CADMUS

Washington Biennium (2018–2019) Electric Impact Evaluation Report

April 15, 2020

Prepared for:

Avista Corporation

1411 East Mission Avenue

Spokane, WA 99202

Prepared by:
Cadmus

CADMUS

Table of Contents

Tables

Figures

Portfolio Executive Summary

For several decades, Avista Corporation (Avista) has administered demand-side management (DSM) programs to reduce electricity and natural gas energy use by its customer portfolio. While most of these programs have been implemented in-house, a few have been fulfilled externally.

Avista contracted with Cadmus to complete process and impact evaluations of its Program Year (PY) 2018 and PY 2019 electric DSM programs in Washington. This report presents the biennium electric impact evaluation findings for these two years. Cadmus did not apply net-to-gross (NTG) adjustments to savings values, except where deemed energy savings values already incorporated NTG as a function of the market baseline.

Evaluation Methodology and Activities

Table 1 shows the variety of methods and activities Cadmus completed in conducting the Washington electric portfolio evaluation.

Table 1. Biennium Electric Program Evaluation Activities

Sector	Program	Document/ Database Review	Verification/ Metering Site Visit	Billing Analysis
Nonresidential	Prescriptive (multiple)	✓	✓	--
	Site Specific	✓	✓	✓
Residential	Simple Steps, Smart Savings™	✓	--	--
	HVAC	✓	--	✓
	Shell	✓	--	✓
	ENERGY STAR® Homes	✓	--	--
	Multifamily Direct Install	✓	--	✓
	Multifamily Direct install Supplemental Lighting	✓	--	--
Low-Income	Low-Income	✓	--	✓
Fuel Efficiency	Site Specific (Nonresidential)	✓	✓	--
	Residential	✓	--	✓
	Low-Income	✓	--	✓

Summary of Impact Evaluation Results

Overall, the Washington electric energy efficiency portfolio achieved a 99% realization rate and acquired 88,501,555 kWh in biennial evaluated savings, as shown in Table 2. Cadmus collected Avista-reported savings through database extracts, drawn from Avista's Customer Care and Billing (Residential), InforCRM and iEnergy (Nonresidential) databases and from data provided by third-party implementers.

Although some individual project results varied, both the Residential and Nonresidential sector performed strongly in PY 2018 and PY 2019.

Table 2. Biennial Reported and Evaluated Energy Efficiency Electric Savings

Sector	Reported Savings (kWh)	Biennial Evaluated Savings (kWh)	Realization Rate
Nonresidential	59,342,483	58,058,064	98%
Residential	28,885,660	29,726,694	103%
Low-Income	725,435	716,797	99%
Total	**88,953,578**	**88,501,555**	**99%**

Conclusions and Recommendations

During the PY 2018 and PY 2019 evaluations, Cadmus identified the areas discussed below for improvements by sector.

Nonresidential Conclusions and Recommendations

The Nonresidential sector achieved total biennial evaluated electric energy savings of 58,058 MWh with a 98% combined realization rate. The Nonresidential sector also exceeded the combined Prescriptive and Site Specific program paths' electric-savings goal of 41,963 MWh by 38%.

Although some individual project results varied, the overall Nonresidential sector performed strongly in PY 2018 and PY 2019. Most projects that Cadmus sampled for the evaluation were well-documented, matching those found during site visit verifications.

Cadmus encountered numerous challenges in evaluating the PY 2019 Nonresidential program due to midyear changes Avista made to its application tracking database system. The new iEnergy database stores and reports the data in different formats and at different aggregation levels than the previous system.

Because the transition occurred midyear and some applications were entered into both systems, Avista and Cadmus staff had to manually combine and recategorize data from the new database to match up with the format used for the old database. Cadmus identified several issues with exports from the new database as well as underlying errors with the way some savings were calculated by the new system. Avista has corrected the issues Cadmus identified, and the new iEnergy database has the potential to facilitate more accurate savings estimates, more detailed project tracking, and more thorough evaluations in the future.

Cadmus offers the following recommendations for improving the Nonresidential sector's energy savings:

- Ensure that final reported savings calculations reflect the most up-to-date project details, including post-installation verification photos, equipment submittals, and invoices. During several project verifications, Cadmus found different installed equipment sizes, quantities, or performance ratings than those used in the reported savings calculations.
- Require additional supporting information about existing HVAC systems and their fuel sources to more accurately calculate potential energy savings for insulation measures. Supporting

information could take the form of electric and natural gas utility bills, equipment nameplate information, or on-site photos of HVAC equipment.

- Review hours-of-use (HOU) estimates for interior and exterior lighting projects when reviewing submissions and conducting installation verifications. Applications claiming 8760 hours should be particularly scrutinized. Before any new equipment installations, confirm the presence or absence of lighting controls, and record how these have been configured. Cadmus found a small percentage of Prescriptive and Site Specific projects where lighting HOU and controls varied significantly from submitted details.
- Ensure the correct categorization of lighting projects as interior or exterior. Cadmus evaluated four Prescriptive lighting projects with fixtures listed under the wrong measure category.
- Carefully review measurement and verification (M&V) plans for Site Specific projects early in the process to ensure an appropriate measurement basis, and work with site contacts to establish trend logs for relevant building management system or industrial control system data points during the baseline period.
- Continue to pursue improvements with Avista installation verification (IV) reports. Cadmus staff found the detail level in IV reports varied. Cadmus recommends that all IV reports include basic information, explicitly stating the quantity and type of equipment found. For lighting projects, this would include confirmed fixture types, quantities, installation locations, controls, and estimated HOU. For most other equipment, this would include nameplates, model numbers, and quantities.

Residential Conclusions and Recommendations

Biennial evaluated electricity savings showed a 103% realization rate on realized savings of 29,726,694 kWh for Residential programs, representing 114% of the savings goal for the biennium.

Lighting measures accounted for 79% of the total Residential sector savings. The following shows the percentage of residential evaluated savings provided by each program:

- Simple Steps, Smart Savings program provided 60% of Residential evaluated savings, mostly through lighting measures
- Multifamily Direct Install (MFDI) and MFDI Supplemental Lighting programs provided 25% of evaluated savings, again mostly through lighting measures
- The Residential HVAC program accounted for 12% of evaluated savings
- Shell and ENERGY STAR Homes programs accounted for a combined 3% of residential evaluated savings

Realization rates varied by program from 89% for the Shell and ENERGY Homes programs to 145% for the HVAC program, resulting in a strong overall realization rate of 103% for PY 2018 and PY 2019. Cadmus identified few discrepancies through document review, which found that the great majority of projects were well documented and met program requirements.

Cadmus offers three recommendations regarding Avista's Residential electric programs:

- Based on billing analysis conducted for this evaluation, adjust the Avista Technical Reference Manual (TRM) to provide higher savings values for variable-speed motors installed with the G Natural Gas Furnace measure and lower savings for replacement windows in electrically heated homes. The billing analysis showed savings for the variable-speed motor measure were more than double the Avista TRM value on average, seemingly due to a shift away from secondary electric heating (such as portable heaters or wall heaters) in some homes after replacing a gas furnace with a high-efficiency model. For windows in electrically heated homes, the billing analysis estimated unit savings of roughly 75% of the 2019 TRM value.
- The MFDI program has proven to be an efficient, effective mechanism for installing high-efficiency lighting and aerators in multifamily units. Continue to focus on replacing high-use, low-efficiency lamps where practical, to maximize program cost-effectiveness while maintaining high savings.
- Ensure that reported savings for all measures are calculated using current TRM or Regional Technical Forum (RTF) unit energy savings (UES) values, and that the TRM provides values for all measures. Cadmus noted no large-scale problems with the PY 2019 measure tracking data but did note numerous measure-tracking records that reported zero savings, despite appearing to have been completed and a rebate having been issued. In addition, some instances of PY 2019 measures used UES values from the 2018 TRM, and reported values for some measures (most notably, smart thermostats) did not match TRM values.

Nonresidential Impact Evaluation

Through its Nonresidential portfolio of programs, Avista promotes the purchase of high-efficiency equipment for commercial and industrial utility customers. Avista provides rebates to partially offset the difference in cost between high-efficiency equipment and standard equipment. Cadmus conducted Nonresidential impact evaluation activities to determine biennial evaluated savings for most programs; the team conducted measurement and verification (M&V) of Prescriptive and Site Specific projects across the full biennial sample.

