Appendix C:

2016-2017 Electric Impact Evaluation

REPORT

Nexant

Reimagine tomorrow.

Impact Evaluation of Washington Electric 2016-2017 Energy Efficiency Programs

Submitted to Avista Utilities

May 30, 2018

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1 Executive Summary

Nexant Inc. and Research into Action (collectively the evaluation team) conducted an impact and process evaluation of Avista's 2016 and 2017 residential and nonresidential energy efficiency programs. This report documents findings from the impact evaluation activities for Avista's Washington electric programs. The primary goal of this evaluation was to provide an accurate summary of the gross energy and demand savings attributable to the following Avista programs offered in 2016 and/or 2017:

- Nonresidential Prescriptive
- Nonresidential Site Specific
- Small Business
- Residential Heating, Ventilation and Air Conditioning (HVAC)
- Residential Water Heat
- Residential ENERGY STAR® Homes
- Residential Fuel Efficiency
- Residential Lighting
- Residential Shell
- Residential Behavioral
- Low Income

1.1 Evaluation Methodology and Activities

The evaluation team performed the impact evaluation through a combination of document audits, customer surveys, engineering analysis and onsite measurement and verification (M&V) of completed program projects. Because it is not cost-effective to complete analysis and onsite inspection on a census of the implemented projects, the evaluation team verified energy savings for a representative sample of projects to draw statistically-measurable results. The gross verified program savings were adjusted by a realization rate (RR), which is the ratio of evaluation verified savings to the program-reported savings within the sample.

The evaluation team conducted 717 document audits, 215 customer surveys, and more than 125 onsite inspections across the residential and nonresidential programs being evaluated (Table 1-1). In addition, the evaluation team conducted billing regression analysis to estimate the impacts of five residential programs and on a case-by-case basis for the nonresidential projects. The samples were designed to meet a 90% confidence and 10% precision level at the portfolio and sector level and were based upon the expected and actual significance (or magnitude) of program participation, the level of certainty of savings, and the variety of measures.

Table 1-1: Summary of Impact Evaluation Activities

Program	Document Audit	Surveys	Onsite M&V	Billing Analysis
Residential				
HVAC Program	113	-	-	√
Water Heat Program	59	-	-	-
ENERGY STAR Homes	68	-	-	-
Fuel Efficiency	76	45	-	√
Residential Lighting Program	-	-	-	-
Shell Program	83	43	-	√
Home Energy Reports	-	-	-	√
Low Income	127	-	-	√
Nonresidential				
Prescriptive Lighting	47	38	38	
Prescriptive Other	37	13	13	
Small Business	39	18	18	as applicable
Site Specific	68	58	58	
Total	**717**	**215**	**127**	

1.2 Summary of Impact Evaluation Results

Avista's Washington electric 2016 and 2017 programs achieved more than 155 GWh of savings over the two year period across all sectors and conservation measures and fuel conversion measures (Table 1-2). Table 1-3 and Table 1-4 summarize Avista's 2016 and 2017 impact evaluation results by sector and program.

Table 1-2: Washington Electric Portfolio Evaluation Results

Sector	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
Nonresidential – Conservation	96,984,260	83%	80,736,243
Nonresidential – Fuel Conversion	1,971,422	92%	1,810,107
Residential – Conservation	40,939,685	98%	40,118,440
Residential – Behavior	18,512,339	103%	19,035,123
Residential – Fuel Conversion	25,215,201	62%	15,730,750
Low Income - Conservation	545,696	71%	385,202
Low Income – Fuel Conversion	740,399	110%	811,211
Total Conservation	**156,981,980**	**89%**	**140,275,008**
Total Fuel Conversion	**27,927,022**	**66%**	**18,352,069**
Total Conservation + Conversion	**184,909,002**	**86%**	**158,627,076**

Table 1-3: Washington Electric Nonresidential Program Evaluation Results

Program	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Verified Gross Savings (kWh)
Energy Smart Grocer	3,066,726	97%	2,966,084
Food Service Equipment	200,090	97%	193,524
Green Motors	100,830	97%	97,521
Motor Controls HVAC	697,760	97%	674,861
Prescriptive Water Heat	4,886	97%	4,726
Prescriptive Lighting	77,964,819	80%	62,720,933
Commercial Insulation	19,335	97%	18,700
Fleet Heat	16,000	97%	15,475
Air Guardian	53,092	97%	51,350
Small Business	2,986,437	103%	3,090,422
Site Specific	13,845,706	92%	12,712,754
Total Nonresidential	**98,955,682**	**83%**	**82,546,350**

Figure 1-1: Washington Electric Nonresidential Sector Program Gross Verified Saving Shares

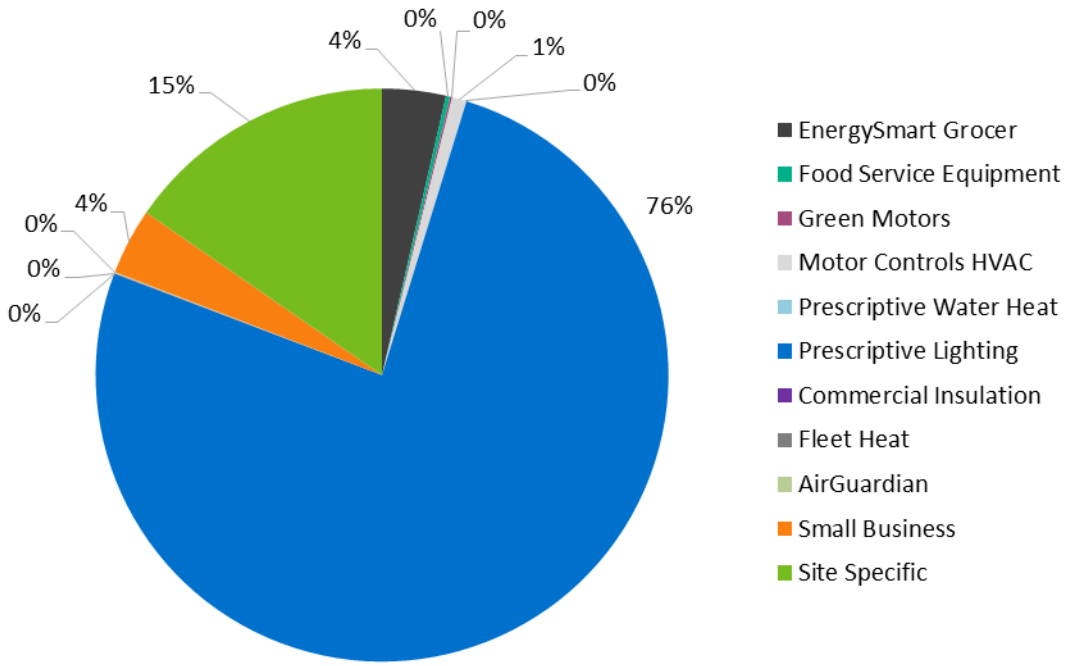
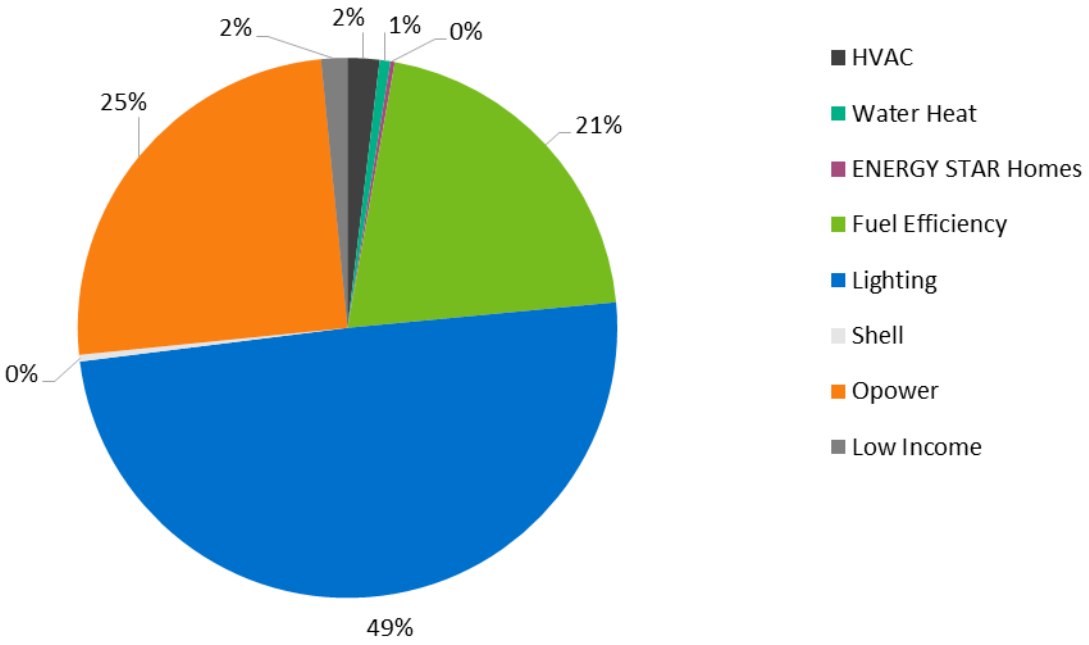


Table 1-4: Washington Electric Residential Program Evaluation Results

Program	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
HVAC	1,546,894	94%	1,450,887
Water Heat	435,442	112%	488,300
ENERGY STAR Homes	153,562	129%	197,826
Fuel Efficiency	25,215,201	62%	15,730,750
Lighting	37,680,674	100%	37,680,842
Shell	1,123,113	27%	300,584
Home Energy Reports	18,512,339	103%	19,035,123
Low Income	1,286,095	94%	1,196,413
Total Residential	**85,953,320**	**89%**	**76,080,726**

Figure 1-2: Washington Electric Residential Sector Program Gross Verified Saving Shares



1.3 Conclusions and Recommendations

The following outlines the key conclusions and recommendations as a result of the evaluation activities. Specific details regarding the conclusions and recommendations outlined here.

1.3.1 Nonresidential Programs

The overall realization rate for the nonresidential portfolio is 83%. The realization rates ranged from 103% for the Small Business program down to 80% for the "Prescriptive Lighting" strata. Prescriptive Lighting was also the largest program in the nonresidential portfolio, with approximately 76% of the total gross verified savings for the portfolio. As early project applications were submitted through the Prescriptive Lighting program, Avista became aware that TLED lamps were labeled under a lower wattage than their Design Lights Consortium (DLC) product specifications. TLED lamps were found in the market with a labeled wattage of 14-15W, while the DLC testing indicated that these lamps consume 17-18W. The evaluation team believes that this discrepancy is because TLED lamp power consumption is subject to different ballast and driver configurations. Avista discovered the inaccuracies in reported savings for many of the 2016 TLED lighting projects and acted quickly to fix the issue. However, the projects impacted by the error composed a large portion of the overall reported savings for the biennium, therefore being a large driver in the portfolio-level realization rate. Looking beyond the TLED measure error, the evaluation team found that the processes Avista is utilizing for estimating and reporting energy savings for the nonresidential programs are predominantly sound and reasonable.

The following outlines key conclusions and recommendations for several of the nonresidential programs. Additional conclusions and recommendations can be found in the program-specific sections of this report and in the Conclusions and Recommendations section (Section 6.3).

Conclusion: The Site Specific program constitutes more than 15% of the program energy shares (gross verified). Within the last 4 years, Avista has increased their level of quality assurance and review on projects that participate through the program. The evaluation team's analysis resulted in a 92% realization rate for the Site Specific program. The majority of the measure categories evaluated had realization rates close to or greater than 100%, with the exception of shell measures (63%) and interior lighting(88%). The overall program-level realization rate indicates that Avista's internal process for project review, savings estimation, and installation verification are working to produce high quality estimates of project impacts.

> **Recommendation**: The evaluation team recommends that Avista continue to operate this program with the current level of rigor.
>
> **Recommendation**: It is recommended that Avista provide a greater level of review of reported hours of use for large lighting projects.

Conclusion: The evaluation team's analysis resulted in an 80% realization rate for the Prescriptive Lighting program, predominately due to the inaccuracies in reported savings for many of the incented TLED measures in the 2016 program year, as noted above. Avista discovered the inaccuracies at the end of 2016 and acted quickly to fix the issue. Two other contributing factors that impacted the realization rate for the Prescriptive Lighting program is the

reporting of operating hours for participating nonresidential facilities and the interactive factors applied by Avista. The evaluation team did find several large projects reporting an incorrect hours of use value. In addition, in several evaluated projects, the evaluation team determined that a lower interactive factor be applied compared to the value utilized by Avista, based on both business type and building heating type.

> **Recommendation**: It is recommended that for large projects and for projects with multiple different space types, that additional verification be conducted on the reported hours of use value. Avista could set a threshold based on the number of fixtures installed, facility/building type, and/or reported savings that triggers an additional level of verification.
>
> **Recommendation**: It is recommended that Avista review the interactive factors applied by their team through its lighting savings estimation tool to ensure more accurate alignment with both business type and building heating type.

Conclusion: The Small Business program implementer has improved their tracking of decommissioned measures in the 2016-2017 biennium, in comparison to the 2014-2015 biennium, as shown by the evaluation team's calculated persistence rate of 98% for the measures included in the sample in the 2016-2017 biennium.

1.3.2 Residential Programs – Including Low Income

The overall realization rate for the residential portfolio is 89%. The realization rates for most programs approached or surpassed 100% with the exception of the Shell and Fuel Efficiency programs having the lowest realization rates (27% and 62% respectively). The evaluation team believes the cause for underachieving realization rates reflects a combination of over-stated reported savings and variation in customer consumption among programs. Several specific conclusions and recommendations for the residential programs are noted below. A complete list of conclusions and recommendations is provided in Section 6.

Conclusion: The evaluation team found a low realization rate for the Fuel Efficiency program (62%). We believe this unchanged realization rate from the previous biennium is primarily the result of two factors:

- Reported savings for the 2016-2017 program cycle were on-average high as the program savings value was initially reduced in mid-Q2 2016 and then further reduced mid-Q1 of 2017 to be in alignment with evaluation results provided from the previous program cycle.
- Annual average household consumption was on average 18% lower for participants in the 2016-2017 program cycle relative to participants in the prior program cycle. If participant consumption had been similar to the previous biennium, the program realization rate would have been approximately 74%.

  Recommendation: For future program cycles, the evaluation team recommends Avista reduce their reported savings for the Fuel Efficiency program. Avista should look to the Low Income conversion deemed savings assumptions and consider better aligning assumptions used to estimate reported savings for Fuel Efficiency and the Low Income programs. Additionally, customer profiling will help gauge anticipated savings by

understanding customers' annual consumption profile and the expected percent savings that can occur through implementation of the Fuel Efficiency program measures.

Conclusion: The evaluation team found no incremental savings were realized during the second year (2017) for the Home Energy Report behavioral program. The finding reflects Avista's decision to not re-fill drop-outs from the program treatment group during the 2016-2017 biennium.

Recommendation: If the Home Energy Reports program is revived within the Avista portfolio in future program cycles, the evaluation team recommends Avista continue to service the treatment group by enrolling new customers to replace drop-outs.

Conclusion: The evaluation team found a 94% realization rate for the HVAC program. Profiling of program participants revealed high annual consumption during the pre-treatment period indicating a strong likelihood that these customers had electric resistance heating prior to their retrofit. This consumption profile supports application of RTF deemed savings for resistance heat conversion

Recommendation: The evaluation team recommends Avista continue to update reported savings based on the most recent iterations of relevant RTF workbooks.

Conclusion: The Low Income program saw the fuel switching homes save significantly more electricity on average than homes that did not have a primary mechanical system converted from electricity to natural gas. The realization rate for the conversion measures was 110%, with homes saving an average of 7,600 kWh annually. The conservation measures achieved a much lower realization rate of 71%. Taken as a whole, the program achieved a 93% realization rate.

Recommendation: The evaluation team recommends re-evaluating the current reported savings assumption to attempt to better align the savings given the program's measure mix and customer profile for conservation measures. We also recommend comparing and attempting to align the fuel conversion savings assumptions between the Low Income and Fuel Efficiency programs to achieve more consistent evaluated impacts.

Conclusion: For showerheads distributed through the Simple Steps program, Avista allocates 50% of its reported savings to electric savings and 50% to natural gas savings to account for homes that have different water heating fuel types.

Recommendation: The evaluation team recommends Avista update this allocation assumption to be based on representative water heater fuel type saturation. These data are available through the Regional Building Stock Assessment study; however, we recommend Avista base the allocation on data specific to its territory.

Conclusion: The evaluation team found Avista's reported savings estimates for the Simple Steps lighting measures aligned with the Simple Steps deemed savings which in turn reflect values that align with the specific product types by lumen bins in accordance with the most current BPA UES measure list.

2 Introduction

2.1 Purpose of Evaluation

The purpose of the impact evaluation was to verify the savings attributed to Avista's 2016–2017 rebate programs and to identify areas for future program opportunities. The evaluation team estimated gross program energy impacts through a combination of documentation audits, and telephone surveys, as well as engineering analysis and site inspections of completed program projects.

2.2 Program Summary

The following section provides a description of each program that was evaluated in Washington. Although the program descriptions outline electric and gas measures, as applicable, the remainder of this report provides the methodology and findings for the electric-only measures and programs.

2.2.1 Nonresidential

The nonresidential energy efficiency market is delivered through a combination of prescriptive and site-specific offerings. Any measure not offered through a prescriptive program is automatically eligible for treatment through the site-specific program, subject to the criteria for participation in that program. Prescriptive paths for the nonresidential market are preferred for measures that are relatively small and uniform in their energy efficiency characteristics. The following subsections provide a summary of Avista's Site Specific and Prescriptive programs, including a description of program offerings, measures, and incentive amounts.

2.2.1.1 Site Specific

Avista's Site Specific program offers nonresidential customers the opportunity to propose any energy efficiency project outside the realm of Avista's other programs. Any project with documentable energy savings (kilowatt-hours and/or therms) and a minimum ten year measure life can be submitted for a technical review and potential incentive through the Site Specific program. The majority of projects that participate in this program are appliance upgrades, compressed air, HVAC, industrial process, motors, shell improvements, custom lighting, and fuel conversion. Multi-family residential developments may also be treated through the Site Specific program when the majority of the units and common areas are receiving the efficiency improvement. The determination of incentive eligibility is based upon the project's individual characteristics as they apply to the Company's electric Schedule 90 or natural gas Schedule 190 tariffs.

Customers or their representative are required to contact Avista for a Site Specific analysis prior to any equipment being purchased or installed. Based on the post-verification process, incentives may not be offered after the installation of energy efficiency equipment or process under this program design. Electric incentives are offered up to 20 cents per kWh for projects with a simple payback less than 15 years. Incentives are capped at 70% of incremental project costs. Natural gas incentives are offered up to $3.00 per therm for projects with a simple payback of less than 15 years. Incentives are capped at 70% of incremental project costs.

Simple payback is calculated as the incremental cost of a measure divided by the annual energy savings of the measure, calculated using the customer's Avista electric and/or gas rate. Incremental costs are only those projects costs necessary for the energy efficiency improvement. Fuel-conversion incentives are available only for conversion to natural gas with an end-use efficiency of 44% or greater.

Avista internally implements the Site Specific program following a multi-stage internal process outlined in Figure 2-1. To be considered for incentives, Avista must receive notification of a potential project during the planning stage. Avista engineers generate energy analyses and savings estimates for each project.

These energy savings estimates are subjected to a rigorous internal review process, with the level of review dependent on the potential incentive level for the project. Avista's current internal review guidelines are as follows:

- Measures that have an incentive of $0 and an energy based simple payback of over 20 years require no report and no review, just a form letter to the customer.
- Measures that have incentives between $1 and $2,000 will be processed by the reporting engineer without any other review.
- Measures that have incentives between $2001 and $25,000 will be reviewed before going to the customer by another qualified engineer.
- Measures over $25,000 will be reviewed by another qualified engineer with an additional technical management review prior to releasing to the customer.
- Measures over $40,000 will be reviewed by another qualified engineer, a technical manager, and an additional director review prior to releasing to the customer.

Avista employs the use of a "Technical Review Top Sheet" at each stage of the review process. The Top Sheet is a checklist intended to ensure that all program processes and policies have been followed and that project documentation is complete.

An "Energy Efficiency Evaluation Report" is generated for each project that includes a summary of the project's scope of work, estimated energy savings and incentives. Following project installation, Avista program staff members perform installation verification on nearly 100% of projects with limited exceptions. Program staff follows a "Payment Top Sheet" prior to incentive payment, which is another checklist to ensure that the project has been appropriately documented, tracked, and finalized.

Figure 2-1: Site Specific Program Process[1]

2.2.1.2 Prescriptive Lighting

The Prescriptive Lighting program is designed to make lighting improvement projects more accessible for Avista's nonresidential customers. This program is implemented internally by Avista, and existing commercial or industrial facilities with electric service provided by Avista with rate schedules 11 or above are eligible to participate. The program provides a pre-determined incentive amount for many common lighting retrofits, as shown in Table 2-1. Installed LED lighting must comply with nationally recognized specifications set forth by ENERGY STAR and Design Lights Consortium (DLC) and the Seattle Lighting Design Lab. Avista's regionally-based Account Executives (AEs) are a key part of delivering the Prescriptive Lighting program along with area vendors and contractors.

[1] Washington and Idaho Demand Side Management Standard Operation Procedures. Avista Utilities. 2017.

Table 2-1: Prescriptive Lighting Program Measures

Lighting	2016 Incentive	2017 Incentive
Exterior 70-89 watt HID to 15-25 watt DLC approved LED Fixture or Retrofit Kit	$55	$60
Exterior 90-100 watt HID to 20-30 watt DLC approved LED Fixture or Retrofit Kit	$75	$80
Exterior 150 watt HID to 25-50 watt DLC approved LED Fixture or Retrofit Kit	$130	$125
Exterior 175 watt HID to 30-79 watt DLC approved LED Fixture or Retrofit Kit	$135	$130
Exterior 250 watt HID to 80-140 watt DLC approved LED Fixture or Retrofit Kit	$145	$140
Exterior 320 watt HID to 100-160 watt DLC approved LED Fixture or Retrofit Kit	$180	$180
Exterior 400 watt HID to 100-175 watt DLC approved LED Fixture or Retrofit Kit	$255	$255
Exterior 1000 watt HID to 300-400 watt DLC approved LED Fixture or Retrofit Kit	$615	$610
Exterior –New Construction-175 watt HID to 30-79 watt DLC approved LED Fixture	$125	$130
Exterior –New Construction-250 watt HID to 80-100 watt DLC approved LED Fixture	$145	$140
Exterior-New Construction- 320- 400 watt HID to 100-175 watt DLC LED Fixture	$180	$175
Exterior-Sign Retrofit-T12's to LED	$17/Ft²	$17/Ft²
Interior 250 watt HID to 80-140 watt DLC approved LED Fixture	$165	$120
Interior 400 watt HID to 100-175 watt DLC approved LED Fixture	$265	$185
Interior 1000 watt HID to 300-400 watt DLC approved LED Fixture	$615	$460
Interior 250 HID to 4-Lamp HP T8 or 2-Lamp T5 Fixture	$175	$0
Interior 250 HID to 4-Lamp HP T8 or 2-Lamp T5 Fixture plus OC Sensors	$205	$0
Interior 400 HID to 4-Lamp T5 Fixture	$155	$0
Interior 400 HID to 6-Lamp T8 Fixture	$175	$0
Interior 400 HID to 8-Lamp T8 Fixture	$145	$0
Interior 40-100 watt Incandescent to 6-20 watt Energy Star Rated LED Lamp	$10 - $25	$8
Interior Over 150 watt Incandescent to 50-60 watt DLC approved LED Fixture	$85	$55
Interior 20-50 watt MR16 to 2-9 watt Energy Star Rated LED MR16 Lamp	$13 - $15	$10
Interior 75-100 watt Incandescent Can Light to 12-20 watt Energy Star LED Can Light Fixture	$45	$20
Interior 32 watt CFL Can Light to 12-20 watt Energy Star LED Can Light Kit	$15	$0
Interior No Occupancy Sensor to Occupancy Sensor that controls greater than 170 watts	$45	$40
Interior 4-Foot 4-Lamp T12/T8 Fixture to 50-75 watt DLC Qualified 2x4 Fixture	$40	$35
Interior 4-Foot 4-Lamp T12/T8 Fixture to 4-Lamp HP T8 Fixture or Retrofit Kit	$15	$0
Interior 4-Foot 4-Lamp T12/T8 Fixture to 3-Lamp HP T8 Fixture or Retrofit Kit	$30	$0
Interior 4-Foot 4-Lamp T12/T8 Fixture to 2-Lamp HP T8 Fixture or Retrofit Kit	$50	$35
Interior 4-Foot 3-Lamp T12/T8 Fixture to 40-60 watt DLC Qualified LED 2x4 Fixture	$30	$29
Interior 4-Foot 3-Lamp T12/T8 Fixture to 2-Lamp HP T8 Fixture or Retrofit Kit	$30	$25
Interior 4-Foot 2-Lamp T12/T8 Fixture to 1-Lamp HP T8 Fixture or Retrofit Kit	$20	$0
Interior 4-Foot 2-Lamp T12/T8 Fixture to 1-lamp HP T8 fixture/retrofit kit	$20	$18
Interior 4-Foot T12/T8 Lamps to TLED's- DLC Qualified 8-23 watt TLED Lamps only	$10 - $15	$6.50
Interior 8-Foot 2-Lamp T12/T8 Fixture to DLC Qualified 50-75 watt LED 2x4 Fixture	$50	$35
Interior 8-Foot 1-Lamp T12/T8 Fixture to DLC Qualified 30W or less LED 1x4 Fixture	$20	$0

2.2.1.3 EnergySmart Grocer

The EnergySmart Grocer program offers a range of proven energy-saving solutions for grocery stores and other customers with commercial refrigeration. The program was designed to offer personalized facility assessments to identify efficiency opportunities and incentives to offset the upfront costs of efficiency projects, making it easy and affordable for participating businesses to achieve significant savings on their utility bills. Incentives varied between 2016 and 2017 program years and were offered for the following measure categories:

- Refrigerated Cases
- Case Lighting
- Anti-Sweat Heater Controls
- Evaporated Fan – Walk-in ECM Controller
- Strip Curtains
- Gaskets for Walk-in Coolers, Walk-in Freezers, and Reach-in Glass Doors
- Evaporator Motors
- Floating Head Pressure

Energy Smart Grocer is administered by CLEAResult with Avista oversight. The program is available to electric (Schedule 11, 12, 21, 25) or natural gas (Schedule 101, 111, 121) customers.

2.2.1.4 Food Service Equipment

The Food Service Equipment Program provides incentives for the purchase and installation of energy efficient commercial food service equipment to Avista's electric (Schedule 11, 12, 21, 25) and natural gas (Schedule 101, 111, 121) customers. Equipment must be commercial grade and must meet Energy Star or Fishnick specifications. Certified equipment is 10-70% more efficient than standard equipment, depending on product type. Types of rebated equipment include fryers, steam cookers, hot food holding cabinets, commercial convection ovens, dish washers, commercial ice machines, pre-rinse sprayers, and commercial rack ovens. Table 2-2 summarizes the incentives available under the Food Service Equipment program. Avista implements this program in a prescriptive manner, and incentives are issued to the participating customer after the measure is installed.

Table 2-2: Food Service Equipment Program Measures

Equipment	Incentive
Commercial Convection Ovens	
Commercial Convection Oven, Natural Gas	$700/ Each
Commercial Convection Oven, Electric	$225/ Each
Commercial Combination Oven, Natural Gas	$1,000/ Each
Commercial Combination Oven, Electric	$1,000/ Each
Dish Washers	
Commercial Low Temp Electric Hot Water	$600/ Each
Commercial High Temp Electric Hot Water	$650/ Each

Equipment	Incentive
Commercial Low Temp Natural Gas Hot Water	$300/ Each
Commercial High Temp Natural Gas Hot Water	$350/ Each
Commercial Ice Machines	
Under 200 LBS/Day Capacity	$40/Each
200-399 LBS/Day Capacity	$60/Each
400-599 LBS/Day Capacity	$80/Each
600-799 LBS/Day Capacity	$100/Each
800-999 LBS/Day Capacity	$120/Each
1000-1199 LBS/Day Capacity	$140/Each
1200-1399 LBS/Day Capacity	$160/Each
1400-1599 LBS/Day Capacity	$180/Each
1600-> LBS/Day Capacity	$200/Each
Pre Rinse Sprayers	
1 to 1.00 GPM Electric	$25
.61 to .80 GPM Electric	$25
.81 to 1.00 GPM Natural Gas	$25
.61 to .80 GPM Natural Gas	$25
Commercial Rack Ovens	
Commercial Rack Ovens, Natural Gas	$235
Hot Food Holding Carts	
Hot Food Holding Carts, >15 cubic feet	$165/each
Fryers	
Commercial Fryer, Natural Gas	$1,000/each
Commercial Fryer, Electric	$300/each
Steam Cookers	
Commercial Steam Cooker Natural Gas	$1,300/ 3 pan
Commercial Steam Cooker Natural Gas	$1,700/ 4 pan
Commercial Steam Cooker Natural Gas	$2,200/ 5 pan
Commercial Steam Cooker Natural Gas	$2,600/ 6 pan
Commercial Steam Cooker Natural Gas	$3,200/ 10 pan or >
Commercial Steam Cooker, Electric	$70/ 3 pan
Commercial Steam Cooker, Electric	$100/ 4 pan
Commercial Steam Cooker, Electric	$135/ 5 pan
Commercial Steam Cooker, Electric	$160/ 6 pan
Commercial Steam Cooker, Electric	$180/ 10 pan or >
Commercial Griddles	

Equipment	Incentive
Commercial Griddle, Electric	$505/each
Commercial Griddle, Natural Gas	$88/each

2.2.1.5 Green Motors

The Green Motors program is implemented by the Green Motors Practice Group with Avista oversight. This program is available to electric (Schedule 11, 12, 21, 25, 31) customers who receive a green motor rewind at a participating service center. To participate, customers must take an existing motor to a participating service center to have a green rewind done. Customers receive an automatic rebate applied at the service center of $1 per hp based on the size of the motor. Motors ranging from 15 to 5,000 hp are eligible to participate. Motor service centers must meet specific criteria to be qualified for the program.

Table 2-3: Green Motor Rewinds Program Measures

Measure	Eligible Motor Size	Rebate
Green Motor Rewind	15 – 5,000 hp	$1 / hp

2.2.1.6 Motor Controls HVAC

This program encourages customers to increase HVAC pump and fan system efficiency through the installation of variable frequency drives (VFDs). Incentives are issued after measure installation. To be eligible for an incentive, a VFD must be installed on commercial heating, ventilation, and air conditioning equipment that is served by an Avista electric non-residential rate schedule (Schedule 11, 12, 21, 25). New construction projects are not eligible to participate. Additionally, only VFDs installed on primary pumps and fans are qualified. Secondary or spare pumps and fans do not qualify. Incentives are paid per VFD retrofit, as shown in Table 2-4. Avista implements this program in a prescriptive manner, and incentives are issued to the participating customer after the measure is installed.

