Exhibit No. ___ (MSK-4)

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

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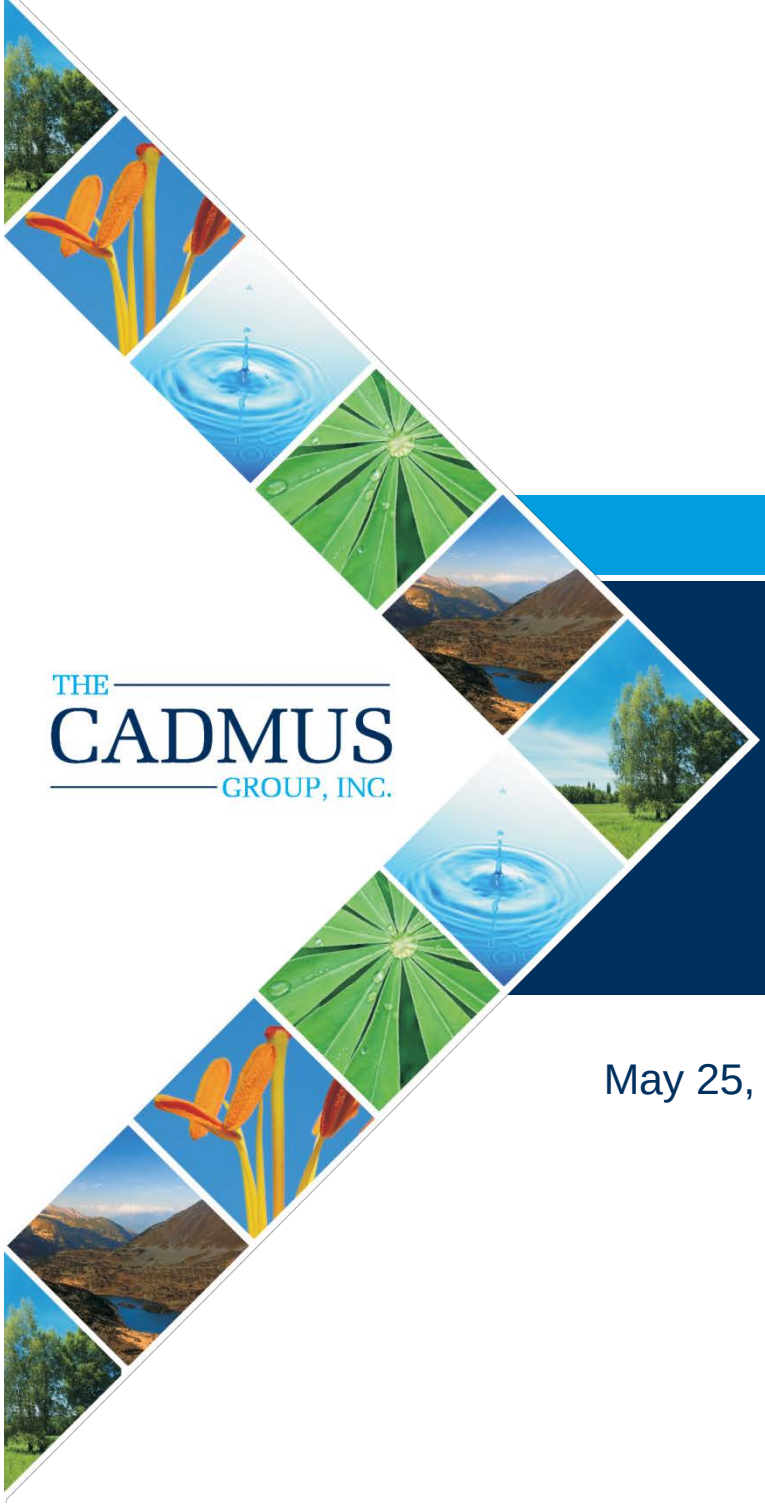
EXHIBIT NO._____(MSK-4)

DR. M. SAMI KHAWAJA

REPRESENTING

THE CADMUS GROUP, INC.



THE CADMUS GROUP, INC.

# Avista 2011 Multi-Sector Gas Impact Evaluation Report

May 25, 2012

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# Table of Contents

# Portfolio Executive Summary

The Cadmus Group, Inc., was contracted by Avista Corporation to complete process and impact evaluations of the 2010 and 2011 gas and electric demand-side management (DSM) programs. This report only presents our impact findings for the PY 2011 gas portfolio.

## Evaluation Activities

For each of the three sectors—residential, nonresidential, and low-income—we employed a variety of evaluation methods and activities. These are shown in Table ES-1.

**Table ES-1. 2011 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 | ✓ | | ✓ | | | ✓ |
| Non-Residential | Prescriptive Programs | ✓ | ✓ | ✓ | ✓ | | |
| | Site-Specific | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Low-Income | Low-Income Programs | ✓ | | | | ✓ | |

## Key Findings and Conclusions

### Residential

For PY2011, Avista's residential gas programs produced 515,188 therms in savings, which yielded an overall realization rate of 66%. Residential gas savings achieved 37% of IRP goals.

The major residential program conclusions are:

- Overall, residential gas customers responded well to the programs, and often installed several measures within the same year.
- Avista's program and tracking databases were sufficient for evaluation purposes, providing adequate contact information, and measure and savings information, and the database review confirmed the information was reliable and accurate.
- All measures rebated through the program were installed and operating. With only a few exceptions, all measures were determined to meet program qualification standards.

### Nonresidential

Cadmus evaluated 55 of 431 measures installed through the nonresidential energy-efficiency programs, representing 57% of reported savings. For PY2011, Avista's nonresidential gas

programs produced 832,374 therms in savings, which yielded an overall realization rate of 87%. Nonresidential gas savings achieved 96% of IRP goals.

In general, Cadmus determined that Avista implemented the programs well. Cadmus identified the following key issues that reduced energy savings:

- Some participants did not operate the incented equipment correctly, or did not complete the improvements expected for the measure.
- Some participant heating or cooling loads did not achieve the level projected for post-installation usage.
- Some energy simulation models did not accurately represent the actual as-built building or system operation.

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

- Several building simulation models were unavailable, due to reported server or laptop crashes.
- Individual new construction measure savings depended heavily on interactive effects. Avista calculated individual measure savings through a rolling baseline, in which each measure was simulated in a set order. Changing the simulation order substantially altered measure savings.
- Cadmus could have streamlined the sampling process if Avista's database had recorded site addresses and contact information. Having measure-level data, such as specific measure type and quantity, for each project would have improved the range and depth of our evaluation activities.
- Interactive effects between HVAC and lighting represent a significant impact on gas usage. We are unable to reliably estimate interactive savings impacts from the data available in Avista's current database.

## Low-Income

For PY2011, Avista's low-income gas programs produced 35,877 therms in savings, which yielded an overall realization rate of 33%. Low-income gas savings achieved 55% of IRP goals.

State-level savings estimates from the 2010 gas billing analysis were applied to 242, gas-saving 2011 program participants. The average, non-conversion model savings per home was 112 therms. An additional 110 participants went through an electric to gas fuel-conversion (Washington only). Savings were assigned to three categories of participants:

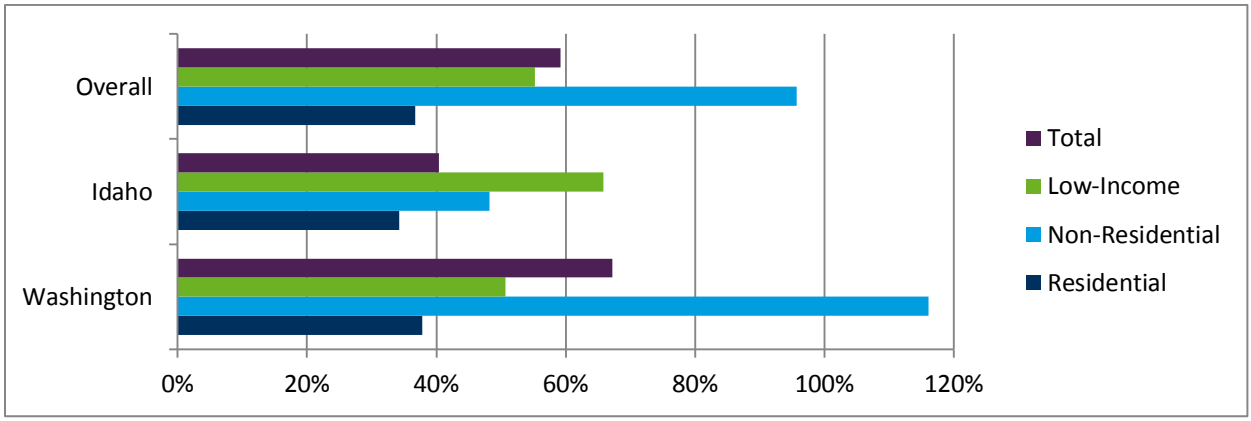
1. Full model savings to those receiving larger bundles of weatherization measures;
2. Savings specific to installation of a high-efficiency gas furnaces, in place of standard efficiency furnaces; and
3. No savings applied (a few cases).

In total, we estimated an additional 8,683 therms in savings for  conversion participants.

## Savings Results

Figure ES-1 displays the portfolio achieved gross savings, relative to reported goals by sector, state, and overall. The nonresidential sector exceeded goals in Washington. The portfolio overall achieved 59% of the stated goals.

**Figure ES-1. Gross Achieved Savings Percentages of IRP Goals**




The following two tables show sector-level gross savings values and realization rates compared to reported savings and IRP goals.

**Table ES-2. 2011 Reported and Gross Verified Savings by State and Sector**

| Sector | Washington | | | Idaho | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Expected Savings | Gross Verified Savings | Real-ization Rate | Expected Savings | Gross Verified Savings | Real-ization Rate | Expected Savings | Gross Verified Savings | Real-ization Rate |
| Residential | 560,430 | 372,330 | 66% | 220,081 | 142,858 | 65% | 780,511 | 515,188 | 66% |
| Nonresidential | 812,857 | 706,657 | 87% | 149,393 | 125,717 | 84% | 962,251 | 832,374 | 87% |
| Low-Income | 77,381 | 23,042 | 30% | 31,675 | 12,835 | 41% | 109,056 | 35,877 | 33% |
| Total | 1,450,668 | 1,102,029 | 76% | 401,149 | 281,410 | 70% | 1,851,818 | 1,383,439 | 75% |

**Table ES-3. 2011 IRP Goals and Gross Verified Savings by State and Sector**

| Sector | Washington | | | Idaho | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Savings Goal | Gross Achieved | % Achieved | Savings Goal | Gross Achieved | % Achieved | Savings Goal | Gross Achieved | % Achieved |
| Residential | 985,175 | 372,330 | 38% | 416,750 | 142,858 | 34% | 1,401,925 | 515,188 | 37% |
| Nonresidential | 608,731 | 706,657 | 116% | 260,885 | 125,717 | 48% | 869,616 | 832,374 | 96% |
| Low-Income | 45,500 | 23,042 | 51% | 19,500 | 12,835 | 66% | 65,000 | 35,877 | 55% |
| Total | 1,639,406 | 1,102,029 | 67% | 697,135 | 281,410 | 40% | 2,336,541 | 1,383,439 | 59% |

In summary, the 2011 gas portfolio achieved a realization rate of 75% of reported savings, and 59% of the IRP goals. Our evaluation verified nearly 100% of the claimed measures. The achieved realization rates are driven entirely by the lower than expected per unit energy savings. The nonresidential sector had the highest realization rate of 87% from reported savings, and also

had the highest goal achievement rate of 96% of Avista-stated IRP goals. Washington had higher goal achievement, overall.

# Recommendations and Further Analysis

## Residential

Cadmus offers the following recommendations, based on evaluation results:

- List energy factors, or at least model numbers for appliances. The inclusion of more information regarding the actual efficiency of equipment installed allows for greater accuracy in estimates of gross energy savings achieved.
- If possible, include existing equipment information.
- Avista should consider moving all ENERGY STAR Clothes Washer rebates to the electric program.

The following research recommendations are based on the results of this impact evaluation and known future changes to program requirements:

- Perform a review of all available secondary research and/or collect primary data on the penetration of gas heated clothes dryers.
- 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 performing the work.

## Nonresidential

We recommend the following for improving program energy-savings impacts and effectiveness of the evaluation:

- Avista should create a quality control system to double-check all projects with savings over 10,000 therms. An Avista EM&V engineer reported he has begun to review these types of projects.
- Avista should consider performing three- to six-month post-installation random inspections to confirm measure persistence, and to identify opportunities to improve performance.
- Avista should consider adding a program for recommissioning measures identified as non-functional during the previous year's evaluation process, and report the energy savings these measures achieve in the subsequent year.
- Avista should consider applying more conservative assumptions on Site-Specific heating loads.
- Avista should save all internally and externally developed simulation models to Avista's servers.

- Avista should consider developing a New Construction measure that would combine the interactive effects associated with all individual measures at new construction projects.
- Avista should consider revising its methodology for calculating and tracking HVAC/lighting interactive effects.

## Low-Income

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

- Standardize expected savings calculations between states.
- Account for additional factors in savings calculations, such as historical consumption, interaction effects, square footage, and primary heating sources.
- Track alternative heating sources in homes.
- Include high-use customers in program participant targeting.
- Conduct further impact analysis, focused on use of a comparison group and estimating savings at the measure-level.
- Perform quality checks on expected savings estimates.
- Consider analyzing easy-to-quantify, non-energy benefits, which can be added to program cost-effectiveness reporting.

Recommendations for possible future analysis include:

- Conduct further gas impact analysis with greater populations to determine measure-level savings.
- Consider conducting a non-energy benefits analysis in the future.

