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IDAHO PUBLIC
UTILITIES COMMISSION

December 7, 2020

Ms. Jan Noriyuki
Commission Secretary
Idaho Public Utilities Commission
P.O. Box 83720
Boise, ID 83720-0074

RE: Case No. INT-G-20-06

Dear Ms. Noriyuki:

Attached for consideration by this Commission is an electronic submission of Intermountain Gas Company's Supplement to Application for a Determination of 2019 Energy Efficiency Expenses as Prudently Incurred.

If you should have any questions regarding the attached, please don't hesitate to contact me at (208) 377-6015.

Sincerely,

Lori A. Blattner
Director, Regulatory Affairs
Intermountain Gas Company

Enclosure

cc: Mark Chiles
Preston Carter

INTERMOUNTAIN GAS COMPANY

CASE NO. INT-G-20-06

SUPPLEMENT TO APPLICATION
AND
EXHIBITS

In the Matter of the Application of INTERMOUNTAIN GAS COMPANY
For a Determination of 2019 Energy Efficiency Expenses as Prudently Incurred

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BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

In the Matter of the Application of INTERMOUNTAIN GAS COMPANY for a Determination of 2019 Energy Efficiency Expenses as Prudently Incurred	**Case No. INT-G-20-06** **SUPPLEMENT TO APPLICATION**

Intermountain Gas Company ("Intermountain" or "Company"), a subsidiary of MDU Resources Group, Inc. with general offices located at 555 South Cole Road, Boise, Idaho, pursuant to the Rules of Procedure of the Idaho Public Utilities Commission ("Commission"), submits additional information pertinent to this case in this Supplement ("Supplement to Application" or "Supplement") to the Application for Determination of 2019 Energy Efficiency Expenses as Prudently Incurred, Case No. INT-G-20-06, filed September 1, 2020 ("Original Application"). This Supplement includes the final report from Intermountain's Evaluation, Measurement and Verification ("EM&V") study, resulting cost-effectiveness tests, and proposed changes to the Company's Residential Energy Efficiency Program ("EE Program") resulting from the EM&V study.[1] The information included in this Supplement application is additive to the Original Application, and does not replace, amend, or remove any portion of the Original Application.

Please address communications regarding this Application to:

[1] In the Original Application, Intermountain noted that the EM&V study was underway but not yet complete. Original Application at 9 ("The CPA, along with the soon to be completed Evaluation, Measurement and Verification ("EM&V") study will be valuable tools in bringing the program back to cost effectiveness in the future."). This Supplement provides the study and summarizes its key results.

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and

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In support of this Supplement to Application, Intermountain alleges and states as follows.

I. INTRODUCTION

Intermountain is a gas utility, subject to the jurisdiction of the Commission, engaged in the sale of and distribution of natural gas within the State of Idaho under authority of Commission Certificate No. 219, issued December 2, 1955, as amended and supplemented by Order No. 6564, dated October 3, 1962.

Intermountain provides natural gas service to the following Idaho communities and counties and adjoining areas:

Ada County - Boise, Eagle, Garden City, Kuna, Meridian, and Star;
Bannock County - Arimo, Chubbuck, Inkom, Lava Hot Springs, McCammon, and Pocatello;
Bear Lake County - Georgetown, and Montpelier;
Bingham County - Aberdeen, Basalt, Blackfoot, Firth, Fort Hall, Moreland/Riverside, and Shelley;
Blaine County - Bellevue, Hailey, Ketchum, and Sun Valley;
Bonneville County - Ammon, Idaho Falls, Iona, and Ucon;
Canyon County - Caldwell, Greenleaf, Middleton, Nampa, Parma, and Wilder;
Caribou County - Bancroft, Grace, and Soda Springs;
Cassia County - Burley, Declo, Malta, and Raft River;
Elmore County - Glenns Ferry, Hammett, and Mountain Home;
Fremont County - Parker, and St. Anthony;
Gem County - Emmett;
Gooding County - Bliss, Gooding, and Wendell;
Jefferson County - Lewisville, Menan, Rigby, and Ririe;
Jerome County - Jerome;

Lincoln County - Shoshone;
Madison County - Rexburg, and Sugar City;
Minidoka County - Heyburn, Paul, and Rupert;
Owyhee County - Bruneau, Marsing, and Homedale;
Payette County - Fruitland, New Plymouth, and Payette;
Power County - American Falls;
Twin Falls County - Buhl, Filer, Hansen, Kimberly, Murtaugh, and Twin Falls;
Washington County - Weiser.

Intermountain's properties in these locations consist of transmission pipelines, liquefied natural gas storage facilities, a compressor station, distribution mains, services, meters and regulators, and general plant and equipment.

II. BACKGROUND

On September 1, 2020, Intermountain filed the Original Application. The Original Application discussed the ongoing EM&V study, though the study had not been completed at the time. *See* Original Application at 9 (discussing EM&V study). Following that filing, on September 16, 2020, Intermountain held a meeting of its Energy Efficiency Stakeholder Committee ("EESC"). At that meeting, ADM Associates, Inc. ("ADM") presented the results of the EM&V study, and Intermountain presented proposed EE Program changes to address the EM&V study recommendations. During that meeting Staff noted it would be helpful to have the study included as part of Case No. INT-G-20-06. The minutes from the EESC meeting are included in Exhibit No. 4 and incorporated by reference.

Intermountain agreed with Staff that it made sense to bring both the EM&V study and resulting cost effectiveness tests as well as the proposed EE Program changes into Case No. INT-G-20-06. This Supplement includes these items.

III. EVALUATION, MEASUREMENT & VERIFICATION

Energy efficiency programs follow a three-step feedback loop of program design, program implementation and program evaluation, measurement and verification. The last step of the feedback loop, EM&V, provides important data and feedback that serve to continually improve the performance of an energy efficiency program.

There are three categories of EM&V studies: impact, process and market evaluations. Respectively, these categories assess the direct and indirect program benefits such as energy and demand savings, systematic assessments of program operations and customer satisfaction, and behavior of market participants or market changes that result from a program. The EESC provided feedback in shaping the depth and scope of the first EM&V study of Intermountain's EE Program. *Case No. INT-G-20-06, Exhibit No. 2 at 16-17*. To get the most value from the study, it was decided the EM&V study would include both an impact evaluation and process evaluation. As a new program it was important to conduct a process evaluation to identify potential areas of improvement in program operations and delivery. The process evaluation reviewed the entire EE Program.

On the other hand, the decision was made to only conduct an impact evaluation on the Whole Home and Furnace rebates. The impact evaluation analyzes therm savings realized by a rebate program. These two rebates accounted for more than 95% of all estimated program savings over the life of the program. Additionally, based on the low uptake of the remaining rebates, changing codes and standards, and suggestions for new offerings outlined in the Company's Conservation Potential Assessment ("CPA"), Intermountain planned to cancel or make revisions to the remaining rebates. Thus, it did not make sense to perform an impact evaluation on rebates that would be cancelled or drastically changed. The EESC agreed that it made sense to revise the smaller rebates and not include them in the EM&V study. *Case No. INT-G-20-06, Exhibit No. 2 at 17*.

In January 2020, Intermountain commissioned an independent third party to conduct the EM&V studies on the first two program years. The Company sent a request for proposal ("RFP") to

29 organizations and posted the RFP on the Association of Energy Services Professionals website. After reviewing 10 proposals and conducting 4 interviews, ADM was selected to conduct the EM&V study.

The impact evaluations of both the Furnace and Whole Home rebates used both a billing analysis and an engineering-based evaluation. In both cases, ADM recommended the Company use the therm savings found in the engineering-based analysis. Although the billing analysis found measurable therm savings, "billing analyses include any changes in household behavior, equipment, or occupancy, and therefore may include factors other than the impact of improved equipment efficiency." *Exhibit No. 5 at 11-12*.

The recommendations resulting from the Furnace impact evaluation included collecting additional information on the rebate form to facilitate more accurate evaluations in the future. Additionally, ADM discovered that furnaces tended to be over-sized in Weather Zone 5 which negatively affects program savings due to repeated shorter run cycles and associated higher use during heating ramp-up. Providing or encouraging contractor training in Manual J sizing calculations should help combat this issue. *Exhibit No. 5 at 11*. The engineering-based evaluation, Equivalent Full Load Hours for Heating ("EFLH") study, found Ex-Post therm savings of 134 per rebate, or a realization rate of 118%. *Exhibit No. 5 at 84*.

In their review of the Whole Home rebate, ADM found that the average non-program home in Intermountain's service territory exceeds amended IECC 2012 Idaho building code. The EM&V study also found that lower HERS scores do not necessarily equate to higher therm savings. In light of these findings as well as the recent legislation to adopt the amended 2018 IECC residential code, ADM recommended imposing specific requirements to directly target natural gas savings. ADM also recommended removing the ENERGY STAR certification requirement as it seems to be a barrier to builder participation. The EM&V study found no basis to state that this requirement saves more energy than current code requirements. *Exhibit No. 5 at 12-13*. The engineering-based evaluation, Simulation Analysis, found Ex-Post therm savings of 274 per rebate, or a realization rate of 134%. *Exhibit No. 5 at 85*.

The EM&V process evaluation focused on identifying potential program improvements to increase program efficiency or effectiveness in terms of customer participation and satisfaction. Surveys, evaluations, conclusions and recommendations from the process evaluation were separated into two categories: appliance rebates and new construction (Whole Home) rebate.

Overall, ADM concluded the EE Program performed well during the first two years, effectively engaging various stakeholders and using a broad range of marketing efforts and community outreach. Recommendations for improvement of the entire EE Program included creating a standard operating procedures manual, increasing communication with contractors, builders and HERS raters, exploring opportunities to incorporate new measures into the program, establishing a builder and contractor approved network, and standardizing tracking database categories. For the Whole Home rebate specifically, ADM recommended working with builders to achieve HERS requirements at a lower cost, providing additional marketing materials to promote the Whole Home rebate, creating company-specific reports and cost-savings estimates that builders can use with homebuyers, continuing to participate in community events, developing materials that increase knowledge on the benefits of owning an energy efficient home, and providing additional education or training opportunities for HERS raters, builders, and real estate agents. In its review of the appliance rebate category, ADM recommended ensuring contractors are aware of all participation options, enabling contractors or customers to track the status of their rebate, creating and distributing promotional materials that can be used by contractors, creating educational materials for customers, considering an Electronically Commutated Motor for the furnace blower as a program requirement, collecting data on the condition of the replaced furnace, incorporating avoided replacement cost into tankless water heater cost-effectiveness calculations, and tracking additional fields in rebate applications to assist in future energy savings estimates. *Exhibit No. 5 at 143 – 146*.

The recommendations from the process evaluation provide an excellent list of opportunities for continued EE Program improvement. Intermountain has already begun to implement many of the recommendations, such as updates to the rebate application, the creation of standard operating procedures documents, standardizing database tracking categories, and improvements to promotion, education and outreach.

Both the impact and process evaluations completed as part of the EM&V study are attached as Exhibit No. 5 and incorporated by reference.

IV. COST EFFECTIVENESS

With the completion of the impact evaluation, Intermountain used the verified therm savings to recalculate the cost-effectiveness of the Furnace and Whole Home rebates. In the original cost-effectiveness tests that were included in this case, the Company used therm savings found in the CPA study. Exhibit No. 6 updates the cost-effectiveness tests for the Furnace and Whole Home rebates to instead use the Ex-Post therm savings of 134 for the Furnace rebate and 274 for the Whole Home rebate. *Exhibit No. 5 at 84-85*.

Because overhead expenses are allocated to the rebates based on therm savings, increasing the therm savings for the Furnace and Whole Home rebates shifted costs away from the remaining rebates. This resulted in the Combi Radiant Heat System, 70% Fireplace, Water Heater, and Tankless Water Heater rebates all becoming slightly more cost-effective. The overall program

Utility Cost Test ("UCT") based cost-effectiveness also increased from the 0.87 included in the 2019 Annual Report (Exhibit No. 1 at 9) to 1.3 as shown on Exhibit No. 6, Page 6. UCT based cost-effectiveness tests resulting from the EM&V study Ex-Post therm savings show the Furnace with a cost-effectiveness of 1.2 and the Whole Home at 1.5. *Exhibit No. 6 at 7-8*. Exhibit No. 6 is attached and incorporated by reference.

V. STAKEHOLDER MEETINGS

Intermountain hosted three EESC meetings to share the EM&V study and discuss resulting program changes. The minutes from all three of these meetings are included as Exhibit No. 4. The first meeting on August 5, 2020 was held to review the material that would be included in the 2019 Annual Report that was filed as part of the Original Application in Case No. INT-G-20-06. *Exhibit No. 4 at 1*.

At the second meeting on September 16, 2020, ADM presented the findings of the EM&V study and Intermountain presented proposed Residential EE Program revisions. The EESC had concerns with several of the changes Intermountain proposed to the Whole Home rebate. *Exhibit No. 4 at 10-11*. As a result of the discussions, Intermountain commissioned a follow-up study from ADM to explore the best options to improve therm savings while encouraging additional builder participation. The Company also reviewed information from the 2019 Idaho Residential Energy Code Field Study and the Idaho Code Collaborative.

On October 27, 2020 the EESC met again to review proposed EE Program revisions. The EESC was supportive of the proposal. A question was raised regarding the appropriate duct leakage requirement to include in the revised Whole Home rebate. The Company agreed to further review that requirement before proposing a final rebate. *Exhibit No. 4 at 12-15*.

VI. PROPOSED RESIDENTIAL PROGRAM

The Company proposes to update its Residential EE Program based on recommendations from the EM&V study (*Exhibit No. 5*), input from the Energy Efficiency Stakeholder Committee (*Exhibit No. 4*), and other resources including the ADM "Residential Whole Home Modeling Result" memorandum (*Exhibit No. 8*), the Idaho Residential Energy Code Field Study (*Exhibit No. 8*), the Idaho Code Collaborative, and upcoming energy code changes.

Exhibit No. 7 outlines in detail the proposed changes to the Residential EE Program. The Company proposes to leave the Furnace rebate at $350, while making the changes recommended by the EM&V study to collect additional data points which will provide a more complete dataset from which to evaluate savings attributed to the Furnace in the future.

Intermountain proposes to retire the 70% Fireplace rebate. This rebate has had very low participation over the life of the program. Additionally, the CPA drastically reduced the therm savings attributed to the fireplace which would result in a minimal rebate to maintain cost-effectiveness.

The Company proposes to add rebates for a Smart Thermostat, Boiler and a second tier Tankless Water Heater. The Smart Thermostat has consistently been the most requested rebate and was a recommended addition in the EM&V study. A residential Boiler rebate will provide a high-efficient heating option for those customers that do not have a forced air furnace. An additional recommendation from the EM&V study was to add a tankless water heater at a lower price point than the current offering. Intermountain is proposing a Tier II Tankless Water Heater with a minimum efficiency level of 0.87 UEF.

Intermountain proposes revisions to the Storage Water Heater, the Tier I Tankless Water Heater, the Combination System, and the Whole Home rebates. The Company's CPA study estimated therm savings for the Storage Water Heater that were higher than those included in the preliminary study Intermountain had used to begin the EE Program. As a result, the Company proposes to increase the rebate for the Storage Water Heater from $50 to $115 to encourage increased participation for this energy efficient appliance. The CPA also identified an increase in therm savings and estimated useful life for the 0.91 UEF Tankless Water Heater included in the Company's original rebate offering. Intermountain plans to retain this Tier I Tankless Water Heater rebate and increase the rebate from $150 to $325.

The existing combination system for space and water heating has had low participation and the equipment requirements of the rebate have often been misunderstood. The Company proposes to clarify this rebate by requiring a combination boiler, designed for both space and water heat. The proposed rebate of $800 would require a minimum efficiency rating of 95% AFUE.

Finally, the Company proposes to revise the Whole Home rebate by retiring the ENERGY STAR certification requirement, creating a two-tier rebate, and allowing the rebate to be combined with Thermostat and Water Heating rebates. Due to higher efficient energy code being implemented in January 2021, therm savings for the proposed rebate will be reduced from the current therm savings identified in the EM&V study. Therefore, the rebate amounts have also been reduced from the current $1,200 to $900 for the proposed Tier I rebate and $700 for the proposed Tier II rebate. Removing the added expense to builders of the ENERGY STAR certification requirement and encouraging the installation of high-efficient water heaters with their associated rebates should continue to make the Whole Home rebate an attractive incentive to encourage energy efficient building. The two-tiers of rebate should allow builders to work through incremental improvements in their build process as they move from qualifying for the Tier II rebate to the Tier I.

As illustrated on Exhibit No. 7, Page 9, the resulting EE Program is cost-effective and each individual rebate is cost-effective with a UCT of 1.0 or greater. Exhibit No. 7 is attached and incorporated by reference. Exhibit No. 8 includes the "Residential Whole Home Modeling Results" memorandum prepared for Intermountain by ADM as well as the Idaho Residential Energy Code Field Study. Both of these documents were used in developing the proposed Whole Home rebate. Exhibit No. 8 is attached and incorporated by reference.

VII. PROPOSED TARIFF

The Company proposes to make the tariff changes effective March 1, 2021. Intermountain's current Rate Schedule EE showing proposed changes in legislative format is attached as Exhibit No. 9, Pages 1-3. As outlined in Case No. INT-G-20-04, Intermountain is proposing to rename Rate Schedule EE to Rate Schedule EE-RS to help avoid confusion with the proposed Commercial Energy Efficiency Rebate Program. Exhibit No. 9, Pages 4-6, provide the clean copy of the resulting tariff including the name change. Exhibit No. 9 is attached and incorporated by reference.

VIII. MODIFIED PROCEDURE

Intermountain requests that this matter be handled under modified procedure pursuant to Rules 201-204 of the Commission's Rules of Procedure. Intermountain stands ready for immediate consideration of this matter.

Because neither the Original Application nor this Supplement propose to change customer rates, Intermountain has not provided direct notice to customers. *See* Commission Rule of Procedure 125.01, IDAPA 3.01.01.125.01.

IX. REQUEST FOR RELIEF

Intermountain respectfully petitions the Idaho Public Utilities Commission as follows:

a. That the Commission provide the relief requested in the Original Application,

b. That the Commission include this Supplement, the attached Exhibits, and the issues identified in this Supplement and the Exhibits within Case No. INT-G-20-06,

c. That Rate Schedule EE be approved as outlined,

d. That this Application be heard and acted upon without hearing under modified procedure, and

e. For such other relief as this Commission may determine proper.

DATED: December 7, 2020.

INTERMOUNTAIN GAS COMPANY	Givens Pursley LLP
By ______________________	By ______________________
Lori A. Blattner	Preston N. Carter
Director – Regulatory Affairs	Attorney for Intermountain Gas Company

CERTIFICATE OF SERVICE

I certify that on December 7, 2020, a true and correct copy of INTERMOUNTAIN GAS COMPANY'S SUPPLEMENT TO APPLICATION was served upon all parties of record in this proceeding via electronic mail as indicated below:

Commission Staff	**Via Electronic Mail**
Jan Noriyuki, Commission Secretary Idaho Public Utilities Commission 11331 W. Chinden Blvd., Bldg. 8, Suite 201-A Boise, ID 83714	jan.noriyuki@puc.idaho.gov
Matt Hunter Deputy Attorney General Idaho Public Utilities Commission 11331 W. Chinden Blvd., Bldg. 8, Suite 201-A Boise, ID 83714	matt.hunter@puc.idaho.gov
Idaho Conservation League	
Benjamin J. Otto Idaho Conservation League 710 N. 6th Street Boise, ID 83702	botto@idahoconservation.org

Lori A. Blattner

EXHIBIT NO. 4

CASE NO. INT-G-20-06

INTERMOUNTAIN GAS COMPANY

Energy Efficiency Stakeholder Committee Meeting Minutes

(15 pages)

Intermountain Gas Energy Efficiency Stakeholder Committee Residential Energy Efficiency Program Updates

August 5, 2020 at 1:00 PM

Minutes Recorded by Kody Thompson

Attendees:

Brad Iverson-Long – IPUC

Heath Chisholm – Building Energy

Ben Otto – Idaho Conservation League

Kevin Keyt - IPUC

Marissa Warren – OEMR

Mike Morrison – IPUC

Brian Bennett – The Energy Auditor

Michael Shepard - Neighborworks

Guests and Presenters:

Lori Blattner – Intermountain Gas

John Fisk – Intermountain Gas

Kody Thompson – Intermountain Gas

Kathy Wold – Intermountain Gas

Meeting Facilitator: Kathy Wold

1:00 PM – Meeting Convened

Kathy began the meeting and went over housekeeping items related to holding the meeting online. An overview of the topics to be discussed was given.

1:05 PM – John Fisk & Kathy Wold

John provided a safety moment for the meeting where he discussed the safe use of electrical outlets in an office environment. Kathy then provided an icebreaker and introduction to kick off the meeting.

1:10 PM – Kathy Wold

Kathy gave an update on the progress made by the Avoided Cost Sub-Committee. An updated methodology has been agreed upon. The Sub-committee agreed to continue to look for a way to include avoided distribution costs in the calculation.

1:10 PM – Kody Thompson & Kathy Wold

Kody reviewed program planned revenues and expenses compared to actual revenues and expenses, as well as the cost-effectiveness of the program as a whole and for each individual measure. In reviewing each measure both pre-CPA and post-CPA cost-effectiveness tests were presented. Committee members asked why Conservation Potential Assessment (CPA) measure inputs were used for therm savings, incremental costs and estimated useful life. It was explained that the updated CPA values were the best available data in 2019. The Evaluation Measurement and Verification (EM&V) study is nearing completion in 2020, this data will be used to guide program changes. A Committee member asked whether changes will be made to the whole home incentive. Intermountain staff affirmed that changes are anticipated. A Committee member inquired when the CPA and EM&V will be made available. Intermountain replied the CPA was filed with the IRP as Exhibit No. 4 and the EM&V is nearly complete and will be filed later in the fall of 2020.

Kathy went over the changes to energy efficiency staff in 2019, including the shift to a full-time energy efficiency manager and the addition of Energy Services Representatives (ESR). With continued program growth, the Energy Efficiency Department needed to add staff to effectively promote the program. Rather than adding two dedicated EE staff members, the decision was made to hire two additional ESRs. Following the addition of the new ESRs, each of the resulting eight ESRs had energy efficiency duties added to their job responsibilities. Energy Efficiency underwrites 25% of each ESR position. A committee member asked for clarification regarding the funding of the ESRs and whether or not new ones were added to staffing. Intermountain explained that prior to adding energy efficiency duties to the ESR job responsibilities and adding the two new ESRs, the Company had 6 ESRs. The Company hired two new positions for a total of 8 ESRs. Energy Efficiency underwrites 25% of the funding of each ESR, which would be the same as separately funding two dedicated Energy Efficiency department staff members. ESRs meet with customers to talk about gas service and seamlessly work the Energy Efficiency Program options into those discussions. Additionally, the ESRs assist with increased energy efficiency outreach and community education in their assigned territories.

1:35 PM – John Fisk

John presented an overview of the outreach and education efforts completed in 2019, which included recognition by the EPA as a Market Leader Award recipient for the whole homes program. Social media was incorporated as an outreach strategy and focused on energy efficiency tips, program promotion, and education. John presented samples from the Fall marketing campaign which included a customer survey and radio/digital media campaign in conjunction with a customer bill insert. John discussed the launch of the Contractor Portal and online rebate application, as well as HVAC training the Company hosted for HVAC partners and the HVAC Course subsidy for ENERGY STAR Certified contractor training offered by the Company. Stakeholders commented that methods used to reach builders were interesting and seemed to be headed in the right direction.

2:00 PM – Kathy Wold

Kathy discussed the 2018-19 partnership with Boise Valley Habitat for Humanity (BVHFH) to build an ENERGY STAR Certified home and raise awareness about the role of energy efficiency in keeping home operating costs affordable. Intermountain was able to create an on-line resource library, now housed on the IGC YouTube channel, about the energy efficiency features of an ENERGY STAR home by video documenting the build process. At the official ribbon cutting ceremony, BVHFH hosted an open house for the community to tour the home for the first time in BVHFH history. Additional partnerships were discussed including the BVHFH Playhouse, St. Jude Dream Home (which was an ENERGY STAR certified home) and participating as a presenter at the South Central Community Action Partnership Weatherization Day, in Twin Falls.

2:10 PM – Lori Blattner

Lori gave an overview of the Gas Technology Institute (GTI) and Intermountain's long history as a member of GTI. GTI is a non-profit gas technology research, development, and training organization that addresses energy and environmental challenges. Intermountain has been a member of GTI for decades. Lori presented a high-level overview of the work of GTI working groups like Operation Technology Development (OTD) and Utilization Technology Development (UTD). These groups deliver new technologies that expand the supply of natural gas and renewable energy, ensure a safe and reliable infrastructure, deliver solutions for efficient and environmentally responsible use of energy, reduce and manage carbon emissions, and advance energy systems innovations that protect air, land, water, and communities while enhancing economic growth.

The EE program participates in a subcommittee working group of UTD, the Emerging Technology Program (ETP), which focuses on the last stage of product development such as hosting demonstrations, product deployment, commercial introduction and implementation of product development. The most current technology ETP has been working on is gas heat pump technology for water heating and combination space and water heating applications. Intermountain is enthusiastic about the market transforming potential of this technology. This led to a discussion of the North American Gas Heat Pump Collaborative.

2:20 PM – Kathy Wold

Kathy provided a high-level explanation of the illustrative market channel from supplier to consumer, and the idea of how new products are moved through this channel from idea to a product on the shelf. Kathy presented an overview of the Company's participation as a charter member in the North American Gas Heat Pump Collaborative (Collaborative), along with 14 other utilities from across the nation. The reasons for forming the Collaborative include bringing new energy and money saving technologies to customers, continuing to provide fuel choice to consumers in their homes and businesses, and seeking least cost methods of reducing greenhouse gasses. The Collaborative activities designed to accelerate adoption of gas heat pump technologies include emerging technology, pilot programs, market research and assessment, supply chain and customer incentives, strategic partnerships and changing codes and standards. The Company confirmed investments in the Collaborative, but not GTI, were paid through the Energy Efficiency Rider.

2:30 PM – Question and Answer

There were no follow up questions. Next meeting date was set for September 16, 2020 to review the proposed changes for the residential program.

2:35 PM – Meeting Adjourned

Intermountain Gas Energy Efficiency Stakeholder Committee Residential Energy Efficiency Program Updates

September 16, 2020 at 1:00 PM

Minutes Recorded by Kody Thompson

Attendees:

Lori Blattner – Intermountain Gas Company

Mark Chiles – Intermountain Gas Company

Kody Thompson – Intermountain Gas Company

John Fisk – Intermountain Gas Company

Donn English – IPUC

Brad Iverson-Long – IPUC

Katie Pegan – OEMR

Heath Chisholm – Building Energy

Ben Otto – Idaho Conservation League

Jerry Peterson – Home Energy Services

Kevin Keyt - IPUC

Marissa Warren – OEMR

Mike Morrison – IPUC

Brian Bennett – The Energy Auditor

Matthew Vandermeer – Momentum

Michael Shepard - Neighborworks

Guests and Presenters:

Kathy Wold – Intermountain Gas Company

Adam Thomas – ADM

Melissa Kosla – ADM

Meeting Facilitator: Kathy Wold

1:00 PM – Meeting Convened

Kathy Wold opened the meeting, welcoming the group to Intermountain Gas Company's meeting to discuss the results of the Evaluation, Measurement, and Verification (EM&V) study, as well as proposed updates to the residential rebate program.

1:15 PM – EM&V Overview – Adam Thomas

Kathy provided background on the selection of the evaluators, before turning the presentation over to Adam Thomas, Principal from ADM Associates, Inc. (ADM). Adam presented the methods used and the results of the impact evaluation of the whole home measure and furnace measure. The following key points were discussed:

- Whole Home Program evaluation
    - Overview of current incentive requirements
    - Billing analysis of 2018 and 2019 homes compared to non-program homes
    - Reviewed a sample of the home simulation models, and the statistical significance of the home matching
    - Whole Home results based on bill analysis estimated 28.21% realization rate, or ex-post savings of 57.54 therms per home. ADM explained the billing analysis is essentially a net savings evaluation, which may implicitly or explicitly include the effects of free-ridership, spillover and induced market effects. To provide a more complete picture of energy savings and program effects, ADM conducted an additional analysis representative of a gross savings approach.
    - The gross savings approach of the Whole Home rebate compared a user defined reference home (UDRH) based on 2012 IECC with amendments to the Idaho Residential Building code against HERS modeling information, submitted by the energy raters, of 80 program homes. This analysis resulted in an estimated realization rate of 134%, or 274 therms per home, and can be found in Appendix B of the report.
- Space Heating Evaluation
    - Overview of current incentive requirements
    - Billing analysis of 2018 and 2019 homes compared against non-participants

- Review of sample of home selection process, and statistical significance of customer matching
- Space Heating Results based on bill analysis estimated 49.37% realization rate, or ex-post savings of 56.03 therms per furnace. Like the whole home analysis, ADM explained the billing analysis is fundamentally an estimate of net savings, which may implicitly or explicitly include the effects of free-ridership, spillover and induced market effects. To provide a more complete picture of energy savings and program effects, ADM recommended employing a TRM-based engineering equation to calculate furnace savings, or Equivalent Full Load Hours (EFLH), referenced as Method 3, in Appendix A of the report. This approach complies with the International Performance Measurement and Verification Protocol (IPMVP) maintained by the Efficiency Valuation Organization (EVO) with sponsorship by the U.S. Department of Energy (DOE) and is often used to calculate deemed savings for gas furnace retrofits.
- Furnace savings results based on the EFLH analysis resulted in an estimated 118% realization rate, or 134 therms saved per furnace.

Committee members wondered when the EM&V study would be filed. The Company plans to file the EM&V study along with proposed revisions to the Residential program to address the issues raised by the EM&V study. Committee members expressed concern with not having the EM&V study included with the already filed Request for Determination of Prudency. The Company agreed to discuss the best way to include the EM&V information in the Prudency case.

A Committee member questioned why County assessor's data for property information was used in place of the information IGC collects when installing a line extension. The Company said this is due to more detailed information being available from the Ada County assessor database. A Committee member wondered why Eastern Idaho wasn't included in the whole home impact analysis. In general, there were far fewer participating whole home program homes in Eastern Idaho over the time period studied. This made it more difficult to create a statistically significant matched sample in Eastern Idaho.

There was a discussion around the use of net versus gross therm savings in cost testing and program planning. The general opinion was that both are important to calculate when possible and both provide important insights into the program. Attempting to address free-ridership is important in program planning but decrementing current cost-effectiveness based on something as difficult to calculate as free-ridership may not be fair to the program. Market transformation can often be confused for free-ridership.

2:30 PM – Proposed Residential Program Updates – Kathy Wold

Kathy highlighted some of the conclusions from the process evaluation: ADM found the Program performed well during the first two program years, customers who participated in the Program were satisfied with the Program and contractors were largely satisfied with the design and participation process of the Program. Based on process evaluation recommendations, Intermountain has completed or is in the process of implementing the following changes:

- Explore incorporating new measures
- Standardize the tracking database
- Develop education materials and training opportunities for raters, builders and add outreach to the real estate sector
- Increase communications, continue to raise program awareness
- Provide builders/contractors with marketing materials

Based on impact evaluation recommendations the Company plans to implement:

- Collecting installation type for each rebate

    - Replace-on-burnout, early retirement, new construction
- Collecting prior efficiency for each early retirement furnace
- Encouraging contractor training for Manual J sizing calculations
- Evaluate the Whole Home offering:
    - ENERGY STAR certified home requirement is a barrier to participation
    - Evaluate a more stringent HERS requirement
    - Targeting natural gas savings by adding specific requirements to the whole home rebate specifically designed to increase natural gas savings

Stakeholders recommended collecting the size of the previous furnace in conjunction with the efficiency of the unit.

The Company proposed a revised whole home rebate structure based on a user defined reference home requiring a HERS score of 60, and specific energy performance targets of 3 ACH, 2% duct leakage to outside and 95% AFUE furnace requirement to target natural gas savings. All these proposed additional requirements could be verified on a HERS certificate which would assist in verification. Under the proposed changes ENERGY STAR would no longer be a program requirement. Committee members expressed concern that builders would not participate under this revised rebate structure due to the rebate amount being reduced from $1,200 to $650, and felt the HERS threshold, ACH and duct leakage targets were too aggressive. While Committee members agreed the current rebate HERS threshold of 75 was not aggressive enough, some expressed concern that builders would drop out of the program at the proposed levels. One energy rater estimated that of the 5 builders currently participating, only 1 would probably continue at the proposed $650 rebate level and with these requirements, others would see it as “not worth the time.” Several participants suggested exploring a tiered rebate structure. It was also suggested that the Company allow builders to stack the water heater and programmable thermostat rebates on top of the whole home rebate.

Intermountain agreed to do some further research into the whole home rebate to include some potential tiers and options on water heaters.

The Company gave an overview of the proposed changes to the remaining measures in the portfolio. The Committee discussed whether measures with a UCT of less than 1.0 should be included. It was agreed that all measures in the program should independently pass the UCT with a ratio of 1.0 or higher. Although there has been much interest in adding a smart thermostat to the Company's program offering, this was one of the measures that had a UCT of 0.9. In reviewing the measure assumptions, Adam Thomas from ADM commented that the 8-year measure life of the smart thermostat referenced in the proposal appeared too low and recommended a minimum 11-year measure life be used. The Committee agreed this would be an appropriate change.

Because of the great discussions, the end of the scheduled meeting time was reached prior to completing the slide deck. The Company proposed sending the presentation to Committee members for further review. The Committee members would then provide feedback to the Company. The Committee approved this suggestion and agreed to reconvene for further discussion after the Company had time to further analyze the whole home rebate proposal.

3:15 PM Meeting Adjourned

Intermountain Gas Energy Efficiency Stakeholder Committee Meeting

Residential Program Proposed Updates

October 27, 2020 at 1:00 pm

Minutes Recorded by Kody Thompson

Attendees:

Landon Barber – IGC

Kody Thompson – IGC

Kathy Wold – IGC

John Fisk – IGC

Kevin Keyt – IPUC

Melissa Kosla – ADM Associates

Mike Morrison – IPUC

Donn English – IPUC

Mark Chiles – IGC

Lori Blattner – IGC

Heath Chisholm – Building Energy

Jerry Peterson – Home Energy Services

Ben Otto – Idaho Conservation League

Brian Bennett – The Energy Auditor

Katie Pegan – OEMR

Brad Iverson-Long – IPUC

Melissa Culverson – ADM Associates

Guests and Presenters:

Kathy Wold

Melissa Kosla

Melissa Culverson

Meeting Facilitator: Kathy Wold

1:00 PM Meeting Convened

Kathy welcomed the group to the Stakeholder meeting and discussed the agenda. John Fisk provided a safety moment regarding cold weather driving tips. Introductions were offered and an ice breaker question was given. Kathy provided a refresher on what was discussed in the previous stakeholder meeting, highlighting the feedback that was received.

1:15 PM Updated Proposed Program Discussed

Kathy provided background on research that was done in preparing the updated program. This included reviewing the 2019 Idaho Residential Code Field Study, consulting with the Idaho Code Collaborative, and commissioning ADM Associates, Inc. to model a Whole Home rebate analysis based on the results of the impact evaluation. A proposed list of measures and cost test estimates for each measure was presented. The Company proposed changes for all rebate offerings except for the furnace rebate. Three new rebates are proposed. The Radiant Combi system naming has been clarified to help customers more easily identify qualifying equipment. A Boiler rebate and a Smart Thermostat offering will be added. The water heater incentive levels will be increased, along with an additional tankless water heater option at a lower efficiency of 0.87 UEF. Feedback was received that the addition of a boiler incentive was a good plan.

Kathy discussed IGC's intent to retire the 70% FE fireplace. This is due to the reduction of therm savings based on the CPA analysis which would necessitate lowering the rebate amount to $40 to maintain cost-effectiveness. Ultimately the appliance is a largely decorative unit that is not typically rated for energy efficiency and a large amount of administrative time was used in trying to get information on equipment and helping customers understand the difference between FE and steady state efficiency.

The updates to Idaho Energy Code effective January 1, 2021 were discussed to provide a reference for the proposed changes to the residential program. A question was asked regarding the difference between ERI (Energy Rating Index) and HERS (Home Energy Rating System). There are slight differences between the two, but HERS is essentially a copyrighted brand name of an energy rating system. Jerry Peterson, from Home Energy Services, clarified that Idaho amended the national IECC performance path ERI requirement from 61 to a 68 (less efficient). This was done to make the ERI score equivalent to an Idaho Code based home under the 2018 Idaho amended IECC.

A two-tier rebate was proposed for the Whole Home rebate with new requirements focused on therm savings. The proposed Whole Home rebate revision would require the home be HERS scored and require specific energy performance targets for air changes per hour, ceiling insulation, duct leakage, and the efficiency of the furnace. The ENERGY STAR Certification requirement will be retired. Builders would now be able to layer water heater and thermostat rebates on top of the whole home rebate.

All appliance rebates are applicable to multi-family structures, since they are also on the residential rate. A separate multi-family listing was not created.

A Committee member asked if IGC was going to lower the HERS score. The Company is proposing that a specific HERS score threshold not be required since it is possible to achieve a lower HERS score by implementing non-therm saving inputs. The proposed rebate instead requires the home receive a HERS score and meet additional requirements. Requiring the home to be HERS scored highlights the importance of energy efficiency in home operation and also provides a simple method for the Company to verify other requirements are met since they are all noted by the rater during the HERS rating process.