Table 2-4: Motor Controls HVAC Program Measures

Measure	Incentive each
HVAC variable frequency drive retrofit	$130

2.2.1.7 Commercial Insulation

The Commercial Insulation program offers incentives to Avista's nonresidential electric (Schedule 11, 12, 21, 25) or natural gas (Schedule 101, 111, 121) customers for improvements to building envelopes through adding insulation. To participate in this prescriptive rebate program, customers must submit documentation of the project that includes post-installation R-values and affected square footage for insulation installation. The incentive levels for insulation project are dependent on the pre-and post-retrofit level of insulation. Avista implements this program in a prescriptive manner, and incentives are issued to the participating customer after the measure is installed.

Table 2-5: Commercial Insulation Measures

Measure	Incentive ($ / sf)
Less than R4 Wall Insulation to R-11-R18 Retrofit	$0.40
Less than R4 Wall Insulation to R19 or above Retrofit	$0.45
Less than R11 Attic Insulation to R30-R44 Retrofit	$0.20
Less than R11 Attic Insulation to R45 or above Retrofit	$0.25
Less than R11 Roof Insulation to R30 or above Retrofit	$0.25

2.2.1.8 Air Guardian

The AirGuardian program is a third party delivered turnkey program (delivered by 4Sight Energy Group LLC) for direct install compressed air and facility efficiency. The program targets compressed air users in Avista's Washington and Idaho service territory. The direct install is a compressed air leak reduction device which generates energy savings by reducing the impact of compressed air leaks during off hour periods. While on site, a leak detection audit is also conducted. Any commercial (Schedule 11, 21, 25) Avista electric customer installing qualified equipment is eligible for this program. The target market for the direct installation of AirGuardian devices are small and medium sized businesses using rotary screw compressors of at least 15 horsepower.

2.2.1.9 Fleet Heat Program

This program offers incentives to Avista's nonresidential electric customers (Schedule 11, 12, 21, 25) for the installation of technology that reduces standby losses of vehicle engine blocks by fleet operators by adding the ability to energize block heaters only when Outside Air Temperature drops below a temperature set-point and the engine mounted thermostat is calling for heat. Traditional block heating technology employs a thermosiphon to drive circulation in an engine block. A more efficient option uses pump driven circulation and results in less wasted heat flow between the engine block and the ambient environment.

2.2.1.10 Small Business

The Small Business program is administered by SBW consulting and is a direct installation/audit program providing customer energy-efficiency opportunities by: (1) directly installing appropriate energy-saving measures at each target site, (2) conducting a brief onsite audit to identify customer opportunities and interest in existing Avista programs, and (3) providing materials and contact information so that customers are able to follow up with additional energy efficiency measures under existing programs. This program is only available to customers who receive electric service under Rate Schedule 11 and gas service under Rate Schedule 101 in Washington and Idaho. Schedule 11 customers typically use less than 250,000 kWh per year.

Direct-install measures include faucet aerators, showerheads, pre-rinse spray valves, screw-in LEDs, smart strips, CoolerMisers, and VendingMisers (Table 2-6).

Table 2-6: Small Business Program Measure Overview

Category	Measure Description
Lighting	Screw in LED Lamp (40W Equivalent)
	Screw in LED Lamp (60W Equivalent)
	Screw in LED Lamp (100W Equivalent)
	Screw in LED BR30
	Screw in LED BR40
	Screw in LED PAR30
	Screw in LEDPAR38
Hot Water	Low-flow faucet aerator (0.5 gpm) Electric Water Heat
	Low-flow faucet aerator (1.0 gpm) Electric Water Heat
	Low-flow faucet aerator (0.5 gpm) Gas Water Heat
	Low-flow faucet aerator (1.0 gpm) Gas Water Heat
	Pre-Rinse Spray Valve Electric Heat
	Pre-Rinse Spray Valve Gas Heat
	Shower Head Fitness Electric
	Shower Head Fitness Gas
	Shower Head Electric
	Shower Head Gas
Cooler Miser	Control for glass-front cooler that uses passive infrared (PIR) sensor to power down machine when surrounding area is vacant
Vending Miser	Control for refrigerated beverage machine that uses passive infrared (PIR) sensor to power down machine when surrounding area is vacant
Tier 1 Smart Power Strip	Eliminate standby power draw of peripheral devices while continuing to power devices in “hot” outlets

2.2.2 Residential

Avista’s residential portfolio is comprised of several approaches to engage and encourage customers to consider energy-efficiency improvements in their homes. Prescriptive rebate programs are the main component of the portfolio together with a variety of other interventions. These include upstream buy-down of low-cost lighting and water-saving measures; select distribution of low-cost lighting and weatherization materials; and a multi-faceted, multichannel outreach and customer engagement effort.

Throughout 2016 and 2017, Avista provided incentives and services for its residential electric and gas customers in its Washington and Idaho service territory. The evaluation team examined eight core programs in Washington that constituted the bulk of Avista’s residential energy-efficiency offerings in 2016 and 2017. Table 2-7 provides a summary of those programs, and the sections below detail each program.

Table 2-7: Residential Program Type and Description

Type	Programs	Implementer	Description
Rebates	ENERGY STAR® Homes	Avista	Rebate for purchase of ENERGY STAR® home
	Fuel Efficiency	Avista	Rebate for conversion of electric to natural gas furnace and/or water heater
	HVAC Program	Avista	Rebate for purchase of energy efficient and high efficiency HVAC equipment, including variable speed motors, air source heat pump, natural gas furnace and boiler, and smart thermostat
	Shell	Avista	Rebate for adding insulation to attic, walls, and floor, as well as adding energy efficient windows.
	Water Heater	Avista	Rebate for installation of high efficiency gas or electric water heater, natural gas water heater, and Smart Savings showerhead.
Midstream	Residential Lighting: Simple Steps, Smart Savings	CLEAResult	Direct manufacture discount for purchase of approved CFLs, LEDs (bulbs and fixtures), low-flow showerheads, and clothes washers.
Behavior	Home Energy Reports	Oracle	The Oracle program generates behavioral savings from a treatment group, which receives Home Energy Reports, which compares the customer's energy usage to similar homes in Avista's service territory.
Low-income	Low-income Programs	Community Action Partners (CAPs)	CAPs within Avista's Washington and Idaho service territories implement the projects. CAPs determine energy-efficiency measure installations based on the results of a home energy audit.

2.2.2.1 HVAC Program

Avista internally manages the HVAC program which encourages the implementation of high efficiency HVAC equipment and smart thermostats through direct incentives issued to the customer after the measure has been installed (Table 2-8). This program is available to all residential electric (Schedule 1) or natural gas (Schedule 101) customers who heat their homes with Avista electricity or natural gas. To qualify for the air source heat pump conversion or the smart thermostat, the home must demonstrate a winter heating season electricity usage of 84,000 or more kilowatt hours of electric space heat. Natural gas customers must demonstrate a winter heating season gas usage of 340 therms to be eligible for participation. Existing or new construction homes are eligible.

Table 2-8 HVAC Measure Overview

HVAC Measures	2016 Rebate	2017 Rebate
Variable speed motor	$100	$80
Electric to air source heat pump	$900	$700
Electric to ductless heat pump	-	$450
High efficiency natural gas furnace	$300	$300
High efficiency natural gas boiler	$300	$300
Smart thermostat – self install	$35	$75
Smart thermostat – contractor install	$70	$100

2.2.2.2 Water Heat

Customers replacing their existing electric or natural gas water heater are eligible to receive a rebate for selecting a high efficiency option. This program also includes discounted showerheads available at participating retailers throughout Avista's WA and ID service territory under the Simple Steps, Smart Savings program. Table 2-9 outlines the measures offered and rebate per unit.

Table 2-9 Water Heat Program Measure Overview

Water Heat Measure	2016 Rebate	2017 Rebate
Heat Pump Water Heater	-	$200
Electric; 35-55 gallon with 0.94 EF or higher	$20	-
Natural Gas: Tankless with 0.82 EF or higher	$180	$200
Simple Steps, Smart Savings Low-flow Showerheads: 1.5-2 GPM	buydown	buydown
Simple Steps, Smart Savings Clothes Washers	buydown	buydown

2.2.2.3 ENERGY STAR® Homes

ENERGY STAR® certified home construction is administered by a Northwest Energy Efficiency Alliance (NEEA) regional program. Avista provides a rebate for homes within their service territory that successfully complete the ENERGY STAR® certification process. In addition to NEEA's program, the manufactured homes industry has established a labeling program for ENERGY STAR certified manufactured homes, which Avista also incentivizes. New home buyers can apply for an $800 rebate for an ENERGY STAR ECO-rated new manufactured home or $1,000 for an ENERGY STAR stick-built home. The purchaser must submit the application and certification paperwork to Avista within 90 days of occupying the residence. The ENERGY STAR home rebate may not be combined with other Avista individual measure rebates (e.g. high efficiency water heaters).

Table 2-10 ENERGY STAR® Homes Measure Overview

Energy Star Home Measure	Rebate
Stick built – electric	$1,000
Stick built or manufactured w/ gas only	$650
Manufactured w/ furnace	$800
Manufactured w/ heat pump	$800

2.2.2.4 Fuel Efficiency Program

The fuel efficiency program offers a rebate for the conversion of electric straight resistance heat to natural gas, as well as the conversion of electric hot water heaters to natural gas models. The home must have used 4,000 or more kWh of electric space heat during the previous winter season to be eligible for flat-rate rebates. If natural gas is not available or is not suitable for the home, the installation of an air source heat pump as a replacement unit is accepted (see electric to air source heat pump measure under Section 2.2.2.1).

Table 2-11 Fuel Efficiency Measure Overview

Fuel Efficiency Measures	2016 Rebate	2017 Rebate
Electric to natural gas conversion – space heat	$2,300	$1,500
Electric to natural gas conversion – water heat	$600	$750
Electric to natural furnace and water heat – combo	$3,200	$2,250
Electric to natural gas wall heaters – space heat	$1,300	$1,300

2.2.2.5 Residential Lighting

The Simple Steps, Smart Savings program provides discounts to manufacturers to lower the price of efficient light bulbs, light fixtures, showerheads, and appliances. This program, launched by Bonneville Power Administration (BPA) and administered by CLEAResult, operates across the Pacific Northwest. Utilities are able to select which reduced price items to include in their territory. Avista's offerings include a selection of general and special CFLs, LED light fixtures, and LED bulbs. Retailers such a big box stores and regional and national chains are the primary recipient of the product and typically select from Avista's approved options what they will carry at their store location. These products are clearly identified with a sticker indicating they are part of the Simple Steps, Smart Savings program.

2.2.2.6 Shell Program

Avista's internally managed shell program incentivizes measures that improve the integrity of the home's envelope (Table 2-12). For insulation and windows: rebates are issued to the customer after measure has been installed. Eligibility guidelines for participation include but may not be limited to: confirmation of electric or natural gas heating usage, itemized invoices including insulation levels or window values and square footage. Pre and/or post-inspection of insulation and windows may occur as necessary throughout the year. Customers must demonstrate a winter heating season electricity usage of 8,000 kilowatt hours or 340 therms to be eligible for insulation and window program participation. Addition of insulation that increases

the R-value by R-10 or greater for both fitted/batt type and blow-in products are eligible. Windows with a U-factor of 0.30 or less that replace single or double pane windows are eligible.

Table 2-12 Shell Measure Overview

Shell Measures	Existing Equipment Efficiency	2016 Rebate ($/sf)	2017 Rebate ($/sf)
Attic insulation	R-19 or less	$0.15	-
Wall insulation	R-5 or less	$0.25	-
Floor insulation	R-5 or less	$0.20	-
Window insulation	0.30 u-factor or lower	$3.54	$1.50
Storm Windows		-	$1.00

2.2.2.7 Home Energy Reports

Avista provides peer comparison reports of home energy consumption, termed Home Energy Reports (HER), through Oracle. This is an opt-out program aimed to encourage customers to save energy. 73,500 customers were initially mailed HERs in June of 2013: 48,300 to WA customers and 25,200 to ID customers. The cadence of reports began by sending out a report every month for the first three months followed by a bi-monthly mailing of reports thereafter. At the start of the 2016-2017 biennium, attrition due to opt outs and account closures reduced the original population of 48,300 treatment customers to about 34,000 customers. At the beginning of the 2016-2017 biennium, Avista 'refilled' the program back to a count of close to 49,000 treatment customers in Washington, who received their first report in April, 2016. Customers must be a recipient of Avista electricity to qualify.

2.2.2.8 Low Income

Avista leverages Community Action Program (CAP) agencies to deliver energy efficiency programs to low-income customers. CAP agencies have resources to income qualify, prioritize and treat homes based upon a number of characteristics. In addition to the Company's annual funding, the Agencies have other monetary resources that they can usually leverage when treating a home with weatherization and other energy efficiency measures. The Agencies either have in-house or contractor crews to install many of the efficiency measures of the program.

Six CAP agencies serve Avista's Washington service territory and receive a total annual funding about of $2 million (Table 2-13). Typically some of the annual funding in Washington goes unspent. In 2016 the Spokane Indian Housing Authority was able to identify and serve Avista customers on the reservation while assisting to spend the formerly unspent remainder of the Washington allocation. (Community Action Partnership – Lewiston serves Avista Idaho customers.) Included in this amount is a permissible 15% reimbursement for administrative costs. Each agency may allocate an additional 15% of funds for expenditure on non-energy health and safety measures that may support the energy efficiency measures installed or help improve the home's habitability.

Table 2-13 Low Income CAP Agencies

CAP Agency	Serving Counties
Spokane Neighborhood Action Program	Spokane
Rural Resources	Stevens, Pend Oreille, Ferry and Lincoln
Whitman County Community Action Center	Whitman
Opportunities Industrialization Council	Grant, Adams
Community Action Partnership	Asotin
Washington Gorge Action Programs	Skamania, Klickitat
Spokane Indian Housing Authority (SIHA)*	Stevens (Spokane Tribe Reservation)
Community Action Partnership – Lewiston**	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, Nez, Perce, Shoshone

*SIHA funding is part of and not in addition to Washington's $2M allocations
**Lewiston serves Avista Idaho customers

Avista provides CAP agencies with an "approved measure list", the items on this list are reimbursed 100% (Table 2-14). Avista also provides a "rebate list" of additional energy saving measures the CAP agencies are able to utilize (Table 2-15).

Table 2-14 Low Income Approved Measure List (100% of costs offset by Avista)

Measures	End Use
Electric to Gas Furnace Conversion	Fuel Conversion
Electric to Gas Water Heater Conversion	Fuel Conversion
Electric to Ductless Heat pump	Fuel Conversion
High Efficiency Furnace (90% AFUE) and High Efficiency Water Heater (0.82 EF)	Natural Gas
Insulation (ceiling / attic, floors and walls)	Electric and Natural Gas
Insulation (duct) / Duct sealing	Electric and Natural Gas
Air Infiltration	Electric and Natural Gas
Energy Star® Doors	Natural Gas
Energy Star® Windows (gas heat)	Natural Gas
LED Lighting	Electric

Table 2-15 Low Income Rebate List (WA, all rebate list measures are electric end-use)

Measures
Electric to air source heat pump (when natural gas not viable)
Electric to heat pump water heater
Energy Star® Doors
Energy Star® Windows
Energy Star® Refrigerators

2.3 Program Participation Summary

Reported participation and savings for Avista's 2016 and 2017 programs is outlined in Table 2-16 and Table 2-17.

Table 2-16 Avista Nonresidential Reported Participation and Savings

Program	2016-2017 Reported Project Count	2016-2017 Reported Savings (kWh)
EnergySmart Grocer	183	3,066,726
Food Service Equipment	67	200,090
Green Motors	27	100,830
Motor Controls HVAC	15	697,760
Prescriptive Water Heat	1	4,886
Prescriptive Lighting	3,023	77,964,819
Prescriptive Shell	21	19,335
Fleet Heat	2	16,000
AirGuardian	5	53,092
Small Business	7,879*	2,986,437
Site Specific	251	13,845,706
Nonresidential Total	**11,474**	**98,955,682**

*Count of unique measures

Table 2-17 Avista Residential Reported Participation and Savings

Program	2016-2017 Reported Participation Count	2016-2017 Reported Savings (kWh)
HVAC	2,035	1,546,894
Water Heat*	4,252	435,442
ENERGY STAR Homes	24	153,562
Fuel Efficiency	2,677	25,215,201
Lighting**	1,707,991	37,680,674
Shell	524	1,123,113
Home Energy Reports***	48,941	18,512,339
Low Income****	19,943	1,286,095
Residential Total	**1,786,387**	**85,953,320**

*Includes counts for both projects and Simple Steps showerheads
**Denotes bulb count and includes Simple Steps and Giveaway
***Number of participants in the Treatment in April, 2016
****Includes both projects and counts of bulbs

2.4 Evaluation Goals and Objectives

"Model Energy-Efficiency Program Impact Evaluation Guide – A Resource of the National Action Plan for Energy Efficiency," published in November 2007. The report states:

Evaluation is the process of determining and documenting the results, benefits, and lessons learned from an energy-efficiency program. Evaluation results can be used in planning future programs and determining the value and potential of a portfolio of energy-efficiency programs in an integrated resource planning process. It can also be used in retrospectively determining the performance (and resulting payments, incentives, or penalties) of contractors and administrators responsible for implementing efficiency programs.

Evaluation has two key objectives:

1. *To document and measure the effects of a program and determine whether it met its goals with respect to being a reliable energy resource.*

2. *To help understand why those effects occurred and identify ways to improve.*

Avista and evaluation team has identified the following objectives for the evaluation:

- Independently verify, measure and document energy savings impacts from Avista's electric and natural gas energy efficiency programs in 2016 and 2017,
- Calculate the cost effectiveness of the portfolio and component programs,
- Identify program improvements, if any, and
- Identify possible future opportunities.

3 Impact Evaluation Methodology

The impact evaluation assessed the gross savings attributable to Avista's 2016 and 2017 energy-efficiency programs. Impact evaluations generally seek to quantify the energy and, when possible, the non-energy savings that have resulted from DSM program operations. These savings may be expressed as all of the changes resulting from the program (gross savings), or only those changes that would not have occurred absent the program (net savings).

The evaluation team verified the gross energy savings of Avista's 2016 and 2017 programs by:

- Understanding the program context
- Designing the impact evaluation sample
- Verifying the project and program savings through document audits, telephone surveys, onsite measurement and verification, and billing analysis
- Comparing Avista-reported savings to savings verified during project-level evaluations to determine verified gross savings.

3.1 Understanding the Program Context

The first significant step of the evaluation activities was to gain a comprehensive understanding of the programs and measures being evaluated. Specifically, the team explored the following documents and data records:

- Avista's 2016 Demand Side Management (DSM) Business Plans which detail processes and energy savings justifications
- Project documents from external sources, such as documents from customers, program consultants, or implementation contractors.

Based on the initial review, the evaluation team outlined the distribution of program contributions to the overall portfolio of programs. In addition, the review allowed the evaluation team to understand the sources for unit energy savings for each measure offered in the programs, along with the sources for energy-savings algorithms and the internal quality assurance and quality control (QA/QC) processes for large nonresidential projects. Following this review, the evaluation team designed the sample strategy for the impact evaluation activities, as discussed in the following section.

3.2 Designing the Sample

Sample development was an important step that enabled the evaluation team to deliver meaningful, defensible results to Avista. The evaluation team used stratified random sampling approaches for much of our data collection activities. Our sampling methodology was guided by a "value of information" (VOI) framework which allowed us to target activities and respondents with expected high impact and yield, while representing the entire population of interest. VOI focuses budgets and rigor towards the programs/projects with high uncertainty and high impact.

For the sample design, the evaluation team organized the programs into 'bins', segmenting the programs based on two metrics:

- **Program Uncertainty:** The risks associated with a program's reported savings (i.e., custom vs. deemed vs. Regional Technical Forum status), delivery mechanism, and performance goals, etc., broken into three categories: high, medium, and low.
- **Program Size:** Either large, or small; based on projected energy savings, and planned budget allocations.

Bins were created for residential and nonresidential programs separately and for electric (WA/ID) and natural gas (WA) programs separately.

In parallel, we calculate a 'level of rigor' value for each program, and based on assumed measure complexity and RTF influence, we identify an appropriate level of sampling and evaluation rigor.

- **Level of Sampling:** Defined as confidence/precision for calculating sample sizes, the evaluation team is using four levels: 90/10, 80/10, 85/15, or 80/20.
- **Evaluation Rigor:** Defined as the level of detail used for the evaluation activities, including four levels: document audit, surveys, onsite inspections, and billing analysis.

The evaluation bin identified for each program was one factor in determining the sample size and level of rigor for the evaluation activities. Additional factors that influence the sample size and level of rigor include evaluation costs, Regional Technical Forum (RTF) influence, and findings and recommendations from prior evaluations.

The approaches (i.e. level of rigor) for estimating the gross energy savings for the programs evaluated included: document audit, surveys, site inspections, and statistical billing analysis. In many cases, a combination of approaches were used to both validate savings and provide insights into any identified discrepancies between reported and verified savings values. The sampling strategy for the impact evaluation also overlapped, as applicable, with the sample approach used for the process evaluation activities in order to obtain information for both the impact and process evaluations during one single onsite inspection and/or survey. This nested sampling approach helped to minimize costs while still maintaining adequate sample sizes.

Table 3-1 and Table 3-2 show the planned sample sizes and level of rigor for WA/ID Electric residential and nonresidential programs. The samples were drawn to meet the specified confidence/precision for each program and to meet 90% confidence and 10% precision at the portfolio level[1]. Because programs do not differ between the Washington and Idaho service territories, the sample approach was combined for both territories, and the findings from the impact evaluation (i.e. realization rates) were applied across both states.

[1] See Appendix A for detailed information on the presentation of uncertainty.

Table 3-1: Planned Sampling and Evaluation Rigor for WA/ID Electric Residential Programs

WA/ID Electric Residential Program	Target Sample Sizes for each Level of Rigor				
	Target C/P[1]	Document Audit	Surveys	Onsite Inspections	Billing Analysis
HVAC Program	census	68	-	-	
Water Heat Program	80/20	68	-	-	-
ENERGY STAR Homes	census	68	-	-	census
Fuel Efficiency	census	68	42	-	census
Residential Lighting Program	census	NA	-	-	-
Shell Program	census	68	42	-	census
Home Energy Reports	census	-	-	-	census
Low Income	census	68	-	-	census
Total	**90/10**	**408**	**84**	**-**	

[1]Sample sizes for document audit designed to meet C/P target and are based on actual 2016 participation values through July, 2016

Table 3-2: Planned Sampling and Evaluation Rigor for WA/ID Electric Nonresidential Programs

WA/ID Electric Nonresidential Program	Target Sample Sizes for each Level of Rigor				
	Target C/P[1]	Document Audit	Surveys	Onsite Inspections	Billing Analysis
Prescriptive Lighting	80/10	42	11	11	-
Prescriptive Other[2]	85/15	24	11	11	-
Small Business	90/15	34	16	16	-
Site Specific	90/10	68	68	68	based on IPMVP
Total	**90/10**	**168**	**106**	**106**	

[1]Sample sizes for document audit designed to meet C/P target and are based on actual 2016 participation values through July, 2016
[2]For purposes of the evaluation sampling, the evaluation team bundled the following Nonresidential Electric Programs into one program titled 'Prescriptive Other': Energy Smart Grocer, Food Service Equipment, Green Motors, Commercial Motor Controls HVAC, Appliance, Shell, Fleet Heat, and AirGuardian

Table 3-3 and Table 3-4 present the achieved sample size and confidence/precision level for each program evaluated.

Table 3-3: Achieved Sampling and Evaluation Rigor for WA/ID Electric Residential Programs

WA/ID Electric Residential Program	Achieved Sample Sizes for each Level of Rigor				
	Achieved Precision at 90% Confidence	Document Audit	Surveys	Onsite Inspections	Billing Analysis
HVAC Program	census	113	-	-	
Water Heat Program	census	59	-	-	
ENERGY STAR Homes	14.4%	68	-	-	
Fuel Efficiency	7.1%	76	45	-	census
Residential Lighting Program	census	-	-	-	
Shell Program	44.9%	83	43	-	census
Home Energy Reports	5.8%	-	-	-	census
Low Income	12.8%	127	-	-	census
Total	**4.3%**	**526**	**88**	**-**	

Table 3-4: Achieved Sampling and Evaluation Rigor for WA/ID Electric Nonresidential Programs

WA/ID Electric Nonresidential Program Name	Achieved Sample Sizes for each Level of Rigor			
	Achieved Precision at 90% Confidence	Document Audit	Surveys	Onsite Inspections
Prescriptive Lighting	16%	47	38	38
Prescriptive Other[2]	23%	37	13	13
Small Business	12%	39	18	18
Site Specific	8%	68	58	58
Total	**12%**	**191**	**127**	**127**

[2]*For purposes of the evaluation sampling, the evaluation team bundled the following Nonresidential Electric Programs into one program titled 'Prescriptive Other': Energy Smart Grocer, Food Service Equipment, Green Motors, Commercial Motor Controls HVAC, Appliance, Shell, Fleet Heat, and AirGuardian.*

3.3 Database Review

For all evaluated programs, the evaluation team conducted a review of the program databases as provided by Avista and its third-party implementers. The purpose of the review was to look for large outliers in program-reported data and to remove any duplicate entries found in the databases. If any large discrepancies were found, the evaluation team confirmed with Avista or its third-party implementers that the discrepancies was or was not an error and if it was noted as an error, the discrepancies were fixed and reported savings values were updated accordingly.

3.4 Verifying the Sample – Gross Verified Savings

The next step in the impact evaluation process was to determine the gross impacts, which are the energy savings that are found at a customer site as the direct result of a program's operation; net impacts are the result of customer and market behavior that can add to or subtract from a program's direct results.

The impact evaluation activities resulted in realization rates, which were applied to the adjusted/ reported savings. The ratio of the savings determined from the site inspections, measurement and verification (M&V) activities, or engineering calculations to the program-reported savings was the project realization rate; the program realization rate was the weighted average for all projects in the sample. The savings obtained by multiplying the program realization rates by the program-adjusted/reported savings were termed the gross verified savings. These gross verified savings reflect the direct energy and demand impact of the program's operations.

Total program gross savings were adjusted using Equation 3-1:

Equation 3-1: Gross Verified Savings Equation

$$kWh_{adj} = kWh_{rep} \cdot Realization\ Rate$$

Where:

kWh_{adj}	=	kWh calculated by the evaluation team for the program, the gross impact
kWh_{rep}	=	kWh reported/adjusted for the program
Realization rate	=	weighted average kWh_{adj} / kWh_{rep} for the research sample

The estimate of gross verified energy savings occurred through one or more levels of evaluation rigor, as detailed in the following sections.

3.4.1 Document Audit

The first level of rigor that the evaluation team used was a document audit of all sampled projects for which documentation existed. Document audits were also a critical precursor for conducting telephone surveys and onsite inspections and, more specifically, for determining project-specific variables to be collected during these activities. The document audit for each sampled project sought to answer three questions:

- Were the data files of the sampled projects complete, well documented, and adequate for calculating and reporting the savings?
- Were the calculation methods correctly applied, appropriate, and accurate?
- Were all the necessary fields properly populated?

3.4.2 Telephone Survey

A second level of evaluation rigor was through stand-alone telephone surveys with program participants. Telephone surveys were conducted in conjunction with the process evaluation

activities and were used to gather information on the energy-efficiency measure implemented, information needed to estimate net-to-gross values, the key parameters needed to verify the assumptions used by RTF for approved values or to estimate verified energy savings, and any baseline data that may be available from the participant.

3.4.3 Onsite Measurement and Verification

A sample of projects in the nonresidential sector was selected for onsite measurement and verification activities. Before conducting site inspections, it was important for field engineers to understand the project that they were verifying. This understanding was built from the document-audit task discussed earlier. For all onsite inspections, a telephone survey served as an introduction to the evaluation activities and was used to confirm that the customer participated in the program, to confirm the appropriate contact, and to verify basic information such as building type and building size. All onsite activities were conducted by evaluation team field engineers.

The evaluation team conducted two levels of rigor associated with the onsite inspections – measurement and verification (M&V) and verification-only (V). Upon review of the project documents, the evaluation team decided which level of rigor was appropriate for each sampled project/measure. In cases where the measure had an approved RTF UES value, the evaluation team's effort focused on verifying the quality and quantity of installation to apply the RTF UES values to.

M&V methods were developed with adherence to the IPMVP. As defined by IMPVP, the general equation for energy savings is defined as: [2]

Normalized Savings =
(Baseline Energy ± Routine Adjustments to fixed conditions ± Non-Routine Adjustments to fixed conditions) - (Reporting Period Energy ± Routine Adjustments to fixed conditions ± Non-Routine Adjustments to fixed conditions)

The broad categories of the IPMVP are as follows:

- Option A, Retrofit Isolation: Key Parameter Measurement – This method uses engineering calculations, along with partial site measurements, to verify the savings resulting from specific measures.
- Option B, Retrofit Isolation: All Parameter Measurement – This method uses engineering calculations, along with ongoing site measurements, to verify the savings resulting from specific measures.
- Option C, Whole Facility: This method uses whole-facility energy usage information, most often focusing on a utility bill analysis, to evaluate savings.
- Option D, Calibrated Simulation: Computer energy models are employed to calculate savings as a function of the important independent variables. The models must include verified inputs that accurately characterize the project and must be calibrated to match actual energy usage.

[2] Efficiency Valuation Organization (EVO) "International Performance Measurement and Verification Protocol (IMPVP) Concepts and Options for Determining Energy and Water Savings Volume 1", April 2007, page 19.

In addition, the evaluation team conducted metering tasks on a subset of the onsite inspection sample chosen for the M&V level of rigor. Projects were selected for metering activities based on the measure type, project complexity, and the level of information needed to estimate gross savings for the project.

3.4.4 Billing Analysis

Participants received an assortment of efficiency measures through Avista's residential rebate programs. Billing analyses are generally considered a best practice for calculating energy savings resulting from "whole-house" efficiency retrofits. Thus, because of the diverse and interactive savings profiles associated with the improvements, the evaluation team determined that a utility bill regression analysis was the best method for quantifying energy savings resulting from these programs' treatment measures.

The utility billing analysis used data from participating customers who had sufficient utility-billed consumption records before and after the measure installation. Specifically, the evaluation team used a billing analysis approach for estimating gross verified savings for all measures in the following residential programs: Shell, Fuel Efficiency, Home Energy Reports, and Low Income.

The evaluation team requested program tracking data and complete billing histories for Avista's residential rebate program participants as well as non-participants to develop a matched comparison group (see Section 3.4.4.1 below). We aimed to use participant data that contained at least one full year of utility billing data before and after measure installation to ensure that seasonal effects of the improvements are captured in the savings estimates. However, because of the timing of measure installations and the nature of certain programs, some participants may have had up to nine months of post-installation data available.