# 1 2010 Residential Gas Impact Report

## Executive Summary

During the 2011 program year, Avista's residential gas DSM programs claimed savings of 780,517 therms. This report explains the methods used to qualify and verify these savings. Avista's 2011 DSM residential gas programs included:

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

### Evaluation Methodology

We employed a variety of evaluation methods and activities for each program, as shown in Table 1-1.

**Table 1-1. 2011 Gas Programs Evaluation Activities**

| Sector | Program | Document/ Database Review | Verification Site Visit | Survey | Billing Analysis | Modeling |
|---|---|---|---|---|---|---|
| Residential | ENERGY STAR Products | ✓ | ✓ | ✓ | | |
| | Heating and Cooling Efficiency | ✓ | ✓ | ✓ | | |
| | Weatherization/Shell | ✓ | ✓ | ✓ | ✓ | |
| | Water Heater Efficiency | ✓ | ✓ | ✓ | | |
| | ENERGY STAR Homes | ✓ | ✓ | ✓ | | ✓ |

### Energy Savings

Cadmus adjusted claimed savings associated with each measure to reflect our deemed savings updates. Most changes resulted from the updated baseline and measure efficiency levels, due to adjustments in federal and ENERGY STAR standards.

Aggregated adjusted gross savings and resulting realization rates are shown in by program (Table 1-2) and by state (Table 1-3). Table 1-4 shows adjusted measure counts. We verified savings of 515,188 therms through the installation of 11,225 measures during the PY 2011. Overall, residential gas programs achieved an adjusted gross realization rate of 64%.

**Table 1-2. Reported and Adjusted Gross Savings**

| Program Name | Reported Savings (Therms) | Adjusted Gross (Therms) | Realization Rate |
|---|---|---|---|
| ENERGY STAR Products | 30,992 | 22,185 | 72% |
| Heating and Cooling Efficiency | 365,679 | 305,789 | 84% |
| Weatherization/Shell | 375,882 | 157,874 | 42% |
| Water Heater Efficiency | 5,009 | 4,334 | 87% |
| ENERGY STAR Homes | 24,096 | 25,006 | 104% |
| Total | 801,658 | 515,188 | 64% |

**Table 1-3. Reported and Adjusted Gross Savings by State**

| Program Name | Washington | | | Idaho | | |
|---|---|---|---|---|---|---|
| | Reported Savings (Therms) | Adjusted Gross (Therms) | Realization Rate | Reported Savings (Therms) | Adjusted Gross (Therms) | Realization Rate |
| ENERGY STAR Products | 22,068 | 15,732 | 71% | 8,924 | 6,453 | 72% |
| Heating and Cooling Efficiency | 250,797 | 209,697 | 84% | 114,882 | 96,092 | 84% |
| Weatherization/Shell | 283,033 | 121,357 | 43% | 92,849 | 36,517 | 39% |
| Water Heater Efficiency | 4,144 | 3,587 | 87% | 865 | 746 | 86% |
| ENERGY STAR Homes | 21,143 | 21,956 | 104% | 2,952 | 3,050 | 103% |
| Total | 581,185 | 372,330 | 64% | 220,472 | 142,858 | 65% |

**Table 1-4. Avista 2011 DSM Programs Adjusted Measure Counts**

| Program | Washington Measure Count | Idaho Measure Count | Total Measure Count |
|---|---|---|---|
| ENERGY STAR Products | 2,999 | 1,200 | 4,199 |
| Heating and Cooling Efficiency | 2,039 | 934 | 2,973 |
| Weatherization/Shell | 2,672 | 787 | 3,459 |
| Water Heater Efficiency | 388 | 83 | 471 |
| ENERGY STAR Homes | 108 | 15 | 123 |
| Total | 8,206 | 3,019 | 11,225 |

## 1.1 Introduction

PY 2011 DSM residential gas programs included:

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

We designed our impact evaluation to verify reported program participation and energy savings, utilizing: data collected and reported in the tracking database; online application forms; on-site visits; phone surveys; and applicable deemed values we developed for Avista's TRM.[1]

## 1.2 Methodology

### 1.2.1 Sampling

Cadmus created separate random samples for surveys and site visits. The following subsections describe methods used to select sufficient samples.

#### Site Visit Sampling

Cadmus randomly selected participants for verification site visits from the 2010 and 2011 electric program population, and from the 2011 gas program population, scheduling site visits via telephone. If a sampled participant could not be reached or refused to participate in a site visit, a replacement was drawn from a backup sample within the same geographic region.

Initially, participants were sampled using a single measure record. However, if a customer received multiple rebates during the program year, all measures were verified during site visits, whether for electric or gas.

Table 1-5 shows Cadmus completed site visits and unique measures.

**Table 1-5. Electric Measure Level Site Visit Completes**

| | |
|---|---|
| Total Homes Visited | 174 |
| Total Measures Verified | 258 |

#### Survey Sampling

For program-level survey results, Cadmus designed participant survey sample sizes to yield significance at the 90% confidence and ±10% precision levels. The participant survey sampling plan drew upon on multiple factors, including: the feasibility of reaching customers, program participant population, and research topics of interest. Customer fuel types were not a factor in survey sampling.

For ENERGY STAR New Homes, Cadmus did not survey buyers as rebates were paid to builders. Customers included in the site visit sample or back-up sample were excluded from the survey population to limit the evaluation's burden on each participant.

Table 1-6 shows numbers of surveys achieved, and the resulting absolute precision for each program.

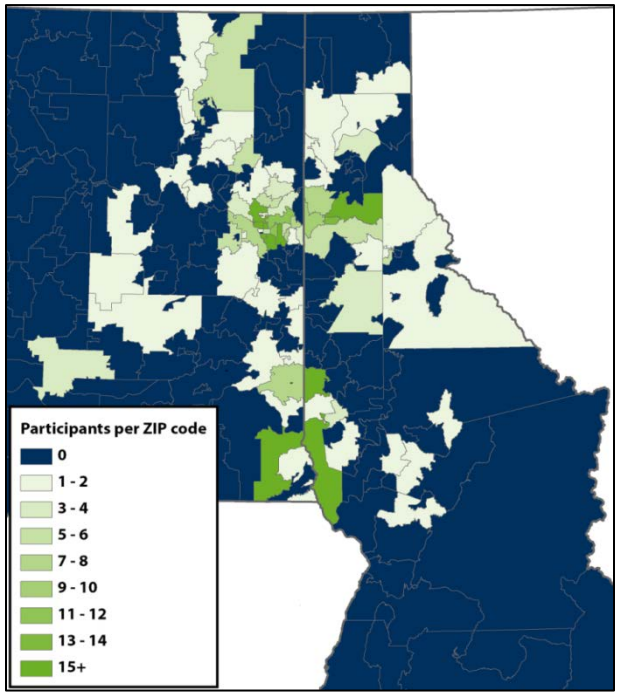
[1] In 2011's first quarter, Cadmus created a TRM for use in deemed measure savings, and updated where necessary for the evaluation's second half (2011 program year).

**Table 1-6. Participant Survey Sample Sizes and Savings-Weighted Precision Estimates by Program (Gas and Electric Participants)**

| Program | Total Program Participants | Survey Completes | Absolute Precision at 90% Confidence |
|---|---|---|---|
| ENERGY STAR Appliance Rebate | 10,983 | 79 | ±9.3% |
| High Efficiency Equipment | 4,156 | 126 | ±7.2% |
| Weatherization and Shell Measures | 3,981 | 72 | ±9.6% |
| Home Energy Audit Pilot | 664 | 56 | ±10.3% |
| Second Refrigerator and Freezer Recycling | 1,903 | 74 | ±9.3% |
| Space and Water Conversions | 314 | 57 | ±9.1% |
| Overall | 22,001 | 464 | ±5.2% |

Program participants included in survey sample frames were called at random. Geographic distributions of survey respondents clustered around urban centers, specifically the cities of Spokane, Pullman, Moscow, and Lewiston, as shown in Figure 1-1, below.

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




## 1.2.2 Data Collection and Analysis

### Site Visits

On-site measure verification included:

- Visual inspections of measures;
- Verifying documentation;
- Ensuring units were still operable;

- Recording make and model information;
- Recording home characteristics; and
- Determining program qualification.

### Surveys

Cadmus contracted with market-research firm Discovery Research Group (DRG) to conduct surveys with sampled participants. To minimize response bias, DRG called customers during various hours of the days and evenings (including on 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 measure level. Survey results at the portfolio level were weighted by program participation to ensure proper representation.

### Database Analysis

Cadmus reviewed the participant database provided by Avista to check for inconsistencies in reported savings and measure duplications. This review was necessary as Avista uses its database to track achieved savings and rebates paid. The review revealed multiple measures that were incorrectly classified, and measures with duplicate records, as rebates were paid in two parts. Cadmus reported all such cases to Avista. In most cases, measure count adjustments were made to correct for the inconsistencies found.

### Unit Energy Savings

Cadmus reviewed every prescriptive measure in Avista's residential gas programs, except Weatherization (savings estimated using a billing analysis). Unit energy savings were updated to reflect gross energy savings achieved by a measure's installation during the program years.

### Billing Analysis

Cadmus conducted a statistical billing analysis to determine adjusted gross savings and realization rates for installed gas weatherization and window measures in PY2011. To estimate energy savings resulting from the program, Cadmus used a pre and post-installation combined Conditional Savings Analysis (CSA) and Princeton Score Keeping Method (PRISM).

## 1.2.3 Verification Rates

Cadmus determined verification rates for each program, but not for each measure. Where applicable, we administered verification site visits and surveys, which included:

- Checking correct measures were tracked in the database;
- Correct quantities were accounted for; and
- Units remained in place and were operable.

We equally weighted site visit and survey observations. All measures researched were in place and operable, resulting in a 100% verification rate.

### 1.2.4 Measure Qualification Rates

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

Two non-qualified measures were identified (out of the entire site visit verification sample):

- A floor insulation project had a base case condition, which should have prevented the project from qualifying.
- A high-efficiency heat pump installation used equipment not meeting required efficiency thresholds.

Neither project impacted the overall residential qualification rate. Average savings for the insulation measure was determined using a billing analysis. Average savings for heat pumps was determined using a metering study.

## 1.3 Program Results and Findings

### 1.3.1 Overview

Cadmus analyzed implementer data records to determine appropriate unit energy savings and measure counts for each supported measure within each program. The end result is: total adjusted gross savings for each measure and program as well as overall realized savings for each program. In the following sections, we describe each program, explain our analysis steps, and discuss the results and findings.

Excluding Weatherization, methods used for calculating adjusted gross measure savings for measures included the following steps:

1. Review of the database to determine whether adjusted measure counts correctly represented the number installed.
2. Conducting a phone survey or site visit to verify installation of measures.
3. Calculating verification and qualification rates.
4. Calculate deemed measure savings for rebated products.
5. Apply rates calculated above and deemed savings to measure counts to determine adjusted gross savings for each measure.

### 1.3.2 ENERGY STAR Products

#### Program Description

The ENERGY STAR Products program included the following gas measures:

- Clothes washer (electric and gas); and
- Dishwasher (with electric or 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 includes electric and gas measures, though this report focuses on gas savings.[2]

## Analysis

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

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

### *Clothes Washers*

Cadmus calculated savings based on a 2009 metering study,[3] 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 experienced 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, it was necessary to estimate the percentage of homes, having gas domestic hot water heaters, which used electric dryers. An 82% assumption, set by the RTF, was used for this analysis. As a result, 82% of the installations of an ENERGY STAR clothes washer in a home with a gas domestic hot water heater achieved significant amount of electricity savings.

The following additional input assumptions were used to determine adjusted gross savings:

- Recent evaluation surveys conducted in the region estimated 377 washing cycles per year. [4,5]
- Cadmus adjusted the average base case and efficient case Modified Energy Factor (MEF), both of which were based on the same data used by the RTF. The baseline MEF equaled the average market efficiency of units not qualifying for the program. The efficient MEF equaled the average market efficiency of units qualifying for the program.

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2 See Appendix 1C for the electricity savings achieved through the gas program.

3 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

4 Pacific Power Washington 2009-2010 Residential Home Energy Savings Evaluation, January 2012.

5 Rocky Mountain Power 2009-2010 Idaho Residential Home Energy Savings Evaluation, February 2012.

***Dishwashers***

Cadmus calculated dishwasher savings employing methods currently used in the ENERGY STAR Calculator,[6] 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 applied:

- Cadmus calculated the average base case and efficient case Energy Factor (EF), both of which were 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.[4,5]
- Fifty-six percent of electricity required to run a dishwasher connected to an electric domestic hot water heater was used for water heating.[7]

### Results and Findings

Table 1-7 shows total reported and adjusted gross savings for gas ENERGY STAR Products program, by measure.

**Table 1-7. ENERGY STAR Products Measured, Program Reported, and Adjusted Savings**

| Measure Name | Measure Count | | Savings per Unit | | Program Savings | | Realization Rate |
|---|---|---|---|---|---|---|---|
| | Avista | Evaluation | Avista | Evaluation | Avista | Evaluation | |
| G CLOTHES WASHER-NAT GAS $H_20$ | 2,498 | 2,499 | 9 | 8.00 | 22,482 | 19,992 | 89% |
| G DISHWASHER-NAT GAS $H_20$ | 1,702 | 1,700 | 5 | 1.29 | 8,510 | 2,193 | 26% |
| PROGRAM TOTAL | 4,200 | 4,199 | N/A | N/A | 30,992 | 22,185 | 72% |

Recent increases to the average efficiency of non-ENERGY STAR baseline units have reduced energy savings achieved by these measures. Appendix 1C addresses electricity savings achieved by the installation of ENERGY STAR products in homes with a gas domestic hot water heater.

