



**FINAL REPORT**

**Avista 2012 Washington Gas Portfolio  
Impact Evaluation Report**

**July 30, 2013**

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Spokane, WA 99220**

**The Cadmus Group, Inc.**

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## Portfolio Executive Summary

Avista Corporation contracted with Cadmus to complete process and impact evaluations of the company's 2012 gas demand-side management (DSM) programs. Avista has been administering DSM programs to reduce energy use of electricity and natural gas for its portfolio of customers for several decades. Most programs are implemented in-house, but a few utilize external implementers. This report presents our impact findings for the PY 2012 gas portfolio in the state of Washington.

### Evaluation Activities

For each of the three sectors—Residential, Nonresidential, and Low Income—we employed a variety of evaluation methods and activities, as shown in Table 1.

**Table 1. 2012 Gas Programs Evaluation Activities**

Sector	Program	Document/ Database Review	Metering	Verification Site Visit	Survey	Billing Analysis	Modeling
Residential	ENERGY STAR Products	✓			✓		
	Heating and Cooling Efficiency	✓			✓		
	Weatherization/Shell	✓			✓		
	Water Heater Efficiency	✓			✓		
	ENERGY STAR Homes	✓					
Nonresidential	Prescriptive Programs	✓	✓	✓			
	Site-Specific	✓	✓	✓		✓	✓
Low Income	Low Income Programs	✓			✓	✓	

### Savings Results

Table 2 presents sector-level reported and gross verified savings values and realization rates. Overall, the Washington portfolio achieved a 98.6% realization rate, and acquired 604,708 in annual therm savings.

**Table 2. 2012 Reported and Gross Verified Savings for Washington**

Sector	Reported Savings (Therms)	Gross Verified Savings (Therms)	Realization Rate
Residential	285,732	281,346	98.5%
Nonresidential	304,096	304,872	100.3%
Low Income	23,666	18,490	78.1%
<b>Total</b>	<b>613,493</b>	<b>604,708</b>	<b>98.6%</b>

Table 3 shows gross verified savings, compared to the Integrated Resource Plan (IRP) goal of 1,742,366 therms. The IRP states its goal as a portfolio-level target; so, for a sector-level comparison, Cadmus adopted the Avista Business Plan goals by sector, and applied those proportions to the IRP target. The 2012 program year achieved 34.7% of the IRP target in Washington.



**Table 3. 2012 IRP Goals and Gross Verified Savings for Washington**

Sector	Savings Goal (Therms)	Gross Achieved (Therms)	Achievement Rate
Residential	650,820	281,346	43.2%
Nonresidential	1,020,047	304,872	29.9%
Low Income	71,499	18,490	25.9%
<b>Total</b>	<b>1,742,366</b>	<b>604,708</b>	<b>34.7%</b>

## Key Findings and Conclusions

### Residential

For PY2012, Avista's residential gas programs produced 281,346 therms in savings, yielding an overall realization rate of 98.5%. Residential gas savings achieved 43% of Residential IRP goals.

The evaluation produced the following, major, residential program conclusions:

- Overall, residential gas customers responded well to the programs, often installing several measures within the same year.
- Avista's program and tracking databases were adequate for evaluation purposes, providing sufficient contact information, and measure and savings information. The database review confirmed the information was reliable and accurate.
- All measures the program rebated had been installed and continued operating. With one exception, all measures reviewed met the program-qualification standards.

### Nonresidential

Cadmus evaluated 31 of 207 measures installed through the nonresidential energy-efficiency programs, representing 42% of reported savings. For PY2012, Avista's nonresidential gas programs produced 304,872 therms in savings, which yielded a 100.3% overall realization rate. Nonresidential gas savings achieved 30% of Nonresidential IRP goals.

Though Cadmus determined that Avista generally implemented the programs well, the following key issues reduced energy savings:

- Calculations provided by participants and contractors contained incomplete information.
- At times, the programs provided incentives for measures that may have been inappropriate.
- Calculations were not always consistent about fuel types after conversion incentives.

Cadmus also found the following implementation issues that affected the impact evaluation:

- Demand controlled ventilation (DCV) saving estimates may benefit from more consistency.
- DCV measures were also labeled as "Site-Specific Motors."



## Low Income

For PY2012, Avista's low income gas programs produced 18,490 therms in savings, yielding a 78.1% overall realization rate. Low income gas savings achieved 26% of Low Income IRP goals.

When state-level Washington savings estimates from the 2010 gas billing analysis were applied to 130 gas-saving 2012 program participants (not receiving fuel-conversion measures), 104 therms per home resulted.

An additional 73 participants received fuel conversions for electric heating and/or water heating equipment, along with bundles of other gas-saving weatherization measures (e.g., insulation). We assigned savings to three categories for these conversion participants: full model savings; partial model savings; and no model savings (only technical reference manual pass-through savings). In total, we estimated an additional 4,970 therms in savings for gas-saving conversion participants.

## *Recommendations and Further Analysis*

### Residential

Based on evaluation results, Cadmus offers the following recommendations to Avista:

- List energy factors (or, at least, model numbers) for appliances. Including more information about the actual efficiency of equipment installed allows for greater accuracy in estimating gross energy savings achieved.
- If possible, include existing equipment information.
- If the measure is reinstated, consider moving all ENERGY STAR Clothes Washer rebates to the electric program.

The following research recommendations draw upon this impact evaluation's the results and from known future changes to program requirements:

- Perform a targeted billing analysis on weatherization participants that use both electricity and gas to heat their homes.
- Perform a billing analysis on ENERGY STAR homes using a nonparticipant comparison group, once enough homes have participated under the new requirements to justify conducting the work.

### Nonresidential

Cadmus offers the following recommendations for improving program energy-savings impacts and evaluation effectiveness:

- Consider more extensively reviewing participant-provided calculations to ensure the assumptions and methodologies are reasonable during the implementation process.
- Conduct an additional review of all projects involving fuel conversions.



Recommendations for possible future analysis include:

- Cadmus will provide an updated DCV calculation tool for Avista consider in support of implementation efforts.

### Low Income

The impact evaluation revealed several areas where program performance and savings calculation accuracy could be improved. Consequently, we recommend that Avista considers the following:

- Include a control/comparison group in future billing analyses.
- Consider targeting high-use customers.
- Track and compile additional data from agency audits.
- Consider analyzing easy-to-quantify, non-energy benefits, which can be added to program cost-effectiveness reporting.

## 1 2012 Residential Gas Impact Report

### 1.1 Introduction

During the 2012 program year, Avista's residential gas demand-side management (DSM) programs in Washington reported savings of 285,732 therms for 4,610 measures. Avista's 2012 DSM residential gas programs included:

- ENERGY STAR Products
- ENERGY STAR Homes
- Heating and Cooling Efficiency
- Water Heating
- Weatherization Measures

This report explains the methods used to qualify and verify these savings.

#### 1.1.1 Evaluation Methodology

We designed our impact evaluation to verify reported program participation and energy savings using:

- Data collected in the tracking database;
- Online application forms;
- Phone surveys; and
- Applicable deemed values developed for Avista's technical reference manual (TRM).<sup>1</sup>

As shown in Table 4, Cadmus employed up to two evaluation methods and activities for each program.

**Table 4. Evaluation Methodology**

	Program	Document/Database Review	Survey
Residential	ENERGY STAR Products	✓	✓
	Heating and Cooling Efficiency	✓	✓
	Weatherization/Shell	✓	✓
	Water Heater Efficiency	✓	✓
	ENERGY STAR Homes	✓	

#### 1.1.2 Energy Savings

Table 5 shows aggregated adjusted gross savings and resulting realization rates by program.

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<sup>1</sup> In 2011's first quarter, Cadmus created a TRM for use in deemed measure savings, and updated it where necessary for the 2012 program year.



**Table 5. Reported and Adjusted Gross Savings**

Program Name	Reported Savings (Therms)	Adjusted Gross Savings (Therms)	Realization Rate
ENERGY STAR Products	9,253	7,057	76.3%
Heating and Cooling Efficiency	231,792	229,938	99.2%
Weatherization/Shell	39,326	39,012	99.2%
Water Heater Efficiency	2,721	2,699	99.2%
ENERGY STAR Homes	2,640	2,640	100.0%
<b>Total</b>	<b>285,732</b>	<b>281,346</b>	<b>98.5%</b>

Table 6 shows the reported measure counts. We verified savings of 281,346 therms through the installation of 4,610 measures during PY 2012. Overall, residential gas programs achieved an adjusted gross realization rate of 98.5%.

**Table 6. Avista 2012 DSM Programs Reported Measure Counts**

Program	Washington Measure Count
ENERGY STAR Products	1,447
Heating and Cooling Efficiency	2,254
Weatherization/Shell	593
Water Heater Efficiency	302
ENERGY STAR Homes	13
<b>Total</b>	<b>4,610</b>

## 1.2 Methodology

### 1.2.1 Sampling

Cadmus randomly sampled program participants to complete surveys. Cadmus also randomly sampled participant applications to be reviewed for this evaluation. The following subsections describe methods used to select the required samples.

#### *Record Review Sampling*

To determine the percentage of measures incented that qualified for the program, Cadmus designed sample sizes to yield significance at the 90% confidence and  $\pm 10\%$  precision levels for each application type, across both states and fuels. Cadmus randomly selected participant measures for a record qualification review from the 2012 gas and electric program populations. We sampled participants using a single measure record. However, if a customer applied for multiple rebates on the same application form during the program year, the record review checked all measures included in the application for qualification, whether for electric or gas.