Before performing the analysis, utility billing records were assessed for quality and completeness. Duplicate observations were removed from the billing data. Billing periods of more than 35 days or less than 26 days were also excluded from the dataset because these observations are not representative of a typical billing cycle.

3.4.4.1 Comparison Group Selection

Nexant selected the comparison groups using propensity score matching to find residential Avista customers who are non-participants with monthly consumption most similar to those of participants. In this procedure, a probit model is used to estimate a score for each customer based on a set of observable variables that are assumed to affect the decision to participate in a rebate program. A probit model is a regression model designed to estimate probabilities—in this case, the probability that a customer would participate. The score can be interpreted two different ways. First, the propensity score can be thought of as a summary variable that includes all the relevant information in the observable variables about whether a customer would choose to participate in a rebate program. Each participant was matched with a customer in the non-participant population that has the closest propensity score. The second way to think of the propensity score is as the probability that a customer will participate in a rebate program based on the included independent variables. Thinking of it this way, each customer in the comparison group was matched to a treated customer with a similar probability of participating given the observed variables.

Nexant performed the match within each program and state. In other words, the match was conducted separately for customers in Washington and Idaho and for each rebate program. The match was based on a set of variables that characterize energy consumption during the full calendar year prior to treatment (2015). Twenty matches based on various combinations of monthly, seasonal, and annual energy consumption were tested and the final probit model which resulted in the closest match between participant and comparison customer average usage each month of 2015 was selected. One match was found for each participant and the same comparison customer could not be matched to multiple participants.

Figure 3-1 displays the average daily kWh consumption in 2015 for participants in the Electric Shell program and for the matched comparison group. Over the year prior to treatment, consumption was very similar between the two groups, with a difference of approximately 0.5% on average. These differences are taken into account by the difference-in-differences estimation methodology described in the following section.

Figure 3-2 displays the average daily therms consumption for each month in 2015 for the Gas Shell group and the corresponding comparison group. Once again, consumption throughout the pre-treatment year is very similar between the two groups, indicating that the matched comparison group behaves similarly to participants in the absence of treatment.

Figure 3-1: Electric Shell Matched Control Group vs Participants

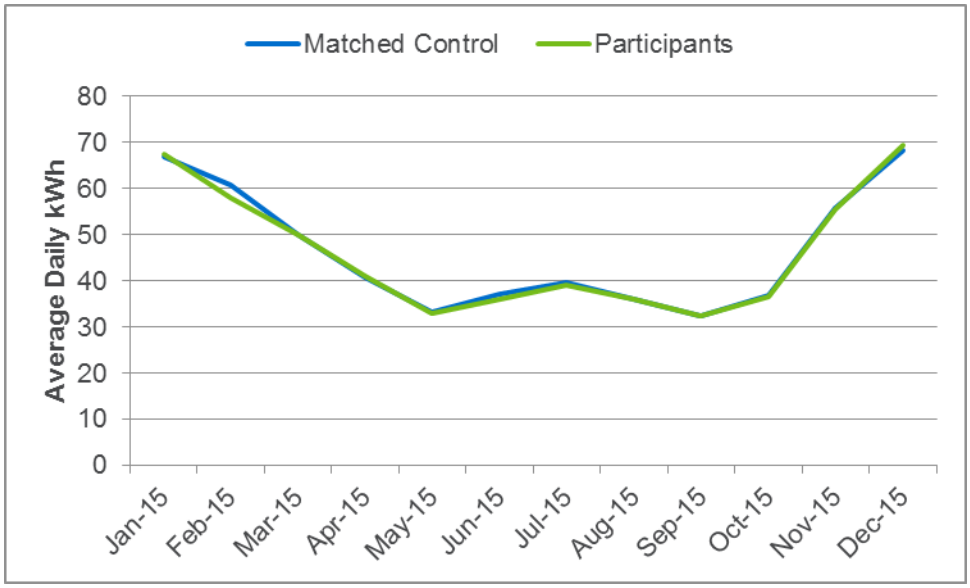
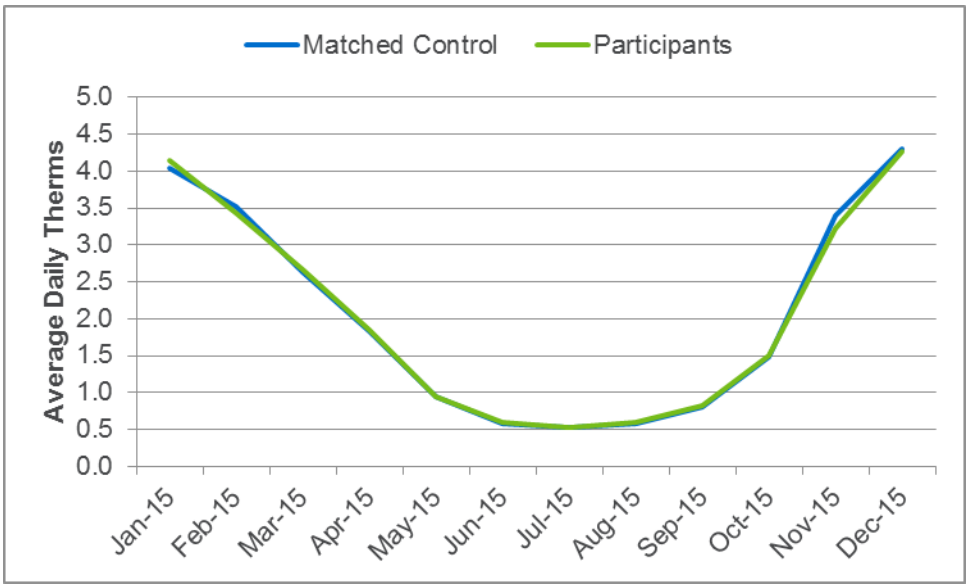


Figure 3-2: Gas Shell Matched Control Group vs Participants



3.4.4.2 Ex Post Estimation Method

After the comparison groups for treatment customers were selected and validated, energy impacts were estimated using a difference-in-differences (DiD) methodology for the Shell, Fuel Efficiency, and Home Energy Reports[3] programs (the Low Income program used a participant pre/post billing analysis, see Section 3.4.4.3 below). Impacts are estimated as the difference in average consumption between treatment and comparison customers in each month, with the slight difference between the two groups on the pre-treatment year removed. This calculation controls for residual differences in load between the groups that are not eliminated through the matching process, thus reducing bias.

The DiD analysis can be done by hand using simple averages or by using panel regression analysis. Customer fixed effects regression analysis allows each customer's mean consumption to be modeled separately, which reduces the standard error of the impact estimates without changing their magnitude. Additionally, panel regression easily facilitates calculation of standard errors, confidence intervals, and significance tests for load impact estimates that correctly account for the correlation in customer loads over time.

The model specification for estimating load impacts is shown in Equation 3-2 and Table 3-5 provides detail for each model variable. The model was estimated separately for each hour and event day.

Equation 3-2: Monthly Energy Savings Model Specification

$$daily\_consumption_i = \alpha + \gamma \text{event} + \beta \text{treatXevent}_i + v_i + \varepsilon$$

[3] The Oracle Home Energy Report program is designed as a randomized control trial and therefore a matched comparison group was not selected for the billing analysis.

Table 3-5: Description of Energy Savings Model Regression Variables

Variable	Description
$daily\_consumption_i$	Per customer consumption (kWh or therms) for customer *i*
α	Mean consumption for all customers
γ	The coefficient on the post-treatment indicator variable
post	Equal to 1 for the post-treatment period and 0 for the same month in 2015
β	DiD estimator of the treatment effect (the impact in kWh or therms)
treatXpost	Interaction of treatment and post variables, equal to 1 for the post-treatment period for participants and 0 otherwise
v_i	The customer fixed effects variable for customer *i*
ε	The error term

In Equation 3-2 the variable $daily\_consumption_i$ equals electricity or gas consumption during the time period of interest, which would be each month of the post-treatment period. The index *i* refers to each individual customer. The estimating database contained electricity and gas consumption data during the pre- and post-treatment periods for both treatment and matched comparison group customers. The variable *post* is equal to 1 for months after installation and a value of 0 for the same month in 2015. The *treatXpost* term is the interaction of *treat* and *post* and its coefficient β is a differences-in-differences estimator of the treatment effect that makes use of the pre-treatment data. The primary parameter of interest is β, which provides the estimated energy impact of the rebate programs during the relevant period. The parameter *a* is equal to mean daily consumption for each customer for the relevant time period (e.g., monthly). The v_i term is the customer fixed effects variable that controls for unobserved factors that are time-invariant and unique to each customer.

This was estimated for each month of 2016 and 2017 separately. Impacts are estimated on a per-customer basis. Reference consumption is equal to observed treatment consumption plus the estimated impact.

3.4.4.3 Low Income Pre/Post Billing Ex Post Estimation Method

For the Low Income program, the evaluation team was unable to select a matched comparison group as Avista does not provide information in its billing records to identify low income customers. Therefore, the evaluation team used a pre/post billing analysis based on participant billing data.

The evaluation team reviewed the participant data in the same method used for the other programs by accessing data quality and completeness. In addition to program participation records and customer billing histories, the evaluation team also collected daily temperature records and normal weather conditions (TMY3) from three weather stations located in Avista's service territory. Observed temperature records were used to calculate the number of heating

degree days (HDD) and cooling degree days (CDD) in each customer's monthly billing period. Weather stations used by the evaluation team include Coeur d'Alene, Idaho; Lewiston, Idaho; and Spokane, Washington. Each participant was matched to the nearest weather station based on service address.

Gross verified energy savings were calculated by comparing billed consumption in months prior to the measure installations to the billed consumption in months after the measure installations. For most programs the evaluation team required homes to have 12 months of pre-retrofit consumption and 12-months of post-retrofit consumption for inclusion in the billing analysis. In cases in which participation was limited, this requirement was relaxed to increase sample sizes, provided that the participating homes had data from the key seasons. For example, switching from electric heat to a natural gas furnace will produce the largest savings during winter months. Because the evaluation team received data through February of 2018, homes who implemented the fuel conversion measure in the summer of 2017 might have a full 12 months of pre-retrofit data but only 6 to 8 months of post-retrofit data. However, the post-retrofit period included the heating season and gave the regression model sufficient data upon which to establish a mathematical relationship between weather and consumption.

Table 3-6 defines the terms and coefficients shown in the two equations that follow. Equation 3-3 shows the general regression model specification used for electric measures, Equation 3-4 shows the general model specification used for gas measures. The key difference between them is the absence of cooling degree day (CDD) terms in the gas model. Because residential gas consumption is predominantly associated with heating, the evaluation team opted to exclude the CDD terms from the gas model, resulting in more robust impact estimates.

Equation 3-3: Regression Model Specification for Electric Measures

$$\mathrm{kWh}_{it} = \beta_i + \beta_1 \times \mathrm{Post}_{it} + \beta_2 \times \mathrm{CDD}_{it} + \beta_3(\mathrm{Post} \times \mathrm{CDD})_{it} + \beta_4 \times \mathrm{HDD}_{it} + \beta_5(\mathrm{Post} \times \mathrm{HDD})_{it} + \epsilon_{it}$$

Equation 3-4: Regression Model Specification for Gas Measures

$$\mathrm{Therms}_{it} = \beta_i + \beta_1 \times \mathrm{Post}_{it} + \beta_2 \times \mathrm{HDD}_{it} + \beta_3(\mathrm{Post} \times \mathrm{HDD})_{it} + \epsilon_{it}$$

Table 3-6: Fixed Effects Regression Model Definition of Terms

Variable	Definition
kWh_{it} / $Therms_{it}$	Estimated consumption in home i during period t (dependent variable)
$Post_{it}$	Indicator variable denoting pre-installation period vs. post-installation period
CDD_{it}	Average cooling degree days during period t at home i
HDD_{it}	Average heating degree days during period t at home i
β_i	Customer specific model intercept representing baseline consumption
β_{1-5}	Coefficients determined via regression describing impacts associated with independent variables
ϵ_{it}	Customer-level random error

4 Nonresidential Impact Evaluation

This section outlines the impact evaluation methodology and findings for each of the evaluated nonresidential programs.

4.1 Overview

Avista offered 11 nonresidential programs in their Washington service territory in 2016 and 2017. The reported savings for the 11 nonresidential programs are summarized in Table 4-1.

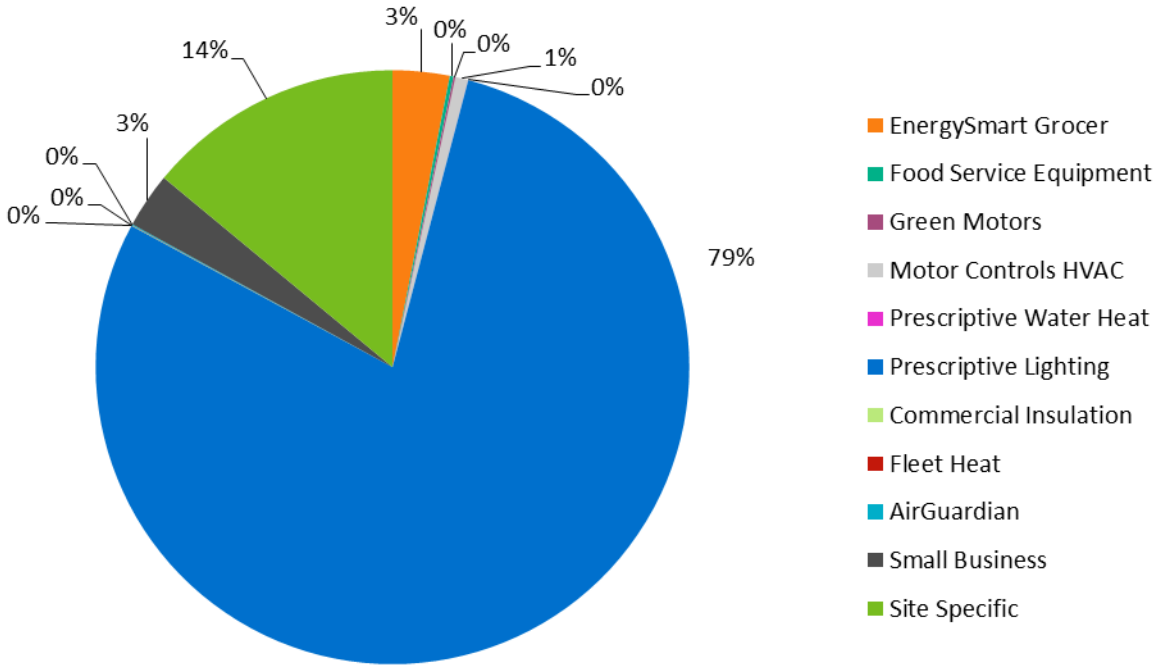
Table 4-1: Nonresidential Program Reported Savings

Program	2016-2017 Reported Project Count	2016-2017 Reported Savings (kWh)
Energy Smart Grocer	183	3,066,726
Food Service Equipment	67	200,090
Green Motors	27	100,830
Motor Controls HVAC	15	697,760
Prescriptive Water Heat	1	4,886
Prescriptive Lighting	3,023	77,964,819
Commercial Insulation	21	19,335
Fleet Heat	2	16,000
Air Guardian	5	53,092
Small Business	7,879*	2,986,437
Site Specific	251	13,845,706
Nonresidential Total	**11,474**	**98,955,682**

*Count of unique measures

The Prescriptive Lighting program contributes the largest share of the reported savings, 79% as shown in Figure 4-1. Site Specific is the next largest contributor at 14%.

Figure 4-1: Nonresidential Program Reported Energy Savings Shares



The evaluation team designed a sampling strategy for these programs placing the most emphasis on the Site Specific program because of its large share of savings in the 2014-2015 biennium and because the Prescriptive Lighting program was found to have a strong realization rate in the prior evaluation. Mid-way through the evaluation cycle, the evaluation team shifted samples from the Site Specific strata to the Prescriptive Lighting strata due to the large amount of savings that had been reported through that program in 2016. As part of the evaluation activities, a total of 191 document audits were conducted, and onsite inspections were conducted on a sub-sample of 127 projects, as shown in Table 4-2. Engineering activities included review of savings calculation methodology and assumptions, verification of operating hours through participant surveys and included use of data loggers in some cases, utility bill analysis, review of energy management system trend data, and energy savings analysis.

Table 4-2: Nonresidential Program Achieved Evaluation Sample

Program	Sample Sizes for Each Level of Rigor			
	Achieved Precision at 90% Confidence	Document Audit	Survey	On-Site Inspections
Prescriptive Lighting	16%	47	38	38
Prescriptive Other[2]	23%	37	13	13
Small Business	12%	39	18	18
Site Specific	8%	68	58	58
Total	**12%**	**191**	**127**	**127**

[2]For purposes of the evaluation sampling, the evaluation team bundled the following Nonresidential Electric Programs into one program titled 'Prescriptive Other': Energy Smart Grocer, Food Service Equipment, Green Motors, Commercial Motor Controls HVAC, Appliance, Shell, Fleet Heat, and AirGuardian

4.2 Prescriptive Lighting

4.2.1 Overview

The Prescriptive Lighting program encourages commercial customers and vendors to make lighting improvements to their businesses. The program provides many common retrofits to receive a pre-determined incentive based on baseline and replacement lamp wattages. The program is internally implemented by Avista.

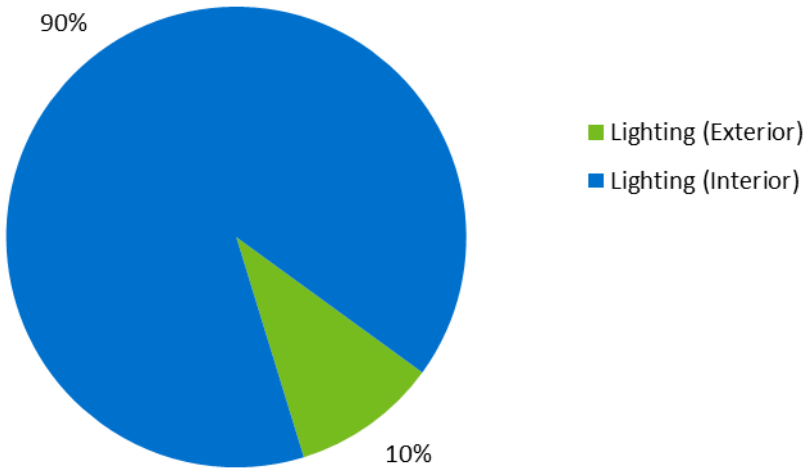
4.2.2 Program Achievements and Participation Summary

A total of 3,023 prescriptive lighting projects at approximately 2,244 unique premises were installed in Washington across the 2016 and 2017 program years. Table 4-3 and Figure 4-2 summarize Avista's 2016-2017 Prescriptive Lighting Program energy impacts by measure category as defined in the Avista tracking database.

Table 4-3: Prescriptive Lighting Reported Energy Savings by Measure

Measure Type	2016-2017 Reported Project Count	2016-2017 Reported Savings (kWh)	% Electric Savings
Lighting (Exterior)	711	7,993,121	10%
Lighting (Interior)	2,312	69,971,698	90%
Total	**3,023**	**77,964,819**	**100%**

Figure 4-2: Prescriptive Lighting Reported Energy Savings Shares



4.2.3 Methodology

The impact evaluation for this program followed the RTF's Nonresidential Lighting Retrofit Standard Protocol, IPMVP Option A (Retrofit Isolation: Key Parameter Measurement), and DOE Uniform Methods Commercial and Industrial Lighting Evaluation Protocol[1]. Engineering activities included installation verification, determination of operational hours including spot-metering in for a sub-sample of projects, and engineering savings calculations.

4.2.3.1 Sampling

The evaluation team conducted document audits for 47 projects. Customer surveys and onsite inspections were completed on a sub-sample of 38 of these projects (Table 4-4). The original sample targets were designed based on the prescriptive lighting share of overall savings from the 2014-2015 biennium and based on the near 100% realization rates of the prescriptive lighting measures from the prior evaluation. However, at end of the 2016 program year, prescriptive lighting measures were the predominant measure of the overall nonresidential portfolio and there were some inconsistencies found in the reporting of energy savings values for tubular light-emitting diode (TLED) measures in 2016. Therefore, the evaluation team shifted samples from the Site Specific strata to the Prescriptive Lighting strata. As such, achieved sample sizes for onsite inspections and surveys is higher than the original sample design of 42 document audits and 11 surveys and onsite inspections as noted in Table 3-2.

Table 4-4: Prescriptive Lighting Achieved Sample

Program	Document Audit	Survey	OnSite Inspections
Prescriptive Lighting	47	38	38

4.2.3.2 Document Audits

Project documentation was requested for each sampled project, including invoices, savings calculations, work order forms, equipment specification sheets, and any other project records that may exist. Thorough review of this documentation was the first crucial step in evaluation of each project.

4.2.3.3 Field Inspections

Participants were recruited for onsite inspection via telephone calls. These onsite inspections provide a more rigorous way to verify energy savings, and allowed the evaluation team to note any discrepancies between onsite findings regarding actual measure and equipment performance and the information gathered through the telephone surveys and project documentation. A survey instrument specific to this program was created in advance of the site inspections to ensure that the correct information was gathered.

Table 4-5 summarizes the information that was collected for each project during the onsite inspection. All parameters needed to support the savings analysis of a project were collected, including fixture counts, baseline and post-retrofit wattages, hours of operation, and HVAC system information (to inform calculation of interactive effects).

[1] http://energy.gov/sites/prod/files/2013/11/f5/53827-2.pdf

Table 4-5: Prescriptive Lighting Onsite Data Collection

End Use Category	Baseline	Retrofit
All Facilities	Year facility was built Number of occupants Number of stories Business Type Operating Hours, posted or otherwise Total conditioned square footage Heating system type/age/efficiency/size/condition Cooling system type/age/efficiency/size/condition	
Lighting	Lamp Type (e.g., T8, T12) Ballast Type (mag. or elec.) Lamp Size (4 ft. or 8 ft.) Quantity of Lamps per Fixture Wattage per Lamp Fixture Quantity Operating Hours Control Type	Lamp Type Confirm Electronic Ballast and Factor Lamp Size Quantity of Lamps per Fixture Wattage per Lamp Fixture Quantity Operating Hours Control Type Confirm ENERGY STAR© rating

Where feasible and appropriate, the evaluation team also used standalone data loggers to minimize uncertainty in the estimation of lighting operating hours. Evaluation team engineers installed HOBO® U9-002 light on/off loggers for a minimum of four months. This collected measured data was supplemented by lighting operating characterization as determined through onsite interviews and surveys of control strategies (dimmers, timers, etc.) to inform the balance of the yearly operating hours.

The data collected over the logging duration was tabulated per hour per week to create an average weekly operation schedule for each measured space with energy efficiency measures. The weekly hourly profile includes 24 hours of each of eight distinct day types (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and holiday). Annual operating hours were created by extrapolating measured values to a calendar year, adjusted as needed per the interviews with onsite personnel.

4.2.3.4 Impact Analysis Methods

To calculate the gross verified energy savings of a lighting retrofit, the evaluation utilized the calculation outlined in Equation 4-1.

Equation 4-1: Prescriptive Lighting Energy Savings Calculation

$$\Delta kWh = \left(\#\ fixtures_{base} * kW_{base} - \#\ fixtures_{retrofit} * kW_{retrofit}\right) * Hours * IF$$

Where:

 # fixtures$_{base\ or\ retrofit}$ = Quantity of fixtures installed in baseline or retrofit of a project

Hours = Annual hours of fixture operation

IF = the ratio of heating and cooling electricity reduction per unit of lighting energy reduction resulting from the reduction in lighting waste heat removed by an electric HVAC system

Equation 4-1 is based on per fixture energy savings as calculated in Equation 4-2 and Equation 4-3:

Equation 4-2: Prescriptive Lighting Base Case Demand Savings Calculation

$$kW_{base} = \frac{\#\ lamps_{base} * Watts_{base} * BF_{base}}{1000}$$

Equation 4-3: Prescriptive Retrofit Case Demand Savings Calculation

$$kW_{retrofit} = \frac{\#\ lamps_{retrofit} * Watts_{retrofit} * BF_{retrofit}}{1000}$$

Where:

 # lamps$_{base\ or\ retrofit}$ = Quantity of lamps installed in a baseline or retrofit fixture

Watts$_{base\ or\ retrofit}$ = Wattage of baseline or retrofit lamp

BF$_{base\ or\ retrofit}$ = Ballast factor of baseline or retrofit light fixture

The analysis utilized a T8 baseline for linear fluorescent replacements, since T12 lamps are no longer compliant under federal regulations (EISA 2007 and EPact 2005).

Interactive Equipment Energy Changes for Lighting Retrofits

The energy consumption of lighting equipment within an enclosed space is not viewed in isolation. Building systems interact with one another and a change in one system will often affect the energy consumption of another. This interaction is important to consider when calculating the benefits provided by lighting equipment because it adopts a comprehensive view of premise-level energy changes rather than limiting the analysis to the energy change directly related to the modified equipment. The evaluation team utilized the interactive factors designated in the RTF's Non-residential Lighting Retrofits protocol[2]. Engineers gathered heating and cooling system types serving each space affected by a lighting retrofit project during the site visit in order to appropriately apply the RTF's factors. For desk reviews without an accompanying site visit, the evaluation team assumed electric cooling with gas heating in absence of better information.

[2] http://rtf.nwcouncil.org/measures/measure.asp?id=213

4.2.4 Findings and Recommendations

The data collected as a result of the desk reviews and onsite data measurement and verification activities were utilized to estimate the gross verified savings. The evaluation team's gross verified savings values for the sample of reviewed projects was almost equal to the reported values for exterior lighting projects and less than Avista's reported values for interior lighting measures, resulting in an overall Prescriptive Lighting realization rate of 80% (Table 4-6).

Table 4-6: Prescriptive Lighting Realization Rate Results

Measure	Sample Unique Projects	Realization Rate	Relative Precision (90% Confidence)
Lighting (Exterior)	6	100%	N/A
Lighting (Interior)	41	75%	
Total	**47**	**80%**	**12%**

By the end of the 2016 program year, the evaluation team had conducted document reviews and onsite verification activities on a sample of 2016 nonresidential projects. Based on these activities, the evaluation team calculated an interim realization rate of 71% for the prescriptive lighting measures. One of the factors behind this realization rate was based on the evaluation team's review of Tubular LED (TLED) measures incented in the 2016 program year.

Specifically, in the 2016 program year and into the first month of 2017, Avista offered two prescriptive lighting measures for TLEDs:

- 1-Lamp T12/T8 Fixture to 1-Lamp LED 8W to 15W, incentivized at $15 per lamp
- 1-Lamp T12/T8 Fixture to 1-Lamp LED 16W to 23W, incentivized at $10 per lamp

As early project applications were submitted, Avista became aware that TLED lamps were labeled under a lower wattage than their Design Lights Consortium (DLC) product specifications. TLED lamps were found in the market with a labeled wattage of 14-15W, while the DLC testing indicated that these lamps consume 17-18W. The evaluation team believes that this discrepancy is because TLED lamp power consumption is subject to different ballast and driver configurations. Thus, a TLED in a low ballast factor (LBF) ballast may only consume 14W, but in a normal ballast factor (NBF) ballast, the same lamp uses 17W. The DLC maintains performance data for its certified lamps as tested with a 0.89 ballast factor.

Because this issue was identified in the middle of the biennium, Avista adjusted the savings associated with this measure for the 2017 program year. However, the issue did impact the overall realization rate for the Prescriptive Lighting measure category (predominately for interior lighting) for the 2016-2017 biennium. Because Avista already corrected this issue, no further recommendations related to this matter are suggested.

Another contributing factor that impacted the realization rate for this program is the reporting of operating hours for participating nonresidential facilities. The evaluation team did find several large projects reporting an incorrect hours of use value. In future program implementation

activities it is recommended that for large projects and for projects with multiple different space types, that additional verification be conducted on the reported hours of use value. Avista could set a threshold based on the number of fixtures installed, facility/building type, and/or reported savings that triggers an additional level of verification. In addition, Avista should review the interactive factors employed by its lighting savings estimation tool. In several evaluated projects, the evaluation team determined that a lower interactive factor be applied compared to the value utilized by Avista, based on both business type and building heating type. Table 4-7 shows the total gross verified savings for the Prescriptive Lighting program.

Table 4-7: Prescriptive Lighting Gross Verified Savings

Program	Reported Savings (kWh)	Energy Realization Rate	Gross Verified Savings (kWh)
Prescriptive Lighting	77,964,819	80%	62,720,933

4.3 Prescriptive Other Programs

4.3.1 Overview

The evaluation team analyzed all of Avista's non-lighting prescriptive electric programs together under a "Prescriptive Other" category. Table 4-8 lists brief summaries of the programs included in this group.

Table 4-8: Prescriptive Other Program Summaries

Electric Programs	Descriptions
Energy Smart Grocer	This program, implemented by CLEAResult, offers a range of proven energy-saving solutions for grocery stores and other customers with commercial refrigeration. Energy savings are primarily achieved through installation of high efficiency case lighting and other refrigeration system efficiency improvements.
Food Service Equipment	This program offers incentives for commercial customers who purchase or replace food service equipment with Energy Star or higher equipment (prescriptive).
Green Motors	The Green Motors Initiative is to organize, identify, educate, and promote member motor service centers to commit to energy saving shop rewind practices, continuous energy improvement and motor driven system efficiency.
Motor Controls HVAC	This program is intended to prompt the customer to increase the energy efficiency of their fan or pump applications with variable frequency drives through direct financial incentives.
Commercial Insulation	This program encourages nonresidential customers to improve the envelope of their building by adding insulation and replacing windows.
Prescriptive Water Heat	This program encourages nonresidential customers to improve the efficiency of their water heating equipment.
Air Guardian	The AirGuardian program is a third party delivered turnkey program (delivered by 4Sight Energy Group LLC) for direct install compressed air and facility efficiency. The target market for the direct installation of AirGuardian devices are small and medium businesses.
Fleet Heat	Installation of technology that reduces standby losses of vehicle engine blocks by fleet operators by adding the ability to energize block heaters only when Outside Air Temperature drops below a temperature set-point and the engine mounted thermostat is calling for heat.