A Committee member suggested that a 2% duct leakage rate would be very difficult to achieve and an alternative requirement of ducts and air handlers in conditioned spaces versus a duct leakage performance target should be considered. ADM explained HVAC placement is a design element in the modeling software, not an energy efficiency measure, so it is difficult to attribute therm savings to this kind of requirement. IGC needs to be able to attribute therm savings to that specific performance target. While one Committee member agreed duct leakage is the next largest area for potential savings next to air infiltration (ACH), it would require a significant amount of builder education, along with the challenge of setting standards such as supply and return duct allowances in unconditioned space. While the Committee agreed on duct sealing as an appropriate energy saving measure, more study is required regarding the therm savings of this measure, and the appropriate application to capture these savings. Intermountain agreed to further review the duct leakage requirement before proposing a final rebate.

Once the whole home rebate specifics are determined, the Company plans to file EM&V results and proposed residential changes as an amendment to the prudency filing.

2:05 PM Meeting Adjourned

EXHIBIT NO. 5

CASE NO. INT-G-20-06

INTERMOUNTAIN GAS COMPANY

Evaluation, Measurement & Verification Study

(329 pages)

2018-2019 ENERGY EFFICIENCY PROGRAM

IMPACT EVALUATION

(127 pages)

Intermountain Gas Company 2018-2019 Energy Efficiency Program Impact Evaluation

Submitted to:

INTERMOUNTAIN GAS COMPANY
A Subsidiary of MDU Resources Group, Inc.

Submitted on:
June 11, 2020

ADM
ENERGY RESEARCH AND EVALUATION

Prepared by:

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Mark Ewalt
Adam Thomas

ADM ENERGY RESEARCH AND EVALUATION

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1 Executive Summary

This report is a summary of the evaluation, measurement, and verification (EM&V) effort of the 2018 and 2019 program years (PY2017-2018, PY2019) portfolio of programs for Intermountain Gas Company (IGC). The evaluation was administered by ADM Associates, Inc (herein referred to as the "Evaluators").

The Evaluators collected data for the evaluation through review of program materials, acquisition of program tracking data, interviews with IGC staff members, participating builders, raters, and contractors, and surveys of participating and nonparticipating customers. Table 1-1 summarizes the measures offered to residential customers in the IGC service area. Table 1-2 summarizes the program implementation budgets for each the 2017-2018 and 2019 program years.

Table 1-1 Summary of Intermountain Gas Company Energy Efficiency Program Measures

Measure	PY2017-2018 Rebates	PY2019 Rebates	PY2017-2018 Incentives	PY2019 Incentives
Whole Home Rebate	619	1,079	$742,800	$1,294,800
95% AFUE Natural Gas Furnace	1,334	2,066	$466,900	$723,100
90% Radiant Combo	3	11	$3,000	$11,000
80% AFUE Fireplace	0	0	$0	$0
70% FE Fireplace	13	14	$1,300	$1,400
0.67 Water Heater	9	8	$450	$400
0.91 Tankless Water Heater	88	159	$13,200	$23,850

Table 1-2 Summary of Intermountain Gas Company Energy Efficiency Program Years

Program Year	Rebate Payments	Labor	Program Delivery	Annual Implementation Budget
2017-2018	$600,000	$147,000	$30,000	$777,000
2019	$1,250,000	$376,840	$94,120	$1,720,960

Table 1-3 and Table 1-4 provide a summary of evaluated savings of the IGC programs. The table presents the ex-ante and ex-post Therms savings per rebate; also included are a comparison between ex-ante and ex-post Therms savings per program.

During PY2017-2018, the 95% AFUE Natural Gas Furnace Rebate and Whole Home Rebate ex-post energy savings totaled 123,668 Therms, with a 44.1% realization rate. During PY2019, the 95% AFUE Natural Gas Furnace Rebate and Whole Home Rebate ex-post energy savings totaled 164,434 Therms, with a 36.4% realization rate.

Table 1-3 PY2017-2018 Summary of Therms Savings

Program	Number of Rebates	Ex-Ante Therms Savings per Rebate	Ex-Post Therms Savings per Rebate	Ex-Ante Therms Savings	Ex-Post Therms Savings	Realization Rate
95% AFUE Furnace	1,332	112.00	66.27	154,224	88,275	57.24%
Whole Home Rebate	619	204.00	57.18	126,276	35,393	28.03%
Total				**280,500**	**123,668**	**44.09%**

Table 1-4 PY2019 Summary of Therms Savings

Program	Number of Rebates	Ex-Ante Therms Savings per Rebate	Ex-Post Therms Savings per Rebate	E- Ante Therms Savings	Ex-Post Therms Savings	Realization Rate
95% AFUE Furnace	2,066	112.00	49.43	231,392	102,123	44.13%
Whole Home Rebate	1,079	204.00	57.75	220,116	62,311	28.31%
Total				**451,508**	**164,434**	**36.42%**

*The Evaluators used number of verified rebates to produce ex-post measure savings

1.1 Conclusions and Recommendations

The Evaluators offers the following conclusions and recommendations for consideration in planning future program cycles.

1.1.1 95% AFUE Natural Gas Furnace Rebate

1.1.1.1 Conclusions

- The 95% AFUE Natural Gas Furnace provides measurable savings through billing analysis. However, the observable energy savings through billing analysis are much lower than expected equipment savings. Billing analyses include any changes in household behavior, equipment, or occupancy, and therefore may include factors other than the impact of improved equipment efficiency.
- The Evaluators found several deviations in furnace capacity size and AFUE in the tracking data compared to AHRI certification values. Other than two instances where a tankless water heater was classified as a furnace erroneously, all rebated units were program-qualifying furnaces.
- Program tracking data maintained by IGC was very comprehensive and readily facilitated the evaluation effort.
- The Evaluators identified a discernable trend in furnace sizing relative to home vintage. Of key note, sizing in Weather Zone 5 was often larger than for Weather Zone 6, despite Zone 5 being a warmer climate.

1.1.1.2 Recommendations

- Collect installation disposition on the project application: replace-on-burnout, early retirement, or new construction. Program tracking currently distinguishes new construction but does not capture replace-on-burnout versus early retirement.
- Verify AHRI certification for all rebated furnaces before approving. All units were program-qualifying, but many had sizing or efficiency data entry errors.
- Provide or encourage contractor training for Manual J sizing calculations for rebated furnaces. Over-sizing in Weather Zone 5 negatively affects program savings due to repeated shorter run cycles and associated higher use during the heating ramp-up (which is the point of greatest energy use for a furnace).
- The Evaluators suggests using engineering-based evaluation approaches that comply with the International Performance Measurement and Verification Protocol (IPMVP) maintained by the

Efficiency Valuation Organization (EVO) with sponsorship by the U.S. Department of Energy (DOE)[1] such as Method 3 described in Appendix A.

1.1.2 Whole Home Rebate

1.1.2.1 Conclusions

- The Evaluators found that the average non-program home in IGC's service territory exceeds IECC 2012 with Idaho amendments requirements. This is observed in the billing analysis, comparing non-program, newly built homes to the newly built program-rebated homes. In addition, the proportion and distribution of HERS-rated homes in the IGC territory suggest that the market already demands efficiency homes. The average non-program newly built home that has been rated receives a HERS Index score of 63. The average program home received a HERS Index score of 60. This suggests that to some extent the market for new homes in Idaho includes high efficiency options without program intervention.
- The Evaluators' benchmarking research indicates that the energy efficiency standard for a code-built home is increasing, and that current program requirements may need to increase efficiency in order to keep up with higher efficiency building codes.
- The Whole Home Rebate provides measurable savings through billing analysis. However, the observable energy savings through billing analysis are much lower than expected equipment savings. Billing analyses include any changes in household behavior, equipment, or occupancy, and therefore are unable to entirely isolate equipment savings.
- It is expected that the lower the HERS Index score, the higher the energy savings. However, the Evaluators found the savings normalized by square footage remains relatively constant across a 20-point HERS Index range. The same lack of relationship is seen when analyzing the electric energy savings across the HERS Index. Homes with lower HERS Index scores do not equate to higher Therms savings. The HERS Index score instead depends on the proportional difference between the RESNET reference home and the rebated home.
- The Evaluators found higher savings in all component loads for the program-rebated homes than the simulated home with only the ENERGY STAR certification, except for window and door component loads. Overall, the program-rebated home displayed 27% higher savings than a home only completing ENERGY STAR requirements.
- Homes rebated through the program are shown to sell on average 39 days faster than non-rebated homes. This information can be forwarded to builders and raters to help increase program participation.

1.1.2.2 Recommendations

- The Evaluators recommends imposing a more stringent HERS Index requirement for the program in light of recent legislation adoption to adopt the 2018 IECC residential code in Idaho. This adoption enforces a required maximum HERS Index score of 68.
- The Evaluators recommends removing ENERGY STAR certification requirement, as it seems to be a barrier to builder participation, and the analysis completed for this study indicates that there is

[1] Core Concepts: International Measurement and Verification Protocol. EVO 100000 – 1:2016, October 2016.

no basis to state that this requirement saves more energy than the current market requirements of energy efficiency in newly built homes.

- To directly target natural gas savings, IGC could impose specific requirements in addition to a HERS requirement. This may include an efficient furnace, tankless water heater, higher insulation levels (such as R-49 ceiling insulation), or more stringent air sealing and duct sealing requirements.

2 General Methodology

This chapter details general impact evaluation methodologies by program-type. This chapter will present full descriptions of:

- Glossary of terminology;
- Sampling methodologies; and
- Process evaluation methodologies.

The following sections contain a glossary of terminology used throughout the report.

2.1 Glossary of Terminology

As a first step to detailing the evaluation methodologies, the Evaluators has provided a glossary of terms to follow:

- **Ex-ante Savings** – Calculated savings used for program and portfolio planning purposes.
- **Ex-post Savings** – Savings estimates reported by an evaluator after the energy impact evaluation has been completed.
- **Deemed Savings** – An estimate of an energy savings outcome (gross savings) for a single unit of an installed energy efficiency measure. This estimate (a) has been developed from data sources and analytical methods that are widely accepted for the measure and purpose and (b) are applicable to the situation being evaluated.
- **Gross Savings** – The change in energy consumption directly resulting from program-related actions taken by participants in an efficiency program, regardless of why they participated.
- **Gross Realization Rate** – Ratio of Ex-Post Savings / Ex-ante Savings (e.g. If the Evaluators verify 100 Therms per furnace, Gross Realization Rate = 100/112 = 89%).

2.2 Sampling Methodology

This section explains the sampling methodology used for evaluating IGC's energy efficiency measures.

2.2.1 95% AFUE Furnace

The Evaluators used simple random sampling strategies to evaluate the measure. The sampling strategies must achieve 10% relative precision at a 90% confidence level (90/10). The required sample size to meet 90/10 requirements is calculated by using the coefficient of variation of savings. The coefficient of variation (CV) is defined as:

$$CV(x) = \frac{Standard\ Deviation\ (x)}{Mean(x)}$$

Where *(x)* represents participant energy savings in each stratum. The required sample size is estimated at:

$$n_0 = \left(\frac{1.645 * CV}{RP}\right)^2$$

Where,

1.645 = Z-score for 90% confidence interval in a normal distribution

CV = Coefficient of variation

RP = Relative precision, 10%

The 95% AFUE Furnace random sample size is shown in Table 2-1. A sample of 80 measure rebate documents were verified for accuracy in the tracking database, provided by IGC. The sample displayed a precision of 4.34% at the 90% confidence interval.

Table 2-1 Sampled Projects

Stratum	Sample Size	Coefficient of Variation	Precision
95% AFUE Natural Gas Furnace	80	0.24	4.34%

2.2.2 Whole Home Rebate

The Whole Home Rebate sampling methodology is similar to the methodology described in Section 2.2.1 The Evaluators developed a stratified sampling plan to achieve the required relative precision at the required confidence level. The Evaluators created a sample of 80 homes to verify, stratified by builder. A total of 68 of the original 80 sampled homes were able to be verified and remain in the sample, as 12 of the simulation files contained unresolvable software errors. The Evaluators received the sample of energy models from program HERS raters as well as application materials via IGC. The Whole Home Rebate stratified random sample is shown in Table 2-2. Builders were stratified by overall contribution to the number of homes rebated. Two builders retained statistically significant precision under 10%, however, the overall sample of 68 displayed a precision of 6% at the 90% confidence interval.

Table 2-2 Whole Home Rebate Sampled Projects

Builder	Percent Contribution of Homes	Sampled Homes	Average Therms Savings per Home	Standard Deviation of Therms Savings per Home	Coefficient of Variation	Relative Precision (90% Confidence Interval)
Builder 1	26.0%	14	272.71	89.26	0.33	14.4%
Builder 2	12.2%	10	258.40	64.61	0.25	13.0%
Builder 3	10.2%	7	268.57	48.20	0.18	11.2%
Builder 4	7.8%	6	242.83	90.26	0.37	25.0%
Builder 5	7.4%	5	180.20	58.52	0.32	23.9%
Builder 6	7.3%	6	253.17	43.82	0.17	11.6%
Builder 7*	6.2%	5	324.80	36.68	0.11	8.3%*
Builder 8	4.3%	4	239.25	66.21	0.28	22.8%
Builder 9**	3.5%	1	260.00	-	-	-
Builder 10	3.1%	3	379.67	51.71	0.14	12.9%
Builder 11	2.7%	2	389.50	111.02	0.29	33.2%
Builder 12**	2.1%	1	350.00	-	-	-
Builder 13*	2.1%	2	357.50	0.71	0.00	0.2%*
Other Builders	5.1%	2	322.50	104.32	0.32	37.6%
Total	**100%**	**68**	**273.94**	**82.48**	**0.30**	**6.0%**

*Statistically significant precision for individual builder

**The Evaluators was unable to calculate precision for some builders, as the standard deviation was 0 due to one total project sampled by that builder

3 95% AFUE Natural Gas Furnace Rebate

The 95% AFUE Natural Gas Furnace rebate was designed to provide financial incentives to encourage residential customers to install energy efficient natural gas furnaces. The rebate provides $350 in incentives for each residential furnace installed that has a thermal efficiency rating of 95% or greater.

3.1 Measure Description

This measure offers incentives for residential customers that purchase and install qualifying high-efficiency natural gas furnaces. The measure requires the participant to be served on the residential rate schedule and to use natural gas exclusively for space heating. Eligible project dispositions include new construction, replacement of existing failed furnaces ("normal replacement" or "replace on burnout"), replacement of existing furnaces that are still functional ("early replacement) as well as furnaces converted from an alternate fuel. The furnace must meet a minimum rated efficiency of 95% AFUE.

The Evaluators estimated savings for 95% AFUE Natural Gas Furnace measures using a matched control group of non-participating residences in IGC's service territory. Table 3-1 presents overall ex-ante and ex-post savings by program year. Across both program years, the program achieved a 49.4% realization rate, with annual ex-post savings per furnace of 56.0 Therms.

Table 3-1 Matched Control Group Regression Analysis Summary

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Valid Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	112	1,332	66.27	154,224	88,275	57.24%
2019	112	2,066	49.43	231,392	102,123	44.13%
All		**3,398**	**56.03**	**385,616**	**190,398**	49.37%

Table 3-2 shows the number of rebated appliances and ex-ante Therms savings for the 95% AFUE Natural Gas Furnace in each program year.

Table 3-2 Ex-Ante Therms Savings of Furnaces by Program Year

Program Year	Number of Furnaces	Ex-Ante Therms Savings per unit	Ex-Ante Therms Savings
2017-2018	1,377	112	154,224
2019	2,066	112	231,392
Total	**3,443**	**112**	**385,616**

3.2 Impact Evaluation Approach

This section describes the impact evaluation of the 95% AFUE Natural Gas Furnace measure. The Evaluators performed a billing analysis with a matched control group as part of the Evaluators' impact evaluation for 95% AFUE Natural Gas Furnaces. The Evaluators utilized a quasi-experimental method of producing a post-hoc control group.

While it is not possible to guarantee the possibility of creating a sufficiently matched control group, this method is preferred because it is likely to have more meaningful results than a treatment-only analysis. Some examples of outside variables that a control group can sufficiently control for are changes in economies and markets, large-scale social changes, or impacts from weather-related anomalies such as flooding or hurricanes.

The Evaluators also conducted the following two additional methods for impact evaluation of this measure:

- Billing Analysis with Pre-Post Model
- Equivalent Full Load Hours for Heating (EFLH) Estimation

The results of the alternative impact evaluation methods can be found in Appendix A.

3.2.1.1 Data Collection

IGC provided the following data to support the analysis:

- Pre- and post-installation monthly gas billing data for 3,331 participants and 5,000 non-participants. The data started on June 21, 2016 and ended on February 27, 2020; and
- Program tracking data for participants, including participant zip code, date of installation (furnace firing date), efficient furnace input capacity (BTU/hr.), and furnace annual fuel utilization efficiency (AFUE).

In addition, the Evaluators acquired:

- Heating degree days (HDD) by month and year from the National Oceanic and Atmospheric Administration (NOAA)[2]. The monthly HDD weather data were collected from four weather stations in Idaho by associating 3-digit zip codes with the nearest weather station having available historical weather data, as shown in Table 3-3. Monthly HDDs are calculated as the sum of daily average temperature values under 63°F in a given month. The degree day base temperature of 63°F was selected by observing the best fitting model for a range of base temperatures between 55 and 75°F.
- HDD by month and year for a Typical Meteorological Year (TMY) for the specified weather stations, as shown in the table below[3].

[2] ftp://ftp.ncdc.noaa.gov/pub/data/noaa/
[3] https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html

Table 3-3: Weather Station Mapping

Major City	Weather Station ID	3-Digit Zip Code	TMY HDD
Boise	726810	836/837	5,188
Twin Falls	725866	833	5,913
Pocatello	725780	832	6,839
Idaho Falls	725785	834	7,588

3.2.1.2 Data Cleaning

The Evaluators performed the following data cleaning steps for participants in preparation for the billing analyses:

- Identified homes in the billing data that participated in the 95% AFUE Natural Gas Furnace Rebate measure
- Excluded homes that also participated in the Whole Home Rebate (did not occur)
- Removed homes with multiple furnace install dates.
- Removed homes missing any billing data.

3.2.1.3 Data Verification

The Evaluators verified tracking data by reviewing invoices and model numbers on a sample of participant households. The Evaluators first screened each furnace rebate household to ensure the customer who received a furnace rebate did not also receive a rebate for the Whole Home measure. There were no overlaps in participation. Tracking data was reviewed to verify each rebated unit satisfies all program efficiency requirements. All rebated furnaces were found to pass efficiency requirements.

The Evaluators verified the tracking data provided by IGC. A sample of 80 furnace model input capacity and AFUE were verified in the AHRI database. The Evaluators used the confirmed, AHRI-verified input capacities and furnace efficiencies in the calculation of the following savings estimate. Although some tracked efficiencies were inconsistent with the AHRI database, the Evaluators found no rebates to display an efficiency lower than the 95% AFUE requirement for the rebate. It should be noted that 448 rebates were found with prior furnace efficiencies within 15% of efficiency of the newly installed furnace. In addition, the tracking data revealed 11 furnaces had prior furnace efficiency above the installed furnace efficiency. Although the Evaluation team applied average savings for these rebates, prior efficiency of replaced furnaces should be noted in future program years to enable proper savings estimates.

The Evaluators also verified a sample of 80 rebate documents provided by IGC and cross referenced the tracking data to verify accurate inputs into the database. The Evaluators found one model number for equipment that was not a furnace in PY2017-2018, removed the rebate from the annual savings estimates, and did not extrapolate savings for that rebate.

The billing data provided by IGC revealed an additional 45 rebate participants in PY2017-2018 did not receive a rebate, and therefore the Evaluators removed these participants from the treatment group. The 45 rebates were removed from savings calculations throughout the evaluation. Table 3-1 displays the original and final number of rebates used in the calculation of the methodologies below.

Table 3-4 Total Verified Rebates

Program Year	Original Rebates	Validated Rebates
2017-2018	1,377	1,332
2019	2,066	2,066
Total	3,443	3,398

Table 3-5 provides summary statistics for rebate efficient furnaces by program year. Furnace efficiencies ranged from a low of 95.0 AFUE to a high of 98.7, while input capacity ranged from 26,000 to 150,000 BTU/hr. The table also displays prior efficiency, although prior efficiency was not used in the calculations in this methodology. The prior efficiency ranged from 50.0 to 98.7 AFUE.

As mentioned in the sections above, the Evaluators found 448 rebates with prior furnace efficiencies within 15% of efficiency of the newly installed furnace. In addition, the tracking data revealed 11 furnaces had prior furnace efficiency above the installed furnace efficiency.

Table 3-5 Summary Statistics for Rebated Efficient Furnaces

Program Year	Avg Capacity	Min Capacity	Max Capacity	Avg AFUE	Min AFUE	Max AFUE	Avg Prior AFUE	Min Prior AFUE	Max Prior AFUE
2017-2018	74,431	26,000	120,000	95.9	95	98.7	81.0	50	98.7
2019	73,529	40,000	140,000	96.0	95	98.7	81.6	60	98.5

A sample of participants were surveyed via online survey or telephone survey to confirm that the units were operational prior to replacement. If the units were found to be inoperative prior to replacement, the Evaluators would re-classify the unit as replace-on-burnout. This would aid in providing more accurate estimation of annual savings by replacement type. The Evaluators found that none of the 80 surveyed furnace appliance rebate participants had a non-operational furnace unit at the time of install.

3.2.1.4 Billing Analysis with Matched Control Group

The Evaluators used participant and non-participant billing data in the pre-period (before furnace retrofit) and participant and non-participant billing data in the post-period (after furnace retrofit) in a difference-in-difference fixed-effects panel regression model to predict weather-dependent Therms savings, as detailed in IPMVP Option C.

The control group was created using propensity score matching (PSM), a method that allows the Evaluators to find the most similar household based on customers' monthly energy consumption trends in the pre-period, specifically covariates for average summer, winter, fall, and spring pre-period usage were used. After matching, a t-test was conducted for each month in the pre-period to help determine the success of PSM. The Evaluators also performed a joint chi-square test, which tests for whether any of the covariates used in PSM are still unbalanced after matching. Lastly, the Evaluators computed the standardized mean difference for each PSM covariate to determine whether any PSM covariates had large differences between treatment and control after matching.

After creating a PSM control group, the Evaluators fit a difference-in-difference fixed-effects panel regression model to estimate weather-dependent daily consumption differences between homes with rebated furnaces and homes without rebated furnaces. The following equation displays the summarizes the model specifications used for this analysis.

Equation 3-1: Difference-in-Difference Fixed-Effects Panel Regression Model Specification

$$\begin{aligned} Daily\ Therms_{it} &= \alpha_0 + \beta_1(Post)_{it} + \beta_2(Treatment)_{it} + \beta_3(HDD)_{it} + \beta_4(Post \times HDD)_{it} \\ &+ \beta_5(Post \times Treatment)_{it} + \beta_6(Treatment \times HDD)_{it} \\ &+ \beta_7(Post \times HDD \times Treatment)_{it} + Customer\ Dummy_i + \varepsilon_{it} \end{aligned}$$

Where,

$Daily\ Therms_{it}$ = Estimated energy usage (dependent variable) in home *i* during period *t*
$Post_{it}$ = Dummy variable indicating whether period *t* was in pre- or post- retrofit for home *i*
$Treatment_i$ = Dummy variable indicating whether household *i* was in the treatment group or control group
HDD_{it} = Average heating degree days (base 63°F) during period *t* for home *i*
$Customer\ Dummy_i$ = Customer-specific dummy variable for fixed effects
ε_{it} = Customer-level random error
α_0= The model intercept for home *i*
β_{1-7} = Coefficients determined via regression

The coefficient β_5 represents the average non-weather-related change in daily consumption between the groups in the post-period. The coefficient β_7 represents the average change in daily weather-related consumption between the groups in the post-period. HDD are calculated from local weather data. HDD was estimated using a range of balance points (55°F to 75°F base temperature) and the HDD result that yielded the greatest model R-square was used in the final analysis. This accounts for the "dead-band" in residential heating loads, as there is a range of temperatures in which a residential customer will be neither heating nor cooling. Typical monthly and annual savings were estimated by extrapolating the β_5 and β_7 coefficients with Typical Meteorological Year (TMY) weather data.

Additional data cleaning steps for combined treatment and control customers included:

- Removed bills with missing billing dates
- Removed account numbers for homes that do not overlap with the furnace install date
- Kept homes with install dates in the first six month of the program year (to allow for sufficient post-period data)
- Restricted to pre-period and post-period data. The post period begins on July 1 of the program year, while the pre-period begins one year prior to the program year and ends at the start of the program year
- Removed bill duration outliers (<9 or > 60 days duration)
- Removed homes with insufficient number of bills (< 12 months)

3.2.2 Impact Evaluation Results

This section provides the propensity score matching and post propensity score matching regression results.

3.2.2.1 Propensity Score Matching

The results of PSM are summarized below. The Evaluators used nearest neighbor, 2 to 1 ratio matching and had a considerable pool of control customers to draw upon, as shown in Table 3-6. Customers were matched on their average pre-period seasonal usage, including winter, spring, summer and fall for each control and treatment household.

Table 3-6 PSM Customer Matches

Program Year	Status	Control	Treated
2017-2018	All	3,563	388
	Matched	776	388
	Unmatched	2,787	0
2019	All	3,805	552
	Matched	1,104	552
	Unmatched	2,701	1

Table 3-7 presents the propensity score covariate summary of pre-period usage for treatment and control customers before and after matching, for each program year. The standardized mean difference prior to matching is often over 0.2 for many covariates; however, after matching the absolute value of the standardized mean difference is less than 0.1, with one season exception in PY2017-2018, which is an ideal outcome.

Table 3-7 PSM Covariate Summary

Program Year	Variable	Before Matching			After Matching		
		Mean Treated	Mean Control	Standardized Mean Difference	Mean Treated	Mean Control	Standardized Mean Difference
2017-2018	Distance	0.106	0.097	0.009	0.106	0.106	0.000
	Pre-period Winter Usage	5.249	4.503	0.746	5.249	5.129	0.121
	Pre-period Spring Usage	1.998	1.756	0.242	1.998	1.933	0.065
	Pre-period Summer Usage	0.567	0.501	0.066	0.567	0.572	-0.006
	Pre-period Fall Usage	2.180	1.881	0.300	2.180	2.181	-0.001
2019	Distance	0.137	0.125	0.012	0.137	0.137	0.000
	Pre-period Winter Usage	4.469	3.885	0.583	4.469	4.417	0.052
	Pre-period Spring Usage	2.037	1.753	0.284	2.037	1.984	0.053
	Pre-period Summer Usage	0.613	0.499	0.113	0.613	0.580	0.033
	Pre-period Fall Usage	2.278	1.890	0.388	2.278	2.252	0.026

Table 3-8 and Table 3-9 provide results for a t-test which helps determine the success of matching. The test measures whether there are statistically significant differences in average daily Therms usage between the treatment and control groups in the pre-period by month. Statistically significant differences occur when the P-Value is less than 0.05 at the 95% significance level. As shown in both tables, the P-Value is much greater than 0.05 for each month in both program years. This result further indicates propensity score matching performed well.

Table 3-8 Post Matching T-Test of Difference in Usage by Month, PY2017-2018

Month	Average Daily Therms Control	Average Daily Therms Treatment	T Stat	Std Error	P-Value	Reject Null?
Jan	6.004	6.169	0.940	0.176	0.348	No
Feb	4.349	4.331	-0.121	0.145	0.904	No
Mar	2.660	2.725	0.722	0.090	0.470	No
Apr	1.940	2.015	1.095	0.068	0.274	No
May	1.126	1.175	0.887	0.055	0.375	No
June	0.670	0.672	0.044	0.044	0.965	No
July	0.505	0.502	-0.097	0.030	0.923	No
Aug	0.549	0.529	-0.501	0.041	0.616	No
Sept	1.054	1.033	-0.389	0.054	0.698	No
Oct	2.171	2.145	-0.366	0.071	0.715	No
Nov	3.279	3.331	0.547	0.095	0.585	No
Dec	4.902	5.009	0.786	0.136	0.432	No

Table 3-9 Post Matching T-Test of Difference in Usage by Month, PY2019

Month	Average Daily Therms Control	Average Daily Therms Treatment	T Stat	Std Error	P-Value	Reject Null?
Jan	4.119	4.191	0.613	0.118	0.540	No
Feb	4.273	4.299	0.236	0.110	0.814	No
Mar	3.260	3.267	0.064	0.110	0.949	No
Apr	1.888	1.978	0.977	0.092	0.329	No
May	0.899	0.964	1.147	0.056	0.252	No
June	0.638	0.676	0.764	0.050	0.445	No
July	0.551	0.549	-0.052	0.042	0.958	No
Aug	0.550	0.609	1.180	0.050	0.238	No
Sept	0.863	0.955	1.201	0.077	0.230	No
Oct	1.997	1.976	-0.346	0.060	0.729	No
Nov	3.857	3.909	0.539	0.097	0.590	No
Dec	4.820	4.873	0.411	0.128	0.681	No

Figure 3-1 displays the density of each variable employed in propensity score matching, before conducting matching for PY2017-2018. Figure 3-2 displays the density of each variable employed in propensity score matching, after conducting matching for PY2017-2018.

Figure 3-1 PY2017-2018 Average Daily Usage by Season in Treatment and Control Groups Before Matching

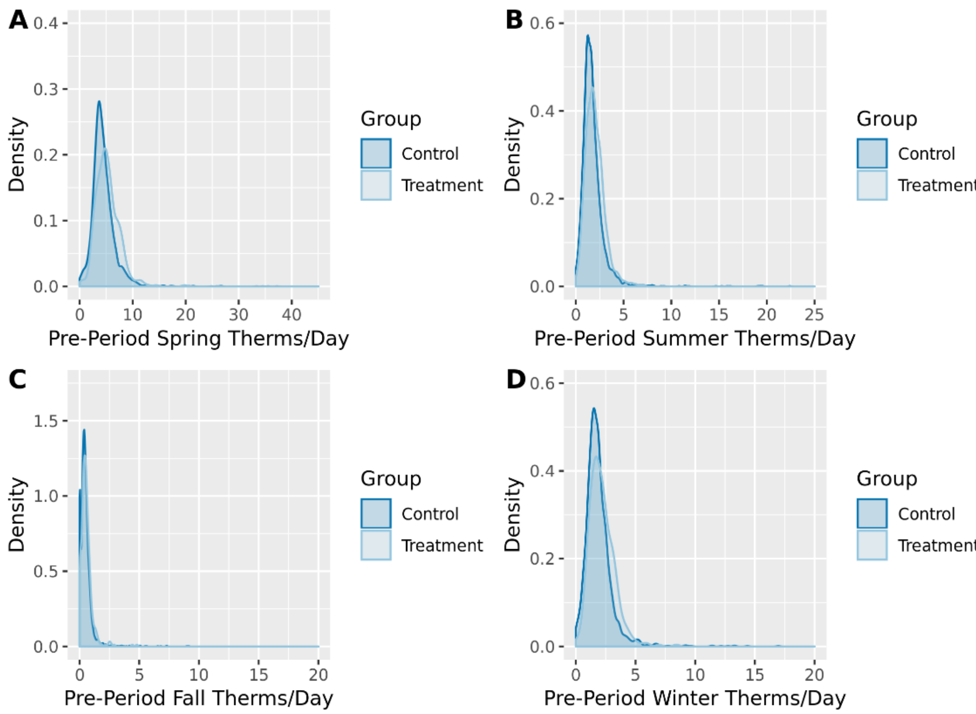


Figure 3-2 PY2017-2018 Average Daily Usage by Season in Treatment and Control Groups After Matching

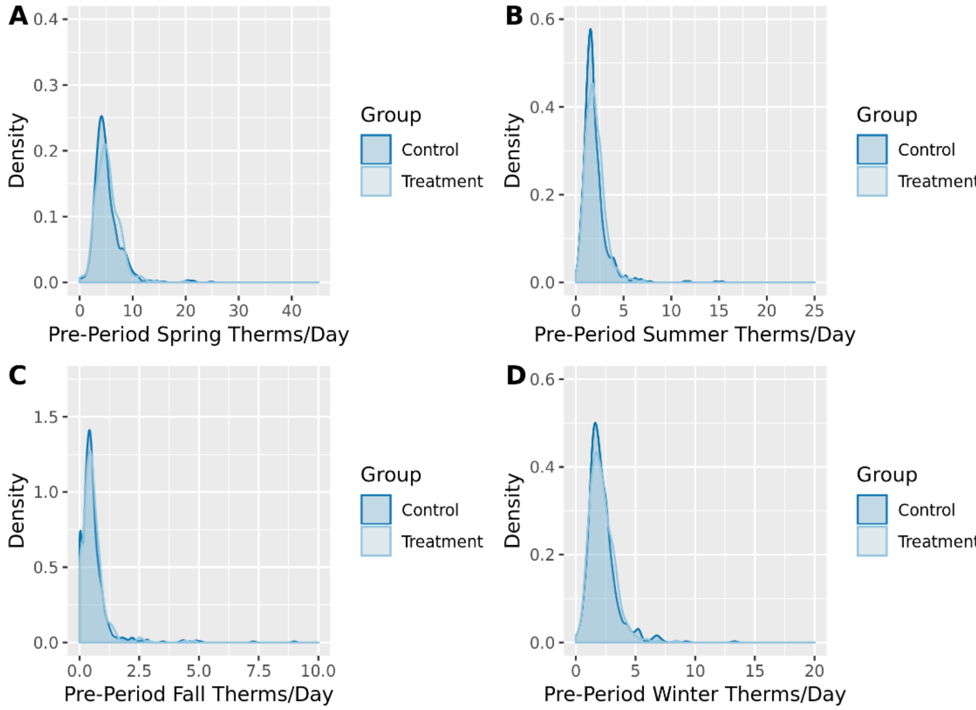


Figure 3-3 through Figure 3-4 display the same home characteristics, before and after matching, for PY2019.

Figure 3-3 PY2019 Average Daily Usage by Season in Treatment and Control Groups Before Matching

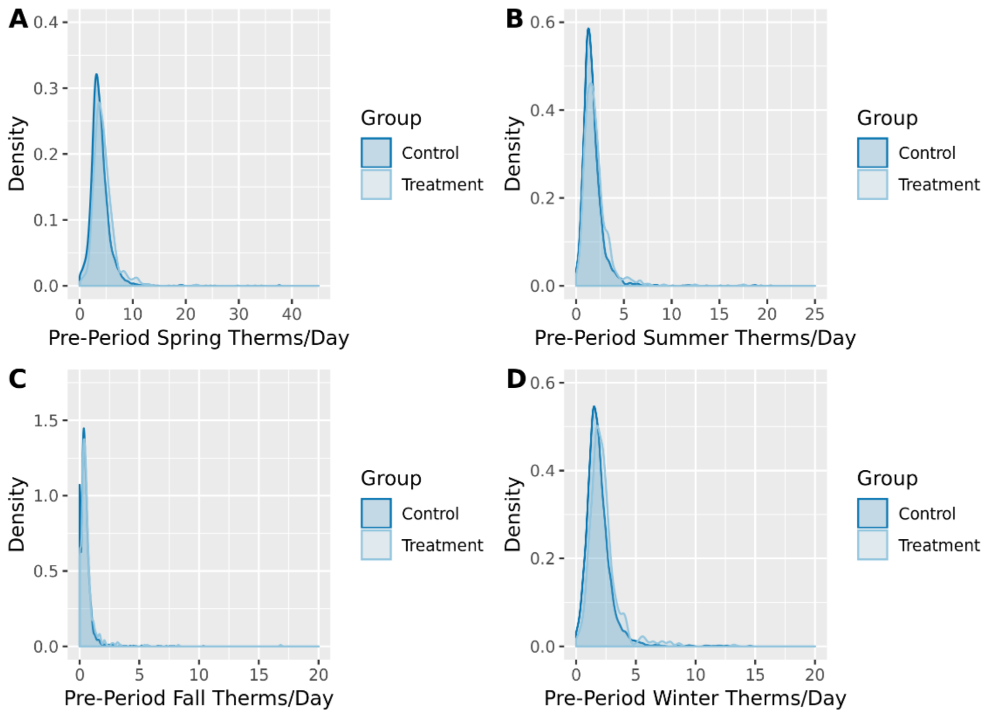
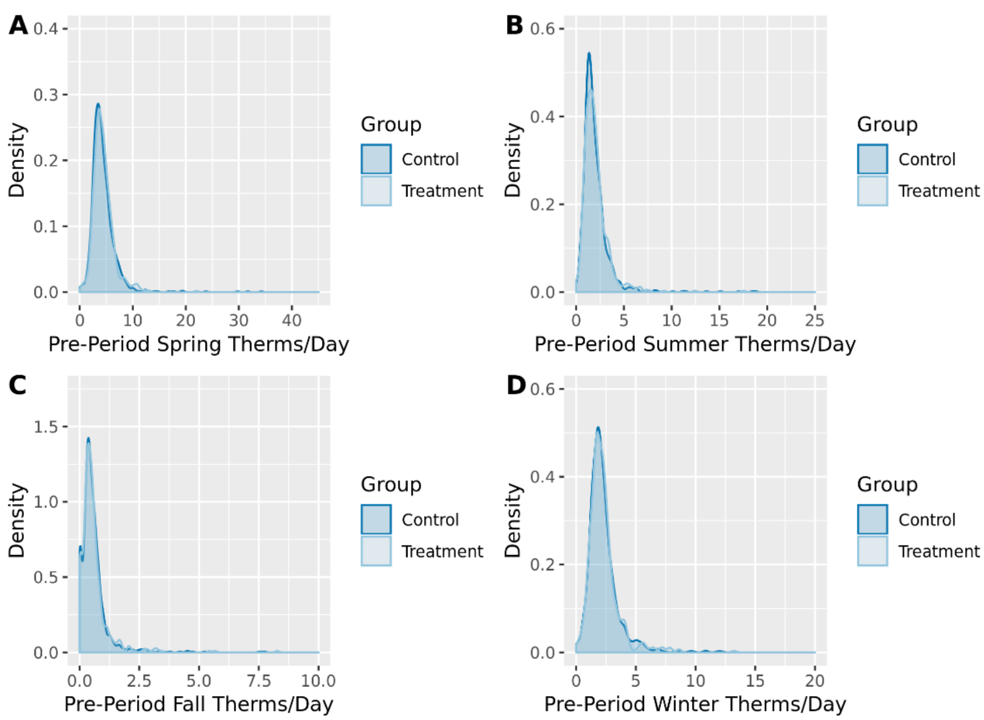


Figure 3-4 PY2019 Average Daily Usage by Season in Treatment and Control Groups After Matching



Lastly, the joint chi-square test for covariate balance had a p-value of 0.51, meaning the Evaluators failed to reject the null hypothesis of covariate balance.