Table 7 shows the number of record reviews completed for unique accounts and unique measures.

**Table 7. Measure Level Record Review Completes**

Total Participants Reviewed	217
Total Measures Qualified	260

**Survey Sampling**

For program-level survey results, Cadmus designed participant survey sample sizes to yield significance at the 90% confidence and  $\pm 10\%$  precision levels for each program within each Washington and Idaho. The participant survey sampling plan drew upon on multiple factors, including:

- The feasibility of reaching customers;
- The program participant population; and
- Research topics of interest.

Customer fuel types did not factor in survey sampling.

Cadmus did not survey home buyers for the ENERGY STAR New Homes program because home builders received the rebates. The evaluation completed a total of 374 surveys with Washington participants. Table 8 shows: the number of surveys achieved; and the resulting absolute precision for each program. Note that the absolute precision achieved did not always meet the  $\pm 10\%$  goal, but is safely within the portfolio precision goal of 90/10.

**Table 8. Participant Survey Sample Sizes and Savings-Weighted Precision Estimates by Program**

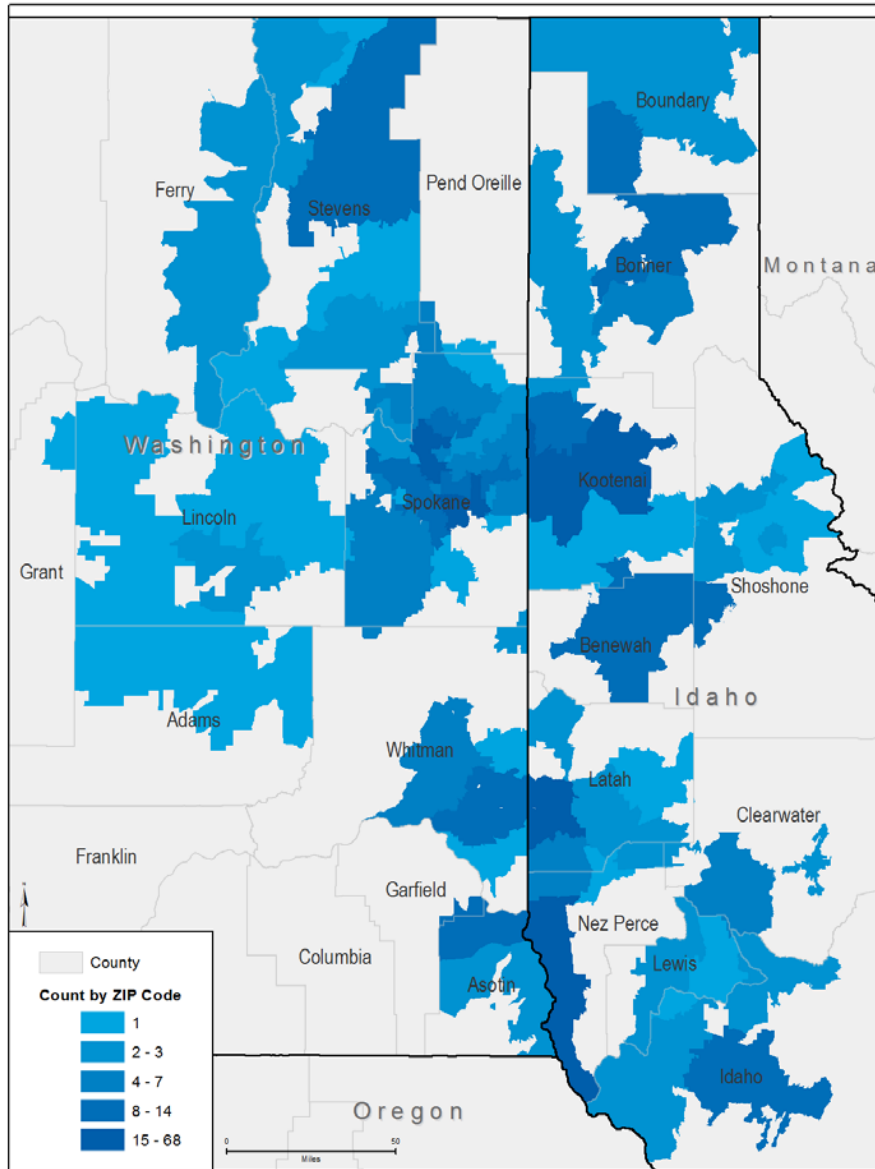
Programs	Reported Population	Proposed Survey Target	Percent of Population	Completes	Absolute Precision at 90% Confidence
<b>Washington</b>					
Space and Water Conversions	149	50	33.6%	23	$\pm 15\%$
Water Heating	509	60	11.8%	62	$\pm 9\%$
ENERGY STAR Products	4,911	70	1.4%	76	$\pm 9\%$
Heating and Cooling Efficiency	3,462	70	2.0%	71	$\pm 10\%$
Second Refrigerator and Freezer Recycling*	1,092	70	6.4%	71	$\pm 9\%$
Weatherization and Shell Measures	712	70	9.8%	71	$\pm 9\%$

\*This program did not claim therms savings.

Cadmus randomly called program participants included in survey sample frames. Geographic distributions of survey respondents clustered around urban centers within Avista's service territory, specifically the cities of Spokane, Pullman, Moscow, and Lewiston, as shown in Figure 1.



**Figure 1. Geographic Distribution of Participant Survey Completes**



### 1.2.2 Data Collection and Analysis

#### *Record Review*

Cadmus reviewed all records for the selected sample of accounts, checking them for completeness and program compliance using the data they contained. Measures qualified if all data found in the application complied with the program specifications. As the evaluation randomly sampled customers by application type (several measures can be found on different application forms), we tracked qualification rates at the application type level.

The review revealed one improperly issued insulation rebate on a Home Improvement application, as it had an existing R-value above the participation requirements (the applied qualification rates include this result).

### *Surveys*

Cadmus contracted with Discovery Research Group (DRG), a market research firm, to conduct surveys with sampled participants. To minimize response bias, DRG called customers during various hours of days and evenings (including weekends), and made multiple attempts to contact individual participants. Cadmus monitored survey phone calls to ensure accuracy, professionalism, and objectivity. We analyzed the survey data at the program level rather than the measure level, and weighted survey results at the portfolio level by program participation to ensure proper representation

### *Database Analysis*

Cadmus reviewed the participant database Avista provided to check for inconsistencies in reported savings and measure duplications. This review did not identify inconsistencies in data tracking. All reported savings were based on the 2012 Avista TRM.

### *Unit Energy Savings*

Cadmus updated the unit energy savings achieved by ENERGY STAR Clothes Washers, based on new survey data of Avista participants. We did not update other unit energy savings.

### **1.2.3 Verification Rates**

Cadmus determined verification rates for each program, but not for each measure. Where applicable, the review covered the following topics:

- Checking that the database tracked the correct measures;
- Accounting for correct quantities; and
- Determining whether units remained in place and were operable.

All measures researched remained in place and were operable, resulting in a 100% verification rate.

### **1.2.4 Measure Qualification Rates**

Cadmus considered a measure qualified if it met the various requirements particular to its category, such as receiving an ENERGY STAR certification or achieving program minimum efficiency standards. When necessary, we conducted online database searches for model numbers, and noted necessary characteristics to verify achievement of all qualifications.

Out of the entire verification sample, we identified one nonqualified measure:

- An attic insulation project had a base case condition that should have prevented it from qualifying.



## 1.3 Program Results and Findings

### 1.3.1 Overview

End results from the review produced total adjusted gross savings for each measure and program as well as overall realized savings for each program. The following sections describe each program, explain analysis steps taken, and discuss results and findings.

Calculating the measures' adjusted gross measure savings required the following steps:

1. Reviewing the database to determine whether adjusted measure counts correctly represented the number of measures installed.
2. Conducting a phone survey with a sample of customers to verify measure installations.
3. Reviewing records to determine measure qualification.
4. Calculating verification and qualification rates.
5. Calculating deemed measure savings for rebated products.
6. Determining adjusted gross savings for each measure by applying the above-calculated rates and deemed savings to measure counts.

### 1.3.2 ENERGY STAR Products

#### *Program Description*

The ENERGY STAR Products program included the following gas measures:

- Clothes washer (gas)
- Dishwasher (with gas water heater)

The program offered direct financial incentives to motivate customers to use more energy-efficient appliances. The program indirectly encouraged market transformation by increasing demand for ENERGY STAR products. The program included electric and gas measures, though this report focuses on gas savings.<sup>2</sup>

#### *Analysis*

Energy savings credited to the ENERGY STAR Products program had to meet multiple criteria:

- Measures had to remain in place and operate properly at the time of verification;
- Numbers of installed equipment pieces and their corresponding model numbers in the applications had to match the database; and
- Units must have been ENERGY STAR-qualified at the time of the program offering.

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<sup>2</sup> See Appendix 1B for the electricity savings achieved through the gas program.



### Clothes Washers

Energy savings calculations drew upon a 2009 Cadmus metering study,<sup>3</sup> which metered more than 100 clothes washers in California homes for three weeks; the largest *in situ* metering study on residential clothes washers and dryers conducted in the last decade, The study indicated higher consumption and savings values than those often estimated.