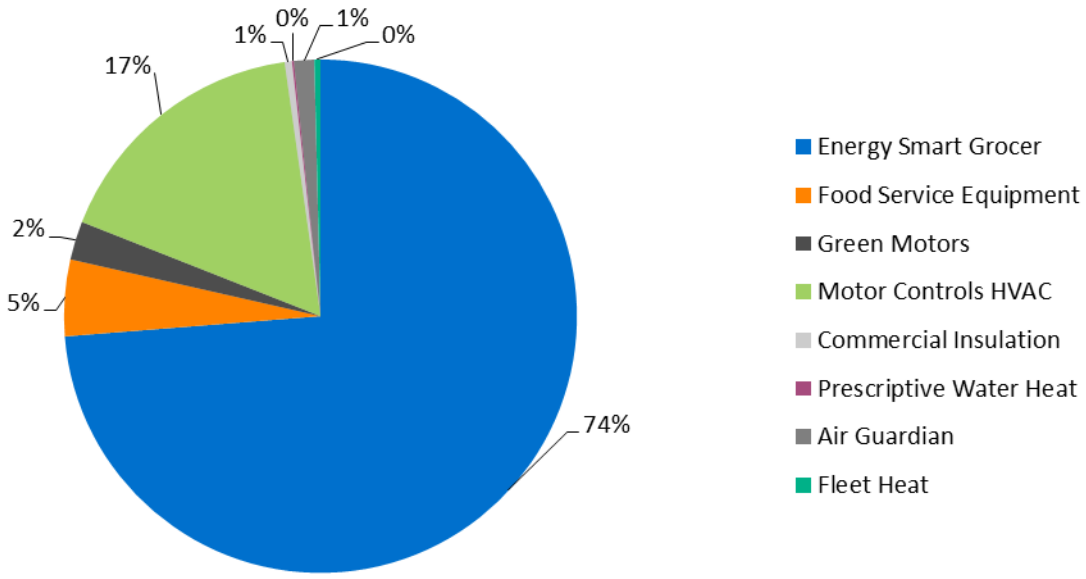
4.3.2 Program Achievements and Participation Study

A total of 321 unique measures were installed in Washington through these "Prescriptive Other" programs in 2016 and 2017. Table 4-9 and Figure 4-3 summarize Avista's 2016-2017 reported project count and energy impacts by measure for these programs in Washington.

Table 4-9: Prescriptive Other Reported Energy Savings by Program

Program	2016-2017 Reported Project Count	2016-2017 Reported Savings (kWh)	% Electric Savings
Energy Smart Grocer	183	3,066,726	74%
Food Service Equipment	67	200,090	5%
Green Motors	27	100,830	2%
Motor Controls HVAC	15	697,760	17%
Commercial Insulation	21	19,335	0%
Prescriptive Water Heat	1	4,886	0%
Air Guardian	5	53,092	1%
Fleet Heat	2	16,000	0%
Total	**321**	**4,158,719**	**100%**

Figure 4-3: Prescriptive Other Reported Energy Savings Shares



4.3.3 Methodology

Engineering activities for the evaluation of these projects varied by measure and included review of project documentation, review of relevant RTF deemed savings values and workbooks, installation verification, determination of operational hours, and savings calculations.

4.3.3.1 Sampling

The evaluation team conducted document audits for 37 projects that were grouped under the "Prescriptive Other" category. Surveys and onsite inspections were conducted for a sub-sample of these projects (Table 4-10). Because of the installation of multiple projects at some sites, the achieved sample size for onsite inspections and surveys was slightly higher than the original sample design of 24 document audits and 11 surveys and onsite inspections as noted in Table 3-2. The breakdown by program for the document audits is provided in Table 4-11. Note that not all programs were included in the sample due to small participation and/or small overall reported savings.

Table 4-10: Prescriptive Other Achieved Sample

	Document Audit	Survey	OnSite Inspections
Prescriptive Other	37	13	13

Table 4-11: Prescriptive Other Achieved Sample by Program

Program	Document Audit Sample Size
Energy Smart Grocer	27
Food Service Equipment	5
Green Motors	0
Motor Controls HVAC	2
Commercial Insulation	3
Prescriptive Water Heat	0
Air Guardian	0
Fleet Heat	0
Total	**37**

4.3.3.2 Document Audits

Project documentation was requested for each sampled project, including invoices, savings calculations, work order forms, equipment specification sheets, and any other project records that may exist. Thorough review of this documentation was the first crucial step in evaluation of each project.

4.3.3.3 Field Inspections

Participants were recruited for onsite inspection via telephone calls. These onsite inspections provide a more rigorous way to verify energy savings, and allowed the evaluation team to note any discrepancies between onsite findings regarding actual measure and equipment performance and the information gathered through the telephone surveys and project documentation review. Because of the wide variety of measures included in this evaluation, site-specific survey instruments were generated in advance of each site inspections to ensure that sufficient information was gathered to support the analysis of each measure.

Table 4-12 summarizes the types of information that were collected for project categories during the onsite inspection.

Table 4-12: Prescriptive Other Onsite Data Collection

End Use Category	Baseline	Retrofit
All Facilities	Year of construction Business Type Number of occupants Number of floors Operating Hours, posted or otherwise Total conditioned square footage	
HVAC	Type (e.g., DX, heat pump) Age Heating & Cooling Capacity Efficiency Operating Hours Operating Temperatures (space, supply, return, including info on setbacks) Control Capability / Strategy Other Features (e.g. economizer)	Type Age Capacity Efficiency Operating Hours Operating Temperatures Control Capability / Strategy Features
Motors	Motor size (hp) Motor Efficiency Age Condition Operating Hours	Motor size (hp) Motor Efficiency Age Condition Operating Hours VFD Speed (current settings and load profile)
Insulation	Insulation Type Insulation Thickness Window Type (no. of panes, type of glass)	Insulation Type Insulation Thickness Affected Wall / Attic Area (sq ft)

End Use Category	Baseline	Retrofit
Energy Smart Grocer Lighting	Case Temperature Lamp Type (e.g., T8, T12) Ballast Type (mag. or elec.) Lamp Size (linear ft.) Quantity of Lamps per Fixture Wattage per Lamp Fixture Quantity Operating Hours Control Type	Case Temperature Lamp Type Confirm Electronic Ballast and Factor Lamp Size (linear ft.) Quantity of Lamps per Fixture Wattage per Lamp Fixture Quantity Operating Hours Control Type Confirm ENERGY STAR© rating
Energy Smart Grocer Cases/Controls/Motors	Type of Equipment (e.g., open reach-in refrigerated case, closed freezer) Operating Temperatures Capacity Efficiency Operating Hours Other Parameters (e.g., motor kW or hp, linear feet of gaskets, thickness of suction line insulation)	Type of Equipment Operating Temperatures Capacity Efficiency Operating Hours Other Parameters

Onsite data collection for Motor Control HVAC (Variable Frequency Drive or VFD) measures included equipment inspection, interviews with site personnel, and collection of energy management system (EMS) trend data if available. Topics covered in the interview included:

- Fan operation prior to the installation of the VFD including baseline fan control capability:
  - On/Off
  - Inlet Guide Vanes
  - Discharge Damper
- Control programming associated with the VFD such as (1) facility operations schedule, (2) temperature setpoints, (3) differential pressure control
- Minimum and maximum observed operating speeds and associated facility and weather conditions
- Typical operating speed
- Annual equipment operation schedule and variation on a daily, weekly, and annual basis
  - After-hours usage in evenings
  - Weekend usage
  - Summer shut down
  - Night setback
- Availability of trended VFD operating data via building EMS or other control system.

Field engineers gathered the following information from equipment nameplates or as-built drawings:

- Motor make and model
- Motor size (hp)
- Motor efficiency
- Motor speed (RPM)
- Motor type
- Fan type
- VFD make and model

Field engineers also collected operating parameters from the VFD drive's user interface control panel (if present). To facilitate this data collection, the field engineers were provided with model-specific guidance for accessing relevant parameters from the control panel. Although the availability of these operating parameters varies between different VFDs, common operating parameters collected include:

- Instantaneous operating parameters:
  - Frequency (Hz)
  - % speed
  - Motor power (W)
  - Motor amperage (A)
- Cumulative kWh and associated time interval

4.3.3.4 Impact Analysis Methods

Energy Smart Grocer

For the evaluation of the Energy Smart Grocer program, evaluation team applied deemed energy savings values as published by the Regional Technical Forum (RTF) where appropriate. Custom analyses were generated for measures not listed with the RTF.

A majority of the measures installed under the EnergySmart Grocer program are active measures with deemed energy savings values published by the RTF. For these measures, the evaluation team reviewed the relevant RTF workbooks[3] and the reported measure savings, verifying eligibility and appropriate application of RTF savings values for each project in the sample. For measures not listed with the RTF, the evaluation team analyzed the energy savings using custom project-specific methods.

Food Service Equipment

The Food Service Equipment projects included in the evaluation sample were for various types of ENERGY STAR-rated kitchen equipment including ice makers and convection ovens. The evaluation team evaluated the energy savings of each type of equipment using the Commercial Kitchen Equipment calculator published by ENERGY STAR[4]

[3] Grocery - Display Case LEDs (Open Cases) v1.0, 1.1, 1.2, and 1.3. Grocery - Display Case LEDs (Reach-In Cases) v2.0, 2.2, 3.0, 3.1, and 3.2. Grocery – ECMs for Display Cases v2.0, 2.1, 2.2, 3.0, and 3.1. Grocery – ECMs for Walk-ins. V1.1, 1.2, 2.0, and 2.1. Grocery – Floating Heat Pressure Controls for Single Compressor Systems v1.0, 1.1, 1.2, and 1.3. Available from http://rtf.nwcouncil.org/measures/Default.asp.

[4] Found on the following website: https://www.energystar.gov/products/commercial_food_service_equipment

Motor Controls

The evaluation team assessed the HVAC Motor Control projects by modeling each affected motor's input power based on motor size, efficiency, and performance curves published by ASHRAE for various baseline motor control techniques (e.g. inlet guide vanes) as well as VFD control. The general form of the algorithm used presented in Equation 4-4.

Equation 4-4: HVAC Motor Controls Energy Savings Calculation

$$\Delta kWh = \sum_{cap=5\%}^{100\%} \left[kW_{baseline,cap} - kW_{efficient,cap}\right] \times hours_{cap}$$

Where:

Cap = operating capacity of the motor, ranging from 5% of full capacity to 100%

$kW_{baseline,cap}$ = Baseline motor power consumption at a specific capacity, based on ASHRAE performance curves for baseline motor control capability

$kW_{efficient,cap}$ = *Post-retrofit motor power consumption at a specific capacity, based on ASHRAE performance curve for VFDs*

$hours_{cap}$ = Number of annual hours operating at each % capacity

Commercial Insulation

For measures affecting building envelope (attic insulation and wall insulation), an industry-standard relationship for insulation improvements was applied. Energy savings during the cooling season were calculated using the algorithm in Equation 4-5:

Equation 4-5: Commercial Insulation Cooling Savings Calculation

$$\Delta kWh_{cooling} = \frac{\left(\frac{1}{R_{pre}} - \frac{1}{R_{post}}\right) \times Area \times 24 \times CDD}{1000 \times \eta_{cool}}$$

Where:

$R_{pre\ and\ post}$ = *Pre- and Post-improvement R-values of insulation*

A_{attic} = *Affected area (sq ft).*

CDD = *Annual cooling degree days*

η_{cool} = Cooling system efficiency, EER or SEER

For buildings with electric heat sources, including both electric resistance furnaces and heat pumps, the calculated savings during the heating season using the following algorithm (Equation 4-6):

Equation 4-6: Commercial Insulation Heating Savings Calculation

$$\Delta kWh_{heating} = \frac{\left(\frac{1}{R_{pre}} - \frac{1}{R_{post}}\right) \times Area \times 24 \times HDD}{\eta_{heat} \times 3412}$$

Where:

HDD = *Annual cooling degree days*

η_{heat} = Heating system efficiency

4.3.4 Findings and Recommendations

Table 4-13 presents the realization rate based on the gross verified savings values for the sample of reviewed projects in the Prescriptive Other category. The following subsections present the findings and any recommendations for each 'Prescriptive Other' program. The evaluation team did not conduct impact activities for projects in the Green Motors, Prescriptive Water Heat, Air Guardian, and Fleet Heat programs because of the small number and size of these programs in the biennium. As such, findings are not included for these programs.

Table 4-13: Prescriptive Non-Lighting Other Realization Rate Results

Program	Sample Unique Projects	Energy Realization Rate	Relative Precision (90% Confidence)
Prescriptive Other	37	97%	23%

Energy Smart Grocer Findings

Application of RTF Deemed Savings Values

The RTF's deemed savings values for specific measures are periodically reviewed and updated based on further research and input from RTF members. For each revision, the RTF publishes a new workbook, and the current workbook as well as all prior versions are available on the RTF website. The program implementer updates its internal measure savings assumptions based on RTF publications, which can result in multiple deemed savings values being used for the same measure within the same biennium.

Site Specific Project Findings

Site specific projects incentivized under the Energy Smart Grocer program had significantly larger reported savings on average than the prescriptive projects, except for one Prescriptive Case measure which had a large reported savings values. The reported energy savings for site specific projects were generally determined using eQuest energy simulation modeling. The evaluation team used utility billing analysis to calculate verified energy savings values for the majority of the evaluated projects. Lower than reported savings were found for a few sampled projects, but the majority of the evaluated savings were in-line with the reported savings value. Because Energy Smart Grocer was included in the 'Prescriptive Other' measure category for

sampling, the realization rate utilized this program is based on the Prescriptive Other realization rate. It should be noted that Energy Smart grocer measures constituted nearly 75% of the 'Prescriptive Other' category, therefore being a large driver in the overall realization rate for the category.

Food Service Equipment, Motor Control HVAC, and Shell Findings

The evaluation team did not find any significant discrepancies in the evaluated sample of Food Service Equipment findings. Avista's reported energy savings are similar to what the evaluation team calculated using the ENERGY STAR calculator. The evaluation team found that Avista is appropriately estimating savings for the Motor Control HVAC and Shell projects. No significant discrepancies were found.

Table 4-14 shows the total gross verified savings for the programs evaluated under the "Prescriptive Other" stratum.

Table 4-14: Prescriptive Other Gross Verified Savings

Program	2016-2017 Reported Energy Savings (kWh)	Realization Rate	2016-2017 Gross Verified Energy Savings (kWh)
Energy Smart Grocer	3,066,726	97%	2,966,084
Food Service Equipment	200,090		193,524
Green Motors	100,830		97,521
Motor Controls HVAC	697,760		674,861
Shell (Commercial Insulation)	19,335		18,700
Prescriptive Water Heat	4,886		4,726
Air Guardian	53,092		51,350
Fleet Heat	16,000		15,475
Total	**4,158,719**	**97%**	**4,022,241**

4.4 Site Specific

4.4.1 Overview

Avista's Site Specific program offers commercial customers the opportunity to propose any energy efficiency project with documentable energy savings (kilowatt-hours and/or therms) for an incentive. The majority of projects in this program are appliance upgrades, compressed air, HVAC, industrial process, motors, shell measures, custom lighting projects, and natural gas multifamily market transformation. The Site Specific program is implemented internally by Avista, and program staff develops custom energy savings estimates for each project with input from the customer. Any project with documentable energy savings (kilowatt-hours and/or therms) and a minimum ten year measure life can be submitted for a technical review and potential incentive through the Site Specific program.

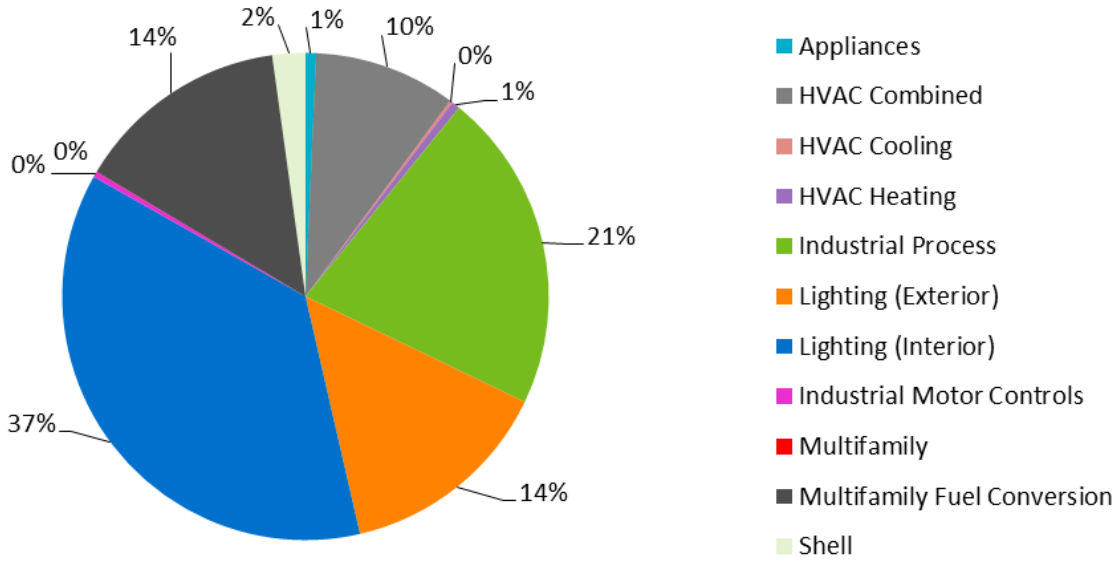
4.4.2 Program Achievements and Participation Summary

A total of 251 unique measures were installed through the Site Specific program at approximately 194 premises in Washington throughout 2016 and 2017. Table 4-15 and Figure 4-4 summarize Avista's reported energy impacts by measure for the Site Specific program.

Table 4-15: Site Specific Reported Energy Savings by Measure

Measure Type	2016-2017 Reported Project Count	2016-2017 Reported Energy Savings (kWh)	% Electric Savings
Appliances	5	96,751	1%
HVAC Combined	13	1,307,274	9%
HVAC Cooling	1	27,510	0%
HVAC Heating	6	75,499	1%
Industrial Process	11	2,941,261	21%
Lighting (Exterior)	59	1,976,665	14%
Lighting (Interior)	116	5,091,806	37%
Industrial Motor Controls	1	50,771	0%
Multifamily	1	2,443	0%
Multifamily Fuel Conversion	14	1,971,422	14%
Shell (Commercial Insulation)	24	304,304	2%
Total	**251**	**13,845,706**	**100%**

Figure 4-4: Site Specific Reported Participation Energy Savings Shares



4.4.3 Methodology

The impact evaluation for this program followed IPMVP guidance as well as the DOE Uniform Method Protocol(s). The RTF's Non-Residential Lighting Retrofit Standard Protocol was

followed for lighting projects and IPMVP Option C was used to guide billing analysis for select projects. Engineering activities included thorough review of the program savings methodology for each project, installation verification, determination of operational hours including spot-metering in some cases, collection of energy management system (EMS) trend data, and associated energy savings calculations.

4.4.3.1 Sampling

The evaluation team conducted 68 document audits on participating projects through the Site Specific program. Customer surveys and onsite inspections were conducted on a subset of these projects. Table 4-16 outlines the achieved sample for the Site Specific Program.

Table 4-16: Site Specific Achieved Sample

Program	Document Audit	Survey	On-site Inspections
Site Specific	68	58	58

4.4.3.2 Document Audits

Project documentation was requested for each sampled project, including Avista's 'Top Sheets', invoices, savings calculations, work order forms, equipment specification sheets, and any other project records that may exist. The evaluation team's desk review process for Site Specific projects included tracking the history of each project through the various stages of the program as documented in the "Top Sheets". Thorough review of this documentation was the first crucial step in evaluation of each project.

For projects where Avista estimated savings using energy modeling software such as eQuest, the evaluation team requested and reviewed the energy models, when provided.

4.4.3.3 Field Inspections

Participants were recruited for onsite inspection via telephone calls. The onsite inspections provide a more rigorous way to verify energy savings, and allowed the evaluation team to note any discrepancies between onsite findings regarding actual measure and equipment performance and the information gathered through the telephone surveys and project documentation review. Because of the wide variety of measures included in this evaluation, project-specific survey instruments were generated in advance of each onsite inspection to ensure that sufficient information was gathered to support the analysis of each measure.

Table 4-17 summarizes the types of information that were collected for each project during the onsite inspection. All parameters needed to support the savings analysis of a project were collected.

Table 4-17: Site Specific Onsite Data Collection

End Use Category	Baseline	Retrofit
All Facilities	Year of construction Business Type Number of occupants Number of floors Operating Hours, posted or otherwise Total conditioned square footage	
HVAC	Type (e.g., DX, heat pump) Age Heating & Cooling Capacity Efficiency Operating Hours Operating Temperatures (space, supply, return, including info on setbacks) Control Capability / Strategy Other Features (e.g. economizer)	Type Age Capacity Efficiency Operating Hours Operating Temperatures Control Capability / Strategy Features
Motors	Motor size (hp) Motor Efficiency Age Condition Operating Hours	Motor size (hp) Motor Efficiency Age Condition Operating Hours VFD Speed (current settings and load profile)
Commercial Insulation	Insulation Type Insulation Thickness	Insulation Type Insulation Thickness Affected Wall / Attic Area (sq ft)
Appliances		Manufacturer Model Number Efficiency

4.4.3.4 Project-Specific Billing Analysis

The evaluation team reviewed utility bill histories for several projects where appropriate. To be a good candidate for savings estimation using utility bill analysis approach, a project must provide energy savings equal to at least 10% of the facility's annual consumption. Secondly, at least 9 months but preferably 12 months of post-project utility bill data must be available at the time of the analysis. Thirdly, conditions at the facility should be relatively static, except for the project of interest. The installation of other energy efficiency measures or other major changes at the facility makes billing analysis inappropriate for project-specific savings estimation. If a project was deemed to be a good candidate for utility bill analysis, then the evaluation team employed IPMVP Option C to estimate energy savings, normalizing for monthly variation in weather conditions.

4.4.3.5 Project-Specific Trend Data Analysis

The evaluation team incorporated project-specific trend data for some projects in the evaluation sample in accordance with IPMVP Option B. Trend data was collected from building energy management systems or other on-site data collection systems whenever available. The period of data collection varied depending on the type of project being evaluated and ranged from a few weeks to several months as available.

4.4.3.6 Algorithm-Based Impact Analysis Methods

Because of the custom nature of the projects that participated in the Site Specific program, a wide array of custom analysis methods were utilized and tailored to each individual project. In many cases, if the evaluation team agreed with the program team's savings methodology, then the evaluation team used the same methodology for the project evaluation, updating only the input values and assumptions based on the results of onsite inspections or other data collection. In some cases, the evaluation team used a different methodology, especially where billing data or trend data allowed for savings to be calculated from measured data.

The evaluation team applied key algorithms for multiple projects, as described in the following sections.

Lighting Projects

The evaluation team utilized the same approach for the lighting projects as described in the methodology section for the Prescriptive Lighting Program (Section 4.2.3.4)

HVAC Replacements

For HVAC projects various permutations of Equation 4-7 were utilized to calculate savings, as applicable:

Equation 4-7: HVAC Replacement Energy Savings Calculation

$$\Delta kWh = EFLH \times kBtuH \times \left(\frac{1}{IEER_{base}} - \frac{1}{IEER_{ee}}\right)$$

Shell (Commercial Insulation)

The evaluation team utilized the same approach for the commercial insulation projects as described in the methodology section for the Prescriptive Other Programs (Section 4.3.3.4)

4.4.4 Findings and Recommendations

The evaluation team found that the 2016-2017 Site Specific program achieved energy savings relatively close to its reported performance, with a program-level realization rate of 92% (Table 4-18). Lighting measures accounted for half of the Site Specific program savings and therefore the lighting realization rate of 88% is the primary driver for the overall program-level realization rate. Overall, the evaluation team recommends that Avista continue to use performance-based incentives for projects with large savings.

Table 4-18: Site Specific Program Realization Rate Results

Program	Sample Unique Projects	Energy Realization Rate	Relative Precision (90% Confidence)
Site Specific	68	92%	8%

Measure-level realization rates for measures where more than one project was included in the evaluation sample are presented in Table 4-19.

Table 4-19: Site Specific Measure-Level Gross Verified Savings

Measure	Sample Unique Projects	Energy Realization Rate
Appliances	2	100%
HVAC Combined	5	100%
Industrial Process	7	93%
Lighting (Exterior)	13	107%
Lighting (Interior)	26	88%
Shell	11	63%

Lighting Project Findings

The review of lighting projects in the evaluation sample for the Site Specific program showed that Avista is generating high quality savings estimates for exterior lighting projects, with measure-level realization rate of 107%. The evaluation team found a realization rate of 88% for interior lighting projects, predominately driven by inconsistencies in reported hours of use values. It is recommended that Avista provide a greater level of review of reported hours of use for large lighting projects.

Shell (Commercial Insulation) Findings

The algorithm the evaluation team applied for cooling season savings is more conservative than what Avista is using. The program utilizes an algorithm that estimates savings based on reduced solar radiation loads. The evaluation team reviewed the SEEM model outputs included in the RTF's workbook for Small Commercial Weatherization for Avista's service territory and determined the program's radiation-based algorithm may be overstating savings. We opted to apply only a conduction-based algorithm, similar to the heating savings algorithm, because the results aligned more closely with the SEEM values. This difference of approach is the primary driver in the 63% realization rate for Shell measures. However, since this measure makes up only 2% of the total program savings, the impact on the program realization rate is minimal.

Appliances Findings

The evaluation team found that Avista is appropriately estimating savings for the Site Specific Appliance projects. No significant discrepancies were found.

HVAC Combined Findings

The evaluation team found that Avista is appropriately estimating savings for the HVAC Combined projects. No significant discrepancies were found.

Industrial Process Findings

The evaluation team found a 93% realization rate for industrial process measures, based on a few minor discrepancies found between the evaluation team's analysis and Avista's analysis. No major discrepancies were noted.

Table 4-20 shows the total gross verified savings for the Site Specific program.

Table 4-20: Site Specific Gross Verified Savings

Program	2016-2017 Reported Energy Savings (kWh)	Realization Rate	2016-2017 Gross Verified Energy Savings (kWh)
Site Specific	13,845,706	92%	12,712,754

4.5 Small Business

4.5.1 Overview

The Small Business (SB) program is a third-party-administered (SBW Consulting), direct installation/audit program, providing customer energy efficiency opportunities by:

1) Directly installing appropriate energy-saving measures at each target site
2) Conducting a brief onsite audit to identify customer opportunities and interest in existing Avista programs
3) Providing materials and contact information so that customers are able to follow up with additional energy efficiency measures under existing programs.

Direct-install measures include:

- Faucet aerators
- Showerheads
- Pre-rinse spray valves
- Screw-in LEDs
- Smart power strips
- CoolerMisers
- VendingMisers

The evaluation team conducted onsite verification, documentation audits, and engineering analysis to determine verified gross savings for each measure in the program.

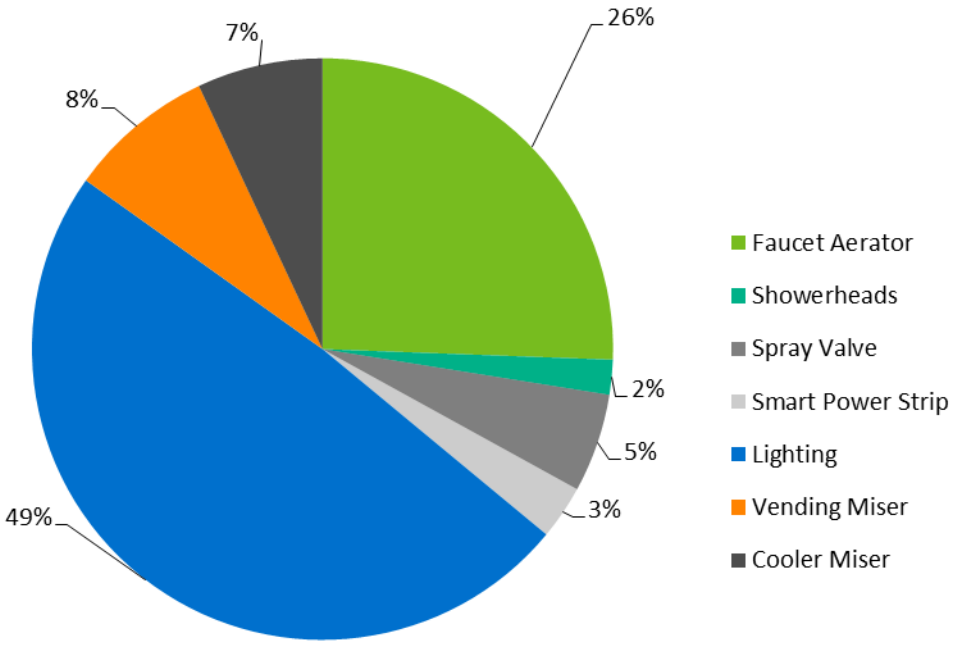
4.5.2 Program Achievements and Participation Summary

A total of 7,879 unique measures were installed at approximately 2,939 unique premises through the Small Business program in Washington throughout 2016 and 2017. Table 4-21 and Figure 4-5 summarize Avista's 2016-2017 Small Business Program reported electric energy impacts by measure type.

Table 4-21: 2016-2017 Small Business Program Reported Energy Savings by Measure

Measure	2016-2017 Reported Unique Measure Count	2016-2017 Reported Energy Savings (kWh)	% Electric Savings
Faucet Aerator	2,920	763,968	26%
Showerheads	85	57,788	2%
Spray Valve	136	163,771	5%
Smart Power Strip	588	89,687	3%
Lighting	3,822	1,458,901	49%
Vending Miser	136	243,412	8%
Cooler Miser	192	208,910	7%
Total	**7,879**	**2,986,437**	**100%**

Figure 4-5: Small Business Program Reported Energy Savings Shares



4.5.3 Methodology

The gross program energy impacts for the Small Business program were evaluated through a combination of documentation audits and onsite inspections of a representative sample of completed program projects.

4.5.3.1 Sampling

The evaluation team selected a simple random sample of 39 project sites for the impact evaluation of the Small Business program. Onsite verification was performed on a sub-sample of 18 sites. The 39 sampled project sites collectively accounted for a total of 679 unique electric measures and 187 unique natural gas saving measures, as reported by the program implementer. Table 4-22 summarizes the achieved sample size.

Table 4-22: Small Business Program Impact Evaluation Achieved Sample

Program	Document Audit	On-Site Verification
Small Business	39	18

4.5.3.2 Document Audits

The evaluation team conducted a review of the project documentation for each sampled project, including invoices, savings calculations, work order forms, equipment specification sheets, and any other project records that may exist. Thorough review of this documentation was the first crucial step in evaluation of each project.

4.5.3.3 Onsite Inspections

The impact evaluation activities included telephone surveys, documentation audits, and onsite inspections for the entire sample. A telephone survey served as an introduction to the evaluation activities and was used to confirm that the customer participated in the program, confirm the appropriate contact, and to verify basic information such as building type and building size. Arrangements for onsite inspections were then made during the telephone survey.

The onsite inspections were used to determine whether:

- The measure tracking database correctly represented the work that was done at each site
- The measures remained installed and were operational
- There were any opportunities for measure installation that were missed

Field engineers were equipped with a custom field data collection tool designed to capture the relevant data points for each measure included in the program. Table 4-23 summarizes the information that was collected for each measure type during the onsite inspection. All parameters needed to support the savings analysis of a project were collected, including, but not limited to, fixture counts, hours of operation, and water heater fuel type.