## 1.3.3 Heating and Cooling Efficiency

### Program Description

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

- Gas Boiler
- Gas Furnace

[6] http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls?7182-1c92

[7] http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls?7182-1c92

This program offers five categories of incentives for residential electric and gas customers seeking to purchase high-efficiency heating and cooling equipment. This report only discusses installations resulting from the $400 incentive, available 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 PY2010 gas impact evaluation report documented a census billing analysis Cadmus performed to determine the change in energy consumption due to installation of a high-efficiency gas furnace. As the billing analysis continued to provide the best information on this measure, results were maintained for the 2011 program year.[8]

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

### Results and Findings

Table 1-8 shows the energy savings achieved by this program in 2011.

**Table 1-8. Heating and Cooling Efficiency Measures and Reported and Adjusted Savings**

| Measure Name | Measure Count | | Savings per Unit | | Program Savings | | Realization |
|---|---|---|---|---|---|---|---|
| | Avista | Evaluation | Avista | Evaluation | Avista | Evaluation | Rate |
| G NAT GAS BOILER | 43 | 43 | 123 | 93 | 5,289 | 3,999 | 76% |
| G NAT GAS FURNACE | 2,930 | 2,930 | 123 | 103 | 360,390 | 301,790 | 84% |
| PROGRAM TOTAL | 2,973 | 2,973 | N/A | N/A | 365,679 | 305,789 | 84% |

The program achieved an 84% realized adjusted gross savings rate.

## 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
- Insulation—Ceiling/Attic
- Insulation—Floor
- Insulation—Wall
- Window Replacement

Avista customers primarily heating with electric or natural gas, and having a wood-burning fireplace, may receive up to $100 for installing a rooftop fireplace damper.

[8] Avista 2010 Multi-Sector Gas Impact Evaluation Report, August 2011.

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

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

For upgrading windows with a U-factor of 0.30 or less, the program offered a $3.00 per square foot incentive for qualifying windows installed, up to 50% of the installation cost. This measure ended April 1, 2011, and customers had until June 30, 2011, to install windows and submit rebate forms to Avista.

## Analysis

Cadmus conducted a statistical billing analysis to determine adjusted gross savings and realization rates for installed gas weatherization and window measures in PY 2010 and PY 2011. To increase accuracy of the analysis, we only included participants with at least 11 months of pre and post billing data. Consequently, the billing analysis includes PY 2010 participants and January PY 2011 participants.

To estimate weatherization and windows energy savings resulting from the program, Cadmus used a pre- and post-installation combined CSA and PRISM approach. We calculated gas model savings estimates for each measure.

### *Billing Analysis Methodology*

Avista provided Cadmus with monthly billing data for all participants, from January 2008 through January 2012. Avista also provided a measure detail file containing participation and measure data. Participant information included:

- Customer details;
- Account numbers;
- Types of measures installed;
- Rebate amounts;
- Measure installation costs;
- Measure installation dates; and
- Deemed savings per measure.

Cadmus first matched weatherization/windows measure information with gas billing data. We obtained daily average temperature weather data from 2008 through January 2012 for 14 National Oceanic and Atmospheric Administration (NOAA) weather stations, representing all ZIP codes in Avista's Washington and Idaho service territories. From daily temperatures, we determined base 65 heating degree days (HDDs) for each station. Using ZIP code mapping for all U.S. weather stations, we determined the nearest station for each ZIP code. We then matched billing data periods with the HDDs from the associated stations.

To prevent bias resulting from differing reading cycles in assigning the pre and post periods, and to simplify the analysis, we allocated therm billing usage and associated matched HDDs to calendar months. As the latest available billing data were from January 2012, and weatherization and windows measures were installed primarily in 2010, we defined the analysis pre period as 2009, before any participation installations occurred. We defined the post period as 2011, where post period data were available for all 2010 participants.

In a few cases, fewer than the standard 12 months of pre- and post-installation billing data months were available. For these cases we paired pre and post months used in the billing analysis. For example, if a customer installed measures in January 2011, we defined the post period as February 2011 through December 2011, and the pre period as the corresponding months from February 2009 through December 2009. This ensured using the same months in pre and post periods, preventing bias from using mismatched months.

### *Data Screening*

#### General Screens

The following screens removed accounts that could skew weatherization and windows savings estimations:

- **Customers indicating unit numbers in the address.** These could potentially indicate weatherization or windows installations occurring in apartments.
- **Accounts with fewer than 11 paired months (330 days) of billing data in the pre or post period**. T

#### PRISM Modeling Screens

Running PRISM models for pre and post billing data provided a second step in the screening process. These models provided weather-normalized pre and post annual usage for each account, and provided an alternate check savings obtained from the CSA model.

For each participant home, we estimated a heating model in both pre and post periods to weather-normalize raw billing data.

The PRISM model specification used was:

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \varepsilon_{it}$$

Where for each customer ‘i’ and calendar month ‘t’:

| | | |
|---|---|---|
| $ADC_{it}$ | = | the average daily therm consumption in the post program period |
| $\alpha_i$ | = | the participant intercept; represents the average daily therm base load |
| $\beta_1$ | = | the model space heating slope |
| $AVGHDD_{it}$ | = | the base 65 average daily HDDs for the specific location |
| $\varepsilon_{it}$ | = | the error term |

From the above model, we computed weather-normalized annual consumption (NAC) as follows:

$$NAC_i = \alpha_i * 365 + \beta_1 LRHDD_i + \varepsilon_i$$

Where for each customer 'i':

| | | |
|---|---|---|
| $NAC_i$ | = | the normalized annual therm consumption |
| $\alpha_i$ | = | the intercept is the average daily or base load for each participant; it represents the average daily base load from the model |
| $\alpha_i * 365$ | = | the annual base load therm usage (non-weather sensitive) |
| $\beta_1$ | = | the heating slope; in effect, this is usage per heating degree from the model above |
| $LRHDD_i$ | = | annual, long-term HDDs of a typical month year (TMY3) in the 1991–2005 series from NOAA, based on home location |
| $\beta_1 * LRHDD_i$ | = | the weather-normalized annual weather sensitive (heating) usage, also known as HEATNAC |
| $\varepsilon_i$ | = | the error term |

After running the models, we applied the following, first set of screens to the PRISM model output, removing outlier participants from the billing analysis:

- **Accounts where the post weather-normalized (POSTNAC) usage was 80% higher or lower than the pre weather-normalized (PRENAC) usage**. Such large changes could indicate property vacancies, when adding or removing "other" gas equipment (such as pools or spas), unrelated to weatherization/windows installations.
- **Accounts where the pre period base load was 0, and the post period base load was greater than 0.** As the base load indicates usage occurring in non-winter and shoulder months, this outcome suggested a gas water heater, gas dryer, or gas range was added to the participant's home. In this situation, the additional base load usage in the post period was not related to weatherization/windows installations.
- **Accounts with negative intercepts and, hence, negative base load,** were included in the analysis, but were truncated to 0. These negative intercepts typically occurred in homes with gas space heating and without gas water heating. The base load for these homes was expected to be 0; thus, we set the base load to 0.

Once we placed these screens on the data, 809 weatherization-only participants and 1,721 windows-only participants remained for use in the CSA model, outlined below, to determine overall savings.

Table 1-9 summarizes weatherization account attrition from the screens listed above. Most attrition occurred in limiting analysis to participants only installing weatherization measures (not additional gas measures).

**Table 1-9. Weatherization Account Attrition**

| Screen | Number Remaining | Percent Remaining | Number Dropped | Percent Dropped |
|---|---|---|---|---|
| Original | 1,703 | 100% | 0 | 0% |
| Accounts that Installed Other Measures | 1,067 | 63% | 636 | 37% |
| Insufficient Pre/Post Months or Moved During Pre or Post | 908 | 53% | 159 | 9% |
| PRISM Screens: Low Heating Usage | 870 | 51% | 38 | 2% |
| Changed Usage Between Pre and Post Period (> 70%) | 860 | 50% | 10 | 1% |
| Added Base Load | 817 | 48% | 43 | 3% |
| Multifamily (Unit Number Present) | 809 | 48% | 8 | 0% |
| Final Analysis Group | 809 | 48% | 894 | 52% |

Table 1-10 summarizes account attrition for windows resulting from the various screens listed above. Most attrition occurred in limiting analysis to participants only installing windows measures (not additional gas measures). Attrition also occurred due to insufficient pre or post data, or participants moving from the pre to post period.

**Table 1-10. Windows Account Attrition**

| Screen | Number Remaining | Percent Remaining | Number Dropped | Percent Dropped |
|---|---|---|---|---|
| Original | 3,654 | 100% | 0 | 0% |
| Accounts that Installed Other Measures | 2,708 | 74% | 946 | 26% |
| Insufficient Pre/Post Months or Moved During Pre or Post | 1,925 | 53% | 783 | 21% |
| PRISM Screens: Low Heating Usage | 1,874 | 51% | 51 | 1% |
| Changed Usage Between Pre and Post Period (> 70%) | 1,853 | 51% | 21 | 1% |
| Added Base Load | 1,763 | 48% | 90 | 2% |
| Multifamily (Unit Number Present) | 1,721 | 47% | 42 | 1% |
| Final Analysis Group | 1,721 | 47% | 1,933 | 53% |

### *CSA Modeling Approach*

To estimate weatherization and windows energy savings from this program, we used a pre-post, CSA, fixed-effects modeling method, utilizing 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 through the inclusion of a separate intercept for each participant. This modeling approach ensured model savings estimates would not be skewed by unusually high-usage or low-usage participants. The following model specification determined overall weatherization and windows savings:

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \beta_2 POST_i * AVGHDD_{it} + \beta_{3..13} M_t + \varepsilon_{it}$$

Where for participant 'i' and monthly billing period 't':

$ADC_{it}$ = the average daily therm consumption during the pre- or post-program period

$\alpha_i$ = the average daily therm base load intercept for each participant (this is part of the fixed effects specification)

$\beta_1$ = the baseline usage per HDD

$AVGHDD_{it}$ = the average daily base 65 HDDs based on home location

$\beta_2$ = the therm savings per HDD for the weatherization or windows measures

$POST_i$ = an indicator variable that is 1 in the post-period (after the weatherization or windows installation), and 0 in the pre-weatherization period

$POST_i * AVGHDD_{it}$ = an interaction between the post indicator ($POST_i$) and the HDDs ($AVGHDD_{it}$)

$M_t$ = an array of bill month dummy variables (Feb, Mar, …, Dec); 0 otherwise[9]

$\varepsilon_{it}$ = the modeling estimation error

The model estimates savings per heating degree for weatherization or windows measures with $\beta_2$. To obtain actual annual savings under normal weather conditions, we applied the 1991–2005 TMY3 normal HDDs, from NOAA.

The per-HDD modeling approach resolved much potential bias from customers with predominantly winter month data. As weatherization and windows measures affect heating usage, a per heating degree savings allowed savings to be allocated across all calendar months as well as being based on HDDs. Furthermore, the per heating degree savings estimation allowed savings to be obtained under normal weather conditions. Using just a post period indicator would have been influenced by any predominance of winter or summer months, resulting in savings biased upwards or downwards.

## Results and Findings

Table 1-11 summarizes model savings results for the 809 weatherization participants and the 1,721 windows measure participants. Model savings for weatherization measures were 72 therms, and 24 therms for windows measures. The precision level indicated the percent error of the savings estimate was less than 10% for weatherization participants, and 18% for windows participants.

**Table 1-11. Weatherization and Windows Savings Summary**

| Group | N | PRENAC | Normal HDDs | Model Savings (Therms) | Precision at 90% Confidence |
|---|---|---|---|---|---|
| Weatherization | 809 | 865 | 6,325 | 72 | 9% |
| Windows | 1,721 | 800 | 6,269 | 24 | 18% |

Table 1-12 compares modeled with deemed savings to obtain realization rates (49% and 29% for weatherization and windows measures, respectively).

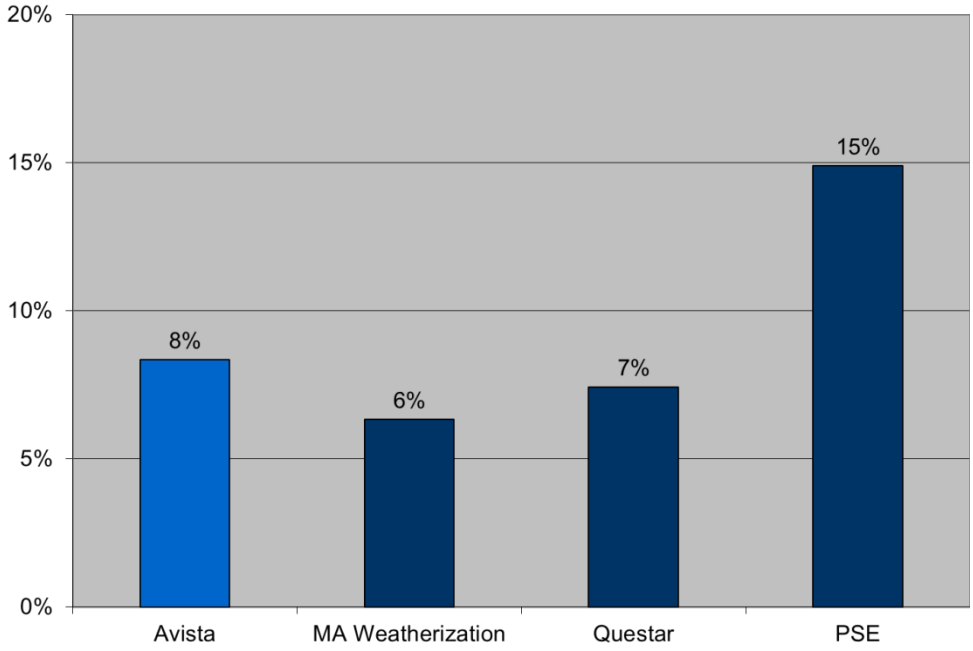
[9] We excluded one dummy variable from the independent variables; otherwise, the 12 monthly indicators would form perfect co-linearity with the intercepts (we excluded January, thus the intercepts included seasonality from January).

