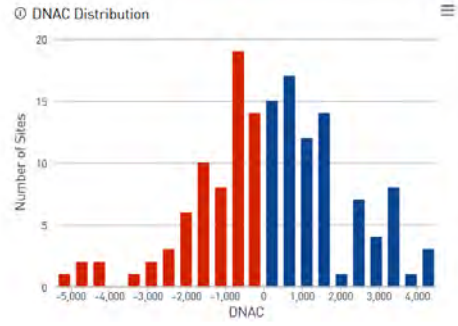


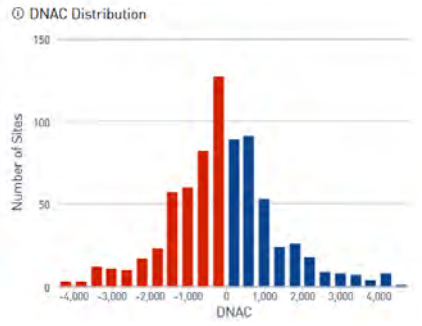
0.246

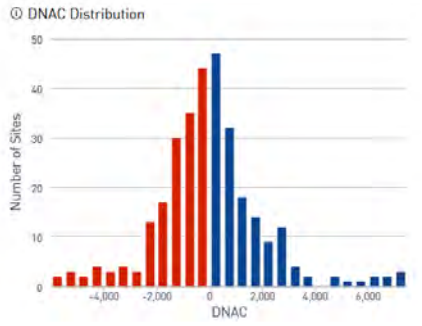
Annual Consumption p-value

0.385

Annual Consumption p-value







201 +/- 273 kWh

Average Difference in Normalized Annual Consumption per Participant

1 +/- 2 %

Difference in Normalized Annual Consumption as a Percent of Baseline

-5 +/- 95 kWh

Average Difference in Normalized Annual Consumption per Participant

-0 +/- 1 %

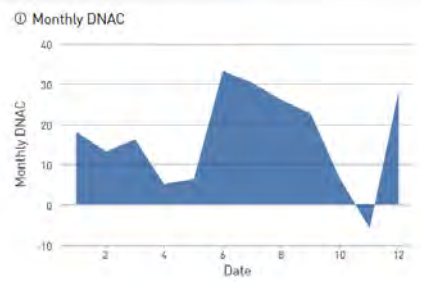
Difference in Normalized Annual Consumption as a Percent of Baseline

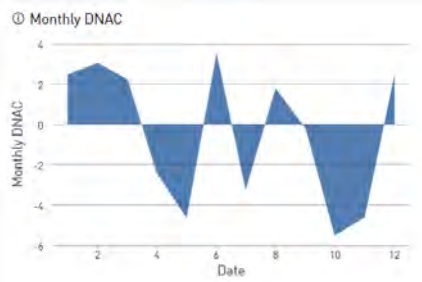
120 +/- 234 kWh

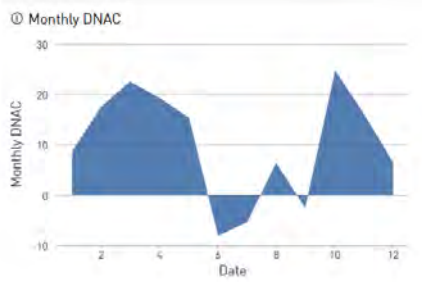
Average Difference in Normalized Annual Consumption per Participant

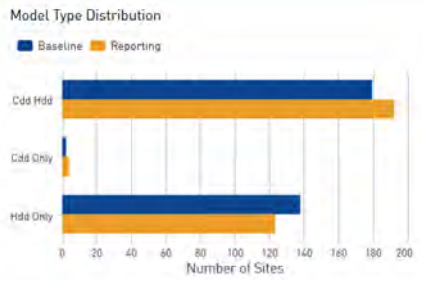
1 +/- 2 %

Difference in Normalized Annual Consumption as a Percent of Baseline









Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2016

Result Summary

Measure: Airduct | Program Year: 2016 | Fuel: Electricity

Last Consumption Data Update: October 1, 2019

Last Participation Data Update: October 1, 2019

CalTRACK Version: 2.0

Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

267	236 +/- 209 kWh	2 +/- 1 %	14,386	27%
Treatment Meters	Average Normal Year Pre-Post Difference in Consumption per Participant	Percent Normal Year Pre-Post Difference in Consumption per Participant	Mean Baseline Consumption (Electricity)	Realization Rate
1,320	235 +/- 223 kWh	2 +/- 2%	13,753	27%
Site-level Matched Meters	Average Savings Relative to Site-level Matched Comparison Group	Percent Savings Relative to Site-level Matched Comparison Group	Mean Baseline Consumption (Electricity)	Realization Rate
305	457 +/- 290 kWh	3 +/- 2%	13,342	52%
Future Participant Meters	Average Savings Relative to Future Participant Group	Savings Relative to Future Participant Group	Mean Baseline Consumption (Electricity)	Realization Rate

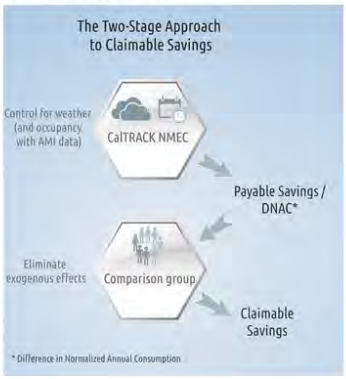
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



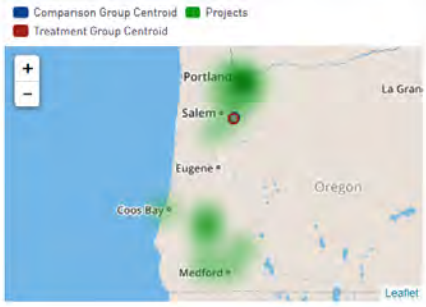
Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