Figure 3-5 displays the average daily Therm usage for both the control and treatment group before matching in PY2017-2018. Figure 3-6 displays the same values after matching. Figure 3-7 and Figure 3-8 display the average daily Therm usage for both the treatment and control groups before and after matching for PY2019.

Figure 3-5 PY2017-2018 Average Daily Therm Usage in Treatment and Control Groups Before Matching

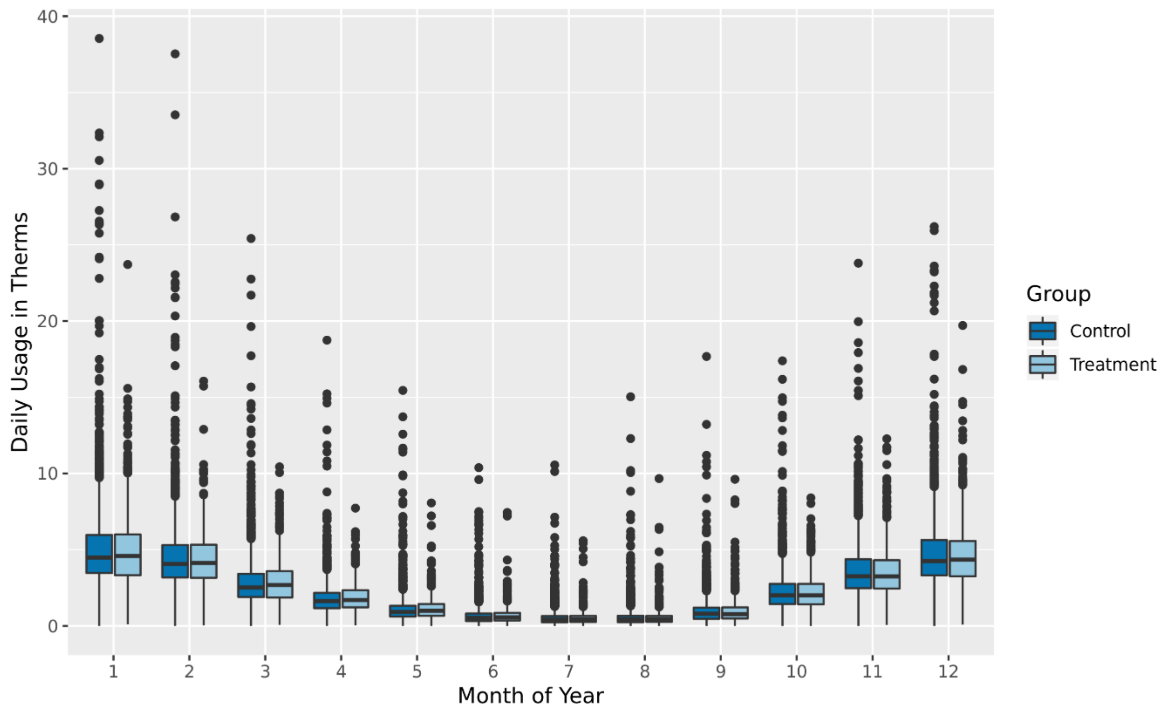


Figure 3-6 PY2017-2018 Average Daily Therm Usage in Treatment and Control Groups After Matching

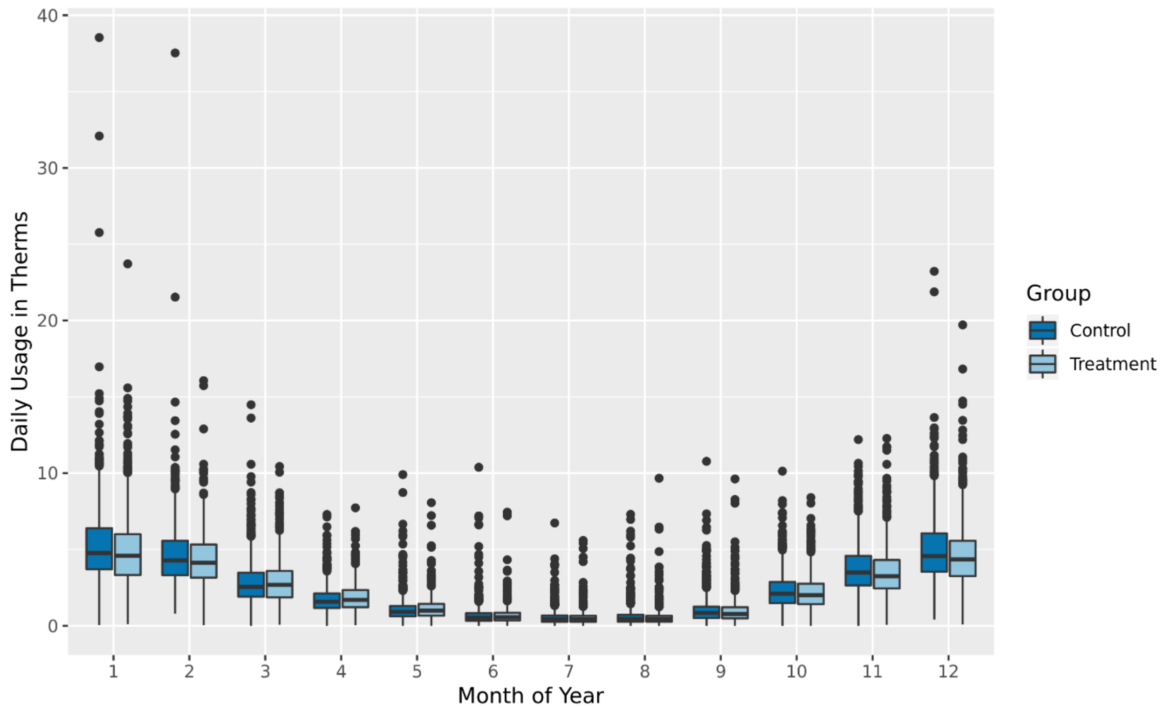


Figure 3-7 PY2019 Average Daily Therm Usage in Treatment and Control Groups Before Matching

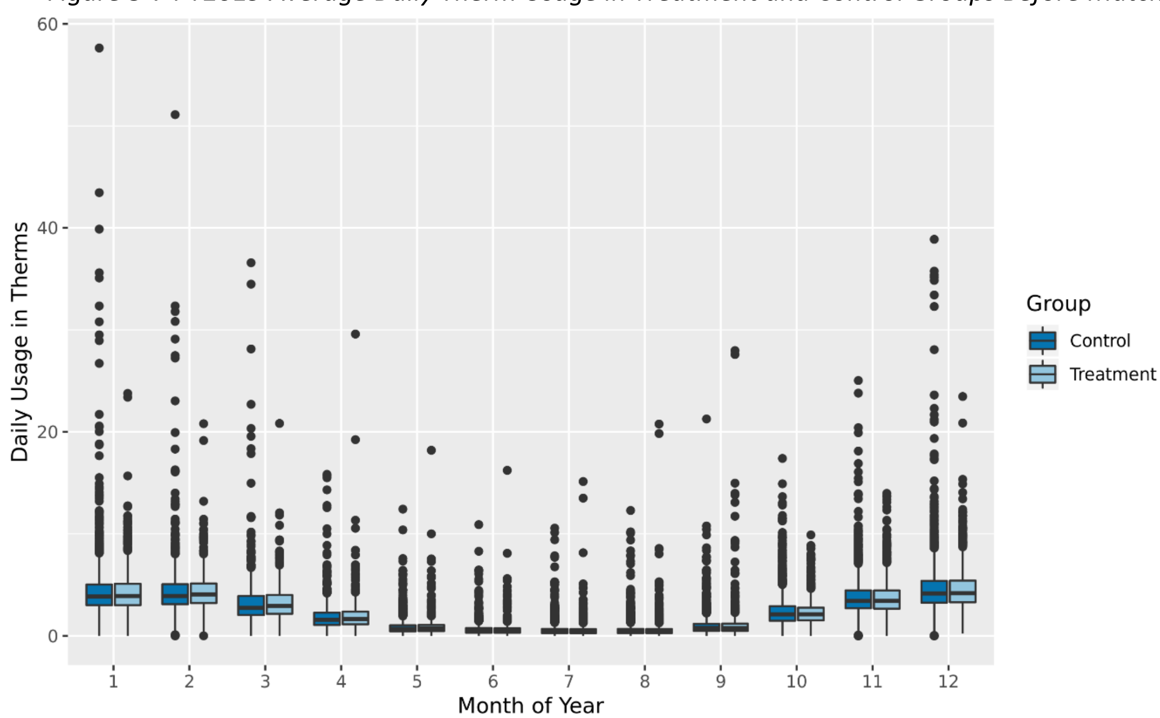
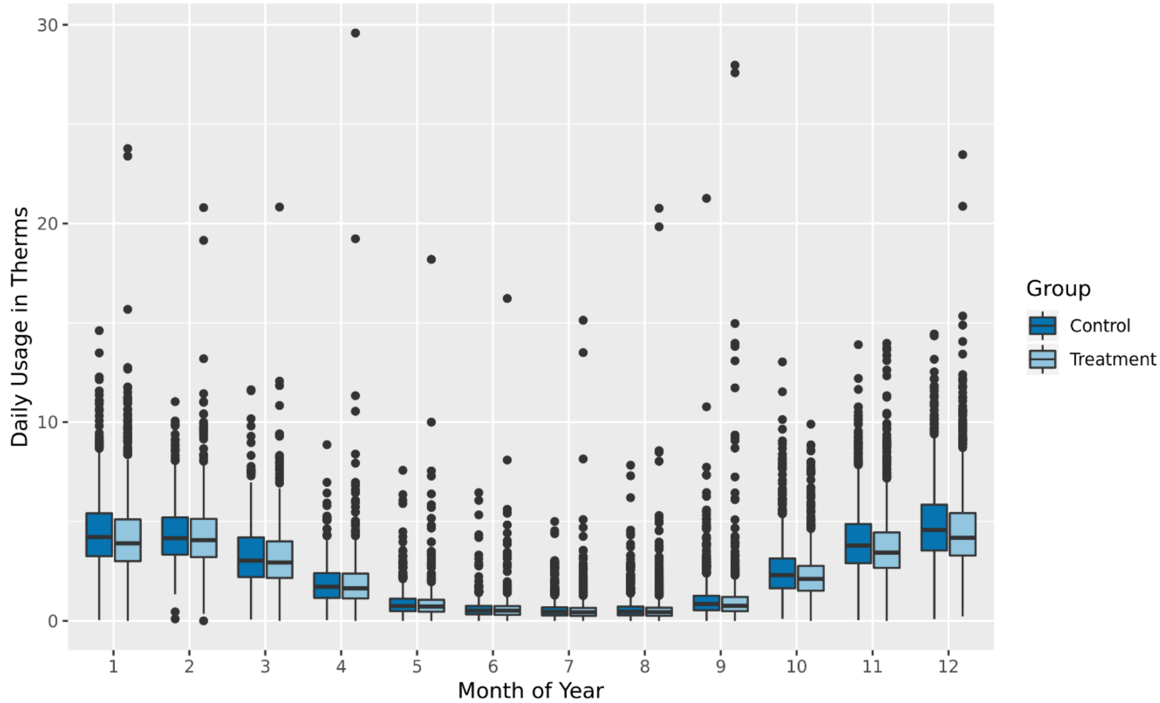


Figure 3-8 Average Daily Therm Usage in Treatment and Control Groups Before Matching



3.2.2.2 Regression Results After Matching

This section details the regression results after performing propensity score matching for participants with a 95% AFUE Natural Gas Furnace measure. Table 3-11 summarizes the results of the billing analysis for participants by program year. A p-value less than 0.05 indicates that the parameter estimate is statistically significant at the 95% confidence level.

As discussed in the evaluation approach section, savings are determined through parameters B5 and B7, which are defined again in Table 3-10, along with all the other model parameters. In any given month, per participant savings are calculated as follows: (B5*Days in Month) + (B7*HDD). In computing HDD for each month, the Evaluators used Typical Meteorological Year 3 (TMY 3) data for the weather stations associated with each 3-digit zip code area (per Table 3-3). This extrapolation provides savings under typical weather conditions. Monthly TMY HDDs were calculated from the TMY data as the sum of daily average temperature values under 63°F in a given month. Monthly TMY HDDs were weighted by the number of rebates found in each 3-digit zip code when computing monthly and annual program savings.

Table 3-10 Method 1 Regression Parameters

Variable	Parameter	Interpretation
Post	B1	Average daily usage in the post-period
Treatment	B2	Average daily usage for the treatment group
Avg.HDD	B3	Average daily usage per HDD
Post*Avg.HDD	B4	Average daily usage per HDD in the post-period
Post*Treatment	B5	Average daily usage in the post-period for the treatment group
Treatment*Avg.HDD	B6	Average daily usage per HDD for the treatment group
Post*Treatment*Avg.HDD	B7	Average daily usage per HDD in the post-period for the treatment group

As shown in Table 3-11, the coefficient estimates for Post*Treatment*Avg.HDD (B7) are negative, indicating lower usage per HDD in the post-period for treatment customers. In addition, these coefficients are statically significant at the 95% level in both program years. The estimate for Post*Treatment (B5) is also negative, indicating positive savings that are independent of the weather or HDDs, but is not statistically significant for PY2017-2018. This is expected for furnace retrofits due to weather dependency.

Table 3-11 Method 1 Regression Results

Program Year	Coefficient	Estimate	Std Error	P Value	5%	95%
2017-2018	Post	0.0370	0.0221	0.0935	0.0007	0.0734
	Treatment	1.8486	0.2708	0.0000	1.4031	2.2940
	Avg.HDD	0.1395	0.0008	0.0000	0.1381	0.1409
	Post*Avg.HDD	-0.0006	0.0011	0.6047	-0.0023	0.0012
	Post*Treatment	-0.0330	0.0380	0.3849	-0.0955	0.0295
	Treatment*Avg.HDD	0.0036	0.0014	0.0117	0.0013	0.0060
	Post*Treatment*Avg.HDD	-0.0095	0.0019	0.0000	-0.0126	-0.0063
2019	Post	0.0654	0.0273	0.0165	0.0205	0.1102
	Treatment	5.0537	0.3749	0.0000	4.4370	5.6704
	Avg.HDD	0.1383	0.0009	0.0000	0.1368	0.1397
	Post*Avg.HDD	0.0014	0.0014	0.3118	-0.0009	0.0036
	Post*Treatment	-0.0220	0.0473	0.6421	-0.0998	0.0558
	Treatment*Avg.HDD	0.0003	0.0015	0.8471	-0.0022	0.0028
	Post*Treatment*Avg.HDD	-0.0072	0.0024	0.0026	-0.0112	-0.0033

*Per-household fixed-effects coefficients were omitted from this table for brevity

Each of the models showed they were a good fit for the data, as seen by the Adjusted R-square in Table 3-12. Model fit is slightly lower for PY2019, which may be due to fewer observations in the post-period relative to PY2017-2018.

Table 3-12 Method 1 Model Fit

Program Year	Adjusted R2	F Statistic	Number of Observations	Number of Treatment Customers
2017-2018	0.8067	128	34,475	388
2019	0.7700	65	29,024	552

Table 3-14 provides monthly savings estimates per rebate and for all rebates by program year. TMY HDDs were weighted by the number of rebates from each 3-digit zip code.

Table 3-13 Number of Premises by 3-Digit Zip Code and Program Year

Program Year	Weather Station ID	3-Digit Zip Code	Number of Premises
2017-2018	725780	832	257
	725866	833	71
	725785	834	99
	726810	836/837	880
Total			**1,307**
2019	725780	832	369
	725866	833	140
	725785	834	177
	726810	836/837	1,336
Total			**2,022**

Table 3-14 Monthly Savings Summary by Program Year

Month	Weighted HDD	PY2017-PY2018 Savings/Rebate (Therms)	PY2019 Savings/Rebate (Therms)
1	1,118	11.59	8.75
2	815	8.64	6.51
3	666	7.32	5.49
4	387	4.65	3.45
5	251	3.40	2.49
6	112	2.05	1.47
7	35	1.35	0.93
8	79	1.77	1.25
9	163	2.53	1.84
10	406	4.86	3.61
11	757	8.15	6.12
12	945	9.96	7.51
Annual	**5,734**	**66.27**	**49.43**

The ex-ante and ex-post Therms savings of the 95% AFUE Natural Gas Furnace are summarized below by program year. The number of rebates used to calculate total ex-post Therms savings is the number of validated furnace rebates, detailed in the verification section above. Table 3-15 displays the total measure ex-ante and ex-post savings for each program year.

Table 3-15 Ex-Ante and Ex-Post Annual Therms Savings for 95% AFUE Natural Gas Furnace by Program Year

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Valid Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	112	1,332	66.27	154,224	88,275	57.24%
2019	112	2,066	49.43	231,392	102,123	44.13%
All		**3,398**	**56.03**	**385,616**	**190,398**	**49.37%**

3.2.3 Furnace Sizing

The Evaluators took steps to review the furnace sizing of rebated furnaces in the program. Most deemed savings protocols (such as equivalent full load heating hours) for residential furnaces assume appropriate sizing for the residence, when the reality is that oversizing by a factor of 33%-48% of HVAC equipment is a commonly observed practice[4]. The Evaluators reviewed rebated furnace equipment sizing to square footage by home vintage. This analysis is meant to provide this feedback to IGC to provide context for any deviations in savings estimates, and to allow for feedback to HVAC contractors on equipment sizing.

The Evaluators calculated the average furnace sizing per square foot by home vintage and weather zone, presented in Table 3-16.

Table 3-16 Average Rebated Furnace Sizing per Square Foot by Vintage and Weather Zone

Year Built	Weather Zone 5 Average Sizing (BTUH/SQFT)	Weather Zone 6 Average Sizing (BTUH/SQFT)
Pre-1979	39.32	43.14
1980-1989	37.82	37.39
1990-1999	37.05	32.34
2000-Present	33.51	30.29
Total	**35.30**	**35.75**

[4] https://www.energy.gov/sites/prod/files/2018/06/f53/bto-ResidentialHVACLitReview-06-2018.pdf, Table 2.

3.3 Conclusions and Recommendations

This section presents conclusions and recommendations for the 95% AFUE Natural Gas Furnace measure.

3.3.1 Conclusions

- The 95% AFUE Natural Gas Furnace provides measurable savings through billing analysis. However, the observable energy savings through billing analysis are much lower than expected equipment savings. Billing analyses include any changes in household behavior, equipment, or occupancy, and therefore may include factors other than the impact of improved equipment efficiency.
- The Evaluators found several deviations in furnace capacity size and AFUE in the tracking data compared to AHRI certification values. Other than two instances where a tankless water heater was classified as a furnace erroneously, all rebated units were program-qualifying furnaces.
- Program tracking data maintained by IGC was very comprehensive and readily facilitated the evaluation effort.
- The Evaluators identified a discernable trend in furnace sizing relative to home vintage. Of key note, sizing in Weather Zone 5 was often larger than for Weather Zone 6, despite Zone 5 being a warmer climate.

3.3.2 Recommendations

- Collect installation disposition on the project application: replace-on-burnout, early retirement, or new construction. Program tracking currently distinguishes new construction but does not capture replace-on-burnout versus early retirement.
- Verify AHRI certification for all rebated furnaces before approving. All units were program-qualifying, but many had sizing or efficiency data entry errors.
- Provide or encourage contractor training for Manual J sizing calculations for rebated furnaces. Over-sizing in Weather Zone 5 negatively affects program savings due to repeated shorter run cycles and associated higher use during the heating ramp-up (which is the point of greatest energy use for a furnace).
- The Evaluators suggests using engineering-based evaluation approaches that comply with the International Performance Measurement and Verification Protocol (IPMVP) maintained by the Efficiency Valuation Organization (EVO) with sponsorship by the U.S. Department of Energy (DOE)[5] such as Method 3 described in Appendix A.

[5] Core Concepts: International Measurement and Verification Protocol. EVO 100000 – 1:2016, October 2016.

4 Whole Home Rebate

The Whole Home measure offers incentives to home builders and buyers for new construction, single-family residential homes that meet energy efficiency standards of the program. The Whole Home measure requires homes must be certified to meet the requirements of the Environmental Protection Agency (EPA) ENERGY STAR certified homes program. In addition, the home must achieve a Residential Energy Services Network (RESNET) Home Energy Rating System (HERS) score of 75 or less with a certificate completed by a certified HERS rater. The Whole Home Rebate cannot be combined with any other appliance rebates in IGC's Energy Efficiency Program.

4.1 Program Description

The objective of the Whole Home Rebate is to encourage homebuilders to include energy efficient measures in the construction of new homes built within IGC's service area. This measure provides a $1,200 rebate for new construction residential ENERGY STAR certified homes with a RESNET Home Energy Rating Score (HERS) of 75 or less.

The Evaluators verified savings for the Whole Home Rebate measure using a billing analysis including a matched control group. Table 4-1 presents the overall ex-ante and ex-post savings by program year. Across all program years, the Evaluators found a 28.2% realization rate, with an annual ex-post savings per rebate of 57.5 Therms.

Table 4-1 Method 1 Ex-Ante and Ex-Post Program Savings

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	204	619	57.18	126,276.00	35,393	28.03%
2019	204	1,079	57.75	220,116.00	62,311	28.31%
All		**1,698**	**57.54**	**346,392.00**	**97,704**	**28.21%**

Table 4-2 shows the number of completed projects and ex-ante Therms savings for the Whole Home Rebate by program year.

Table 4-2 Ex-Ante Therms Savings of Whole Home Rebate by Program Year

Program Year	Number of Homes	Ex-Ante Therms Savings per unit	Ex-Ante Therms Savings
2017-2018	619	204	126,276
2019	1,079	204	220,116
Total	**1,698**	**204**	**346,392**

The Evaluators also presents a HERS Index analysis between the program and non-program group, as well as between the matched control and treatment group used in the billing analysis.

4.2 Impact Evaluation Approach

The following section presents the methodology that was used for estimating energy impacts resulting from the Whole Home Rebate measure.

The Evaluators performed a billing analysis with a matched control group as part of the impact evaluation for Whole Home Rebate measure. While it is not possible to guarantee the possibility of creating a sufficiently matched control group, this method is preferred because it is likely to have more meaningful results than a treatment-only analysis. Some examples of outside variables that a control group can sufficiently control for are changes in economies and markets, large-scale social changes, or impacts from weather-related anomalies such as flooding or hurricanes.

The Evaluators also conducted a whole building simulation analysis as an alternative method for impact evaluation of this measure. The results of the alternative impact evaluation methods can be found in Appendix B. Each of these approaches comply with the International Performance Measurement and Verification Protocol (IPMVP) maintained by the Efficiency Valuation Organization (EVO) with sponsorship by the U.S. Department of Energy (DOE)[6].

4.2.1.1 Data Collection

IGC provided the following data to support the analysis:

- Monthly gas billing data for 1,698 program homes and 10,433 non-program homes. The data started on November 28, 2016 and ended on March 30, 2020;
- Program tracking data for program homes, including household zip code, year built, HERS rating, and equipment information (appliance firing date, capacity, efficiencies);
- Ada County Assessor data for program and non-program premises; and
- REM/Rate files and HERS certification documents from HERS Raters for a sample of 80 Whole Home-rebated premises.

In addition, the Evaluators acquired:

- Heating degree days (HDD) by month and year from the National Oceanic and Atmospheric Administration (NOAA)[7]. The monthly HDD weather data were collected from the Boise (KBOI) weather station. Monthly HDDs are calculated as the sum of daily average temperature values under 63°F in a given month. The degree day base temperature was selected by observing the best fitting model for a range of base temperatures between 55°F and 75°F.
- HDD by month and year for a Typical Meteorological Year (TMY) for the specified weather station is shown in the table below[8].

4.2.1.2 Data Cleaning

The Evaluators began impact evaluation work by reviewing the data tracking systems for completeness and found them to be satisfactory for use in assessing program impacts, regulatory reporting and other

[6] Core Concepts: International Measurement and Verification Protocol. EVO 100000 – 1:2016, October 2016.

[7] ftp://ftp.ncdc.noaa.gov/pub/data/noaa/

[8] TMY Source: https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html

requirements. The Evaluators also reviewed the tracking system for overlaps in redemption of Appliance rebates and a Whole Home Rebate. The Evaluators found there to be no home that received both a Whole Home Rebate and any of the Appliance rebates.

The following steps were taken to prepare data for regression analysis:

1. Gather billing data for homes that participated in the Whole Home Rebate (program homes).
2. Gather billing data for new, occupied homes that did not participate in the Whole Home Rebate measure (non-program homes).
3. Exclude program and non-program homes that also participated in the 95% AFUE Natural Gas Furnace Program (no occurrences).
4. Connect county records associated with non-program homes for household characteristics.
5. Exclude homes that started occupation after July in the program year (to ensure analysis of the same post-period in the treatment and control groups).
6. Exclude homes missing winter-season or summer-season billing history.
7. Exclude bills with consumption indicated to be outliers.
8. Exclude bills that contain less than ten days of valid usage out of the month.

The following additional billing restrictions were used:

1. PY2017-2018 required all program and non-program premises have at minimum eight of the nine heating months (October through April) and at minimum nine months total.
2. PY2019 required all program and non-program premises have at minimum four of the nine heating months (October through April) and at minimum six months total.

4.2.1.3 Data Verification

The Evaluators screened each Whole Home Rebate household to ensure the customer did not also receive a rebate for the 95% AFUE Natural Gas Furnace Rebate measure. There were no occurrences of double participation. Tracking data and ENERGY STAR and HERS certificates were reviewed to verify each household satisfies all program efficiency requirements.

The Evaluators created a sample of 80 homes to verify documentation and simulation files, stratified by builder. The Evaluators developed a sampling plan to achieve the required relative precision at the required confidence level. The Evaluators received the sample of energy models from program HERS raters as well as application materials via IGC. All data was reviewed for consistency and accuracy.

IGC provided 80 of the requested files on behalf of the HERS raters. The Evaluators encountered several barriers with the model files provided by the HERS raters and was unable to resolve the errors in 12 of the 80 exported files IGC provided the Evaluators. Therefore, 68 of the original 80 home sample was used to develop savings estimates from this Method. The final sample plan is summarized in Section 2.2.2.

4.2.1.4 Billing Analysis with Matched Control Group

The Evaluators conducted a linear regression billing analysis using billing data from Whole Home-rebated homes and newly built non-program homes. The Evaluators successfully created a statistically similar control group using propensity score matching (PSM). The control group consists of similar newly constructed residential homes without the energy efficiency standards required in the Whole Home Rebate.

The Evaluators fit a simple differences panel linear regression model with random effects to estimate weather-dependent daily consumption differences between efficient homes and baseline homes. Under the random effects model the goal is not to estimate one true effect, but to estimate the mean of a distribution of effects. The Evaluators included the independent variables Heating Degree Days and square footage to use for forecasting and to understand the relative change between treatment and control groups, magnitude, and direction of consumption differences in heating months. A household is considered a treatment household if it received a Whole Home Rebate. It is considered a control household if the household did not receive a Whole Home Rebate.

The following equation displays the model specifications the Evaluators used for this analysis.

Equation 4-1 Simple Difference Regression Model Specification

$$Daily\ Heating\ Load\ Therms/SQFT_{it} = \beta_1(Treatment)_i + \beta_2(HDD)_{it} + \beta_3(HDD \times Treatment)_{it}$$

Where,

$Daily\ Heating\ Load\ Therms/SQFT_{it}$ = Estimated heating energy usage (dependent variable) in home *I* during period *t* per square footage of home *i*

$Treatment_i$ = Dummy variable indicating whether household *i* was in the treatment group or control group

HDD_{it} = Average heating degree days (base 63°F) during period *t* at home *i*

β_{1-3} = Coefficients determined via regression

β_1 and β_3 represent the average change in daily heating load in the post-period between the treatment and control group, and the change in weather-related daily consumption in the post-period between the groups respectively. HDD was estimated using a range of balance points (55°F to 75°F base temperature) and the HDD result that yielded the greatest model R-square was used in the final analysis. This accounts for the "dead-band" in residential heating loads, as there is a range of temperatures in which a residential customer will be neither heating nor cooling. Typical monthly and annual savings is estimated by extrapolating the β_1 and β_3 coefficients with Typical Meteorological Year (TMY) weather data.

4.2.2 Impact Evaluation Results

The following section details the Evaluators' impact evaluation findings for the Whole Home Rebate under each of the methods described above.

The Evaluators estimated savings for Whole Home Rebate measure using a matched control group. Table 4-3 presents the overall ex-ante and ex-post savings by program year. Across all program years, the program achieved a 28.2% realization rate, with annual ex-post savings per Whole Home Rebate of 57.5 Therms.

Table 4-3 Savings Summary for Billing Analysis

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	204.00	619	57.18	126,276.00	35,393	28.03%
2019	204.00	1,079	57.75	220,116.00	62,311	28.31%
All		**1,698**	**57.54**	**346,392.00**	**97,704**	**28.21%**

4.2.2.1 Data Cleaning

The following tables summarize the number of customers filtered out due to the above criteria, for each program year and for each of the treatment and control groups. For each program year, the separate program year-specific restrictions were conducted on the same control group. Therefore, PY2017-2018 and PY2019 each started with the full non-program group to match against.

Table 4-4 Program Premises Data Cleaning Steps

Criteria	PY2017-2018 Program Homes	PY2019 Program Homes
Total received billing data	619	1,079
After removing premises still owned by builders	611	948
After removing premises without Ada County Assessor data	539	807
After removing premises without a valid occupancy date and with billing data occurring after occupancy date	531	751

Table 4-5 Non-Program Data Cleaning Steps

Criteria	Non-Program Premises
Total received billing data	12,277
After removing premises with an associated Appliance or Whole Home Rebate	10,430
After removing premises without Ada County Assessor data (No premises removed)	10,430
After removing premises without a valid occupancy date and with billing data occurring after occupancy date	9,101
After removing premises with more than one number of dwellings in County Assessor Data	9,081

Table 4-6 Billing Data Cleaning Steps

Criteria	PY2017-2018 Program Homes	PY2019 Program Homes	PY2017-2018 Non-Program Premises	PY2019 Non-Program Premises
Total number of premises after household-level cleaning steps	531	751	9081	9,081
After calendarizing	531	751	9081	9,081
After removing non-program premises with year built outside of treatment customer year builds	531	751	7476	5,333
After removing non-program premises without Ada County Assessor data	531	751	7470	5,328
After removing billing months without sufficient number of days occupied	531	738	7470	5,327
After removing bill outliers	532	739	7445	5,298
After removing premises without sufficient post-period for each program year	324	403	3294	2,599
After removing premises without sufficient summer months to calculate baseload	322	380	3240	2,310

The typical treatment period of an analysis contains at least twelve months of billing data in the post-period. Although the data used in this analysis contains sufficient winter-period billing data for PY2019, it contains seven months of total post-period data. Results from less than one full year of a treatment period are not fully indicative of 12-month savings that may be anticipated going forward. The analysis for PY2017-2018 allows for a sufficient number of post-period months. It is recommended that future program year impact analyses allow for collection of 12 months of post-period data.

4.2.2.2 Heating Load Analysis

The Evaluators found there to be statistically significant differences in treatment and control summer Therms usage. In the months of June, July, and August, variation in usage is expected to be very low between households, as space heating is no longer required in the summer months. The statistically significant difference in heating load usage in summer months is indicative of differences in number of occupants between the treatment group and the control group. This is because the majority of gas usage in summer months comes from water heating and gas cooking appliances. Higher usage from these sources indicates larger demand for hot water and kitchen appliances, indicating a larger number of people living in the home. Figure 4-1 visually displays the differences between treatment and control daily usage per square foot by treatment and control group. The treatment group displays a higher daily usage per square foot than the control group in the summer months (June, July, and August).

Figure 4-1 Average Daily Usage by Group

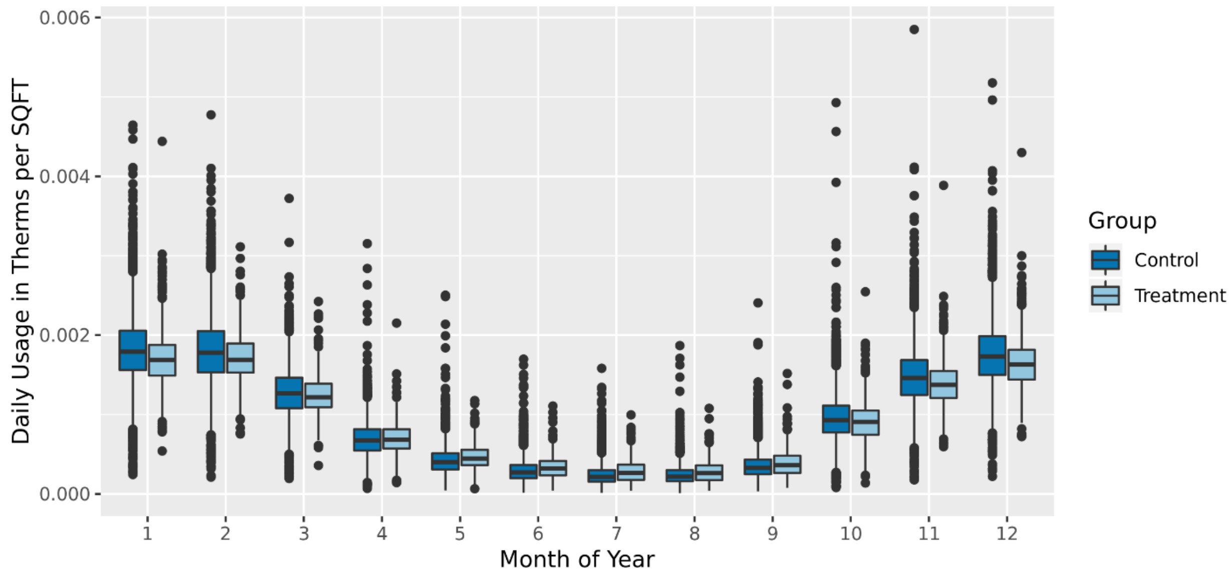


Table 4-7 displays the statistically significant differences in daily energy consumption per square foot between the treatment and control groups for each program year. A p-value of less than 0.05 indicates strong evidence against the null hypothesis at the 95% confidence interval. It means there is less than a 5% probability that the groups display similar behaviors to usage in the summer months.

Table 4-7 Summer Daily Usage T-test

Program Year	Month	Treatment Average Daily Therms per SQFT	Control Average Daily Therms per SQFT	P-value
2018	June	0.00034	0.000296	0.000134
	July	0.000283	0.000247	0.000402
	August	0.000284	0.00025	0.000818
2019	July*	0.000287	0.000241	0.000206
	August	0.000273	0.000241	0.001382

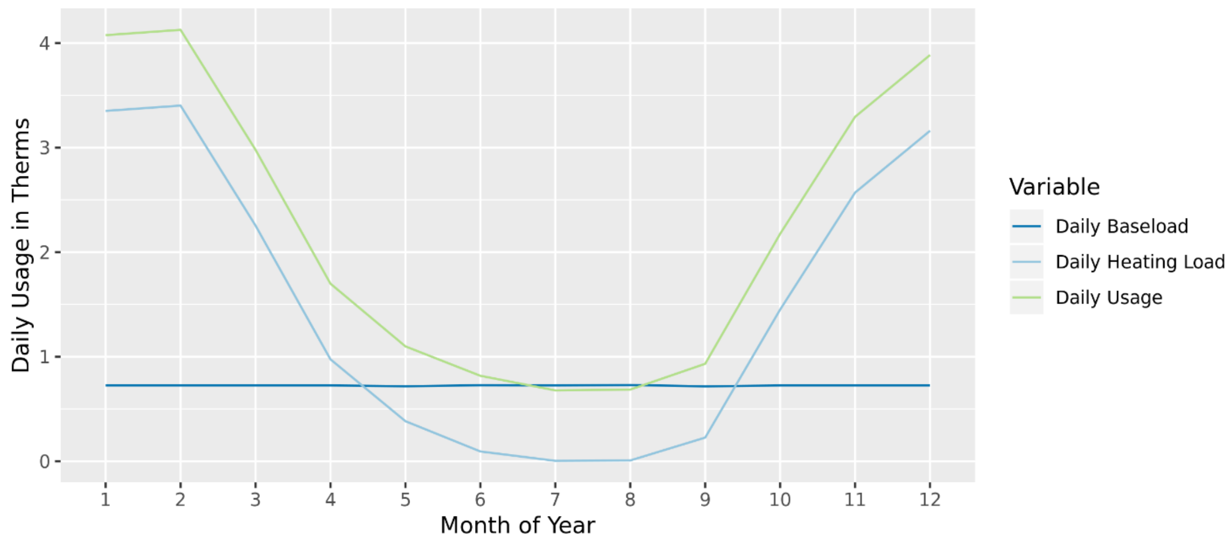
*PY2019 does not include June in the analysis due to post-period restrictions between the treatment group and control group.