**Table 1-12. Realization Rate Summary**

| Group | N | PRENAC | Model Savings (Therms) | Expected Savings | Realization Rate | Savings as Percent of Pre |
|---|---|---|---|---|---|---|
| Weatherization | 809 | 865 | 72 | 147 | 49% | 8% |
| Windows | 1,721 | 800 | 24 | 83 | 29% | 3% |

Figure 1-2 compares weatherization percent savings to similar gas weatherization evaluations. To improve comparisons, the respective chart includes only attic insulation savings, which are the predominant component of the program.

**Figure 1-2. Gas Weatherization Percent Savings Benchmarking**




To extrapolate billing analysis results to the entire program population, realization rates shown in Table 1-12 were applied to total savings for measures reported in the Avista database. The one measure not included in the billing analysis was Fireplace Dampers. For this measure, Cadmus maintained the deemed savings value developed for the 2011 Avista TRM. Table 1-13 shows total reported and adjusted savings for gas Weatherization program measures.

**Table 1-13. Weatherization Measure and Program Reported and Adjusted Savings**

| Measure Name | Measure Count | | Savings per Unit | | Program Savings | | Realization Rate |
|---|---|---|---|---|---|---|---|
| | Avista | Evaluation | Avista | Evaluation | Avista | Evaluation | |
| G Fireplace Damper-Nat Gas Ht | 15 | 15 | 76 | 6 | 1,140 | 83 | 7% |
| G Windows | 1,620 | 1,620 | 79 | 22 | 128,429 | 36,385 | 28% |
| G Insulation | 1,824 | 1,824 | 135 | 67 | 246,313 | 121,405 | 49% |
| Program Total | 3,459 | 3,459 | N/A | N/A | 375,882 | 157,874 | 42% |

## 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
- High-Efficiency Tankless Water Heater

Through this program, Avista offers a $50 incentive to residential customers installing an eligible high-efficiency water heater. To qualify for the program, natural gas water heaters with tanks must have 0.60 EF or greater for a 50-gallon tank, and 0.62 EF or greater for a 40-gallon tank. Avista no longer offers an incentive on tankless water heaters. The two units rebated in 2011 were completed prior to termination of the incentive.

### Analysis

Cadmus updated deemed savings assumptions and algorithms for each measure to the most recent research available for the region and technology.

### Results and Findings

Table 1-14 shows total reported and adjusted savings for the various measures.

**Table 1-14. Water Heater Efficiency Measure and Reported and Adjusted Savings**

| Measure Name | Measure Count | | Savings per Unit | | Program Savings | | Realization Rate |
|---|---|---|---|---|---|---|---|
| | Avista | Evaluation | Avista | Evaluation | Avista | Evaluation | |
| G 40 Gallon Nat Gas Hot Water | 90 | 90 | 8 | 9 | 720 | 792 | 110% |
| G 50 Gallon Nat Gas Hot Water | 379 | 379 | 11 | 9 | 4,169 | 3,426 | 82% |
| G HE WH Tankless | 2 | 2 | 60 | 58 | 120 | 116 | 96% |
| Program Total | 471 | 471 | N/A | N/A | 5,009 | 4,334 | 87% |

## 1.3.6 ENERGY STAR Homes

### Program Description

The ENERGY STAR Homes program offers incentives to builders constructing single-family or multifamily homes complying with ENERGY STAR criteria (and verified as ENERGY STAR Homes). Avista provides a $900 incentive for homes using their electric or their electric and natural gas service for space and water heating. Avista provides a $650 incentive for homes only using their natural gas service (both hot water and space heating must be natural gas).

### Analysis

Using the ENERGY-10 modeling software, Cadmus simulated models of an ENERGY STAR home and a standard built-to-code home. We completed one model for each state (Washington and Idaho) to account for all differences in state building codes (see Appendix 1B). We averaged savings results of each simulation, according to the proportion of ENERGY STAR home rebates

awarded in each state. Finally, we applied weighted averaged savings to the entire population of ENERGY STAR homes that Avista provided with rebates for during PY 2011.

### Results and Findings

Table 1-15 shows total reported and adjusted savings for the gas measures within ENERGY STAR Homes. Participating homes using both Avista electric and gas were funded through both the electric and gas programs. Electric savings associated with these homes are addressed in the 2010 and 2011 electric impact evaluation report.

**Table 1-15. ENERGY STAR Home Measure and Program Reported and Adjusted Savings**

| Measure Name | Measure Count | | Savings per Unit (therms) | | Program Savings (therms) | | Realization Rate |
|---|---|---|---|---|---|---|---|
| | Reported | Adjusted | Reported | Adjusted | Reported | Adjusted | |
| HOME-GAS ONLY | 15 | 15 | 197 | 203 | 2,955 | 3,050 | 103% |
| ELEC/GAS (GAS) | 108 | 108 | 196 | 203 | 21,141 | 21,956 | 104% |
| PROGRAM TOTAL | 123 | 123 | | | 24,096 | 25,006 | 104% |

## 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 based on deemed savings estimates only, the error in the deemed savings is due to error in each of the input assumptions. Typically, this is due to the sampling error associated with research into each input. To simplify this analysis, Cadmus has conservatively estimated that the standard error associated with each deemed measure is 20% of the unit energy savings unless recent evaluation research has developed a more accurate estimate. This estimate is greater than values Cadmus typically determines, but provides for a conservative estimate of program precision. Two programs use more accurate estimates of error based on recent research. The standard error for the Heating and Cooling efficiency program is based on the billing analysis performed last year.[10] The standard error for the Weatherization/Shell program is based on the billing analysis performed this year. Following the determination of program measure savings based error, Cadmus applies the verification error determined through this year's surveys to each program except the two using billing analysis results. Verification rates are not applied to savings determined through a billing analysis as their results include any homes where the installation was stated to have occurred, but did not occur. Table 1-16 shows the program level error and precision for the residential portion of the portfolio. Overall the residential programs achieved 4% relative precision at the 90% confidence interval.

[10] Avista 2010 Multi-Sector Gas Impact Evaluation Report, August 2011.

**Table 1-16. Program Savings Precision at the 90% Confidence Interval**

| Program | Adjusted Gross Savings (therms) | Standard Error (therms) | Relative Precision at 90% Confidence |
|---|---|---|---|
| ENERGY STAR Products | 22,185 | 4,044 | 30% |
| Heating and Cooling Efficiency | 305,789 | 7,304 | 4% |
| Weatherization/Shell | 157,874 | 7,752 | 8% |
| Water Heater Efficiency | 4,334 | 708 | 27% |
| ENERGY STAR Homes | 25,006 | 4,459 | 29% |
| Total | 515,188 | 12,255 | 4% |

## 1.4 Conclusions

Overall, the 2011 residential gas programs produced 515,188 therms in savings. The evaluation yielded an overall realization rate of 64%. (See Table 1-17, Table 1-18, and Table 1-19)

**Table 1-17. Total Program Reported and Verified Gross Savings and Realization Rates**

| Program | Reported Savings (Therms) | Verified Gross (Therms) | Realization Rate |
|---|---|---|---|
| ENERGY STAR Products | 30,992 | 22,185 | 72% |
| Heating and Cooling Efficiency | 365,679 | 305,789 | 84% |
| Weatherization/Shell | 375,882 | 157,874 | 42% |
| Water Heater Efficiency | 5,009 | 4,334 | 87% |
| ENERGY STAR Homes | 24,096 | 25,006 | 104% |
| Total | 801,658 | 515,188 | 64% |

**Table 1-18. Program Reported and Verified Gross Verified Savings and Realization Rates—Washington**

| Program | Reported Savings (Therms) | Adjusted Gross (Therms) | Realization Rate |
|---|---|---|---|
| ENERGY STAR Products | 22,068 | 15,732 | 71% |
| Heating and Cooling Efficiency | 250,797 | 209,697 | 84% |
| Weatherization/Shell | 283,033 | 121,357 | 43% |
| Water Heater Efficiency | 4,144 | 3,587 | 87% |
| ENERGY STAR Homes | 21,143 | 21,956 | 104% |
| Total | 581,185 | 372,330 | 64% |

**Table 1-19. Program Reported and Verified Gross Verified Savings and Realization Rates—Idaho**

| Program | Reported Savings (Therms) | Adjusted Gross (Therms) | Realization Rate |
|---|---|---|---|
| ENERGY STAR Products | 8,924 | 6,453 | 72% |
| Heating and Cooling Efficiency | 114,882 | 96,092 | 84% |
| Weatherization/Shell | 92,849 | 36,517 | 39% |
| Water Heater Efficiency | 865 | 746 | 86% |
| ENERGY STAR Homes | 2,952 | 3,050 | 103% |
| Total | 220,472 | 142,858 | 65% |

Table 1-20 shows achievement rates of gross savings, compared to IRP goals for the residential sector.

**Table 1-20 IRP Goals and Gross Verified Savings by State**

| | Washington | | | Idaho | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| Sector | Savings Goal | Gross Achieved | Achiev-ement Rate | Savings Goal | Gross Achieved | Achiev-ement Rate | Savings Goal | Gross Achieved | Achiev-ement Rate |
| Residential | 985,175 | 372,330 | 38% | 416,750 | 142,858 | 34% | 1,401,925 | 515,188 | 37% |

## 1.5 Recommendations

Cadmus offers the following recommendations, based on evaluation results:

- Avista should collect and record equipment efficiency information, or at least model numbers for appliances. Including equipment-specific information regarding the actual efficiency of equipment installed would allow greater accuracy in estimating 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.
- Avista should consider moving all ENERGY STAR Clothes Washer rebates to the electric program. Given the large percentage of savings achieved through reduced dryer energy, and most participants likely having an electric dryer, this measure predominantly produces electric energy savings.

### 1.5.1 Future Research Areas

These research recommendations are based on the results of this impact evaluation and known future changes to program requirements.

- Perform a review of all available secondary research (including the Residential Building Stock Assessment (RBSA)) and/or collect primary data on the penetration of gas heated clothes dryers. This information can be used to refine the estimated gas and electric savings associated with the purchase of an ENERGY STAR clothes washer in a home with a gas domestic hot water tank.

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

# 2 2010 Nonresidential Gas Impact Report

## Executive Summary

### Program Overview

Avista's nonresidential programs promote the purchase of industry-proven, high-efficiency equipment for commercial utility customers. They provide rebates to partially offset the difference in cost between high-efficiency and standard equipment, reducing the first-cost barrier and making high-efficiency equipment a more viable option for commercial customers.

Avista's nonresidential gas portfolio has nine programs in two major categories: eight Prescriptive and one Site-Specific (custom). The programs are:

- Prescriptive:
  - ENERGY STAR Residential Products (APP)
  - Commercial Clothes Washer (PCW)
  - Commercial HVAC (PCH)
  - Commercial Shell (PCS)
  - Demand Controlled Ventilation (PDCV)
  - Food Service (PFS)
  - Refrigerated Warehouse (PRW)
  - Steam Trap Replacement (PSTR)
- Site-Specific (SS)

Avista administers both the Prescriptive and Site-Specific programs. Cadmus conducted both qualitative (process) and quantitative (impact) evaluations of these programs. We also documented the evolution of these programs and provided timely feedback to enable recommended program improvements.

The Site-Specific program reported the largest quantity of savings. For the purposes of this evaluation, Cadmus subdivided the Site-Specific program into the following major measure categories:

- Site-Specific HVAC (SSHVAC)
- Site-Specific Other (SSO)
- Site-Specific Shell (SSS)

### Key Findings

Cadmus evaluated 55 of 431 measures installed through the nonresidential energy efficiency programs, representing 57% of reported savings. Throughout the impact evaluation, we documented program achievements and identified issues such as lower-than-expected achieved savings.

Avista's reported and evaluated savings are shown in Table 2-1 through Table 2-3. The gross evaluated program savings were 832,374 therms.

**Table 2-1. Program Summary**

| Measure Category | Number of Measure Installations | Gross Program Reported Savings (therms) | Gross Program Evaluated Savings (therms) | Realization Rate |
|---|---|---|---|---|
| Prescriptive | 173 | 104,286 | 95,963 | 92% |
| SSHVAC | 115 | 628,625 | 489,993 | 78% |
| SSO | 24 | 15,867 | 15,998 | 101% |
| SSS | 119 | 213,473 | 230,420 | 108% |
| Total | 431 | 962,251 | 832,374 | 87% |

**Table 2-2. Program Summary - Idaho**

| Measure Category | Number of Measure Installations | Gross Program Reported Savings (therms) | Gross Program Evaluated Savings (therms) | Realization Rate |
|---|---|---|---|---|
| Prescriptive | 41 | 16,184 | 14,893 | 92% |
| SSHVAC | 43 | 96,426 | 70,476 | 73% |
| SSO | 8 | 4,569 | 4,607 | 101% |
| SSS | 38 | 32,214 | 35,741 | 111% |
| Total | 130 | 149,393 | 125,717 | 84% |

**Table 2-3. Program Summary - Washington**

| Measure Category | Number of Measure Installations | Gross Program Reported Savings (therms) | Gross Program Evaluated Savings (therms) | Realization Rate |
|---|---|---|---|---|
| Prescriptive | 132 | 88,102 | 81,070 | 92% |
| SSHVAC | 72 | 532,199 | 419,517 | 79% |
| SSO | 16 | 11,298 | 11,392 | 101% |
| SSS | 81 | 181,259 | 194,679 | 107% |
| Total | 301 | 812,857 | 706,657 | 87% |

Avista did not report participation goals by number of projects but did report energy savings goals as shown in Table 2-4. The overall PY 2011 nonresidential gas portfolio achieved 96% of the natural gas integrated resource plan (IRP) savings goal.