Dryers produced the majority of energy consumption and savings, as high-efficiency washing machines removed more moisture from clothes, allowing shorter drying times. As most energy savings resulted from decreased dryer use, the study had to estimate the percentage of homes using gas domestic hot water heaters and electric dryers. The Regional Technical Forum (RTF) advocates an 82% assumption, which this analysis used. Consequently, 82% of installations of ENERGY STAR clothes washers in homes with a gas domestic hot water heaters achieved significant amounts of electricity savings.

Determining adjusted gross savings required using the following, additional input assumptions:

- Recent independent evaluation surveys from the Residential Building Stock Assessment (RBSA) and 2012 Avista Participant surveys estimated 262 washing cycles per year. Unit energy savings values have been adjusted accordingly, as reflected in the realization rate for this measure.<sup>4</sup>
- Cadmus utilized the California metering study to estimate consumption per wash and dry cycle for the base and efficient equipment.

### Dishwashers

Cadmus estimated dishwasher savings based on methods currently used in the ENERGY STAR Calculator<sup>5</sup> (the only calculator available providing consistent energy-savings estimates in the presence of a gas or electric domestic hot water heater). The following input assumptions were applied:

- Cadmus calculated the average base case and efficient case Energy Factor (EF), with both based on data utilized by the RTF. The baseline EF equaled the average market efficiency of units not qualifying for the program. The efficient EF equaled the average market efficiency of units qualifying for the program at the time of their rebate.
- Recent evaluation surveys conducted in the region estimated 245 washing cycles per year.<sup>6,7</sup>

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<sup>3</sup> The Cadmus Group, Inc. 2010. "Do the Savings Come Out in the Wash? A Large Scale Study of In-Situ Residential Laundry Systems."  
[http://www.cadmusgroup.com/pdfs/Do\\_the\\_Savings\\_Come\\_Out\\_in\\_the\\_Wash.pdf](http://www.cadmusgroup.com/pdfs/Do_the_Savings_Come_Out_in_the_Wash.pdf)

<sup>4</sup> Ecotope Inc. 2012. 2011 *Residential Building Stock Assessment: Single-Family Characteristics and Energy Use*. Seattle, WA: Northwest Energy Efficiency Alliance.

<sup>5</sup> [http://www.energystar.gov/ia/business/bulk\\_purchasing/bpsavings\\_calc/CalculatorConsumerDishwasher.xls?7182-1c92](http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls?7182-1c92)

<sup>6</sup> *Pacific Power Washington 2009-2010 Residential Home Energy Savings Evaluation.*, January 2012.

<sup>7</sup> *Rocky Mountain Power 2009-2010 Idaho Residential Home Energy Savings Evaluation.*, February 2012.



- Water heating consumed 56% of electricity required to run a dishwasher connected to an electric domestic hot water heater.<sup>8</sup>

### Results and Findings

Table 9 shows: total reported and qualified counts, savings, and realization rates of gas ENERGY STAR Products measures in Washington.

**Table 9. ENERGY STAR Products Program Results**

Program Name	Reported Measure Count	Reported Savings (Therms)	Adjusted Savings (Therms)	Qualification Rate	Verification Rate	Adjusted Gross (Therms)	Realization Rate
G Clothes Washer-Nat Gas H <sub>2</sub> O	1,102	8,808	6,612	100%	100%	6,612	75.1%
G Dishwasher-Nat Gas H <sub>2</sub> O	345	445	445	100%	100%	445	100.0%
<b>Program Total</b>	<b>1,447</b>	<b>9,253</b>	<b>7,057</b>	<b>100%</b>	<b>100%</b>	<b>7,057</b>	<b>76.3%</b>

Appendix 1B addresses electricity savings achieved by the installation of ENERGY STAR products in homes with a gas domestic hot water heater.

The program achieved a 76.3% realized adjusted gross savings rate, a result driven by the reduction in assumed clothes washer cycles per year.

### 1.3.3 Heating and Cooling Efficiency

#### Program Description

The Heating and Cooling Efficiency program included the following gas measures:

- Gas Boiler
- Gas Furnace

The program offered a \$400 direct financial incentive to motivate customers to use more energy-efficient heating and cooling equipment. Participants could receive the incentive for installing a high-efficiency natural gas furnace of 90% AFUE (heating efficiency) or greater, or a natural gas boiler of 90% AFUE or greater.

#### Analysis

The PY 2010 gas impact evaluation report documented a census billing analysis Cadmus performed to determine the change in energy consumption due to the installation of a high-efficiency gas furnace. As

<sup>8</sup> [http://www.energystar.gov/ia/business/bulk\\_purchasing/bpsavings\\_calc/CalculatorConsumerDishwasher.xls?7182-1c92](http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls?7182-1c92)

the billing analysis provided the best information on this measure, Cadmus continued tracking results for the 2012 program year.<sup>9</sup>

We calculated energy savings achieved through installations of high-efficiency gas boilers by adjusting the billing analysis results to the typical participant home installing a high-efficiency boiler.

### *Results and Findings*

Table 10 shows total reported and qualified counts, savings, and realization rates of gas Heating and Cooling Efficiency measures in Washington.

**Table 10. Heating and Cooling Efficiency Program Results**

Program Name	Reported Measure Count	Reported Savings (Therms)	Adjusted Savings (Therms)	Qualification Rate	Verification Rate	Adjusted Gross (Therms)	Realization Rate
G Nat Gas Boiler	37	3,441	3,441	99.2%	100.0%	3,413	99.2%
G Nat Gas Furnace	2,217	228,351	228,351	99.2%	100.0%	226,524	99.2%
<b>Program Total</b>	<b>2,254</b>	<b>231,792</b>	<b>231,792</b>	<b>99.2%</b>	<b>100.0%</b>	<b>229,938</b>	<b>99.2%</b>

The program achieved a 99.2% realized adjusted gross savings rate, reduced slightly due to qualification.

### **1.3.4 Weatherization/Shell**

#### *Program Description*

This program incented five categories of measures, available to residential electric and gas customers with homes heated with fuel provided by Avista:

- Fireplace Dampers (Discontinued)
- Insulation—Ceiling/Attic
- Insulation—Floor
- Insulation—Wall
- Window Replacement (Discontinued)

The program incented qualifying ceiling and attic insulation (both fitted/batt and blown-in), which increased the R-value by 10 or more, at \$0.25 per square foot of new insulation, and up to 50% of installation costs. Homes qualified if they had existing attic insulation less than R-19.

The program incented floor and wall insulation (both fitted/batt and blown-in), which increased the R-value by 10 or more, at \$0.50 per square foot of new insulation, up to 50% of the installation cost. Homes qualified if they had existing floor and/or wall insulation less than R-5.

<sup>9</sup> *Avista 2010 Multi-Sector Gas Impact Evaluation Report*. August 2011.



In 2011, Avista terminated Fireplace Dampers and Window Replacements, though two installations of each measure carried over into 2012.

### **Analysis**

The PY2011 gas impact evaluation report documented a census billing analysis Cadmus performed to determine the change in energy consumption resulting from installation of weatherization and window measures. As the billing analysis continued to provide the best information on this measure, results were maintained for the 2012 program year.<sup>10</sup> Cadmus did not evaluate energy savings associated with the Fireplace Damper and Windows Replacement measures due to their minimal impact on program savings.

Table 11 shows total reported and qualified counts, savings, and realization rates of gas Weatherization program measures.

**Table 11. Weatherization Program Results**

Program Name	Reported Measure Count	Reported Savings (Therms)	Adjusted Savings (Therms)	Qualification Rate	Verification Rate	Adjusted Gross (Therms)	Realization Rate
G Fireplace Damper-Nat Gas Ht	2	11	11	99.2%	100.0%	11	99.2%
G Windows	2	45	45	99.2%	100.0%	45	99.2%
G Insulation	590	39,270	39,270	99.2%	100.0%	38,956	99.2%
<b>Program Total</b>	<b>594</b>	<b>39,326</b>	<b>39,326</b>	<b>99.2%</b>	<b>100.0%</b>	<b>39,012</b>	<b>99.2%</b>

## **1.3.5 Water Heater Efficiency**

### **Program Description**

The Water Heater Efficiency program includes the following gas measures:

- High-Efficiency 40-Gallon Water Heater
- High-Efficiency 50-Gallon Water Heater

Through this program, Avista offered a \$50 incentive to residential customers installing eligible high-efficiency water heaters. To qualify for the program, natural gas water heaters with tanks had to have a 0.60 EF or greater for a 50-gallon tank, and a 0.62 EF or greater for a 40-gallon tank.

### **Analysis**

Deemed unit energy savings remained consistent with those used in the 2011 program year, thus no changes were necessary.

<sup>10</sup> Avista 2011 Multi-Sector Gas Impact Evaluation Report. May 2012.

### Results and Findings

Table 12 shows total reported and qualified counts, savings, and realization rates of gas Water Heater Efficiency measures in Washington.