With this knowledge, the Evaluators regressed on daily heating load per square foot rather than daily usage per square foot to filter out differences in summer occupancy. The Evaluators performed the following calculations as part of the daily heating load per square foot estimation:

- Calculated average daily baseload usage per square foot for each premise, where baseload is average summer usage in June, July, and August.
- Calculated average daily heating load for each premise by taking the difference between average daily usage per square foot and daily baseload usage per square foot.
- Set any negative heating loads to zero (assumed to be deviations from average baseload usage).

Figure 4-2 displays PY2017-2018 treatment group's average daily usage, average daily baseload in the summer months, and the calculated average daily heating load as an example of heating load distribution throughout the year. The Evaluators removed the daily baseload usage from the daily overall usage, with daily heating load remaining.

Figure 4-2 PY2017-2018 Average Daily Usage by Load Type



4.2.2.3 Propensity Score Matching

The Evaluators used propensity score matching to create a statistically similar group of control households for each program year. Customers were matched on the following household-level characteristics:

- Zip code
- Year built
- Number of bedrooms
- Number of bathrooms
- Number of fireplaces
- Square footage of home
- Square footage of upper floor
- Square footage of pool
- Square footage of attic
- Square footage of garage

The Evaluators had a considerable pool of control customers to draw upon, as shown in Table 4-8. The Evaluators used nearest neighbor for all the above characteristics, and exact matching for zip code with a 1:1 ratio for matching. It is important the homes being compared are in as similar geography as possible. Therefore, during the matching process, the 5-digit zip code must match exactly to the control household, with all other variables matched at the nearest household. This accounts for small geographic differences between the groups.

Table 4-8 PSM Customer Matches

Program Year	Status	Control	Treated
2017-2018	All	3,240	322
	Matched	322	322
	Unmatched	2,918	0
2019	All	2,310	380
	Matched	380	380
	Unmatched	1,930	0

Figure 4-3 displays the home characteristics for the treatment and control groups before matching. Figure 4-4 displays the home characteristics for the treatment and control groups after matching. Home characteristics for PY2019 are also displayed in Figure 4-5 and Figure 4-6, before and after matching.

Figure 4-3 PY2017-2018 Home Characteristics Before Matching Treatment and Control Groups

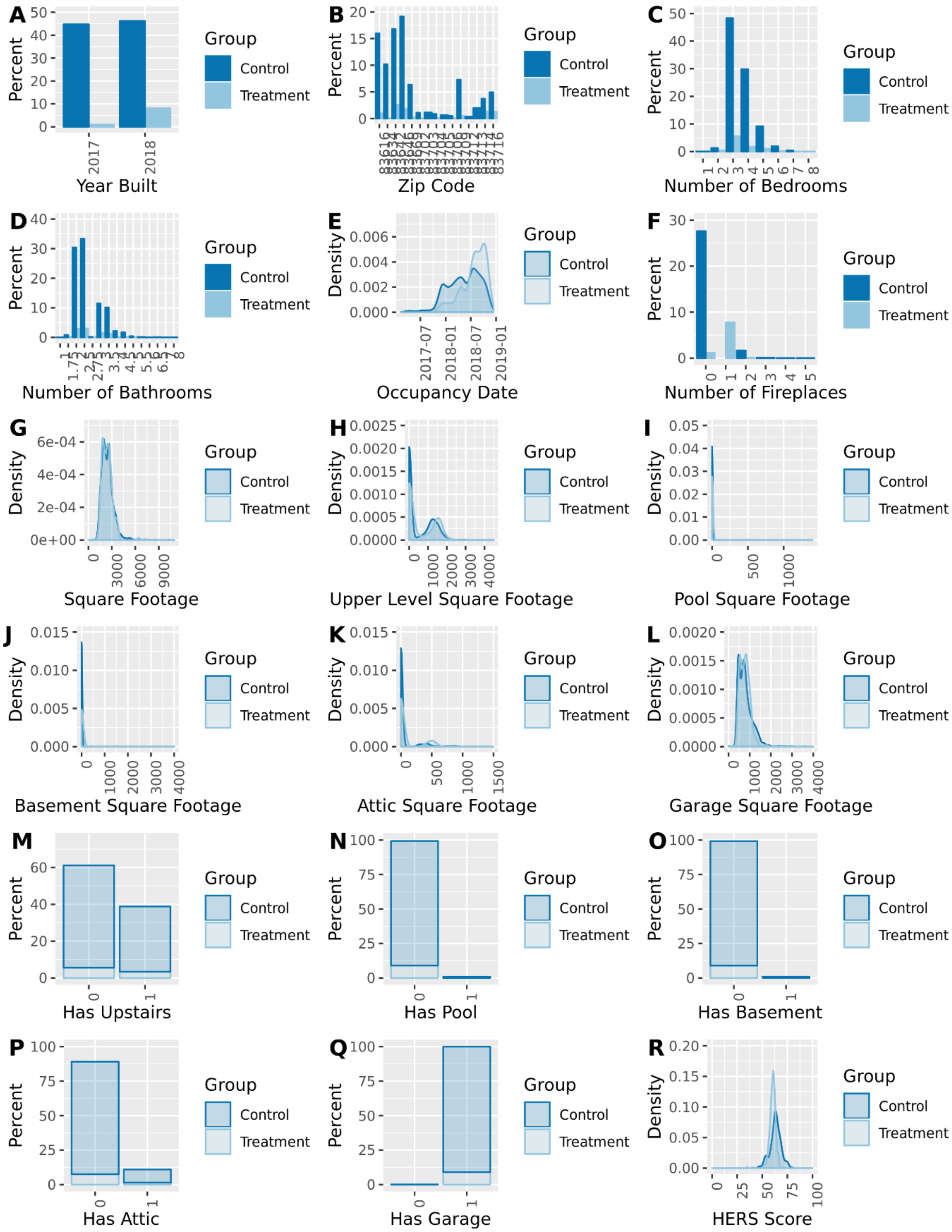


Figure 4-4 PY2017-2018 Home Characteristics After Matching Treatment and Control Groups

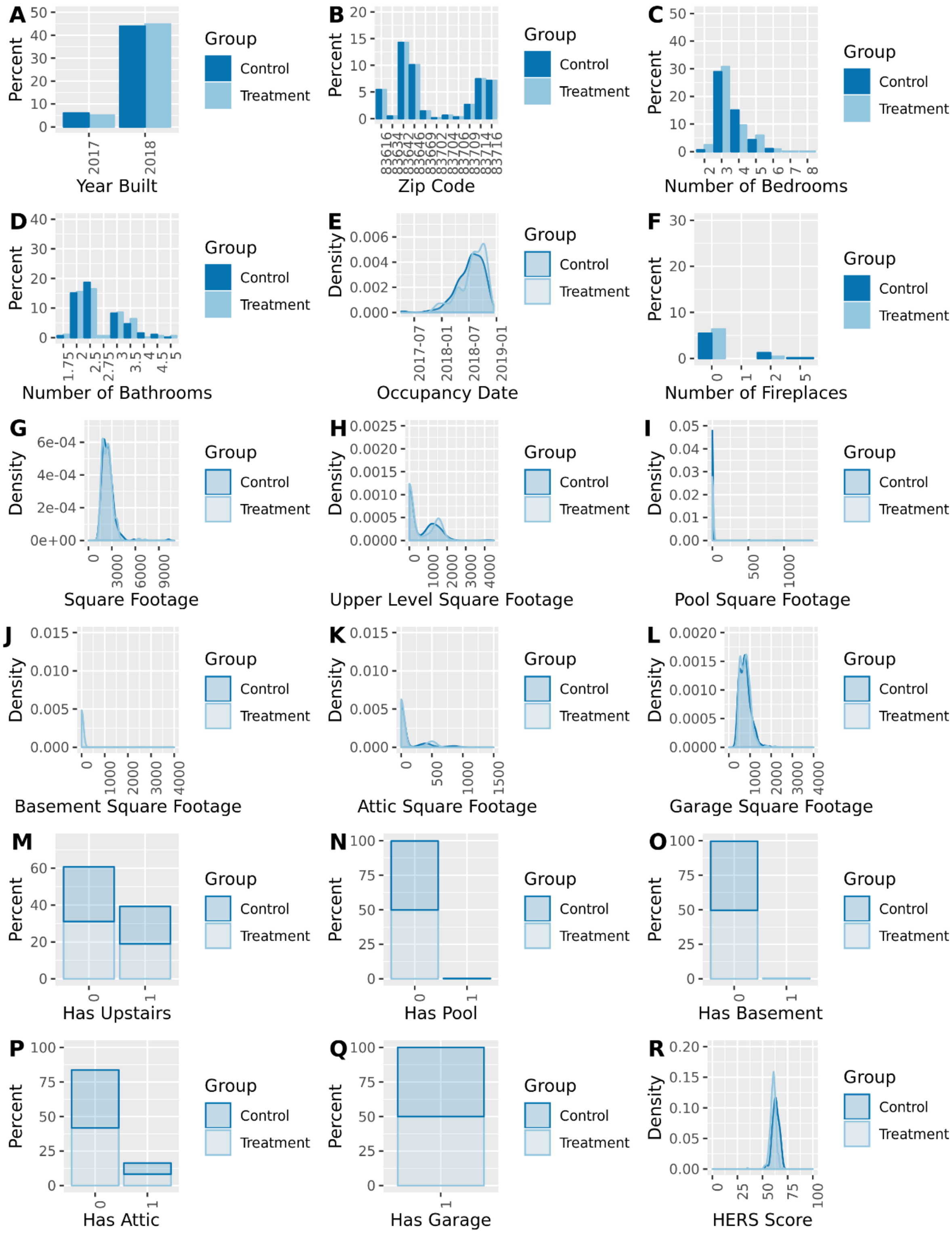


Figure 4-5 PY2019 Home Characteristics Before Matching Treatment and Control Groups

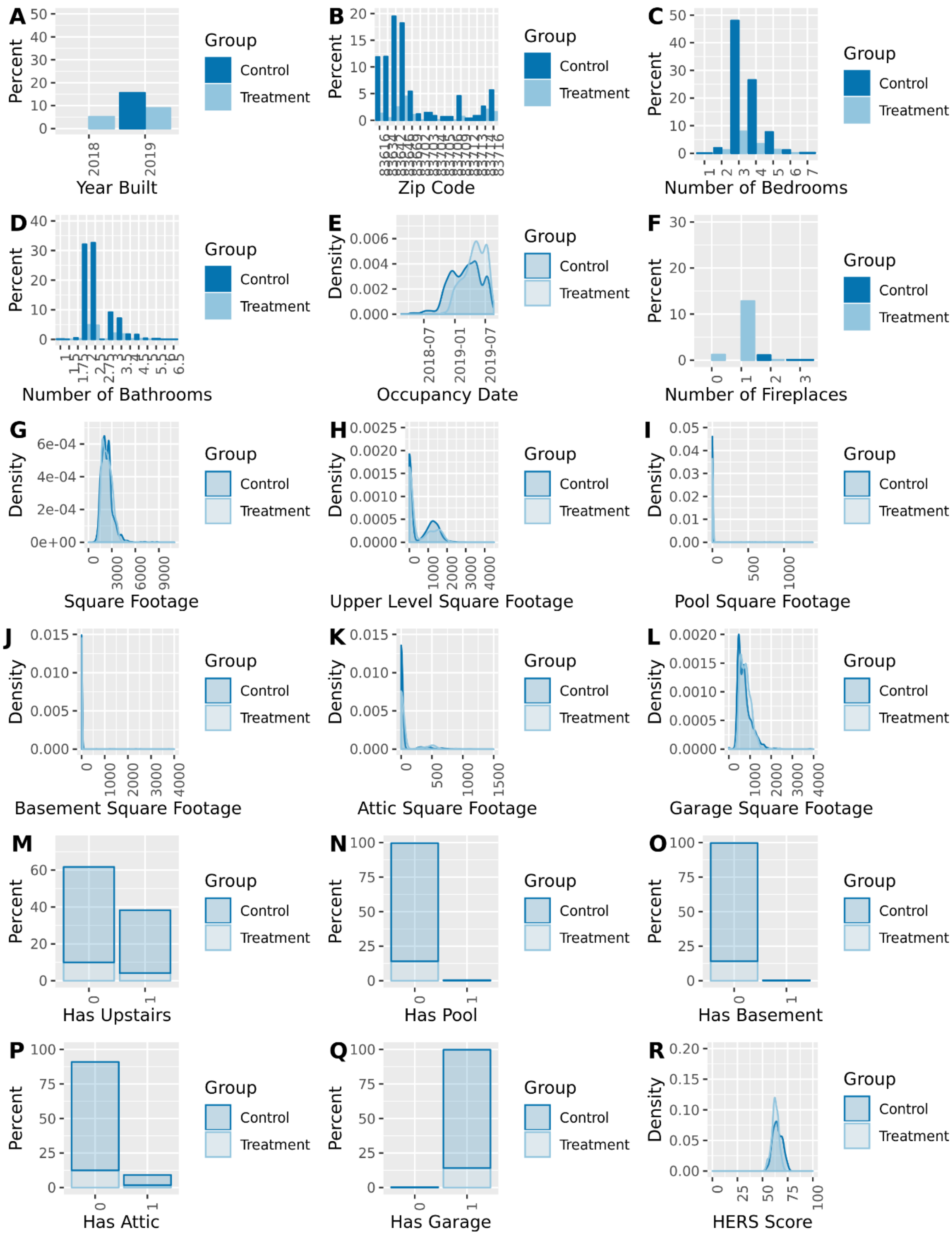


Figure 4-6 PY2017-2018 Home Characteristics After Matching Treatment and Control Groups

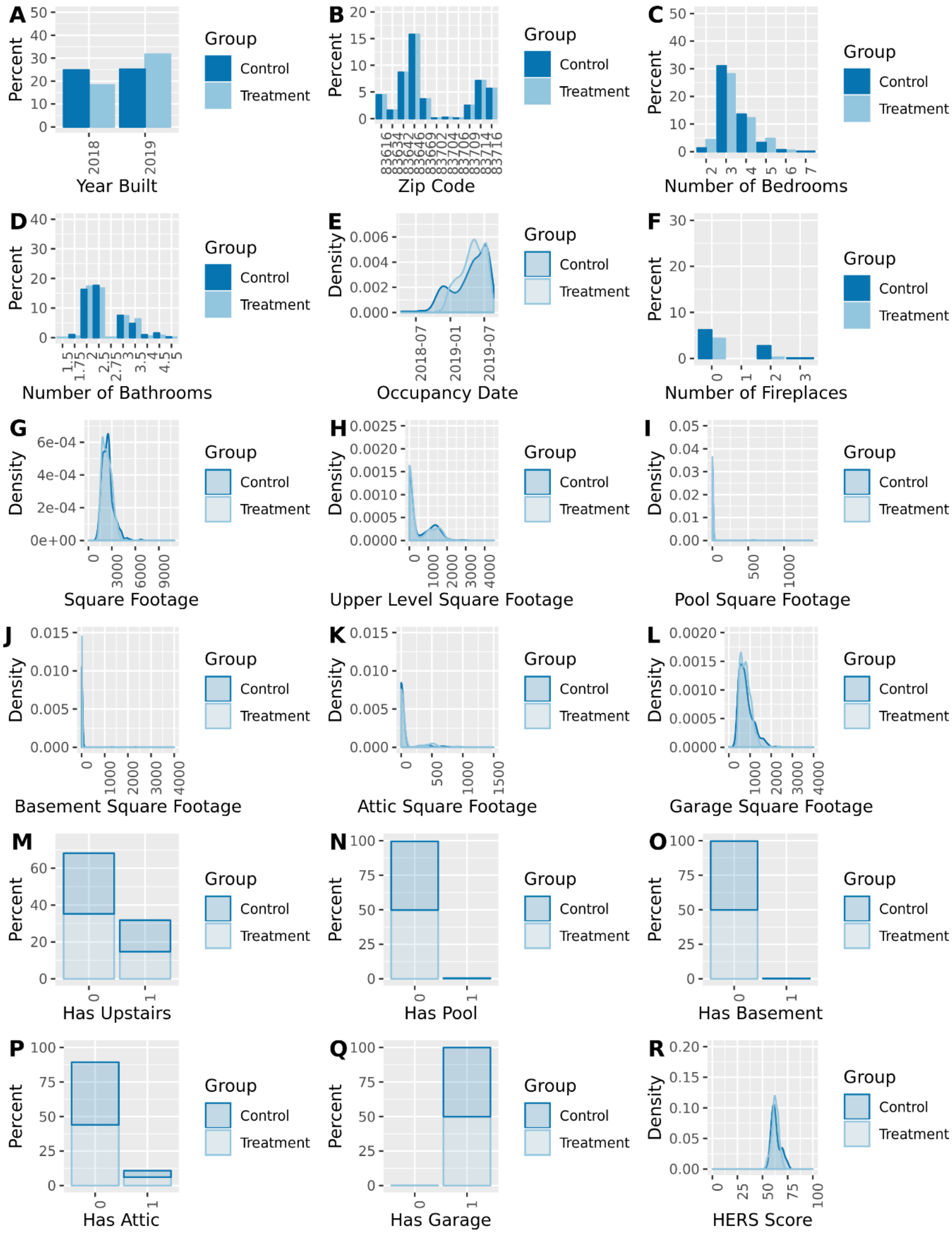


Table 4-9 presents the propensity score covariate summary of pre-period usage for treatment and control customers before and after matching, for each program year.

Table 4-9 PSM Covariate Summary

Program Year	Variable	Before Matching			After Matching		
		Mean Treated	Mean Control	Mean Difference	Mean Treated	Mean Control	Mean Difference
2017-2018	Distance	0.234	0.076	0.157	0.234	0.227	0.007
	Year Built	2017.898	2017.508	0.389	2017.898	2017.879	0.019
	Number of Bedrooms	2.605	2.597	0.007	2.605	2.613	-0.009
	Number of Bathrooms	3.463	3.595	-0.132	3.463	3.528	-0.065
	Number of Fireplaces	0.882	0.720	0.162	0.882	0.929	-0.047
	Square Footage of home	2418.683	2435.734	-17.051	2418.683	2456.186	-37.503
	Square footage of upstairs	525.016	500.323	24.693	525.016	530.491	-5.475
	Square footage of attic	81.186	48.649	32.537	81.186	80.506	0.680
	Square footage of garage	778.183	793.360	-15.176	778.183	772.112	6.071
	Square footage of pool	2.795	4.704	-1.909	2.795	1.590	1.205
	Zip Code*	0.109	0.176	-0.067	0.109	0.109	0.000
2019	Distance	0.365	0.104	0.261	0.365	0.299	0.066
	Year Built	2018.634	2018.181	0.453	2018.634	2018.503	0.132
	Number of Bedrooms	2.570	2.535	0.036	2.570	2.595	-0.024
	Number of Bathrooms	3.379	3.519	-0.140	3.379	3.426	-0.047
	Number of Fireplaces	0.918	0.627	0.291	0.918	0.937	-0.018
	Square Footage of home	2390.366	2341.966	48.400	2390.366	2450.600	-60.234
	Square footage of upstairs	383.789	500.965	-117.175	383.789	429.903	-46.113
	Square footage of attic	59.166	40.342	18.823	59.166	46.858	12.308
	Square footage of garage	790.266	739.175	51.091	790.266	808.389	-18.124
	Square footage of pool	2.842	2.461	0.381	2.842	3.053	-0.211
	Zip Code*	0.089	0.138	-0.049	0.089	0.089	0.000

*Zip Code displays a single zip as opposed to all 30. The mean difference after matching for all 30 zip codes is 0 due to exact matching for this variable.

Each matched control group passed the chi square equivalency test, a test that estimates the goodness of fit between two groups. A p-value of less than 0.05 indicates there is a statistically significant difference between the treatment and control group in terms of the matching criteria. The chi square test accepted the null hypothesis, as the p-value is over 0.05 for each program year, indicating there are no statistically significant differences between the treatment and control groups household-level characteristics. Table

4-10 summarizes the results of the chi square test between the two matched groups for each program year.

Table 4-10 Treatment-Control Equivalency Test

Program Year	Chi Square Value	Degrees of Freedom	P-value
2018	14	22	0.903
2019	20.1	22	0.575

Figure 4-7 and Figure 4-8 displays the average daily heating load usage for the matched treatment and control groups for each program year. The post-period for PY2019 contained the months of July 2019 through February 2020, due to data cleaning restrictions and therefore the figure displays only these months.

Figure 4-7 PY2017-2018 Average Daily Heating Load for Matched Groups

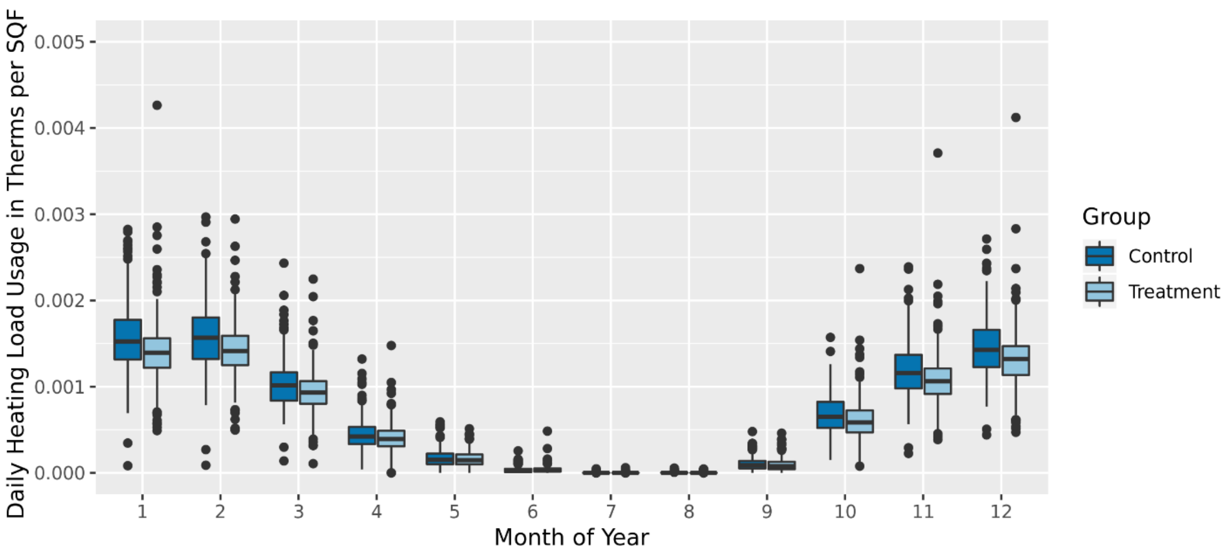
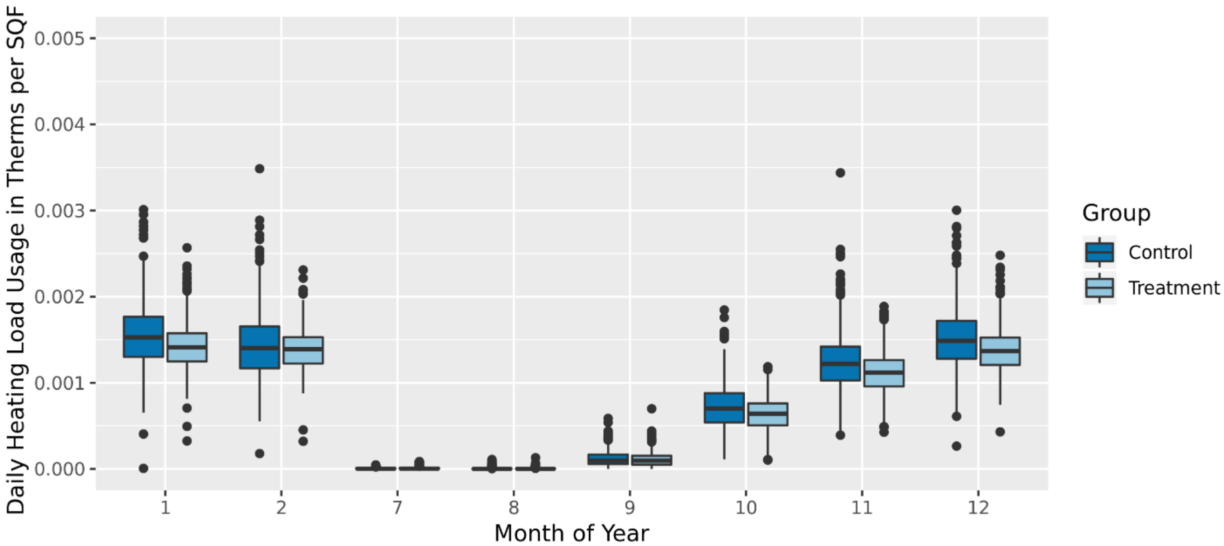


Figure 4-8 PY2019 Average Daily Heating Load for Matched Groups



4.2.2.4 Regression Results After Matching

This section details the regression results after performing propensity score matching for program premises. The Evaluators associated 3-digit zip codes with the nearest weather station with historical weather data and found all homes in the program to match with Boise weather station. As discussed in the evaluation approach section, savings are determined through parameters B1 and B3, which are defined again in Table 4-11, along with all the other model parameters. In any given month, per program home savings are calculated as follows: (B1*Days in Month*Square footage of Home) + (B3*HDD*Square footage of home). In computing HDD for each month, the Evaluators used TMY3 data for the Boise International Airport weather station. Monthly HDDs were calculated from the TMY data as the sum of daily average temperature values under 63°F in a given month.

Table 4-11 Whole Home Regression Parameters

Variable	Parameter	Interpretation
Treatment	B1	Average daily heating load usage per square foot for the treatment group
Daily HDD	B2	Average daily heating load usage per square foot per HDD
Treatment*Daily HDD	B3	Average daily heating load usage per square foot per HDD for the treatment group

Table 4-12 summarizes the results of the billing analysis for program participant households by program year. A p-value less than 0.05 indicates that the parameter estimate is statistically significant at the 95% confidence level. The coefficient estimates for Treatment*Daily HDD (B3) are negative, indicating lower usage per HDD in the post-period for treatment customers. In addition, these coefficients are statically significant at the 95% level in both program years.

The estimate for Treatment (B1) is positive for both, indicating negative savings that are independent of the weather or HDDs. This coefficient is not statistically significant for PY2019 but is statistically significant for PY2017-2018. This indicates that for PY2017-2018 homes, the treated homes display a statistically significant difference in heating load usage, independent of weather. This behavior difference was not able to be controlled with a valid control group matched on home characteristics and indicates some bias may remain between the groups for this program year.

Table 4-12 Whole Home Regression Results

Program Year	Variable	Estimate	Std Error	P-Value	5% CI	95% CI
2017-2018	(Intercept)	-1.45E-04	6.57E-06	<2e-16	-1.56E-04	-1.35E-04
	Treatment	1.88E-05	9.29E-06	0.0430	3.52E-06	3.41E-05
	Daily HDD	5.74E-05	3.42E-07	<2e-16	5.69E-05	5.80E-05
	Treatment*Daily HDD	-5.74E-06	4.84E-07	<2e-16	-6.54E-06	-4.94E-06
2019	(Intercept)	-1.10E-04	9.23E-06	2.69E-32	-1.25E-04	-9.47E-05
	Treatment	1.29E-05	1.29E-05	0.3179	-8.37E-06	3.42E-05
	Daily HDD	5.81E-05	4.58E-07	0.0000	5.73E-05	5.88E-05
	Treatment*Daily HDD	-5.57E-06	6.54E-07	2.06E-17	-6.65E-06	-4.50E-06

Each of the models showed they were a good fit for the data, as seen by the high Adjusted R-square and F values in Table 4-13. Model fit is slightly lower for PY2019, which is likely due to fewer observations in the post-period.

Table 4-13 Whole Home Model Fit

Program Year	Adjusted R2	F Statistic	Number of Observations	Number of Premises
2017-2018	0.8594	17,020	8,355	322
2019	0.8388	9,680	5,583	380

Table 4-14 summarizes monthly savings for each program year, extrapolated from TMY Heating Degree Days per month with a degree day base temperature of 63°F. The degree day base temperature was selected by observing the best fitting model for a range of base points between 55 and 75°F.

Table 4-14 Monthly Savings by Program Year

Month	HDD	PY2017-2018 Savings per Rebate (Therms)	PY2019 Savings per Rebate (Therms)
January	1,054	13.65	13.07
February	732	9.17	8.87
March	625	7.50	7.36
April	343	3.50	3.63
May	216	1.64	1.91
June	92	0.09	0.30
July	22	-1.14	-0.67
August	72	-0.43	0.00
September	122	0.35	0.70
October	341	3.42	3.57
November	712	8.80	8.55
December	857	10.82	10.44
Total	**5,188**	**57.18**	**57.75**

Method 1 using billing analysis provides the Whole Home Rebate measure an overall realization rate of 28% with 97,704 Therms savings across both program years. Table 4-15 presents the ex-ante, ex-post, and realization rate for each program year.

Table 4-15 Summary of Annual Program Savings

Program Year	Verified Program Savings (Therms)	Ex-Ante Program Savings (Therms)	Realization Rate
2018	35,393	126,276	28.03%
2019	62,311	220,116	28.31%
Total	**97,704**	**346,392**	**28.21%**

It is important to note that this billing analysis compares homes in the program-rebated homes to non-program homes built in the past few years. This analysis suggests that newer homes are being built at standards greater than the current residential building code. Simulated modeling with REM/Rate compares these homes to a code-built home and shows typical Therms savings values. Although new homes are built to meet current building codes, they are often more energy efficient, and can incorporate more recent technology. The Evaluators presents the results of an alternative approach to impact measurement for the program using calibrated simulation in Appendix B.

4.3 Program and Non-Program HERS Index Analysis

The Evaluators performed an exploratory analysis on the HERS Index scores between the treatment and control groups. IGC provided a dataset of HERS-rated homes in the territory. The Evaluators matched the supplied newly built non-program homes to the HERS dataset and found a number of non-program homes to be rated. The HERS dataset provided to the Evaluators did not contain any homes rated in 2019. Therefore, all non-program homes built in 2019 were removed from this analysis.

When comparing HERS Index scores between the program homes and non-program homes, it is important to remember that non-program homes would likely only get HERS-rated if the builder, homeowner, or rater believes that it will be energy-efficient enough to provide a satisfactory HERS rating. Otherwise, the builder, homeowner, or rater would likely not invest the additional cost of getting the house rated. Therefore, the HERS Index scores across non-program households is likely not indicative of the efficiency of non-rated households. However, it is still informative to compare the efficiency of the rated, non-program households, as they provide information about the changing market towards higher efficiency homes, even without incentives provided.

4.3.1 Total Program and Non-Program Households

The Evaluators found a total of 12% of non-program homes were built by participating builders in the IGC territory, and 15% of non-program homes received a HERS rating. The following table summarizes the percent of non-program homes built by participating builders and the percent of non-program homes rated. Of the 1,160 homes found in the HERS dataset, 902 (78%) were built by participating builders, but did not apply for a Whole Home Rebate. This represents 12% of all newly built homes in the IGC territory that IGC delivered to the Evaluators.

Table 4-16 Non-Program Homes in HERS Dataset

Year Built	Number of Homes	Homes in HERS Dataset	Built by Program Builder	% Built by Program Builder	Rated	% Rated
2016	15	15	15	100%	15	100%
2017	3,775	697	579	15%	697	18%
2018	3,813	448	308	8%	448	12%
2019	2,850	0	0	0%	0	0%
Total*	**7,603**	**1,160**	**902**	**12%**	**1,160**	**15%**

*Total estimates do not contain homes built in 2019

Of the non-program homes that were rated, the average HERS Index score was 63. The Whole Home Rebate homes displayed an average HERS Index score of 60 and 62 for program years 2018 and 2019, respectively. Table 4-17 displays the HERS Index score distribution for non-program homes built in 2016 through 2018. Table 4-18 displays the HERS Index score distribution for Whole Home Rebate participating homes for each program year.

Table 4-17 Non-Program Home Average Rating

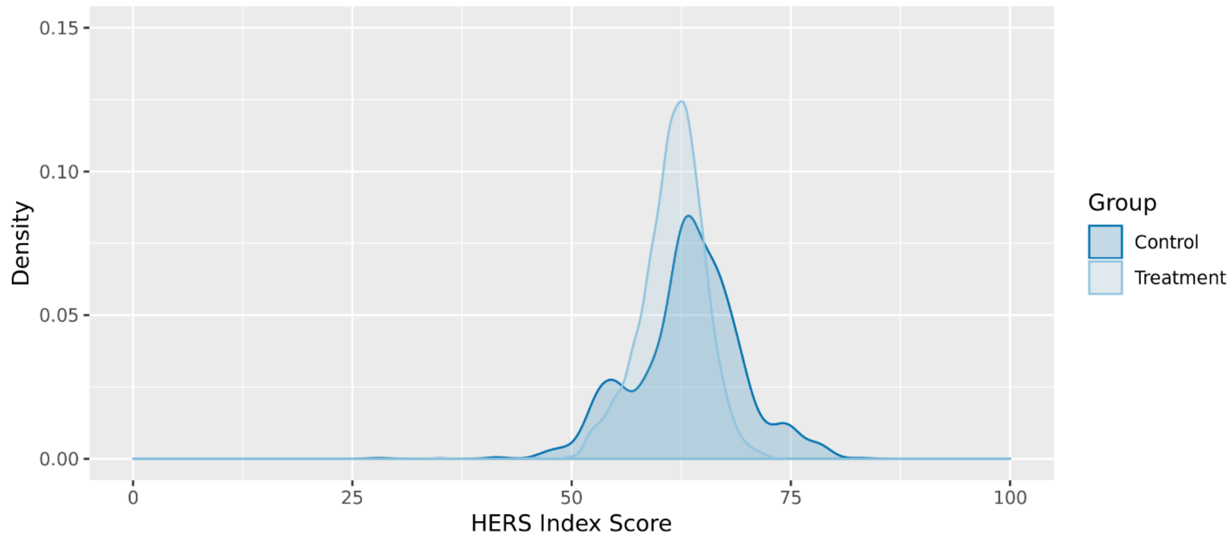
Year Built	Number of Rated Homes	Average HERS Index Score	Median HERS Index Score	Minimum HERS Index Score	Maximum HERS Index Score
2016	15	63.3	62	54	83
2017	697	63.0	64	28	79
2018	448	63.8	63	47	80
Total	**1,160**	**63.3**	**64**	**28**	**83**

Table 4-18 Whole Home Rebate Home Average Rating

Year Built	Number of Rated Homes	Average HERS Index Score	Median HERS Index Score	Minimum HERS Index Score	Maximum HERS Index Score
2017-2018	619	60.1	61	35	71
2019	1,079	62.4	63	50	72
Total	**1,698**	**61.6**	**62**	**35**	**72**

Figure 4-9 displays the distribution of HERS Index scores between all program and non-program premises found in the HERS dataset.

Figure 4-9 HERS Index Score Distribution by Group



This analysis shows that there are a number of homes outside of the program that are already being built to program standards. As noted prior, it should be noted that the homes in the HERS dataset are biased to be efficient because only homes that are being built efficiently will go through the effort to get a HERS rating from a certified HERS rater. However, this shows that the market for above-code, energy efficient homes is significant in the IGC territory and that homes have been and are still currently being built to above-code standards outside of the program.

4.3.2 Matched Program and Non-Program Households

The tables above display the statistics for all program homes and all non-program homes provided by IGC. The following tables display the statistics for the matched treatment and control group used in the billing analysis. These tables provide insight on a portion of the control group and how those homes compare against the treatment group, normalized by home characteristics matched during PSM.

Table 4-19 Matched Control Group in HERS Dataset

Program Year	Number of Matched Homes	Homes in HERS Dataset	Built by Program Builder	% Built by Program Builder	Rated	% Rated
2017-2018	322	46	32	10%	46	14%
2019	380	17	7	2%	17	4%
Total*	**702**	**63**	**39**	**6%**	**63**	**9%**

Table 4-20 Matched Control and Treatment Group Average HERS Ratings

Program Year	Group	Number of Rated Homes	Average HERS Index Score	Median HERS Index Score	Minimum HERS Index Score	Maximum HERS Index Score
2017-2018	Treatment	322	60	61	35	71
	Control	46	63	63	54	69
2019	Treatment	380	63	63	52	72
	Control	17	63	62	57	74
Total	**Treatment**	**702**	**62**	**62**	**35**	**72**
	Control	**63**	**63**	**63**	**54**	**74**

4.4 Incremental HERS Index Score Savings Analysis

In addition to estimating measure impact through this analysis, the Evaluators utilized the results of the simulation analysis detailed in Appendix B to determine if the HERS Index threshold of 75 or less is adequate enough to supply sufficient Therms savings in relation to incentive levels offered by this measure. This was accomplished by exploring how savings estimates change with respect to efficient home HERS ratings.