**Table 2-4. IRP Energy Savings Achievements Compared to Goals**

| Program | Program Gross Goals (therms) | Evaluated Gross Program (therms) | Goal Achievement |
|---|---|---|---|
| Idaho | 260,885 | 125,717 | 48% |
| Washington | 608,731 | 706,657 | 116% |
| Total | 869,616 | 832,374 | 96% |

The energy savings results shown in Table 2-4 do not account for therm penalties due to increased lighting efficiency. Lighting systems convert a large portion of their input energy to useful light output, but a substantial portion is converted to waste heat. Any reduction in lighting input energy also reduces waste heat, which, if reduced, lowers the site's required cooling load while increasing the heating load. Cadmus noted that Avista tracked these HVAC interactive effects for calculating cost-effectiveness but did not include them in energy savings goals or reported savings values. Avista noted its methodology for calculating interactive impacts was not as robust as that for energy savings. The Avista database extract did not provide sufficient detail for Cadmus to calculate those impacts.

## 2.1 Introduction

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

The nonresidential gas portfolio has nine programs in two major categories: eight prescriptive and one Site-Specific (custom).

### 2.1.1 ENERGY STAR Residential Products (APP)

This program is available to nonresidential customers who use residential-grade appliances in a small business application. Savings are determined through deemed estimates.

### 2.1.2 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 is designed to reach customers quickly and effectively to promote ENERGY STAR or Consortium for Energy Efficiency (CEE) listed units.

### 2.1.3 Prescriptive Commercial HVAC (PCH)

Beginning in January 2011, the installation of efficient HVAC systems has been processed through a prescriptive program rather than through the Site-Specific program. Measures eligible for the prescriptive program are limited to the following installations:

- 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

### 2.1.4 Prescriptive Commercial Shell (PCS)

Beginning in January 2011, the installation of commercial insulation has been processed through a prescriptive program in addition to the Site-Specific program. Projects eligible for the prescriptive program are those with pre-existing:

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

### 2.1.5 Prescriptive Demand Controlled Ventilation (PDCV)

Under this program, nonresidential electric and natural gas customers receive direct incentives to install DCV in existing buildings. This type of ventilation measures the approximate number of people occupying a space—based on carbon dioxide levels—and resets the outdoor air intake rate for occupant ventilation. To be eligible for the program, the existing equipment must maintain the temperature of the conditioned spaces between 65 and 75 degrees during operating hours. Also, the controlled conditioned space must be a minimum of 2,000 square feet.

### 2.1.6 Prescriptive Food Service (PFS)

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

#### Prescriptive Refrigerated Warehouse (PRW)

This program offers nonresidential electric customers a direct incentive for efficiency improvements in refrigerated warehouses. Although the customer base for this program is limited, the opportunities for energy savings from the program's measures are significant.

#### Prescriptive Steam Trap Replacement (PSTR)

This program offers rebates to nonresidential gas customers who repair or replace failed steam traps on the steam distribution lines of a boiler heating system. The key criteria for this rebate are:

- The replacement must be a new steam trap of the same duty as the trap it replaces.
- Each steam trap repair or replacement is only eligible for a rebate once every five years.
- The repaired or replaced trap must include a strainer.

#### Site-Specific (SS)

The Site-Specific program is for nonresidential measures that do not fit any of the prescriptive applications and thus must be considered based on their project-specific information. For a measure to be considered, it must have demonstrable kWh and/or therm savings. These measures are available to all commercial, industrial, or pumping customers who receive electric or natural gas service from Avista and want to make cost-effective, energy-efficiency improvements to their business. Electric and gas saving measures included in the program are:

- Site-Specific HVAC
  - HVAC combined
  - HVAC heating

- Site-Specific other
  - Appliances
  - Industrial process
- Site-Specific shell

Avista designs, manages, and implements the prescriptive and Site-Specific programs. It also developed the algorithms it uses to calculate measure savings and 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 reported program participation and estimate energy savings. In the impact evaluation we determined gross savings through engineering calculations, verification site visits, metering, and some project-level billing analysis.

Cadmus worked with a subcontractor for this evaluation, SBW. We reviewed Avista's reported gross energy savings and available documentation such as audit reports and savings calculation work papers for a sample of sites, giving particular attention to the calculation procedures and documentation for savings estimates. We also verified the appropriateness of Avista's analyses to calculate savings, as well as the operating and structural parameters of the analyses. We then determined gross evaluated energy savings through site visits and engineering calculations for a sample of projects.

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 any changes to the operating parameters since the measures were first installed. We also interviewed facility staff to ask their experience of the operating conditions of the installed system and any additional benefits or shortcomings of the installed system. Cadmus used the savings realization rates from site visits to estimate savings and develop recommendations for future studies.

### 2.2.1 Sampling

We developed a sampling calculation tool to estimate the number of metered projects and site verifications required to achieve the rigor levels of the precision target. We used preliminary program population data provided by Avista and determined we needed to meter 18 projects and visit 33 sites. The proposed precision targets for these two evaluation activities are shown in Table 2-5.

**Table 2-5. Proposed PY 2011 Nonresidential Evaluation Activities**

| Stratum | Precision Target | Proposed Metering Projects | Proposed Site Visits |
|---|---|---|---|
| Prescriptive | 90/20 | 3 | 10 |
| SSHVAC | 90/20 | 10 | 1 |
| SSO | 90/15 | 5 | 19 |
| SSS | 90/15 | 0 | 3 |
| Total | 90/10 | 18 | 33 |

We selected both a census and random sample for each stratum. The census projects represented a small number of those participants with large savings impacts for the stratum. The census savings cutoff for each stratum is shown in Table 2-6 below. We visited all sites with reported savings above this census level. In each stratum, we also randomly selected additional participants from the remaining population of projects.

**Table 2-6. Census Level Cutoff by Stratum**

| Stratum | Reported Savings (therms) |
|---|---|
| Prescriptive | 10,000 |
| SSHVAC | 35,000 |
| SSO | 10,000 |
| SSS | 20,000 |

In Table 2-7, we show the precision achieved for the actual number of evaluation activities for gas measures. Subsequent sections of this report will explain the differences between our initial proposed and actual sampling plan for evaluation activities. For example, our initial sampling plan categorized ENERGY STAR appliances in the Site-Specific other category. As the impact evaluation progressed, we determined these measures were more appropriate for the prescriptive category.

**Table 2-7. Final FY 2011 Gas Evaluation Activity Sample**

| Stratum | Precision Achieved | Completed Metering Projects | Completed Site Visits |
|---|---|---|---|
| Prescriptive | 90/37 | 3 | 17 |
| SSHVAC | 90/11 | 8 | 11 |
| SSO | 90/6 | 3 | 4 |
| SSS | 90/14 | 0 | 9 |
| Total | 90/9 | 14 | 41 |

As explained above and presented in Table 2-6, we selected projects with large reported savings. In selecting the rest of our sample, we found that the extract from Avista's database did not include addresses so that we could identify if projects performed for the same company were at different sites nor did it list what specific measures were installed. Therefore, the sampling process was iterative. From the extract, we selected projects of interest, asked Avista for additional data to determine how many and what types of projects were at various locations, and obtained their project files, until we had compiled the final primary and backup samples.

Cadmus also found that the database extract provided program-level but not measure-level information. Therefore, we attempted to verify savings for every incented measure at each site, regardless of whether it achieved gas or electric savings. We were unable to determine whether we evaluated an accurate distribution of measure types within each program. To establish this distribution, we would have required an exhaustive review of project files, which was not within the scope of the evaluation.

### 2.2.2 Data Collection

Cadmus collected data from 14 metering projects and 41 on-site verifications. For each, we first conducted a document review to determine measure type, quantity, operational parameters, and calculation methodology.

#### Document Review

Avista provided Cadmus with documentation of the energy-efficiency projects undertaken at the sample sites. This documentation included program forms, the tracking database, audit reports, and savings calculation work papers for each rebated measure. In our review of calculation spreadsheets and energy simulation models, we paid particular attention to calculation procedures and documentation for savings estimates.

Cadmus reviewed each application for the following information:

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

#### Short-Term Metering

Avista provided hourly usage for 14 sites through each site's gas meter. The metered data for six sites came from digital meters that Avista had previously installed. The metered time period varied from several weeks to several months for each meter. For the other eight sites, Avista installed a connection to the analog gas flow meter so we could install data loggers to record pulse counts for two weeks.

#### Site Visits

Cadmus performed on-site visits to verify measure installations, collect primary data to calculate savings impacts, and interview facility staff.

We accomplished three primary tasks during the on-site visits:

1. We verified the implementation status of all measures for which customers received incentives. We verified that the energy-efficiency measures were installed correctly and still functioned properly, and we also verified the operational characteristics of the installed equipment, such as temperature set points and operating hours.

2. We collected the physical data, such as boiler capacity or operational temperature, and analyzed the energy savings realized from the installed improvements and measures.
3. We conducted interviews with facility personnel to obtain additional information on the installed system to supplement data from other sources.

### 2.2.3 Engineering Analysis

Nonresidential Prescriptive and Site-Specific programs required significantly different methods of analysis.

#### Overview

Our procedures for verifying savings through an engineering analysis depended on the type of measure being analyzed. The analytical methods used in this evaluation are listed below and described in the following sections:

- Prescriptive deemed savings
- Short-term metering
- 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 then compared these with the values we had developed for the new technical reference manual (TRM).[11] We focused our verification activities on the installed quantity and equipment nameplate data and on the proper installation of equipment and operating hours. Where appropriate, we used data from site verification visits to re-analyze prescriptive measure savings with Avista's Microsoft Excel calculation tools, ENERGY STAR calculation tools, Regional Technical Forum deemed savings, and other secondary sources.

#### Short-Term Metering

Cadmus used the hourly gas flow data from analog and digital meters to characterize site gas usage quantities and patterns. Where possible, we attempted to isolate the impact of the particular measure for which the participant received incentives.

#### Billing Analysis

Cadmus analyzed Avista's metered billing data for six 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). It also determined savings based on normalized weather conditions, since the actual weather conditions may have been milder or more extreme than the TMY3 (typical meteorological year) 15-year normal weather averages from 1991-2005 obtained from the National Oceanic and Atmospheric Administration (NOAA).

[11] Avista's new iteration of the TRM is expected around July 2012.

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

We followed a modified PRISM approach when developing the analysis models, which normalized all dependent and independent variables for the days in each billing period and allowed for model coefficients to be interpreted as average daily values. We used this methodology to account for differences in the length of billing periods. For each project, we modeled the average daily consumption in kWh as a function of some combination of 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.

Cadmus calculated three scenarios after estimating model coefficients for each site. First, 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 the consumption would have been in the absence of the program. We calculated the energy savings as the difference between the counterfactual scenario and the actual consumption.

Cadmus then 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 represents the long-term expected annual savings.

### Calculation Spreadsheets

Avista developed calculation spreadsheets to analyze energy savings for a variety of measures, including the building of envelope measures such as ceiling and wall insulation. The calculation spreadsheets require input of relevant parameters such as square footage, efficiency value, HVAC system details, and location details. From these data, energy savings are estimated through algorithms programmed by Avista. For each spreadsheet, we reviewed input requirements and output estimates and determined if the approach was reasonable.

### Energy Simulation Modeling

Avista determined savings for many Site-Specific HVAC and shell projects with energy simulation modeling, which it chose because of the complex interactions between heating and cooling loads and the building envelope. Avista provided the original energy simulation models, and we reviewed the models to determine the relevant parameters and operating details (such as temperature set points) for the applicable measure. We updated the models as necessary based on our on-site verification data.

## 2.3 Results and Findings

### 2.3.1 Overview

Cadmus adjusted gross savings estimates based on our evaluated findings. Further details by program are discussed in the following sections.

### 2.3.2 Prescriptive Programs

We evaluated savings for a sample of sites across eight prescriptive programs. Table 2-8 through Table 2-10 show the savings and realization rates by program. Further evaluation details in each program are described below. The realization rate for all but the residential appliances (APP) and steam trap measures (PSTR) are high, and the APP measures only delivered a small portion of savings.