Program Summary

Avista completed and incented 2,510 nonresidential electric measures in Washington during PY 2018 and PY 2019, and reported total electric energy savings of 59,342,483 kWh. Through the Nonresidential sector, Avista offers incentives for high-efficiency equipment and controls through three program paths: Prescriptive, Site Specific, and Multifamily Market Transformation.

The Prescriptive program path applies to smaller, straightforward equipment installations that generally have similar operating characteristics (such as lighting, simple HVAC systems, food service equipment, and variable-frequency drives). The Site Specific program path applies to more unique projects that require custom savings calculations and technical assistance from Avista's account executives (such as compressed air, process equipment and controls, and comprehensive lighting retrofits).

A Site Specific program, Multifamily Market Transformation prompts building owners and developers to consider natural gas as the fuel of choice when constructing new multifamily housing. These measures, represented by a combination of electric savings and natural gas penalties, typically involve replacing electric space-heating or water-heating systems with natural gas equipment. See the *Fuel Efficiency Impact Evaluation* section for the evaluation methodology and the results discussion for Nonresidential Fuel Efficiency measures.

Program Participation Summary

This section summarizes Nonresidential sector participation and progress toward biennium goals through the Prescriptive and Site Specific program paths.

Nonresidential Prescriptive Programs

Table 3 shows electric energy savings goals assigned to Avista's Nonresidential Prescriptive programs for PY 2018 and PY 2019 as well as reported savings and a comparison between reported savings and goals.

Table 3. Nonresidential Prescriptive Electric Savings

Program Type	Savings Goals (kWh)	Savings Reported (kWh)	Percentage of Goal
Interior Lighting	14,605,253	19,393,898	133%
Exterior Lighting	5,035,794	16,135,239	320%
Shell Measure	15,706	62,456	398%
Green Motors	157,950	47,743	30%
Motor Control (VFD)	904,342	719,547	80%
Fleet Heat	64,000	188,000	294%
Food Service Equipment	219,222	65,105	30%
AirGuardian	84,000	33,752	40%
Energy Smart Grocer	2,876,349[a]	273,234	9%
Total	**23,962,616**	**36,918,974**	**154%**

[a] The Energy Smart Grocer savings goal includes Site Specific Energy Smart Grocer measures. The Site Specific portion constitutes approximately 10% of the overall goal.

Table 4 shows biennium participation goals by rebated equipment quantities, provided by Avista. The Nonresidential tracking database extract listed individual projects but did not include rebated equipment quantities. For reference, Table 5 provides participation by unique application numbers.

Table 4. Nonresidential Prescriptive Participation Goals by Equipment Rebated

Program Type	Participation Goal
Interior Lighting	84,800
Exterior Lighting	17,612
Shell Measure[a]	185,000
Green Motors	36
Motor Control (VFD)	660
Fleet Heat	8
Food Service Equipment	33
AirGuardian	14
Energy Smart Grocer[b]	9,779

[a] The Shell Measure participation goal includes participants with natural gas savings.

[b] The Energy Smart Grocer goal includes Site Specific Energy Smart Grocer participants.

Table 5. Nonresidential Prescriptive Participation by Project

Program Type	Participation Reported[a]
Interior Lighting	930
Exterior Lighting	1,052
Shell Measure	17
Green Motors	19
Motor Control (VFD)	15
Fleet Heat	1
Food Service Equipment	23
AirGuardian	2
Energy Smart Grocer	13
Total[b]	**2,072**

[a] Participant is defined as a unique application number.

[b] Total participants. A single application may contain measures from multiple programs.

Nonresidential Site Specific Program

Table 6 shows electric savings goals assigned to the Site Specific program path in Avista's Nonresidential sector for PY 2018 and PY 2019 as well as reported savings and a comparison between reported savings and goals. The table does not include reported electric savings for the Fuel Efficiency sector (such as those associated with the Multifamily Market Transformation program).

Table 6. Nonresidential Site Specific Electric Savings

Program	Savings Goals (kWh)	Savings Reported (kWh)	Percentage of Goal
Site Specific	18,000,000	22,423,509	125%

Nonresidential Impact Evaluation Methodology

As the first step in evaluating biennial savings for the Nonresidential sector, Cadmus explored the following documents and data records to gain an understanding of the programs and measures slated for evaluation:

- Avista's annual business plans, detailing processes and energy savings justifications
- Project documents from external sources (such as customers, program consultants, or implementation contractors)

Based on the initial review, Cadmus checked the distribution of program contributions with the overall program portfolio. The review provided insight into the sources for unit energy savings (UES) claimed for each measure offered in the programs, along with sources for energy-savings algorithms, internal quality assurance, and quality control processes for large Nonresidential sector projects.

Following this review, Cadmus designed a sample strategy for impact evaluation activities. Cadmus performed the following evaluation activities in each of four waves:

- Selected evaluation sample and requested project documentation from Avista
- Reviewed project documentation
- Prepared on-site M&V plans

- Performed site visits and collected on-site data (such as trend data, photos, and operating schedules)
- Used site visit findings to calculate biennial evaluated savings by measure
- Applied realization rates to the total reported savings population to determine overall biennial evaluated savings

Sample Design

Cadmus created four sample waves for PY 2018 and PY 2019:

- Sample 1 included program data from January 2018 through April 2018
- Sample 2 included program data from May 2018 through December 2018
- Sample 3 included program data from January 2019 through June 2019
- Sample 4 included program data from July 2019 through December 2019

As a guideline, Cadmus used the proposed overall PY 2018 and PY 2019 Nonresidential sample sizes by subprogram in the M&V plan, seeking to complete approximately one-quarter of the samples during each of the first three waves. Cadmus adjusted the final sample to meet the overall confidence and precision targets for the entire biennium.

For each activity wave, Cadmus organized submitted program applications by path and measure (such as the Site Specific Shell Measure, Prescriptive Lighting, or Prescriptive Motor Controls), allowing the team to select the highest-savings applications in each category with certainty. For non-certainty applications, the team assigned random numbers and developed a random sample. In some cases, Cadmus sampled another application at the same location or facility was previously selected (and where the team could assess both applications with one site visit, a cost-effective verification strategy even if the second application represented minimal claimed savings).

As Avista implements its programs similarly in both states, Cadmus sampled randomly selected sites across Washington and Idaho. The team pooled results from the randomly selected sites to calculate a realization rate by stratum and applied that realization rate to projects in both states. Cadmus applied evaluated savings for sites selected with certainty only to the state in which they had been implemented.

Table 7 summarizes the Washington Nonresidential Prescriptive program path evaluation sample. Cadmus sampled 45 Prescriptive applications at 34 unique sites overall. Of the sampled applications, the team selected 19 for certainty review based on scale of savings, measure type, or location, and selected the remaining 28 applications randomly. There were two participants in the AirGuardian program in PY 2019 and only one participant in the Fleet Heat program in PY 2018. Cadmus did not sample either Fleet Heat or AirGuardian program measures due to low savings and participation. Table 7 shows the total number of unique application IDs in each program, including two applications containing measures from more than one program.

Table 7. Washington Nonresidential Prescriptive Electric Evaluation Sample

Program Type	Applications Sampled	Sampled Savings (kWh)	Percentage of Reported Savings
Interior Lighting	13	4,441,440	23%
Exterior Lighting	7[a]	924,893	6%
Shell Measure	5	16,524	26%
Green Motors	3	8,903	19%
Motor Control (VFD)	8	473,549	66%
Fleet Heat	0	0	N/A
Food Service Equipment	6	20,343	31%
AirGuardian	0	0	N/A
Energy Smart Grocer	3	12,388	5%
Nonresidential Prescriptive	**45**	**5,898,041**	**16%**

[a] Two interior lighting applications also included exterior lighting measures that are not reflected in this total.

Table 8 summarizes the Washington Nonresidential Site Specific program's path evaluation sample, where Cadmus sampled 21 Site Specific applications at 17 unique sites overall. Of the sampled applications, the team selected eight for certainty review, based on the savings scale, measure type, or location, and selected the remaining 13 applications randomly.

Table 8. Washington Nonresidential Site Specific Electric Evaluation Sample

Program	Applications Sampled	Sampled Savings (kWh)	Percentage of Reported Savings
Site Specific	21	5,600,711	25%

Document Review

Cadmus requested and reviewed project documentation for each sampled application and prepared M&V plans to guide its site visits. Typically, project documentation included incentive applications, calculation tools (usually based on the 2017 Regional Technical Forum [RTF]),[1] invoices, equipment specification sheets, and installation verification reports.