This is a parametric analysis of savings versus cost at different HERS levels and is based on estimated energy usage from the M&V sample reflecting various score levels (in 5-point increments on the HERS scale).

The HERS Index was developed by RESNET as a nationally recognized system for inspecting and calculating a home's energy performance[9]. The HERS Index is calculated on a per-home basis by comparing the home's data against a reference home – a designed model home of the same size and shape as the actual home. Therefore, the score is relative to the size of the home. Some of the components included in an energy rating are:

- Exterior walls (above and below grade);
- Floors over unconditioned spaces;

[9] https://www.hersindex.com/hers-index/what-is-the-hers-index/

- Ceilings and roofs;
- Attics, foundations and crawlspaces;
- Windows and doors, vents and ductwork; and
- HVAC systems, water heating systems, and thermostats.

RESNET defines their reference home based on the 2006 International Energy Conservation Code (IECC)[10]. Therefore, a home built to the 2006 building energy code would receive a HERS Index of 100. A Home Energy Rater performs an energy analysis of the home and assigns a HERS Index score to the home, based on how efficient it compares to the reference home. The home's score reduces by 1 point for every 1% more efficient it is simulated to be against the reference home. Therefore, if a home is 10% more efficient than the 2006 IECC, the home would receive a score of 90. The lower the score, the more efficient a home.

The Therms savings presented in this section is calculated by comparing the program-rebated homes to a User Defined Reference Home (UDRH) with 2012 IECC with Idaho amendments, instead of the RESNET reference home using 2006 IECC. The Evaluators used the 2012 IECC with Idaho amendments in order to define savings based on current residential code. Further details on the specifications of the UDRH is provided in Appendix B.

4.4.1 Savings by HERS Index Score

The Evaluators performed a comparative savings analysis using the 2012 IECC UDRH on a sample of homes using REM/Rate across homes receiving different HERS Index scores. The Evaluators combined homes into groups by 5-point increment HERS Index bracket. A number of variables were explored in this analysis in order to understand how savings vary as the HERS Index score reduces. The Evaluators compared Therms savings normalized by home size.

This represents the average difference in household usage between a home simulated as the Whole Home rebated household and the User Defined Reference Home (UDRH) built to the same physical specifications of the program homes. The following tables display the average Therms and kWh savings by 5-point increments in HERS Index.

Table 4-21 Whole Home to UDRH Therms Savings by HERS Bin

HERS Index	Number of Homes	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)
51 to 55	4	280.25	12.50	0.00	292.75
56 to 60	20	258.25	12.75	0.00	271.10
61 to 65	36	252.39	14.42	0.00	266.94
66 to 70	8	288.63	14.25	0.00	303.13

[10] https://www.resnet.us/raters/hers-raters/

Table 4-22 Whole Home to UDRH kWh Savings by HERS Bin

HERS Index	Number of Homes	Space Heating (kWh)	Cooling (kWh)	Lights & Appliances (kWh)	Total (kWh)
51 to 55	4	145	160	1,116	1,446
56 to 60	20	162	125	952	1,239
61 to 65	36	134	120	886	1,139
66 to 70	8	138	218	982	1,338

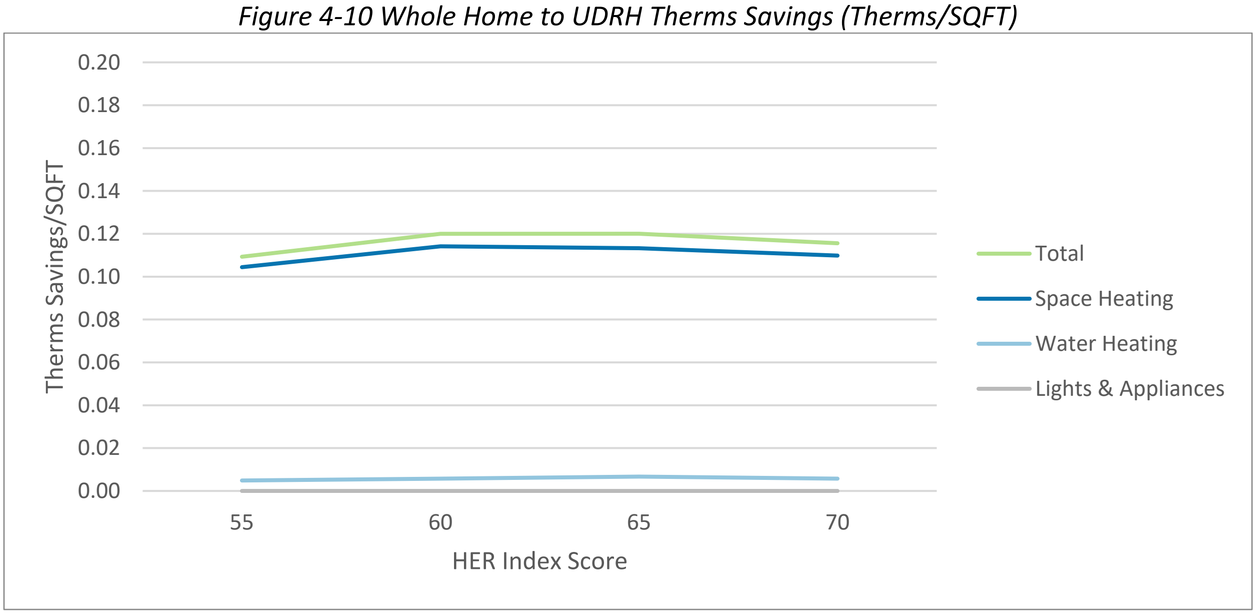
The absolute savings between homes scoring 70 and homes scoring 50 ranges between 11 and 37 Therms and between 108 and 307 kWh. The savings do not show a trend of increasing across the HERS Index bins.

Instead of comparing absolute savings between the HERS brackets, the Evaluators compared the savings normalized by home square footage to discover if there is a trend in fuel per square footage across the brackets. Table 4-23 displays the savings differences between each HERS Index score normalized by home square footage. Normalizing the savings by square footage allows comparison between differing households. A visual representation of the values is presented in Figure 4-10.

Table 4-23 Whole Home to UDRH Therms Savings by HERS Bin

HERS Index	Number of Homes	Space Heating (Therms/SQFT)	Water Heating (Therms/SQFT)	Lights & Appliances (Therms/SQFT)	Total (Therms/SQFT)
51 to 55	4	0.1147	0.0051	0	0.1197
56 to 60	20	0.1062	0.0052	0	0.1114
61 to 65	36	0.1157	0.0066	0	0.1224
66 to 70	8	0.1335	0.0064	0	0.1400

Figure 4-10 Whole Home to UDRH Therms Savings (Therms/SQFT)

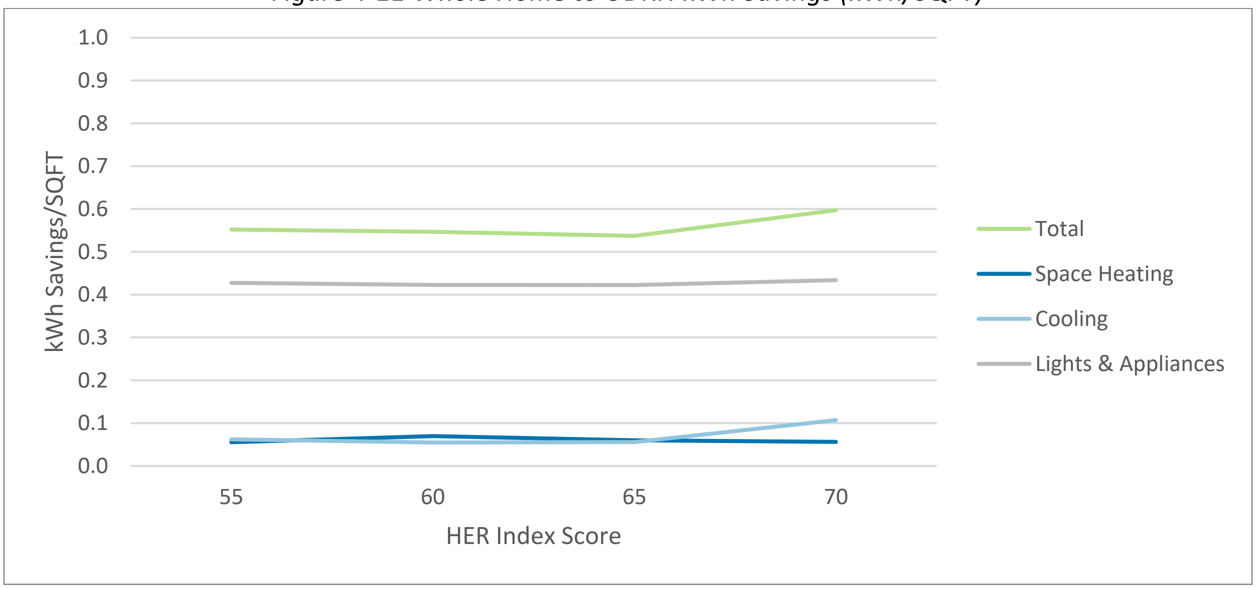


It is expected that the lower the HERS Index score, the higher the energy savings. However, the Evaluators found the savings normalized by square footage remains relatively constant across a 20-point HERS Index range. The same lack of relationship is seen when analyzing the electric savings across the HERS Index. Table 4-24 and Figure 4-11 display the electric savings across the HERS Index.

Table 4-24 Whole Home to UDRH kWh Savings by HERS Bin

HERS Index	Number of Homes	Space Heating (kWh/SQFT)	Cooling (kWh/SQFT)	Lights & Appliances (kWh/SQFT)	Total (kWh/SQFT)
51 to 55	4	0.0588	0.0652	0.4536	0.5892
56 to 60	20	0.0681	0.0529	0.3820	0.5030
61 to 65	36	0.0616	0.0545	0.4167	0.5322
66 to 70	8	0.0634	0.0982	0.4698	0.6317

Figure 4-11 Whole Home to UDRH kWh Savings (kWh/SQFT)



The lack of trend is apparent when inspecting ten homes that were given a HERS Index score of 60. Between the 10 homes, total normalized Therms savings ranged between 0.05 Therms per square foot and 0.18 Therms per square foot. That amounts to an equivalent of a range of 125 Therms to 450 Therms for a 2,500 square foot home.

4.4.2 Percent Savings by HERS Index Score

The following section presents the proportion of energy saved against the 2012 IECC with amendments UDRH by HERS Index. The following tables and figures show that as the HERS Index score lowers (improves efficiency), total percent savings in both gas and electric end uses increase, from 28% to 32% for gas usage and from 15% to 17% for electric usage. The majority of savings for both fuels stems from increased efficiency in space heating. A more efficient home on the HERS Index saves as much as 39% Therms in space heating against the UDRH, while a less efficient home on the HERS Index saves 32%. The source of the increased proportional savings can be pinpointed by evaluating how the component load changes across HERS Index, detailed in the section below.

Table 4-25 Whole Home to UDRH Percent Therms Savings by HERS Bin

HERS Index	Number of Homes	Space Heating (%)	Water Heating (%)	Lights & Appliances (%)	Total (%)
51 to 55	4	39.49%	8.16%	0.00%	32.31%
56 to 60	20	34.85%	8.65%	0.00%	29.89%
61 to 65	36	33.14%	9.79%	0.00%	28.74%
66 to 70	8	32.28%	8.87%	0.00%	28.26%

Table 4-26 Whole Home to UDRH Percent kWh Savings by HERS Bin

HERS Index	Number of Homes	Space Heating (%)	Water Heating (%)	Lights & Appliances (%)	Total (%)
51 to 55	4	29.74%	16.14%	15.89%	17.01%
56 to 60	20	23.44%	13.55%	14.28%	15.05%
61 to 65	36	19.31%	11.62%	13.52%	13.89%
66 to 70	8	19.40%	17.51%	13.65%	14.48%

Figure 4-12 Whole Home to UDRH Percent Therms Savings (%)

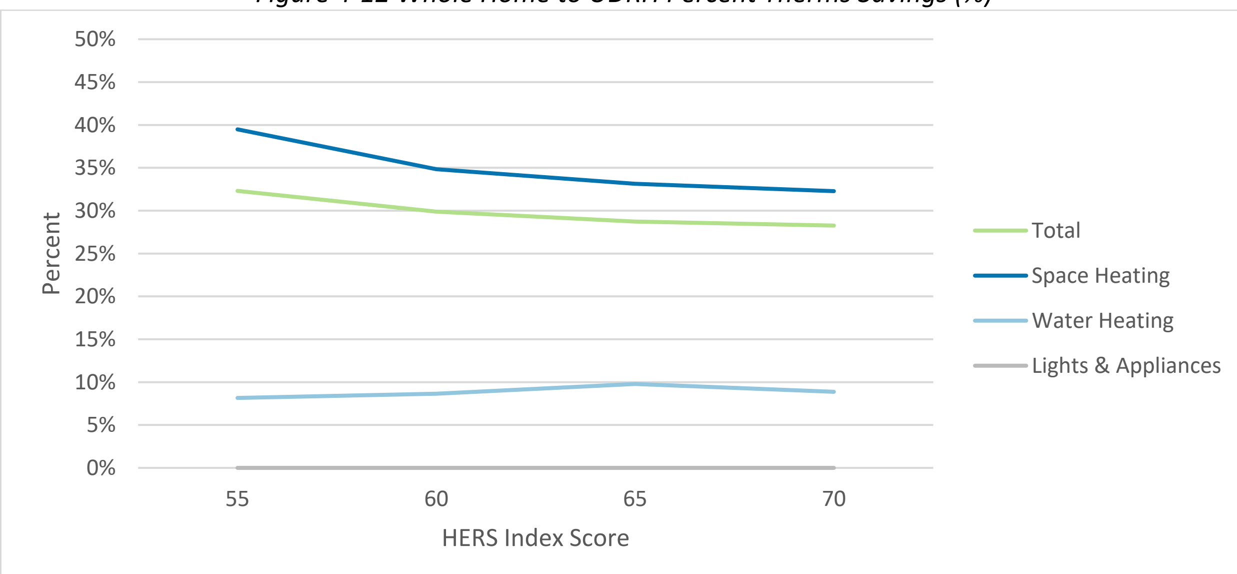
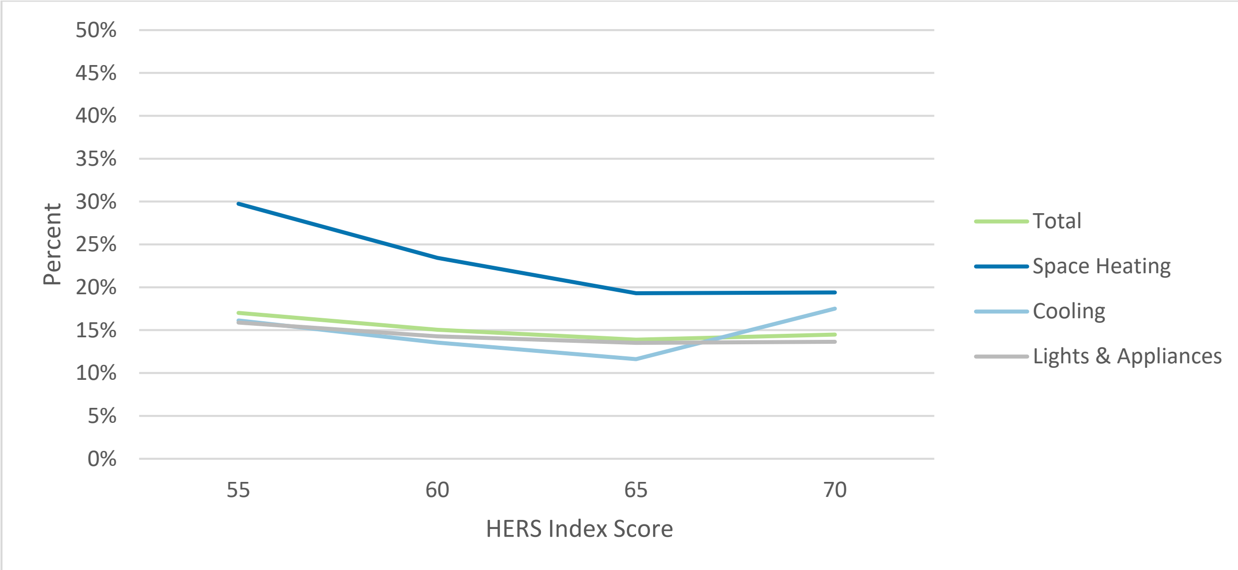


Figure 4-13 Whole Home to UDRH Percent kWh Savings (%)



4.4.3 Component Load Savings by HERS Index Score

To identify energy efficient variables that contribute the most to energy savings in a new home, the Evaluators compared the sampled home's as-built heating component loads against its reference home heating component loads. The component load consists of the main categories compared in the simulated analysis, using inputs from the HERS raters and the 2012 IECC. The Evaluators found the infiltration reduction in the program home displayed the largest component load reductions. About two thirds of the total component load reductions stem from infiltration reduction. Other measures that contribute to savings are: energy efficient windows, duct sealing, and ceiling insulation. Table 4-27 displays the energy savings by component load between the program homes and the UDRH in the REM/Rate analysis.

Table 4-27 Whole Home to UDRH Component Load Annual MBtuh Savings

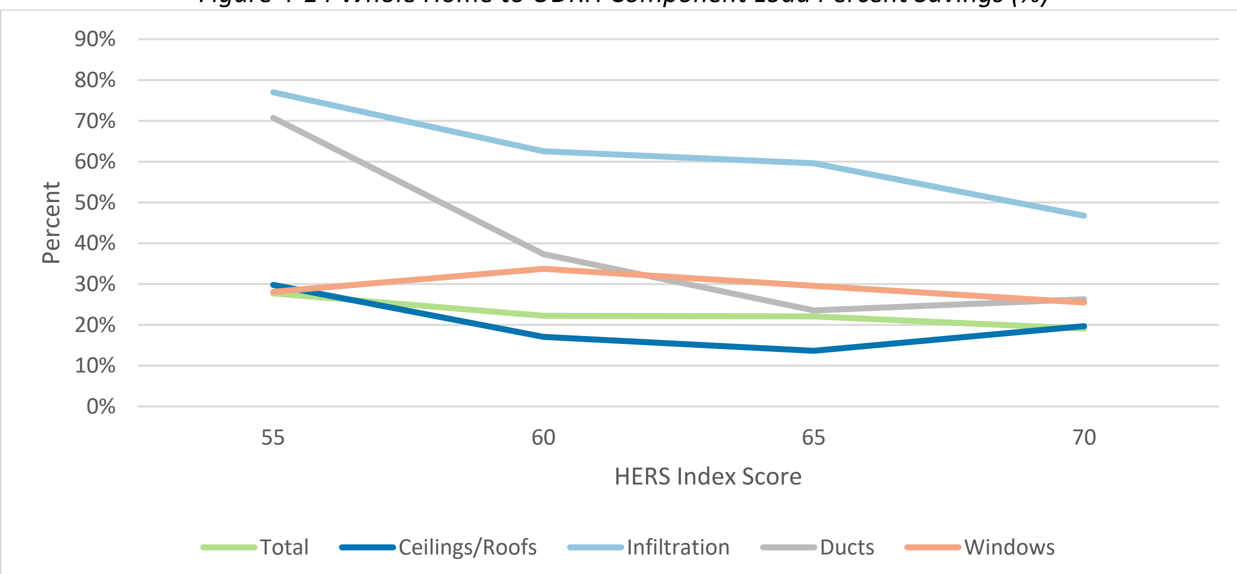
HERS Index	Ceilings/Roofs	Rim/Band Joists	Above Grade Walls	Foundation Walls	Doors	Window/Skylights	Frame Floors	Crawl Space	Slab Floors	Infiltration	Mechanical Ventilation	Ducts	Active Solar	Sunspace	Internal Gains	Whole House Ventilation	Total
51 to 55	2.20	0.13	1.35	-0.02	0.55	2.13	0.00	0.00	-1.63	11.28	0.00	2.13	0.00	0.00	-2.30	0.00	15.75
56 to 60	1.26	0.21	0.71	0.25	0.66	3.27	0.04	-0.08	-1.81	8.96	-0.01	1.97	0.00	0.00	-1.99	0.00	13.41
61 to 65	1.07	0.18	0.24	0.50	0.64	3.29	-0.02	-0.12	-1.45	8.28	-0.02	1.69	0.00	0.00	-1.71	0.00	13.28
66 to 70	1.76	0.19	0.66	-0.35	0.65	3.80	-0.20	0.00	-0.10	7.49	0.00	1.94	0.00	0.00	-1.94	0.00	13.94

Table 4-28 Whole Home to UDRH Component Load Percent Savings

HERS Index	Ceilings/Roofs	Rim/Band Joists	Above Grade Walls	Foundation Walls	Doors	Window/Skylights	Frame Floors	Crawl Space	Slab Floors	Infiltration	Mechanical Ventilation	Ducts	Active Solar	Sunspace	Internal Gains	Whole House Ventilation
51 to 55	30%	7%	11%	6%	34%	28%	0%	0%	-26%	77%	0%	71%	0%	0%	14%	0%
56 to 60	17%	12%	6%	9%	36%	34%	2%	-3%	-29%	63%	0%	37%	0%	0%	13%	0%
61 to 65	14%	11%	2%	11%	34%	30%	0%	-3%	-22%	60%	0%	24%	0%	0%	12%	0%
66 to 70	20%	10%	5%	-3%	34%	25%	-2%	0%	-2%	47%	0%	26%	0%	0%	12%	0%

The components leading to the highest magnitude savings is the increased efficiency in ceiling insulation, windows, infiltration, and duct sealing. These categories represent the largest differences between the UDRH and the rebated homes in the sample. The increase in proportional savings for these components can be seen in Figure 4-14.

Figure 4-14 Whole Home to UDRH Component Load Percent Savings (%)



4.4.4 Summary of Incremental HERS Index Score Savings Analysis

The HERS Index places value on the percent change in annual household energy usage between the as-built home and the 2006 IECC reference home rather than the absolute energy usage of the household. This means that a household that has 5 bedrooms, 5 bathrooms, and is 4,000 square feet has the potential to receive the same score as a household that has 1 bedroom, 1 bathroom, and is 1,000 square feet large.

This is because the HERS Index depends on the proportional difference between the as-built home and the reference home is the same percent, rather than the magnitude of the reference home annual usage.

Therefore, the Evaluators is unable to recommend an incremental savings value for each HERS Index bracket. The Therms savings per household varies widely based on the baseline annual energy usage of each household. The results of this analysis suggest that lowering the HERS Index requirement of the Whole Home measure does not guarantee higher Therms savings per rebate. The HERS Index is not designed to evaluate absolute energy savings of a household, but rather used as a comparison against other homes with very similar physical characteristics, such as number of bedrooms, bathrooms, and square footage.

To improve savings, IGC should consider more specific requirements in the construction of the home:

- 95% AFUE furnaces
- Tankless water heaters
- R-49 attic insulation
- Increased air sealing and duct sealing

4.4.5 Benchmarking HERS Index Score Requirements

Although the Evaluators is unable to determine incremental savings between HERS Index scores, a benchmarking analysis was completed on current building codes and reports.

The Evaluators summarized the total percent Therms savings for each HERS Index present in the sample of 68 households, displayed in Table 4-29. According to the HERS Index calculation method, a home scoring 60 should be 40% more efficient than the reference home. However, because RESNET's reference home uses an outdated building code from 2006, the percent savings comparing the program homes to the 2012 IECC with Idaho's amendments UDRH is lower. The percent savings a home scoring 60 displays in the Evaluators' analysis is 19% more efficient than the reference home.

Table 4-29 Percent Therms Savings by Prevalent Component Load (%)

HERS Index Score	Total
53	30%
54	28%
55	25%
56	27%
57	29%
58	23%
59	22%
60	19%
61	22%
62	21%
63	27%
64	18%
65	16%
66	23%
67	17%
68	17%

The U.S. Department of Energy estimates the 2012 IECC is expected to decrease energy consumption in homes by 30% when compared to the 2006 IECC[11]. Therefore, a home built to 2012 IECC code would achieve a HERS Index score of 70. IGC requires a HERS Index score of 75; this is less efficient than 2012 IECC and thus is an insufficient requirement to provide incremental savings above code.

RESNET reported 1,164 households were HERS-rated in 2018 with an average HERS rating of 61[12]. The average Idaho rating is 1 point higher than the average HERS rating across all program-rebated homes. As mentioned before, this comparison includes the caveat that HERS-rated homes will likely only get rated if the builder, homeowner, or rater believes it will receive a satisfactory HERS Index score. However, this does indicate that the housing market is progressing towards higher efficiency homes, as a higher proportion of homes are receiving HERS Index scores in the IGC territory.

In addition, the 2020 Idaho Legislature has recently adopted the 2018 IECC with amendments, effective January 1, 2021[13]. The 2018 IECC includes a new requirement that the home's Energy Rating Index (ERI) score must be 68 or less. The HERS Index is one type of ERI and qualifies as a suitable index for this requirement. According to this new legislature, the Whole Home rebate HERS Index score requirement would be less efficient than effective residential building code, starting at the beginning of 2021.

The Pacific Northwest National Laboratory analyzed the relationship between the RESNET HERS Index and the traditional simulation-based Performance Path used in the IECC[14]. The analysis evaluates the ranges of HERS Index values that would imply compliance with the 2012 IECC. The report summarized the range of HERS Index scores that would be required to comply with current building codes, for each weather zone. The following table summarizes largest range of HERS Index requirements presented in the report, for weather zones 5 and 6, the weather zones in Idaho and in the IGC service territory[15].

Table 4-30 Pacific Northwest National Laboratory HERS Index Compliance Range

Zone	Lowest	Highest	Range
Zone 5, Moist	53	64	11
Zone 5, Dry	53	65	12
Zone 6, Moist	48	63	15
Zone 6, Dry	51	65	14

It is important to note that, as described above, score of the home does not relate to the absolute Therms savings per household. Therefore, homes may still achieve measurable Therms savings while still receiving

[11] http://www.resnet.us/wp-content/uploads/archive/resblog/2014/06/EnergyRatings_FactSheet1_Final.pdf

[12] https://www.resnet.us/articles/demand-for-hers-continues-to-grow-over-236000-homes-hers-rated-in-2018/

[13] https://www.idahoenergycode.com/2018-iecc-a-quick-look

[14] https://www.energycodes.gov/sites/default/files/documents/HERSandIECCPerformancePath_TechnicalReport.pdf

[15] The values presented in this table represent the aggregated lowest and highest CHI for each weather zone, and therefore the range differs compared to the disaggregated value ranges in the report.

a high HERS Index score. This benchmarking study does, however, indicate that the HERS Index score standard for a code-built home is decreasing, and that program requirements may need to increase in order to keep up with building codes.

4.5 ENERGY STAR Certification Analysis

In addition to calculating the average savings between a UDRH and the Whole Home-rebated home, the Evaluators conducted a comparative analysis between a UDRH and an ENERGY STAR certified home. This was accomplished by using the home model simulation with adjusted inputs to reflect a home satisfying ENERGY STAR certification requirement. The ENERGY STAR certification requirements are included in the software REM/Rate and were readily available for each modeled home in the sample of 68 households.

This analysis provides insight into one of the two requirements for the Whole Home Rebate: the ENERGY STAR certification. The outcome of this analysis can guide the decision to make adjustments to program requirements in the future.

4.5.1 ENERGY STAR Compared Against UDRH

The Evaluators compiled the annual energy savings for each of the 68 households. The average Therms savings between the UDRH and an ENERGY STAR-certified home are summarized in Table 4-31 by program year. In addition, the average kWh savings is presented in Table 4-32.

Table 4-31 ENERGY STAR to UDRH Average Annual Therms Savings

Program Year	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)
2017-2018	263.71	-54.33	1.04	210.88
2019	241.11	-49.50	-0.18	191.20
Total	**249.09**	**-51.21**	**0.23**	**198.15**

Table 4-32 ENERGY STAR to UDRH Average Annual kWh Savings

Program Year	Space Heating (kWh)	Cooling (kWh)	Lights & Appliances (kWh)	Total (kWh)
2017-2018	172.46	-529.96	-337.25	-696.88
2019	136.05	-436.61	473.93	173.18
Total	**148.90**	**-469.56**	**187.63**	**-133.90**

The average ENERGY STAR-certified home saves nearly 200 Therms compared to the UDRH. The savings originate from the increase in space heating efficiency. However, the ENERGY STAR certified homes display a negative savings for water heating. In terms of electric usage, the ENERGY STAR requirements show larger annual electric usage than the baseline UDRH. The negative savings originates from the cooling components of the household.

As a reference, the average program home saved nearly 274 Therms compared to the UDRH. Therefore, this analysis suggests the ENERGY STAR certification results in 27% lower savings than a home that meets other IGC requirements but is not ENERGY STAR-certified. However, it is important to note that the

Evaluators is unable to separate the Whole Home requirement from the ENERGY STAR requirement. The ENERGY STAR requirement may therefore supplement the program's HERS Index score requirement, rather than being included in it.

4.5.2 ENERGY STAR Homes Compared Against Program Homes

As a supplement, the Evaluators also compared the ENERGY STAR home to the as-built Whole Home. This analysis may provide insight into the incremental savings between a rebated home and an ENERGY STAR certified home. The average savings between the 68 sampled Whole Home and the equivalent modeled ENERGY STAR certified homes are presented in Table 4-33 and Table 4-34.

Table 4-33 ENERGY STAR to Whole Home Average Annual Therms Savings

Program Year	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)
2017-2018	-18.58	-66.88	1.04	-84.25
2019	-6.75	-63.98	-0.59	-71.18
Total	-10.93	-65.00	-0.01	-75.79

Table 4-34 ENERGY STAR to Whole Home Average Annual kWh Savings

Program Year	Space Heating (kWh)	Cooling (kWh)	Lights & Appliances (kWh)	Total (kWh)
2017-2018	1.04	-689.33	-1,170.79	-1,858.83
2019	7.82	-558.39	-509.50	-1,062.68
Total	5.43	-604.60	-742.90	-1,343.68

This analysis estimates that an ENERGY STAR certified home, on average, uses an additional 75 Therms per year when compared against a rebated home. In addition, an ENERGY STAR certified home uses 1,300 more kWh per year than a rebated home. The increased energy usage towards space heating and cooling stems from lower duct sealing and window efficiency requirements for ENERGY STAR homes than the rebated homes currently being built in Idaho. In addition, the rebated homes have much more efficient lighting and appliances than an ENERGY STAR certified home. The ENERGY STAR certified home shows lower efficiency in all household load components except doors and windows. This comparison shows that the ENERGY STAR certification alone leads to lower savings than the Whole Home requirements of both the ENERGY STAR certification and the HERS Index score requirement.

4.5.3 ENERGY STAR Certification Analysis Summary

The Evaluators compared simulated energy usage between the UDRH, the rebated home, and simulated ENERGY STAR certified home. Although the Evaluators are unable to separate the savings from the ENERGY STAR certification and the HERS requirement, the average differences in savings between each scenario provides insight into the combination of requirements. This analysis revealed that the ENERGY STAR certification alone amounts to approximately 27% lower annual Therms savings than the rebated homes. The rebated homes display higher efficiency in all load components except doors and windows.

4.6 Program Home Time-on-Market Analysis

The Evaluators conducted an analysis to determine if there is a statistically significant difference in the amount of time it took to sell a participating house and a non-participating housed. Over the course of the of the Energy Efficiency programs, IGC was instrumental in the increase from two builders to the current 18 builders in the service territory to become 100% ENERGY STAR certified. The information from this analysis may be useful in encouraging more builders to become 100% ENERGY STAR certified as well.

The Evaluators performed a linear regression on the amount of time a Whole Home rebated home remained on the market compared to the amount of time nonparticipant households remained on the market. This analysis can reveal tangible benefits of participating in the Whole Home Rebate with the connection of IGC's efficiency approval to active homebuyers.

4.6.1 Time-on-Market Analysis Methodology

The billing data provided sufficient information to carry out this analysis. IGC provided premise information including earliest billed date and occupancy date, unique to each premise. Using the information above, the Evaluators conducted the following data cleaning steps:

- Removed observations with unknown occupancy dates (104 occurrences)
- Calculated number of days between earliest bill date and occupancy date
- Removed observations with invalid earliest bill dates (15 occurrences)
- Removed observations with occupancy date equal to or earlier than earliest bill date (18 occurrences)
- Removed program and non-program households outside of previously matched groups from Method 1.

The Evaluators selected a random sample of 200 of the remaining treatment premises after the cleaning steps above. The Evaluators then matched to 200 nonparticipating homes, following the above cleaning steps. The matching criteria is the same matching criteria used in the Method 1 billing analysis for Whole Home-rebated homes. Summarized here again, those criteria were:

- Zip code
- Year built
- Number of bedrooms
- Number of bathrooms
- Number of fireplaces
- Square footage of home
- Square footage of upper floor
- Square footage of pool
- Square footage of attic
- Square footage of garage

The Evaluators used nearest neighbor for all the above characteristics, and exact matching for zip code with a 1:1 ratio for matching. It is important the homes being compared are in as similar geography as possible. Therefore, during the matching process, the 5-digit zip code must match exactly to the control household, with all other variables matched at the nearest household. This will account for small geographic differences between the groups. This analysis combined both program years into one treatment group and therefore only one regression was completed.

The matched control group passed the chi square equivalency test, a test that estimates the goodness of fit between two groups. A p-value of less than 0.05 indicates there is a statistically significant difference between the treatment and control group in terms of the matching criteria. The chi square test accepted the null hypothesis, as the p-value is over 0.05 for each program year, indicating there are no statistically significant differences between the treatment and control groups household-level characteristics. Table 4-35 summarizes the results of the chi square test between the treatment and control group.

Table 4-35 Treatment-Control Equivalency Test

Chi Square Value	Degrees of Freedom	P-value
8.53	21	0.992

The Evaluators collected assessed home value from the Ada County Assessor database to include in the regression model to correct for differences in costs for program- and non-program homes.

Equation 4-2: Random-Effects Panel Regression Model Specification

$$\begin{aligned} Days\ on\ Market_i &= \beta_1(Treatment)_{it} + \beta_2(SQFT)_{it} + \beta_3(Bedrooms)_{it} + \beta_4(Bathrooms)_{it} \\ &+ \beta_5(HERS\ Dummy)_{it} + \beta_6(Pool\ Dummy)_{it} + \beta_7(Zip\ Code)_{it} \\ &+ \beta_8(Month\ Listed)_{it} + \beta_9(Year\ Built)_{it} + \beta_{10}(Home\ Value)_{it} \end{aligned}$$

Where,

$Days\ on\ Market_i$ = Number of days between earliest premise bill and occupancy in home *i*

$Treatment_i$ = Dummy variable indicating whether household *i* was in the treatment group or control group

$SQFT_i$ = Square footage of home *i*

$Bedrooms_i$ = Number of bedrooms of home *i*

$Bathrooms_i$ = Number of bathrooms of home *i*

$HERS\ Dummy_i$ = Dummy variable indicating whether household *i* has a HERS rating

$Pool\ Dummy_i$ = Dummy variable indicating whether household *i* has a pool

$Zip\ Code_i$ = The 5-digit zip code of household *i*

$Month\ Listed_i$ = The month of the earliest bill date for household *i*

$Year\ Built_i$ = The year household *i* was built

$Home\ Value_i$ = The home value of household *i* from Ada County Assessor database

β_{1-10} = Coefficients determined via regression

The coefficient β_1 represents the average change in days on market between the groups.

4.6.2 Time-on-Market Analysis Results

This section details the time-on-market regression results after performing propensity score matching for program homes with Whole Home Rebate. As discussed in the methodology section, the difference in time on market between groups is determined through parameter B1, which is the average change in days on market for the treatment group.

Table 4-36 summarizes the results of the analysis. A p-value less than 0.05 indicates that the parameter estimate is statistically significant at the 95% confidence level. The coefficient estimate for Treatment (B1) is negative, indicating the treatment group is on the market for a lower number of days than the control group. In addition, this coefficient is statically significant at the 95% level.

Table 4-36 Whole Home Regression Results

Variable	Estimate	Std Error	P-Value	5% CI	95% CI
Intercept	123.0540	21.8329	3.48E-08	87.0509	159.0570
Treatment	-38.6892	11.9828	1.36E-03	-58.4491	-18.9293
SQFT	0.0176	0.0080	2.79E-02	0.0044	0.0307
Bedrooms	0.5149	4.6818	9.12E-01	-7.2056	8.2353
Bathrooms	-0.1644	7.5745	9.83E-01	-12.6549	12.3260
HERS Dummy	33.7273	12.0843	5.53E-03	13.7999	53.6547
Pool Dummy	19.9998	39.1337	6.10E-01	-44.5327	84.5324
Zip Code	0.9241	20.2587	9.64E-01	-32.4831	34.3312
Month Listed	8.3444	12.7904	5.15E-01	-12.7472	29.4361
Year Built	-33.0853	12.6134	9.08E-03	-53.8851	-12.2854
Home Value	-6.91E-05	2.25E-05	2.25E-03	-1.06E-04	-3.21E-05

The following table represents the model fit for this analysis. The adjusted R-squared value is 0.1775, indicating that the model accounts for 17.8% of the variation present in the data. Although this adjusted R-squared value is low, the model contains many of the primary covariates present in determining the marketability of a household. Further addition of covariates could lead to overfitting the model, where the coefficients would not apply to homes outside of the dataset.