**Table 2-8. Evaluated Results for PY11 Nonresidential Gas Prescriptive Sample**

| Program | Total FY11 Measure Installations | Evaluated Sample | Gross Reported Savings (therms) | Gross Evaluated Savings (therms) | Realization Rate |
|---|---|---|---|---|---|
| APP | 16 | 8 | 51 | 21 | 41% |
| PCW | 6 | 0 | N/A | N/A | N/A |
| PCH | 51 | 4 | 2,131 | 2,852 | 134% |
| PCS | 65 | 2 | 1,237 | 1,385 | 112% |
| PDCV | 3 | 2 | 651 | 651 | 100% |
| PFS | 28 | 2 | 2,678 | 2,630 | 98% |
| PRW | 1 | 0 | N/A | N/A | N/A |
| PSTR | 3 | 2 | 3,248 | 1,654 | 51% |
| Total | 173 | 20 | 9,996 | 9,193 | 92% |

**Table 2-9. Evaluated Results for PY11 Nonresidential Gas Prescriptive Sample - Idaho**

| Program | Total FY11 Measure Installations | Evaluated Sample | Gross Reported Savings (therms) | Gross Evaluated Savings (therms) | Realization Rate |
|---|---|---|---|---|---|
| APP | 3 | 2 | 10 | 3 | 49% |
| PCH | 12 | 2 | 652 | 673 | 103% |
| PCS | 14 | 0 | N/A | N/A | N/A |
| PDCV | 2 | 1 | 550 | 550 | 100% |
| PFS | 10 | 2 | 2,678 | 2,630 | 98% |
| Total | 41 | 7 | 3,890 | 3,856 | 99% |

**Table 2-10. Evaluated Results for PY11 Nonresidential Gas Prescriptive Sample - Washington**

| Program | Total FY11 Measure Installations | Evaluated Sample | Gross Reported Savings (therms) | Gross Evaluated Savings (therms) | Realization Rate |
|---|---|---|---|---|---|
| APP | 13 | 6 | 41 | 18 | 44% |
| PCW | 6 | 0 | N/A | N/A | N/A |
| PCH | 39 | 2 | 1,479 | 2,179 | 147% |
| PCS | 51 | 2 | 1,237 | 1,385 | 112% |
| PDCV | 1 | 1 | 101 | 101 | 100% |
| PFS | 18 | 0 | N/A | N/A | N/A |
| PRW | 1 | 0 | N/A | N/A | N/A |
| PSTR | 3 | 2 | 3,248 | 1,654 | 51% |
| Total | 132 | 13 | 6,106 | 5,337 | 87% |

Overall, the Prescriptive program analysis achieved a level of 90/37 confidence and precision. Cadmus identified several necessary adjustments to the reported savings for the Prescriptive programs. We note that the calculations often rely on reported equipment and operations data, which may vary from parameters identified during on-site verification visits and metering.

Our adjustments decreased savings by 8%. Typical adjustments were to correct equipment efficiency, fuel type, operating schedules, and operating parameters as described below:

- One dishwasher and one clothes washer measure used electric water heating instead of gas, so this reduced electric energy savings. Cadmus attributed the electric savings to the nonresidential electric program. In addition, one dishwasher measure used gas water heating instead of electric, as reported. This increased the evaluated gas savings.
- For ENERGY STAR clothes washers we applied the results from a previous Cadmus clothes washer study[12]. The Cadmus study estimated larger energy savings for this measure than the reported values.
- For two commercial HVAC measures, we adjusted savings based on short-term metered usage data and utility billing data. One measure used less gas than reported, which reduced savings. The other measure used much more gas than reported, which increased energy savings. The overall impact resulted in additional savings.
- For two commercial shell measures we updated the savings estimate to account for additional insulation square footage and heating setpoints using Avista's calculator for this measure. The adjustments increased energy savings.
- One Prescriptive Food Service project installed a commercial dishwasher that relied on gas heating instead of electric, as reported. The gas savings were attributed to the nonresidential gas program.

[12] The Cadmus Group, Inc. "Do the Savings Come Out in the Wash? A Large Scale Study of In-Situ Residential Laundry Systems." 2010. http://www.cadmusgroup.com/pdfs/Do_the_Savings_Come_Out_in_the_Wash.pdf

- One steam trap replacement project replaced and repaired steam traps on a low pressure steam system (3 to 5 psi). The measure did not qualify for the program since it fell below the threshold requirement of 15 psi; therefore, we did not attribute savings to this project.

### 2.3.3 Site-Specific

Cadmus performed site visits on 35 Site-Specific program projects, which represented a variety of measure types. We calculated an overall realization rate for all randomly selected (non-census) projects in both Idaho and Washington and then applied the resulting realization rate to the non-census savings for each state and major measure type. Table 2-11 lists the different measure types we evaluated, as well as the number of projects and reported savings. Table 2-12 and Table 2-13 show our evaluated results for the program.

**Table 2-11. Site-Specific Measure Types and Projects Evaluated**

| Measure Type | Idaho | | Washington | | Total | |
|---|---|---|---|---|---|---|
| | Evaluated Projects | Reported Savings (therms) | Evaluated Projects | Reported Savings (therms) | Evaluated Projects | Reported Savings (therms) |
| SSHVAC | 5 | 52,534 | 14 | 397,423 | 19 | 449,957 |
| SSO | 3 | 4,499 | 4 | 11,103 | 7 | 15,602 |
| SSS | 3 | 12,303 | 6 | 50,062 | 9 | 62,365 |
| Total | 11 | 69,336 | 24 | 458,588 | 35 | 527,924 |

**Table 2-12. Evaluated Results for PY 2011 Nonresidential Site-Specific Sample**

| State | Total FY11 Measure Installations | Evaluated Sample | Gross Reported Sample Savings (therms) | Gross Evaluated Sample Savings (therms) | Sample Realization Rate |
|---|---|---|---|---|---|
| Total | 258 | 35 | 527,924 | 437,905 | 83% |
| Idaho | 89 | 11 | 69,336 | 53,348 | 77% |
| Washington | 169 | 24 | 458,588 | 384,558 | 84% |

**Table 2-13. Evaluated Results for PY 2011 Nonresidential Site-Specific Measure Categories**

| Measure Category | Gross Reported Sample Savings (therms) | Gross Evaluated Sample Savings (therms) | Realization Rate |
|---|---|---|---|
| SSHVAC | 628,625 | 489,993 | 78% |
| SSO | 15,867 | 15,998 | 101% |
| SSS | 213,473 | 230,420 | 108% |
| Total | 857,965 | 736,412 | 86% |

Overall, the Site Specific program analysis achieved a level of 90/9 confidence and precision. Cadmus identified many adjustments to Site-Specific program project reported savings. Site-Specific projects tend to be more complex, and energy savings parameters and impacts can be 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, our adjustments decreased savings by 14% due to reductions in Site-Specific HVAC savings (realization rate of 78%). We evaluated higher than reported savings for both the Site-Specific other (101%) and Site-Specific shell (108%) sample.

We typically adjusted savings values to correct equipment efficiency, operating schedules, temperature set points, and building parameters. We also identified errors in simulation models and Microsoft Excel calculation tools, which when corrected resulted in adjustments. We made the following specific adjustments:

- One manufacturing facility installed an overhead radiant system to replace unit heaters that received heat from fan coils on a boiler loop. The participant did not decommission the boiler and left two unit heaters operational over the loading dock. The new system radiantly heated the production area as intended, but the unit heaters attempted to bring the entire space temperature up to the set point. As a result, the system used more gas than in the baseline condition, resulting in a savings reduction of 14,641 therms.
- Cadmus found Avista's assumptions for post-installation heating loads on several large projects resulted in savings reductions. Based on our analysis of billing data and heating degree days, we calculated lower than reported savings on the following projects:
  - Athletic club boiler retrofit (92% realization rate, savings reduction of 3,293 therms)
  - Jail boiler to central steam plant retrofit (84% realization rate, savings reduction of 3,276 therms)
  - Medical center HVAC controls retrofit (91% realization rate, savings reduction of 1,983 therms)
  - University code baseline to efficient boiler (72% realization rate, savings reduction of 1,792 therms)
- Avista reported savings based on LEED simulation models for three HVAC projects at a prison in southeast Washington. The third-party engineer who developed the LEED models lost them in a server crash, and Avista did not obtain a copy of the models prior to project approval. For one building that installed all three measures (high-efficiency equipment and heat recovery), we created a new Trane TRACE simulation model using architectural drawings, mechanical specifications, site verification data, and utility billing data. We also located high-efficiency gas equipment measures in 15 other buildings on the prison campus. We combined modified simulation models and spreadsheet calculations to evaluate savings on these measures. The combined realization rate for all three HVAC measures was 75%, a reduction of 64,787 therms. The specific issues for each measure are noted below.
  - The measure with the largest reported savings involved high-efficiency boilers and domestic water heating systems in most buildings on the prison campus. The prison utility billing data did not support the heating loads projected in the original simulation models. We evaluated the measure's realization rate at 85%, a reduction of 29,814 therms.

  - The second largest measure was a heat recovery system for one building's laundry facilities. We calculated savings using participant records on laundry loads, as well as equipment specifications, operating details, and temperature data we verified during the visit. The measure's realization rate was 62%, a reduction of 12,178 therms. Cadmus could not obtain the LEED model to identify the exact source of discrepancy.
  - The third measure used heat recovery from refrigeration compressors to heat incoming air and water. Our simulation model indicated the system's water storage capacity acted as a limiting factor for heat transfer and that the tanks could not recharge fast enough during the day to keep up with demand. The original LEED simulation model may not have accounted for this effect. The realization rate was 14%, a reduction of 22,795 therms.

- Cadmus identified multiple discrepancies and simulation model errors on an office project with HVAC direct digital control upgrades. The realization rate was 43%, a reduction of 5,568 therms. The discrepancies between the model and our site visit were:
  - The proposed window U-values did not match installed values.
  - The modeled computer room area was smaller than the actual area.
  - The model listed one system zone per floor whereas the as-built zoning used one system for the building perimeter and one system for the building interior.
  - The model used 8,760 hours per year for the occupancy schedule in the model baseline and followed a normal office schedule in retrofit case. The schedule should have used the same conventional office operating schedule for both baseline and retrofit conditions. The higher baseline operating hours inflated savings.
- Cadmus identified issues with simulation model calibration to utility billing data on one HVAC heating project. The simulation model had been stored on an Avista engineer's laptop and was lost due to a hardware issue, so we could not perform an updated calibration. We analyzed the project by comparing pre- and post-installation utility billing data and heating degree days and calculated the realization rate at 67%, a reduction of 569 therms.
- Individual new construction measure savings were heavily dependent on interactive effects. Avista applies a rolling baseline in which each energy-efficiency measure's savings reduce the energy-usage baseline for all of the successive measures. The order in which the analysis is performed will change energy savings results by measure type. As an example, a newly constructed school installed various shell and gas efficiency measures, as well as daylighting controls. The daylighting controls reduce waste heat from lighting and increase gas heating requirements. If the daylighting controls measure is modeled first, it increases the baseline energy usage for the shell and gas measures. If the daylighting controls measures is modeled last, its savings does not impact the baseline, which reduces potential gas measure savings.

### 2.3.4 Extrapolation to Program Population

For our evaluation of the nonresidential gas programs, we selected sites that could provide the most impactful information. We designed the site visits to achieve a statistically valid sample for the major strata, as discussed previously. For measures in the random (non-census) sample, we calculated realization rates (the ratio of claimed-to-verified savings) to apply to the programs at

the remaining non-sampled sites. These realization rates are weighted averages, based on the random verification sample and using the following four equations:

$$RR_{ij} = \frac{Verified_{ij}}{Claimed_{ij}};\ for\ measure\ j\ at\ site\ i \quad (1)$$

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

$$\sum_k Verified_k = RR_j\, x \sum_k Claimed_k;\ for\ measure\ j\ across\ all\ sites\ in\ measure\ population \quad (3)$$

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

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 measure type (Equation 1). We then calculated the realization rates for the measure types using the ratio of the sum of verified savings to the sum of claimed savings from the randomly selected sample for each measure type (Equation 2). We calculated the non-census population verified savings by multiplying the measure type realization rate from the random sample by the claimed savings for the non-census population of each measure type (Equation 3). We then added the claimed and verified savings from census stratum measures to calculate the total reported and verified savings for each program. The program realization rate is the ratio of all verified to all claimed savings (Equation 4).

Cadmus summed these values to determine the total adjusted evaluated savings and program-level realization rates for the programs as a whole and for Idaho and Washington, as shown in Table 2-14 through Table 2-16. The overall portfolio gross realization rate is 87%.

**Table 2-14. PY 2011 Gas Gross Program Realization Rates**

| Measure Category | Gross Sample Reported Savings (therms) | Gross Sample Evaluated Savings (therms) | Realization Rate | Gross Program Reported Savings (therms) | Gross Program Evaluated Savings (therms) |
|---|---|---|---|---|---|
| Prescriptive | 9,996 | 9,193 | 92% | 104,286 | 95,963 |
| SSHVAC | 449,957 | 359,408 | 78% | 628,625 | 489,993 |
| SSO | 15,602 | 15,732 | 101% | 15,867 | 15,998 |
| SSS | 62,365 | 62,332 | 108% | 213,473 | 230,420 |
| Total | 537,920 | 446,665 | 87% | 962,251 | 832,374 |

**Table 2-15. PY 2011 Gas Gross Program Realization Rates - Idaho**

| Measure Category | Gross Sample Reported Savings (therms) | Gross Sample Evaluated Savings (therms) | Realization Rate | Gross Program Reported Savings (therms) | Gross Program Evaluated Savings (therms) |
|---|---|---|---|---|---|
| Prescriptive | 3,890 | 3,856 | 92% | 16,184 | 14,893 |
| SSHVAC | 52,534 | 33,549 | 73% | 96,426 | 70,476 |
| SSO | 4,499 | 4,064 | 101% | 4,569 | 4,607 |
| SSS | 12,303 | 15,735 | 110% | 32,214 | 35,741 |
| Total | 73,226 | 57,203 | 84% | 149,393 | 125,717 |

**Table 2-16. PY 2011 Gas Gross Program Realization Rates - Washington**

| Measure Category | Gross Sample Reported Savings (therms) | Gross Sample Evaluated Savings (therms) | Realization Rate | Gross Program Reported Savings (therms) | Gross Program Evaluated Savings (therms) |
|---|---|---|---|---|---|
| Prescriptive | 6,106 | 5,337 | 92% | 88,102 | 81,070 |
| SSHVAC | 397,423 | 325,859 | 79% | 532,199 | 419,517 |
| SSO | 11,103 | 11,668 | 101% | 11,298 | 11,392 |
| SSS | 50,062 | 47,031 | 107% | 181,259 | 194,679 |
| Total | 464,694 | 389,895 | 87% | 812,857 | 706,658 |

## 2.3.5 Achievements Compared to Goals

Avista outlined goals for various programs to save a total of 869,616 therms as its integrated resource planning (IRP) goal, as shown in Table 2-17. The overall Avista portfolio's evaluated gross savings achieved 96% of its goals.