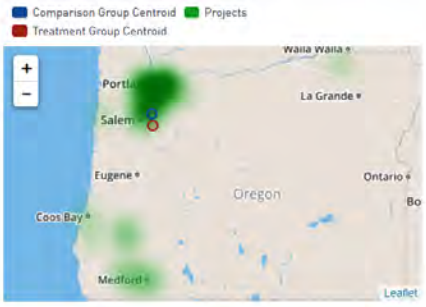
Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Treatment Site Locations

Site-level Matched Site Locations



Future Participant Site Locations

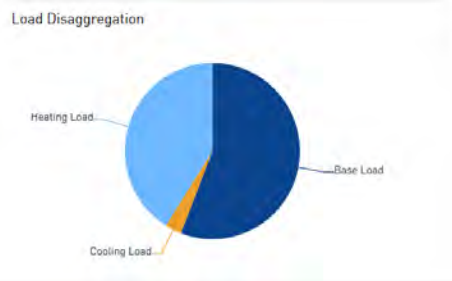


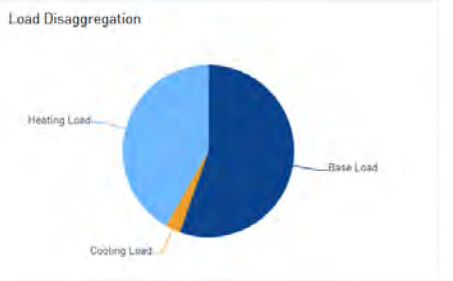
130.5 miles
80% of projects lie within this distance from treatment group centroid

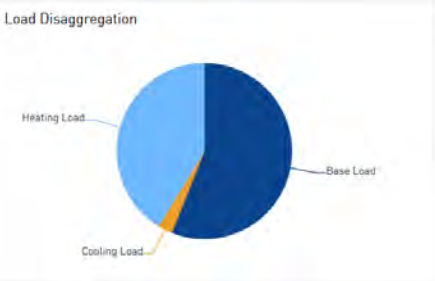
3.8 miles
Distance between treatment and comparison group centroids

13.3 miles
Distance between treatment and future participant group centroids

Treatment Group		Comparison Group		Future Participant Group	
267	14,386	1,320	13,753	305	13,342
Meters	Mean Baseline Consumption (Electricity)	Meters	Mean Baseline Consumption (Electricity)	Meters	Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

903	267	30%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

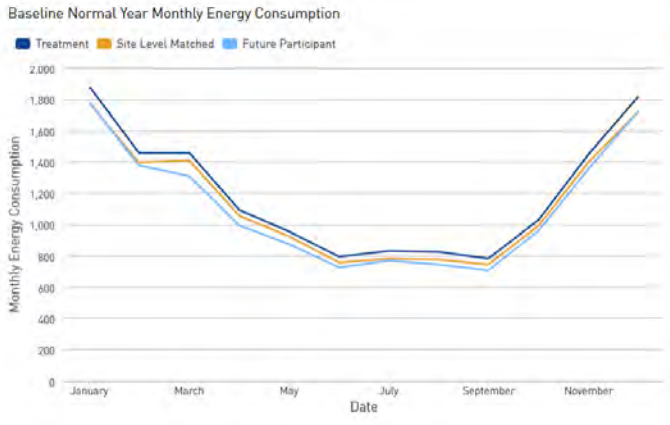
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2016 -- Fuel: Electricity	--	903
Meters with valid consumption data in baseline and/or reporting periods.	--	22	881
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	881
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	41	840
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	840
Other measure-specific filters.	--	0	840
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	211	629
Meters with at least 5 site-level matched meters from the comparison group pool.	--	12	617

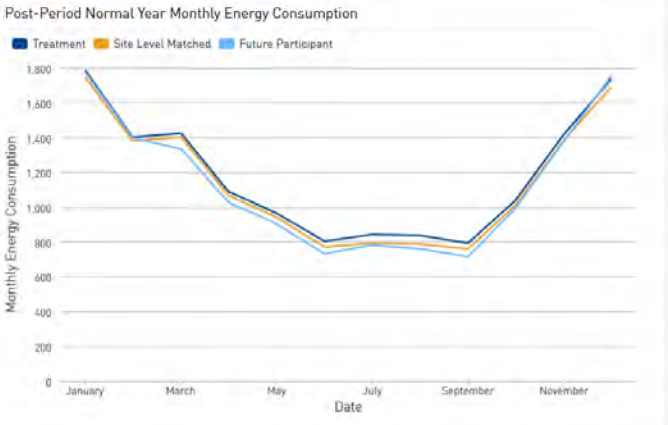
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	3	614
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	614
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	3	611
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	52	559
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	559
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	559
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	559
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	292	267
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	267