Table 4-37 Time-on-Market Model Fit

Adjusted R2	F Statistic	Number of Observations	Number of Premises
0.17747	3.939	366	396

The regression analysis suggests the Whole Home-rebated house sell 39 days faster than a similar non-Whole Home rebated house. This statistic is statistically significant at the 95% confidence interval. The median number of days a non-program home remains on market is 90, similar to current realtor estimates in the United States. This analysis suggests that, on average, a non-program builder may be able to reduce the amount of time invested to sell a home by 43%. Because the control group was matched by home characteristics, location, and price, this suggests the Whole Home Rebate measure requirements and IGC's mark of approval from the program results in program homes selling more quickly than non-program homes. This information can be communicated to builders as an incentive to building homes that meet program requirements of home energy efficiency.

4.7 Builder and Rater Savings Profile

Realization rates were examined for commonalities among home builders and HERS raters to inform IGC if any program partner demonstrated a statistically significant increased likelihood of association with low or high realization rates. The Evaluators then reviewed the home results in further detail to identify root-cause of statistically significant differences.

The tracking data for PY2017-2018 and PY2019 included 27 unique builders total. The Evaluators randomly selected 80 homes, stratified by builder and program year in order to ensure representativeness. This sample included 15 unique builders and two unique raters. The following sections presents the findings from examination of each builder's and each rater's simulation analysis results.

4.7.1 Builder Savings Profile

The Evaluators created a profile for each builder's estimated savings through simulation analysis. The average HERS Index scores, absolute Therms savings, normalized Therms savings, and realization rates are summarized below for each of the 15 sampled builders. Builder 5 has the lowest realization rate of all the builders at 88%, while Builder 10 and Builder 14 have the highest realization rates, at 186%. Figure 4-15 displays each builder's average HERS Index score and Therms savings per rebate. Figure 4-16 displays each builder's average HERS Index score and normalized Therms savings by square footage. These figures display that HERS Index score is not representative of Therms savings, absolute and normalized.

Table 4-38 Simulation Analysis Summary by Builder

Builder	Sampled Homes	Average HERS Index Score	Average Therms Savings per Rebate	Average Therms Savings per Square Foot	Average Realization Rate (%)
Builder 1	14	63.4	272.71	0.1291	133.68%
Builder 2	10	60.3	258.40	0.1088	126.67%
Builder 3	7	62.0	268.57	0.1169	131.65%
Builder 4	6	60.5	242.83	0.1110	119.04%
Builder 5	5	62.8	180.20	0.1096	88.33%
Builder 6	6	62.7	253.17	0.1266	124.10%
Builder 7	5	62.8	324.80	0.1160	159.22%
Builder 8	4	57.5	239.25	0.1359	117.28%
Builder 9	1	63.0	260.00	0.1183	127.45%
Builder 10	3	57.7	379.67	0.1081	186.11%
Builder 11	2	64.5	389.50	0.1294	190.93%
Builder 12	1	55.0	350.00	0.1229	171.57%
Builder 13	2	56.5	357.50	0.1316	175.25%
Builder 14	1	68.0	380.00	0.1084	186.27%
Builder 15	1	67.0	265.00	0.0778	129.90%

Figure 4-15 Average HERS Index Score and Therms Savings per Rebate by Builder

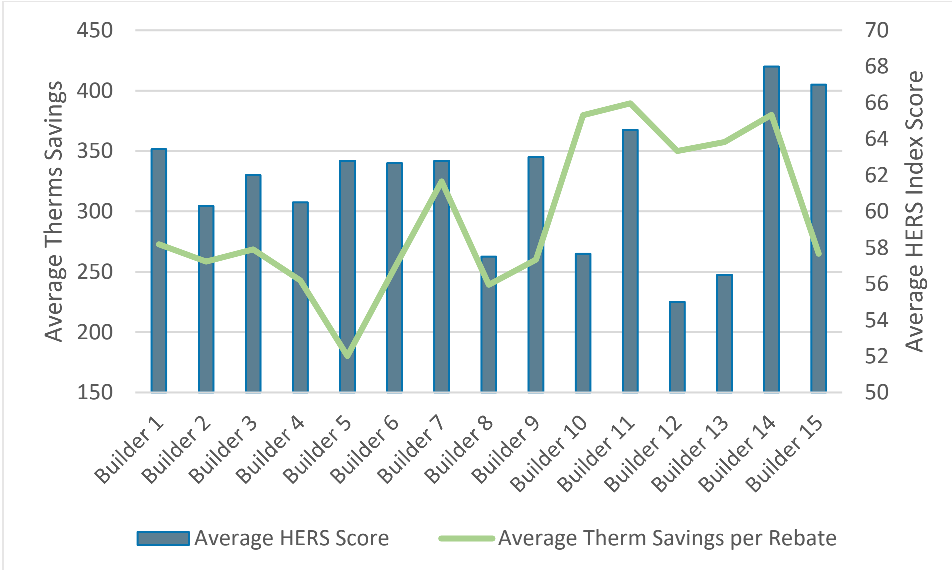
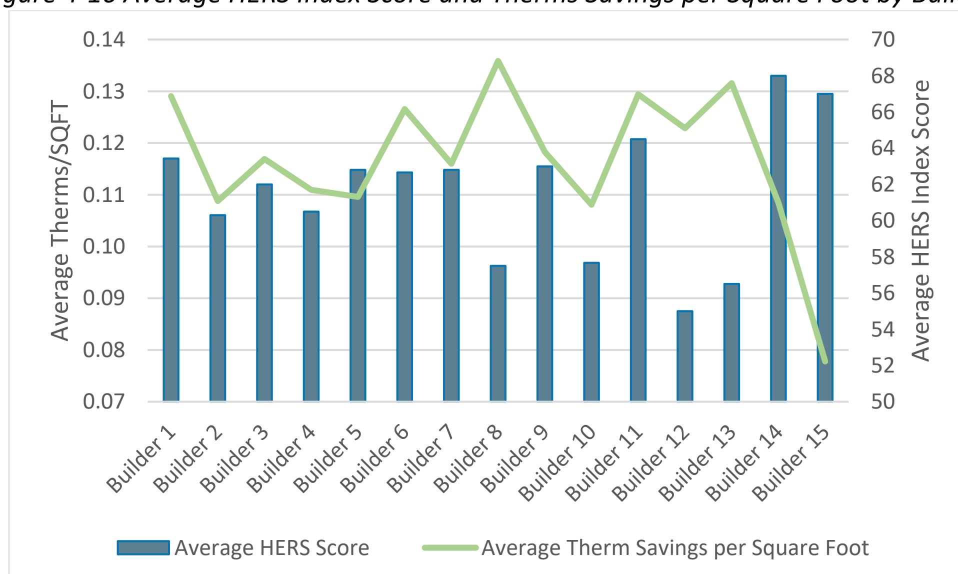


Figure 4-16 Average HERS Index Score and Therms Savings per Square Foot by Builder



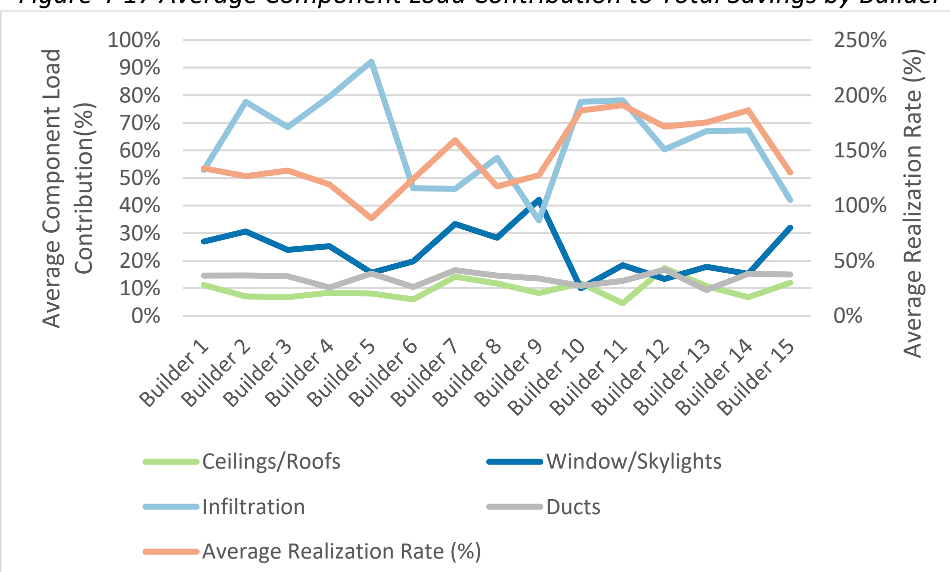
To assist with the examination of the 15 builders, the Evaluators also summarized the average proportion of savings for the four major component loads (ceilings/roof sealing, window efficiency, infiltration, and duct sealing) for each builder. Table 4-39 and Figure 4-17 portray the component load contribution to total savings by builder.

Builders that achieve higher realization rates tend to have reduced infiltration, duct leakage, and increase ceiling/roof insulation. These home's infiltration reduction provides the most energy savings (60-78% of the total savings). Duct sealing and ceiling efficiency gains provide about 10-17% of total savings.

Table 4-39 Component Load Contribution to Total Savings by Builder

Builder	Average Realization Rate (%)	Ceilings/Roofs	Window/Skylights	Infiltration	Ducts
Builder 1	133.68%	11.18%	26.97%	52.92%	14.61%
Builder 2	126.67%	7.05%	30.60%	77.60%	14.64%
Builder 3	131.65%	6.75%	23.94%	68.44%	14.36%
Builder 4	119.04%	8.37%	25.26%	79.52%	10.31%
Builder 5	88.33%	8.13%	15.66%	92.17%	15.36%
Builder 6	124.10%	5.96%	19.75%	46.24%	10.46%
Builder 7	159.22%	14.20%	33.33%	46.05%	16.54%
Builder 8	117.28%	11.74%	28.34%	57.29%	14.57%
Builder 9	127.45%	8.27%	42.11%	34.59%	13.53%
Builder 10	186.11%	11.80%	9.98%	77.61%	10.89%
Builder 11	190.93%	4.59%	18.38%	78.11%	12.70%
Builder 12	171.57%	17.32%	13.41%	60.34%	16.76%
Builder 13	175.25%	10.77%	17.80%	66.98%	9.37%
Builder 14	186.27%	6.78%	15.25%	67.23%	15.25%
Builder 15	129.90%	12.00%	32.00%	42.00%	15.00%

Figure 4-17 Average Component Load Contribution to Total Savings by Builder



In addition to summary statistics for each builder, the Evaluators examined the existence of statistically significant differences between builders in terms of realization rate, absolute Therms savings, normalized Therms savings, square footage of homes built, and HERS Index scores. The Evaluators conducted t-tests for each category, with the builder in question against the other 14 builders. The t-test was unable to be conducted on Builders 9, 12, 14, and 15 due to there only being one home sampled from each of these builders. A p-value of less than 0.05 indicates that there is a statistically significant difference between the groups. The tables below also display the 90% confidence intervals, along with p-value and mean difference between the groups being compared.

The Evaluators found there to be no statistically significant differences in normalized Therms savings. However, some builders display statistically significant differences in realization rate, absolute Therms savings, square footage, and HERS Index scores. The results of the t-tests for normalized Therms savings are displayed in Table 4-40.

Table 4-40 Average Normalized Therms Savings T-Test by Builder

Builder	Mean Difference	P-Value	5% CI	95% CI
Builder 1	0.0141	0.4576	-0.0251	0.0532
Builder 2	-0.0117	0.5117	-0.0495	0.0261
Builder 3	-0.0039	0.7640	-0.0321	0.0243
Builder 4	-0.0003	0.9910	-0.0731	0.0724
Builder 5	-0.0102	0.6618	-0.0678	0.0474
Builder 6	0.0088	0.6166	-0.0314	0.0491
Builder 7	-0.0058	0.6224	-0.0323	0.0206
Builder 8	0.0164	0.5621	-0.0602	0.0929
Builder 9	NA	NA	NA	NA
Builder 10	-0.0153	0.3642	-0.0614	0.0309
Builder 11	0.0147	0.8016	-0.5274	0.5568
Builder 12	NA	NA	NA	NA
Builder 13	0.0002	0.9919	-0.1599	0.1603
Builder 14	NA	NA	NA	NA
Builder 15	NA	NA	NA	NA

The results of the t-tests for realization rates are displayed in Table 4-41. The Evaluators found there to be statistically significant differences in realization rates for Builder 5, Builder 7, and Builder 13. Builders 7 and 13 display higher than average realization rates, while Builder 5 displays lower than average realization rates. The t-test revealed Builders 7 and 13 display, on average, 27% and 42% higher realization rates than the rest of the group, respectively; a difference that is statistically significant.

Table 4-41 Average Realization Rate T-Test by Builder

Builder	Mean Difference	P-Value	5% CI	95% CI
Builder 1	-0.01	0.9538	-0.28	0.26
Builder 2	-0.09	0.4464	-0.33	0.15
Builder 3	-0.03	0.8392	-0.35	0.29
Builder 4	-0.17	0.4082	-0.63	0.30
Builder 5	-0.50	0.0090*	-0.81	-0.18
Builder 6	-0.11	0.3035	-0.34	0.12
Builder 7	0.27	0.0230*	0.05	0.49
Builder 8	-0.18	0.3538	-0.67	0.31
Builder 9	NA	NA	NA	NA
Builder 10	0.54	0.2484	-0.87	1.96
Builder 11	0.58	0.3680	-4.00	5.17
Builder 12	NA	NA	NA	NA
Builder 13	0.42	0.0000*	0.32	0.52
Builder 14	NA	NA	NA	NA
Builder 15	NA	NA	NA	NA

*T-test indicates statistically significant difference between groups at the 90% confidence interval

The results of the t-tests for absolute Therms savings are displayed in Table 4-42. The Evaluators found there to be statistically significant differences in average absolute Therms savings per household for Builders 5, 7, and 13 as well.

Table 4-42 Average Absolute Therms Savings T-Test by Builder

Builder	Mean Difference	P-Value	5% CI	95% CI
Builder 1	-1.54	0.9538	-56.61	53.52
Builder 2	-18.22	0.4464	-67.88	31.44
Builder 3	-5.99	0.8392	-71.69	59.72
Builder 4	-34.12	0.4082	-128.49	60.26
Builder 5	-101.18	0.0090*	-165.51	-36.85
Builder 6	-22.78	0.3035	-69.90	24.33
Builder 7	54.90	0.0230*	9.81	99.98
Builder 8	-36.86	0.3538	-137.32	63.60
Builder 9	NA	NA	NA	NA
Builder 10	110.61	0.2484	-178.24	399.45
Builder 11	119.06	0.3680	-816.04	1054.16
Builder 12	NA	NA	NA	NA
Builder 13	86.09	0.0000*	65.81	106.37
Builder 14	NA	NA	NA	NA
Builder 15	NA	NA	NA	NA

*T-test indicates statistically significant difference between groups at the 90% confidence interval

The results of the t-tests for square footage are displayed in Table 4-43. The Evaluators found there to be statistically significant differences in average square footage per household for Builders 5, 6, 7, and 8.

Builders 5, 6, and 8 are shown to build homes that range between 414 and 721 square feet smaller than the rest of the group, whereas Builder 7 builds homes 469 square feet larger than the rest of the group.

Table 4-43 Average Square Footage T-Test by Builder

Builder	Mean Difference	P-Value	5% CI	95% CI
Builder 1	-165.19	0.3375	-512.71	182.33
Builder 2	174.08	0.4901	-359.99	708.14
Builder 3	-126.33	0.4372	-467.98	215.32
Builder 4	-138.37	0.6315	-806.76	530.03
Builder 5	-721.15	0.0410*	-1398.51	-43.78
Builder 6	-414.02	0.0208*	-751.28	-76.76
Builder 7	468.53	0.0595*	-25.98	963.03
Builder 8	-643.95	0.0004*	-917.30	-370.61
Builder 9	NA	NA	NA	NA
Builder 10	1199.95	0.1334	-867.44	3267.33
Builder 11	618.36	0.3726	-3987.69	5224.41
Builder 12	NA	NA	NA	NA
Builder 13	607.03	0.3895	-4208.14	5422.20
Builder 14	NA	NA	NA	NA
Builder 15	NA	NA	NA	NA

*T-test indicates statistically significant difference between groups at the 90% confidence interval

The Evaluators found there to be statistically significant differences in HERS Index score for Builders 2, 8, 11, and 13. The results of the t-tests for HERS Index scores are displayed in *Table 4-44*. Builders 2, 8, and 13 receive HERS scores that are, on average, 1.5, 4.4, and 5.3 points lower than the rest of the group, respectively. Builder 11 receives HERS Index scores that are, on average, 3 points higher than the rest of the group.

Table 4-44 Average HERS Index Score T-Test by Builder

Builder	Mean Difference	P-Value	5% CI	95% CI
Builder 1	2.28	0.0117	0.55	4.01
Builder 2	-1.54	0.0485*	-3.08	-0.01
Builder 3	0.43	0.5047	-0.87	1.73
Builder 4	-1.23	0.1788	-3.12	0.67
Builder 5	1.28	0.4427	-2.72	5.27
Builder 6	1.15	0.2427	-0.94	3.24
Builder 7	1.28	0.4121	-2.42	4.97
Builder 8	-4.38	0.0396*	-8.40	-0.35
Builder 9	NA	NA	NA	NA
Builder 10	-4.13	0.4268	-21.90	13.63
Builder 11	2.97	0.0221*	0.83	5.11
Builder 12	NA	NA	NA	NA
Builder 13	-5.27	0.0053*	-7.44	-3.10
Builder 14	NA	NA	NA	NA
Builder 15	NA	NA	NA	NA

*T-test indicates statistically significant difference between groups at the 90% confidence interval

In summary, Builder 5 displayed a lower than average realization rate, as well as lower than average absolute Therms savings, both statistically significant. However, it is seen that Builder 5 builds homes that are smaller. Although this builder displayed the largest percent savings in infiltration, and average percent savings in all other component loads, the total Therms savings are lower than the rest of the builders, because the baseline home already used a lower amount of Therms than the rest, and therefore absolute Therms savings is lower as well.

Builder 7 displays higher realization rates, higher absolute Therms savings, and higher average square footage than the rest of builders. Although this builder displayed lower than average savings in infiltration, the overall savings were still large enough due to the larger baseline home and therefore larger opportunity for absolute Therms savings.

Builder 13 displayed realization rate and absolute savings that were higher than the rest of sampled homes, and statistically significant, as well as HERS Index scores that were lower. Examination of component load savings displayed this builder's homes were two stories or over, and therefore saved much more in duct sealing and infiltration than the rest of builders.

The above relationships between realization rate, absolute savings, HERS Index scores, square footage, and component load savings are repeated throughout the builders with statistically significant differences in each.

4.7.2 Rater Savings Profile

In addition to examining builder profiles, the Evaluators examined the raters for statistically significant differences. The sample of 68 homes included two unique raters. One rater had rated the majority (63) of the 68 sampled homes. The following table displays the summary of homes for each rater. The Evaluators found there to be statistically significant differences in each rater's realization rates, as seen in Table 4-46. Rater 1 displays a higher realization rate than Rater 2. Rater 1 displays double the savings in insulation and ceiling components than Rater 2, leading Rater 1 to display 51% higher average realization rate. However, the Evaluators found no statistically significant differences between the two Rater's projects in terms of absolute savings and HERS Index score.

Table 4-45 Simulation Analysis Summary by Rater

Rater	Sampled Homes	Average HERS Index Score	Average Therms Savings per Rebate	Average Therms Savings per Square Foot	Average Realization Rate (%)
Rater 1	5	57.2	371	0.117473	182%
Rater 2	63	62.0	266	0.118981	131%

Table 4-46 Average Realization Rate T-Test by Rater

Rater	Mean Difference	P-Value	5% CI	95% CI
Rater 1	0.5125	0.0498	0.0007	1.0243
Rater 2	-0.5125	0.0498	-1.0243	-0.0007

*T-test indicates statistically significant difference between groups at the 90% confidence interval

4.8 Conclusions and Recommendations

4.8.1 Conclusions

- The Evaluators found that the average non-program home in IGC's service territory exceeds IECC 2012 with Idaho amendments requirements. This is observed in the billing analysis, comparing nonparticipating newly built homes to the newly built program-rebated homes. In addition, the proportion and distribution of HERS-rated homes in the IGC territory suggest that the market already demands high-efficiency homes. The average non-program newly built home that has been rated receives a HERS Index score of 63. The average participating home receives a HERS Index score of 60. This suggests that a proportion of the homes rebated through the program may be free-riders. A free-rider is a program household that would have been built at the same efficiency even if the program and its incentives were not present.
- The Evaluators' benchmarking research indicates that the energy efficiency standard for a code-built home is increasing, and that current program requirements may need to increase efficiency in order to keep up with higher efficiency building codes.
- The Whole Home Rebate provides measurable savings through billing analysis. However, the observable energy savings through billing analysis are much lower than expected equipment savings. Billing analyses include any changes in household behavior, equipment, or occupancy, and therefore are unable to entirely isolate equipment savings.
- It is expected that the lower the HERS Index score, the higher the energy savings. However, the Evaluators found the savings normalized by square footage remains relatively constant across a 20-point HERS Index range. The same lack of relationship is seen when analyzing the electric savings across the HERS Index. Homes with lower HERS Index scores do not equate to higher Therms savings. The HERS Index score instead depends on the proportional difference between the RESNET reference home and the rebated home.
- The Evaluators found higher savings in all component loads for the program-rebated homes than the simulated home with only the ENERGY STAR certification, except for window and door component loads. Overall, the program-rebated home displayed 27% higher savings than a home only completing ENERGY STAR requirements.
- Homes rebated through the program are shown to sell on average 39 days faster than non-rebated homes. This information can be forwarded to builders and raters to help increase program participation.

4.8.2 Recommendations

- The Evaluators recommends imposing a more stringent HERS Index requirement for the program in light of recent legislation adoption to adopt the 2018 IECC residential code in Idaho. This adoption enforces a required maximum HERS Index score of 68.
- The Evaluators recommends removing ENERGY STAR certification requirement, as it seems to be a barrier to builder participation, and the analysis completed for this study indicates that there is no basis to state that this requirement saves more energy than the current market requirements of energy efficiency in newly built homes.

- To directly target natural gas savings, IGC could impose specific requirements in addition to a HERS requirement. This may include an efficient furnace, tankless water heater, higher insulation levels (such as R-49 ceiling insulation), or more stringent air sealing and duct sealing requirements.

5 Appendix A: 95% AFUE Natural Gas Alternative Impact EM&V Methods and Results

The following sections present alternative EM&V methodology for estimating the 95% AFUE Natural Gas Furnace rebate impact for program years 2017-2018 and 2019.

As a secondary analysis, the Evaluators estimated savings for 95% AFUE Natural Gas Furnace measures using a pre-post treatment only model. This method will be referred to as "Method 2." This model does not have the advantage of a control group and is therefore potentially subject to greater bias. Table 5-1 presents overall ex-ante and ex-post savings by program year. Across all program years, the program achieved a 26.0% realization rate, with annual ex-post savings per furnace of 29.4 Therms.

Table 5-1 Method 2 Ex-Ante Ex-Post Program Savings Summary

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Valid Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	112.00	1,332	42.62	154,224.00	56,764.03	36.81%
2019	112.00	2,066	20.95	231,392.00	43,285.80	18.71%
All		**3,398**	**29.44**	**385,616.00**	**100,049.82**	**25.95%**

A third method the Evaluators used to estimate savings is calculating Equivalent Full Load Hours for Heating (EFLH) from monthly consumption bills and employing a TRM-based engineering equation to calculate average furnace savings. This method will be referred to as "Method 3." This is a widely used equation for calculating gas furnace hours of use. Table 5-2 summarizes the overall ex-ante and ex-post savings by program year. Across all program years, this method results in a 118.0% realization rate, with annual ex-post savings per furnace of 133.9 Therms.

Table 5-2 Method 3 Ex-Ante Ex-Post Program Savings Summary

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Valid Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	112.00	1,332	134.64	154,224.00	179,344.07	116.29%
2019	112.00	2,066	133.37	231,392.00	275,533.86	119.08%
All		**3,398**	**133.87**	**385,616.00**	**454,877.93**	**117.96%**

The following sections detail the alternative methods and results for impact evaluation of the 95% AFUE Natural Gas Furnace rebate.

5.1 Billing Analysis with Pre-Post Model

In addition to estimation of savings via PSM, the Evaluators estimated savings using pre- and post-program participant billing data. The assumption of this model is that program participants' pre-period data can provide a sufficient baseline in which to compare post-period data, once normalized on weather differences in each period.

5.1.1 Pre-Post Model Methodology

The pre-post model estimated weather-dependent energy consumption differences between the pre-retrofit period and post-retrofit period for program participants only in a fixed-effects panel regression model. The Evaluators merged the natural gas billing data with historic weather conditions and program tracking data in both the pre-retrofit and post-retrofit periods for each home. The following equation summarizes the model specifications used for this analysis.

Equation 5-1: Fixed-Effects Panel Regression Model Specification

$$Daily\ Therms_{it} = \alpha_0 + Customer\_Dummy_i + \beta_1(Post)_{it} + \beta_2(HDD)_{it} + \beta_3(Post \times HDD)_{it} + \varepsilon_{it}$$

Where,

$Daily\ Therms_{it}$ = Estimated energy usage (dependent variable) in home *i* during period *t*
$Post_{it}$ = Dummy variable indicating whether period *t* was in pre- or post- retrofit
HDD_{it} = Average heating degree days (base 63°F) during period *t* at home *i*
ε_{it} = Customer-level random error
α_0= The model intercept for home *i*
$Customer\_Dummy_i$ = A vector of dummy variables measuring fixed effects for each customer *i*

β_{1-3} = Coefficients determined via regression

β_1, β_2, and β_3 represent the average change in daily baseload in the post-period, daily Therms per HDD, and daily Therms per HDD in the post-period, respectively.

Additional data cleaning steps for program participants included:

- Removed bills with missing billing dates
- Removed account numbers for homes that do not overlap with the furnace install date
- Removed bill duration outliers (<9 or > 60 days duration)
- Removed homes with insufficient number of bills (< 12 months)

5.1.2 Pre-Post Model Results

This section details the regression results from estimating savings for program participants only with a pre- post-model. Table 5-4 summarizes the results of the billing analysis for program participants by program year. A p-value less than 0.05 indicates that the parameter estimate is statistically significant at the 95% confidence level. Not shown in the tables below are the coefficients for each treatment program participant (dummy variables) for the sake of brevity.

Savings are determined through parameters B1 and B3, which are defined in Table 5-3. In any given month, per program participant savings are calculated as follows: (B1*Days in Month) + (B3*HDD). In computing HDD for each month, the Evaluators used TMY3 data for the weather stations associated with each 3-digit zip code (per Table 3-3). This extrapolation provides savings under typical weather conditions. Monthly TMY HDDs were calculated from the TMY data as the sum of daily average temperature values under 63°F in a given month. Monthly TMY HDDs were weighted by the number of rebates found in each weather station area defined by the first 3 digits of the 5-digit zip code when computing monthly and annual program savings (see Table 3-13 for rebate counts).

Table 5-3 Method 2 Regression Parameters

Variable	Parameter	Interpretation
Post	B1	Average daily usage in the post-period
Avg.HDD	B2	Average daily usage per HDD
Post*Avg.HDD	B3	Average daily usage per HDD in the post-period

As shown in Table 5-4, the coefficient estimates for Post*Avg.HDD (B3) are negative, indicating lower usage per HDD in the post-period for treatment customers. In addition, these coefficients are statically significant at the 95% level in both program years. The estimate for Post (B1) is positive, indicating negative savings that are independent of the weather or HDDs, but these coefficients are not statistically significant. This result is what one would expect for furnace measures, which are a weather dependent savings measure.

Table 5-4 Method 2 Regression Results

Program Year	Coefficient	Estimate	Std Error	P Value	5%	95%
2017-2018	Post	0.009	0.018	0.624	-0.021	0.038
	Avg.HDD	0.121	0.001	0.000	0.119	0.123
	Post*Avg.HDD	-0.008	0.001	0.000	-0.009	-0.007
2019	Post	0.014	0.021	0.524	-0.022	0.049
	Avg.HDD	0.119	0.002	0.000	0.116	0.121
	Post*Avg.HDD	-0.005	0.001	0.000	-0.006	-0.003

*Customer-specific fixed effects coefficients are omitted for brevity

Each of the models showed they were a good fit for the data, as seen by the high Adjusted R-square in Table 5-5.

Table 5-5 Method 2 Model Fit

Program Year	Adjusted R2	F Statistic	Number of Observations
2017-2018	0.83	179	28,700
2019	0.81	159	31,947

Table 5-6 provides monthly savings estimates per rebate and for all rebates by program year. HDDs were weighted by the number of rebates from each of the associated weather stations.

Table 5-6 Method 2 Monthly Savings Summary by Program Year

Month	Weighted HDD	PY2017-PY2018 Savings/Rebate (Therms)	PY2019 Savings/Rebate (Therms)
Jan	1,118	8.66	4.64
Feb	815	6.27	3.30
Mar	666	5.05	2.59
Apr	387	2.83	1.34
May	251	1.74	0.71
June	112	0.63	0.10
July	35	0.01	(0.27)
Aug	79	0.36	(0.07)
Sept	163	1.04	0.33
Oct	406	2.97	1.41
Nov	757	5.78	3.01
Dec	945	7.28	3.85
Annual	**5,734**	**42.62**	**20.95**

The above methodology results in an ex-post savings of 29.4 Therms per rebate and with 100,049.8 Therms savings across both program years with a realization rate of 26.0%. The summary of savings is displayed in Table 5-7.

Table 5-7 Method 2 Ex-Ante Ex-Post Program Savings Summary

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Valid Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	112.00	1,332	42.62	154,224.00	56,764.03	36.81%
2019	112.00	2,066	20.95	231,392.00	43,285.80	18.71%
All		**3,398**	**29.44**	**385,616.00**	**100,049.82**	**25.95%**

5.2 Equivalent Full Load Hours for Heating ($EFLH_h$)

The Evaluators estimated Equivalent Full Load Hours for Heating (EFLHh) for gas furnace participants in the post-period. An EFLHh estimate provides a way to estimate Therms savings for each furnace in each household using TRM-based engineering equations, under various scenarios for pre- and post- efficiency factors and furnace capacities.

This approach complies with the International Performance Measurement and Verification Protocol (IPMVP) maintained by the Efficiency Valuation Organization (EVO) with sponsorship by the U.S. Department of Energy (DOE)[16]. It is often used to calculate deemed savings for gas furnace retrofits.

5.2.1 Data Collection

IGC provided the Evaluators with the necessary data to compute EFLH estimates specific two weather zones: 5 and 6, present in the IGC service territory. The EFLH was estimated separately for weather zone because furnace runtimes vary depending on weather zone and associated heating degree days (HDDs). For instance, Table 5-8 shows that Boise and Twin Falls are in weather zone five where HDDs average less than 6,000 per year, while Pocatello and Idaho Falls are in weather zone six where HDDs average over 6,500 per year in a typical year.

Table 5-8 TMY HDD and Weather Zone by Major City

Major City	Weather Zone	Weather Station ID	3-Digit Zip Code	TMY HDD
Boise	5	726810	836/837	5,188
Twin Falls	5	725866	833	5,913
Pocatello	6	725780	832	6,839
Idaho Falls	6	725785	834	7,588

The information required to conduct this analysis included:

- Efficient furnace capacity

[16] Core Concepts: International Measurement and Verification Protocol. EVO 100000 – 1:2016, October 2016.

- Efficient furnace AFUE
- Monthly billing data for 95% Furnace rebate participants
- Heating Degree Days from local weather stations

5.2.2 EFLH Methodology

Traditionally, the TRM defines the EFLH to be used in the engineering equation below. This EFLH estimate is calculated using a large dataset of primary consumption and on-site measurements tailored to each geographic region. The Evaluators performed the following calculations as part of the EFLH estimation process:

- Calculated post-period baseload usage (Therms) for each participant, where baseload is average summer usage in June, July, and August.
- Calculated average daily heating load for each participant in the post-period by taking the difference between average daily usage (Therms) and baseload usage.
- Set any negative heating loads to zero (assumed to be deviations from average baseload usage).
- Calculated average input capacity for furnaces (BTU/hr).
- Calculated average post-install furnace efficiency factor in terms of Annual Fuel Utilization Efficiency (AFUE).

The components listed above are used in the following equation for $EFLH_h$ estimation:

$$EFLH_h = Heatload\ (Therms) * Conversion\ Factor / Input\ Capacity * AFUE$$

Where,

$Heatload\ (Therms)$ = Average daily heating load usage for participants in the post period

$Conversion\ Factor$ = 100,000 BTU/Therms

$Input\ Capacity$ = Average furnace input capacity (BTU/hr) for participant in the post period

$AFUE$ = Annual Fuel Utilization Efficiency (AFUE) factor, which measures the furnace efficiency ratio in terms of output to input Therms usage.

Once the EFLH values are defined for each of the two weather zones, the following TRM engineering equation is used to estimate the annual Therms savings for each furnace retrofit measure, using the actual input capacity and actual post-retrofit AFUE collected from each furnace rebate. The default 80% efficiency value is used for prior furnace efficiency.

The equation for estimating gas furnace savings with EFLH in puts is shown below[17]:

[17] Indiana TRM V1: Residential Market Sector: Condensing Furnace-Residential, pg. 159

$$Annual\ Furnace\ Savings\ (Therms) = Input\ Capacity\ \left(\frac{BTU}{hr}\right) * EFLH_h * \left(\frac{1}{AFUE\ base} - \frac{1}{AFUE\ eff}\right) / (Conversion\ Factor)$$

Where,

$Conversion\ Factor$ = 100,000 BTU/Therms;

$Input\ Capacity$ = Average furnace input capacity (BTU/hr);

$EFLH_h$ = Equivalent full load hours for heating;

$AFUE\ base$ = Pre-retrofit AFUE; and

$AFUE\ eff$ = Post-retrofit AFUE.

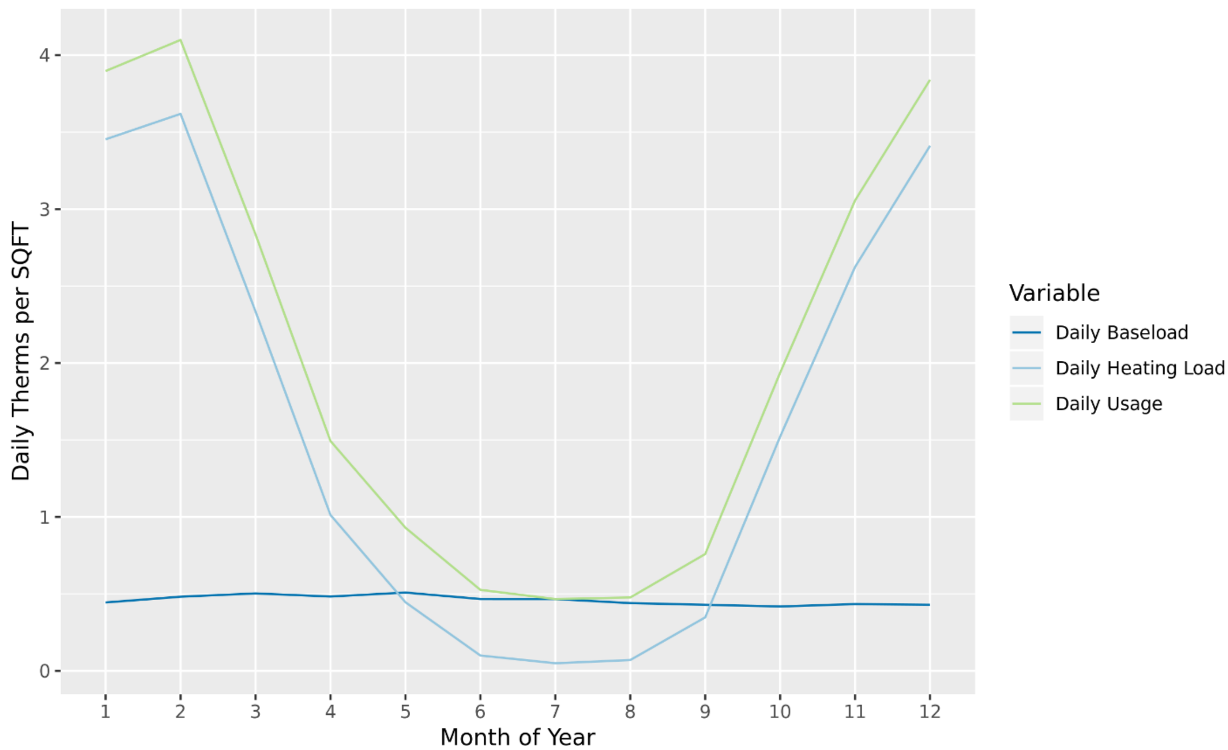
The Evaluators chose to include only new construction rebated furnaces in the estimation of EFLH. Customers replacing older, less efficient furnaces through early retirement and replace-on-burnout often observe a “snapback” in energy usage. Snapback is a common user behavior in which a customer adopts less efficient energy usage behaviors due to the fact that they installed more efficient equipment. The Evaluators aimed to separate the snapback phenomenon from the EFLH calculation by including new construction rebated furnaces only.