**Table 12. Water Heater Efficiency Program Results**

Program Name	Reported Measure Count	Reported Savings (Therms)	Adjusted Savings (Therms)	Qualification Rate	Verification Rate	Adjusted Gross (Therms)	Realization Rate
G 40 Gallon Nat Gas Hot Water	39	343	343	99.2%	100.0%	340	99.2%
G 50 Gallon Nat Gas Hot Water	263	2,378	2,378	99.2%	100.0%	2,358	99.2%
<b>Program Total</b>	<b>302</b>	<b>2,721</b>	<b>2,721</b>	<b>99.2%</b>	<b>100.0%</b>	<b>2,699</b>	<b>99.2%</b>

### 1.3.6 ENERGY STAR Homes

#### Program Description

The ENERGY STAR Homes program offered incentives to builders constructing single-family or multifamily homes complying with ENERGY STAR criteria (and verified as ENERGY STAR Homes). Avista provided a \$900 incentive for homes that have Avista electric or electric and natural gas service for space and water heating. Avista provided a \$650 incentive for homes that only have natural gas service (both hot water and space heating had to be natural gas).

#### Analysis

The PY2011 gas impact evaluation report documented the simulation modeling Cadmus performed to determine the energy savings achieved by these measures. As the simulation results continue to provide accurate estimates of savings, results were maintained for the 2012 program year.<sup>11</sup>

#### Results and Findings

Table 13 shows total reported and adjusted counts, savings, and realization rates for gas measures within ENERGY STAR Homes. The electric and gas programs funded participating homes using both Avista electric and gas. The associated electric impact evaluation report will address electric savings associated with these homes.

<sup>11</sup> Avista 2011 Multi-Sector Gas Impact Evaluation Report. May 2012.



Table 13. ENERGY STAR Home Program Results

Program Name	Reported Measure Count	Reported Savings (Therms)	Adjusted Savings (Therms)	Qualification Rate	Verification Rate	Adjusted Gross (Therms)	Realization Rate
Home-Gas Only	4	813	813	100.0%	100.0%	813	100.0%
Elec/Gas (Gas)	9	1,827	1,827	100.0%	100.0%	1,827	100.0%
<b>Program Total</b>	<b>13</b>	<b>2,640</b>	<b>2,640</b>	<b>100.0%</b>	<b>100.0%</b>	<b>2,640</b>	<b>100.0%</b>

### 1.3.7 Residential Programs Confidence and Precision

Cadmus determined the overall precision of the adjusted gross savings by estimating the standard error associated with each measure. For measures only based on deemed savings estimates, error in the deemed savings resulted from error in each of the input assumptions.

Typically, the error for each savings estimate results from the sampling error associated with the research into each savings equation input. To simplify this analysis, Cadmus conservatively estimated a standard error associated with each deemed measure as 20% of the unit energy savings, unless recent evaluation research developed a more accurate estimate. Though a greater estimate than the values Cadmus typically determines, this provided a conservative estimate of program precision.

Two programs used more accurate estimates of error, based on recent research. The standard error for the Heating and Cooling efficiency program drew upon the billing analysis performed in 2011.<sup>12</sup> The standard error for the Weatherization/Shell program drew upon the billing analysis performed in 2012.<sup>13</sup> Following determination of program measure savings-based error, Cadmus applied the verification error determined through this year's surveys to each program, except for the two using billing analysis results. We did not apply verification survey error to savings determined through a billing analysis as their results included homes where installations were stated to have occurred, but did not occur. Table 14 shows the program level error and precision for the portfolio's residential portion. Overall, the residential programs achieved 3.6% relative precision at the 90% confidence interval.

Table 14. Program Savings Precision at the 90% Confidence Interval

Program	Adjusted Gross Savings (therms)	Standard Error (therms)	Relative Precision at 90% Confidence
ENERGY STAR Products	9,547	2,381	41.0%
Heating and Cooling Efficiency	335,775	8,082	4.0%
Weatherization/Shell	50,369	2,754	9.0%
Water Heater Efficiency	3,164	564	29.3%
ENERGY STAR Homes	4,469	634	23.4%
<b>Total</b>	<b>403,324</b>	<b>8,905</b>	<b>3.6%</b>

<sup>12</sup> Avista 2010 Multi-Sector Gas Impact Evaluation Report. August 2011.

<sup>13</sup> Avista 2011 Multi-Sector Gas Impact Evaluation Report. May 2012.

## 1.4 Conclusions

Overall, the 2012 residential gas programs in the state of Washington produced 281,346 therms in savings. As shown in Table 15, the evaluation yielded a 98.5% realization rate of 98.5%.

**Table 15. Program Reported and Verified Gross Verified Savings and Realization Rates—Washington**

Program Name	Reported Savings (Therms)	Adjusted Savings (Therms)	Qualification Rate	Verification Rate	Adjusted Gross (Therms)	Realization Rate
ENERGY STAR Products	9,253	7,057	100.0%	100%	7,057	76.3%
Heating and Cooling Efficiency	231,792	231,792	99.2%	100%	229,938	99.2%
Weatherization/Shell	39,326	39,326	99.2%	100%	39,012	99.2%
Water Heater Efficiency	2,721	2,721	99.2%	100%	2,699	99.2%
ENERGY STAR Homes	2,640	2,640	100.0%	100%	2,640	100.0%
<b>Total</b>	<b>285,732</b>	<b>283,536</b>	<b>99.2%</b>	<b>100%</b>	<b>281,346</b>	<b>98.5%</b>

Table 16 shows the achievement rates for gross savings compared to the IRP goals for the residential sector.

**Table 16. Overall Evaluated Gas Savings and IRP Goals**

IRP Goal (Therms)	Evaluated Gas Savings (Therms)	Goal Achievement
650,820	281,346	43%

## 1.5 Recommendations

Cadmus offers the following recommendations, based on evaluation results:

- Avista should collect and record equipment efficiency information in the database tracking system, or at least record the model numbers for appliances. Including equipment-specific information addressing the actual efficiency of the equipment installed would allow greater accuracy in estimating the gross energy savings achieved. Future evaluations could use collected information to determine savings, rather than relying on regional market average estimates, which do not account for the self-selection inherent in rebate programs.
- If the Clothes Washer measure is reinstated, Avista should consider moving all rebates to the electric program, as the majority of savings will likely result from a reduction in consumed electricity from the dryer. Qualifying for the program should be based on the presence of an electric dryer in the home. Given the large percentage of savings achieved through reduced dryer energy, and because of the high likelihood that most participants have an electric dryer, this measure predominantly produces electric energy savings.

### 1.5.1 Future Research Areas

The following research recommendations draw upon this impact evaluation's results and on known future changes in program requirements:



- Perform a targeted billing analysis for weatherization participants using both electricity and gas to heat their homes.
- Perform a billing analysis for ENERGY STAR homes using a nonparticipant comparison group, once enough homes have participated under the new requirements to justify the work.



## 2 2012 Nonresidential Gas Impact Report

### 2.1 Introduction

Avista's nonresidential portfolio of programs promotes the purchase of industry-proven, high-efficiency equipment for its commercial customers. The company provides rebates to partially offset the cost differences between high-efficiency equipment and standard equipment, reducing first-cost barriers and making the high-efficiency equipment a more viable option for commercial customers.

Five programs make up the nonresidential gas portfolio, divided into two major categories:

- Prescriptive (four programs)
- Site-Specific (one program)

#### 2.1.1 Prescriptive

##### *Prescriptive Commercial Clothes Washer (PCW)*

To encourage customers to select high-efficiency clothes washers, this program targets nonresidential electric and natural gas customers in multifamily or commercial Laundromat facilities. The program's streamlined prescriptive approach, designed to reach customers quickly and effectively, promotes ENERGY STAR or Consortium for Energy Efficiency (CEE) listed units.

##### *Prescriptive Commercial HVAC (PCH)*

Beginning in January 2011, installations of efficient HVAC systems have been processed through a prescriptive program rather than the site-specific program. The prescriptive program limits eligible measures to the following:

- Furnaces under 225 kBtu, with an efficiency greater than 90% AFUE.
- Furnaces between 225 kBtu and 300 kBtu, with an efficiency greater than 85% AFUE.

##### *Prescriptive Commercial Windows and Insulation (PCS)*

Beginning in January 2011, installation of commercial insulation has been processed through a prescriptive program, in addition to the site-specific program. Projects qualify for the prescriptive program if they have the following, pre-existing qualities:

- Wall insulation levels of less than R4, improved to R11 or better.
- Attic insulation of less than R11, improved to R30 or better.
- Roof insulation of less than R11, improved to R30 or better.

##### *Prescriptive Food Service Equipment (PFS)*

Applicable to nonresidential electric and gas customers with commercial kitchens, this program provides direct incentives to customers choosing high-efficiency kitchen equipment. To qualify for an incentive, the equipment must meet ENERGY STAR or CEE tier levels (depending on the unit).



### 2.1.2 Site-Specific

The Site-Specific program addresses nonresidential measures that do not fit the prescriptive applications; thus, they must be considered based on their project-specific information. Measures eligible for consideration must produce demonstrable kWh or therm savings, and are available to commercial, industrial, or pumping customers: receiving electric or natural gas service from Avista; and seeking to make cost-effective, energy-efficiency improvements to their businesses. The program includes the following measures:

- Site-specific HVAC (SSHVAC)
  - HVAC combined
  - HVAC heating
- Site-specific other (SSO)
  - Appliances
  - Motors (demand controlled ventilation)
- Site-specific shell (SSS)

Avista designs, manages, and implements the prescriptive and site-specific programs. It has also developed algorithms it uses to calculate measure savings and to determine measure and customer eligibility.

Avista staff fields inquiries from potential participants and contractors, and maintains a tracking database for projects. Throughout the program, Avista manages projects by reviewing and approving applications at all stages of the process, calculating project savings, and populating the database with relevant information.