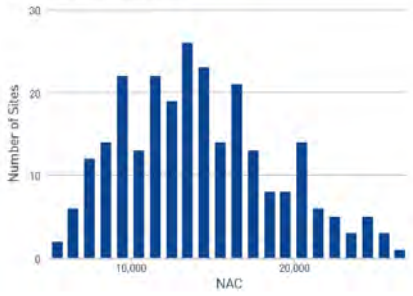
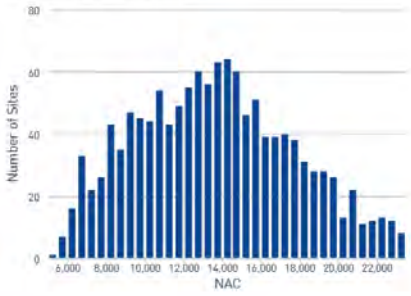
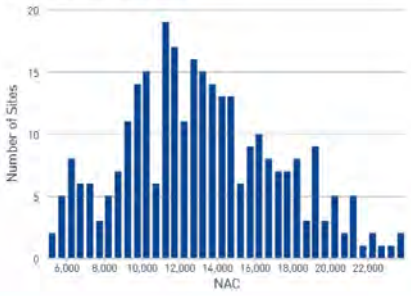
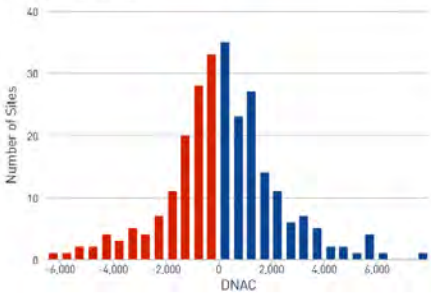
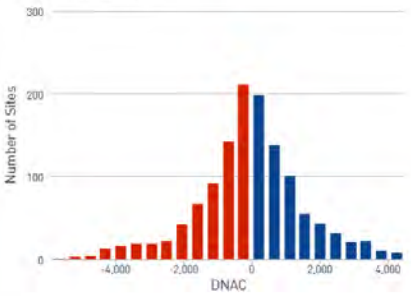
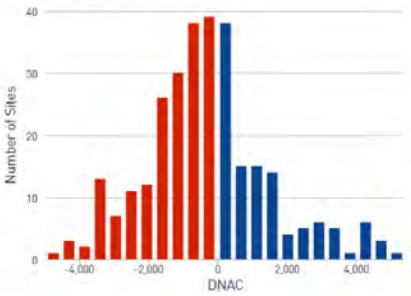
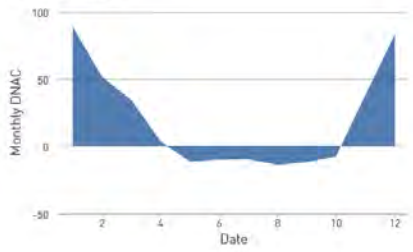
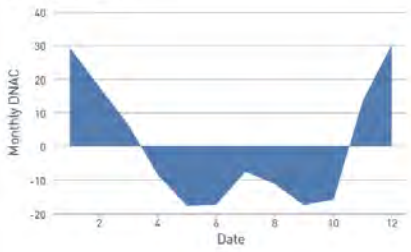
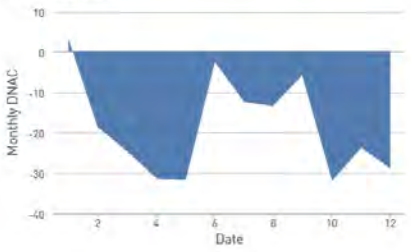
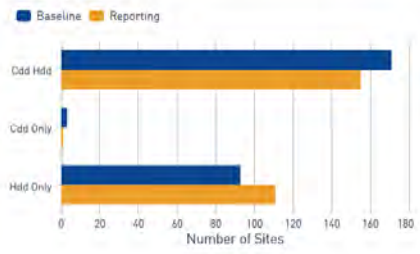
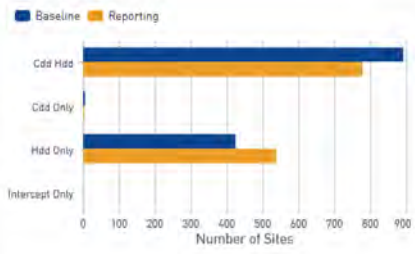
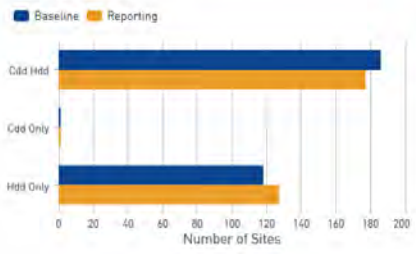
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution	ⓘ Baseline NAC Distribution
		
	ⓘ 0.164 Annual Consumption p-value	ⓘ 0.0293 Annual Consumption p-value
ⓘ DNAC Distribution	ⓘ DNAC Distribution	ⓘ DNAC Distribution
		
236 +/- 209 kWh Average Difference in Normalized Annual Consumption per Participant	1 +/- 77 kWh Average Difference in Normalized Annual Consumption per Participant	-221 +/- 201 kWh Average Difference in Normalized Annual Consumption per Participant
2 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	0 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-2 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline
ⓘ Monthly DNAC	ⓘ Monthly DNAC	ⓘ Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution
		

Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2017

Result Summary

Measure: Airduct	Program Year: 2017		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

245 Treatment Meters	354 +/- 210 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	3 +/- 2 % Percent Normal Year Pre-Post Difference in Consumption per Participant	13,706 Mean Baseline Consumption (Electricity)	37% Realization Rate
1,199 Site-level Matched Meters	360 +/- 224 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	13,255 Mean Baseline Consumption (Electricity)	37% Realization Rate
142 Future Participant Meters	224 +/- 366 kWh Average Savings Relative to Future Participant Group	2 +/- 3% Savings Relative to Future Participant Group	13,685 Mean Baseline Consumption (Electricity)	23% Realization Rate