On-Site Verification

Cadmus performed site visits at 51 unique Nonresidential locations to assess electric savings for 68 unique Prescriptive and Site Specific measures from 66 different applications (not including Fuel Efficiency measures). Site visits involved verifying installed equipment types, make and model numbers, operating schedules, and set points, as applicable. Cadmus used the project documentation review and on-site findings to adjust reported savings calculations, where necessary.

Nonresidential Impact Evaluation Results

This section summarizes electric impact evaluation results for the Nonresidential sector's Prescriptive and Site Specific program paths over the 2018–2019 biennium.

[1] Regional Technical Forum. 2017. "Standard Protocols." https://rtf.nwcouncil.org/standard-protocols

Nonresidential Prescriptive Programs

Table 9 shows biennial reported and evaluated electric energy savings for Avista's Nonresidential Prescriptive program path as well as the realization rates between biennial evaluated and reported savings for PY 2018 and PY 2019. The overall Nonresidential Prescriptive program path achieved a 99% electric realization rate.

Table 9. Nonresidential Prescriptive Electric Impact Findings

Program Type	Reported Savings (kWh)	Biennial Evaluated Savings (kWh)	Realization Rate
Interior Lighting	19,393,898	18,904,698	97%
Exterior Lighting	16,135,239	16,080,344	100%
Shell Measure	62,456	51,570	83%
Green Motors	47,743	47,875	100%
Motor Control (VFD)	719,547	723,001	100%
Fleet Heat	188,000	188,000	100%
Food Service Equipment	65,105	65,095	100%
AirGuardian	33,752	33,752	100%
Energy Smart Grocer	273,234	271,587	99%
Nonresidential Prescriptive	**36,918,974**	**36,365,922**	**99%**

Of 45 evaluated applications, Cadmus identified discrepancies for 27 measures, based on site visits and project documentation reviews. Table 10. Nonresidential Prescriptive Evaluation Summary of Discrepancies summarizes the reasons for discrepancies between reported and biennial evaluated savings. Four measures had realization rates of 99% due to minor calculation differences and are not included in the summary of discrepancies.

Table 10. Nonresidential Prescriptive Evaluation Summary of Discrepancies

Project Type	Number of Occurrences	Savings Impact	Reason(s) for Discrepancy
Green Motor Rewind	1	↑	• The reported savings reference for 2017 RTF. Cadmus applied deemed motor savings from the 2018 TRM workbook.
Refrigerator Door Gaskets	1	↓	• The reported savings for one refrigerator door gasket project corresponded to 17 doors. Cadmus only received documentation for and verified installation of 15 doors at this site.
Interior Lighting	11	↓	• Cadmus reduced the fixture counts for three projects as the verified installed quantity on the site was lower than the quantity reported on the application. • Cadmus reduced the hours of use (HOU) for four projects which reported 24/7 operations after determining that occupancy controls and schedule controls were in place to reduce the lighting runtime prior to and after the project. • The Avista database categorized two projects as interior lighting which only had exterior fixtures. These savings were subtracted from interior lighting and added to exterior lighting.

Project Type	Number of Occurrences	Savings Impact	Reason(s) for Discrepancy
	2	↑	• Cadmus determined that the store hours at one site were higher than reported on the application. The team also determined that new occupancy controls were added which were not reported on the application, further decreasing installed HOU relative to baseline HOU. • Cadmus found that the installed fixtures for one project had a lower wattage than reported on the application.
Exterior Lighting	3	↓	• Cadmus reduced exterior lighting HOU from 8,760 to 4,288 for one project after determining that all exterior fixtures at the site were controlled by photocells. • Cadmus reduced fixture counts and increased HOU at one site where the building underwent a remodel shortly after completing the project and no longer matched the conditions reported at the time the application was submitted. • Cadmus calculated savings for an outdoor display sign using the actual quantity and wattage of the lamps inside the sign. The Avista calculator used an estimated watts per square foot method for exterior sign lighting based on assumed typical values.
	4	↑	• Cadmus updated the savings calculations to use the actual verified fixture wattage instead of the assumed typical value for two projects. • Cadmus determined that two exterior lighting measures were incorrectly categorized as interior lighting measures in the Avista database and transferred those savings to exterior lighting.
Motor Control (VFD)	2	↓	• Cadmus determined that two return air fans with VFDs and reported as 3.0 HP were actually 2.5 HP.
Shell Measure	1	↓	• Cadmus determined there was no space cooling and space was heated with natural gas. As a result, the team removed electric savings from ceiling/wall insulation.
	2	↓	• Avista reported incorrect savings values for two Shell insulation projects due to an error in their new database software. Cadmus reviewed all Prescriptive Shell measures to confirm that only two projects were affected by the bug. Cadmus treated the two affected projects as certainty projects and evaluated savings using the typical savings calculator methodology.

Nonresidential Site Specific Program

Table 11 shows biennial reported and evaluated electric energy savings for Avista's Nonresidential sector Site Specific program path for the biennium as well as comparing biennial verified and reported savings. The overall Site Specific program path had a 97% electric realization rate. The table does not include biennial reported and evaluated electric savings for measures in the Fuel Efficiency path.

Table 11. Nonresidential Site Specific Electric Impact Findings

Program	Reported Savings (kWh)	Biennial Evaluated Savings (kWh)	Realization Rate
Site Specific	22,423,509	21,692,142	97%

Of 24 evaluated applications, Cadmus identified discrepancies in 10, based on site visits and project documentation reviews three projects had realization rates of 99% or 101% due to minor differences in calculations. The discrepancies between reported and evaluated savings in the remaining seven

applications are summarized in Table 12. We note that it should be expected to identify discrepancies when conducting a custom review of a prescriptive project. However, this had little impact on the overall savings.

Table 12. Nonresidential Site Specific Evaluation Summary of Discrepancies

Project Type	Number of Occurrences	Savings Impact	Reason(s) for Discrepancy
Interior Lighting	3	↓	• Cadmus reduced the lighting hours from 100% on to 75% on one project, based on interviews with on-site staff. Cadmus also found a lower installed fixture quantity than that reported in the application. • Cadmus could not replicate the reported savings on one project based on reported fixture types and quantities. However, the team retained the reported quantities as they could not visit all spaces at the site for verification. • Cadmus determined that 13 W fixtures were installed in place of the 9 W fixtures reported on the application.
Exterior Lighting	1	↓	• The site installed a higher quantity of exterior LED fixtures. • Cadmus found that reported savings in database did not match the implementer's submitted calculation workbook.
	1	↓	• The site installed fewer LED pole lighting fixtures and more LED wall pack fixtures than reported.
Appliance	1	↑	• Cadmus decreased the pounds of food cooked per day (from that shown in the calculator workbook, "PGE broiler testing report calculator.xlsx") for the broiler measure, based on the site interview.
Shell Measure	1	↑	• Cadmus' on-site review of installed, triple-pane windows confirmed that some windows had lower U-values than reported, and all windows had a higher solar heat gain coefficient than reported.

Cadmus reviewed one large Site Specific chiller plant replacement project at a large hospital, which was analyzed with a bin temperature weather regression analysis using electric meter data for the entire site. The hospital's building management system contained data points for the chiller plant energy consumption, but the site did not retain baseline trend data during the system upgrade.

The whole-site meter data analysis approach was not appropriate for such a large and complex site, where the chiller plant accounted for less than 10% of the total site energy load. Cadmus could not reevaluate the savings using the trend data as no data were available from the baseline period. The site contact stated that they would have set up trends and retained the data if they had been requested at the beginning of the project.

Cadmus attempted to estimate savings using the equipment specifications with a bin temperature model to estimate the percent load, but, due to the size of the equipment, small differences in the assumptions used in the model resulted in savings either significantly higher or slightly lower than the reported savings. These results indicated the reported savings were likely reasonable, if not underestimated. Avista's Energy Efficiency Engineering Team noted that, in the absence of baseline data, they took a conservative approach to estimate savings. Cadmus chose to pass through the reported savings on this project because there was insufficient baseline data available to create a more accurate model.

Throughout the evaluation, Cadmus staff found that the level of detail in installation verification (IV) reports varied. Most IV reports Cadmus reviewed only stated that the reviewer "found the installation to match the application submitted," including for a portion of projects where Cadmus' inspections found discrepancies between the installation and the application. Some IV reports did not contain any text at all and only provided unlabeled photos. Cadmus evaluated a lighting project where the IV report only contained one photograph of each fixture type and no information about quantities.

Nonresidential Conclusions and Recommendations

The Nonresidential sector achieved total biennial evaluated electric energy savings of 58,058 MWh with a 98% combined realization rate. The Nonresidential sector also exceeded the combined Prescriptive and Site Specific program paths' electric-savings goal of 41,963 MWh by 38%.