## 2.2 Methodology

Cadmus designed the impact evaluation to verify tracked program participation and to estimate energy savings. We determined gross savings using: engineering calculations, desk reviews, verification site visits, and some project-level billing analysis.

Cadmus reviewed Avista's tracked gross energy savings and available documentation, such as audit reports and savings calculation work papers, for a sample of sites, particularly focusing on calculation procedures and documentation for savings estimates. We also verified the appropriateness of Avista's analyses for calculating savings, and the operating and structural parameters of the analyses. Through site visits or desk reviews of a sample of projects, we collected data on equipment installation and operation and evaluated gross energy savings through engineering calculations.

Cadmus collected baseline, tracking, and program implementation data through on-site interviews with facility staff. During on-site visits, we verified measure installations and determined changes to the operating parameters occurring since measure installation. Facility staff interviews included questions regarding the installed systems' operating conditions, additional benefits, or shortcomings. We used the

savings realization rates from sample sites to estimate savings and to develop recommendations for future studies.

### 2.2.1 Sampling

Avista reported planning to phase out the gas programs due to cost-effectiveness concerns associated with the declining price of natural gas in 2011. Consequently, Cadmus and Avista found it appropriate to apply a lower rigor level to sampling than that used in the 2010 and 2011 evaluations. Cadmus selected a precision target of 80% confidence and a 20% confidence interval for the 2012 program sample. We developed a sampling calculation tool to estimate the number of site verifications and desk reviews required to achieve the precision target's rigor levels.

Using program population data provided by Avista, we determined 43 sites would require evaluations across Washington's and Idaho's program populations. Cadmus will calculate the combined 2012 and 2013 evaluation precision following the 2013 program evaluation.

Table 17

Table 17 shows the proposed precision targets for the site verification and desk review evaluation activities.

**Table 17. Proposed PY 2012-2013 Nonresidential Idaho and Washington Gas Evaluation Sample**

Measure Category	Precision Target	Evaluated Projects
Prescriptive	80/20	24
SSHVAC	80/20	7
SSO	80/20	8
SSS	80/20	4
<b>Total</b>	<b>80/20</b>	<b>43</b>

We assigned a census and a random sample for each stratum. The census stratum represented the six projects with the highest overall gas savings, with five of the six sites located in Washington. Each census site reported over 10,000 therms in savings and combined to represent 24% of total program reported savings. For the non-census stratum, we randomly selected additional participants from the remaining project population.

Cadmus found the database extract from Avista provided program-level but not measure-level information (e.g., boilers, water heaters, window retrofits). Therefore, we sought to verify savings for every incented measure at each site, regardless of whether or not it achieved gas or electric savings. Establishing whether we evaluated an accurate distribution of specific measure types within each program would have required an exhaustive review of project files, which fell outside of the evaluation's scope.



### 2.2.2 Data Collection

Cadmus collected data from nine on-site verifications in Washington and conducted 22 desk reviews. For each sample project, we first conducted a document review to determine measure types, quantities, operational parameters, and calculation methodologies.

#### *Document Review*

Avista provided Cadmus with documentation on the sample sites' energy-efficiency projects, including: program forms, the tracking database, audit reports, and savings calculation work papers for each rebated measure. Our review of calculation spreadsheets and energy simulation models paid particular attention to calculation procedures and documentation for savings estimates.

Cadmus reviewed each application for the following information:

- Equipment replaced: descriptions, schematics, performance data, and other supporting information.
- New equipment installed: descriptions, schematics, performance data, and other supporting information.
- Savings calculation methodology: the methodology type used, specifications of assumptions, sources for these specifications, and the correctness of calculations.

#### *Site Visits*

Cadmus on-site visits sought to accomplish the three primary tasks that follow:

1. Verifying the implementation status of all measures for which customers received incentives. This required verifying the energy-efficiency measures had been installed correctly and functioned properly. We also verified the operational characteristics of the installed equipment, such as temperature set points and operating hours.
2. Collecting physical data, such as boiler capacities or operational temperatures, and analyzing the energy savings realized from the installed improvements and measures.
3. Conducting interviews with facility personnel to obtain additional information regarding the installed systems, thus supplementing data from other sources.

#### *Desk Reviews*

For some prescriptive and site-specific projects, we analyzed and evaluated energy savings by reviewing calculation spreadsheets and documentation submitted with the rebate applications. The analysis verified equipment efficiency based on: equipment model numbers provided in rebate applications; and savings calculation methodologies. These 22 projects realized smaller therm savings than the census-level projects selected for site visits.

### 2.2.3 Engineering Analysis

Nonresidential prescriptive and site-specific programs required significantly different methods of analysis.

### *Overview*

Procedures used for verifying savings through an engineering analysis depended on the type of measure analyzed. This evaluation used the following analytical methods, with descriptions included in their respective sections:

- Prescriptive deemed savings
- Billing analysis
- Calculation spreadsheets
- Energy simulation modeling

### *Prescriptive Deemed Savings*

For most prescriptive measures, we verified the deemed savings estimates that Avista used for savings calculations, and then compared these with the values we developed for the TRM. Verification activities focused on:

- The installed quantity;
- Equipment nameplate data;
- Proper installation of equipment; and
- Operating hours.

Where appropriate, we used data from site verification visits to reanalyze prescriptive measure savings using Avista's Microsoft Excel calculation tools, ENERGY STAR calculation tools, RTF deemed savings, and other secondary sources.

### *Billing Analysis*

Cadmus analyzed Avista's metered billing data for two site-specific HVAC projects. Using a pre- and post-modeling approach, we developed retrofit savings estimates for each site. This modeling approach accounted for differences in heating degree days (HDDs), and determined savings based on normalized weather conditions, as actual weather conditions may have been milder or more extreme than the TMY3's (typical meteorological year) 15-year normal weather averages from 1991–2005, obtained from the National Oceanic and Atmospheric Administration (NOAA).

NOAA also provided daily weather data for each weather station associated with the participant projects, and we calculated the base 65 reference temperature HDDs. We matched participant billing data to the nearest weather station by ZIP code, and matched each monthly billing period to the associated base 65 HDDs.

In developing the analysis models, we followed a modified PRISM approach, which normalized all dependent and independent variables for the days in each billing period, and allowed model coefficients to be interpreted as average daily values. This methodology accounted for differences in the length of billing periods. For each project, we modeled average daily consumption in kWh as a function of some combination of the average standing base load, HDD, and (where appropriate) daily consumption.



For each site, Cadmus estimated two demand models: one for the pre-period; and one for the post-period. We chose this methodology over a single standard treatment effects model to account for structural changes in demand that might occur due to retrofits.

After estimating model coefficients for each site, Cadmus calculated three scenarios:

- We estimated a reference load for the previous 12 billing cycles, using the pre-period model. This scenario extrapolated the counterfactual consumption (i.e., what consumption would have been in the program's absence). We calculated energy savings as the difference between the counterfactual scenario and the actual consumption.
- We estimated two normalized scenarios: one using the pre-model; and one using the post-model. Both scenarios used 15-year TMY3 data as the annual HDD and mean annual values for the usage data. The difference between these two scenarios represented the long-term expected annual savings.

### ***Calculation Spreadsheets***

Avista developed calculation spreadsheets to analyze energy savings for a variety of measures, including the construction of envelope measures (such as ceiling and wall insulation). The calculation spreadsheets required entering relevant parameters, such as square footage, efficiency values, HVAC system details, and location details. From these data, energy savings could be estimated using algorithms programmed by Avista. For each spreadsheet, we reviewed input requirements and output estimates, and determined if the approach proved reasonable.

### ***Energy Simulation Modeling***

Avista determined savings for many site-specific HVAC and shell projects using energy simulation modeling (chosen due to the complex interactions between heating and cooling loads and the building envelope). Avista provided the original energy simulation models, which we reviewed to determine the relevant parameters and operating details (such as temperature set points) for the applicable measures. We updated the models as necessary, based on on-site verification data.

## ***2.3 Results and Findings***

### **2.3.1 Overview**

Cadmus adjusted gross savings estimates based on our evaluated findings. The following sections discuss further details, by program.

### **2.3.2 Prescriptive Programs**

We evaluated savings for a sample of sites across four prescriptive programs. Table 18 shows the savings and realization rates by program. Further evaluation details for each program follow. Table 19 shows the combined Idaho and Washington prescriptive results. These results were used for final extrapolation because the sample was chosen from a combined sampling methodology.

Table 18. Evaluated Results for PY2012 Nonresidential Gas Prescriptive Sample—Washington

Program	Total PY12 Measure Installations	Evaluated Sample	Gross Reported Savings (Therms)	Gross Evaluated Savings (Therms)	Realization Rate
PCW	2	0	N/A	N/A	N/A
PCH	41	4	1,626	1,634	101%
PCS	69	6	1,640	1,575	96%
PFS	18	2	5,136	4,677	77%
<b>Total</b>	<b>130</b>	<b>12</b>	<b>8,402</b>	<b>7,886</b>	<b>94%</b>

Table 19. Evaluated Results for PY2012 Nonresidential Gas Prescriptive Sample—Combined Washington and Idaho

Program	Total PY12 Measure Installations	Evaluated Sample	Gross Reported Savings (Therms)	Gross Evaluated Savings (Therms)	Realization Rate
ESG	1	1	900	1,053	117%
PCW	2	0	N/A	N/A	N/A
PCH	65	6	2,224	2,304	104%
PCS	90	8	1,736	1,728	100%
PFS	26	2	5,136	4,677	91%
<b>Total</b>	<b>184</b>	<b>17</b>	<b>9,996</b>	<b>9,762</b>	<b>98%</b>

Cadmus identified several necessary adjustments to the tracked savings for the prescriptive programs. The calculations often relied on reported equipment and operations data, which could vary from parameters identified during on-site verification visits and metering.