1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

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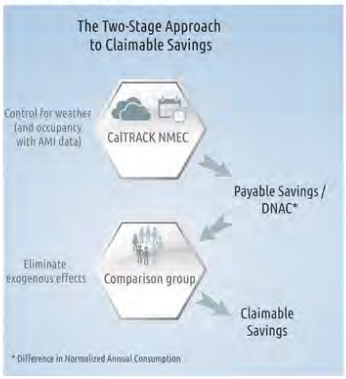
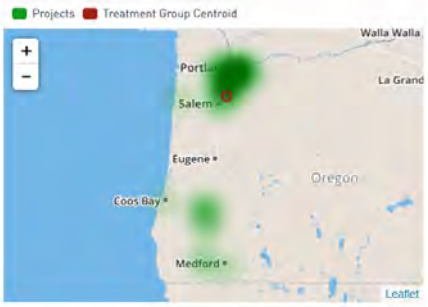
Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



128.3 miles

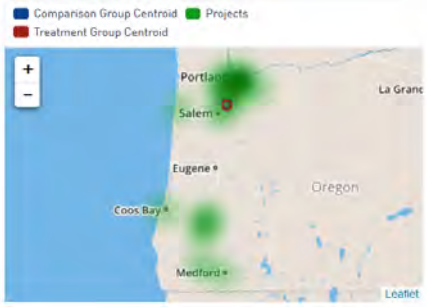
80% of projects lie within this distance from treatment group centroid

245
Meters

13,706
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



3.9 miles

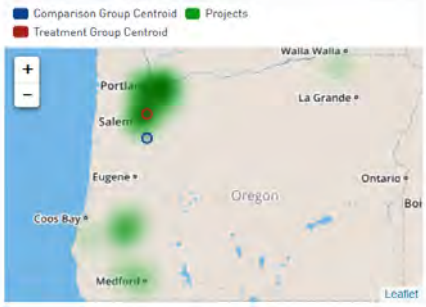
Distance between treatment and comparison group centroids

1,199
Meters

13,255
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

Future Participant Site Locations

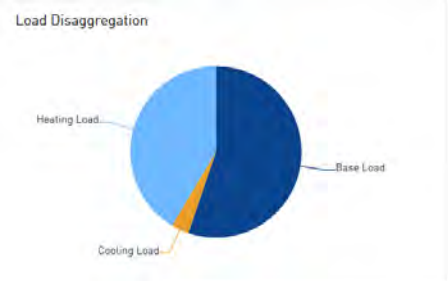


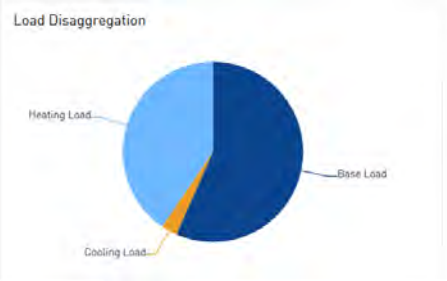
27.0 miles

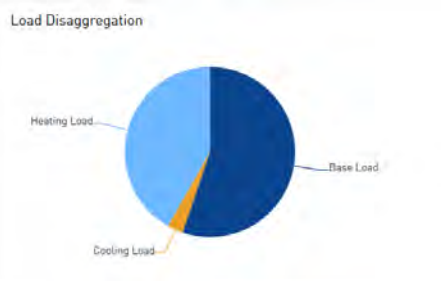
Distance between treatment and future participant group centroids

142
Meters

13,685
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

780	245	31%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

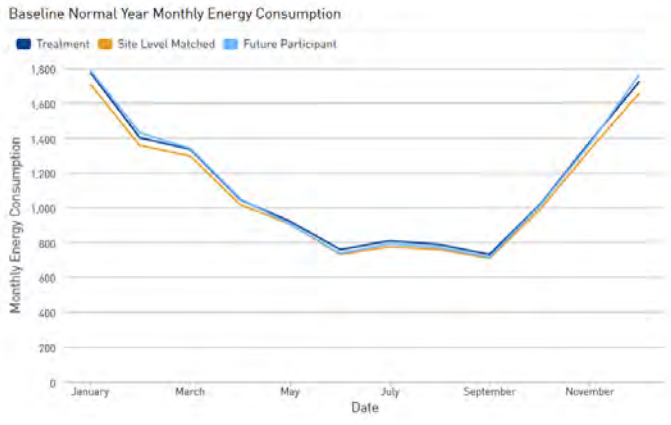
Filter	Selected Filter Value (if applicable)	Number of Dropped Meters	Sample Size after Applying Filter
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2017 -- Fuel: Electricity	--	780
Meters with valid consumption data in baseline and/or reporting periods.	--	39	741
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	741
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	58	683
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	683
Other measure-specific filters.	--	0	683
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	229	454
Meters with at least 5 site-level matched meters from the comparison group pool.	--	5	449

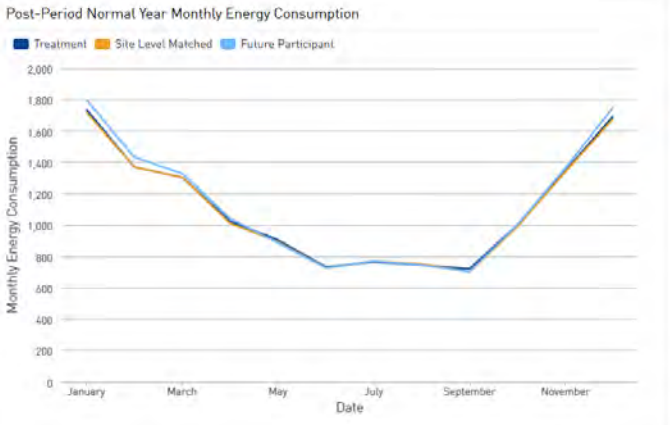
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	3	446
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	446
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	2	444
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	39	405
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	405
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	405
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	405
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	160	245
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	245