Although some individual project results varied, the overall Nonresidential sector performed strongly in PY 2018 and PY 2019. Most projects that Cadmus sampled for the evaluation were well-documented, matching those found during site visit verifications.

Cadmus encountered challenges evaluating the PY 2019 Nonresidential program due to midyear changes Avista made to their application tracking database system. The new iEnergy database stores and reports data in different formats and different aggregation levels than the previous InforCRM system.

As the transition occurred midyear and some applications were entered into both systems, Avista and Cadmus staff had to manually combine and recategorize data from the new database to match up with the format used for the old database. Cadmus identified several issues with exports from the new database as well as underlying errors with the way some savings were calculated by the new system. Avista has corrected the issues Cadmus identified, and the new iEnergy database has the potential to facilitate more accurate savings estimates, more detailed project tracking, and more thorough evaluations in the future.

Cadmus offers the following recommendations for improving the Nonresidential sector's energy savings:

- Ensure that the final reported savings calculations reflect the most up-to-date project details, including post-installation verification photos, equipment submittals, and invoices. During a small number of project verifications, Cadmus found different installed equipment sizes, quantities, or performance ratings than those used in the reported savings calculations.
- Require additional supporting information about existing HVAC systems and their fuel sources to more accurately calculate potential energy savings for insulation measures. Supporting information could take the form of electric and natural gas utility bills, equipment nameplate information, or on-site photos of HVAC equipment.
- Review HOU estimates for interior and exterior lighting projects when reviewing submissions and conducting installation verifications. Applications claiming 8760 hours should be particularly scrutinized. Before any new equipment installations, confirm the presence or absence of lighting

controls and record how they have been configured. Cadmus found several Prescriptive and Site Specific projects where lighting HOU and controls varied from submitted details.

- Ensure the correct categorization of lighting projects as interior or exterior. Cadmus evaluated four Prescriptive lighting projects with fixtures listed under the wrong measure category.
- Review M&V plans for Site Specific projects carefully early in the process to ensure an appropriate measurement basis, and work with site contacts to establish trend logs for relevant building management system or industrial control system data points during the baseline period.
- Provide more thorough documentation with Avista IV reports. Cadmus staff found that the detail level in IV reports varied. Cadmus recommends that all IV reports include basic information, explicitly stating the quantity and type of equipment found. For lighting projects this would include confirmed fixture types, quantities, installation locations, controls, and estimated HOU. For most other equipment, this would include nameplates, model numbers, and quantities.

Residential Impact Evaluation

Cadmus designed the Residential sector impact evaluation to verify reported program participation and energy savings. The team used data collected and reported in the tracking database, online application forms, Avista Technical Reference Manual (TRM) and RTF savings review, and analysis of participant electricity consumption data to evaluate savings. This approach provided the strongest estimate of achieved savings practical for each program, given its delivery method, magnitude of savings, number of participants, and availability of billing data.

Program Summary

In PY 2018 and PY 2019, Avista completed and provided incentives for 1,496,591 residential electric measures or units in Washington and reported total electric energy savings of 28,885,660 kWh. Participation is defined as installed pieces of equipment (such as a furnace or showerhead) for some measures and square feet of surface for others (such as wall insulation and windows replacement).

The Residential path includes several programs:

- Simple Steps, Smart Savings, which encourages consumers to purchase and install high-quality LEDs, light fixtures, and energy-efficient showerheads
- Residential HVAC, which offers incentives for high-efficiency heating and cooling equipment
- Residential Shell, which provides rebates to encourage customers to install high-efficiency windows and storm windows
- ENERGY STAR Homes, which offers 15% to 25% of energy savings relative to state energy codes
- Multifamily Direct Install (MFDI), which provides free direct-install measures to multifamily residences (five units or more) and common areas
- MFDI Supplemental Lighting, which revisited multifamily properties served by the MFDI program to install additional common area lighting.

Program Participation Summary

This section summarizes Residential sector program path participation and progress toward PY 2018 and PY 2019 goals.

Residential Programs

Table 13 shows savings goals assigned to Avista's Residential programs for PY 2018 and PY 2019, in addition to reported savings. All programs except Simple Steps, Smart Savings exceeded savings goals based on reported savings, leading to an overall achievement of 111% of the savings goal for residential programs.

Table 13. Residential Programs Reported Electric Savings

Program	Savings Goals (kWh)	Savings Reported (kWh)	Percentage of Goal
Simple Steps, Smart Savings	20,662,311	17,746,169	86%
HVAC	2,058,350	2,529,589	123%
Shell	561,483	604,213	108%
ENERGY STAR Homes	72,778	295,442	406%
Multifamily Direct Install	2,234,050	5,942,355	266%
Multifamily Direct Install Supplemental Lighting	392,000	1,767,892	451%
Residential Programs Total	**25,980,972**	**28,885,660**	**111%**

Table 14 summarizes participation goals and reported participation in Avista's Residential programs for PY 2018 and PY 2019, along with the percentage of goals achieved.

Table 14. Residential Programs Participation

Program	Participation Goals	Participation Reported	Percentage of Goal
Simple Steps, Smart Savings[a]	1,435,614	1,391,198	97%
HVAC[b]	2,043	2,713	133%
Shell[c]	119,138	85,146	71%
ENERGY STAR Homes[b]	22	73	332%
Multifamily Direct Install[d]	3,437	13,170	383%
Multifamily Direct Install Supplemental Lighting[e]	1,750	4,291	245%
Residential Programs Total	**1,562,004**	**1,496,591**	**96%**

[a] Participation is defined as the number of purchased units.

[b] Participation is defined as the number of rebates.

[c] Participation is defined as square feet of installed windows or storm windows.

[d] Participation is defined as the number of living units and common areas served.

[e] Participation is defined as the number of installed units.

Residential Impact Evaluation Methodology

To determine the Residential sector's biennial evaluated savings for PY 2018 and PY 2019, Cadmus employed a combination of three impact evaluation methods:[2]

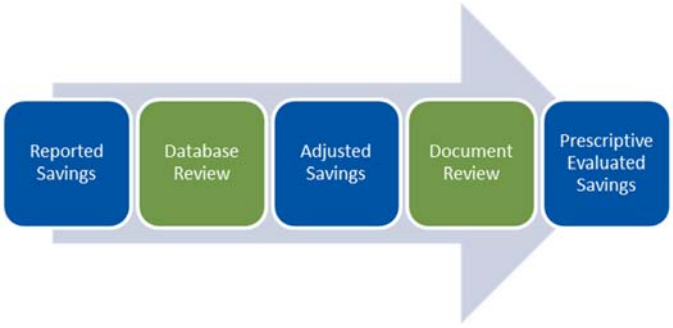
- Database review
- Document review
- Billing analysis

First, Cadmus calculated adjusted savings for each program based on results of a database review. For the HVAC, Shell, and Fuel Efficiency programs, Cadmus also applied realization rates for the document reviews. For these programs, Cadmus calculated prescriptive evaluated savings by multiplying adjusted

[2] With approval from Avista, Cadmus ceased performing a fourth impact activity—verification surveys—in Q3 PY 2018; this eliminated redundancy between verification surveys and document reviews.

savings by the document review realization rate, as shown in Figure 1. With programs for which document review was not conducted, adjusted savings is considered prescriptive evaluated savings.

Figure 1. Residential Impact Process



To provide, where practical, the most rigorous evaluation method, Cadmus analyzed consumption data for all available participants of the HVAC, Shell, Fuel Efficiency, and MFDI programs. As described in more detail in the Billing Analysis section, Cadmus applied billing analysis results to determine evaluated savings only for measures where savings could be isolated (that is, where a sufficient number of participants could be identified who installed only that measure) and where confidence and precision met specific targets. Program-level realization rates for the HVAC, Shell, and Fuel Efficiency programs incorporate billing analysis results for some measures.

Database Review

For the impact evaluation database review, Cadmus used UES values provided in the TRM to calculate savings for measures reported in the measure tracking database. Such impact activity may help identify incorrect UES values used to calculate reported savings. Cadmus defined savings calculated during the database review as *adjusted savings*.

For this biennial evaluation, Cadmus applied 2018 Avista TRM values to PY 2018 measures and 2019 Avista TRM values to PY 2019 measures.