The Evaluators parsed out new construction furnaces using billing data and tracking data. Furnaces were only included in the EFLH estimation if the install date occurred during the same year as the home’s built year and if they did not portray more than 3 months of bills before the date of installation. In addition, furnaces were removed from EFLH estimation that did not have sufficient bills to calculate average summer time baseload. Only post-period (post-installation) billing data was used in this estimation.

5.2.3 EFLH Results

The Evaluators calculated daily heating load after filtering for new construction furnaces. Figure 5-1 displays the average load by end use for the new construction furnaces. The heating load was calculated by subtracting the average daily baseload from the average daily Therm usage.

Figure 5-1 Average Daily Usage by Load Type



The Evaluators estimated EFLH for heating by city and weather zone[18]. The results of the EFLH$_h$ estimation for each the 5 and 6 weather zone is summarized in the table below.

Table 5-9 Calculated EFLH by Weather Zone

Weather Zone	EFLH Heating
5	846.85
6	936.61

Table 5-10 provides average monthly heating load and EFLH$_h$ by month. Participants averaged 1.76 Therms/day across the entire year, with usage varying from a low of 0.05 and 0.06 Therms/day in July to a high of 3.65 and 3.49 Therms/day in February.

[18]Weather zone was obtained for each city using the following source:
https://www.energy.gov/sites/prod/files/2015/10/f27/ba_climate_region_guide_7.3.pdf

Table 5-10 Average Monthly Heating Load and $EFLH_h$

Month	Weather Zone 5 Average Heating Load (Therms/Day)	Weathe6 Zone 5 Average Heating Load (Therms/Day)	Weather Zone 5 Monthly EFLH Heating	Weather Zone 6 Monthly EFLH Heating
Jan	3.49	3.33	159.33	168.63
Feb	3.65	3.49	151.91	161.06
Mar	2.33	2.34	106.52	118.59
Apr	0.99	1.08	43.85	52.92
May	0.41	0.60	18.82	30.19
June	0.10	0.10	4.43	4.76
July	0.05	0.06	2.11	3.07
Aug	0.06	0.09	2.92	4.58
Sept	0.30	0.48	13.40	23.69
Oct	1.47	1.69	67.14	85.68
Nov	2.69	2.39	118.96	117.49
Dec	3.45	3.27	157.47	165.94
Annual	**1.58**	**1.58**	**846.85**	**936.61**

This Method uses the default 80% AFUE baseline efficiency to calculate savings. Using the actual capacity and efficient AFUE from each rebated furnace in each program year, the Evaluators applied the TRM-based engineering equation for annual furnace savings referenced in the impact evaluation approach. The Evaluators assumed baseload efficiency factor of 80% AFUE.

As a concrete example of the TRM-based savings calculation, assuming a furnace has an input capacity of 75,000 (BTU/hr.), an AFUE of 0.98, and is installed in Boise, Idaho the estimated annual savings is as follows:

Annual Savings (Therms) = 75,000 (BTU/hr.)*868 (EFLH)*(1/0.80 – 1/0.98)/100,000 = 149.5 Therms

The TRM-based methodology for estimating gas furnace savings using $EFLH_h$ is shown again below for reference purposes[19]:

$$Annual\ Furnace\ Savings\ (Therms) = Input\ Capacity\ \left(\frac{BTU}{hr}\right) * EFLH_h * (\frac{1}{AFUE\ base} - \frac{1}{AFUE\ eff})/(Conversion\ Factor)$$

Where,

$Conversion\ Factor$ = 100,000 BTU/Therms;

[19]Indiana TRM V1: Residential Market Sector: Condensing Furnace-Residential, pg. 159

$Input\ Capacity$ = Average furnace input capacity (BTU/hr.);

$EFLH_h$ = Equivalent full load hours for heating;

$AFUE\ base$ = Pre-retrofit AFUE; and

$AFUE\ eff$ = Post-retrofit AFUE.

The above methodology results in an ex-post savings of 133.9 Therms per rebate and with 454,878 Therms savings across both program years with a realization rate of 117.96%. The summary of savings is displayed in Table 5-11.

Table 5-11 Method 3 Ex-Ante Ex-Post Program Savings Summary

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Valid Rebates	Ex-Post per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	112.00	1,332	134.64	154,224.00	179,344.07	116.29%
2019	112.00	2,066	133.37	231,392.00	275,533.86	119.08%
All		**3,398**	**133.87**	**385,616.00**	**454,877.93**	**117.96%**

6 Appendix B: Whole Home Alternative Impact EM&V Methods and Results

The following sections present alternative EM&V methodology for estimating the Whole Home Rebate impact for program years 2017-2018 and 2019.

6.1 Simulation Analysis

As a secondary analysis, the Evaluators estimated savings for the Whole Home Rebate measure using calibrated simulation. This method will be referred to as "Method 2." Method 2 does not employ the use of a control group. It instead compares the HERS Rater's modeling files to a User Defined Reference Home (UDRH) specific to Idaho's residential building code requirements. Table 6-1 presents overall ex-ante and ex-post savings by program year. Across all program years, the program achieved a 134.28% realization rate, with annual ex-post savings per furnace of 273.94 Therms. In addition, the Evaluators estimated electric savings of 1,210 kWh per year per rebate.

Table 6-1 Method 2 Ex-Ante and Ex-Post Program Savings

Program Year	Ex-Ante Savings per Rebate (Therms)	Number of Rebates	Ex-Post Savings per Rebate (Therms)	Ex-Ante Program Savings (Therms)	Ex-Post Program Savings (Therms)	Realization Rate
2017-2018	204.00	619	295.13	126,276.00	182,682.38	144.67%
2019	204.00	1,079	262.39	220,116.00	283,114.89	128.62%
All		**1,698**	**273.94**	**346,392.00**	**465,152.12**	**134.28%**

6.1.1 UDRH Baseline Homes

The Evaluators incorporated a User Defined Reference Home (UDRH) into the energy models provided by the HERS raters. The UDRH reflects Idaho's code minimum house, based on the 2012 IECC with Idaho-specific amendments. Some of the key UDRH assumption are shown in Table 6-2.

Table 6-2 UDRH Key Assumptions

Input	UDRH Assumption	Source
Infiltration	7 ACH50	2012 IECC with Idaho Amendments
Duct Leakage	0.04 CFM25/CFA	2012 IECC with Idaho Amendments
Percent Efficiency Lighting	50	2012 IECC with Idaho Amendments
Gas Instant Water Heater (%)	82	2012 IECC with Idaho Amendments
Attic Insulation (U-factor)	0.03	2012 IECC with Idaho Amendments
Wall Insulation (U-factor)	0.57	2012 IECC with Idaho Amendments
Window SHGC	0.4	2012 IECC with Idaho Amendments
Window U-factor	0.35	2012 IECC with Idaho Amendments
Furnace AFUE	80	Federal minimum efficiency

6.1.2 Simulation Analysis Methodology

In addition to estimating impact savings for the Whole Home Rebate using matched treatment and control billing analysis, the Evaluators estimated savings using Method 2, an alternative approach. This alternative approach involves the comparison of program-participating homes with a User Defined Reference Home (UDRH). The Evaluators used the simulation models to compare a sample of 80 participating homes with a User Defined Reference Home (UDRH), an agreed upon set of efficiency standards built to represent the baseline residential home in the state of Idaho.

The Evaluators utilized the whole building energy modeling program REM/Rate during the review and verification efforts in the impact evaluation for this measure. REM/Rate is software used by organizations to conduct HERS Ratings. REM/Rate files were reviewed for a sample of 80 program-participating homes. The sampling approach stratify the sample by home builder to ensure representativeness of the 18 builders participating in the program. The REM/Rate data was subset by the builders in the sample and used to develop a profile for each builder by program year. Energy savings was calculated per-home with the following calculation:

Equation 6-1 Simulation Savings

$$Therm\ Savings = Consumption_{UDRH} - Consumption_{ENERGY\ STAR}$$

Where,

$Consumption_{UDRH}$ = Simulated energy consumption values from REM/Rate for a household under the UDRH efficient code standards

$Consumption_{ENERGY\ STAR}$ = Simulated energy consumption from REM/Rate for a household built referencing the HERS certification values

The UDRH represents a home built to meet the state of Idaho's current minimum energy efficiency code requirements. Idaho currently uses the residential 2012 International Energy Conservation Code (IECC) with amendments[20] for newly constructed residential homes. The Evaluators used the residential 2012 IECC with Idaho-specific amendments efficiency values when creating the UDRH in REM/Rate. This comparison provides an accurate simulation of a newly constructed minimum efficient code residential home to compare against efficiency, program-participating homes.

6.1.3 Simulation Analysis Results

Energy models of the as-built house were created by HERs raters to model the energy use of the actual house. This model was compared to the User Defined Reference Home (UDRH). The UDRH reflects the 2012 International Energy Conservation Code with Idaho's amendments. The UDRH was developed by inspecting building codes, HVAC equipment codes, and appliance codes. Most of the energy saving in the as-built home comes from the home's sealing of its envelope and ducts. Furthermore, the as-built home's windows and HVAC systems are more efficient than the code minimum house. The primary goal of the desk review verification effort is to verify as much data as possible using supporting documentation. The Evaluators can verify the following metrics through this type of desk review:

- Efficiency of furnaces and water heaters;
- Size, layout, shape, and location of the home

[20] https://www.energycodes.gov/adoption/states/idaho

Table 6-3 and Table 6-4 displays the average annual UDRH and rebated home Therms and kWh values for space heating, water heating, lighting, and appliances in each program year. These values represent the results of the simulation model prior to billing calibrations.

Table 6-3 UDRH and Whole Home Modeled Annual Therms Usage

Program Year	UDRH				Program Homes			
	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)
2017-2018	779.38	144.67	14.71	939.13	497.08	132.13	14.71	644.00
2019	743.95	153.84	18.16	915.59	496.09	139.36	17.75	653.20
Total	**756.46**	**150.60**	**16.93**	**923.90**	**496.44**	**136.81**	**16.68**	**649.96**

Table 6-4 UDRH and Whole Home Modeled Annual kWh Usage

Program Year	UDRH				Program Homes			
	Space Heating (kWh)	Cooling (kWh)	Lights & Appliances (kWh)	Total (kWh)	Space Heating (kWh)	Cooling (kWh)	Lights & Appliances (kWh)	Total (kWh)
2017-2018	723.46	1,033.67	6,527.63	8,282.21	552.04	874.29	5,694.08	7,120.25
2019	636.41	957.86	6,809.20	8,403.64	508.18	836.09	5,825.77	7,167.77
Total	**667.13**	**984.62**	**6,709.82**	**8,360.78**	**523.66**	**849.57**	**5,779.29**	**7,151.00**

Table 6-5 and Table 6-6 displays the average of the per-home annual usage differences between UDRH and Whole Home-rebated homes for each program year. Both program years display a zero savings value for lighting and appliances. The simulated participating homes in PY2017-2018 saved an average of 295 Therms per home and an average of 262 Therms per home in PY2019. The average savings per home across both program years is 274 Therms.

The occupancy and home characteristics between the UDRH modeled simulation and the as-built modeled simulation remain constant, which means the as-built home, with all else constant, uses less energy to heat the space of the home than the code-built efficient home, leading to savings for those categories. The majority of the gas savings (95%) are displayed in space heating due to higher home sealing and more efficient HVAC equipment. The majority of electric savings (77%) for electric usage is from lighting and appliances.

Table 6-5 Average Modeled Therms Savings per Home

Program Year	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)
2017-2018	282.29	12.54	-	295.13
2019	247.86	14.48	0.41	262.39
Total	**260.01**	**13.79**	**0.25**	**273.94**

Table 6-6 Average Modeled kWh Savings per Home

Program Year	Space Heating (kWh)	Cooling (kWh)	Lights & Appliances (kWh)	Total (kWh)
2017-2018	171.42	159.38	833.54	1,161.96
2019	128.23	121.77	983.43	1,235.86
Total	**143.47**	**135.04**	**930.53**	**1,209.78**

This method used REM/Rate simulation models to provide the Whole Home Rebate measure an overall realization rate of 134.28% with 465,152 Therms savings across both program years. In addition, this method allowed the Evaluators to estimate annual electric savings of 1,210 kWh per home.

Table 6-7 Method 2 Ex-Ante and Ex-Post Program Savings

Program Year	Ex-Ante Therms Savings	Ex-Post Therms Savings	Therms Savings Realization Rate	Ex-Post kWh Savings
2017-2018	126,276	182,682	144.67%	1,163
2019	220,116	283,115	128.62%	1,237
Total	**346,392**	**465,152**	**134.28%**	**1,211**

7 Appendix C: Impact Evaluation Scripts

The following section displays the R code utilized to produce the impact evaluation results presented in this report.