**Table 2-17. PY 2011 Gas Program Achievements Compared to IRP Goals**

| Program | Program Gross Goals (therms) | Evaluated Gross Program (therms) | Goal Achievement |
|---|---|---|---|
| Idaho | 260,885 | 125,717 | 48% |
| Washington | 608,731 | 706,658 | 116% |
| Total | 869,616 | 832,374 | 96% |

### 2.3.6 HVAC / Lighting Interactive Impacts

The Avista portfolio results did not account for gas heating penalties due to increased lighting efficiency. Lighting systems convert a large portion of their input energy to useful light output, but a substantial portion is converted 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 tracks and records these HVAC interactive effects for many projects to determine program cost-effectiveness. Most interactive effects involved prescriptive or Site-Specific lighting projects, although some therm penalties were reported for the Energy Smart Grocer (in Avista's electric portfolio) and Site-Specific HVAC program projects.

Cadmus typically applies interactive factors based on values supplied by the RTF of the Northwest Power and Conservation Council. Those values rely on the fixture savings, building type, and HVAC system; however, that information was not available for most of the affected projects we evaluated. Avista noted its methodology for calculating interactive effects was not as robust as that for its energy savings methodology.

In addition, Avista did not factor interactive effects into their portfolio energy savings goals, which would have reduced goals.

## 2.4 Conclusions

Cadmus evaluated 55 of 431 measures installed through the program, representing 57% of reported savings.

In general, Cadmus determined that Avista implemented the programs well. Gross evaluated savings achieved 96% of reported program savings goals. The overall portfolio achieved an 87% realization rate when we compare gross evaluated savings to gross reported savings.

Cadmus identified the following key issues that reduced energy savings:

- Some participants did not operate the incented equipment correctly or did not complete the improvements expected for the measure.
- Some participant heating or cooling loads did not achieve the level projected for post-installation usage.
- Some energy simulation models did not accurately represent the actual as-built building or system operation.

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

- Several building simulation models were unavailable due to reported server or laptop crashes on the part of either Avista implementation staff or third-party consultants. At one site, a LEED consultant lost the building simulation model that had been used to estimate 25% of the total nonresidential gas savings.

- Individual new construction measure savings were heavily dependent on interactive effects. Avista calculated individual measure savings through a rolling baseline in which each measure was simulated in a set order. Changing the simulation order substantially altered measure savings.
- Cadmus could have streamlined the sampling process if Avista's database had recorded site addresses and contact information. Having measure-level data, such as specific measure type and quantity, for each project would have improved the range and depth of our evaluation activities.
- Interactive effects between HVAC and lighting represent a significant impact on gas demand. We are unable to reliably estimate interactive savings impacts from the data available in Avista's current database.

## 2.5 Recommendations

Cadmus recommends that Avista continue to offer incentives for measure installation through the evaluated programs. We recommend the following for improving program energy savings impacts and effectiveness of the evaluation:

- Avista should create a quality control system to double-check all projects with savings over 10,000 therms. An Avista EM&V engineer reported he has begun to review these types of projects.
- Avista should consider performing three- to six-month post-installation random inspections to confirm measure persistence and to identify opportunities to improve performance.
- Avista should consider adding a program for recommissioning measures that were identified as non-functional during the previous year's evaluation process and report the energy savings these measures achieve in the subsequent year. Recommissioning measure costs would primarily be for utility and implementer staff to resolve issues and to re-inspect the measure. We recommend that recommissioning measures be evaluated through a census sample, and the verified energy savings should not be extrapolated to the overall program population.
- Avista should consider applying more conservative assumptions on Site-Specific heating loads.
- Avista should save all internally and externally developed simulation models to Avista's servers.
- Avista should consider developing a New Construction measure that would combine the interactive effects associated with all individual measures at new construction projects.
- Avista should consider revising its methodology for calculating and tracking HVAC/lighting interactive effects.

# 3 2011 Low-Income Gas Impact Report

## Executive Summary

### Program Overview

Avista's Low-Income Weatherization Program in Washington and Idaho seeks to lower customers' energy consumption and reduce their utility bills. At no cost to income-qualified customers, the program provides: a complete home energy audit, and installation of energy-efficient measures.

### Evaluation Approach

For the 2011 impact evaluation, we used gas savings estimates, calculated through billing analysis of 2010 gas participants. The final model's savings estimates from the 2010 impact evaluation have been applied to 2011 gas participants. Savings are reported for all 2011 gas participants in Avista's Washington and Idaho service territories. Major tasks performed for the evaluation are described in detail below.

#### Data Collection

Table 3-1 lists data required for this evaluation and their sources.

**Table 3-1. Data Sources**

| Data | Source |
|---|---|
| Program participant and measure data | Avista |
| Expected savings by measure installation | Avista / CAP agencies |

#### Evaluation of Program Energy Savings

Cadmus reviewed Avista's estimated savings, and calculated the average achieved household and total savings, as described below:

- **Expected Savings:** Based on expected measure-level gas savings estimates, provided by Avista, and drawn from their program participant database.
- **Actual Savings:** Calculated using a pre-post CSA, fixed-effects regression model, estimating weather-normalized, program-induced energy savings, based on participant billing data. Model savings estimates from the 2010 Impact Report's billing analysis were applied to current 2011 participants. In addition, we utilized data from Avista's 2010 Residential evaluation to determine savings achieved for participants receiving electric to high-efficiency gas furnace conversions.

### Gas Impact Findings and Conclusions

State-level savings estimates from the 2010 gas billing analysis were applied to 242, gas-saving 2011 program participants, summarized in Table 3-2. An additional 110 participants received electric to gas fuel-conversion measures. Savings for these installations are discussed below.

**Table 3-2. Non-Conversion Whole House Gas Savings by State**

| State | Total Participants | Average Expected Savings Per Participant (Therms) | Model Savings Per Participant (Therms) | Realization Rate |
|---|---|---|---|---|
| Idaho | 104 | 305 | 123 | 41% |
| Washington | 138 | 361 | 104 | 29% |
| Overall | 242 | 337 | 112 | 33% |

### Fuel-Conversion Savings

Of the 110 participants receiving fuel conversions for electric heating and/or water heating equipment, along with bundles of other gas-savings weatherization measures (e.g., insulation), conversion installations occurred only in Washington. Savings were assigned to three categories of participants:

1. Full model savings to those receiving larger bundles of weatherization measures;
2. Savings specific to installation of a high-efficiency gas furnaces, in place of standard efficiency furnaces; [13] and
3. No savings applied (a few cases).

In total, we estimated an additional 8,683 therms savings for gas-saving conversion participants.

### Overall Gas Savings

Table 3-3 compares reported gas savings for 2011 IRP goals against evaluated savings, drawn from our analysis. The 2011 Low-Income portfolio achieved savings of nearly 36,000 therms, resulting in approximately 55% of IRP's savings goals.

**Table 3-3. Overall Evaluated Gas Savings and IRP Goals**

| State | Total Customers | IRP Goal (Therms) | Evaluated Gas Savings (Therms) | Goal Achievement |
|---|---|---|---|---|
| Idaho | 104 | 19,500 | 12,835 | 66% |
| Washington* | 248 | 45,500 | 23,042 | 51% |
| Overall | 352 | 65,000 | 35,877 | 55% |

* Includes 138 participants receiving model savings, and 110 conversion customers.

## Recommendations

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

[13] The program participant database did not indicate water heater conversions were replaced with efficient units; therefore, no additional gas savings were applied.

- Standardize expected savings calculations between states;
- Account for additional factors in savings calculations, such as historical consumption, interaction effects, square footage, and primary heating sources;
- Track alternative heating sources in homes;
- Include high-use customers in program participant targeting;
- Conduct further impact analysis, focused on use of a comparison group and estimating savings at the measure-level;
- Perform quality checks on expected savings estimates; and
- Consider analyzing easy-to-quantify, non-energy benefits, which can be added to program cost-effectiveness reporting.

## 3.1 Introduction

In 2010, Cadmus conducted a statistical billing analysis, determining adjusted gross savings and realization rates for energy-efficient measures installed through the Low-Income Weatherization Program. Analysis and results were performed at the household or participant level, rather than the measure level. In this report, we apply these savings estimates to the 2011 participant population and report total gas impacts associated with the 2011 program year.[14]

To estimate 2010 energy savings resulting from the program, Cadmus used a pre- and post-installation, combined CSA and PRISM approach, using 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. A detailed discussion of the regression model and methodology used for this analysis can be found in Avista's 2010 Gas Impact Report.

### 3.1.1 Program Description

Five programs comprise the Low-Income Weatherization Program, listed in Table 3-4. Local Community Action Partners (CAPs), within Avista's Idaho and Washington service territories, implement all 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.

While both states operate very similar weatherization programs, each state has individual programs, with different, sovereign statewide administrators, implementation agencies, and weatherization protocols. Table 3-4 describes the measures installed under each program component, along counts of gas measures installed in PY 2011, and included in our gas impact analysis (findings on evaluated electric measures are contained in a separate report).

[14] Due to time constraints imposed by the filing schedule (not allowing a full year of usage data to be accrued for a billing analysis of 2011 participants), we felt it appropriate to extrapolate results from the recent 2010 gas impact analysis to the 2011 participants for this report.

**Table 3-4. 2011 Gas Efficiency Installations by Program Component**

| Low-Income Program Component | Measure Description | Measure Installations |
|---|---|---|
| Shell/Weatherization | Insulation, window/door installation, air infiltration, programmable thermostat | 924 |
| Hot Water Efficiency | High-efficiency water heater replacement | 1 |
| HVAC Efficiency | High-efficiency gas furnace replacement | 90 |

### 3.1.2 Data Collection

Cadmus primarily drew impact evaluation data from the program participant database. Avista provided information regarding program participants and installed measures for each state. Specifically, these data included lists of measures installed per home, and expected savings from each completed 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.

## 3.2 Methodology

### 3.2.1 Sampling

In applying the 2010 gas billing analysis results, we used a census of program participants, comprised of 242 gas accounts, and not including any of the 110 gas customers receiving conversion measures.

### 3.2.2 Data Collection Activities

#### Documentation Review/Database Review

Cadmus used the 2011 Idaho and Washington program participant database, provided by Avista, to develop a complete population for applying the 2010 billing analysis results. The participant data included: customer information; account numbers; types of measure installed; rebate amounts; measure installation costs; measure installation dates; and expected 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 utilizes pooled monthly time-series (panel) billing data.

The fixed-effects modeling approach corrects for differences between the pre- and post-installation weather conditions as well as for differences in usage consumption between participants, including a separate intercept for each participant. Our modeling approach ensures model savings estimates will not be skewed by unusually high-usage or low-usage participants. Monthly consumption also is 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.

# 3.3 Results and Findings

## 3.3.1 Overall Program Results

Applying state-level savings estimates from the billing analysis to the gas-saving participant program population achieved total therms savings of 27,194. Savings estimates were only applied to gas-savings participants not receiving conversion measures. Table 3-5 provides greater detail on overall savings calculations by state.

**Table 3-5. Non-Conversion Gas Savings by State**

| State | Total Participants | Average Expected Savings Per Participant (Therms) | Model Savings Per Participant (Therms) | Realization Rate |
|---|---|---|---|---|
| Idaho | 104 | 305 | 123 | 41% |
| Washington | 138 | 361 | 104 | 29% |
| Overall | 242 | 337 | 112 | 33% |

We compared average expected measure savings, and noticed some discrepancies between the two states. Table 3-6 provides average expected savings for each installed gas measure, by state.

**Table 3-6. 2011 Average Expected Savings by Measure and by State**

| Measures | Expected Therms Savings | | Number of Installations | |
|---|---|---|---|---|
| | ID | WA | ID | WA |
| Wall Insulation | 239 | 250 | 12 | 43 |
| Duct Insulation | 222 | 89 | 18 | 13 |
| Floor Insulation | 207 | 117 | 44 | 78 |
| Doors | 89 | 52 | 38 | 58 |
| Air infiltration controls | 89 | 142 | 95 | 103 |
| Attic Insulation | 82 | 82 | 37 | 106 |
| Windows | 22 | 22 | 37 | 60 |
| High-efficiency furnace replacement | N/A | 123 | N/A | 8 |
| High-efficiency water heater replacement | N/A | 11 | N/A | 1 |
| T-stat (No AC) | N/A | 31 | N/A | 2 |
| T-stat (AC) | N/A | 31 | N/A | 1 |

Note: Frequencies reflect all gas savings measures from gas-saving participants not receiving conversion measures.

As shown, expected savings associated with duct and floor insulation were substantially higher in Idaho than Washington. Many expected savings estimates in 2011 appeared higher than those averaged from 2010 (which is discussed in more detail below). Generally, the measure mix was relatively similar for the two years. In both cases, agencies appeared to implement whole-house weatherization measures throughout participant homes.

The remaining 110 participants in Washington received electric to gas conversion measures, including high-efficiency gas furnaces and water heaters. Table 3-7 provides a distribution of all Avista-funded measure installations for the conversion participants.