Document Review

To conduct the document review, Cadmus compared information from rebate forms and other supporting documents to measure tracking data for a random sample of projects. This impact activity may identify installed measures that did not meet eligibility requirements, quantities not matching the measure tracking database, and other discrepancies. Following a review of all projects, Cadmus calculated a realization rate for the document review by dividing savings calculated for the sample (using the revised information) by reported savings for the sample. This realization rate was then multiplied by adjusted savings for the entire program to determine *prescriptive evaluated savings* for the biennium.

Cadmus conducted document reviews for the programs shown in Table 15, drawing roughly equal samples from participants in each quarter through the first half of PY 2019. Based on the low variation in document review results, these sample sizes easily met the target of ±10% relative precision at 90% confidence established for this evaluation activity.

Table 15. Residential Programs Electric Impact Document Review

Program	Complete Through Q2 PY 2019
HVAC	51
Shell	51

Billing Analysis

For the Residential sector, Cadmus conducted billing analysis using available electricity and natural gas consumption data from Avista for the HVAC, Shell, Fuel Efficiency, and MFDI programs. Evaluating Simple Steps, Smart Savings program savings through billing analysis was not practical because participants of the midstream retail program were largely unknown. The ENERGY STAR Homes program has too few participants to produce meaningful billing analysis results.

HVAC, Shell, and Fuel Efficiency Savings Estimates

With the HVAC, Shell, and Fuel Efficiency programs, Cadmus eliminated the effects of multiple energy efficiency measures by only including participants in the analysis who installed one measure. With these programs, the goal was to provide average unit savings values at the measure level to ensure the most accurate values possible were used for evaluated savings and cost-effectiveness.

Cadmus used the unit savings value provided by the billing analysis for a given measure when results for that measure met two requirements: the number of sites in the participant group was at least five, and the relative precision achieved was no greater than ±40% at the 90% confidence level. If results calculated using only Washington participants met these requirements, those results were used. If results based only on Washington participants failed to meet the requirements, Cadmus checked the combined results for Washington and Idaho participants to determine if those results passed. In all cases, billing analysis results applied for this biennial evaluation were based only on Washington participants.

Data Sources

To conduct the consumption analysis, Cadmus used program measure tracking data provided by Avista, monthly electric and gas consumption data provided by Avista, and weather data, which included actual average daily temperatures for 10 weather stations from the National Oceanic and Atmospheric Administration (NOAA) for the billing analysis period. The team used zip codes to match daily heating and cooling degree days to respective monthly bill read dates. Additionally, Cadmus used typical meteorological year (TMY3) 15-year normal weather values from 1991–2005, obtained from NOAA for the same weather stations, in assessing energy use under normal weather conditions.

Participant and Comparison Group Designation

Cadmus gathered data for a participant (treatment) group comprising all HVAC, Shell, and Fuel Efficiency program participants with measures installed in 2018. This allowed for enough pre- and post-consumption data to analyze the various measures' effects.

To isolate the impact of exogenous factors (such as energy rate changes, economic condition changes, and non-programmatic effects) on energy use, Cadmus utilized a quasi-experimental[3] design that involved selection of a comparison group, composed of participants with installation dates in late PY 2019. Through this approach, the team compared the treatment group's pre- and post-change energy use (assumed to capture the program treatment) to the comparison group's change in energy use (reflecting what would have happened absent the program). To ensure similarity between treatment and control groups, the team chose to use future participants as the comparison group because they would have similar qualifications and could be assumed to have not participated in energy efficiency programs prior to program treatment.

Data Screening

Starting with all HVAC, Shell, and Fuel Efficiency participants and the comparison group, Cadmus cleaned the data and screened for several criteria to identify final analysis samples. Data cleaning included performing account-level reviews of the pre- and post-period monthly consumption of all individual participants to identify anomalies (such as periods of unoccupied units) that could bias the results. The team conducted the consumption analysis using participants who had not moved since participating and who had at least 10 months of pre- and post-period billing data.

The team applied several screens to remove anomalies, incomplete records, and outlier accounts. The following are examples of accounts excluded from the analyses:

- Accounts missing records, prohibiting the team from merging participant program tracking data with consumption data
- Accounts with low annual use in the pre- or post-period, such as less than 1,240 kWh annually
- Customers with incorrect signs on Princeton Scorekeeping Method (PRISM) parameter estimates
- Accounts with other extreme values, including vacancies in billing data (outliers), non-program-related heating or cooling system changes (such as added or removed heating or cooling loads), baseload equipment changes, or changes in occupancy. This included screening for accounts with large gaps in interval data, such as having zero consumption across multiple months.

Analysis

To estimate measure level impacts, Cadmus employed a pre- and post-installation savings analysis using household-level PRISM models that accounted for differences in pre- and post-installation weather conditions. Cadmus estimated the heating and cooling PRISM model using variable 45- to 85-degree heating and cooling bases in both the pre- and post-period for each customer.

---

[3] A quasi-experimental design is when treatment and control groups are not randomized prior to treatment. In this case, the comparison group was created after the treatment had occurred and participants self-selected the treatment.

Multifamily Direct Install

With the MFDI program, isolating individual measures was not possible, because most living units received a range of LED light bulbs as well as water saving measures such as aerators and showerheads. To provide an accurate estimate of the energy savings for the program a whole, Cadmus performed a complex and rigorous evaluation involving matching tracking data with billing data at the account level.

Cadmus estimated weather-normalized facility level usage. There were two main components of usage that were combined to develop the pre- and post-facility level usage estimates: unit-level usages and common area usages.

Cadmus referenced the same data sources for MFDI consumption analysis as those identified for HVAC, Shell, and Fuel Efficiency analyses (see Data Sources section above) as well as the participant and comparison group approach to isolate the impact of exogenous factors (see Participant and Comparison Group Designation). Additionally, Cadmus cleaned the data to remove anomalies, incomplete records, and outlier accounts (see Data Screening).

Analysis

To estimate program impacts, Cadmus employed a pre- and post-installation savings analysis using household-level PRISM models that account for differences in pre- and post- installation weather conditions.

Cadmus estimated the heating and cooling PRISM model using variable 45- to 85-degree heating and cooling bases in both the pre- and post-period for each MFDI unit and common area account. Because typically some units in a facility could not be matched to billing data or did not pass the screening process, Cadmus found it necessary to extrapolate the available weather normalized pre and post period unit level PRISM usages to the facility level for all units. For each facility the number of units in the facility was known. To obtain the final unit level component – Cadmus calculated the average pre period usage, post period usage, and savings per unit. Cadmus then multiplied those per-unit values by the number of units in the facility to obtain the total unit component facility usages, savings, and *ex ante* estimates. If the facility also had a common area component, Cadmus added usage for that area to the facility level unit usage component to develop the final total facility usage.

Cadmus then applied weighting to calculate the final program savings estimate. A facility with 100 units has more weight than a facility with 10 units. The final savings estimates and *ex-ante* estimates were weighted by the number of units.

The MFDI Washington participant group showed a reliable relative precision estimate of ±14% at the 90% confidence level for the 101 facilities included in the analysis and a percent savings of 7.5%, the comparison group had only 8 facilities and showed a reduction in usage of 0.9% - however with very high relative precision estimate of ±214%. This large confidence band around the comparison group shows that the usage change was not significantly different than zero (i.e., a savings increase was within the error bound), so a comparison group adjustment was not applied.

Residential Impact Evaluation Results

The following sections summarize findings for each impact evaluation methodology and provide biennial evaluated savings.

Database Review

Table 16 shows database review findings with adjusted savings higher than the reported savings for some programs and lower than the reported for others. The difference between adjusted and reported savings for ENERGY STAR Homes resulted largely from a reported unit savings value more than 50% greater than the most applicable TRM value in 2018 for the "E Energy Star Home – Manufactured Furnace" measure. The discrepancy with MFDI Supplemental Lighting resulted mostly from an error in reported savings at one apartment complex in the PY 2018 pilot project and, in PY 2019, primarily the omission of heating interactive effects for measures in common areas indicated as heated. The larger adjusted savings for the HVAC and Shell programs resulted partly from some instances in the tracking data reporting zero energy savings, despite appearing complete in all other ways and indicating that a rebate had been paid.