3. Modeling Results

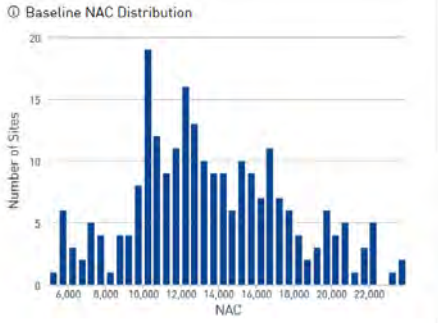
This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

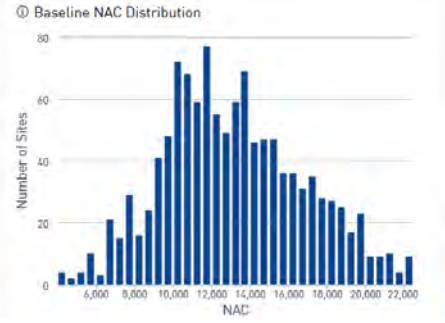
Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.

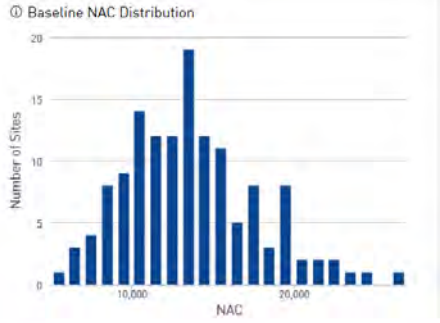




Treatment Group	Site-level Matched Comparison Group	Future Participant Group





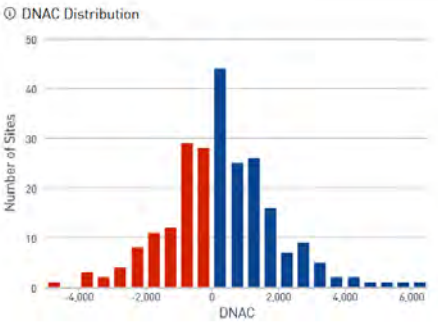


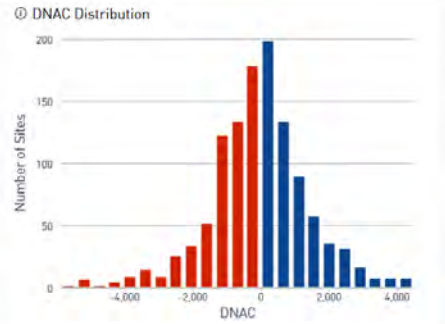
0.152

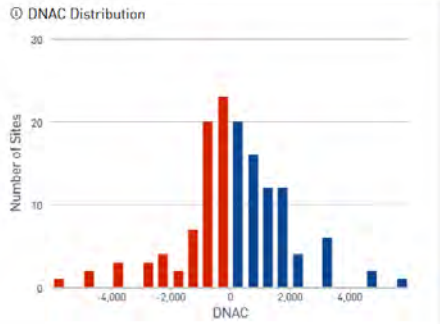
Annual Consumption p-value

0.282

Annual Consumption p-value







354 +/- 210 kWh

Average Difference in Normalized Annual Consumption per Participant

3 +/- 2 %

Difference in Normalized Annual Consumption as a Percent of Baseline

-6 +/- 79 kWh

Average Difference in Normalized Annual Consumption per Participant

-0 +/- 1 %

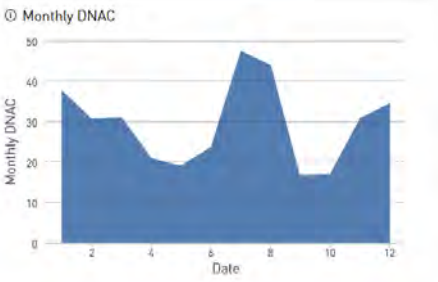
Difference in Normalized Annual Consumption as a Percent of Baseline

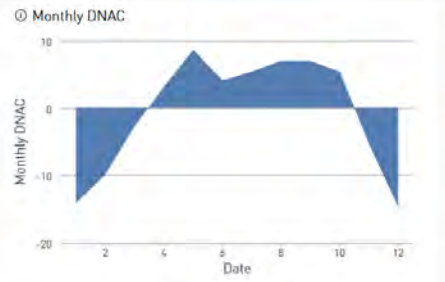
130 +/- 300 kWh

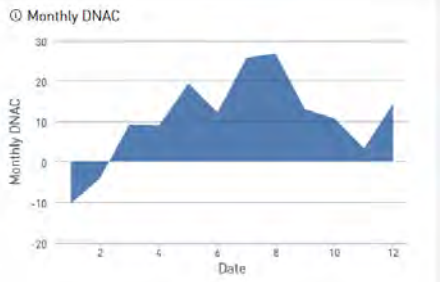
Average Difference in Normalized Annual Consumption per Participant

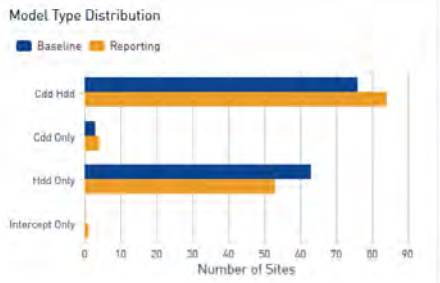
1 +/- 2 %

Difference in Normalized Annual Consumption as a Percent of Baseline









Impact Evaluation Report

Electricity Impact of Airduct in Program Year 2018

Result Summary

Measure: Airduct	Program Year: 2018		Fuel: Electricity	
Meter Data Filters:	DNAC: <100%	DNAC Percentile: All	Annual Consumption Percentile: Remove Top and Bottom 0.5%	*Last Consumption Data Update:* October 1, 2019 *Last Participation Data Update:* October 1, 2019
Model Filters:	Period Length: 11 Months or Longer	R-Squared: >0.5	CV(RMSE): < 1	*CalTRACK Version:* 2.0
Metadata Filters:	Cooling Zone[s]: All	Heating Zone[s]: All	Heating Fuel: Electricity	Heat Pump Manufacturer: All
	Thermostat Name: All	Heat Pump Baseline: All	Multi Measure Filter: No Filtering Based on Measures	Heat Pump Adv. Controls or Commissioning: All
	Air / Duct type: Air and Duct (electricity)	Home size: No Filtering Based on Home Size	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	LikelyGasWaterHeating: All