Our adjustments decreased savings by 6% for Washington projects, and the combined adjustments for both states reduced savings by 2%. Typical adjustments corrected equipment efficiencies, fuel types, operating schedules, and operating parameters, as described below:

- For one prescriptive windows retrofit project, Cadmus did not award any therm savings. The rebate application indicated the building used an electric resistive heating system rather than natural gas.
- On a prescriptive HVAC boiler replacement project, Cadmus verified the actual boiler efficiency as lower than the tracked value, based on the equipment model number provided in the rebate application. This adjustment reduced the project's realization rate by 9%.
- One prescriptive food service equipment measure included installations of kitchen vent hood exhaust fan controls. We adjusted the gas savings, based on an industry-standard calculator.<sup>14</sup> Cadmus awarded a 54% realization rate to this project.

<sup>14</sup> [http://www.fishnick.com/publications/appliancereports/hoods/mark\\_hopkins\\_melink\\_report.pdf](http://www.fishnick.com/publications/appliancereports/hoods/mark_hopkins_melink_report.pdf)



### 2.3.3 Site-Specific

Cadmus evaluated the savings for 19 site-specific program projects in Washington, representing a variety of measure types. We calculated an overall realization rate for all randomly selected (non-census) projects in Washington, and then applied the resulting realization rate to the non-census population for each state and major measure type. Table 20 shows our evaluated results for the program. Table 21 shows the combined Idaho and Washington site-specific results. These results were used for final extrapolation because the sample was chosen from a combined sampling methodology.

**Table 20. Evaluated Results for PY2012 Nonresidential Gas Site Specific Sample—Washington**

Program	Total PY2012 Measure Installations	Evaluated Sample	Gross Reported Savings (Therms)	Gross Evaluated Savings (Therms)	Realization Rate
SSHVAC - Census	5	5	78,732	74,102	94%
SSHVAC	26	4	14,415	14,755	102%
SSO	26	7	8,354	8,181	98%
SSS	20	3	19,329	19,474	101%
<b>Total</b>	<b>77</b>	<b>19</b>	<b>120,830</b>	<b>116,512</b>	<b>96%</b>

**Table 21. Evaluated Results for PY2012 Nonresidential Gas Site Specific Sample—Combined Washington and Idaho**

Program	Total PY2012 Measure Installations	Evaluated Sample	Gross Reported Savings (Therms)	Gross Evaluated Savings (Therms)	Realization Rate
SSHVAC - Census	6	6	96,999	77,298	80%
SSHVAC	35	7	24,950	26,504	106%
SSO	33	8	8,363	8,187	98%
SSS	26	3	26,673	26,818	101%
<b>Total</b>	<b>100</b>	<b>24</b>	<b>156,985</b>	<b>138,807</b>	<b>88%</b>

Cadmus identified several adjustments to tracked savings from site-specific program projects. Site-specific projects tend to be more complex, making energy-savings parameters and impacts more difficult to estimate. In addition, the calculations often rely on participant-supplied building, equipment, and operations data, which may vary from parameters identified during an on-site verification visit.

In aggregate, the site-specific program performed well, achieving an overall combined realization rate of 88%. We made the following specific adjustments to Washington projects, based on our review of rebate applications and billing data:

- For one site-specific project the measure replaced an existing pool dehumidification unit with a new, higher-efficiency unit. Cadmus analyzed and evaluated the savings for this measure using a linear regression of utility billing data. We determined the project achieved an 82% realization rate.



- For another project, the participant installed a high-efficiency, domestic hot water heater. Project documentation used 99% efficiency for this unit, a rate higher than any standard unit with similar specifications. Based on the Cadmus engineer's experience with similar equipment, we analyzed the project's savings using a 95% operating efficiency. The project achieved an 84% realization rate.
- Avista estimated domestic water heating savings for high-efficiency equipment at two new construction multifamily facilities. Cadmus analyzed the utility billing data for both projects, and determined Avista underestimated the hot water consumption. This increased energy savings, resulting in realization rates of 111% and 114%.
- Avista estimated energy savings for HVAC improvements on multiple floors of an office building using an eQuest energy simulation model. Cadmus updated the eQuest model using more than one full year of post-installation billing data. This model calculated lower than reported savings. The project achieved a realization rate of 74%.

Cadmus also revised gross energy savings for residential clothes washers installed in multi-family facilities, as follows:

- Cycle: In the previous evaluation, the washing cycles per year (377) were derived from Pacific Power and Rocky Mountain Power Home Energy Savings participant surveys. Recent independent evaluation surveys from the Residential Building Stock Assessment (RBSA) and 2012 Avista Participant surveys estimated 262 washing cycles per year. Unit energy savings values have been adjusted accordingly, as reflected in this measure's realization rate.
- Consumption: Cadmus used the California metering study to estimate the consumption per wash and dry cycle for the base and efficient equipment.
- One Washington clothes washer project exhibited a resulting realization rate of 69%. Cadmus evaluated the overall Site-Specific realization rate based on the combined Idaho and Washington sample.

### 2.3.4 Extrapolation to Program Population

In evaluating the nonresidential gas programs, we selected sites that could provide the most significant impacts. We designed the site visits to achieve a statistically valid sample for the major strata, as discussed. For measures in the random (non-census) sample, we calculated realization rates (the ratio of tracked-to-evaluated savings) to apply to programs at the remaining non-sampled sites. These realization rates were weighted averages, based on the random verification sample, and using the following four equations:

$$RR_{ij} = \frac{Evaluated_{ij}}{Tracked_{ij}}; \text{ for measure } j \text{ at site } i \quad (1)$$



$$RR_j = \frac{\sum_i Evaluated_i}{\sum_i Tracked_i}; \text{ for measure } j \text{ across all sample sites} \quad (2)$$

$$\sum_k Evaluated_k = RR_j \times \sum_k Tracked_k; \text{ for measure } j \text{ across all sites in measure population} \quad (3)$$

$$RR_l = \frac{\sum_k Evaluated_k}{\sum_k Tracked_k}; \text{ for the population (all sites and measures)} \quad (4)$$

Where:

- RR = the realization rate
- i = the sample site
- j = the measure type
- k = the total population for measure type 'j'
- l = the total program population

We calculated realization rates for each individual site in the sample based on the measure type (1). We then calculated the realization rates for the measure types using the ratio of the sum of evaluated savings to the sum of reported savings from the randomly selected sample for each measure type (2). We calculated non-census population evaluated savings by multiplying the measure type realization rate ( $RR_j$ ) from the random sample by the reported savings for the non-census population of each measure type (3). We then added the reported and evaluated savings from census stratum measures to calculate the total reported and evaluated savings for each program. The program realization rate derived from the ratio of all evaluated to all reported savings (4).

Table 22 summarizes of the results for all prescriptive and site-specific programs in Washington. Washington achieved an overall non-residential portfolio gross realization rate of 100.3%.

**Table 22. PY 2012 Gas Gross Program Realization Rates—Washington**

Measure Category	Gross Program Reported Savings (Therms)	Gross Program Evaluated Savings (Therms)	Realization Rate
Prescriptive	85,880	83,869	97.7%
SSHVAC	159,809	162,486	101.7%
SSO	10,461	10,242	97.9%
SSS	47,945	48,275	100.7%
<b>Total</b>	<b>304,095</b>	<b>304,872</b>	<b>100.3%</b>

### 2.3.5 Fuel Conversion and HVAC / Lighting Interactive Impacts

The Avista natural gas portfolio reported savings do not include increases in gas consumption due to fuel conversions from electric heating to gas heating, or from increased lighting efficiency. Lighting systems convert a large portion of their input energy to useful light output, but a substantial portion also converts to heat. Any reduction in lighting input energy also reduces waste heat. Reducing waste heat lowers the site's required cooling load, but increases the site's heating load.

Cadmus noted that Avista tracked and recorded these gas consumption effects for many projects to determine electric program cost-effectiveness. Most tracked interactive effects involved prescriptive or site-specific lighting projects, although some therm penalties resulted from the Energy Smart Grocer (in Avista's electric portfolio) and site-specific HVAC program projects.

In addition, Avista did not factor interactive effects into its portfolio energy-savings goals (which would have reduced goals).

## 2.4 Conclusions

Cadmus evaluated 31 of 207 measures installed through the program in Washington, representing 42% of tracked savings.

The evaluation determined that Avista generally implemented the programs well. Cadmus identified the following key issues that reduced evaluated energy savings below the reported values:

- Calculations provided by participants/contractors contained incomplete information.
- The programs sometimes incented measures that may not have been appropriate.
- Calculations did not always consistently address fuel types after conversion incentives.

Cadmus also found the following implementation issues affected the impact evaluation:

- DCV saving estimates may benefit from greater consistency.
- DCV measures also were labeled as "Site Specific Motors."

## 2.5 Recommendations

Cadmus offers the following recommendations, based on evaluation results:

- Consider more extensively reviewing participant-provided calculations to ensure reasonable assumptions and methodologies.
- Conduct an additional review of all projects involving fuel conversions.
- Discuss concerns or questions regarding the Cadmus DCV calculation tool.
- DCV measures should be labeled "Site Specific HVAC."