Table 4-23: Small Business Program Onsite Data Collection

Measure Type	Key Parameters
All Facilities	Number of occupants Business Type Operating Hours, posted or otherwise Water Heater Type (Tank or Tankless) Water Heater Fuel Type (Natural Gas or Electric)
Lighting	Quantity of Lamps Installed Quantity of Lamps Decommissioned Lighting Hours of Use Pre- and Post-retrofit Lamp Wattage
Faucet Aerators Pre-rinse Sprayers Showerheads	Quantity of Efficient Fixtures/Aerators Installed Quantity of Efficient Fixtures/Aerators Decommissioned Device Flow Rate Water Heater Type Facility Hot Water Load
Tier 1 Smart Power Strips	Quantity Installed Quantity Decommissioned Connected Plug Loads Baseline Conditions

4.5.3.4 Impact Analysis Methods

The evaluation team estimated gross verified savings using the field verified quantities and the program-specified deemed savings value for each measure. The deemed savings values used by the program originate from a variety of sources including (UES) measures from the Regional Technical Forum (RTF), California DEER database[5], and the findings of the 2014-2015 Impact Evaluation. Verified energy savings were generally calculated for each measure using Equation 4-8:

Equation 4-8: Small Business Program Energy Savings Calculation

$$\Delta kWh = Quantity\ Verified\ x\ kWh\ Saved/Unit$$

Where:

Quantity Verified = Quantity of devices/fixtures/lamps verified onsite

kWh Saved = Program-stipulated electric energy (kWh) saved per unit installed

4.5.4 Findings and Recommendations

The gross verified electric energy savings for the sample of reviewed projects resulted in an overall program realization rate of 103%. Realization rates for any measure wherein more than 5 quantities were reviewed are presented in Table 4-24.

[5] http://www.deeresources.com/

Table 4-24: Small Business Program Realization Rate Summary

Measure	Sampled Quantities	Electric Energy Realization Rate	Relative Precision (90% Confidence)
Faucet Aerators	69	101%	12%
Smart Power Strip	10	112%	
Lighting	595	107%	
Total Program	**679***	**103%**	**12%**

*Also includes 5 measures evaluated for Cooling Miser, Vending Miser, Spray Valves, and Showerheads

The evaluation team found a greater than 100% realization rate for the majority of electric measures assessed. The evaluation team understands that the Small Business program implementer applied the realization rates and decommissioned rates from the 2014-2015 evaluation to the deemed savings values noted in Avista's Technical Reference manual. The evaluation team utilized the deemed savings value per measure and applied the persistence rate found during the current evaluation to the TRM value, therefore resulting in a gross verified savings values greater than the reported values. In summary, the Small Business program implementer improved their tracking of decommissioned measures in the 2016-2017 biennium. The following subsection outlines the persistence rates found for the current evaluation.

4.5.4.1 Installation Persistence

The program implementer keeps track of measures that are decommissioned by program participants, when program participants inform the implementer that they have removed measures. The evaluation team evaluated the persistence of measures installed for program participants, or the percent of measures that were removed by participants wherein the implementer was not informed of the removal. Table 4-25 provides a summary of the reported installation quantities, the verified installation quantities, and the persistence rate for all measures where greater than 10 measure quantities were evaluated. Overall, the program had a high persistence rate with 98% of the total quantity of measures still installed at the time of the evaluation activities.

Table 4-25: Small Business Installation Persistence

Measure	Sample Reported Quantity*	Sample Verified Quantity	Persistence Rate
Faucet Aerator (0.5 GPM)	120	120	100%
Faucet Aerator (1.0 GPM)	37	34	92%
Showerhead	22	21	95%
Lighting	595	588	99%
Overall	**774**	**761**	**98%**

*Includes measures associated with both gas and electric savings

Table 4-26 shows the total gross verified savings for the Small Business Program in total.

Table 4-26: Small Business Program Gross Impact Evaluation Results

Program	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
Small Business	2,986,437	103%	3,090,422

4.6 Nonresidential Sector Results Summary

Table 4-27 lists the gross verified savings for each of Avista's nonresidential programs in Washington in 2016-2017. The Washington electric nonresidential sector achieved an 83% realization rate and the relative precision of the program-level electric realization rate was ±12% at the 90% confidence level

Table 4-27: Nonresidential Program Gross Impact Evaluation Results

Washington Electric Nonresidential Program	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Verified Gross Savings (kWh)
Energy Smart Grocer	3,066,726	97%	2,966,084
Food Service Equipment	200,090	97%	193,524
Green Motors	100,830	97%	97,521
Motor Controls HVAC	697,760	97%	674,861
Prescriptive Water Heat	4,886	97%	4,726
Prescriptive Lighting	77,964,819	80%	62,720,933
Shell (Commercial Insulation)	19,335	97%	18,700
Fleet Heat	16,000	97%	15,475
AirGuardian	53,092	97%	51,350
Small Business	2,986,437	103%	3,090,422
Site Specific	13,845,706	92%	12,712,754
Nonresidential Total	**98,955,682**	**83%**	**82,546,350**

5 Residential Impact Evaluation

The following sections outline the impact evaluation methodology and findings for each of the evaluated residential programs and the low income program.

5.1 Overview

Avista offered six electric incentive-based residential programs, one residential behavioral program (Home Energy Reports), and the low income program in their Washington service territory in 2016 and 2017. The reported savings for these residential programs are summarized in Table 5-1.

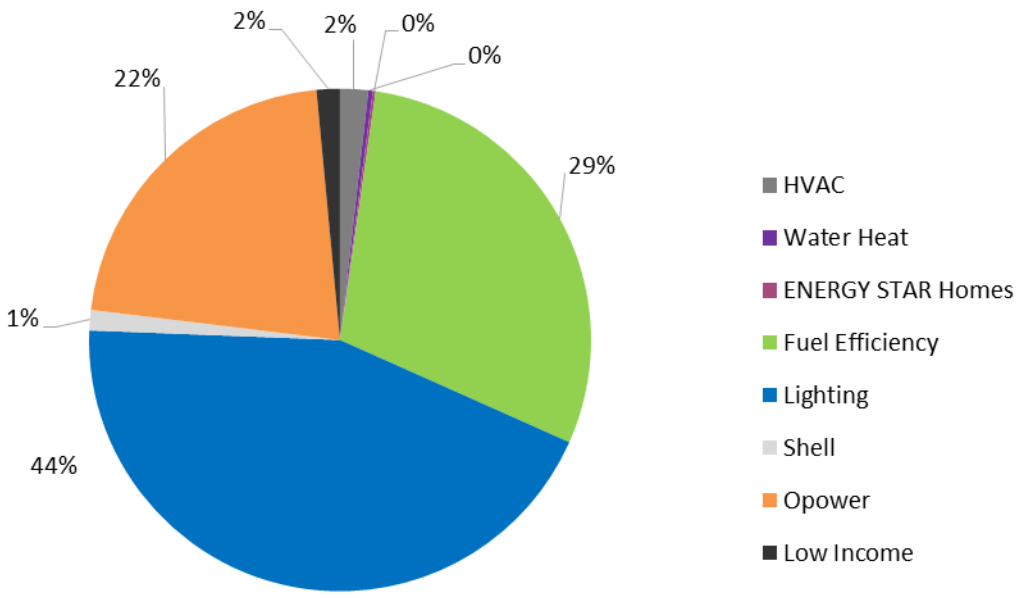
Table 5-1: Residential Program Reported Savings

Washington Electric Program	2016–2017 Participation Count	2016–2017 Reported Savings (kWh)
HVAC	2,035	1,546,894
Water Heat*	4,252	435,442
ENERGY STAR Homes	24	153,562
Fuel Efficiency	2,677	25,215,201
Lighting**	1,707,991	37,680,674
Shell	524	1,123,113
Home Energy Reports***	48,941	18,512,339
Low Income****	19,943	1,286,095
Residential Total	**1,786,387**	**85,953,320**

*Includes counts for both projects and Simple Steps showerheads
**Denotes bulb count and includes Simple Steps and Giveaway
***Number of participants in the Treatment in April, 2016
****Includes both projects and counts of bulbs

The Lighting program contributes the largest share of the reported savings, 44% as shown in Figure 5-1. Fuel Efficiency is the next largest contributor at 29%.

Figure 5-1: Residential Program Reported Energy Savings Shares



The evaluation team designed a sampling strategy for these programs placing the most emphasis on the programs with the highest projected savings and the highest level of uncertainty. As part of the evaluation activities, document audits and telephone surveys were conducted, as shown in Table 5-2. Engineering activities included review of savings calculation methodology and assumptions, utility bill analysis, and energy savings analysis.

Table 5-2: Residential Program Achieved Evaluation Sample

Electric Residential Program	Achieved Precision at 90% Confidence	Document Audit	Surveys
HVAC Program	census	113	-
Water Heat Program	census	59	-
ENERGY STAR Homes	14.4%	68	-
Fuel Efficiency	7.1%	76	45
Residential Lighting Program	census	-	-
Shell Program	44.9%	83	43
Home Energy Reports	5.8%	-	-
Low Income	12.8%	127	-
Residential Total	**4.3%**	**526**	**88**

5.2 HVAC Program

5.2.1 Overview

Avista internally manages the HVAC program which encourages the implementation of high efficiency HVAC equipment and smart thermostats through direct incentives issued to the customer after the measure has been installed. The evaluation team used a combination of desk reviews and billing analysis to estimate the gross-verified savings for the program.

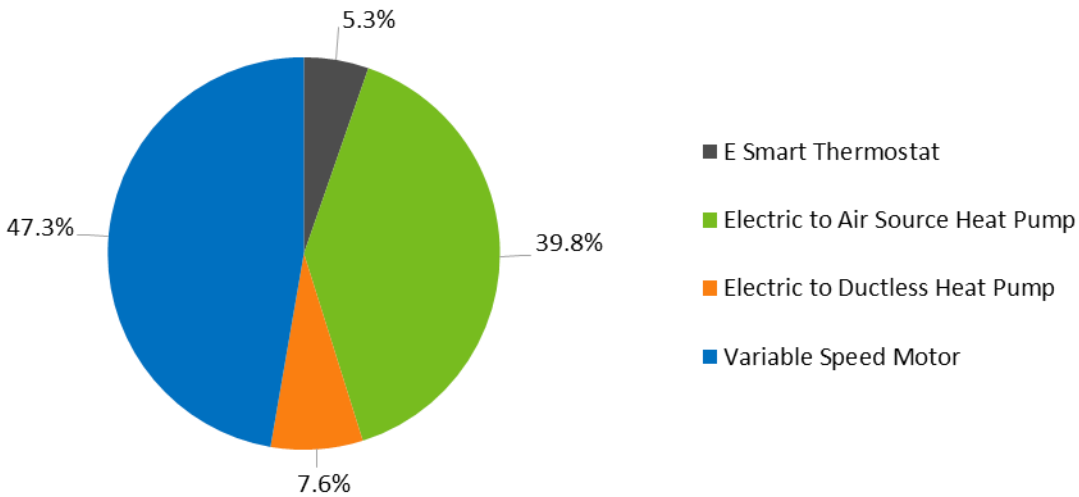
5.2.2 Program Achievements and Participation Summary

Participation in the 2016–2017 HVAC program, and resulting energy impacts, are summarized in Table 5-3 Figure 5-2

Table 5-3: HVAC Program Reported Participation and Savings

Measure	2016–2017 Reported Measure Count	2016–2017 Reported Savings (kWh)
E Smart Thermostat	132	82,561
Electric to Air Source Heat Pump	147	615,647
Electric to Ductless Heat Pump	52	117,468
Variable Speed Motor	1,704	731,218
Total	**2,035**	**1,546,894**

Figure 5-2: 2016–2017 HVAC Program Reported Energy Saving Shares



5.2.3 Methodology

The evaluation team investigated measures under the residential HVAC program separately but utilized similar methods across multiple measures. The following four measure categories were analyzed:

- Air Source Heat Pump (ASHP)
- Natural Gas Furnace
- Electric Variable Speed Motor
- Smart Thermostat

We conducted 113 document audits as part of our evaluation activities. As discussed in Section 3.4.1, these document audits were conducted to confirm participation in the program, confirm efficiency levels of installed equipment as applicable, check that Avista reported data matched project files and that Avista is reporting the savings value for each applicable measure as noted in their Technical Reference Manual (TRM). The evaluation team also conducted a review of Avista's complete 2016 and 2017 program databases to check for errors in measure-level reporting.

5.2.3.1 Regional Technical Forum Review

With the exception of variable speed motors, each measure rebated in the HVAC program has a stipulated deemed savings value provided in the Regional Technical Forum (RTF). As Avista programs may claim RTF savings for applicable measures, the evaluation team reviewed RTF measure workbooks for air source heat pumps, ductless heat pumps, and smart thermostats. The evaluation team referenced RTF workbooks that corresponded to the 2016-2017 biennium. Based on the review, the evaluation team cited the following per unit savings to verify the HVAC program impacts presented in **Error! Reference source not found.**.

Table 5-4: RTF Deemed Savings for HVAC Program

Measure	Per Unit Saving (kWh)	Baseline	Heating/ Cooling Zone	Workbook Version
E Smart Thermostat	549	Electric forced air furnace or heat pump; retail or direct install	2	1.0
Electric to Air Source Heat Pump	3,605	Electric forced air furnace with central air conditioner - house with good insulation	2	4.1
Electric to Ductless Heat Pump	2,259	Zonal heating/cooling	2	4.1

The variable speed motor savings were deemed based on the program reported savings as no RTF value was available.

5.2.4 Findings and Recommendations

The findings from the document audits and database review found that all records matched between the Avista reported database and the project documentation. Additionally, we reviewed participant consumption data and found participants averaged approximately 20,945 kWh

annual consumption during the pre-treatment period. This level of annual consumption indicates a likely high saturation of electric resistance heating in customer homes.

Table 5-5 outlines the program reported and gross verified savings value for each measure in the HVAC program. The evaluation team found a 94% realization rate across the entire HVAC program. Air source heat pumps achieved a realization rate of 86% while smart thermostats achieved an 88% realization rate. Ductless heat pumps and variable speed motors both achieved a 100% realization rate. The lower realization rates for air source heat pumps and smart thermostats are due primarily to the fact that reported savings were adjusted midstream during the 2016-2017 biennium.

Table 5-5: HVAC Program Gross Verified Savings

Measure	2016-2017 Reported Participation Count	2016-2017 Reported Savings (kWh)	Reported Savings per unit	Verified Savings	RR	2016-2017 Gross Verified Savings
E Smart Thermostat	132	82,561	625	549	88%	72,468
Electric to Air Source Heat Pump	147	615,647	4,188	3,605	86%	529,935
Electric to Ductless Heat Pump	52	117,468	2,259	2,259	100%	117,468
Variable Speed Motor	1,704	731,218	429	429	100%	731,016
TOTAL	**2,035**	**1,546,894**	**-**	**-**	**94%**	**1,450,887**

5.3 Water Heat Program

5.3.1 Overview

The evaluation team's assessment of the Water Heat program included analysis and verification of electric water heating-related measures offered by Avista including clothes washers, electric water heaters, and low flow showerheads. Incentives for both clothes washers and showerhead measures were offered through the Simple Steps upstream program.

5.3.2 Program Achievements and Participation Summary

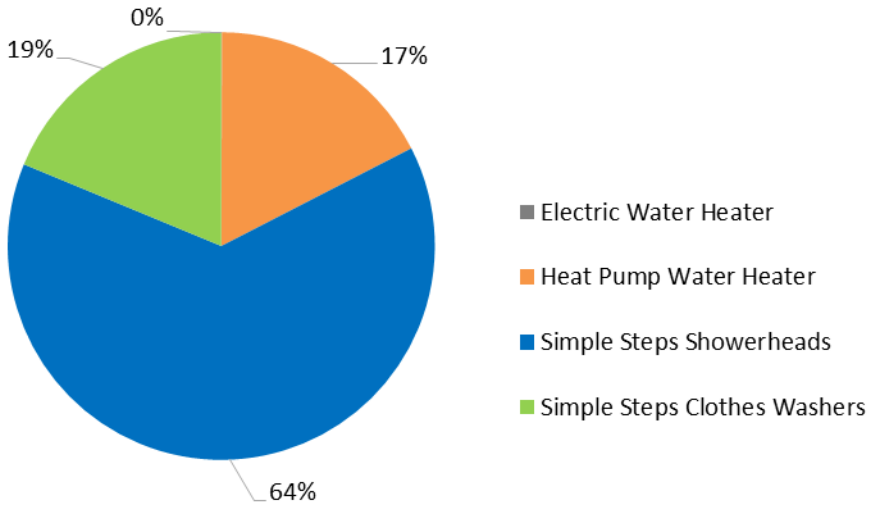
Participation in the 2016–2017 Water Heat program included distinct showerhead and clothes washer counts from Simple Steps, and rebated water heaters offered directly through Avista. Table 5-6 and Figure 5-3 summarizes Avista's 2016–2017 Water Heat program participation and energy impacts.

Table 5-6: 2016–2017 Water Heat Reported Participation and Savings

Measure	2016–2017 Reported Measure Count	2016–2017 Reported Savings (kWh)
E Electric Water Heater	2	220
Heat Pump Water Heater	58	75,748
Simple Steps Showerheads*	3,073	277,787
Simple Steps Clothes Washers	1,119	81,687
Total	**4,252**	**435,442**

*Inclusive of 1.5, 1.75, and 2.0 gpm low flow showerheads

Figure 5-3: 2016–2017 Water Heat Program Reported Energy Saving Shares



5.3.3 Methodology

The evaluation team performed verification of the program measures through two distinct methods based on whether the measure was rebated by Avista or purchased through the Simple Steps retail program.

Verification of Avista rebated measures is designed to confirm the program tracking database is aligned with project documentation. This verification included a review of sampled project documentation (project application materials and supporting invoices), survey results[1], and a participation database review. These sources were used to compare reported energy savings and unit efficiency to assess if the data recorded in the program tracking database was accurate.

Simple Steps showerheads and clothes washers were verified using deemed savings values from the Simple Steps database as reported to Avista. This database review included a cross-reference with the RTF-sourced BPA database from which Simple Steps sourced savings values (as diagrammed in Figure 5-8 in Section 5.6.3).

5.3.4 Findings and Recommendations

Based on the database reviews for both Simple Steps and Avista rebated Water Heat measures, the evaluation team did not identify any errors. The evaluation team assessed and agreed with the savings value being reported for the Simple Steps clothes washer and electric water heater measures. Therefore, these measures have been assigned a 100% realization rate.

The evaluation team also assessed and agreed with the savings value being reported at each measure level for Simple Steps showerheads. However, Avista assumes that 50% of Simple Steps showerheads are tied to an electric Water Heater. The evaluation team assumes 59.51% of showerheads are tied to an electric water heater per RBSA[2], which results in a 119% realization rate for this measure. The total program realization rate and savings are presented in Table 5-7.

Table 5-7: Water Heat Program Gross Verified Savings

Measure	2016-2017 Reported Savings (kWh)	Realization Rate (%)	2016-2017 Gross Verified Savings (kWh)
Electric Water Heater	220	100%	220
Heat Pump Water Heater	75,748	100%	75,748
Simple Steps Showerheads	277,787	119%	330,645
Simple Steps Clothes Washers	81,687	100%	81,687
Total	**435,442**	**112%**	**488,300**

[1] The 2016-2017 evaluation's weighted sampling approach did not specifically target water heat participants; however, 27 participants targeted for the sample also reported having installed a water heat related measure during the evaluation timeframe.

[2] https://neea.org/docs/reports/residential-building-stock-assessment-single-family-characteristics-and-energy-use.pdf?sfvrsn=8

5.4 ENERGY STAR® Homes

5.4.1 Overview

The ENERGY STAR® Homes program provided new home buyers with an $800 rebate for an ENERGY STAR ECO-rated new manufactured home or $1,000 for an ENERGY STAR stick-built home. Reported energy saving assumptions did not change for the ENERGY STAR Homes program between the 2014-2015 and 2016-2017 program years. As the program parameters did not change, the evaluation team conducted a document review and database review for 2016-2017 participants and used the realization rate from the 2014-2015 evaluation cycle to calculate verified savings.

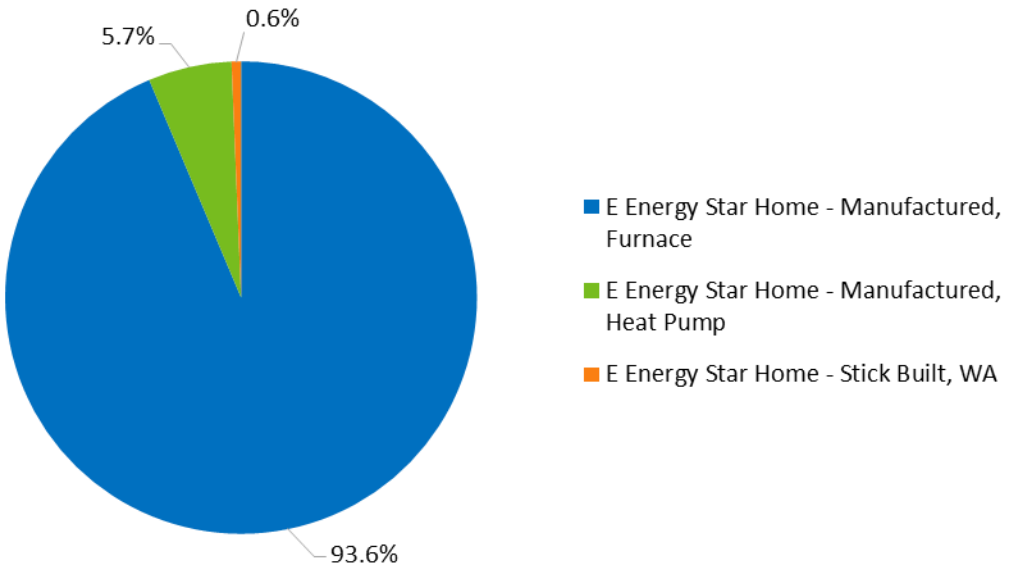
5.4.2 Program Achievements and Participation Summary

Participation and energy impacts in the 2016-2017 ENERGY STAR Homes program are summarized in Table 5-8 and Figure 5-4 below.

Table 5-8: 2016–2017 ENERGY STAR® Homes Reported Participation and Savings

Measure	2016–2017 Reported Participation Count	2016–2017 Reported Savings (kWh)
E Energy Star Home - Manufactured, Furnace	21	143,787
E Energy Star Home – Manufactured, Heat Pump	2	8,780
E Energy Star Home – Stick Built, WA	1	995
TOTAL	**24**	**153,562**

Figure 5-4: 2016–2017 ENERGY STAR® Homes Program Reported Energy Saving Shares



5.4.3 Methodology

The evaluation team conducted a document audit of 68[3] ENERGY STAR Homes application materials along with a participation database review to ensure accurate program savings values were recorded. The document audit and database review did not find any errors in reporting of savings values for Washington Electric 2016-2017 ENERGY STAR Homes participants. As the ENERGY STAR Homes program qualification and savings parameters did not change between the 2014-2015 and 2016-2017 biennium, the evaluation team utilized the realization rate for ENERGY STAR Homes from the 2014-2015 evaluation cycle to calculate verified savings for the 2016-2017 biennium. For the analysis method used in the prior evaluation, the evaluation team collected Home Energy Rating System (HERS) Index scores for participating ENERGY STAR Homes. A baseline HERS Index score of 80 was assumed as standard for non-program new meter hookups. The evaluation team estimated weather normalized annual consumption for ENERGY STAR Homes using the same basic model specification shown in Equation 3-3 and Equation 3-4. Because these newly built homes do not have a pre-retrofit period, only "post-retrofit" consumption was estimated by the model[4].

Equation 5-1 shows the calculation of estimated consumption absent the program.

Equation 5-1: Calculation of Consumption Absent Program

$$\mathrm{kWh_{NP}} = \mathrm{kWh_P} \times \frac{\mathrm{HERS_{Base}}}{\mathrm{HERS_{Home}}}$$

Table 5-9 provides additional information about the terms in Equation 5-1.

Table 5-9: Calculation of Consumption Absent Program Definition of Terms

Variable	Definition
kWh_{NP}	Estimated electric energy consumption in home absent the program
kWh_{P}	Weather normalized annual consumption of the home
$HERS_{Base}$	2012 IECC HERS Index Score for climate zone 5 = 80
$HERS_{Home}$	HERS Index Score for the home

Table 5-10 shows the 2014-2015 evaluation calculations for electric savings and realization rate for ENERGY STAR Stick Built homes in Washington.

[3] Included projects in both WA and ID

[4] To determine verified energy savings, a recommendation from the 2014-2015 evaluation was that Avista track more detailed characteristics of the ENERGY STAR® program homes and non-program homes to allow for a reliable non-participant comparison group billing analysis approach, which is preferred compared to the HERS index score approach utilized in that evaluation. Avista's response to the recommendation was that the regional program effort leverages regional savings estimates and Avista does not have access to additional data points.

Table 5-10: ENERGY STAR Home: Results for Stick Built homes in Washington from 2014-2015 Evaluation

n Homes	Ex Ante kWh	Annual kWh	Base kWh	Delta kWh	Weight	Realization Rate
2	4,734	6,861	11,694	4,833	1.7	102%

Annual consumption and realization rate for ENERGY STAR - Manufactured, Furnace homes from the 2014-2015 program evaluation are summarized in Table 5-11. Because of the small participation for the ENERGY STAR Manufactured, Heat Pump homes (three homes participated from 2014-2017), the evaluation team applied the same realization to the two participants in 2016-2017.

Table 5-11: ENERGY STAR Home: Results for Furnaces in Manufactured Homes from 2014-2015 Evaluation

n Homes	Ex Ante kWh	Annual kWh	Base kWh	Delta kWh	Weight	Realization Rate
17	6,847	14,173	23,016	8,843	1.6	129%

5.4.4 Findings and Recommendations

Table 5-12 outlines the program reported and gross verified savings value for each measure in the ENERGY STAR homes program.

Table 5-12: ENERGY STAR® Homes Program Gross Verified Savings

Measure	2016–2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
E Energy Star Home: Manufactured, Furnace	143787	129%	185,485
Energy Star Home: Manufactured, Heat Pump	8780	129%	11,326
Energy Star Home: Stick Built	995	102%	1,015
TOTAL	**153,562**	**129%**	**197,826**

Similar to recommendations in the 2014-2015 evaluation, a billing analysis would be the preferred method to assess savings as a result of ENERGY STAR Homes measures. In order to conduct a reliable billing analysis, a non-program comparison group is needed to allow for a reliable non-participant comparison group billing analysis approach. This data could be made available via the Avista billing database should Avista track the following for new service point

ID's: identifying new construction accounts with a flag, and collecting basic home information such as square footage and number of stories.

At a minimum, Avista may find more accurate savings projections by incorporating energy savings values from the prior evaluation cycle into their TRM.

5.5 Fuel Efficiency

5.5.1 Overview

The fuel efficiency program offers a rebate for the conversion of electric resistance heat to natural gas as well as the conversion of electric hot water heaters to natural gas models. The evaluation team conducted a document review, database review, telephone surveys, and a billing analysis on a sample of the population in order to estimate the gross verified savings for the program.

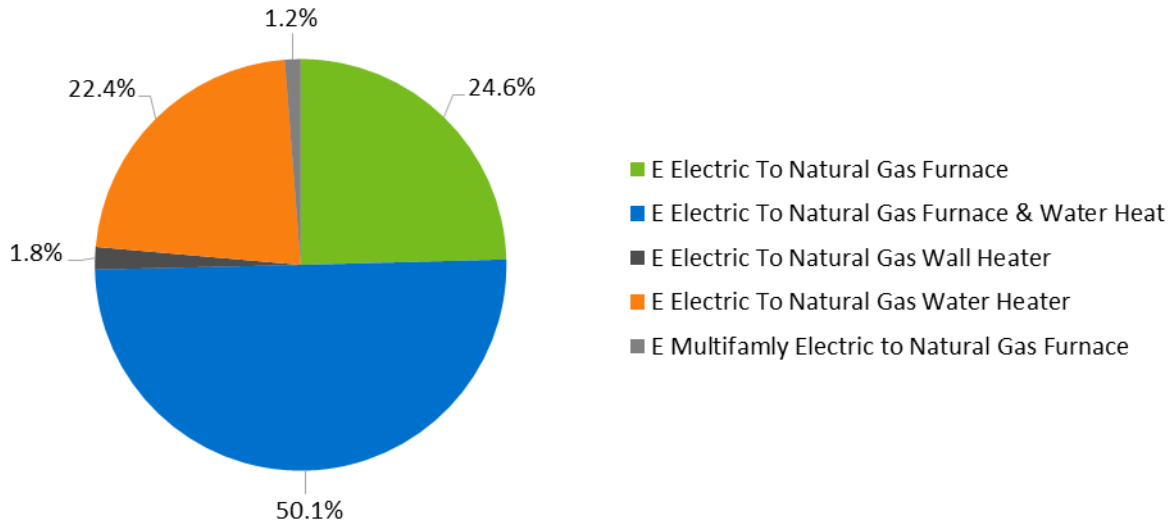
5.5.2 Program Achievements and Participation Summary

Participation in the 2016-2017 Fuel Efficiency program, and resulting energy impacts, is summarized in Table 5-13 and Figure 5-5.

Table 5-13: 2016-2017 Fuel Efficiency Reported Participation and Savings

Measure	2016–2017 Reported Measure Count	2016–2017 Reported Savings (kWh)
Electric to Natural Gas Furnace	658	5,512,927
Electric to Natural Gas Furnace & Water Heater	1,340	16,867,772
Electric to Natural Gas Wall Heater	47	385,556
Electric to Natural Gas Water Heater	599	2,377,897
E Multifamily Electric to Natural Gas Furnace	33	71,049
Total	**2,677**	**25,215,201**

Figure 5-5: 2016–2017 Fuel Efficiency Program Reported Energy Saving Shares



5.5.3 Methodology

The Fuel Efficiency program is a dynamic offering because participants modify the fuel source used for space heating and/or water heating within their residences. These measures produce a large reduction in electric consumption, which is offset by increased consumption of natural gas. The evaluation team examined the electric savings regression analysis of billing data provided by Avista.

5.5.4 Program billing analysis

The evaluation team requested monthly consumption records for each account that received a Fuel Efficiency rebate (both Washington and Idaho) from Avista in 2016 and 2017. Billing records were requested for January 2015 through February 2018 to maximize the quantity of pre- and post-retrofit data available. We filtered customers who participated in other Avista programs in order to capture effects of only the Fuel Efficiency program. This resulted in the removal of several participants in the analysis as the Fuel Efficiency program and HVAC program incent measures that are easily coupled. For example, while the Fuel Efficiency program provides a customer with an incentive to switch from electric heating to a natural gas furnace, the HVAC program provides an incentive to upgrade to a high efficient natural gas furnace as well as a variable speed motor fan. However, the evaluation team did include Fuel Efficiency participants who only upgraded to a high efficiency gas furnace through the HVAC program. The evaluation team estimated impacts using the general form of the electric regression model as shown in Section 3.4.4 of this report and the detailed regression outputs are presented in Appendix B.