139 Treatment Meters	510 +/- 272 kWh Average Normal Year Pre-Post Difference in Consumption per Participant	4 +/- 2 % Percent Normal Year Pre-Post Difference in Consumption per Participant	13,350 Mean Baseline Consumption (Electricity)	52% Realization Rate
686 Site-level Matched Meters	356 +/- 290 kWh Average Savings Relative to Site-level Matched Comparison Group	3 +/- 2% Percent Savings Relative to Site-level Matched Comparison Group	12,985 Mean Baseline Consumption (Electricity)	36% Realization Rate
26 Future Participant Meters	725 +/- 774 kWh Average Savings Relative to Future Participant Group	5 +/- 6% Savings Relative to Future Participant Group	12,786 Mean Baseline Consumption (Electricity)	73% Realization Rate

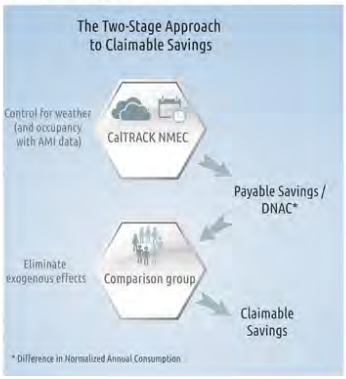
1. Introduction

This report contains the results of applying the two-stage approach (informed by the DOE's uniform methods chapter on whole building analysis) for calculating claimable savings to the selected portfolio of energy efficiency projects (see Figure). This approach begins with identification of two comparison groups for the treatment sample: (a) a site-level matched comparison group and (b) a future participant group. These groups are described below along with summary statistics (site locations, sample size, baseline consumption and baseline load disaggregation).

The CalTRACK methods are then applied to arrive at site-level savings, normalized for weather, and reflective of energy consumption changes for customers at the meter. Using a difference of differences for the treatment group with each comparison group accounts for population-level consumption changes (e.g. economic changes, rate changes, natural energy efficiency adoption etc.). The methods contained within this report are the outcome of a recent peer-reviewed study completed by Energy Trust of Oregon and Open Energy Efficiency (see "Methodology" section for more details).

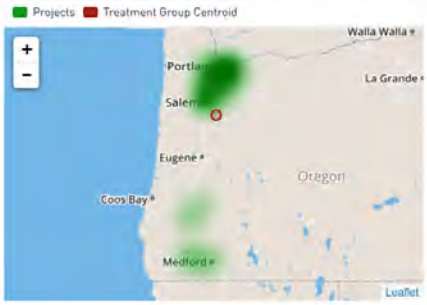
The report includes the following sections:
Result Summary - Includes the overall portfolio results
Section 1. Introduction - Overview of report and the different groups included in the analysis
Section 2. Data Preparation - Data cleaning and sample attrition
Section 3. Modeling Results - CalTRACK model outputs and Difference in Normalized Annual Consumption (DNAC) results
Section 4. Methodology - Description of methods used in this report

Two-Stage Approach



Treatment Group
The treatment group consists of sites that participated in the specified energy efficiency projects in the specified program year. Only sites that installed single measures are included in the treatment group. And this group includes the subset of sites that had sufficient data quality for modeling.

Treatment Site Locations



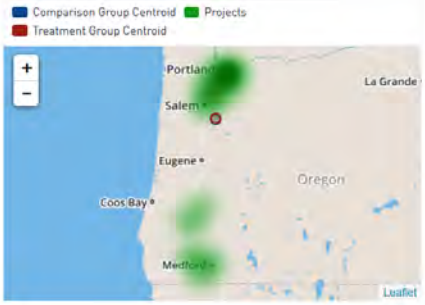
166.4 miles
80% of projects lie within this distance from treatment group centroid

139
Meters

13,350
Mean Baseline Consumption (Electricity)

Site-level Matched Comparison Group
This group includes comparison group sites that were matched at the site-level to treatment group sites. Each treatment group site is matched to five comparison group sites from the same zipcode, but only the sites with sufficient data quality were included in the group. Matching was performed using monthly consumption in the baseline period as detailed in the Methodology section.

Site-level Matched Site Locations



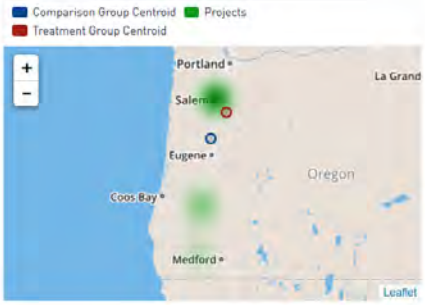
4.1 miles
Distance between treatment and comparison group centroids

686
Meters

12,985
Mean Baseline Consumption (Electricity)

Future Participant Group
The pool of sites that was used to create this group was composed of sites that installed the same measure in the year following the specified program year. The final sites were selected by stratified sampling using deciles of annual energy consumption.