**Table 3-7. Measure Installations for Conversion Participants**

| Measure Description | 2011 Frequency |
|---|---|
| Electric air infiltration controls | 4 |
| Electric doors | 1 |
| Electric refrigerator replacement | 5 |
| Electric windows | 1 |
| Electric water heater replacement | 1 |
| Electric attic insulation | 2 |
| Electric duct insulation | 1 |
| Electric floor insulation | 2 |
| Electric wall insulation | 2 |
| Electric furnace conversion | 81 |
| Electric water heater conversion | 91 |
| Gas air infiltration controls | 36 |
| Gas doors | 19 |
| Gas windows | 23 |
| Gas furnace replacement | 82 |
| Gas attic insulation | 42 |
| Gas duct insulation | 3 |
| Gas floor insulation | 40 |
| Gas wall insulation | 15 |
| Gas t-stat (no ac) | 1 |

Over half of these 110 participants received water heater and high-efficiency furnace conversions (n = 65), while 16 only received high-efficiency furnace conversions, and 26 only received water heater conversions. These customers experienced a net increase in therm usage; however, based on Avista's approach to correcting for these impacts through its cost-effectiveness analysis, this report calculated therm savings associated with:

1. Installation of gas-savings weatherization measure bundles; and
2. Furnace conversion replacement, using high-efficiency gas equipment, compared to standard gas equipment.[15]

In the 2010 report, very few additional gas-saving weatherization measures were installed in conversion participant households; so therm savings were only applied to conversion participants installing high-efficiency gas furnaces. To account for gas savings experienced through high-efficiency furnace replacement, we used savings calculated through the 2010 evaluation of Avista's residential furnace replacement program (84 therms for Washington participants), and

[15] Electric savings associated with conversion measure installations will be addressed in the 2010–2011 Avista Electric Impact Report.

scaled this value to reflect low-income participant home square footage, thus resulting in 61 therms.[16]

Due to the mix of additional gas-savings weatherization measures that conversion participants received, we adjusted the 2010 impact analysis approach. Of 110 conversion participants, three categories were identified for attributing savings:

- Full model savings (104 therms per Washington participant) were assigned to:
  - Participants with four or more distinct gas-saving measures (including high-efficiency gas furnaces) (n = 46); and
  - Participants with two distinct gas-savings measures (not including high-efficiency gas furnaces) (n = 3).
- Furnace-specific savings (61 therms per participant) were assigned to participants with two or less measures (including high-efficiency gas furnaces) (n = 59).
- No savings were applied to participants only receiving one (non-furnace) gas-saving measure (n = 2).

Table 3-8 provides overall gas savings by state, including savings attributed to fuel conversion participants receiving gas-saving measures.

**Table 3-8. Overall Gas Savings by State**

| State | Total Model Savings (Therms) | Conversion Participant Savings (Therms) | Total Savings (Therms) | Total Expected Savings (Therms) | Realization Rate |
|---|---|---|---|---|---|
| Idaho | 12,835 | N/A | 12,835 | 31,675 | 41% |
| Washington | 14,359 | 8,683 | 23,042 | 77,381 | 30% |
| Overall | 27,194 | 8,683 | 35,877 | 109,056 | 33% |

## 3.3.2 Goals Comparison

We compared evaluated savings for the 352 gas participants against Avista's IRP goals. Table 3-9 summarizes overall evaluated savings, IRP savings goals, and achievement rates, overall and by state. In all, the low-income weatherization program achieved approximately 55% of its gas savings goals.

[16] For Washington, low-income participants averaged 1,250 square feet per home, while single-family participants averaged 1,728 square feet per home.

**Table 3-9. IRP Program Goals Comparison**

| State | Total Customers | Reported Savings (Therms) | Evaluated Gas Savings (Therms) | Goal Achievement |
|---|---|---|---|---|
| Idaho | 104 | 19,500 | 12,835 | 66% |
| Washington* | 248 | 45,500 | 23,042 | 51% |
| Overall | 352 | 65,000 | 35,877 | 55% |

* Includes 138 participants receiving model savings, and 110 conversion customers.

## 3.4 Conclusions

Changes in Avista's expected savings calculations have affected differences in realization rates, when comparing 2010 and 2011 results. Table 3-10 compares average per-participant expected savings.

**Table 3-10. Expected Savings Comparison of 2010 and 2011 Participants***

| State | Expected Savings (Therms) | | Percent Change |
|---|---|---|---|
| | 2010 | 2011 | |
| Idaho | 207 | 305 | 47 |
| Washington | 347 | 361 | 4 |
| Overall | 293 | 337 | 15 |

* Average expected savings are only provided for gas-savings, non-conversion participants from the 2010 final model and 2011 gas-saving, non-conversion participants.

As shown, a significant increase in expected savings occurred in Idaho between 2010 and 2011, while Washington's average per participant expected savings remained fairly constant.

Table 3-11 compares average, measure-specific, expected savings estimates by state for 2010 and 2011.

**Table 3-11. Average Measure-Level Expected Savings by State and Year (in therms)**

| Measures | Idaho | | Washington | |
|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 |
| Wall Insulation | 75 | 239 | 155 | 245 |
| Duct Insulation | 42 | 222 | 68 | 105 |
| Floor Insulation | 88 | 207 | 131 | 119 |
| Doors | 23 | 22 | 24 | 22 |
| Air infiltration controls | 46 | 89 | 83 | 133 |
| Attic Insulation | 59 | 82 | 184 | 79 |
| Windows | 132 | 89 | 54 | 53 |
| High-efficiency furnace replacement | N/A | N/A | 150 | 123 |
| High-efficiency water heater replacement | N/A | N/A | 11 | 11 |
| T-stat (No AC) | N/A | N/A | N/A | 31 |
| T-stat (AC) | N/A | N/A | N/A | 31 |

As shown, few measure-level savings estimates appeared constant across program years or states.

The 2010 Gas Impact Report presented recommendations for standardizing expected savings calculations, and for accounting for factors to achieve more robust savings estimates. These factors included:

- Historical consumption;
- Square footage;
- Primary and alternative heating sources; and
- Interaction effects.

We were not provided with detail regarding how expected savings estimates were modified, or whether they accounted for the factors listed above. It appears, however, that changes to these calculations had different effects on the previous savings estimates by state (i.e., resulting in increased per participant savings in Idaho, and decreased per participant savings in Washington).

Aside from the expected savings calculations, differences in distributions of measures installed in each program year likely contributed to changes in expected savings estimates between years.

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

## 3.5 Recommendations

The following subsections outline our suggestions for enhancements to help improve program impact results.

- **Standardize Expected Savings Calculations**. Standardizing expected savings calculations across both states will help avoid wide discrepancies in realization rates.
- **Account for Additional Factors in Savings Calculations.** Accounting for pre-period annual consumption, square footage, and interaction effects will help create a more robust savings estimate, and avoid overestimates that could occur through a prescriptive application of deemed estimates.
- **Track Alternative Heating Sources.** As inexpensive alternatives 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 allow more reasonable estimates where gas is used as a secondary heating source.

  We recommend working with 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.

- **Perform Quality Checks on Expected Savings Estimates.** Avista claims changes were made to expected savings calculations starting in 2011, which is evident when comparing these estimates between program years; however, it appears additional quality checks on values will strengthen the robustness and reliability of these estimates. Specifically, Avista should screen savings relative to historical consumption, making certain the percent of savings is no more than 100% of typical annual usage, and most non-conversion projects experience no more than 50%. Typically, savings over 30% as a percent of pre-period usage is considered high, and may indicate other changes occurring within a household, aside from weatherization provided through the program (e.g., changes in occupancy, take-back, change in heating/cooling usage).
- **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 with particularly high energy consumption. In fact, DOE and Washington state 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 are equipped to incorporate energy-consumption characteristics into their program participant prioritization. Not only would weatherizing high-use customers likely result in higher energy savings, it is possible some customers are overly burdened with energy bills, due to their housing characteristics, and the program could provide some 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.

- **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 some non-energy benefits associated with low-income weatherization that are applicable to the TRC test. In particular, analyses of economic impacts and payment pattern improvements (including reduced arrearages and collections costs) can produce monetized values of benefits to program stakeholders; these have been used other utilities reporting low-income weatherization cost-effectiveness in both Idaho and Washington. While standard cost-effectiveness testing using the TRC test accounts for all program costs, only including energy savings as program benefits clearly omits some genuine non-energy benefits experienced by participants (as discussed in greater detail in the 2010 Process Evaluation).

### 3.5.1 Recommended Possible Future Analysis

- **Conduct Further Gas Impact Analysis: Measure-Level Impacts.** As Avista attempts to refine its expected savings estimates, performing a billing analysis aimed at specific measure-level impacts will help develop reasonable ranges for benchmarking these estimates. Through increasing the participant sample available for billing analysis, modeling measure-specific savings estimates becomes more reliable. Measures such as heating system replacements and major weatherization (insulation and air sealing) will likely generate large energy savings, relative to total household energy consumption, and can be more easily estimated through billing analysis.

- **Analyze Easily Quantified Non-Energy Benefits for Cost-Effectiveness Reporting.** Recommended non-energy benefit analyses were included in the 2010 Gas Impact report, and have been briefly discussed with Avista over the past year. In light of the increased emphasis on program cost-effectiveness as well as the inclusion of non-energy benefits (e.g., economic impacts, payment impacts) by other Idaho and Washington utilities, we recommend revisiting the discussion to address some of these analyses in more detail, and to determine any of these analyses to be pursued with further research.

# Appendix 1A: Residential Weatherization Measures Billing Model Outputs

The following tables summarize model result outputs[17] from our billing analysis of PY 2010 and January 2011 participants.

**Table A1. Weatherization Measure Savings Regression Model (Overall Savings)**

| Source | Analysis of Variance | | | | |
|---|---|---|---|---|---|
| | DF | Sum of Squares | Mean Square | F Value | Pr > F |
| Model | 13 | 45208 | 3477.5101 | 4265.41 | <.0001 |
| Error | 19234 | 15681 | 0.81528 | | |
| Corrected Total | 19247 | 60889 | | | |
| | | | | | |
| Root MSE | 0.90293 | | R-Square | 0.7425 | |
| Dependent Mean | 2.42E-17 | | Adj R-Square | 0.7423 | |
| Coeff Variable | 3.73E+18 | | | | |
| Source | Parameter Estimates | | | | |
| | DF | Parameter Estimates | Standard Error | t value | Prob. t |
| AVGHDD | 1 | 0.10507 | 0.00428 | 24.54 | <.0001 |
| POST * AVGHDD | 1 | -0.01142 | 0.00059987 | -19.01 | <.0001 |
| Feb | 1 | -0.08351 | 0.03434 | -2.43 | 0.015 |
| Mar | 1 | -0.325 | 0.04688 | -7.02 | <.0001 |
| Apr | 1 | -0.65081 | 0.0735 | -8.94 | <.0001 |
| May | 1 | -0.79757 | 0.1091 | -7.4 | <.0001 |
| Jun | 1 | -0.72477 | 0.13843 | -5.34 | <.0001 |
| Jul | 1 | -0.58576 | 0.15259 | -3.94 | 0.0001 |
| Aug | 1 | -0.57488 | 0.15425 | -3.83 | 0.0002 |
| Sep | 1 | -0.73161 | 0.1368 | -5.44 | <.0001 |
| Oct | 1 | -0.7923 | 0.08346 | -9.58 | <.0001 |
| Nov | 1 | -0.40127 | 0.04453 | -9.06 | <.0001 |
| Dec | 1 | -0.1275 | 0.03283 | -3.85 | 0.0001 |

[17] We ran all models with a fixed-effects specification, which has a separate intercept for each participant. Due to the large amount of output resulting from showing model coefficients for each intercept, we only present the average of all separate intercepts in the output.

# Appendix 1B: Residential ENERGY STAR Home Model Inputs

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

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

| Measure | Type | ENERGY STAR® Home | WA Code - Climate Zone II, R-3 | ID Code - IECC 2006 Zone 5 |
|---|---|---|---|---|
| Insulation | Ceiling | R-38 | R-38 | R-38 |
| | Wall | R-19 | R-19 + R-5 | R-19 |
| | Floors Over Unconditioned Space | R-30 | R-30 | R-30 |
| | Slab Floors | R-10 | R-10 | R-10 |
| Windows & Doors | Windows | 0.35 | 0.35 | 0.35 |
| | Max Glazing Area | 0.21 | Unlimited | Set to ENERGY STAR standards |
| | Doors | R-5 | 0.2 U-factor | Set to ENERGY STAR standards |
| Ducts | Insulation | R-8 | R-10 | R-8 |
| | Sealing | Mastic only | Tapes allowed | Tapes allowed |
| | Max Leakage | <0.06 CFM/sqft or 75 CFM total @50Pa | Set to ENERGY STAR standards | Set to ENERGY STAR standards |
| Ventilation & Air Sealing | Ventilation System | Exhaust ventilation | Exhaust ventilation | Exhaust ventilation |
| | Envelope Tightness | 0.35 normal ACH | 0.35 normal ACH | 0.35 normal ACH |
| Heating & Cooling Equipment | Gas Furnace | 90 AFUE | 78 AFUE | 80 AFUE |
| | Air Conditioner | SEER 13 | SEER 13 | SEER 13 |

# Appendix 1C: Electricity Savings Achieved by the Gas Program

The following table shows the electricity saved in kWh by the 2011 gas energy efficiency programs. The believed high penetration of electric dryers in homes with gas domestic hot water heating is the reason for the significant savings achieved. The electricity saved through the installation of an efficient dishwasher is associated with the machine operation, not water savings. The 2010 gas furnace billing analysis showed that a portion of participants are choosing 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 the installation of efficient windows was determined through a billing analysis and is associated with a reduction in the summer cooling load.

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

| Measure Name | Measure Count | UES (kWh) | Total Savings (kWh) |
|---|---|---|---|
| G CLOTHES WASHER-NAT GAS H20 | 2,499 | 318 | 794,682 |
| G DISHWASHER-NAT GAS H20 | 1,700 | 22 | 37,825 |
| G NAT GAS FURNACE | 2,930 | -165 | -483,743 |
| G WINDOWS (kWh) | 1,620 | 86 | 139,320 |
| TOTAL | 8,749 | | 488,084 |