## 3 2012 Low Income Gas Impact Report

### 3.1 Introduction

In 2010, Cadmus conducted a statistical billing analysis, determining adjusted gross savings and realization rates for energy-efficient measures installed through Avista's Low Income Weatherization Program. We performed analysis and calculated savings at the household or participant level, rather than at the measure level.

This report:

- Applies these 2010 billing analysis savings to the 2012 participant population; and
- Reports total gas impacts associated with the 2012 program year.

Cadmus anticipates collecting a full year of post-period consumption data to perform a billing analysis of the 2012 participant population. In the interim, the evaluation report extrapolates results from the recent 2010 gas impact analysis to 2012 participants. The new billing analyses will take place in the first quarter of 2014.

To estimate 2010 energy savings resulting from the program, Cadmus used a pre- and post-installation, combined CSA and PRISM approach, which utilized monthly billing data. We analyzed savings estimates for Idaho and Washington, and ran a series of diagnostics (such as a review of savings by pre-consumption usage quartile), and outlier analysis. *Avista's 2010 Gas Impact Report* presents a detailed discussion of the regression model and methodology used for this analysis.

#### 3.1.1 Program Description

Five programs, listed in Table 23, make up Avista's Low Income Weatherization Program. Local Community Action Partners (CAPs), within Avista's Idaho and Washington service territories, implement these low income programs. CAPs holistically evaluate homes for energy-efficiency measure applicability, combining funding from different programs to apply appropriate measures to a home, based on results of a home energy audit.

Table 23 also describes measures installed under each program component, along with counts of gas measures installed in PY 2012 and included in our gas impact analysis (a separate report contains findings on evaluated electric measures).

Table 23. 2012 Gas Efficiency Installations by Program Component

Low Income Program Component	Measure Description	Measure Installations
Shell/Weatherization	Insulation, window/door installation, air infiltration, programmable thermostat	549
HVAC Efficiency	High-efficiency gas furnace replacement	61
Hot Water Efficiency	High-efficiency water heater replacement	3
Fuel Conversion*	Electric furnace, heat pump, or water heater replacement with gas units	N/A
ENERGY STAR Appliance	High-efficiency refrigerator replacement	N/A

\*The Avista portfolio considers (and reports) fuel conversion measures as electric-saving measures.

### 3.1.1 Data Collection

Cadmus primarily drew impact evaluation data from the program participant database. Avista provided information regarding program participants and installed measures for Washington. Specifically, these data included:

- Lists of measures installed per home; and
- Expected savings from each completed measure installation.

The data, however, did not include the quantity of measures installed (such as the square footage of installed insulation) or per-unit savings estimates.

Starting in 2012, Avista incorporated TRM savings estimates that Cadmus developed specific to Avista's low income customer segment. These measure-specific savings estimates incorporated data from regional and secondary research (e.g., RTF, U.S. Department of Energy [DOE]) as well as input assumptions derived from analysis of low income weatherization program participant consumption (e.g., pre-period heating consumption).

## 3.2 Methodology

### 3.2.1 Sampling

In applying the 2010 gas billing analysis results, we used a census of program participants, composed of 130 gas accounts, but excluding the 73 gas participants receiving conversion measures.

### 3.2.2 Data Collection Activities

#### *Documentation Review/Database Review*

Cadmus used the 2012 Idaho and Washington program participant database, provided by Avista, to develop a complete population for applying the 2010 billing analysis results. Participant data included:

- Customer information;
- Account numbers;



- Types of measure installed;
- Rebate amounts;
- Measure installation costs;
- Measure installation dates; and
- TRM savings per measure.

### **Billing Analysis—CSA Modeling Approach**

To estimate energy savings from this program, we used a pre-post CSA fixed-effects modeling method, which utilized pooled monthly time-series (panel) billing data.

The fixed-effects modeling approach corrected for differences between pre- and post-installation weather conditions as well as for differences in usage consumption between participants (i.e., including a separate intercept for each participant). Our modeling approach ensured model savings estimates would not be skewed by unusually high-usage or low-usage participants. Monthly consumption was also paired between pre- and post-months to maintain the same time frame for evaluating unique participants.

Additional details regarding the 2010 billing analysis can be found in the *Avista 2010 Gas Impact Report*.

### **3.2.3 Estimating Conversion Participant Savings**

Cadmus used a similar approach for calculating gas savings for Washington conversion participants as used in the 2011 evaluation report. This approach assigned savings to conversion participants (n = 73), based on three distinct customer categories:

1. **Full model savings** (104 therms), assigned to participants (n = 26) receiving three or more distinct gas-saving measures (including a high-efficiency furnace).
2. **Partial model savings** (61 therms), specific to participants that installed of a high-efficiency gas furnace in place of a standard-efficiency electric furnace.<sup>15</sup> These participants received the high-efficiency furnace replacement and no more than one additional gas-saving measure (n = 34). For participants in this group with one additional gas-savings measure, we passed through the TRM savings associated with the non-furnace measures.
3. **No model savings**, for customers receiving at most one gas-saving measure (n = 13) and not a high-efficiency furnace. For these customers, we passed through TRM savings if they received a gas-savings measure.

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<sup>15</sup> The program participant database did not indicate that water heater conversions were replaced with efficient units; therefore, no additional gas savings could be applied.

To account for gas savings experienced through high-efficiency furnace replacements, we used savings calculated through the 2010 evaluation of Avista’s residential furnace replacement program (84 therms), scaling this value to reflect low income participant home square footage, which resulted in 61 therms.<sup>16</sup>

### 3.3 Results and Findings

#### 3.3.1 Overall Program Results

##### *Non-Conversion Participant Results*

Applying savings estimates from the billing analysis to the gas-saving participant program population produced total savings of 104 therms per participant. We applied these modeled savings to 2012 gas-savings participants not receiving conversion measures, and calculated average reported TRM savings by summing measure savings at each household, then taking the mean household savings across individual participants. Table 24 compares the average participant savings TRM and modeled savings for non-conversion customers.

**Table 24. Non-Conversion Gas Savings**

Total Non-Conversion Participants	Average Reported TRM Savings Per Participant (Therms)	Model Savings Per Participant (Therms)	Realization Rate	Total Non-Conversion Savings
130	113	104	92%	13,520

Table 25 shows the count of 2012 gas-saving measure installations (including non-conversion and conversion participants). Air infiltration has the highest distribution of installations, followed by attic and duct insulation.

**Table 25. Average Reported Savings and Installation Count by Measure**

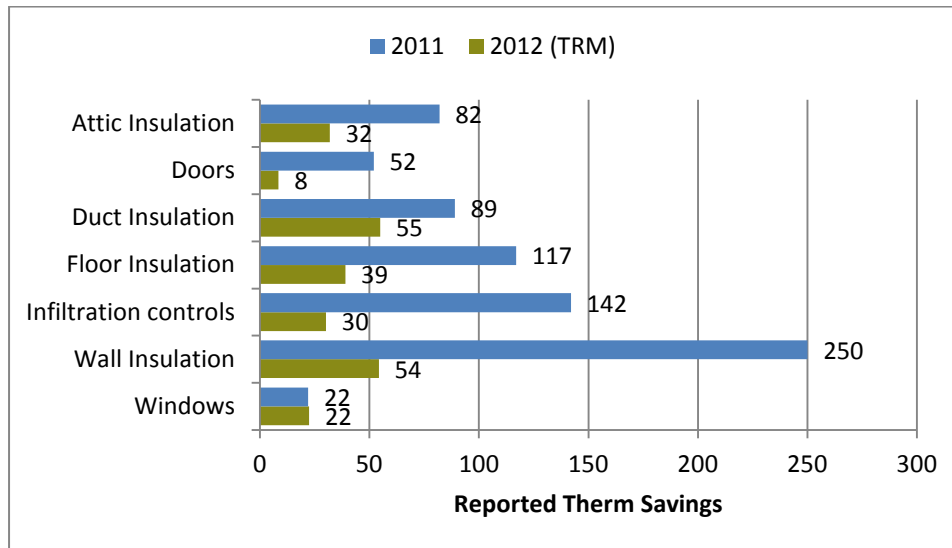
Measures	Count	Avg Reported TRM Savings (Therms)
Attic insulation	122	32
Doors	69	8
Duct insulation	9	55
Floor insulation	107	39
High-efficiency furnace replacement	61	103
High-efficiency water heater replacement	3	9
Infiltration controls	127	30
Thermostat (AC)	4	14
Thermostat (No AC)	2	14
Wall insulation	58	54
Windows	51	22

<sup>16</sup> Low income participants averaged 1,250 square feet per home, while single-family participants averaged 1,728 square feet per home.



To highlight some distinctions in Avista's reported savings, we compared average expected measure savings from 2011 to the 2012 TRM estimates. Figure 2 highlights differences between average savings.

**Figure 2. Comparison of 2011 and 2012 Average Reported Savings by Measure**



Savings reported in 2012 using TRM estimates were lower for a number of measures than 2011 average savings, most notably for infiltration controls, doors, and insulation measures. Generally, the two years offered a relatively similar mix of measure installations, with infiltration controls and insulation the most frequently installed measures for gas-saving participants.