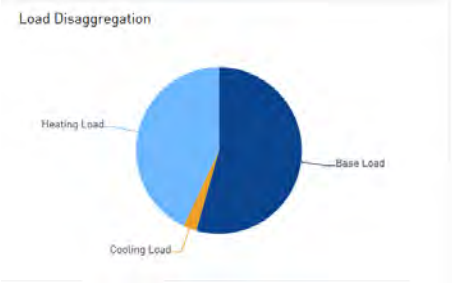
Future Participant Site Locations

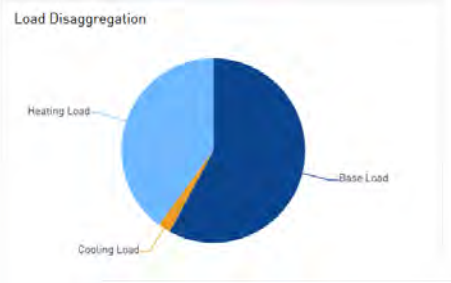


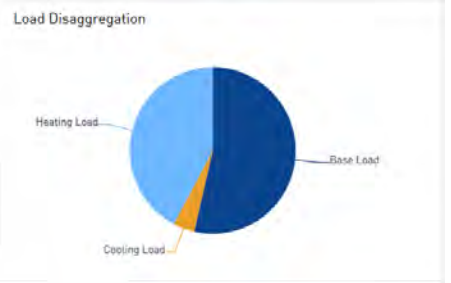
34.0 miles
Distance between treatment and future participant group centroids

26
Meters

12,786
Mean Baseline Consumption (Electricity)







2. Data Preparation

Consumption data preparation and cleaning followed best practices defined in the CalTRACK 2.0 billing methods. Some key aspects of the data cleaning process are highlighted here; please see the resources section for links to more detailed documentation. The initial and final sample sizes are shown below along with the percent of the treatment population that is represented by the sample. The sample attrition table shows the impact of each filtering criterion on sample size.

555	139	25%
Meters in Treatment Population	Final Sample Size	Percent of Treatment Population Represented by Sample

Sample Attrition Table

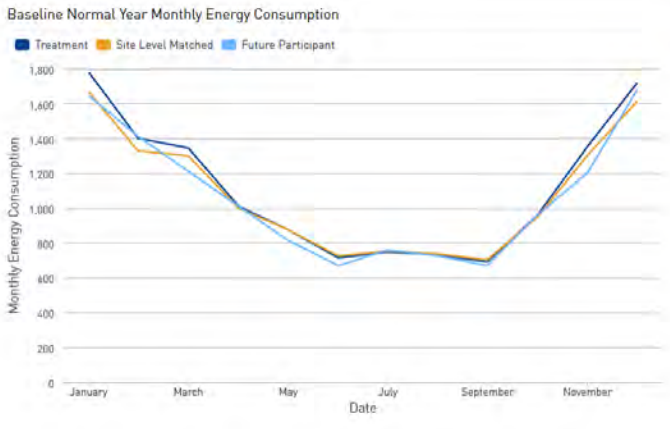
Measure: Meters associated with a particular measure in program participation data. **Year:** Program year. **Fuel:** Type of metered fuel.	Measure: Airduct -- Year: 2018 -- Fuel: Electricity	--	555
Meters with valid consumption data in baseline and/or reporting periods.	--	57	498
MultiMeasure_Filter: Meters with single/multiple measure installations in baseline and/or reporting periods.	Multi Measure Filter: No Filtering Based on Measures	0	498
HeatingFuel: Meters with a valid heating fuel that corresponds to the selected filter value.	Heating Fuel: Electricity	70	428
HeatingZone, CoolingZone: Meters in selected heating and/or cooling climate zones.	Heating Zone: All -- Cooling Zone: All	0	428
Other measure-specific filters.	--	0	428
PeriodLength_Threshold: Meters meeting a threshold number of months of valid consumption data.	Period Length: 11 Months or Longer	149	279
Meters with at least 5 site-level matched meters from the comparison group pool.	--	19	260

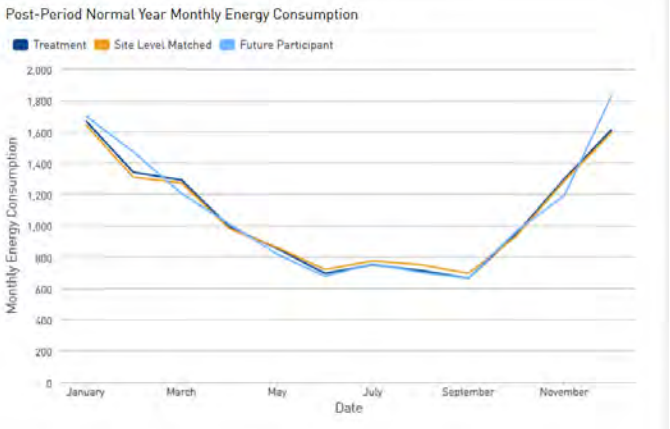
DNAC_Threshold: Meters with normalized change in annual energy consumption under a specified threshold.	DNAC: <100%	2	258
DNACPercentile_Threshold: Meters within specified percentile bands of normalized change in annual consumption.	DNAC Percentile: All	0	258
ConsumptionPercentile_Threshold: Meters within specified percentile bounds of annual energy consumption.	Annual Consumption Percentile: Remove Top and Bottom 0.5%	1	257
R2_Threshold: Meters with valid model R-squared for the baseline and reporting periods that meet a specified threshold. Models may have invalid R-squared due to data issues.	R-Squared: >0.5	27	230
CVRMSE_Threshold: Meters with valid model CV(RMSE) for the baseline and reporting periods that meet a specified threshold.	CV(RMSE): < 1	0	230
home_size: Meters with manufactured home size meeting a specific criteria (single-wide, double-wide, or triple-wide).	Home Size: No Filtering Based on Home Size	0	230
complex_duct_sealing: Meters with the 'MH Complex Add-On' measure.	Complex Duct Sealing: No Filtering Based on Complex Duct Sealing	0	230
airduct_type: Meters that used specific measures relevant to Air and Duct Sealing programs.	Air/duct Type: Air and Duct (electricity)	91	139
likely_gas_water_heating: Metrs with more than 0.2 therms per day average gas consumption in August.	Likely gas water heating: All	0	139