Table 16. Residential Programs Database Review Electric Impact Findings

Program	Reported Electric Savings (kWh)	Adjusted Electric Savings (kWh)	Percentage Change
Simple Steps, Smart Savings	17,746,169	17,709,142	0%
HVAC	2,529,589	2,632,543	4%
Shell	604,213	642,032	6%
ENERGY STAR Homes	295,442	261,581	(11%)
Multifamily Direct Install	5,942,355	5,899,881	(1%)
Multifamily Direct Install Supplemental Lighting	1,767,892	1,646,542	(7%)
Residential Programs Total	**28,885,660**	**28,791,721**	**0%**

During the PY 2018 evaluation, Avista confirmed that UES values used to calculate reported savings for numerous residential measures had not been updated to match 2018 Avista TRM values. This proved especially pronounced in the Residential HVAC program, where reported savings understated savings for heat pump measures. Under Avista's direction, Cadmus adjusted reported savings for these measures to match the 2018 TRM UES values. Cadmus used those same adjusted reported savings values for 2018 measures for this biennial evaluation. All savings reported for PY 2019 match values provided in the Avista tracking data.

Document Review

Table 17 summarizes document review findings for measures installed from Q1 PY 2018 through Q2 PY 2019. The HVAC program achieved a 97% electric realization rate and the Shell program achieved a realization rate of 87%.

Table 17. Residential Programs Electric Impact Document Review Realization Rates

Program	Document Audit Count	Sample Reported Savings (kWh)	Sample Biennial Evaluated Savings (kWh)	Biennial Document Audit Realization Rate
HVAC	51	50,106	48,800	97%
Shell	51	73,925	64,268	87%

Cadmus' document review (through Q2 PY 2019) identified the following discrepancies:

- For four window measures, documentation showed a square footage for installed windows that differed from the reported window area. In three cases, the documented window area was lower than the reported area and resulted in lower evaluated savings. In one case the documented window area was higher than that reported and resulted in higher evaluated savings based on the corrected area.
- For four window measures reported for sites with electric heating, project documents identified heating fuels other than electricity. Cadmus added natural gas savings and removed electricity savings at two sites identified as using natural gas heating. Documentation for the other two sites identified liquid propane as the heating fuel for one site and wood pellets as the fuel for the other; consequently, Cadmus removed electricity savings for these sites.
- One PY 2018 heat pump water-heater measure had a tank capacity of 80 gallons, per the documentation. However, conditions for the rebate required a tank size below 55 gallons in PY 2018; consequently, Cadmus removed savings for this measure.

Billing Analysis

Table 18 shows measure-level billing analysis results, used when calculating biennial electric energy savings. The participant count and relative precision for each measure easily met requirements established to ensure meaningful results, which required a participant count of at least five and a relative precision no greater than ±40% at the 90% confidence level.

Table 18. Residential Programs Billing Analysis Results

Measure	2019 Avista TRM Unit Energy Savings (kWh)	n[a]	Pre-Installation Weather Normalized Usage (kWh)	Annual Unit Energy Savings (kWh)	Realization Rate	Relative Precision at 90% Confidence
E Variable Speed Motor[b]	414.00	555	11,334	967.99	234%	18%
E Storm Window with Electric Heat	10.30	10,406	135	11.51	112%	33%
E Window Replc from Single Pane W Electric Heat[b]	15.25	10,406	135	11.51	75%	33%

[a]To provide unit savings values that align with TRM units, this table presents participant count in sq. ft. of window surface for storm widow and replacement window measures.

[b]Results shown represent combined analysis of storm window and window-replacement measures, to maximize relative precision. Separate results for each measure appeared similar.

Billing analysis results showed surprisingly high savings for the E Variable Speed Motor measure, with its realization rate of 234% relative to the 2019 Avista TRM UES value of 414 kWh. These participants generally also replaced an existing gas furnace with a high-efficiency model (via the G Natural Gas Furnace measure). The high electric energy savings appears to have resulted at least partly from a shift in some homes away from secondary electric heating, such as portable electric heaters or electric wall heaters, after installing the new gas furnace. Specifically, 154 of 555 participants in Washington increased natural gas usage after installing the high-efficiency furnace with variable speed fan motor, and they sharply reduced electricity consumption. This pattern was not strong enough to suggest that the primary heating system had changed from some other fuel to natural gas, but it did suggest that the high-efficiency furnace prompted participants to move away from secondary heating with electricity. As noted in the *Washington Biennium (2018-2019) Natural Gas Impact Evaluation Report*, this apparent shift from secondary electric heating also resulted in much lower savings than expected for the G Natural Gas Furnace measure, because natural gas consumption increased rather than decreased for these participants.

Billing analysis provided relatively low electric energy savings for replacement windows relative to the 2019 TRM value of 15.25 kWh per square foot of window area, resulting in a realization rate of 75%. The billing analysis UES value of 11.51 kWh per square foot had less of an impact for 2018 savings, where the 2018 Avista TRM used a UES value of 12.60 kWh per square foot. To provide participant counts high enough to support statistically significant estimates, Cadmus combined participants for the storm window and replacement window measures. Replacement windows accounted for the great majority of electric energy savings for the two measures in Washington during PY 2018 and PY 2019, with 40,593 square feet of windows replaced and 176 square feet of installed storm windows.

Billing analysis for the MFDI program showed strong electric energy savings for the program as a whole. As noted previously in *Residential Impact Evaluation Methodology*, isolating the impact of individual measures was not possible for MFDI because most living units received a range of LED light bulbs as well as water saving measures such as aerators and showerheads. To provide an accurate estimate of the energy savings for the program as a whole, Cadmus performed a complex and rigorous evaluation involving 7,098 living units in 101 apartment buildings and complexes. The analysis yielded a realization rate of 101% for electric energy savings in Washington, with a relative precision of ±14% at a 90% confidence level. The billing analysis did not evaluate savings from the MFDI Supplemental Lighting program.

Biennial Evaluated Savings

To calculate biennial evaluated savings, Cadmus used unit savings values determined through billing analysis for the measures shown in Table 18. For the remaining measures, Cadmus applied the results of database review and, where applicable, document review to evaluate savings for each measure. The analysis then rolled up measure-level evaluated savings to calculate evaluated savings and a realization rate for each program. Table 19 shows the resulting biennial evaluated savings and realization rates.

Table 19. Residential Programs Electric Impact Findings

Program	Reported Electric Savings (kWh)	Biennial Evaluated Electric Savings (kWh)[a]	Realization Rates
Simple Steps, Smart Savings	17,746,169	17,709,142	100%
HVAC	2,529,589	3,672,286	145%
Shell	604,213	537,261	89%
ENERGY STAR Homes	295,442	261,581	89%
Multifamily Direct Install	5,942,355	5,899,881	99%
Multifamily Direct Install Supplemental Lighting	1,767,892	1,646,542	93%
Residential Programs Total	**28,885,660**	**29,726,694**	**103%**

Residential Conclusions and Recommendations

Biennial evaluated electricity savings show a 103% realization rate on realized savings of 29,726,694 kWh for Residential programs, representing 114% of the savings goal for the biennium.

Lighting measures accounted for 79% of the total Residential sector savings. The following shows the percentage of residential evaluated savings provided by each program:

- Simple Steps, Smart Savings program provided 60% of residential evaluated savings, mostly through lighting measures
- MFDI and MFDI Supplemental Lighting programs provided 25% of evaluated savings, again mostly through lighting measures
- Residential HVAC program accounted for 12% of evaluated savings
- Shell and ENERGY STAR Homes programs accounted for a combined 3% of residential evaluated savings

Cadmus offers three recommendations regarding Avista's Residential electric programs:

- Based on billing analysis conducted for this evaluation, adjust the Avista TRM to provide higher savings values for variable speed motors installed with the G Natural Gas Furnace measure and lower savings for replacement windows in electrically heated homes. The billing analysis showed savings for the variable speed motor measure well more than double the Avista TRM value on average, seemingly because of a shift away from secondary electric heating (such as portable heaters or wall heaters) in some homes after replacing a gas furnace with a high-efficiency model. For windows in electrically heated homes, the billing analysis estimated unit savings roughly 75% of the 2019 TRM value.
- The MFDI program has proven to be an efficient, effective mechanism for installing high-efficiency lighting and aerators in multifamily units. Continue to focus on replacing high-use, low-efficiency lamps where practical, to maximize program cost-effectiveness while maintaining high savings.
- Ensure that reported savings for all measures are calculated using current TRM or RTF UES values, and that the TRM provides values for all measures. Cadmus noted no large-scale problems with the PY 2019 measure tracking data but did note numerous measure tracking

records that reported zero savings, despite appearing to have been completed and a rebate being issued. In addition, some instances of PY 2019 measures used UES values from the 2018 TRM, and reported values for some measures (most notably, smart thermostats) did not match TRM values.

Low-Income Impact Evaluation

Cadmus designed the Low-Income program impact evaluation to verify reported program participation and energy savings. Evaluation methods included database review and billing analysis.