### **Conversion Participant Results**

Of 203 total Washington gas-savings participants, 73 received electric-to-gas conversion measures, including electric-to-gas furnace and water heater replacements. This analysis considered these participants separately, as the methodology for estimating evaluated savings differed slightly from the non-conversion participant group. Table 26 provides a distribution of all Avista-funded measure installations for conversion participants.

**Table 26. Measure Installations for Conversion Participants**

Measure Type	Measure Description	2012 Count
Electric-Saving Conversion Measures	Electric-to-gas furnace replacement	55
	Electric-to-gas water heater replacement	58
	Electric-to-gas heat pump replacement	1
Gas-Saving Measures	Doors	13
	Duct insulation	1
	High-efficiency furnace replacement	54
	Infiltration controls	25
	Thermostat (No AC)	2
	Thermostat (AC)	4



	Windows	10
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Of the 55 conversion participants receiving a gas furnace conversion, 54 had a high-efficiency gas furnace installed. None of the 58 water heater conversion participants received high-efficiency gas water heaters.

In total, we estimated an additional 4,970 therms savings for gas conversion participants, as shown in Table 27.

**Table 27. Conversion Participant Gas Savings – Washington**

Conversion Customer Tier	Count	Average Model Savings Applied (Therms)	Total Savings (Therms)
Full model savings	26	104	2,704
Partial savings (HE furnace)*	34	61	2,204
No model savings*	13	N/A	62
<b>Total</b>	<b>73</b>		<b>4,970</b>

\*Total evaluated savings may include instances of pass-through TRM measure-level savings.

A net increase in therm usage occurred for all conversion customers. However, based on Avista's approach to correcting for these impacts through its cost-effectiveness analysis, this report calculated therm savings associated with the following:

1. Installation of gas-savings weatherization measure bundles.
2. Furnace conversion replacements, using high-efficiency gas equipment, compared to standard gas equipment.<sup>17</sup>

### Overall Participant Results

Table 28 provides overall gas savings, including those attributed to fuel conversion participants receiving gas-saving measures.

**Table 28. Overall Gas Savings**

Evaluated Savings			Total Reported TRM Savings (Therms)	Realization Rate
Total Non-Conversion Participant Model Savings (Therms)	Total Conversion Participant Savings (Therms)	Total Savings (Therms)		
13,520	4,970	18,490	23,666	78%

<sup>17</sup> Electric savings associated with conversion measure installations will be addressed in the *2010–2011 Avista Electric Impact Report*.



### 3.3.2 Goals Comparison

Cadmus compared evaluated savings for the 203 Washington gas participants against Avista's IRP goals. Table 29 summarizes: overall evaluated savings, IRP savings goals, and achievement rates. In all, the low income weatherization program achieved approximately 26% of its gas-savings goals.

**Table 29. IRP Program Goals Comparison**

Total Participants*	IRP Goal (Therms)	Evaluated Gas Savings (Therms)	Goal Achievement
203	71,499	18,490	26%

\*Includes 130 participants receiving model savings and 73 conversion customers.

### 3.4 Conclusions

Upon comparing 2011 and 2012 results, changes in Avista's expected savings calculations led to differences in realization rates. Average reported gas savings per (non-conversion) participant decreased by 50% between the years, falling from 361 therms in 2011 to 182 therms in 2012 (based on the TRM). This appears to primarily drive shifting realization rates, from 30% for Washington in 2011 to 78% in 2012.

As shown in Figure 2 (above), except windows, all measure-level estimates observed significant changes in therm savings between 2011 reporting and the 2012 TRM estimates, with these decreases in average savings ranging between 3 to 10 times the previously reported estimates, most notably for infiltration and insulation measures.

### 3.5 Recommendations

This section outlines our suggestions for enhancements to help improve program impact results:

- Use a control or comparison group in future billing analyses.** For upcoming impact evaluations that employ billing analysis, we suggest using 2013–2014 participants as a control group to analyze the treatment group of 2012 participants. For such analysis, 2011 and 2013 annual participant consumption histories would be used as the pre- and post-periods. Using a control or comparison group of nonparticipants would allow analysis to control for exogenous factors (e.g., macroeconomic, rate changes, technological trends) that may result in trends affecting consumption. Controlling for these trends using a control/comparison group would reflect a more robust experimental design and defensible methodology for estimating accurate energy-savings impacts.
- Include high-use customers in program targeting.** While prioritization guidelines for targeting low income weatherization participants are set at the federal level, some utilities, for targeting purposes, actively track customer usage and provide agencies with lists of customers that experience particularly high energy consumption. In fact, DOE protocols list high-energy consumption as a factor allowed in participant prioritization.

In such cases, along with other targeting criteria (e.g., families with children, senior citizens), agencies may incorporate energy-consumption characteristics into their program participant

prioritization. Not only would weatherizing high-use customers likely result in higher energy savings, but some customers may be overly burdened with energy bills due to their housings' characteristics, and the program could provide some financial relief.

Methods exist for identifying high-usage customers while controlling for factors contributing to consumption (e.g., square footage, income, number of people per household). Using such an approach would allow Avista to identify high-use customers.

Given reductions in federal funding for weatherization and associated reduced agency capacities resulting in more limited leveraging opportunities, Avista has an opportunity to lead new efforts for continued delivery of energy-savings resources to low income residential customers. By considering high-usage targeting, a potential exists to secure cost-effective energy savings through one segment of this population, while continuing to support weatherization for income-qualified customers, which may result in lower savings and prove less cost-effective. Efficient targeting can aid in balancing these efforts to provide whole-house weatherization, while continuing to leverage the agency network as a resource for outreach and delivery.

- **Track and compile additional data from agency audits.** These data include information on primary and secondary heating and cooling and on the size of a home. As an inexpensive alternative to gas heat, gas customers may turn to electric room heaters and wood stoves, thereby reducing impacts of weather-sensitive measures installed through weatherization (e.g., insulation). Collecting information on customers' primary heating usage at the time of weatherization will provide more reasonable savings estimates.

We recommend working with the agencies to develop explicit, on-site tracking protocols for collecting information on participant heating sources. Agencies should collect the following information to better inform heating (and cooling) sources:

- Visual inspections of all heating equipment found on site;
  - Participant-reported primary and supplemental heating sources used;
  - Quantities of secondary heating, if applicable (e.g., numbers of electric room heaters); and
  - Any indicators suggesting discrepancies between actual and reported primary heating.
- **Consider performing quantitative, non-energy benefit analyses.** With respect to ongoing Advisory Group discussions surrounding quantifying non-energy benefits, we recommend Avista consider pursuing additional analyses, aimed at quantifying non-energy benefits associated with low income weatherization, and applicable to the TRC test. In particular, analyses of economic impacts and payment pattern improvements (including reduced arrearages and collections costs) can provide program stakeholders with monetized values for benefits. Other utilities have used such analyses in reporting low income weatherization cost-effectiveness in the Northwest (e.g., Idaho, Washington). Standard cost-effectiveness testing, using TRC test accounts for all program costs (only including energy savings as program benefits), clearly omit some genuine



non-energy benefits experienced by participants (as discussed in greater detail in the *2010 Process Evaluation*).

## Appendix 1A: Residential ENERGY STAR Home Model Inputs

The following table summarizes the inputs used to simulate homes in Washington.

**Table B1. ENERGY STAR, Washington, and Idaho  
Construction Standards for New Homes**

Measure	Type	ENERGY STAR <sup>®</sup> Home	WA Code - Climate Zone II, R-3
Insulation	Ceiling	R-38	R-38
	Wall	R-19	R-19 + R-5
	Floors Over Unconditioned Space	R-30	R-30
	Slab Floors	R-10	R-10
Windows & Doors	Windows	0.35	0.35
	Max Glazing Area	0.21	Unlimited
	Doors	R-5	0.2 U-factor
Ducts	Insulation	R-8	R-10
	Sealing	Mastic only	Tapes allowed
	Max Leakage	<0.06 CFM/sqft or 75 CFM total @50Pa	Set to ENERGY STAR standards
Ventilation & Air Sealing	Ventilation System	Exhaust ventilation	Exhaust ventilation
	Envelope Tightness	0.35 normal ACH	0.35 normal ACH
Heating & Cooling Equipment	Gas Furnace	90 AFUE	78 AFUE
	Air Conditioner	SEER 13	SEER 13



## Appendix 1B: Electricity Savings Achieved by Residential Gas Programs

The following table shows electricity saved in kWh by the 2012 gas energy-efficiency programs. High penetration of electric dryers in homes with gas domestic hot water heating likely resulted in the significant savings achieved. Electricity saved through the installation of an efficient dishwasher was associated with the machine operation, not water savings.

The 2010 gas furnace billing analysis showed a portion of participants choose to install an air source heat pump at the same time they install a new high-efficiency furnace. This switch from all-gas heating to dual-fuel heating results in an electric penalty.

The electricity saved through installations of efficient windows, determined through a billing analysis, was associated with a reduction in the summer cooling load.

The table shows values for all measure installations in Washington, both inside and outside Avista's electric service territory.

**Table 1B. Electricity Savings for Gas Program in Washington**

Measure Name	Measure Count	UES (kWh)	Total Savings (kWh)
G CLOTHES WASHER-NAT GAS H2O	1,102	223	245,746
G DISHWASHER-NAT GAS H2O	345	27	9,343
G NAT GAS FURNACE	2,217	-165	-366,093
G WINDOWS (kWh)	590	78	46,020
<b>TOTAL</b>	4,254	NA	-79,814