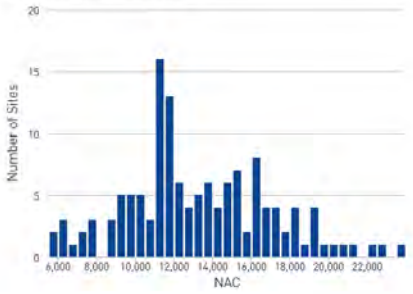
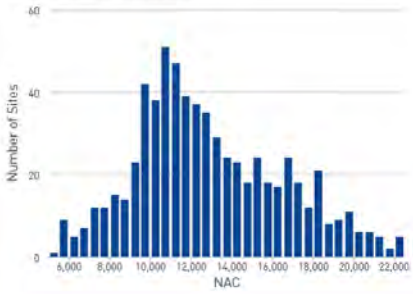
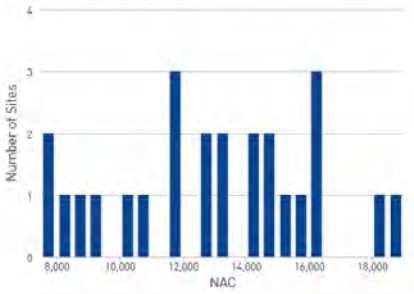
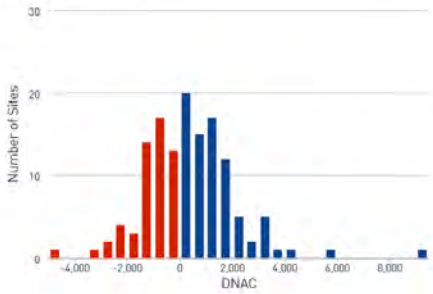
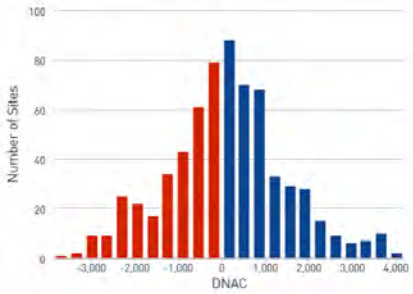
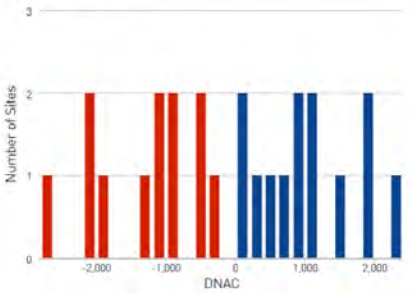
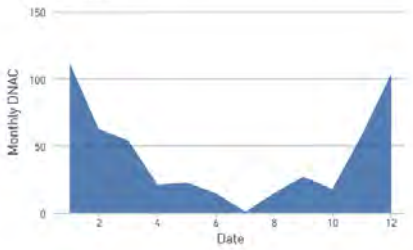
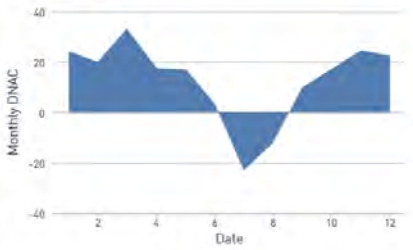
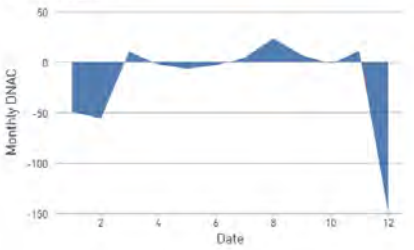
3. Modeling Results

This section includes summaries of the Difference in Normalized Annual Consumption (DNAC) results for the treatment and comparison groups. The time series of monthly energy consumption illustrates the similarities and/or differences in energy consumption for the different groups in the baseline and reporting periods.

Below, you will find a breakdown of the DNAC results by group, showing the histograms of DNAC as well as the mean value expressed in raw units and as a percent of baseline annual consumption. Finally, the distribution of model types in the baseline and reporting periods are also provided as an additional layer of analysis.





Treatment Group	Site-level Matched Comparison Group	Future Participant Group
Baseline NAC Distribution	Baseline NAC Distribution	Baseline NAC Distribution
		
	0.205 Annual Consumption p-value	0.261 Annual Consumption p-value
DNAC Distribution	DNAC Distribution	DNAC Distribution
		
510 +/- 272 kWh Average Difference in Normalized Annual Consumption per Participant	154 +/- 100 kWh Average Difference in Normalized Annual Consumption per Participant	-214 +/- 724 kWh Average Difference in Normalized Annual Consumption per Participant
4 +/- 2 % Difference in Normalized Annual Consumption as a Percent of Baseline	1 +/- 1 % Difference in Normalized Annual Consumption as a Percent of Baseline	-2 +/- 6 % Difference in Normalized Annual Consumption as a Percent of Baseline
Monthly DNAC	Monthly DNAC	Monthly DNAC
		
Model Type Distribution	Model Type Distribution	Model Type Distribution