Program Summary

A group of five Community Action Program agencies and one tribal weatherization organization deliver energy efficiency programs to Avista's low-income residential customers within the Washington service territory. With annual funding of $2,350,000, these Community Action Program agencies qualify low-income customers, generate referrals through energy assistance efforts, and make funding resources available to meet customers' home energy needs.

For PY 2018 and PY 2019, the program achieved 725,435 kWh of reported electric savings in Washington, plus an additional 828,124 from the Community Energy Efficiency Program (CEEP). Cadmus received CEEP reported savings too late to allow for those savings to be included in the current evaluation, other than noting them as reported savings.

Program Participation Summary

Table 20 shows Avista's savings goals for the Low-Income sector as well as reported savings and goal portions achieved throughout the biennium.

Table 20. Low-Income Reported Savings

Program	Savings Goals (kWh)	Reported Savings (kWh)[a]	Percentage of Goal
Low-Income	1,050,822	725,435	69%

[a] Reported savings do not include Low-Income Fuel Efficiency savings, shown in the *Fuel Efficiency Impact Evaluation* section.

Table 21 summarizes participation goals for the Low-Income programs, along with the participation reported and achieved in PY 2018 and PY 2019.

Table 21. Low-Income Participation

Program	Participation Goals[a]	Participation Reported[a]	Percentage of Goal
Low-Income	160,372	215,350	134%

[a] Participation numbers do not include Low-Income Fuel Efficiency participation, shown in the *Fuel Efficiency Impact Evaluation* section. Participation is defined as the number of installed units or square feet of installed insulation or windows.

Low-Income Impact Evaluation Methodology

Cadmus evaluated Low-Income program measures by conducting a database review (described in the *Database Review* section) and billing analysis. The team used UES values provided in the TRM to calculate savings for measures reported in the measure tracking database. Cadmus labeled savings calculated during the database review as *adjusted savings*.

For many measures reported in the tracking database, notes indicated that savings were capped at 20% of consumption. When duplicating savings calculations using TRM values, Cadmus used the newly

calculated value if it was less than the capped value, but used the capped value where the TRM value indicated greater savings.

Cadmus conducted billing analysis for the Low-Income program using all electricity consumption data available from Avista for PY 2018 and PY 2019 program participants. Because of the relatively small number of Low-Income program participants, Cadmus was unable to isolate measure-level savings for the program (which are necessary for cost effectiveness calculations). However, the billing analysis did provide reliable savings estimates for the program as a whole.

Low-Income Impact Evaluation Results

Table 22 shows reported and adjusted electric savings for Low-Income conservation measures but does not include savings for Low-Income Fuel Efficiency measures (shown in the *Low-Income Fuel Efficiency Impact Findings* section).

Table 22. Low-Income Electric Impact Findings

Program	Reported Electric Savings (kWh)	Adjusted Electric Savings (kWh)	Biennial Evaluated Electric Savings (kWh)	Realization Rate
Low-Income	725,435	716,797	716,797	99%

During the database and TRM review, Cadmus noted a number of errors or challenges with the measure tracking data. For example, although the 2019 Avista TRM moved to providing a savings value per square foot of living space for air sealing, many instances of air sealing in the tracking data used the previous TRM value and did not include the area of the home. With ENERGY STAR doors, some instances installed two doors but reported savings for only one. Some instances of several measures reported low or high electric savings values. The errors largely offset one another at the program level, as shown by the program's 99% realization rate.

The billing analysis estimated a realization rate of 101% for Low-Income electric savings, excluding homes that received fuel efficiency measures, but participation was not high enough to allow for isolation from the effects of other installed measures. Such isolation is necessary to provide valid measure-level savings, which are necessary to support cost effectiveness calculations for each measure. Accordingly, Cadmus based biennial evaluated savings on prescriptive methods. The billing analysis results confirm that the 99% realization rate calculated for the Low-Income program accurately estimates program savings. Relative precision for the 101% realization rate was ±26% at the 90% confidence level.

Low-Income Conclusions and Recommendations

With a 99% realization rate for electricity savings, the Low-Income program achieved 716,797 kWh in savings. The evaluated savings of 716,797 kWh equals 68% of the Low-Income program biennial electric savings goal for PY 2018 and PY 2019.

Cadmus noted a number of errors and challenges with the Low-Income program tracking data, including anomalies that appeared to result from simple error. Cadmus recommends continuing and

strengthening efforts to ensure that the Low-Income program measure tracking data accurately represent installed measures.

For many instances of measures in the Low-Income tracking data, notes indicate that savings have been capped at 20% of consumption. The tracking data do not include adequate information to determine when savings values are being appropriately capped. Cadmus recommends that annual consumption be provided for each measure in the tracking data, if practical, so that evaluation can including verifying that savings are being capped at 20% of consumption for applicable measures.

Fuel Efficiency Impact Evaluation

Cadmus designed the Fuel Efficiency sector impact evaluation to verify reported program participation and energy savings. Evaluation methods included a database review, document review, and billing analysis.

Program Summary

Fuel Efficiency measures replace electric space-heating or water-heating systems with equipment that uses natural gas. These measures are offered within the Nonresidential Site Specific path, Residential programs, and the Low-Income program. Across these programs, Avista reported Fuel Efficiency participation of 1,774 in PY 2018 and PY 2019 and electric energy savings of 17,295,419 kWh.

Fuel Efficiency measures provide positive electricity savings and negative natural gas consumption impacts, reflecting increased natural gas consumption and negative avoided costs. The team incorporated these negative avoided costs in the electric cost-effectiveness calculations and report the negative natural gas savings in the *Washington Biennium (2018–2019) Natural Gas Impact Evaluation Report*.

Program Participation Summary

This section summarizes Fuel Efficiency sector participation and progress toward PY 2018 and PY 2019 goals for the Nonresidential Site Specific path (which includes HVAC Combined, refrigerator case doors, industrial process, and Multifamily Market Transformation measures), Residential programs, and Low-Income program.

Table 23 shows Avista's combined PY 2018 and PY 2019 participation goals and reported participation for Residential and Low-Income Fuel Efficiency measures as well as achieved percentages of goals. Avista did not set participation goals for Site Specific Fuel Efficiency measures outside of the Multifamily Market Transformation program.

Table 23. Residential and Low-Income Fuel Efficiency Reported Participation

Program	Participation Goals[a]	Participation Reported[a]	Percentage of Goal
Residential Fuel Efficiency	2,361	1,604	68%
Low-Income Fuel Efficiency	93	142	153%

[a] Participation defined as the number of rebates.

Table 24 shows savings goals, reported savings, and percentage of goal for Nonresidential Site Specific, Multifamily Market Transformation, Residential, and Low-Income Fuel Efficiency measures.

Table 24. Avista Portfolio Fuel Efficiency Reported Electric Savings

Program	Savings Goals (kWh)	Savings Reported (kWh)	Percentage of Goal
Nonresidential Site Specific	N/A	723,127	N/A
Multifamily Market Transformation	3,183,708	2,324,042	73%
Residential Fuel Efficiency	20,713,391	13,709,953	66%
Low-Income Fuel Efficiency	308,226	538,297	175%

Fuel Efficiency Impact Evaluation Methodology

This section presents the impact methodology for Fuel Efficiency measures included in the Nonresidential Site Specific path, Residential programs, and Low-Income program.

Nonresidential Site Specific Fuel Efficiency Impact Methodology

For Fuel Efficiency measures, Cadmus followed the same impact evaluation methodology as that described in the *Impact Evaluation Methodology* section. In evaluating Nonresidential sector Fuel Efficiency, Cadmus sampled seven Multifamily Market Transformation program project measures, shown in Table 25.

Table 25. Nonresidential Fuel Efficiency Evaluation Sample

Fuel Efficiency Measure	Applications Sampled	Sampled Savings (kWh)	Percentage of Reported Savings
Nonresidential Site Specific	0	0	0%
Multifamily Market Transformation	7	1,058,081	46%
Total	**7**	**1,058,081**	**35%**

Cadmus performed site visits at six unique Nonresidential locations to assess electric savings for the seven Multifamily Market Transformation program applications evaluated. Site visits involved verifying installed equipment types, make and model numbers, operating schedules, and set points, as applicable. Cadmus did not evaluate any Nonresidential Site Specific applications in the Fuel Efficiency program but did evaluate various measures in the same measure categories in the electric and gas Site Specific programs.