5.5.5 Findings and Recommendations

Figure 5-6 below illustrates program impacts observed in the 2017 program year. The figure depicts significant impacts during the heating season as customers replaced their electric-fueled space heating with gas-fueled furnaces. Also of note is the evident baseline savings observed during the summer months reflecting the conversion from electric water heating to gas water heating.

Figure 5-6: Fuel Efficiency Post-treatment Consumption

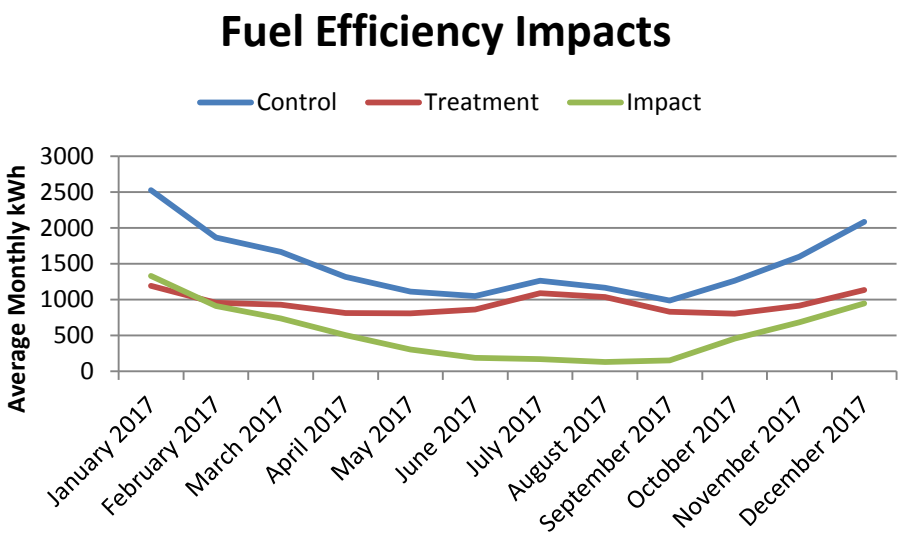


Table 5-14 outlines the program reported and gross verified savings value for each measure in the Fuel Efficiency program. The electric realization rate for the program is estimated at 62% with a relative precision of ±7.1% at the 90% confidence level.

The program realization rate remained the same relative to the prior evaluation findings. We believe this outcome is primarily the result of two issues:

- Reported savings for the 2016-2017 program cycle were on-average high as the program savings value was initially reduced in mid-Q2 2016 and then further reduced mid-Q1 of 2017 to be in alignment with evaluation results provided from the previous program cycle.

- Annual average household consumption was on average 18% lower for participants in the 2016-2017 program cycle relative to participants in the prior program cycle. If participant consumption had been similar to the previous biennium, the program realization rate would have been approximately 74%.

These two issues ultimately suppress the program realization rate. While the program reported savings per participant were estimated at 9,865 kWh on average, the evaluation team ultimately estimated average impacts per customer at 6,527 kWh.

For future program cycles, the evaluation team recommends Avista reduce their reported savings for the Fuel Efficiency program. Moreover, customer profiling will help gauge anticipated savings by understanding customers' annual consumption profile and the expected percent savings that can occur through implementation of the Fuel Efficiency program measures.

Table 5-14: Fuel Efficiency Program Gross Verified Savings

Program	2016–2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
Fuel Efficiency	25,215,201	62%	15,730,750

5.6 Residential Lighting Program

5.6.1 Overview

In 2016 and 2017, the Avista residential lighting program was comprised of two delivery streams: Simple Steps, Smart Savings™ (Simple Steps) and the Avista Bulb Giveaway.

The Simple Steps program provides discounts to manufacturers to lower the price of efficient light bulbs, light fixtures, showerheads, and appliances. This program, launched by Bonneville Power Administration (BPA) and administered by CLEAResult, operates across the Pacific Northwest. Utilities may select which reduced-price items to include in their territory. Avista's offerings included a selection of general and special CFLs, LED light fixtures, and LED bulbs that are clearly identified with a sticker indicating they are part of the Simple Steps, Smart Savings program. Retailers—big-box stores, regional chains, and national chains—are the primary recipients of the products. Beyond Simple Steps, Avista gave its customers free, energy-efficient LED lamps at corporate and regional events.

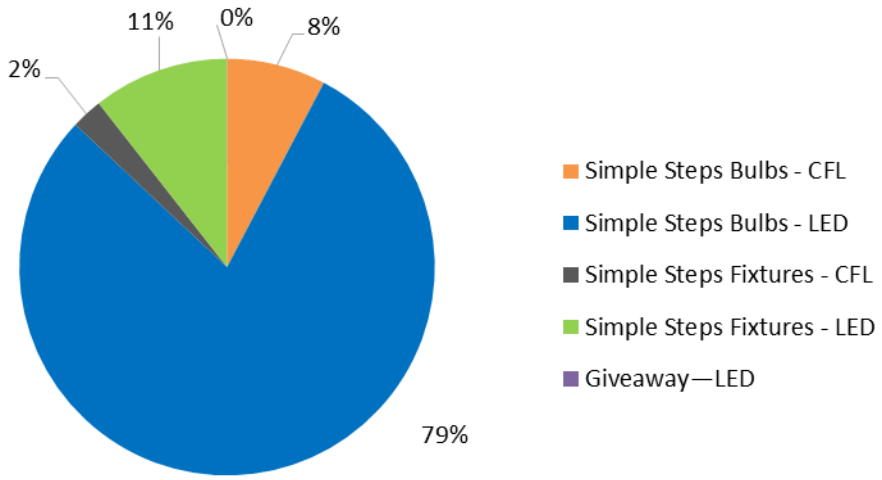
5.6.2 Program Achievements and Participation Summary

Table 5-15 and Figure 5-5 summarize Avista's 2016 and 2017 residential lighting program participation and energy impacts.

Table 5-15: 2016–2017 Residential Lighting Reported Participation and Savings

Delivery Stream - Measure	2016–2017 Reported Measure Count (Bulbs)	2016–2017 Reported Savings (kWh)
Simple Steps Bulbs – CFL	277,449	2,906,917
Simple Steps Bulbs – LED	1,316,296	29,865,675
Simple Steps Fixtures – CFL	8,633	913,285
Simple Steps Fixtures – LED	104,729	3,985,047
Giveaway—LED	884	9,751
Total	**1,707,991**	**37,680,674**

Figure 5-7: Distribution of Lighting Energy Savings by Technology Type and Program

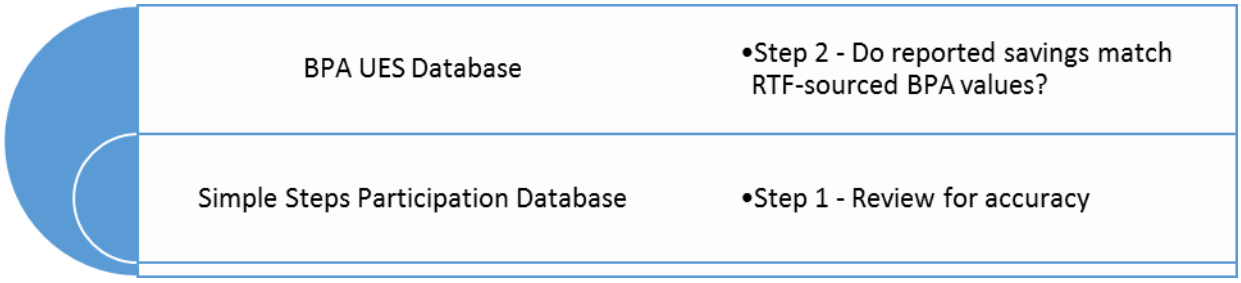


Reported energy savings are based on a per-lamp or fixture basis, using a deemed value for each lamp product type and delivery approach (i.e. retail, direct installation, giveaway) based on legacy Regional Technical Forum values.

5.6.3 Methodology

The Residential Lighting program gross impact analysis involved two distinct program components (the Simple Steps program and the Avista giveaways). For the Simple Steps program the evaluation team conducted a database review (as diagrammed in Figure 5-8). First the Simple Steps participation database as reported to Avista was reviewed for accuracy and consistency with reported energy savings values per bulb (step 1). Then the Simple Steps savings values per bulb and unique lighting type identifier were compared to the RTF-sourced BPA UES Database to ensure Simple Steps is importing correct values into the Avista participation database (step 2).

Figure 5-8: Process of the Simple Steps Database Review



The Avista giveaway bulbs represent LED lamps categorized as “LED-General Purpose and Dimmable-250-1049 lumens” in the Simple Steps database. To verify this savings value the evaluation team referenced the deemed RTF savings value for this lamp category using version 4.2 RTF lighting workbook[5].

[5] https://rtf.nwcouncil.org/measure/residential-lighting

5.6.4 Findings and Recommendations

The evaluation team found accurate reporting of lighting sales quantities and their associated savings values between the BPA UES Database and the Simple Steps Participation Database submitted to Avista.

The verified savings for Avista's bulb giveaways resulted in a minor update: Avista reported 11.03 kWh savings per bulb whereas the RTF value for the corresponding measure type is 11.22 kWh resulting in a 102% realization rate for the giveaway bulbs. The verified Simple Steps and Giveaway savings values results in an overall electric realization rate of 100% for the Residential Lighting program, as shown in Table 5-16.

Table 5-16: Residential Lighting Realization Rates and Gross Verified Savings

Delivery Stream - Measure	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
Simple Steps Bulbs — CFL	2,906,917	100%	2,906,917
Simple Steps Bulbs — LED	29,865,675	100%	29,865,675
Simple Steps Fixtures — CFL	913,285	100%	913,285
Simple Steps Fixtures — LED	3,985,047	100%	3,985,047
Giveaway — LED	9,751	102%	9,918
Total	**37,680,674**	**100%**	**37,680,842**

5.7 Shell Program

5.7.1 Overview

Avista's internally managed shell program incentivizes measures that improve the integrity of the home's envelope such as insulation (attic, floor and wall), and window replacements. The evaluation team conducted a database review, document audits, customer telephone surveys, and a billing analysis to estimate the gross verified savings for the program.

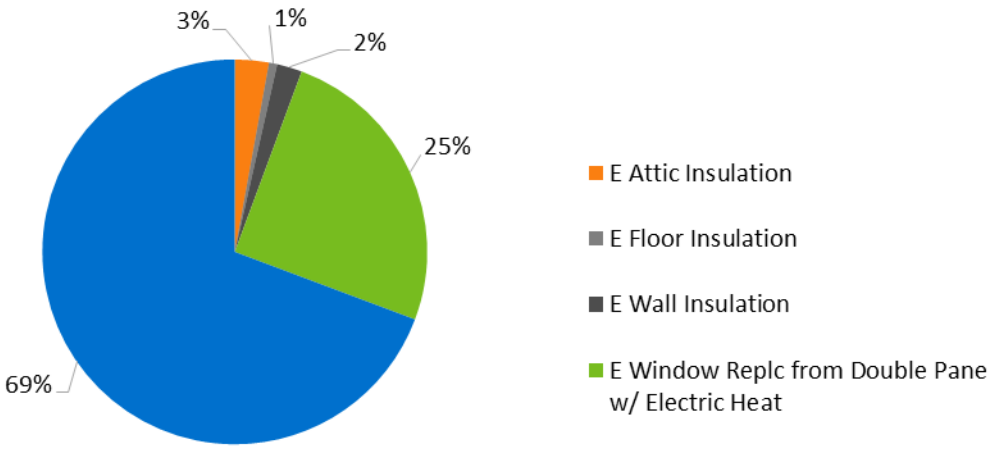
5.7.2 Program Achievements and Participation Summary

Participation and resulting energy impacts from the 2016 and 2017 Shell program are presented below in Table 5-17 and Figure 5-9.

Table 5-17: 2016–2017 Shell Program Reported Participation and Savings

Measure	2016-2017 Reported Measure Count	2016-2017 Reported Savings (kWh)
E Attic Insulation	36	32,009
E Floor Insulation	6	7,754
E Wall Insulation	11	23,716
E Window Replacement from Double Pane w/ Electric Heat	126	281,433
E Window Replacement from Single Pane w/ Electric Heat	345	778,200
TOTAL	**524**	**1,123,113**

Figure 5-9: 2016–2017 Shell Program Reported Energy Saving Shares



5.7.3 Methodology

The evaluation team conducted 68 document audits as part of our evaluation activities. As discussed in Section 3.4.1, these document audits were conducted to confirm participation in the program, confirm efficiency levels of installed equipment as applicable, check that Avista reported data matched project files and that Avista is reporting the savings value for each applicable measure as noted in their Technical Reference Manual (TRM). The evaluation team also conducted a review of Avista's complete 2016 and 2017 program databases to check for errors in measure-level reporting.

5.7.3.1 Program billing analysis

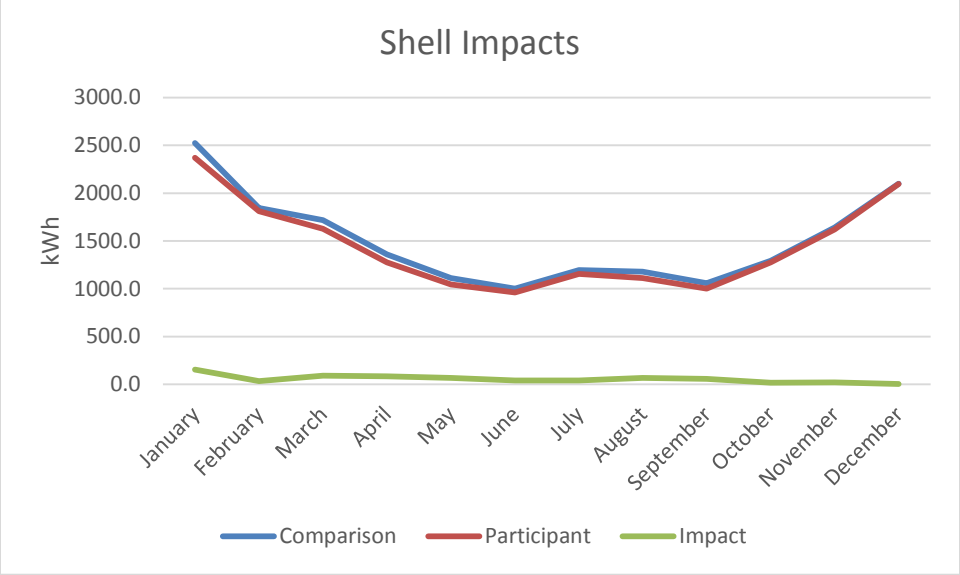
Following the same method used to estimate impacts for the HVAC and Fuel Efficiency programs, the evaluation team requested monthly consumption records for each account that received a Shell rebate (both Washington and Idaho) from Avista in 2016 and 2017. Billing records were requested for January 2015 through February 2018 to maximize the quantity of

pre- and post-retrofit data available. We filtered customers who participated in other Avista programs in order to capture effects of only the Shell program. The evaluation team estimated impacts by selecting a matched comparison group of non-participants to conduct a difference in differences regression model as discussed in Section 3.4.4 of this report and the detailed regression outputs are presented in Appendix B.

5.7.4 Findings and Recommendations

Figure 5-10 below illustrates program impacts observed in the 2017 program year. The figure denotes modest savings during the winter months and minimal savings across the summer season.

Figure 5-10: Shell Post-Treatment Impacts



The electric realization rate for the Shell program was estimated at 27% (see Table 5-18) based on an estimated 668 kWh savings per household. The relative precision of the program level electric realization rate was ±44.9% at the 90% confidence level. The precision for the analysis suffered largely due to a very low sample of participants. While the program rebated 524 measures to 487 customers over 2016 and 2017, the analysis was constrained to using just 287 customers who had sufficient post-treatment data and did not participate in other programs.

The Shell program's realization rate decreased significantly from the prior evaluation, which found a 62% realization rate. However, the prior evaluation included the UCONS Manufactured Homes program which helped offset the program's other measures' lower realization rates. Without the UCONS Manufactured Homes program, the prior evaluation's realization rate for the Shell program would have been 38%. Additionally, the average reported savings per participant increased 64% for the 2016-2017 program cycle; therefore, it is not unexpected that the realization rate decreased to 27%.

Savings from shell improvements should be realized almost exclusively through reductions in heating and cooling usage within participating homes. The evaluation team recommends Avista examine planning assumptions about per-home consumption and percent reductions in heating

and cooling loads from shell improvements. It may be that the percent reduction assumptions are sound, but they are being applied to an overstated assumption of the average electric HVAC consumption per home.

Table 5-18: Shell Program Gross Verified Savings

Program	2016–2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
Shell	1,123,113	27%	300,584

5.8 Home Energy Reports Program

5.8.1 Overview

Home Energy Report (HER) programs have been widely shown to obtain savings through reduced energy consumption among households that receive them. Avista's behavioral program relies on normative comparisons of energy usage to similar homes to increase awareness of energy consumption levels and to stimulate recipients to alter their behavior and consume less energy. The evaluation approach relies on a combination of large sample sizes and random assignment to enable straightforward quantification of associated energy savings.

HERs provide residential customers with detailed information about how their home uses energy and includes charts that compare their energy use to that of similar homes. Participants receive up to seven, but in most cases five or six, home energy reports annually.

The program launched in June 2013. Because of a change in the Avista billing system, reports were suspended and none were sent out from February to August of 2015. Reports were reinstated in September 2015 and continued normal mailings through 2017.

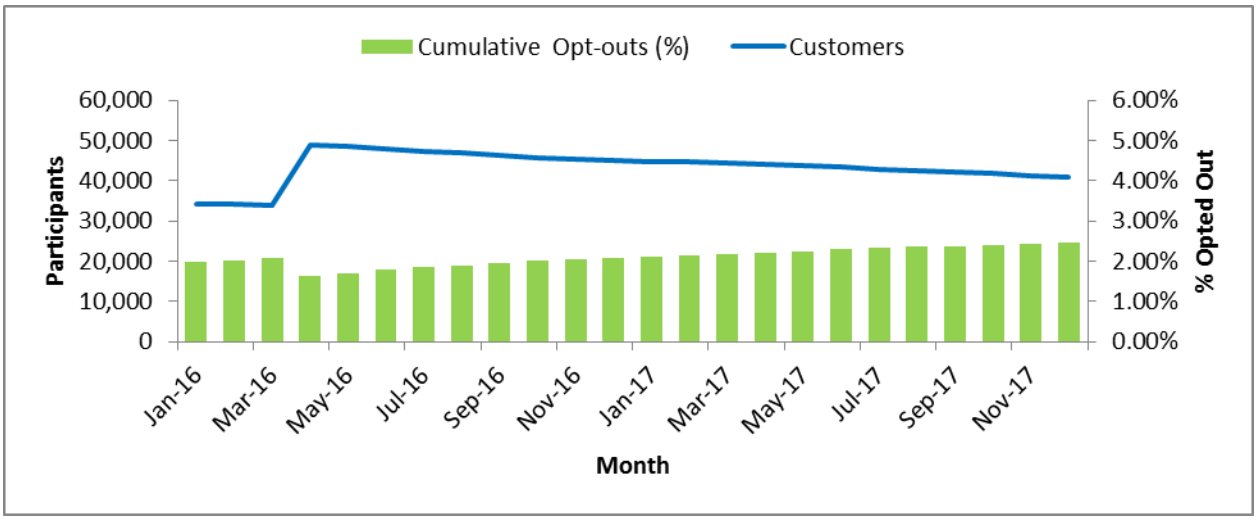
Avista added a new cohort of program participants in January 2016. Unless these customers opt out of the program or move, they will have received reports throughout the duration of the 2016-2017 biennium, beginning in April 2016.This analysis estimates combined savings from both the customers that started receiving reports in 2013 and those who started receiving reports in 2016 for the 2016-2017 biennium. Accordingly, the energy savings from January 2016 through March 2016 are attributed to the customers that started receiving reports in 2013. Energy savings from April 2016 through December 2017 are comprised of savings from both the 2013 and 2016 cohorts.

5.8.2 Program Achievements and Participation Summary

In Washington, approximately 13,000 control participants were selected and 48,300 treatment customers were randomly enrolled in the behavioral program in the original 2013 wave. An additional 15,500 treatment and 15,500 control participants were randomly added to the program in 2016. In total, 63,800 treatment and 28,500 control participants have been enrolled in Avista's behavioral program.

The Home Energy Reports program is set up as an “opt out” program, not an “opt in” program, meaning that while households are randomly selected to receive a HER, they can also choose to opt out. As with many behavioral programs, some attrition due to both account closure and opting out of the program is to be expected in the course of program operations. At the start of the 2016-2017 biennium, attrition due to opt outs and account closures reduced the original population of 48,300 treatment customers to about 34,000 customers. Figure 5-11 presents the number of treatment participants and opt outs as a cumulative percentage of total program enrollment by month in the post-period. As of December 2017, approximately 2.33% of the 63,791 customers assigned to treatment since program inception in 2013 opted out of the program.

Figure 5-11 Treatment Customer Enrollment Counts and Cumulative Opt-outs by Month



5.8.3 Methodology

5.8.3.1 Data Sources and Management

To develop estimates of the electric savings attributable to Avista’s Home Energy Report program, the evaluation team requested data covering two core components:

1) Participation records: A list of all billing accounts that are part of the initiative, treatment\control designation, date assigned, service zip code, and any demographic or rate code status information available in Avista’s customer information system.

2) Consumption History: Monthly electric billing records for each account in the treatment and control group including the meter read date and number of days in the billing period. Billing history for the period January 2015 to December 2017 was made available for the 2016 cohort and for the period February 2012 to December 2018 for the 2013 cohort.

In preparation for the impact analysis, the evaluation team combined and cleaned the billing data provided by Avista. The dataset included 61,287 distinct accounts from the original 2013 wave, 48,291 of which were assigned to the treatment group and 12,996 of which were assigned to the control group. The dataset also included 31,000 distinct accounts from the 2016

wave of participants, with 15,500 assigned to both the treatment and control groups. In total, the dataset contained 92,287 unique accounts to be evaluated, which is comprised of 63,791 treatment participants and 28,496 control customers.

The participation numbers used to calculate the aggregate impacts for each program month is the number of unique treatment accounts with billing data that month. Treatment group homes that opted out of the program were not removed from the impact analysis or the participation counts. Although this may seem counterintuitive, it is necessary to preserve the integrity of the RCT design because control group homes do not have the option to opt out and there is no way to determine which control group homes would opt out if they were assigned to treatment. This approach dilutes the per-home impacts to some extent because only ~ 99% of the participants were actively receiving HERs at a given time, but this is negated by including all active accounts in the estimation of aggregate impacts.

Like most utilities, Avista does not bill its customers for usage within a standard calendar month interval. Instead, billing cycles are a function of meter read dates and vary across accounts. Since the interval between meter reads vary by customer and by month, the evaluation team "calendarized" the usage data to reflect each calendar month, so that all accounts represent usage on a uniform basis. The calendarization process includes expanding usage data to daily usage, splitting the billing month's usage uniformly among the days between reads. The average daily usage for each calendar month is then calculated, by taking the average of daily usage within the calendar month.

5.8.3.2 Equivalence Testing

The next step in the evaluation team's analysis approach was to perform a detailed review of the assignment randomization by comparing consumption patterns for the treatment and control group for a year prior to exposure to treatment. This pre-treatment period differs by wave: the pre-period for the 2013 wave is June 2012 to May 2013 while the pre-treatment period for the 2016 wave is April 2015 to March 2016. The purpose of this analysis is to determine if structural differences in electricity consumption existed between the treatment and control group before HER exposure. Pre-treatment differences can take the form of total annual consumption or variation in the seasonality of consumption. The findings of this step are of critical importance because they will determine the appropriate model specification to estimate savings. The results of the pre-treatment equivalence tests are presented separately by cohort (2013 and 2016) since the pre-treatment timeframe differs due to the difference in timing of when participants began receiving reports. Table 5-19 displays the results of a difference in means two-sided t-test by month for the 2013 cohort to validate the randomization and confirms that there is no significant difference in usage between the treatment and control groups in the pre-treatment period June 2012 through May 2013. The results confirm that the randomization is robust and that there is no real difference in the energy consumption of the two groups.

Table 5-19 Difference in Means t-test Values – 2013 Cohort

Month-Year	Treatment Average Daily Usage: Pre-treatment	Control Average Daily Usage: Pre-treatment	T-stat	P-value
Jun-12	39.76	39.60	-0.82	0.41
Jul-12	38.17	37.87	-1.27	0.20
Aug-12	35.81	35.76	-0.19	0.85
Sep-12	42.56	42.36	-0.83	0.41
Oct-12	45.27	45.05	-1.12	0.26
Nov-12	54.36	54.33	-0.15	0.88
Dec-12	52.78	52.65	-0.43	0.66
Jan-13	52.30	52.03	-0.91	0.36
Feb-13	61.14	60.99	-0.56	0.57
Mar-13	53.10	53.07	-0.15	0.88
Apr-13	44.95	45.00	0.25	0.80
May-13	38.70	38.67	-0.17	0.86

Figure 5-12 and Figure 5-13 present usage in the pre-treatment period visually for the 2013 cohort and echoes the results of the statistical test. Figure 5-12 displays the pre-treatment equivalence through a box-plot by displaying a comparison of the control group's mean consumption and the treatment group's mean consumption broken out by month. The box and whiskers show that the treatment and control groups not only have indistinguishable mean consumption, but also the variation in consumption is also comparable. Figure 5-13 further illustrates pre-treatment equivalence by showing nearly identical consumption patterns for the treatment and control groups in the pre-treatment period.

Figure 5-12: Treatment and Control Energy Usage in the Pre-treatment Period – 2013 Cohort

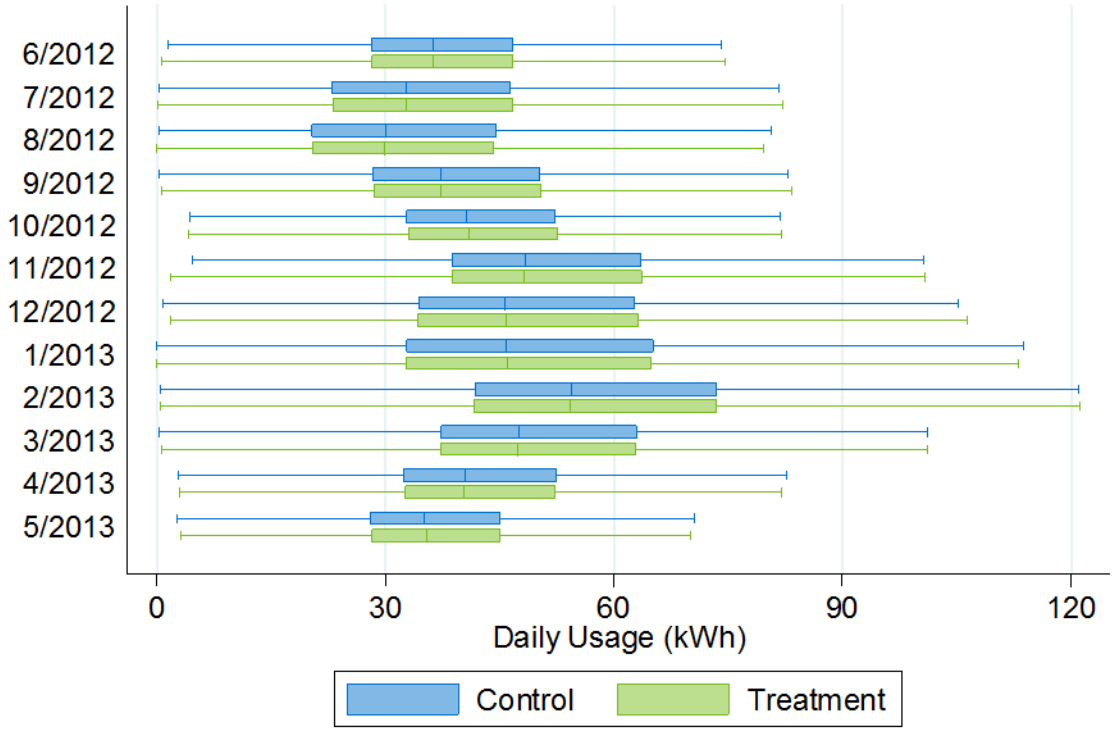


Figure 5-13: Treatment and Control Consumption in the Pre-treatment Period – 2013 Cohort

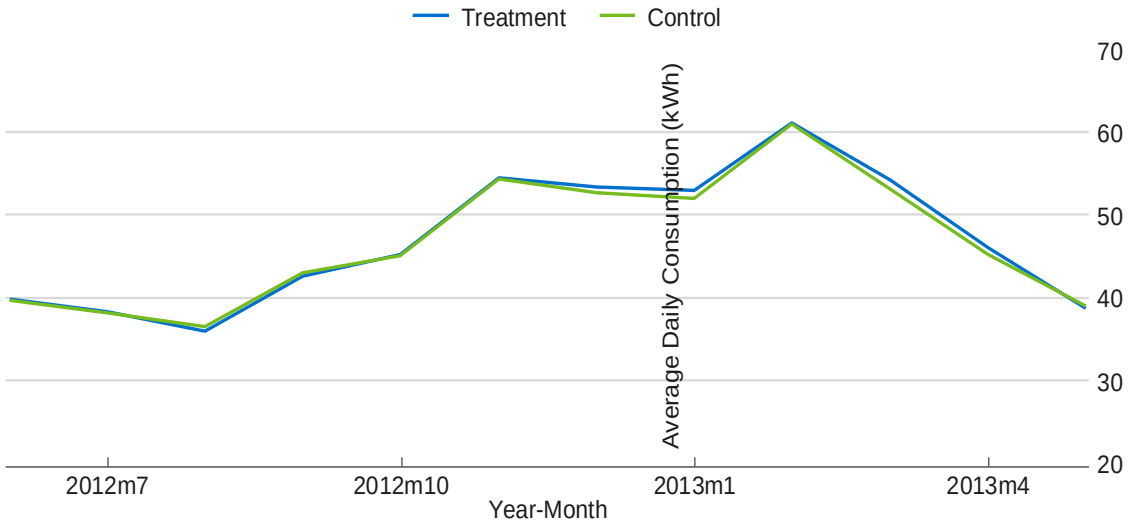


Table 5-20 presents the results of a difference in means two-sided t-test by month for the 2016 cohort to validate the randomization and confirms that there is no significant difference in usage between the treatment and control groups in the pre-treatment period April 2015 through March 2016. The results confirm that the randomization is also robust for the new cohort and that there is no real difference in the energy consumption of the treatment and control groups.

Table 5-20: Difference in Means t-test Values – 2016 Cohort

Month-Year	Treatment Average Daily Usage: Pre-treatment	Control Average Daily Usage: Pre-treatment	T-stat	P-value
Apr-15	35.54	35.56	0.15	0.88
May-15	33.91	33.90	-0.06	0.95
Jun-15	39.78	39.70	-0.42	0.67
Jul-15	43.72	43.63	-0.41	0.68
Aug-15	39.20	39.17	-0.16	0.88
Sep-15	34.30	34.32	0.10	0.92
Oct-15	35.90	35.95	0.29	0.77
Nov-15	44.28	44.28	0.02	0.98
Dec-15	52.68	52.67	0.00	1.00
Jan-16	53.06	53.16	0.31	0.76
Feb-16	46.90	47.16	0.96	0.34
Mar-16	40.27	40.59	1.45	0.15

Figure 5-14 and Figure 5-15 examine usage in the pre-treatment period visually for the 2016 cohort and echoes the results of the statistical test. Figure 5-14 displays the pre-treatment equivalence through a box-plot by displaying a comparison of the control group's mean consumption and the treatment group's mean consumption broken out by month. The box and whiskers show that the treatment and control groups not only have indistinguishable mean consumption, but also the variation in consumption is also comparable. Figure 5-15 also demonstrates pre-treatment period equivalence by showing nearly identical consumption patterns for the treatment and control groups in the pre-treatment period.

Figure 5-14: Treatment and Control Energy Usage in the Pre-treatment Period – 2016 Cohort

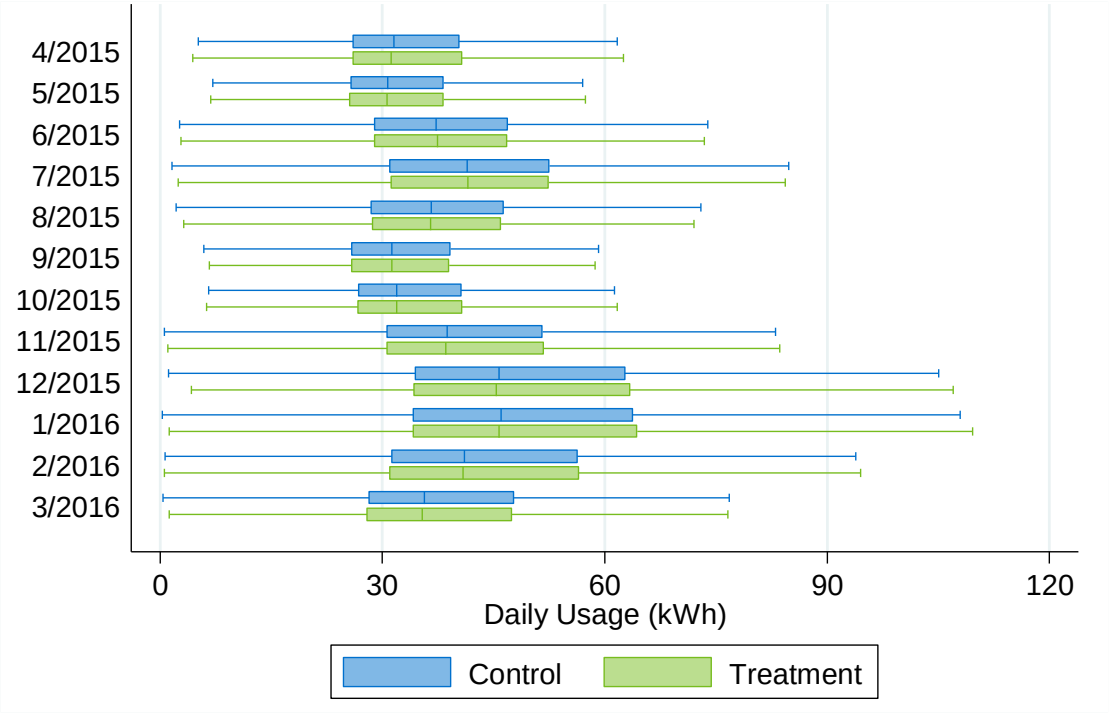
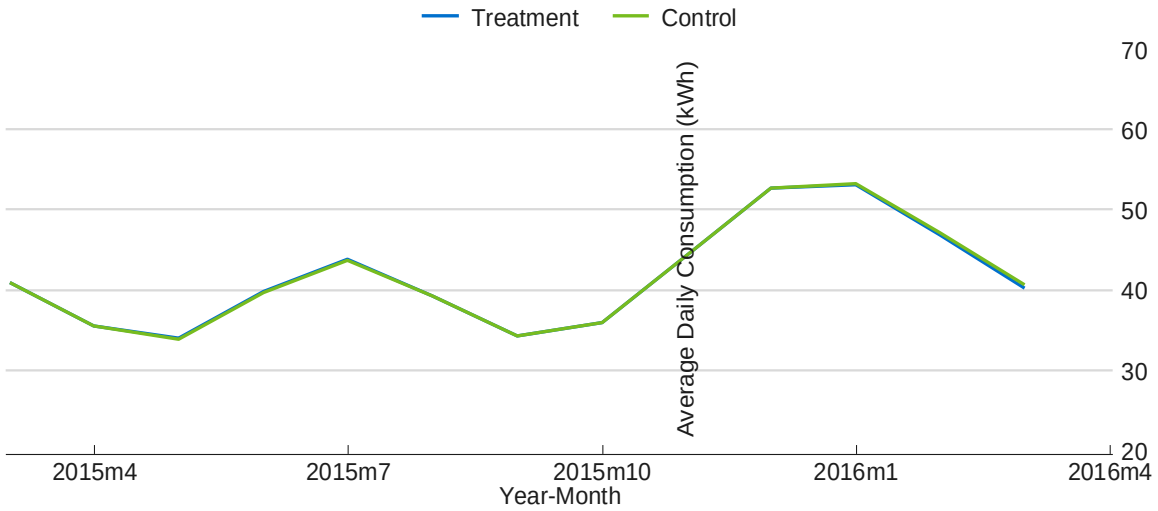


Figure 5-15: Treatment and Control Consumption in the Pre-treatment Period – 2016 Cohort



5.8.3.3 Regression Analysis

The evaluation team used a lagged dependent variable (LDV) model to estimate savings. The LDV model is the preferred analysis approach to use when the randomization of homes to treatment and control is sound and results in groups with equivalent usage prior to HER exposure, as presented in the section above. If pre-assignment differences in electric

consumption are present, a linear fixed effects regression model (LFER) would have been the more appropriate model.

The LDV model is a category of specifications in which the dependent variable in the equation is restricted to the post-test period. The customers' usage prior to the onset of treatment for the same period (i.e., usage in the same monthly period in the prior year) is entered into the regression model as an independent variable – thus the name lagged dependent variable model – and the coefficient for the treatment variable is interpreted as the change in consumption due to treatment. The specification used is shown in Equation 5-2, and the corresponding variables are defined in Table 5-21.

Equation 5-2: Lagged Dependent Variable Model Specification

$$kWh_{ity} = \beta_0 + \sum_{t=1}^{12}\sum_{y=1}^{n} I_{ty} * \beta_{ty} + kWh_{i,t,y-n} * \beta_{t,y-n} + \tau * treatment_i * I_{ty} + \varepsilon_{it}$$

Table 5-21: Lagged Dependent Variable Model Definition of Terms

Variable	Definition
β_0	The intercept, or the coefficient on the billing month t, post-period year indicator variable that is left out due to collinearity
kWh_{ity}	Customer i's average daily energy usage in billing month t of the post-period y
I_{ty}	Indicator variable that equals one for each monthly billing period t, post-period y and zero otherwise.
β_{ty}	The coefficient on the billing month t, post-period year indicator variable
$kWh_{i,t,y-n}$	The lagged usage of customer in the corresponding billing month t, in the pre-period y-n
$\beta_{t,y-n}$	The coefficient for the corresponding billing month t, in the pre-period y-n
$treatment_i$	Treatment variable, equal to one if customer if in the treatment group and zero if control
τ	Estimated average daily energy reduction of the treatment group in bill month t for the post-period y
ε_{it}	Error term for customer i for bill month t

The average daily treatment effect (τ) for each month of the study is multiplied by the number of active customers in the treatment group times the number of days in that month to estimate the monthly aggregate savings (MWh). The monthly savings impacts are summed over the study horizon to produce the total change in energy consumption in treated homes over the period under study. The results of an overlap analysis discussed below are then subtracted from this total change in consumption to arrive at the ex post energy savings attributable to the behavioral program.

5.8.3.4 Overlap Analysis

The ability to serve as a marketing tool for other energy efficiency initiatives is an important part of what makes normative comparison reports so attractive to utilities and agencies. The billing analysis methodology captures all savings at the meter, even those claimed by other programs. To the extent that the treatment and control group participate in other Avista programs at a different rate, the difference in kWh needs to be netted off of the behavioral program impact to prevent any double-counting or under-statement of savings. For measures promoted by Avista and tracked at the customer level, the amount of savings overlap is estimated by matching the treatment and control group customers to the energy efficiency program participation data. Next, the difference between treatment and control groups in rebated savings per home is calculated and the difference multiplied by the number of treatment group homes.

5.8.4 Findings and Recommendations

5.8.4.1 Per-home kWh and Percent Impacts

The evaluation team estimates the average home in the Home Energy Report Program saved approximately 894 kWh of electricity from January 2016 through December 2017. This represents a 2.66% reduction in total electric consumption compared to the control group over the same period. The 894 kWh and 2.66% impact estimates include HER savings net of savings from incremental participation in other Avista Energy Efficiency (EE) programs.

As explained in Section 5.8.3.4, an overlap analysis was performed to prevent double-counting of savings that have already been attributed to another energy-saving program. The overlap analysis found that treatment group homes participated in energy efficiency programs at a greater rate than the control group, necessitating a downward adjustment of the impacts. This means a net decrease in usage for the Home Energy Reports Program when comparing the treatment to the control. Therefore, a downward adjustment was applied to each monthly savings estimate based on differential energy efficiency participation and the greater per-home EE savings for the treatment group. The dual participation downward adjustment totaled 643 MWh for all customers over the 24-month period of analysis. Table 5-22 shows the impact estimates in each month for the average treatment household. The table also shows the subsequent adjustment for savings attributed to the energy efficiency overlap, totaling 14.93 kWh per household over the 24-month period of analysis.

Table 5-22: Per Customer and Per Treated Home Oracle Behavioral Program Impact Estimates with EE Adjustments

Month-Year	Treatment Participants	kWh Impact per Customer	kWh Impact from EE Overlap	kWh Savings per Treated Home	Baseline Usage per Treated Home (kWh)	% Impact
Jan-16	34,343	52.63	0.00	52.63	1,896	2.78%
Feb-16	34,165	43.97	0.06	43.91	1,562	2.81%
Mar-16	33,990	43.70	0.06	43.64	1,431	3.05%
Apr-16	48,941	28.01	0.21	27.80	1,124	2.47%
May-16	48,457	25.52	0.28	25.24	1,075	2.35%
Jun-16	47,957	24.47	0.31	24.17	1,085	2.23%
Jul-16	47,405	27.52	0.01	27.51	1,235	2.23%
Aug-16	46,878	29.14	0.32	28.83	1,230	2.34%
Sep-16	46,294	30.50	-0.06	30.56	1,093	2.80%
Oct-16	45,860	39.27	-0.09	39.37	1,179	3.34%
Nov-16	45,483	47.21	0.04	47.17	1,423	3.31%
Dec-16	45,163	62.10	-0.08	62.17	1,959	3.17%
2016 Total		**454.04**	**1.06**	**452.98**	**16,292**	**2.75%**
Jan-17	44,855	61.11	0.10	61.01	2,075	2.94%
Feb-17	44,614	44.20	0.93	43.26	1,643	2.63%
Mar-17	44,386	41.20	1.28	39.91	1,519	2.63%
Apr-17	44,103	35.71	1.18	34.52	1,218	2.84%
May-17	43,786	31.00	1.12	29.88	1,124	2.66%
Jun-17	43,366	25.32	0.91	24.41	1,148	2.13%
Jul-17	42,895	28.59	1.13	27.46	1,351	2.03%
Aug-17	42,495	31.98	1.23	30.74	1,308	2.35%
Sep-17	42,095	29.74	1.42	28.32	1,136	2.49%
Oct-17	41,751	35.37	1.42	33.94	1,238	2.74%
Nov-17	41,404	40.50	1.53	38.97	1,469	2.65%
Dec-17	41,096	50.27	1.59	48.68	1,756	2.77%
2017 Total		**454.98**	**13.87**	**441.11**	**16,985**	**2.58%**
Biennium Total		***909.02***	***14.93***	***894.09***	***33,356***	***2.66%***

5.8.4.2 Aggregate Impacts

The total impact of the Oracle Behavioral Program is calculated by multiplying the per-home impacts (adjusted for incremental EE participation) for each calendar month by the number of treatment group homes in that month. Over the twenty-four month period examined by the evaluation team, Washington participants saved a total of 38,397 MWh of electricity. The monthly and annualized aggregate savings are shown in Table 5-23.

Table 5-23: Aggregate Oracle Behavioral Program Impact Estimates with EE Adjustments

Month-Year	Treatment Participants	Aggregate MWh Impact for All Customers	Aggregate MWh Impact from EE Overlap	Aggregate MWh Savings for All Treated Homes	Aggregate Baseline Usage for All Customers (MWh)	% Impact
Jan-16	34,343	1,807	0.00	1,807	65,148	2.77%
Feb-16	34,165	1,502	2.05	1,500	53,469	2.81%
Mar-16	33,990	1,485	2.15	1,483	48,424	3.06%
Apr-16	48,941	1,371	10.44	1,360	54,224	2.51%
May-16	48,457	1,236	13.40	1,223	51,524	2.37%
Jun-16	47,957	1,174	14.67	1,159	51,960	2.23%
Jul-16	47,405	1,305	0.52	1,304	57,971	2.25%
Aug-16	46,878	1,366	14.80	1,351	57,145	2.36%
Sep-16	46,294	1,412	-2.62	1,415	49,997	2.83%
Oct-16	45,860	1,801	-4.27	1,805	54,056	3.34%
Nov-16	45,483	2,147	2.01	2,145	64,935	3.30%
Dec-16	45,163	2,804	-3.54	2,808	88,151	3.19%
2016 Total		**19,411**	**49.61**	**19,362**	**697,004**	**2.75%**
Jan-17	44,855	2,741	4.64	2,737	93,280	2.93%
Feb-17	44,614	1,972	41.71	1,930	73,491	2.63%
Mar-17	44,386	1,829	57.01	1,772	67,430	2.63%
Apr-17	44,103	1,575	52.17	1,523	53,701	2.84%
May-17	43,786	1,357	49.01	1,308	49,146	2.66%
Jun-17	43,366	1,098	39.56	1,058	49,472	2.14%
Jul-17	42,895	1,227	48.67	1,178	58,050	2.03%
Aug-17	42,495	1,359	52.46	1,306	55,862	2.34%
Sep-17	42,095	1,252	59.82	1,192	47,615	2.50%
Oct-17	41,751	1,477	59.38	1,417	51,819	2.73%
Nov-17	41,404	1,677	63.28	1,613	60,362	2.67%
Dec-17	41,096	2,066	65.45	2,000	71,425	2.80%
2017 Total		**19,628**	**593.16**	**19,035**	**731,652**	**2.58%**
Biennium Total		***39,040***	***643***	***38,397***	***1,428,656***	***2.66%***

Avista claims full savings for the Home Energy Reports program in the first year of the biennium and claims incremental savings in the second year of the biennium (incremental savings are those savings that occurred on top of savings already reported in the first year). As such, Avista reported 16,512 MWh of savings in 2016 in WA and reported an additional incremental savings of 2,000 MWh in 2017, resulting in a total reported savings in WA across the biennium of 18,512 MWh, as provided directly from Oracle. The evaluation team, however, did not observe any incremental savings achieved between 2016 and 2017. Rather, we observed a decrease in annual savings in the 2017 program year. For this reason, the evaluation team believes the more conservative verified savings value calculated for 2017 best represents the impacts achieved by the program. Using this value results in a Home Energy Reports program realization rate of 103% (Table 5-24).

Table 5-24: 2016-2017 Oracle Program Incremental Annual MWh Savings

Year	Reported MWh impact	Reported Incremental MWh	Verified MWh impact	Verified Incremental MWh	Realization Rate
2016	16,512	-	19,362	-	-
2017	18,512	2,000	19,035	0	-
Biennium Impact	**18,512**	**2,000**	**19,035**	**0**	**103%**

5.8.4.3 Precision of Findings

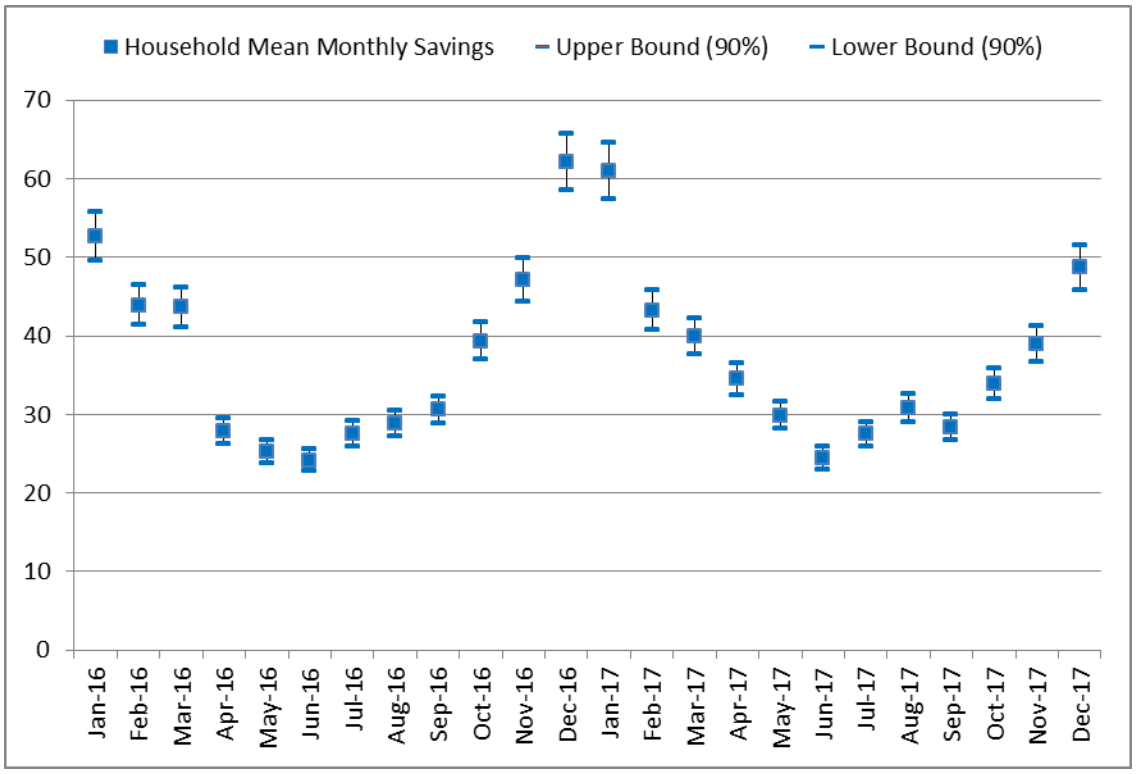
The margin of error of the impact estimates are also important to consider. If the margin of error is wide, the true savings value could actually differ from the point estimates by a large amount. The margin of error for the per-home biennium impact estimate is ± 52 kWh at the 90% confidence level. Table 5-25 presents the upper and lower bounds of the 90% confidence interval for biennium per-home kWh savings, percent reduction, and aggregate impact estimates.

Table 5-25: Confidence Intervals Associated with Behavioral Program Impact Estimates

Parameter	Lower Bound (90%)	Point Estimate	Upper Bound (90%)
2016–2017 Program Savings per Home	842 kWh	894 kWh	946 kWh
Percent Reduction	2.52%	2.66%	2.84%
Aggregate Impact	36,574 MWh	38,933 MWh	41,145 MWh

The impact estimate has an absolute precision of ± 0.16% and a relative precision of ± 5.8% at the 90% level of confidence. The estimates are statistically significant, as the confidence interval does not include zero. Figure 5-16 illustrates the monthly savings estimates with relative precision upper and lower bounds.

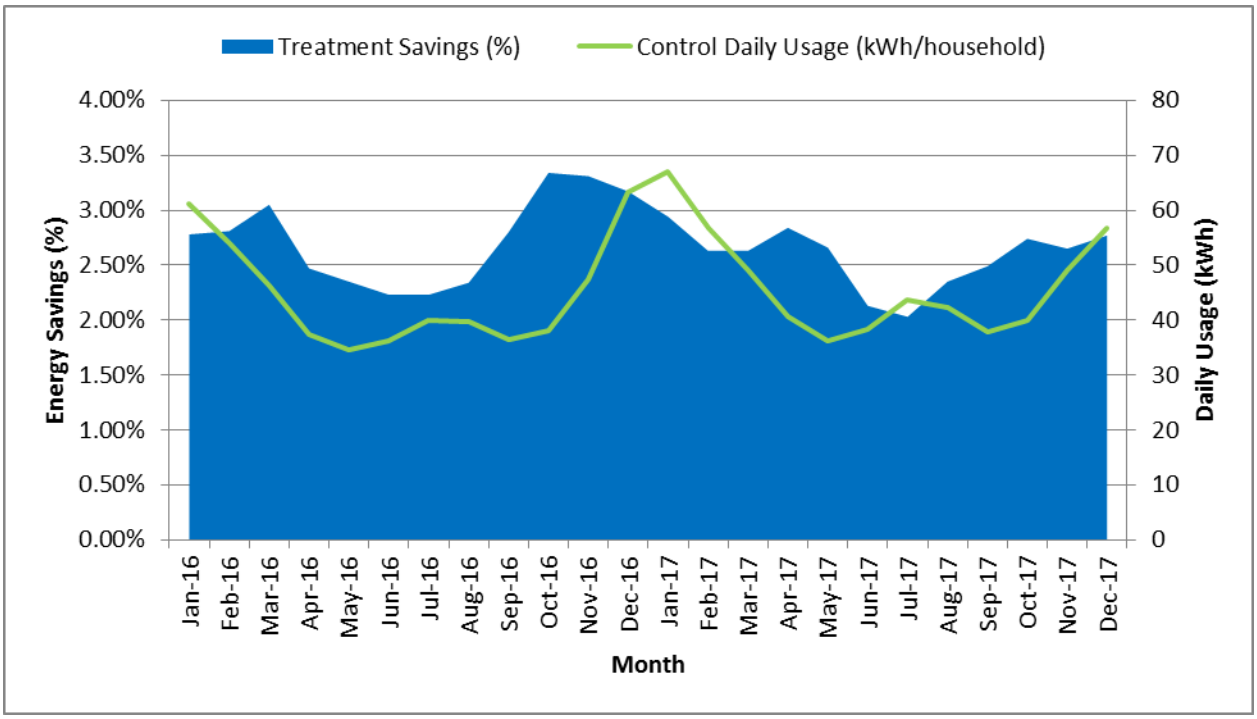
Figure 5-16: Average Monthly Savings per Household with Relative Precision Bounds



5.8.4.4 Savings Patterns

Avista currently mails out reports to the treatment group on a varying cycle, with participants receiving up to seven reports annually. The blue series in Figure 5-20 depicts the estimated percent reduction for each month of the treatment period, January 2016 through December 2017. Figure 5-20 also shows the average daily kWh usage of the control group with a green line. The control group's average daily usage shows highest electricity usage in the winter months.

Figure 5-17: Average Percent Savings and Control Daily Usage by Month



In conclusion, the evaluation team found that program savings in the 2016-2017 biennium matured to 2.66%. Prior to netting out savings claimed by other EE programs, the average Home Energy Report program participant saved 909 kWh; after netting out savings claimed by other EE programs the per-participant savings is found to be 894 kWh. Overall, the Home Energy Reports program delivered 38,397 MWh of savings to the Avista electric system.

5.9 Low Income

5.9.1 Overview

Avista's electric Low Income program offers a variety of conservation and fuel efficiency measures to low income households. Avista leverages Community Action Program (CAP) agencies to deliver energy efficiency programs to the Company's low income customer group. CAP agencies have resources to income qualify, prioritize and treat homes based upon a number of characteristics. In addition to the Company's annual funding, the Agencies have other monetary resources that they can usually leverage when treating a home with weatherization and other energy efficiency measures. The Agencies either have in-house or contractor crews to install many of the efficiency measures of the program. Avista provides CAP agencies with an "Approved Measure List" of energy efficiency measures. Any measure installed on this list by the Agency in an income qualified home will receive 100% reimbursement for the cost for the work. In addition to the "Approved Measures", there is a "Rebate Measure List" with associated rebates specific to the low-income program.

5.9.2 Program Achievements and Participation Summary

Participation and associated energy savings from the 2016-2017 Low Income program is summarized in Table 5-26 below. Figure 5-18 presents the energy savings for non-lighting

conservation measures, lighting conservation measures, and the fuel conversion measures. The non-lighting conservation measure breakout is detailed in Figure 5-19.

Table 5-26: 2016–2017 Low-Income Program Reported Participation and Savings

Measure Category	Measure	2016–2017 Reported Measure/ Participant Count	2016–2017 Reported Savings (kWh)
Non-Lighting Conservation	E Air Infiltration	84	35,980
Non-Lighting Conservation	E Duct Sealing	14	11,330
Non-Lighting Conservation	E Insulation	177	174,180
Non-Lighting Conservation	E ENERGY STAR Doors	29	8,429
Non-Lighting Conservation	E Energy Star Windows	27	19,372
Non-Lighting Conservation	E Energy Star Refrigerator	5	2,475
Non-Lighting Conservation	E HE Water Heater	2	162
Non-Lighting Conservation	E To Heat Pump Conversion	16	62,728
Fuel Conversion	E To G H20 Conversion	120	260,019
Fuel Conversion	E To G Furnace Conversion	110	480,380
Lighting Conservation	CFL Bulbs	30	3,116
Lighting Conservation	LI Giveaway CFL bulbs	118	1,770
Lighting Conservation	LI Giveaway LED bulbs	19,211	226,154
Total		**19,943**	**1,286,095**

Figure 5-18: 2016-2017 Low Income Program Reported Energy Saving Shares: Measure Category

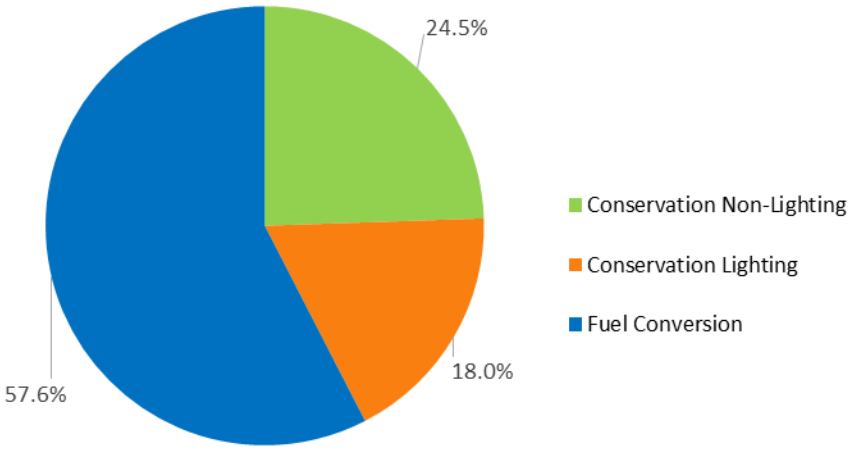
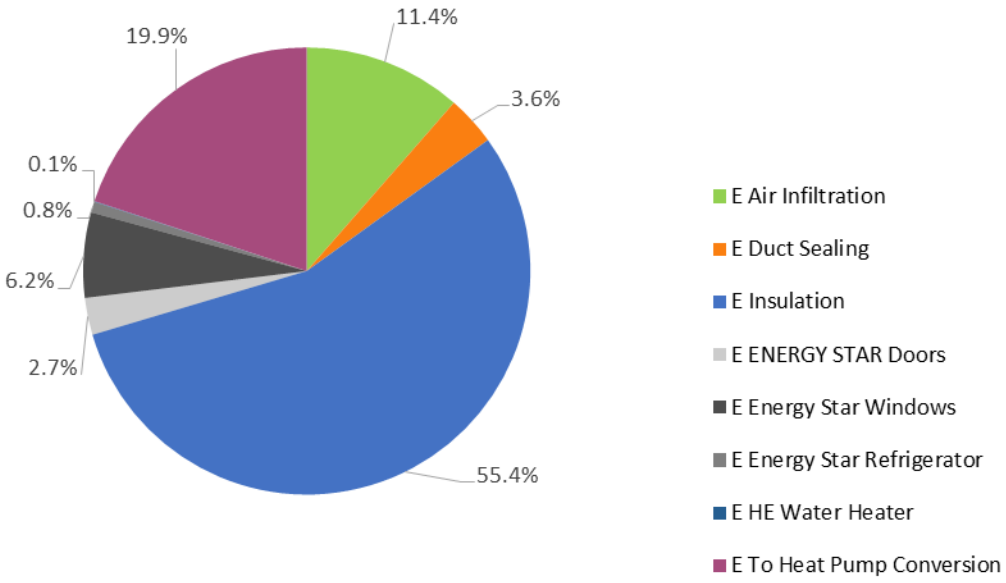


Figure 5-19: 2016-2017 Low-Income Program Reported Energy Saving Shares: Non-Lighting Conservation



5.9.3 Methodology

The evaluation team organized the analysis for the Low Income Program based on conversion and conservation measures. For the non-lighting conservation and fuel conversion measures, the evaluation team employed a regression analysis. For the lighting conservation measures, the evaluation team followed the same methodology as outlined in the Residential Lighting

Section (Section 5.6.3). The remainder of this section outlines the methodology for the non-lighting conservation and fuel conversion measures.

The Low Income program operates as a dual fuel program in Washington with CAP Agencies targeting both electric and natural gas savings opportunities. Participating homes generally received multiple improvements so the electric and gas savings values from all measures installed within a given home were aggregated to arrive at the total reported savings for each home. For the electric savings analysis, the evaluation team first filtered the program population to include only those homes with claimed electric savings in the program tracking data. We then relied on a regression analysis of Avista billing data to estimate per-home impacts for homes claiming electric savings.