Residential Fuel Efficiency Impact Methodology

Cadmus applied billing analysis results to evaluate savings for all but two Residential Fuel Efficiency measures, using the methodology described previously in *Billing Analysis*. For the remaining measures—two multifamily measures with low participation--Cadmus applied the results of the database and document reviews. This approach provided the strongest estimate of achieved savings practical for each measure. Cadmus completed document reviews for 50 Fuel Efficiency participants from Q1 PY 2018 through Q2 PY 2019.

Low-Income Fuel Efficiency Impact Methodology

To evaluate impacts for the Low-Income Fuel Efficiency measures, Cadmus conducted a database review (described in the *Database Review* section) and billing analysis. The relatively low number of participants for the Low-Income program made it impractical for the billing analysis to isolate savings for

specific measures. Using unit savings values provided in the TRM, Cadmus calculated savings for measures reported in the measure tracking database. For Low-Income program measures in general (including Low-Income Fuel Efficiency measures), the evaluation relied on results from the database review to determine biennial evaluated savings.

Fuel Efficiency Impact Evaluation Results

The following sections summarize findings for the Nonresidential Site Specific path, Residential programs, and Low-Income program Fuel Efficiency measures.

Nonresidential Fuel Efficiency Impact Findings

Table 26 shows reported and biennial evaluated electric energy savings for Avista's Nonresidential sector Fuel Efficiency measures, along with realization rates.

Table 26. Nonresidential Fuel Efficiency Electric Impact Findings

Fuel Efficiency Measure	Reported Savings (kWh)	Biennial Evaluated Savings (kWh)	Realization Rate
Nonresidential Site Specific	723,127	723,127	100%
Multifamily Market Transformation	2,324,042	2,288,596	98%
Total	**3,047,169**	**3,011,723**	**99%**

Of the seven Multifamily Market Transformation Fuel Efficiency applications evaluated, Cadmus identified discrepancies in two measures installed at the same site based on the evaluation site visit and the project documentation review. The site installed 95% efficient furnaces instead of the 80% efficient furnaces reported in the application, resulting in lower natural gas energy consumption for the installed units in comparison to baseline efficiency units, and offsetting less electricity consumption than reported.

As noted previously, Cadmus did not evaluate any Nonresidential Site Specific applications in the Fuel Efficiency program but did evaluate various measures in the same measure categories in the electric and gas Site Specific programs. Cadmus found 100% electric realization rates for all evaluated Nonresidential Site Specific measures in the relevant measure categories, and therefore applied a 100% realization rate to those measure categories in the Fuel Efficiency program.

Residential Fuel Efficiency Impact Findings

Database review of Residential Fuel Efficiency measures resulted in roughly a 1% reduction in adjusted savings, primarily because reported savings for some instances used a higher UES value than the Avista TRM value.

In reviewing documentation for 50 Residential Fuel Efficiency measures, Cadmus found issues with two conversions to gas furnaces: documentation for each site indicated that the furnace replaced an oil-fired heating system. The team eliminated electricity savings for the natural gas furnaces, given that the replaced system did not use electric heating. These adjustments led to a document review realization rate of 97%, as shown in Table 27.

Table 27. Residential Fuel Efficiency Electric Impact Document Review Realization Rate

Fuel Efficiency Measure	Document Audit Count	Sample Reported Savings (kWh)	Sample Biennial Evaluated Savings (kWh)	Biennial Document Audit Realization Rate
Residential Fuel Efficiency	50	462,507	447,537	97%

Table 28 shows reported, adjusted, and prescriptive evaluated electric energy savings for the Residential Fuel Efficiency measures.

Table 28. Residential Fuel Efficiency Electric Impact Findings

Fuel Efficiency Measure	Reported Electric Savings (kWh)	Adjusted Electric Savings (kWh)	Prescriptive Evaluated Electric Savings (kWh)	Realization Rate
Residential Fuel Efficiency	13,709,953	13,515,032	13,077,590	95%

Table 29 shows measure-level billing analysis results used when calculating biennial electric energy savings. The participant count and relative precision for each measure easily met requirements established to ensure meaningful results, which required a participant count of at least five and relative precision no greater than ±40% at the 90% confidence level. The billing analysis found lower energy savings than indicated in the 2019 Avista TRM for three measures and higher energy savings for two measures. For the two highest-volume measures—E Electric to Natural Gas Furnace & Water Heater and E Electric to Natural Gas Furnace—realization rates were 92% and 99%, respectively.

Table 29. Residential Fuel Efficiency Billing Analysis Results

Measure	2019 Avista TRM Unit Energy Savings (kWh)	n	Pre-Installation Weather Normalized Usage (kWh)	Annual Unit Energy Savings (kWh)	Realization Rate	Relative Precision at 90% Confidence
E Electric To Natural Gas Water Heater[a]	2,409	32	11,018	2,832	75%	18%
E Electric To Natural Gas Furnace & Water Heat	8,513	319	18,684	10,354	92%	5%
E Electric To Natural Gas Furnace	6,104	224	18,469	7,345	99%	8%
E Electric To Natural Gas Wall Heater[b]	10,624	19	15,559	5,981	105%	20%
E Multifamily Electric to Natural Gas Furnace and Water Heat	4,566	21	12,259	8,133	178%	13%

[a] The 2019 Avista TRM does not include the E Electric to Natural Gas Water Heater measure. The TRM value shown is the difference between TRM values for the E Electric to Natural Gas Furnace & Water Heat and E Electric to Natural Gas Furnace measures.

[b] The 2019 Avista TRM does not include the E Electric to Natural Gas Wall Heater measure. The TRM value shown is taken from the 2018 Avista TRM.

Table 30 shows biennial evaluated energy savings for Residential Fuel Efficiency measures as a whole. The program achieved an overall realization rate of 98% on evaluated savings 13,389,264 kWh.

Table 30. Residential Fuel Efficiency Electric Impact Findings

Fuel Efficiency Measure	Reported Electric Savings (kWh)	Prescriptive Evaluated Electric Savings (kWh)	Biennial Evaluated Electric Savings (kWh)	Realization Rate
Residential Fuel Efficiency	13,709,953	13,077,590	13,389,263	98%

Low-Income Fuel Efficiency Impact Findings

Table 31 shows reported and adjusted electric energy savings for Low-Income Fuel Efficiency measures based on the database review.

Table 31. Low-Income Fuel Efficiency Program Electric Impact Findings

Fuel Efficiency Measure	Reported Electric Savings (kWh)	Adjusted Electric Savings (kWh)	Biennial Evaluated Electric Savings (kWh)	Realization Rate
Low-Income Fuel Efficiency	538,297	518,775	518,775	96%

The billing analysis estimated a realization rate of 176% for Low-Income Fuel Efficiency electric savings, with a relative precision of ±12% at the 90% confidence level. Participation was not high enough to allow for isolating savings at the measure level, which are necessary for calculating cost-effectiveness, but the results do indicate much greater electric savings for Low-Income Fuel Efficiency measures as a whole than indicated by 2019 Avista TRM values. This finding also supports the natural gas billing analysis finding that the natural gas penalties for Low-Income Fuel Efficiency measures are much higher than estimated by the 2019 Avista TRM (see *Washington Biennium (2018–2019) Natural Gas Impact Evaluation Report*). Together, the electric and natural gas billing analysis results suggest a much greater heating load than indicated by TRM values, which is evident as the heating load shifts from electricity to natural gas.

Fuel Efficiency Conclusions and Recommendations

Nonresidential Site Specific and Multifamily Market Transformation Fuel Efficiency measures achieved biennial evaluated savings of 3,011,723 kWh, yielding a 99% realization rate. The Multifamily Market Transformation Fuel Efficiency measures achieved 72% of the 3,183,708 kWh electric energy savings goal.

As stated in the *Nonresidential Conclusions and Recommendations* section, Cadmus recommends ensuring that the final reported savings calculations reflect the most up-to-date project details, including post-installation verification photos, equipment submittals, and invoices. During two project verifications, the team found different installed equipment performances than those used in the reported savings calculations.

Residential Fuel Efficiency measures achieved biennial evaluated savings of 13,389,263 kWh, yielding a 98% realization rate and achieving 65% of the savings goal. Cadmus recommends that Avista update TRM values to match measure-level UES values calculated by the billing analysis. Cadmus also recommend that Avista ensure all measures are represented in the TRM.

For Low-Income Fuel Efficiency measures, the biennial evaluated savings of 518,775 easily exceeded Avista's savings goals, achieving 168% of the savings target. Additionally, billing analysis indicated that

program electric savings are likely much higher, based on the billing analysis realization rate of 176% for Low-Income Fuel Efficiency measures. Based on this finding, Cadmus recommends increasing Avista TRM UES values.