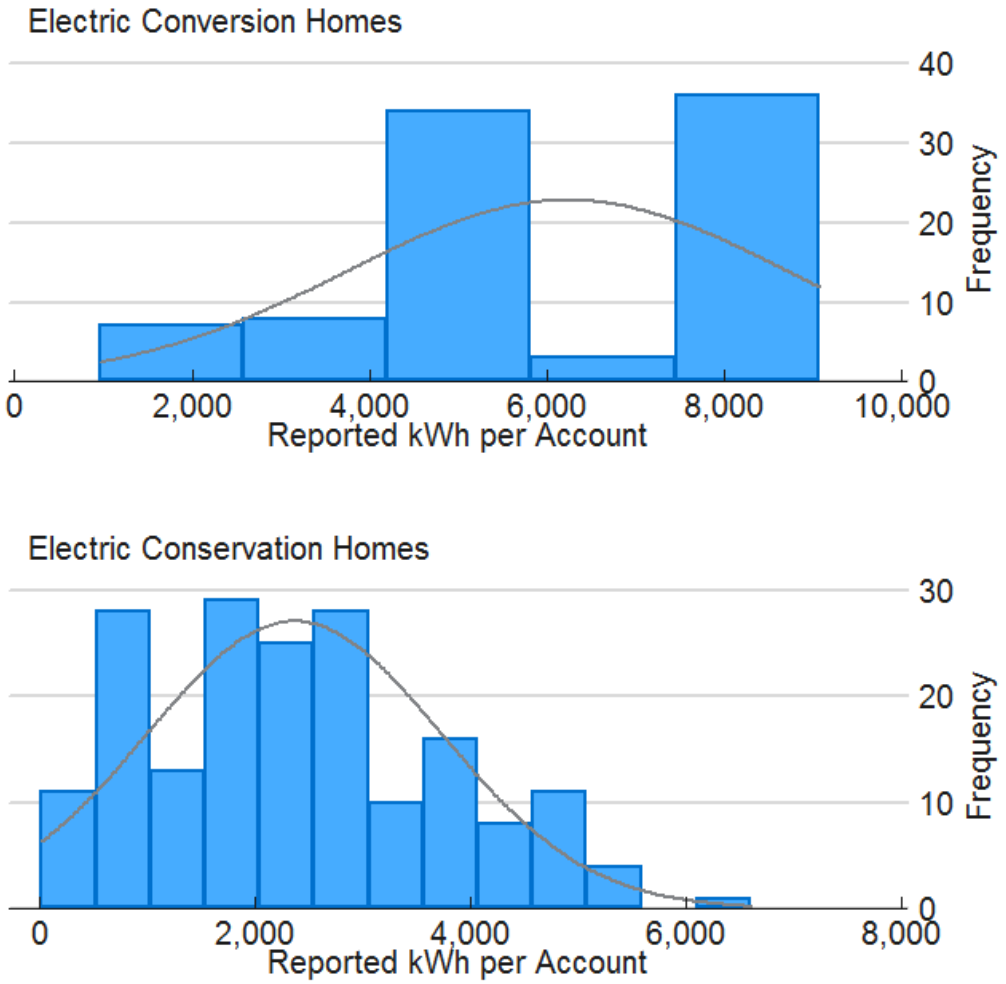
Next, homes were assigned to one of two groups for analysis:

1) **Conservation Participants** – these customers participated only in conservation-related measures in the program.

2) **Conversion Participants** – these customers were unique participants only partaking in conversion measures through the program.

Figure 5-20 shows the distribution of per-home reported electric savings for the two groups. Reported electric impacts for the fuel switching homes were generally larger.

Figure 5-20: Distribution of Reported kWh Values by Home Type



As described in Section 3.4.4, each home was matched to the nearest weather station and historical weather records were merged with historical consumption. Homes were required to have at least 12 months of pre-retrofit and 12 months of post-retrofit billing data for inclusion in the analysis. The evaluation team used a fixed effects panel regression model to establish the average relationship between electric consumption and weather before and after service. Separate models were estimated for fuel conversion customers and electric conservation customers and both Idaho and Washington participants were used in the analysis to boost the precision of the results. Regression coefficients were then applied to normal weather conditions (TMY3) for the region to estimate weather-normalized annual electric savings. The regression coefficients and relevant goodness of fit statistics are presented in Appendix B.

5.9.4 Findings and Recommendations

5.9.4.1 Non-Lighting Conservation and Fuel Conversion Homes

Table 5-27 summarizes the key inputs and outputs of the regression analysis. As expected the fuel switching homes saved significantly more electricity on average than homes that did not

have a primary mechanical system converted from electricity to natural gas. The average percent reduction in electric consumption for the 78 fuel switching homes analyzed was 46.9%, meaning the post-retrofit electric consumption was nearly half of what it was pre-retrofit. Conservation participants used approximately the same on average pre-retrofit as fuel switching homes (16,197 kWh vs. 16,279 kWh). However, this group saved less on both an absolute and percent basis and ultimately achieved a 73% realization rate.

Table 5-27: Low Income Billing Analysis Findings

Stratum	Fuel Conversion Participants	Conservation Participants
Number of Homes Analyzed	78	101
Average Reported kWh per Home	6,966	2,333
Weather Normalized Annual kWh Pre-Retrofit	16,279	16,197
Weather Normalized Annual kWh Post-Retrofit	8,646	14,934
Average kWh Savings per Home	7,633	1,263
Realization Rate	109.6%	54.1%
Relative Precision (90% confidence level)	11.6%	56.2%
Average Percent Reduction in Annual Electric Consumption	46.9%	7.8%

The realization rate for the conversion measures was 110%, with homes saving an average of 7,600 kWh annually. The evaluation team noted that the reported savings assumptions for electric to gas conversion of heating and water heating in Low Income program were more conservative than the Fuel Efficiency program, which assumed an average savings of 9,865 per participant in Washington and 11,950 kWh in Idaho. Evaluation results actually found a higher per home impact from fuel switching in the Low Income program than in Fuel Efficiency program. For future program cycles, the evaluation team recommends that Avista review reported savings for each program and attempt to better align assumptions for fuel switching savings.

5.9.4.2 Lighting Conservation

The 2016 and 2017 Low Income programs CAP agencies conducted multiple “giveaway” events throughout the program cycle and reported bulb type (CFL/LED) and bulb count for each of the events and the location of the event so that Avista could allocate the savings attributable to their Washington and Idaho service territories. Based on the program reported data, the average kWh savings attributed to the bulbs was 12.1 kWh. Based on the methodology outlined in Section 5.6.3 above, the evaluation team estimates the average savings for the giveaway CFLs to be 11.8 kWh. Table 5-28 presents the realization rate and per-unit gross verified savings.

Table 5-28: Low-Income Lighting Conservation Measures Gross Verified Savings

Bulb Type	Average Reported Savings (kWh/bulb)	Realization Rate	Gross Verified Savings (kWh/bulb)
CFL and LED Giveway	12.1	93%	11.2

The overall electric realization rate for the Low Income program was 93%. This program level realization rate was developed by taking a weighted average of the realization rates of the measure types shown in Table 5-29. The relative precision of the program level electric realization rate was ±12.6% at the 90% confidence level.

Table 5-29: Low-Income Program Gross Verified Savings

Measure Category	2016–2017 Reported Measure Count	2016–2017 Reported Savings (kWh)	Realization Rate	Gross Verified Savings (kWh)
Conservation Non-Lighting	354	314,656	54%	170,342
Conservation Lighting	19,359	231,040	93%	214,860
Fuel Conversion	230	740,399	110%	811,211
Total	**19,943**	**1,286,095**	**93%**	**1,196,413**

5.10 Residential Sector Results Summary

Table 5-30 lists the gross verified savings for each of Avista's residential programs in Washington in 2016 and 2017 and for the overall portfolio. The Washington electric residential sector achieved an 89% realization rate and the relative precision of the program-level electric realization rate was ±4.3% at the 90% confidence level

Table 5-30: Residential Program Gross Impact Evaluation Results

Program	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
HVAC	1,546,894	94%	1,450,887
Water Heat	435,442	112%	488,300
ENERGY STAR Homes	153,562	129%	197,826
Fuel Efficiency	25,215,201	62%	15,730,750
Lighting	37,680,674	100%	37,680,842
Shell	1,123,113	27%	300,584
Home Energy Reports	18,512,339	103%	19,035,123
Low Income	1,286,095	94%	1,196,413
Total Residential	**85,953,320**	**89%**	**76,080,726**

6 Conclusions and Recommendations

6.1 Summary

The following outlines the evaluation team's conclusions and recommendations for Avista to consider for future program implementation and reporting. Additional details regarding the conclusions and recommendations outlined here can be found in the program-specific sections of this report.

6.2 Impact Findings

The evaluation team performed the impact evaluation for Avista's 2016 and 2017 Washington electric programs through a combination of document audits, customer surveys, engineering analysis and onsite measurement and verification (M&V) on a sample of participating projects. The impact evaluation activities resulted in an 86% realization rate across Avista's 2016-2017 portfolio of conservation and fuel conversion programs (Table 6-1). Table 6-3 and Table 6-2 summarize Avista's 2016 and 2017 impact evaluation results by sector and program.

Table 6-1: 2016-2017 Washington Electric Portfolio Evaluation Results

Sector	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
Nonresidential – Conservation	96,984,260	83%	80,736,243
Nonresidential – Fuel Conversion	1,971,422	92%	1,810,107
Residential – Conservation	40,939,685	98%	40,118,440
Residential – Behavior	18,512,339	103%	19,035,123
Residential – Fuel Conversion	25,215,201	62%	15,730,750
Low Income - Conservation	545,696	71%	385,202
Low Income – Fuel Conversion	740,399	110%	811,211
Total Conservation	**156,981,980**	**89%**	**140,275,008**
Total Fuel Conversion	**27,927,022**	**66%**	**18,352,069**
Total Conservation + Conversion	**184,909,002**	**86%**	**158,627,076**

Table 6-2: Washington Electric Nonresidential Program Evaluation Results

Program	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Verified Gross Savings (kWh)
EnergySmart Grocer	3,066,726	97%	2,966,084
Food Service Equipment	200,090	97%	193,524
Green Motors	100,830	97%	97,521
Motor Controls HVAC	697,760	97%	674,861
Prescriptive Water Heat	4,886	97%	4,726
Prescriptive Lighting	77,964,819	80%	62,720,933
Commercial Insulation	19,335	97%	18,700
Fleet Heat	16,000	97%	15,475
AirGuardian	53,092	97%	51,350
Small Business	2,986,437	103%	3,090,422
Site Specific	13,845,706	92%	12,712,754
Total Nonresidential	**98,955,682**	**83%**	**82,546,350**

Table 6-3: Washington Electric Residential Program Evaluation Results

Program	2016-2017 Reported Savings (kWh)	Realization Rate	2016-2017 Gross Verified Savings (kWh)
HVAC	1,546,894	94%	1,450,887
Water Heat	435,442	112%	488,300
ENERGY STAR Homes	153,562	129%	197,826
Fuel Efficiency	25,215,201	62%	15,730,750
Lighting	37,680,674	100%	37,680,842
Shell	1,123,113	27%	300,584
Home Energy Reports	18,512,339	103%	19,035,123
Low Income	1,286,095	94%	1,196,413
Total Residential	**85,953,320**	**89%**	**76,080,726**

6.3 Conclusions and Recommendations

The following outlines the key conclusions and recommendations as a result of the evaluation activities. Specific details regarding the conclusions and recommendations outlined here, along with additional conclusions and recommendations can be found in the program-specific sections of this report.

6.3.1 Nonresidential Programs

The overall realization rate for the nonresidential portfolio is 83%. The realization rates ranged from 103% for the Small Business program down to 80% for the "Prescriptive Lighting" strata. Prescriptive Lighting was also the largest program in the nonresidential portfolio, with approximately 76% of the total gross verified savings for the portfolio. Avista discovered the inaccuracies in reported savings for many of the 2016 TLED lighting projects and acted quickly to fix the issue. Unfortunately, the projects impacted by the error composed a large portion of the overall reported savings for the biennium, therefore being a large driver in the portfolio-level realization rate. Looking past the TLED measure error, the evaluation team found that the processes Avista is utilizing for estimating and reporting energy savings for the nonresidential programs are predominantly sound and reasonable. The following subsections outline specific conclusions and recommendations for several of the nonresidential programs.

6.3.1.1 Site Specific Program

Conclusion: The Site Specific program constitutes more than 15% of the program energy shares (gross verified). Within the last 4 years, Avista has increased their level of quality assurance and review on projects that participate through the program. The evaluation team's analysis resulted in a 92% realization rate for the Site Specific program. The majority of the measure categories evaluated had realization rates close to or greater than 100%, with the exception of shell measures (63%) and interior lighting. The 88% realization rate found for interior lighting projects was predominately driven by inconsistencies in reported hours of use values. The overall program-level realization rate indicates that Avista's internal process for project review, savings estimation, and installation verification are working to produce high quality estimates of project impacts.

> **Recommendation**: The evaluation team recommends that Avista continue to operate this program with the current level of rigor.
>
> **Recommendation**: It is recommended that Avista provide a greater level of review of reported hours of use for large lighting projects.
>
> **Recommendation**: While the impact from the shell measures under the Site Specific program are minimal, Avista should further review its algorithm for cooling season savings achieved by insulation measures. The algorithm that Avista currently uses may be overstating the impacts of these replacements on air condition energy consumption.

6.3.1.2 Prescriptive Lighting Program

Conclusion: The Prescriptive Lighting program is the largest program in Avista's nonresidential portfolio, constituting more than 75% of the energy savings. The evaluation team's analysis resulted in an 80% realization rate for the Prescriptive Lighting program, predominately due to the inaccuracies in reported savings for many of the incented TLED measures in the 2016

program year. Avista discovered the inaccuracies at the end of 2016 and acted quickly to fix the issue. Unfortunately, the projects impacted by the error composed a large portion of the overall reported savings for the biennium, therefore being a large driver in the portfolio-level realization rate.

Two other contributing factors that impacted the realization rate for the Prescriptive Lighting program is the reporting of operating hours for participating nonresidential facilities and the interactive factors applied by Avista. The evaluation team did find several large projects reporting an incorrect hours of use value. In addition, in several evaluated projects, the evaluation team determined that a lower interactive factor be applied compared to the value utilized by Avista, based on both business type and building heating type.

> **Recommendation**: It is recommended that for large projects and for projects with multiple different space types, that additional verification be conducted on the reported hours of use value. Avista could set a threshold based on the number of fixtures installed, facility/building type, and/or reported savings that triggers an additional level of verification.
>
> **Recommendation**: It is recommended that Avista review the interactive factors applied by their team through its lighting savings estimation tool to ensure more accurate alignment with both business type and building heating type.

6.3.1.3 Prescriptive Other Programs

Conclusion: Avista's 'Prescriptive Other' Programs constitute just short of 5% of the overall savings for the nonresidential portfolio, with the Energy Smart Grocer program accounting for the majority of these savings. Lower than reported savings were found for a few sampled projects, but the majority of the evaluated savings were in-line with the reported savings value.

6.3.1.4 Small Business Program

Conclusion: The Small Business program in WA constituted just short of 4% of the total savings for the nonresidential portfolio. The evaluation team found a 103% realization for the program.

Conclusion: The Small Business program implementer has improved their tracking of decommissioned measures in the 2016-2017 biennium, in comparison to the 2014-2015 biennium, as shown by the evaluation team's calculated persistence rate of 98% for the measures included in the sample in the 2016-2017 biennium.

6.3.2 Residential Programs – Including Low Income

The overall realization rate for the residential portfolio is 89%. The realization rates for most programs approached or surpassed 100% with the exception of the Shell and Fuel Efficiency programs having the lowest realization rate (27% and 62% respectively). The evaluation team believes the cause for underachieving realization rates reflects a combination of over-stated reported savings and variation in customer consumption among programs. The following outlines specific conclusions and recommendations for the residential programs.

6.3.2.1 HVAC Program

Conclusion: The evaluation team found a 94% realization rate for the HVAC program. Profiling of program participants revealed high annual consumption during the pre-treatment period indicating a strong likelihood that these customers had electric resistance heating prior to their retrofit. This consumption profile supports application of RTF deemed savings for resistance heat conversion.

Recommendation: The evaluation team recommends Avista continue to update reported savings based on the most recent iterations of relevant RTF workbooks.

6.3.2.2 Water Heat

Conclusion: For showerheads distributed through the Simple Steps program, Avista allocates 50% of its reported savings to electric savings and 50% to natural gas savings to account for homes that have different water heating fuel types.

Recommendation: The evaluation team recommends Avista update this allocation assumption to be based on representative water heater fuel type saturation. These data are available through the Regional Building Stock Assessment study; however, we recommend Avista base the allocation on data specific to its territory.

6.3.2.3 Fuel Efficiency

Conclusion: The evaluation team found a low realization rate for the Fuel Efficiency program (62%). We believe this unchanged realization rate from the previous biennium is primarily the result of two issues:

- Reported savings for the 2016-2017 program cycle were on-average high as the program savings value was initially reduced in mid-Q2 2016 and then further reduced mid-Q1 of 2017 to be in alignment with evaluation results provided from the previous program cycle.
- Annual average household consumption was on average 18% lower for participants in the 2016-2017 program cycle relative to participants in the prior program cycle. If participant consumption had been similar to the previous biennium, the program realization rate would have been approximately 74%.

Recommendation: For future program cycles, we recommend Avista reduce their reported savings for the Fuel Efficiency program. Avista should look to the Low Income conversion deemed savings assumptions and consider better aligning assumptions used to estimate reported savings for Fuel Efficiency and the Low Income programs. Additionally, customer profiling will help gauge anticipated savings by understanding customers' annual consumption profile and the expected percent savings that can occur through implementation of the Fuel Efficiency program measures.

6.3.2.4 Residential Lighting

Conclusion: The evaluation team found Avista's reported savings estimates for the Simple Steps lighting measures aligned with the Simple Steps deemed savings which in turn reflect values that align with the specific product types by lumen bins in accordance with the most current BPA UES measure list.

6.3.2.5 Shell Program

Conclusion: The evaluation team found a low realization rate (27%) for shell rebate measures (windows and insulation). This finding is similar to the previous evaluation and indicates that reported savings values were too aggressive on average.

> **Recommendation:** The evaluation team recommends Avista examine planning assumptions about per-home consumption, and percent reductions in heating and cooling loads from shell improvements. It may be that the percent reduction assumptions are sound, but they are being applied to an overstated assumption of the average electric HVAC consumption per home. Conversely, the assumed end-use shares may be accurate, but the end-use reduction percentage is inflated. This investigation should be conducted separately for electrically heated homes and dual fuel homes as the heating electric end-use share will be different.

6.3.2.6 Home Energy Reports Program

Conclusion: The evaluation team found no incremental savings were realized during the second year (2017) for the Home Energy Report behavioral program. The finding reflects Avista's decision to not re-fill drop-outs from the program treatment group.

> **Recommendation:** If the Home Energy Reports Program is included within the Avista portfolio in future program cycles, the evaluation team recommends Avista continue to service the treatment group by enrolling new customers to replace drop-outs.

6.3.2.7 Low Income Program

Conclusion: The Low Income program saw the fuel switching homes save significantly more electricity on average than homes that did not have a primary mechanical system converted from electricity to natural gas. The realization rate for the conversion measures was 110%, with homes saving an average of 7,600 kWh annually. The conservation measures achieved a much lower realization rate of 73%. The program overall achieved a 94% realization rate.

> **Recommendation:** The evaluation team recommends re-evaluating the current reported savings assumption to attempt to better align the savings given the program's measure mix and customer profile for conservation measures. We also recommend comparing and attempting to align the fuel conversion savings assumptions between the Low Income and Fuel Efficiency programs to achieve more consistent evaluated impacts.

Appendix A Sampling and Estimation

The gross verified energy savings estimates presented in this report from Avista's electric energy efficiency programs were generally determined through the observation of key measure parameters among a sample of program participants. A census evaluation would involve surveying, measuring, or otherwise evaluating the entire population of projects within a population. Although a census approach would eliminate the sampling uncertainty for an entire program, the reality is that M&V takes many resources both on the part of the evaluation team and the program participants who agree to be surveyed or have on-site inspections conducted in their home or business. When a sample of projects is selected and analyzed, the sample statistics can be extrapolated to provide a reasonable estimate of the population parameters. Therefore, when used effectively, sampling can improve the overall quality of an evaluation study. By limiting resource-intensive data collection and analysis to a random sample of all projects, more attention can be devoted to each project surveyed.

The nuances and tradeoffs considered by the evaluation team when developing sampling approaches varied across the portfolio and are discussed in more detail in Section 3.2. However, several common objectives were shared across sectors and programs. The most important sampling objective was representativeness – that is the projects selected in the evaluation were representative of the population they were selected from and will produce unbiased estimates of population parameters. A second key sampling objective was to consider the value of information being collected and align sample allocations accordingly. This effort generally involves considering the size (contribution to program savings) and uncertainty associated with the area being studied and making a determination about the appropriate level of evaluation resources to allocate.

The evaluation team used two broad classes of probability estimation techniques to make inferences about program or stratum performance based on the observations and measurements collected from the evaluation sample. Auxiliary information refers to the reported savings estimates stored in the program tracking system.

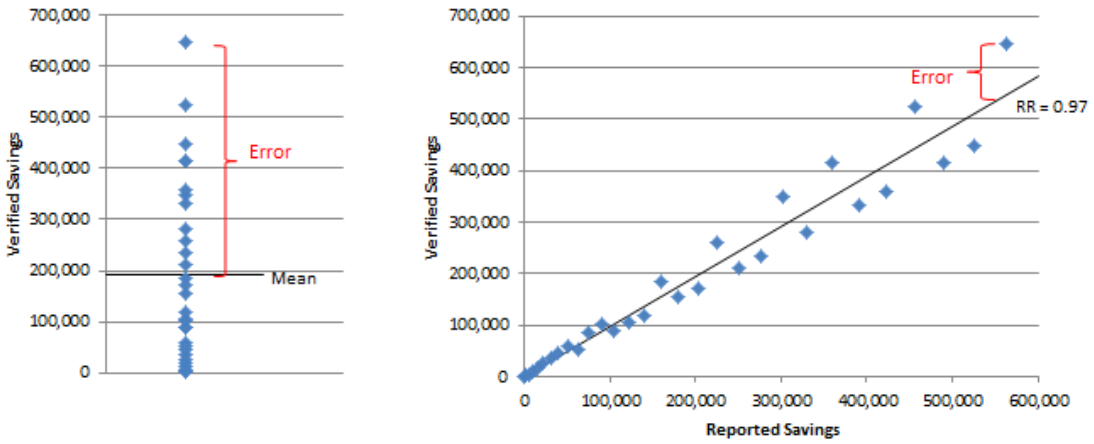
1) **Mean-Per-Unit** (or estimation in the absence of auxiliary information): This technique was used to analyze samples drawn from populations that are similar in size and scope. This approach was used primarily for residential programs that include a large number of rebates for similar equipment types where the evaluation objective is to determine an average kWh savings per rebated piece of equipment. With mean-per-unit estimation the average kWh savings observed within the sample is applied to all projects in the population.
2) **Ratio Estimation** (or estimation using auxiliary information): This technique was used for nonresidential programs and residential programs with varying savings across projects. This technique assumes that the ratio of the sum of the verified savings estimates to the sum of the reported savings estimates within the sample is representative of the program as a whole. This ratio is referred to as the *realization rate*, or *ratio estimator*, and is calculated as follows:

Equation A- 1: Coefficient of Variation

$$Realization\ Rate = \frac{\sum_i^n Verified\ Savings}{\sum_i^n Reported\ Savings}$$

Where *n* is the number of projects in the evaluation sample. The realization rate is then applied to the claimed savings of each project in the population to calculate gross verified savings. Figure A- 1 shows the reduction in error that can be achieved through ratio estimation when the sizes of projects within a program population vary considerably. The ratio estimator provides a better estimate of individual project savings than a mean savings value by leveraging the reported savings estimate.

Figure A- 1: Comparison of Mean-Per-Unit and Ratio Estimation



A.1 Stratification

In a few cases, the evaluation team used sample stratification with both classes of estimation techniques. Stratification is a departure from simple random sampling (SRS), where each sampling unit (customer/project/rebate/measure) has an identical likelihood of being selected in the sample. Stratified random sampling refers to the designation of two or more sub-groups (strata) from within a program population prior to the selection process. Whenever stratification was employed the evaluation team took great care to ensure that each sampling unit within the population belonged to one (and only one) stratum. In each program sample design where stratification was used, the probability of selection is different between strata and this difference must be accounted for when calculating results. The inverse of the selection probability is referred to as the *case weight* and is used in estimation of impacts when stratified random samples are utilized. Consider the following simplified example in Table A- 1 based on a fictional program with two measures; refrigerators and clothes washers.

Table A- 1: Case Weights Example

Measure	Population Size	Sample Size	Case Weight
Clothes Washer	15,000	30	500
Refrigerator	6,000	30	200

Because refrigerators are sampled at a higher rate (1-in-200) than clothes washers (1-in-500), each sample point carries less weight in the program results than an individual clothes washer sample point. In general, the evaluation team designed samples so that strata with high case weights had low per-unit impacts or were well-understood measures. Low case weights were reserved for large and complex measures.

The evaluation team felt that stratification was advantageous and utilized it in the sample design for a variety of reasons across the portfolio:

1) Increased precision if the within-stratum variability was expected to be small compared to the variability of the population as a whole. Stratification in this case allows for increased precision or smaller total sample sizes, which lowered evaluation costs.
2) To ensure that a minimum number of units within a particular stratum will be verified. Although a program's contribution to portfolio savings may be small, the evaluation team felt it was important to sample enough projects to independently estimate program performance.
3) It is easy to implement a value-of-information approach through which the largest projects are sampled at a much higher rate than smaller projects by creating size-based strata.
4) Sampling independently within each stratum allows for comparisons among groups. Avista and the evaluation team find value in comparing results between strata; e.g., comparing the realization rates between measures within a program.

A.2 Presentation of Uncertainty

There is an inherent risk, or uncertainty, that accompanies sampling, because the projects selected in the evaluation sample may not be representative of the program population as a whole with respect to the parameters of interest. As the proportion of projects in the program population that are sampled increases, the amount of sampling uncertainty in the findings decreases. The amount of variability in the sample also affects the amount of uncertainty introduced by sampling. A small sample drawn from a homogeneous population will provide a more reliable estimate of the true population characteristics than a small sample drawn from a heterogeneous population. Variability is expressed using the coefficient of variation (C_v) for programs that use simple random sampling, and an error ratio for programs that use ratio estimation. The C_v of a population is equal to the standard deviation (σ) divided by the mean (μ) as shown in Equation A- 2.

Equation A- 2: Coefficient of Variation

$$C_v = \frac{\sigma}{\mu}$$

When ratio estimation is utilized, standard deviations will vary for each project in the population. The error ratio is an expression of this variability and is analogous to the C_v for simple random sampling.

Equation A- 3 provides the formula for estimating error ratio.

Equation A- 3: Error Ratio

$$Error\ Ratio = \frac{\sum_{i=1}^{N} \sigma_i}{\sum_{i=1}^{N} \mu_i}$$

Equation A- 4 shows the formula used to calculate the required sample size for each evaluation sample, based on the desired level of confidence and precision. Notice that the C_v term is in the numerator, so required sample size will increase as the level of variability increases. For programs that rely on ratio estimation, error ratio replaces the C_v term in Equation A- 4. Results of the 2014-2015 portfolio evaluation were the primary source of error ratio and C_v assumptions for the evaluation.

Equation A- 4: Required Sample Size

$$n_0 = \left(\frac{z * C_v}{D}\right)^2$$

Where:

- n_0 = The required sample size before adjusting for the size of the population
- Z = A constant based on the desired level of confidence (equal to 1.645 for 90% confidence two-tailed test)
- C_v = Coefficient of variation (error ratio for ratio estimation)
- *D* = Desired relative precision

The sample size formula shown in Equation A- 4 assumes that the population of the program is infinite and that the sample being drawn is reasonably large. In practice, this assumption is not always met. For sampling purposes, any population greater than approximately 7,000 may be considered infinite for the purposes of sampling. For smaller, or finite, populations, the use of a finite population correction factor (FPC) is warranted. This adjustment accounts for the extra precision that is gained when the sampled projects make up more than about 5% of the program savings. Multiplying the results of Equation A- 4 by the FPC formula shown in Equation A- 5 will produce the required sample size for a finite population.

Equation A- 5: Finite Population Correction Factor

$$fpc = \sqrt{\frac{N - n_0}{N - 1}}$$

Where:

- N = Size of the population
- n_0 = The required sample size before adjusting for the size of the population

The required sample size (*n*) after adjusting for the size of the population is given by Equation A- 6.

Equation A- 6: Application of the Finite Population Correction Factor

$$\boldsymbol{n = n_0 * fpc}$$

The margin of error can be introduced by sampling or via estimation error from a billing analysis, or both. Billing analyses rely on consumption data that often contains variability not explained by weather or other independent variables. This inherent variability in the data introduces uncertainty because program savings effects must be separated from underlying noise. The standard errors of coefficients in the regression model quantify this uncertainty and allow a margin of error to be calculated. Verified savings estimates always represent the point estimate of total savings, or the midpoint of the confidence interval around the verified savings estimate for the program. Equation A- 7 shows the formula used to calculate the margin of error for a parameter estimate.

Equation A- 7: Error Bound of the Savings Estimate

$$Error\ Bound = se * (z - statistic)$$

Where:

se = The standard error of the population parameter of interest (proportion of customers installing a measure, realization rate, total energy savings, etc.) This formula will differ according to the sampling technique utilized.

$z - statistic$ = Calculated based on the desired confidence level and the standard normal distribution.

The 90% confidence level is a widely accepted industry standard for reporting uncertainty in evaluation findings. Unless otherwise noted, the confidence levels and precision values presented in this report are at the 90% confidence level. The z-statistic associated with 90% confidence is 1.645.

The evaluation team also reports the relative precision value associated with verified savings estimates. When evaluators or regulators use the term “90/10”, the 10 refers to the relative precision of the estimate. The formula for relative precision shown in Equation A- 8:

Equation A- 8: Relative Precision of the Savings Estimate

$$Relative\ Precision_{Verified\ Savings} = \frac{Error\ Bound_{(kWh\ or\ kW)}}{Verified\ Impact_{(kWh\ or\ kW)}}$$

An important attribute of relative precision to consider when reviewing achieved precision values is that it is “relative” to the impact estimate. Therefore programs with low realization rates are likely to have larger relative precision values because the error bound (in kWh) is being divided by a smaller number. This means two programs with exactly the same reported savings and sampling error in absolute terms, with have very different relative precision values (example in Table A- 2).

Table A- 2: Relative Precision Example

Program	Reported kWh	Realization Rate	Error Bound (kWh)	Verified kWh	Relative Precision (90%)
Program #1	4,000,000	0.5	400,000	2,000,000	± 20%
Program #2	4,000,000	1.0	400,000	4,000,000	± 10%

In many cases a program-level savings estimate requires summation of the verified savings estimates from several strata. In order to calculate the relative precision for these program-level savings estimates, the evaluation team used Equation A- 9 to estimate the error bound for the program as a whole from the stratum-level error bounds.

Equation A- 9: Combining Error Bounds across Strata

$$Error\ Bound_{Program} = \sqrt{Error\ Bound^2_{Stratum1} + Error\ Bound^2_{Stratum2} + Error\ Bound^2_{Stratum3}}$$

Using this methodology, the evaluation team developed verified savings estimates for the program and an error bound for that estimate. The relative precision of the verified savings for the program is then calculated by dividing the error bound by the verified savings estimate.

Appendix B Billing Analysis Regression Outputs

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