7.1 95% AFUE Natural Gas Furnace Rebate Script

```
# install and initialize packages
# install.packages("easypackages")
library(easypackages)

# list of required packages to complete analysis
package_list <- c("doBy", "RItools", "cowplot", "MatchIt", "openxlsx", "dplyr", "lazyeval",
"lubridate", "ggplot2", "broom", "readr", "lme4")

# install and load the list of required packages
packages(package_list)

# functions
# function to compute weather variables for each billing interval
weather_for_interval <- function(x, noaa_dta){
  f_dta <- data.frame(Bill.St = x$Bill.St, Bill.End = x$Bill.End, USAF = x$USAF)
  obs_in_range   <- noaa_dta$Date >= x$Bill.St & noaa_dta$Date <= x$Bill.End & x$USAF ==
noaa_dta$USAF
  # sequence of temps to calculate HDD/CDD with diff base temps
  seq <- seq(from = 55, to = 75, by = 1)
  for (i in seq) {
    f_dta[,paste("HDD.",i,sep="")] <- sum(noaa_dta[obs_in_range, paste("HDD.",i,sep="")],
na.rm = T)
  }
  return(f_dta)
}

# function that checks a condition is true or false and halts execution if false
assert <- function(x) {
  if(x == TRUE) print("condition is true")
  else          stop("condition is false")
}

# function that checks if a data frame is unique to a variable
isid <- function(idvars, data) {
  length_st  <- length(data[, 1])
  length_end <- length(as.data.frame(unique(data[, idvars]))[, 1])
  if(length_st != length_end) stop("dataset not unique by id variables")
  else                        print("dataset is unique by id variables")
}

# parameters
st_dt_cutoff <- as.Date("2016-01-01")

# set up program paths and create directories
vers <- "script"
wd       <- getwd()
code_dir <- paste(wd, "Code", sep = "/")
sub_dir  <- paste(wd, "Code", "Subroutines", sep = "/")
```

```
raw_dir  <- paste(wd, "Raw", sep = "/")
noaa_dir  <- paste(wd, "Raw/Weather", sep = "/")
inter    <- paste(wd, "Inter", vers, sep = "/")
results  <- paste(wd, "Results", vers, sep = "/")

# create directories
dir.create(code_dir, recursive = T)
dir.create(raw_dir, recursive = T)
dir.create(inter, recursive = T)
dir.create(results, recursive=T)

# read in the raw files
# import billing data
fl_name <- "IGC INDIVIDUAL REBATE BILLING DATA (1).xlsx"
pct <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 4, startRow=2, detectDates =
TRUE)
save(pct, file = paste(inter, "pct.RData", sep = "/"))

fl_name <- "IGC NONPARTICIPANT DATA (REVISED).xlsx"
non_pct <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 4,startRow=2, detectDates =
TRUE)
save(non_pct, file = paste(inter, "non_pct.RData", sep = "/"))

# import nonparticipant site info
fl_name <- "IGC NONPARTICIPANT DATA (REVISED).xlsx"
site <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 3,startRow=2, detectDates =
TRUE)
save(site, file = paste(inter, "site.RData", sep = "/"))

# import tracking data
fl_name <- "All Appliances.xlsx"
track <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 3)    # files must be closed
save(track, file = paste(inter, "track.RData", sep = "/"))

# import rebate file
fl_name <- "IGC INDIVIDUAL REBATE BILLING DATA (1).xlsx"
rebate_raw <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 3, startRow=2, detectDates
= TRUE)
save(rebate_raw, file = paste(inter, "rebate_raw.RData", sep = "/"))

# import whole home rebate file to check for nonparticipant overlaps
fl_name <- "IGC NEWLY BUILT DATA.xlsx"
whole_homes_raw <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 3, startRow=2,
detectDates = TRUE)
save(whole_homes_raw, file = paste(inter, "whole_homes_raw.RData", sep = "/"))

fl_name <- "IGC WHOLE HOME DATA.xlsx"
whole_homes_bills <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 3, startRow=2,
detectDates = TRUE)

fl_name <- "Whole Home Tracking Data Aggregate.xlsx"
whole_homes_tracking <- read.xlsx(paste(raw_dir, fl_name, sep = "/"), sheet = 2, detectDates =
TRUE)

# check there are no appliance rebate participants in whole home participants
table(whole_homes_raw$ENERGY_STAR, whole_homes_raw$INDIVIDUAL_REB)
whole_homes_part <- whole_homes_raw[whole_homes_raw$ENERGY_STAR==1,]
rebate_raw[rebate_raw$PREMISE_ID %in% whole_homes_part$PREM_ID,] # 0
```

```
rebate_raw[rebate_raw$PREMISE_ID %in% whole_homes_bills$PREM_ID,] # 0
rebate_raw[rebate_raw$ADDRESS1_UPR %in% whole_homes_part$ADDRESS1_UPR,] # 0
rebate_raw[rebate_raw$ADDRESS1_UPR %in% whole_homes_bills$SITE_ADDRESS,] # 0

# check there are no appliance rebate nonparticipants in whole homes participants
nonpart_in_whole_home <- site[site$PREM_ID %in% whole_homes_part$PREM_ID,] # 0
nonpart_in_whole_home <- unique(rbind(nonpart_in_whole_home, site[site$ADDRESS1_UPR %in%
whole_homes_part$ADDRESS1_UPR,])) # 0
nonpart_in_whole_home_tracking <- site[site$ADDRESS1_UPR %in%
toupper(whole_homes_tracking$Site.Address),] # 0
nonpart_in_whole_home_bills <- site[site$PREM_ID %in% whole_homes_bills$PREMISE_ID,] # 0
nonpart_in_whole_home_bills <- site[site$ADDRESS1_UPR %in%
toupper(whole_homes_bills$SITE_ADDRESS),] # 0

non_pct_in_whole_home <- non_pct[non_pct$PREM_ID %in% whole_homes_part$PREM_ID,] # 0
non_pct_in_whole_home <- unique(rbind(non_pct_in_whole_home, non_pct[non_pct$ADDRESS1_UPR %in%
whole_homes_part$ADDRESS1_UPR,])) # 0
non_pct_in_whole_home_tracking <- non_pct[non_pct$ADDRESS1_UPR %in%
toupper(whole_homes_tracking$Site.Address),] # 0
non_pct_in_whole_home_bills <- non_pct[non_pct$PREM_ID %in% whole_homes_bills$PREMISE_ID,] # 0
non_pct_in_whole_home_bills <- non_pct[non_pct$ADDRESS1_UPR %in%
toupper(whole_homes_bills$SITE_ADDRESS),] # 0

# Pulled weather data from ADM Shiny App
# 3 digit zip assignments:
# Boise: 836, 837
# Twin Falls: 833
# Pocatello: 832
# Idaho Falls: 834

# USAF Codes
# Boise: 726810
# Twin Falls: 725866
# Pocatello: 725780
# Idaho Falls: 725785

list.files <- list.files(path=noaa_dir)
head(list.files)

# import all weather station data
import_noaa <- function(x) {
  df <- read_csv(paste(noaa_dir,list.files[x],sep="/"))
  df$USAF <- substr(list.files[x],1,6)
  df <- as.data.frame(df)
  return(df)
}

# combine weather station data into one data frame
noaa <- lapply(1:length(list.files), import_noaa)
noaa <- do.call("rbind",noaa)
noaa$datetime <- as.POSIXct(noaa$date_UTC)

# keep only necessary columns
keep_cols <- c("date_UTC", "date_local", "temp", "USAF", "datetime")
noaa <- noaa[,keep_cols]

# get year
noaa$year <- year(noaa$datetime)
```

```
# convert to date fmt
noaa$Date <- as.Date(as.character(noaa$datetime), "%Y-%m-%d")
# some duplicate datetimes occured
noaa <- noaa[!duplicated(noaa),]

# sequence of temps to calculate HDD/CDD with diff base temps
seq <- seq(from = 55, to = 75, by = 1)
for (i in seq) {
  # data must be hourly
  noaa[,paste("HDD.",i,sep="")] <- pmax((i-noaa$temp),0)/24
}
assert(sum(noaa$HDD!=noaa$HDD.65, na.rm=TRUE)==0)
save(noaa, file = paste(inter, "noaa.RData", sep = "/"))
rm(noaa)

# prepare data for regression modeling
# prepare participant rebate and tracking data to merge with monthly billing data
load(paste(inter, "rebate_raw.RData", sep = "/"))
rebate_raw <- rebate_raw[, colnames(rebate_raw)[colnames(rebate_raw) != "IGC_ACCOUNT_NO"]]
load(paste(inter, "track.RData", sep = "/"))
table(track$Source)
track <- track[,c("Rebate.Type", "Rebate.ID", "Source",
"Site.Zip","Owner.First.Name","Owner.Last.Name","ADM.Verified.Furnace.Size.(BTUH)","ADM.Verifi
ed.AFUE",
                  "Furnace.Size.(BTUH)","AFUE" )]
track <- track[!is.na(track$Rebate.ID),]

# check for duplicates
sum(duplicated(track))
# checks data is unique
isid(idvars = c("Rebate.ID"), d = track)
table(track$Source, track$Rebate.Type)

track$Name <- paste0(track$Owner.Last.Name,", ",track$Owner.First.Name)
track$Cap.Input <-
suppressWarnings(as.numeric(ifelse(!is.na(track$`ADM.Verified.Furnace.Size.(BTUH)`),track$`ADM
.Verified.Furnace.Size.(BTUH)`, track$`Furnace.Size.(BTUH)`)))
track$AFUE      <-
suppressWarnings(as.numeric(ifelse(!is.na(track$ADM.Verified.AFUE),track$ADM.Verified.AFUE,tra
ck$AFUE)))

track <- track[!is.na(track$Rebate.ID),]
track <- track %>% dplyr::filter(Rebate.Type == "95% Furnace")
track <- track[,c("Source", "Rebate.ID", "Site.Zip", "Name","Cap.Input","AFUE")]
names(track)[names(track)=="Site.Zip"] <- "Zip"

not_found <- rebate_raw[!rebate_raw$REBATE_ID %in% track$Rebate.ID,]
table(not_found$REBATE_TYPE)

# get zip and name from tracking data
rebate_raw <- merge(rebate_raw, track,by.x="REBATE_ID",by.y="Rebate.ID")
table(rebate_raw$REBATE_TYPE, rebate_raw$Source)

# check for duplicates
sum(duplicated(rebate_raw))
rebate <- rebate_raw
rm(rebate_raw)
```

```
# let install date equal date furnace fired
rebate$Install.Dt     <- ymd(as.Date(rebate$DATE_FIRED, origin="1899-12-30"))
# define install year
rebate$Install.Year <- year(rebate$Install.Dt)

# reorganize and rename
rebate <- rebate[, c("Source", "PREMISE_ID", "REBATE_TYPE",
"REBATE_ID","Install.Dt","Install.Year",
"ADDRESS1_UPR","SITE_CITY","Name","Zip","Cap.Input","AFUE")]
names(rebate) <- c("Source", "PREM_ID","Install.Type","Rebate_ID",
"Install.Dt","Install.Year","Address","City","Name","Zip","Cap.Input","AFUE")
trmt_counts <- data.frame(Detail="Starting
Count",PY18Count=n_distinct(rebate$PREM_ID[rebate$Source == "2017-2018"]), PY19Count =
n_distinct(rebate$PREM_ID[rebate$Source == "2019"]))   # count participants at the start

# trmt counts prior to any restrictions (use at the end to get total program savings)
trmt_by_year <- rebate %>%
  dplyr::group_by(Install.Year) %>%
  dplyr::summarize(n.cust = n_distinct(PREM_ID)) %>% as.data.frame()
write.csv(trmt_by_year, paste(results, "trmt_by_program_year.csv", sep = "/"))
rm(trmt_by_year)
rebate$Install.Year <- NULL

# check for customers with multiple addresses for same account number (will remove)
multi.address <- rebate %>%
  dplyr::group_by(PREM_ID) %>%
  dplyr::summarise(n.address = n_distinct(Address)) %>%
  dplyr::filter(n.address>1) %>%
  as.data.frame
# none found
table(multi.address$n.address)

# remove customers with multiple addresses
rebate <- rebate[!(rebate$PREM_ID %in% multi.address$PREM_ID),]
trmt_counts <- rbind(trmt_counts, data.frame(Detail="Remove for multiple
addresses",PY18Count=n_distinct(rebate$PREM_ID[rebate$Source == "2017-2018"]), PY19Count =
n_distinct(rebate$PREM_ID[rebate$Source == "2019"])))  # count participants

# check for duplicates
sum(duplicated(rebate))
# check for multiple rows for a given measure
dup.installs <- rebate %>%
  dplyr::group_by(PREM_ID) %>%
  dplyr::mutate(ndups = n_distinct(Install.Dt)) %>%
  dplyr::filter(ndups >1) %>%
  dplyr::slice(1) %>%
  as.data.frame
# 7 customers with multiple install dates. drop them.
n_distinct(dup.installs$PREM_ID)
rebate <- rebate[!(rebate$PREM_ID %in% dup.installs$PREM_ID),]
trmt_counts <- rbind(trmt_counts, data.frame(Detail="Remove for multiple rebate
premises",PY18Count=n_distinct(rebate$PREM_ID[rebate$Source == "2017-2018"]), PY19Count =
n_distinct(rebate$PREM_ID[rebate$Source == "2019"])))  # count participants

# some customers have multiple rebate IDs. remove.
mult.rebate <- rebate %>%
  dplyr::group_by(PREM_ID) %>%
  dplyr::summarise(n=n_distinct(Rebate_ID)) %>%
```

```
  dplyr::filter(n>1) %>%
  dplyr::select(PREM_ID)

rebate <- rebate %>% dplyr::filter(!PREM_ID %in% mult.rebate$PREM_ID)
table(rebate$Source)
# check data is unique by customer
isid(idvars = c("PREM_ID"), d = rebate)

trmt_counts <- rbind(trmt_counts, data.frame(Detail="Remove homes with multiple furnace
rebates",PY18Count=n_distinct(rebate$PREM_ID[rebate$Source == "2017-2018"]), PY19Count =
n_distinct(rebate$PREM_ID[rebate$Source == "2019"])))  # count participants

# missing install dates  (0 occurences)
sum(is.na(rebate$Install.Dt))
save(rebate, file = paste(inter, "rebate.RData", sep = "/"))
str(rebate)
rm(dup.installs,multi.address,track)

# Prep Non-Participant Billing Data
load(paste(inter, "non_pct.RData", sep = "/"))
load(paste(inter, "site.RData", sep = "/"))
non_pct$treatment <- 0

# merge corrected bills
str(non_pct)
non_pct <- non_pct %>%
  dplyr::group_by(PREM_ID, ACCT_ID, BSEG_START_DT, BSEG_END_DT,treatment) %>%
  dplyr::summarise(CONSUMPTION = sum(CONSUMPTION)) %>% as.data.frame()

nrow(unique(non_pct[, c("PREM_ID", "ACCT_ID")]))
length(unique(non_pct$PREM_ID))

str(site)
site <- site[,c("PREM_ID", "ADDRESS1_UPR","POSTAL", "CITY_UPR","ENTITY_NAME")]
names(site) <- c("PREM_ID", "Address","Zip","City","Name")

# get site info for non-participants
non_pct <- merge(non_pct,site,by="PREM_ID",all.x=T)
non_pct <- non_pct[,c("PREM_ID", "ACCT_ID",
"Name","Address","City","Zip","BSEG_START_DT","BSEG_END_DT","CONSUMPTION","treatment")]
rm(site)

# prep participant billing data
load(paste(inter, "pct.RData", sep = "/"))
str(pct)

names(pct)[names(pct)=="PREMISE_ID"] <- "PREM_ID"
pct$treatment <- 1

# merge corrected bills
pct <- pct %>%
  dplyr::group_by(PREM_ID, ACCT_ID, BSEG_START_DT, BSEG_END_DT, treatment) %>%
  dplyr::summarise(CONSUMPTION = sum(CONSUMPTION))
nrow(unique(pct[, c("PREM_ID", "ACCT_ID")]))
length(unique(pct$PREM_ID))

# check that rebated customers are not in non-participant billing data  (did not occur)
sum(unique(pct$PREM_ID) %in% unique(non_pct$PREM_ID))
```

```
str(pct)

# get site info for participants and restrict bills to treatment customers
pct <- pct[,c("PREM_ID", "ACCT_ID", "BSEG_START_DT","BSEG_END_DT","CONSUMPTION","treatment")]
pct <- merge(pct,rebate,by="PREM_ID")
sum(is.na(pct$Install.Dt))
# all treatement customers have billing data
assert(n_distinct(pct$PREM_ID)==n_distinct(rebate$PREM_ID))

trmt_counts <- rbind(trmt_counts, data.frame(Detail="Missing Billing
Data",PY18Count=n_distinct(rebate$PREM_ID[rebate$Source == "2017-2018"]), PY19Count =
n_distinct(rebate$PREM_ID[rebate$Source == "2019"])))  # count participants
write.csv(trmt_counts, paste(results, "trmt_counts.csv", sep = "/"))
rm(trmt_counts)

sum(is.na(pct$Install.Type))
pct <- pct[,c("PREM_ID", "ACCT_ID",
"Name","Address","City","Zip","BSEG_START_DT","BSEG_END_DT","CONSUMPTION","treatment")]

# combine participant and non-participant billing data
mo_dta <- rbind(pct,non_pct)
mo_dta <- merge(mo_dta,rebate[,c("Source",
"PREM_ID","Install.Type","Install.Dt","Cap.Input","AFUE")],by="PREM_ID",all.x=T)

clean_counts <- data.frame(Detail="Starting Count",
                           Non_Pct_2017_2018 = n_distinct(mo_dta[mo_dta$treatment==0
,"PREM_ID"]),
                           Non_Pct_2019      = n_distinct(mo_dta[mo_dta$treatment==0
,"PREM_ID"]),
                           Pct_2017_2018     = n_distinct(mo_dta[mo_dta$treatment==1 &
mo_dta$Source == "2017-2018","PREM_ID"]),
                           Pct_2019          = n_distinct(mo_dta[mo_dta$treatment==1 &
mo_dta$Source == "2019","PREM_ID"]))

rm(pct,non_pct,rebate)
save(mo_dta, file = paste(inter, "mo_dta.RData", sep = "/"))

# prep combined billing data
load(paste(inter, "mo_dta.RData", sep = "/"))

mo_dta$Bill.St    <- ymd(as.Date(mo_dta$BSEG_START_DT, origin="1899-12-30"))
mo_dta$Bill.End   <- ymd(as.Date(mo_dta$BSEG_END_DT, origin="1899-12-30"))
mo_dta$Therms     <- mo_dta$CONSUMPTION

mo_dta$BSEG_END_DT <- NULL
mo_dta$BSEG_START_DT <- NULL
mo_dta$CONSUMPTION <- NULL

# order by customer id and st dt
mo_dta <- mo_dta[order(mo_dta$PREM_ID, mo_dta$ACCT_ID, mo_dta$Bill.St), ]

# customers with empty billing info
sum(is.na(mo_dta$BillEnd) | is.na(mo_dta$Bill.St))
# drop customers with empty billing info
mo_dta <- mo_dta[!(is.na(mo_dta$Bill.End) | is.na(mo_dta$Bill.St)),]

clean_counts <- rbind(clean_counts,data.frame(Detail="Remove if billing dates are NA",
```

```
                                              Non_Pct_2017_2018 =
n_distinct(mo_dta[mo_dta$treatment==0 ,"PREM_ID"]),
                                              Non_Pct_2019      =
n_distinct(mo_dta[mo_dta$treatment==0 ,"PREM_ID"]),
                                              Pct_2017_2018     =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                              Pct_2019          =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2019","PREM_ID"])))

# make sure no bills have bill.end less than bill.st
sum(mo_dta$Bill.End<mo_dta$Bill.St)

# estimate billed use during month
mo_dta$Billed.Use    <- mo_dta$Therms

# calculate bill duration
mo_dta$Bill.Duration <- as.numeric(mo_dta$Bill.End - mo_dta$Bill.St + 1)

# billing midpoint
mo_dta$Midpoint      <- mo_dta$Bill.St + (mo_dta$Bill.Duration/2)

# assign month for billing interval as billing midpoint
mo_dta$Month         <- month(mo_dta$Midpoint)

# assign the year based on billing midpoint
mo_dta$Year          <- year(mo_dta$Midpoint)

mo_dta$Yr_Mo         <- paste(mo_dta$Year,mo_dta$Month,sep="_")

# average daily billed use for billing interval (for regression)
mo_dta$therms.day <- mo_dta$Billed.Use / mo_dta$Bill.Duration

# dummy for winter months
mo_dta$Winter        <- ifelse(mo_dta$Month %in% c(11,12,1,2,3,4), 1, 0)
sum(is.na(mo_dta$PREM_ID))

str(mo_dta$Zip)
str(mo_dta$PREM_ID)

# adhoc fixing missing/incorrect customer Zip data (used google street/city)
mo_dta$Zip[mo_dta$PREM_ID==1711033471] <- "83607"
mo_dta$Zip[mo_dta$PREM_ID==7307503980] <- "83686"
mo_dta$Zip[mo_dta$PREM_ID==  2055203847] <- "83221"

# define 3 digit zip
mo_dta$zip_3d <-     substr(mo_dta$Zip,1,3)
table(mo_dta$zip_3d)

# assign install date to control group
# control group's install date will be the average install date of the treatment group, if
they installed in the first 6 months of the PY
trmt <- mo_dta[mo_dta$treatment == 1,]
custs <- unique(trmt[, c("PREM_ID", "ACCT_ID", "treatment", "Source", "Install.Dt")])
install_dates <- data.frame(Source = c("2017-2018", "2019"),
                            treatment = c(0,0),
                            Install.Dt = c(mean(custs$Install.Dt[custs$Source == "2017-2018" &
year(custs$Install.Dt) == 2018 & month(custs$Install.Dt) %in% c(1:6)], na.rm = T),
```

```
                                           mean(custs$Install.Dt[custs$Source == "2019" &
year(custs$Install.Dt) == 2019 & month(custs$Install.Dt) %in% c(1:6)], na.rm = T)),
                            stringsAsFactors = F)

ctrl_18 <- mo_dta[mo_dta$treatment == 0,]
ctrl_19 <- mo_dta[mo_dta$treatment == 0,]
ctrl_18$Source <- "2017-2018"
ctrl_19$Source <- "2019"
ctrl <- rbind(ctrl_18, ctrl_19) %>% dplyr::select(-Install.Dt)
ctrl <- merge(ctrl, install_dates, by = c("Source", "treatment"))
mo_dta <- rbind(trmt, ctrl)
rm(ctrl_18,ctrl_19,trmt,ctrl)

custs <- unique(mo_dta[, c("PREM_ID", "ACCT_ID", "treatment", "Source", "treatment")])
table(custs$Source, custs$treatment)

# remove accoutns that dont overlap with intervention date
cust_bills <- mo_dta %>%
  dplyr::group_by(PREM_ID, ACCT_ID, treatment, Source, Install.Dt) %>%
  dplyr::summarise(min_bill = min(Bill.St),
                   max_bill = max(Bill.End)) %>%
  dplyr::mutate(install_cust = ifelse(min_bill <= Install.Dt & max_bill >= Install.Dt,1,0))
%>%
  dplyr::filter(install_cust == 1) %>%
  dplyr::select(PREM_ID, ACCT_ID, treatment, Source)
mo_dta <- merge(cust_bills, mo_dta, by = c("PREM_ID", "ACCT_ID", "treatment", "Source"), all.x
= T)

custs <- unique(mo_dta[, c("PREM_ID", "ACCT_ID", "treatment", "Source", "treatment")])
table(custs$Source, custs$treatment)

clean_counts <- rbind(clean_counts,data.frame(Detail="Keep only account numbers that overlaps
with install date",  # CRJ also removed control accounts
                                             Non_Pct_2017_2018 =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                             Non_Pct_2019      =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2019","PREM_ID"]),
                                             Pct_2017_2018     =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                             Pct_2019          =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2019","PREM_ID"])))
clean_counts

# clean pre- and post-periods
# define install year
mo_dta$Install.Year <- year(mo_dta$Install.Dt)

# check distribution of billing data by trmt and year_mo
table(mo_dta$treatment,mo_dta$Yr_Mo, mo_dta$Source)

#check how many customers had trmt in first half of the year
mo_dta$first.half.yr <- ifelse(month(mo_dta$Install.Dt) %in% c(1,2,3,4,5,6), 1,0)
uniq_trmt <-  unique(mo_dta[mo_dta$treatment==1 &
mo_dta$first.half.yr==1,c("PREM_ID","Install.Year", "treatment", "Source")])
table(uniq_trmt$Install.Year, uniq_trmt$Source)

# summarize customers by install year
x <- unique(mo_dta[, c("PREM_ID", "Install.Year", "Source", "treatment")])
```

```
table(x$Install.Year, x$treatment, x$Source)

# define post and pre period
mo_dta$pre  <- ifelse(mo_dta$Bill.End < mo_dta$Install.Dt,1,0)
mo_dta$post <- ifelse(mo_dta$Bill.St  > mo_dta$Install.Dt,1,0)
mo_dta$Install.Year <- year(mo_dta$Install.Dt)

#calculate Baseload average for each customer to compute Avg daily heating load
# number of customers before restrictions
n_distinct(mo_dta$PREM_ID)
mo_dta <- mo_dta %>%
  dplyr::group_by(PREM_ID) %>%
  dplyr::mutate(Baseload.Avg = mean(ifelse(Month %in% c(6,7,8), therms.day, NA), na.rm =
TRUE)) %>%
  as.data.frame()
# 187 customers missing summer months
n_distinct(mo_dta[is.na(mo_dta$Baseload.Avg),"PREM_ID"])

# average daily heating load
mo_dta$Heatload.Avg         <- pmax(0, mo_dta$therms.day - mo_dta$Baseload.Avg)
save(mo_dta, file = paste(inter, "mo_dta.RData", sep = "/"))

# check for and remove problem obs
load(paste(inter, "mo_dta.RData", sep = "/"))
summary(mo_dta[, c("Month", "Bill.Duration", "therms.day", "Winter", "Bill.St",
"Bill.End","Midpoint")])   # summarise numeric/date variables
mo_dta <- mo_dta[mo_dta$Bill.Duration >= 9 & mo_dta$Bill.Duration <= 60, ]        # remove if
original billing duration too short/too long

clean_counts <- rbind(clean_counts,data.frame(Detail="Bill Duration Outliers (<9 or >60 days",
                                              Non_Pct_2017_2018 =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                              Non_Pct_2019      =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2019","PREM_ID"]),
                                              Pct_2017_2018     =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                              Pct_2019          =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2019","PREM_ID"])))

nrow(mo_dta)
n_distinct(mo_dta$PREM_ID)
# remove outliers in terms of therms usage (none)
mo_dta <- mo_dta[mo_dta$therms.day < 200,]
# remove bills occuring prior to this date (no weather data available from degreedays); did
not occur
mo_dta <- mo_dta[mo_dta$Bill.St >= as.Date(st_dt_cutoff),]
n_distinct(mo_dta$PREM_ID)

# customer restrictions
test <- mo_dta %>%
  group_by(PREM_ID, ACCT_ID, Source, treatment) %>%
  summarise(n_bills_pre = sum(pre),
            n_bills_post = sum(post),
            avg.therms = mean(Billed.Use))
table(test$n_bills_pre, test$treatment, test$Source)
table(test$n_bills_post, test$treatment, test$Source)
```

```
x <- unique(test[test$Source == "2017-2018", c("PREM_ID", "ACCT_ID", "treatment",
"n_bills_pre", "n_bills_post")])
x <- x %>% dplyr::group_by(n_bills_pre, n_bills_post, treatment) %>% summarise(n=n()) %>%
dplyr::filter(n_bills_pre > 6 & n_bills_post > 3)

# require avg.therms is positive and more than 12 bills
mo_dta <- mo_dta %>%
  group_by(PREM_ID, ACCT_ID, Source, treatment) %>%
  mutate(n_post_restriction = ifelse(Source == "2017-2018",9,6),
         n_bills_pre = sum(pre),
         n_bills_post = sum(post),
         avg.therms = mean(Billed.Use),
         keep = (avg.therms > 0 & n_bills_pre >= 12 & n_bills_post >= n_post_restriction)) %>%
  as.data.frame

sapply(mo_dta[, c("n_bills_pre","avg.therms")], quantile, na.rm=TRUE, probs = seq(from = 0, to
= 1, by = 0.025))
sapply(mo_dta[, c("n_bills_post","avg.therms")], quantile, na.rm=TRUE, probs = seq(from = 0,
to = 1, by = 0.025))
# percent of customers to be dropped
n_distinct(mo_dta[mo_dta$keep==0,"PREM_ID"])/n_distinct(mo_dta$PREM_ID)*100

mo_dta$keep <- as.numeric(mo_dta$keep)
sumry <- unique(mo_dta[,c("PREM_ID","keep","treatment")])
sumry <- table(sumry$treatment,sumry$keep)
missing_bills  <- data.frame(treatment = c(0,1),drops = c(sumry[1],sumry[2]), keep =
c(sumry[3],sumry[4]))
# percent of control customers with insufficient data
sumry[1]/(sumry[1]+sumry[3])*100
# percent of treatment customers with insufficient data
sumry[2]/(sumry[2]+sumry[4])*100
rm(sumry)

# remove customers with insufficient data
mo_dta <- mo_dta[mo_dta$keep==1,]
mo_dta$keep <- NULL

clean_counts <- rbind(clean_counts,data.frame(Detail="Insufficient bill data (<12 months of
bills)",
                                              Non_Pct_2017_2018 =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                              Non_Pct_2019      =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2019","PREM_ID"]),
                                              Pct_2017_2018     =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                              Pct_2019          =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2019","PREM_ID"])))
clean_counts


# Still premises with more than one account? only keep the one with the most data
keep <- mo_dta %>% dplyr::group_by(PREM_ID, treatment, Source) %>% dplyr::summarise(n =
n_distinct(ACCT_ID)) %>% filter(n>1)
keep <- mo_dta %>% dplyr::group_by(PREM_ID, treatment, Source) %>% mutate(n_months = n()) %>%
arrange(desc(n_months)) %>% slice(1) %>% select(PREM_ID, ACCT_ID, treatment, Source)
mo_dta <- merge(keep, mo_dta, by = c("PREM_ID", "ACCT_ID", "treatment", "Source"))
```

```
clean_counts <- rbind(clean_counts,data.frame(Detail="Keep acct with most bill data from a
premise",
                                              Non_Pct_2017_2018 =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                              Non_Pct_2019      =
n_distinct(mo_dta[mo_dta$treatment==0 & mo_dta$Source == "2019","PREM_ID"]),
                                              Pct_2017_2018     =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2017-2018","PREM_ID"]),
                                              Pct_2019          =
n_distinct(mo_dta[mo_dta$treatment==1 & mo_dta$Source == "2019","PREM_ID"])))
clean_counts
# data is now unique by premise ID

# get weather
load(paste(inter, "noaa.RData", sep = "/"))
str(noaa)
str(mo_dta$zip_3d)

table(mo_dta$zip)
mo_dta$USAF <- ""
mo_dta$USAF[mo_dta$zip_3d %in% c("836","837")] <- "726810"
mo_dta$USAF[mo_dta$zip_3d %in% c("833")]       <- "725866"
mo_dta$USAF[mo_dta$zip_3d %in% c("832")]       <- "725780"
mo_dta$USAF[mo_dta$zip_3d %in% c("834")]       <- "725785"
table(mo_dta$USAF)

unique(noaa$USAF)
unique(mo_dta$USAF)

# get the unique combination of billing intervals
uniq_bills <- unique(mo_dta[c("Bill.St", "Bill.End","USAF")])
nrow(uniq_bills)

# source file that gets weather for billing intervals
source(paste(sub_dir, "weather_for_interval.R", sep = "/"), echo = TRUE)
# get weather for each unique billing interval
weather <- lapply(split(uniq_bills, 1:nrow(uniq_bills)),
                  FUN = weather_for_interval, noaa_dta = noaa
)
# convert from list to dataframe
weather <- do.call("rbind", weather)
head(weather)

n_distinct(mo_dta$PREM_ID)
mo_dta <- merge(mo_dta, weather, all.x = TRUE)
mo_dta <- mo_dta[order(mo_dta$PREM_ID, mo_dta$Bill.St), ]
n_distinct(mo_dta$PREM_ID)

# ensure no missing or NAN values for weather data
assert(is.finite(sum(mo_dta$HDD.55)))

mo_dta$HDD.day <- mo_dta$HDD.63 / mo_dta$Bill.Duration    # use 63 for the setpoint for HDD
(from optimal testing)
save(mo_dta, file = paste(inter, "mo_dta.RData", sep = "/"))

#check weather is correct (adhoc)
sum(noaa[noaa$Date>=weather[1,1] & noaa$Date <= weather[1,2] & noaa$USAF
=="726810","HDD.56"])==weather$HDD.56[1]
```

```
rm(noaa,weather,uniq_bills)

# PSM only (method 1) restrictions
psm_dta <- mo_dta

# only keep treatment customers that installed their furnace in the first 6 months of the year
trmt <- psm_dta %>%
  dplyr::mutate(inst_in_py = ifelse(Source == "2017-2018" & Install.Year ==
2018,1,ifelse(Source == "2019" & Install.Year == 2019,1,0))) %>%
  dplyr::filter(treatment == 1 & month(Install.Dt) %in% 1:6 & inst_in_py == 1) %>%
  dplyr::select(-inst_in_py)

ctrl <- psm_dta %>% dplyr::filter(treatment == 0)

psm_dta <- rbind(trmt, ctrl)
x <- unique(psm_dta[, c("PREM_ID", "treatment", "Source", "Install.Year")])
table(x$Install.Year, x$Source)

clean_counts <- rbind(clean_counts,data.frame(Detail="Keep only trmt accounts with installs in
first 6 months of PY",
                                              Non_Pct_2017_2018 =
n_distinct(psm_dta[psm_dta$treatment==0 & psm_dta$Source == "2017-2018","PREM_ID"]),
                                              Non_Pct_2019      =
n_distinct(psm_dta[psm_dta$treatment==0 & psm_dta$Source == "2019","PREM_ID"]),
                                              Pct_2017_2018     =
n_distinct(psm_dta[psm_dta$treatment==1 & psm_dta$Source == "2017-2018","PREM_ID"]),
                                              Pct_2019          =
n_distinct(psm_dta[psm_dta$treatment==1 & psm_dta$Source == "2019","PREM_ID"])))

# restrict to pre period before program year and post period starting on July 1st of program
year (alternate definition)
psm_dta <- psm_dta %>% mutate(PY = ifelse(Source == "2017-2018", 2018,2019)) %>%
  dplyr::filter(Midpoint < as.Date(paste0(as.character(PY),"-01-01")) | Midpoint >=
as.Date(paste0(as.character(PY),"-07-01")))
table(year(psm_dta$Midpoint), psm_dta$pre, psm_dta$PY)

# restrict to pre period only in year before install (year install -1)
psm_dta <- psm_dta %>% dplyr::filter((pre == 1 & year(Midpoint) == PY-1) | post == 1)
clean_counts <- rbind(clean_counts,data.frame(Detail="Keep only pre and post period data.
Post-period starts the July of the PY",
                                              Non_Pct_2017_2018 =
n_distinct(psm_dta[psm_dta$treatment==0 & psm_dta$Source == "2017-2018","PREM_ID"]),
                                              Non_Pct_2019      =
n_distinct(psm_dta[psm_dta$treatment==0 & psm_dta$Source == "2019","PREM_ID"]),
                                              Pct_2017_2018     =
n_distinct(psm_dta[psm_dta$treatment==1 & psm_dta$Source == "2017-2018","PREM_ID"]),
                                              Pct_2019          =
n_distinct(psm_dta[psm_dta$treatment==1 & psm_dta$Source == "2019","PREM_ID"])))

save(psm_dta, file = paste(inter, "psm_dta.RData", sep = "/"))
rm(psm_dta,trmt,ctrl)

write.csv(missing_bills, file = paste(results,"customers_missing_full_year_bills.csv", sep =
"/"))
write.csv(clean_counts, file = paste(results, "clean_counts.csv", sep = "/"))
save(missing_bills, file = paste(results, "missing_bills.RData", sep = "/"))
save(mo_dta, file = paste(inter, "mo_dta.RData", sep = "/"))
rm(missing_bills,mo_dta)
```

```
rm(mult.rebate,clean_counts,custs,install_dates,keep,not_found,test,uniq_trmt,x)

# prepare for propensity score matching
py <- c(2018, 2019)
py_prog <- c("2017-2018", "2019")

load(paste(inter, "psm_dta.RData", sep = "/"))
mo_dta <- psm_dta

for (i in 1:2) {

  comb <- mo_dta[mo_dta$Source == py_prog[i],]

  # restrict to the pre period for PSM
  score_dta <- comb[comb$pre==1,]
  # count how many customers are left with pre period data
  counts <- score_dta %>%
    dplyr::group_by(treatment,Install.Year) %>%
    dplyr::summarize(n.cust = n_distinct(PREM_ID)) %>% as.data.frame()
  counts
  write.csv(counts, file = paste(results,
paste0(py[i],"Met_enrollment_and_pre_period_requirements.csv"), sep = "/"))
  rm(counts)

  score_dta <- score_dta %>% dplyr::mutate(zip_5 = as.factor(substr(Zip,1,5)))

  # calculate average usage in pre period
  score_dta <- score_dta %>%
    dplyr::group_by(PREM_ID, ACCT_ID, treatment, Source, zip_5) %>%
    dplyr::summarise(pre.fall.therms = mean(therms.day[month(Midpoint) %in% c(9,10,11)], na.rm
= T),
                     pre.winter.therms = mean(therms.day[month(Midpoint) %in% c(12,1,2)],
na.rm = T),
                     pre.spring.therms = mean(therms.day[month(Midpoint) %in% c(3,4,5)], na.rm
= T),
                     pre.summer.therms = mean(therms.day[month(Midpoint) %in% c(6,7,8)], na.rm
= T))

  # check how many customers have complete pre-period data
  score_dta$is.complete <- as.numeric(!is.na(rowSums(score_dta[,grepl("therms",
colnames(score_dta))])))
  pre_period_completes <- score_dta %>%
    dplyr::group_by(treatment) %>%
    dplyr::summarize(nobs = n(),
                     completes = sum(is.complete),
                     pct.complete = completes/nobs*100) %>%
    as.data.frame()
  pre_period_completes
  save(pre_period_completes, file = paste(inter, paste0(py[i],".pre_period_completes.RData"),
sep = "/"))
  write.csv(pre_period_completes, file = paste(results,
paste0(py[i],".pre_period_completes.csv"), sep = "/"))
  rm(pre_period_completes)

  # remove customers with incomplete pre-period data
  score_dta$prog.year <- py[i]
  score_dta <- score_dta[score_dta$is.complete==1,]
```

```
  # plot densities before matching
  score_dta <- score_dta %>% dplyr::mutate(Group = ifelse(treatment == 1, "Treatment",
"Control"))
  str(score_dta)
  score_dta$Group <- as.factor(score_dta$Group)
  pre.fall   <- ggplot(score_dta, aes(x=pre.fall.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Winter Therms/Day") + ylim(0,0.6) + xlim(0,20)
  pre.winter <- ggplot(score_dta, aes(x=pre.winter.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Spring Therms/Day") + ylim(0,0.4) + xlim(0,45)
  pre.spring <- ggplot(score_dta, aes(x=pre.spring.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Summer Therms/Day") + ylim(0,0.6) + xlim(0,25)
  pre.summer <- ggplot(score_dta, aes(x=pre.summer.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Fall Therms/Day") + ylim(0,1.75) + xlim(0,20)
  zip <- ggplot(score_dta, aes(x=as.factor(zip_5), color=Group, fill = Group)) +
    geom_bar(aes(y = (..count..)/sum(..count..)), position=position_dodge())
+scale_fill_manual(values = c("#0574b0", "#92c5de")) +scale_colour_manual(values =
c("#0574b0", "#92c5de"))+
    xlab("Zip Code") + ylab("Density") +theme(axis.text.x = element_text(angle = 90, hjust =
1)) + ylim(0,0.06)

  ggsave(paste(results, paste0("zip_before_matching_", py[i], ".png"), sep = "/"),zip)

  # write to png file
  plot <- plot_grid(pre.winter,pre.spring,pre.summer,pre.fall,labels = "AUTO")
  ggsave(paste(results, paste0("plot_grid_before_matching_", py[i], ".png"), sep = "/"),plot)
  rm(pre.fall,pre.winter,pre.spring,pre.summer,plot)

  save(score_dta, file = paste(inter, paste0(py[i],".score_dta.RData"), sep = "/"))
  rm(score_dta,comb)

}

set.seed(101)
py <- c(2018, 2019)
py_prog <- c("2017-2018", "2019")

for(i in 1:2) {
  load(paste(inter, paste0(py[i],".score_dta.RData"), sep = "/"))
  dta <- score_dta

  # propensity score matching
  # define matching method
  psm_ratio <- 2
  psm_method <- "nearest"


  dta <- dta %>% as.data.frame()

  # match
  dta <- ungroup(dta)
```

```
  nearest      <- matchit(treatment ~ pre.winter.therms + pre.spring.therms + pre.summer.therms
+ pre.fall.therms,
                   data = dta,
                   method = psm_method,
                   ratio = psm_ratio,
                   replace = FALSE)


  # summary
  a <- summary(nearest)

  # save
  psm_ratio <- data.frame(".PSM Matching Ratio" = psm_ratio)
  psm_method <- data.frame(".PSM Matching Method" = psm_method)
  save(psm_ratio, file = paste(inter, paste0(py[i], ".psm_ratio.RData"), sep = "/"))
  save(psm_method, file = paste(inter, paste0(py[i],".psm_method.RData"), sep = "/"))

  # save matched output
  df.match <- match.data(nearest)
  table(df.match$treatment)

  # extract matched account numbers
  matches <- data.frame(nearest$match.matrix)
  str(matches)

  # save matched df
  save(df.match, file = paste(inter, paste0(py[i],".df.match.RData"), sep = "/"))

  # compute balance after matching
  treated <- (df.match$treatment==1)
  df.match$zip_num <- as.numeric(as.character(df.match$zip_5))
  cov1 <- df.match[,c(colnames(df.match)[grepl("therms", colnames(df.match))], "zip_num")]  #
restrict to propensity covariates
  std.diff <- apply(cov1,2,function(x) 100*(mean(x[treated])-
mean(x[!treated]))/(sqrt(0.5*(var(x[treated]) + var(x[!treated])))))  # computes standardized
difference
  std.diff <- abs(std.diff)   # should be less than 25
  write.csv(std.diff, file = paste(results, paste0(py[i],".standardized_difference.csv"), sep
= "/"))
  rm(treated,cov1,std.diff)

  df.match$treatment_num <- as.integer(df.match$treatment)
  chi.test <- xBalance(treatment_num ~ pre.fall.therms + pre.winter.therms + pre.spring.therms
+ pre.summer.therms, data=df.match, report = c("chisquare.test"))
  chi.output <- capture.output(chi.test) # if p-value is < 0.05, then imbalance occurs in one
of the covariates
  chi.output
  write.csv(chi.output, file = paste(results, paste0(py[i],".chi_square_test.csv"), sep =
"/"))
  df.match$treatment <- as.factor(df.match$treatment)
  rm(chi.output,chi.test)

  # output summaries
  a$nn
  a$sum.all[c(1,2,3,4)]
  a$sum.matched[c(1,2,3,4)]

  # print stats
```

```
  table_before <- data.frame(a$sum.all)
  table_after <- data.frame(a$sum.matched)

  # save output summaries and stats
  match_summary <- a$nn

  save(match_summary, file = paste(inter, paste0(py[i],".summary_nn.RData"), sep = "/"))
  save(table_before, file = paste(inter, paste0(py[i],".summary_all.RData"), sep = "/"))
  save(table_after, file = paste(inter, paste0(py[i],".summary_matched.RData"), sep = "/"))

  write.csv(match_summary, file = paste(results, paste0(py[i],".summary_nn.csv"), sep = "/"))
  write.csv(table_before, file = paste(results, paste0(py[i],".summary_all.csv"), sep = "/"))
  write.csv(table_after, file = paste(results, paste0(py[i],".summary_matched.csv"), sep =
"/"))

  df.match <- df.match %>% dplyr::mutate(Group = ifelse(treatment == 1, "Treatment",
"Control"))

  str(df.match)
  df.match$Group <- as.factor(df.match$Group)
  pre.fall   <- ggplot(df.match, aes(x=pre.fall.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Winter Therms/Day") + ylim(0,0.6) + xlim(0,20)
  pre.winter <- ggplot(df.match, aes(x=pre.winter.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Spring Therms/Day") + ylim(0,0.4) + xlim(0,45)
  pre.spring <- ggplot(df.match, aes(x=pre.spring.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Summer Therms/Day") + ylim(0,0.6) + xlim(0,25)
  pre.summer <- ggplot(df.match, aes(x=pre.summer.therms, color=Group,fill=Group ))
+geom_density(alpha=0.2)+scale_fill_manual(values = c("#0574b0", "#92c5de"))
+scale_colour_manual(values = c("#0574b0", "#92c5de")) + ylab("Density") + xlab("Pre-Period
Fall Therms/Day") + ylim(0,1.75) + xlim(0,10)
  zip <- ggplot(df.match, aes(x=as.factor(zip_5), color=Group, fill = Group)) +
    geom_bar(aes(y = (..count..)/sum(..count..)), position=position_dodge())
+scale_fill_manual(values = c("#0574b0", "#92c5de")) +scale_colour_manual(values =
c("#0574b0", "#92c5de"))+
    xlab("Zip Code") + ylab("Density") +theme(axis.text.x = element_text(angle = 90, hjust =
1)) + ylim(0,0.06)

  ggsave(paste(results, paste0("zip_after_matching_", py[i], ".png"), sep = "/"),zip)

  # save plots
  plot <- plot_grid(pre.winter,pre.spring,pre.summer,pre.fall,labels = "AUTO")
  ggsave(paste(results, paste0("plot_grid_after_matching_", py[i], ".png"), sep = "/"),plot)
  rm(pre.fall,pre.winter,pre.spring,pre.summer,plot)
}

py <- c(2018, 2019)
py_prog <- c("2017-2018", "2019")

load(paste(inter, "psm_dta.RData", sep = "/"))
mo_dta <- psm_dta

# combine program year regression and matched data
```

```
reg_dta <- data.frame()

for(i in 1:2) {

  # monthly billing data
  comb <- mo_dta[mo_dta$Source == py_prog[i],]
  # customer level matched
  load(paste(inter, paste0(py[i],".df.match.RData"), sep = "/"))
  n_distinct(df.match$PREM_ID)
  # keep matched customers
  comb <- merge(df.match,comb, by=c("PREM_ID", "ACCT_ID", "treatment", "Source"))
  n_distinct(comb$PREM_ID)
  reg_dta <- rbind(reg_dta,as.data.frame(comb))
}
rm(comb,df.match)
head(reg_dta)
table(reg_dta$prog.year)

reg_dta <- reg_dta %>% select(-zip_5, -Group)

# get weather
load(paste(inter, "noaa.RData", sep = "/"))
str(noaa)
str(reg_dta$zip_3d)

table(reg_dta$zip)
reg_dta$USAF <- ""
reg_dta$USAF[reg_dta$zip_3d %in% c("836","837")] <- "726810"
reg_dta$USAF[reg_dta$zip_3d %in% c("833")]       <- "725866"
reg_dta$USAF[reg_dta$zip_3d %in% c("832")]       <- "725780"
reg_dta$USAF[reg_dta$zip_3d %in% c("834")]       <- "725785"
table(reg_dta$USAF)

unique(noaa$USAF)
unique(reg_dta$USAF)

# get the unique combination of billing intervals
uniq_bills <- unique(reg_dta[c("Bill.St", "Bill.End","USAF")])
nrow(uniq_bills)

# get weather for each unique billing interval
weather <- lapply(split(uniq_bills, 1:nrow(uniq_bills)),
                  FUN = weather_for_interval, noaa_dta = noaa
)
# convert from list to dataframe
weather <- do.call("rbind", weather)

reg_dta <- merge(reg_dta, weather, all.x = TRUE)
reg_dta <- reg_dta[order(reg_dta$PREM_ID, reg_dta$Bill.St), ]

# ensure no missing or NAN values for weather data
assert(is.finite(sum(reg_dta$HDD.55)))

# use 63 for the setpoint for HDD (from optimal testing)
reg_dta$HDD.day <- reg_dta$HDD.63 / reg_dta$Bill.Duration
save(reg_dta, file = paste(inter, "reg_dta.RData", sep = "/"))

# check weather is correct (adhoc)
```

```
sum(noaa[noaa$Date>=weather[1,1] & noaa$Date <= weather[1,2] & noaa$USAF
=="726810","HDD.56"])==weather$HDD.56[1]
rm(noaa,weather,uniq_bills)

# TMY by weather station (HDD setpoint=63 from optimal testing)
TMY <-rbind(data.frame(USAF = "725780",HDD.TMY=6838.6),
            data.frame(USAF = "726810",HDD.TMY=5188.1),
            data.frame(USAF = "725866",HDD.TMY=5912.6),
            data.frame(USAF = "725785",HDD.TMY=7588.5))

# run regression
for(i in 1:2) {

  load(paste(inter, "reg_dta.RData", sep = "/"))

  #restrict to program year
  reg_dta <- reg_dta[reg_dta$prog.year==py[i],]

  #run regression with matched PS group (method 1)
  model <- lm(therms.day ~ post + treatment + HDD.day + post*HDD.day +
post*HDD.day*treatment+as.factor(PREM_ID), data = reg_dta)
  summary(model)
  model_output <- capture.output(summary(model))
  coeff <- as.data.frame(summary(model)$coeff)
  coeff <- coeff[!grepl("PREM_ID", rownames(coeff)),]

  write.csv(coeff, paste(results, paste0(py[i], ".coeff.csv"), sep = "/"))
  write.csv(model_output, paste(results, paste0(py[i], ".model_output.csv"), sep = "/"))
  rm(coeff,model,reg_dta)

}
rm(TMY)
```

7.2 Whole Home Rebate Script

```
# install and load required packages for analysis
install.packages("easypackages")
library(easypackages)
packages("readxl", "dplyr", "lubridate", "zoo", "ggplot2", "cowplot", "MatchIt", "stringr",
"data.table", "RItools", "broom")

# parameters
setpoint <- 63

# functions
# tracks treatment customers
tracking_trmt <- function(string, count18, count19) {
  tracking_dta <- data.frame(Detail = string,
                             `PY2018 Count` = count18,
                             `PY2019 Count` = count19, stringsAsFactors = F)
  return(tracking_dta)
}

# tracks control customers
tracking_ctrl <- function(string, count) {
  tracking_dta <- data.frame(Detail = string,
```

```
                             `Ctrl Count` = count, stringsAsFactors = F)
  return(tracking_dta)
}

# tracks treatment and control customers
tracking <- function(string, count18, count19, countctrl18, countctrl19) {
  tracking_dta <- data.frame(Detail = string,
                             "2017-2018 Trmt Count" = count18,
                             "2019 Trmt Count" = count19,
                             "2017-2018 Ctrl Count" = countctrl18,
                             "2019 Ctrl Count" = countctrl19, stringsAsFactors = F)
  return(tracking_dta)
}

# calendarization functions
func_fd <- function(x) {
  return(ymd(paste(year(x),
                   month(x),
                   01)))
}

func_month_between <- function(end_date, start_date) {
  dif_year <- year(end_date) - year(start_date)
  dif_month <- month(end_date) - month(start_date)
  12 * dif_year + dif_month
}

func_month_fd <- function(input.date, n.month) {
  date <- as.character(input.date)
  y <- as.integer(substr(date, 1, 4))
  m <- as.integer(substr(date, 6, 7)) + n.month - 1
  r <- m %% 12
  q <- m %/% 12
  y <- ifelse(r == 0, y + q - 1, y + q)
  m <- ifelse(r == 0, 12, r)
  new.date <- paste(y, m, 1, sep = "-")
  ymd(new.date)
}

# set up program paths
vers <- "script"
wd       <- getwd()
code_dir <- paste(wd, "Code", sep = "/")
raw_dir  <- paste(wd, "Raw", sep = "/")
inter    <- paste(wd, "Inter", vers, sep = "/")
results  <- paste(wd, "Results", vers, sep = "/")

# create directories
suppressWarnings(dir.create(code_dir, recursive = T))
suppressWarnings(dir.create(raw_dir, recursive = T))
suppressWarnings(dir.create(inter, recursive = T))
suppressWarnings(dir.create(results, recursive=T))

# read in raw data files
# whole homes tracking data
fl_info <- "Whole Home Tracking Data Aggregate.xlsx"
tracking_raw <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 2, skip = 0, col_types =
"text") # NEED TO SPECIFY AS CHARACTER
```

```
save(tracking_raw, file = paste(inter, "tracking_raw.RData", sep = "/"))

# whole homes participant billing data ---
fl_info <- "IGC WHOLE HOME DATA.xlsx"
homes_participant_info_raw    <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 3, skip
= 1)
homes_participant_billing_raw <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 4, skip
= 1)
save(homes_participant_info_raw,    file = paste(inter, "homes_participant_info_raw.RData",
sep = "/"))
save(homes_participant_billing_raw, file = paste(inter, "homes_participant_billing_raw.RData",
sep = "/"))

# nonparticipant whole homes data
# this dataset includes households that received a whole home rebate or an appliance rebate,
as well as new homes that are nonparticipant.
# need to first filter out any participants
fl_info <- "IGC NEWLY BUILT DATA.xlsx"
all_info_raw    <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 3, skip = 1)
all_billing_raw <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 4, skip = 1)
all_billing_housing_char <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 5, skip = 2)
save(all_info_raw,    file = paste(inter, "all_info_raw.RData", sep = "/"))
save(all_billing_raw, file = paste(inter, "all_billing_raw.RData", sep = "/"))
save(all_billing_housing_char, file = paste(inter, "all_billing_housing_char.RData", sep =
"/"))

# appliance rebate tracking data
fl_info <- "All Appliances.xlsx"
rebate_tracking_raw <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 3, skip = 0,
col_types = "text") # NEED TO SPECIFY AS CHARACTER
save(rebate_tracking_raw, file = paste(inter, "rebate_tracking_raw.RData", sep = "/"))

# appliance rebate participant billing data
fl_info <- "IGC INDIVIDUAL REBATE BILLING DATA (1).xlsx"
rebate_participant_info_raw    <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 3,
skip = 1)
rebate_participant_billing_raw <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 4,
skip = 1)
save(rebate_participant_info_raw,    file = paste(inter, "rebate_participant_info_raw.RData",
sep = "/"))
save(rebate_participant_billing_raw, file = paste(inter,
"rebate_participant_billing_raw.RData", sep = "/"))

# HERS dataset
fl_info <- "ESRI_HERS.xlsx"
hers <- read_xlsx(paste(raw_dir, fl_info, sep = "/"), sheet = 1, skip = 0, col_types = "text")
# NEED TO SPECIFY AS CHARACTER
save(hers, file = paste(inter, "hers.RData", sep = "/"))

# load data ---
load(paste(inter, "homes_participant_info_raw.RData", sep = "/"))
load(paste(inter, "homes_participant_billing_raw.RData", sep = "/"))
load(paste(inter, "tracking_raw.RData", sep = "/"))
load(paste(inter, "all_billing_housing_char.RData", sep = "/"))
load(paste(inter, "all_info_raw.RData", sep = "/"))

# make sure all rebates are found in tracking data and vice versa
tracking_raw$`Rebate ID`[!tracking_raw$`Rebate ID` %in% homes_participant_info_raw$REBATE_ID]
```

```
# tracking count start
part_tracking_dta <- tracking_trmt("Starting premises", nrow(tracking_raw[tracking_raw$Source
== "2017-2018",]), nrow(tracking_raw[tracking_raw$Source == "2019",]))

n_before <- length(unique(homes_participant_info_raw$PREMISE_ID))
homes_participant_info_raw$REBATE_ID[!homes_participant_info_raw$REBATE_ID %in%
tracking_raw$`Rebate ID`]
n_after <- length(unique(homes_participant_info_raw$PREMISE_ID))
if(n_before != n_after) {stop("MISSING REBATES")}

# participant data
# testing
# check if IGC_ACCOUNT_NO is the most recent customer's account number or the original rebate
account number
part_raw <- merge(homes_participant_billing_raw, homes_participant_info_raw, by =
c("PREMISE_ID"))
part_raw <- merge(part_raw, tracking_raw, by.x = "REBATE_ID", by.y = "Rebate ID")
part_raw_earliest <- part_raw %>%
  dplyr::arrange(PREMISE_ID,BSEG_START_DT)  %>%
  dplyr::group_by(PREMISE_ID) %>%
  slice(1)
# Note all original rebate account ids
orig_acct_ids <- part_raw$IGC_ACCOUNT_NO

# merge billing data with customer household info by premise ID
part <- merge(homes_participant_info_raw, homes_participant_billing_raw, by = c("PREMISE_ID"))

# merge billing data and customer household info with tracking data by rebate ID
part <- merge(part, unique(tracking_raw[, c("Source", "Rebate ID", "IGC Account No", "Site
Address", "HERS Score")]), by.x = "REBATE_ID", by.y = "Rebate ID")

# tracking
part_tracking_dta <- rbind(part_tracking_dta, c("Fully merged premises",
length(unique(part$PREMISE_ID[part$Source == "2017-2018"])),
length(unique(part$PREMISE_ID[part$Source == "2019"]))))

# make sure all participating homes have HERS scores (from builder tracking data and from ada
assessor data)
part %>% dplyr::select(PREMISE_ID, `HERS Score`, Source) %>% dplyr::distinct() %>%
dplyr::filter(!is.na(`HERS Score`)) %>% dplyr::group_by(Source) %>%
dplyr::summarise(mean_score = mean(as.numeric(`HERS Score`), na.rm = T), n = n())
part %>% dplyr::select(PREMISE_ID, HERS_SCORE, Source) %>% dplyr::distinct() %>%
dplyr::filter(!is.na(HERS_SCORE)) %>% dplyr::group_by(Source) %>% dplyr::summarise(mean_score
= mean(as.numeric(HERS_SCORE), na.rm = T), n = n())

# keep this dataset to do sold time analysis
sell_analysis_trmt <- part
sell_analysis_trmt$trmt <- 1
sell_analysis_trmt <- sell_analysis_trmt[, !grepl("^4", colnames(sell_analysis_trmt))]
save(sell_analysis_trmt, file = paste(inter, "sell_analysis_trmt.RData", sep = "/"))

# find and remove unoccupied homes (homes still owned by builders)
names <- part %>%
  dplyr::select(ENTITY_NAME, SITE_ADDRESS) %>%
  distinct() %>%
  dplyr::group_by(ENTITY_NAME) %>%
  dplyr::summarise(n=n())
```

```
confirmed_builder_names <- c("Hubble Homes", "Brighton Homes", "Todd Campbell Construction",
"Brighton Living",
                             "Clyde Development", "Tresidio Corporation", "Berkeley Building
Company", "Eaglewood Homes Inc",
                             "Riverwood Homes", "Shadow Mountain Homes", "Avimor Partners
Corp", "Gardner Homes Idaho, LLC",
                             "Titan Homes LLC", "Arden Lynn Aker Trust", "Brandt Agency",
"Foothill Construction",
                             "Hale Developement", "SDH Construction", "St Marks Church",
"Sustainable Homes LLC", "Vega Holdings V, LLC",
                             "Douglass, Patrick")

# remove all original rebate account ids (these are the builders)
part <- part[part$ACCT_ID != part$IGC_ACCOUNT_NO,]
# remove all remaining builder names found
part <- part[!part$ENTITY_NAME %in% confirmed_builder_names,]
# make sure there are no builder IDS
part <- part[!part$ACCT_ID %in% orig_acct_ids,]
# remove all business identifiers
part <- part[part$PER_OR_BUS_FLG == "P",]
part <- part %>%
  dplyr::select(Source, PREMISE_ID, PER_ID, ACCT_ID, PARCEL, SITE_ADDRESS, SITE_CITY,
ENTITY_NAME,
                BSEG_START_DT, BSEG_END_DT, CONSUMPTION, `HERS Score`, BUILDER_SQUARE_FOOTAGE,
YEAR_BUILT) %>%
  dplyr::rename(BUILDER_YEARBUILT = YEAR_BUILT)

# tracking
part_tracking_dta <- rbind(part_tracking_dta, c("After removing homes still owned by
builders", length(unique(part$PREMISE_ID[part$Source == "2017-2018"])),
length(unique(part$PREMISE_ID[part$Source == "2019"]))))

# merge billing data with ada county assessor household data by premise ID
ada_info <- merge(all_billing_housing_char, all_info_raw, by = c("PREM_ID", "PARCEL"))
# remove the 3 hoursholds that have different year built
ada_info$equal <- ada_info$YEARBUILT.x == ada_info$YEARBUILT.y
ada_info <- ada_info %>%
  dplyr::filter(equal == TRUE) %>%
  dplyr::select(-YEARBUILT.y) %>%
  dplyr::rename(YEARBUILT = YEARBUILT.x)
# how many premises are repeated with different info in ada info?
multiple_ada_info <- ada_info %>%
  dplyr::group_by(PREM_ID, PARCEL) %>%
  dplyr::summarise(n = n()) %>%
  filter(n > 1)
table(multiple_ada_info$n)
# remove the ones with multiple rows
ada_info <- ada_info %>% anti_join(multiple_ada_info)
# save
save(ada_info, file = paste(inter, "ada_info.RData", sep = "/"))
# keep matching variables
ada_info <- ada_info %>%
  dplyr::select(PREM_ID, PARCEL, OCCDATE, YEARBUILT, BEDROOMS, BATHROOMS, FIREPLACE, HEATING,
AC,
                ASSESSOR_SQUARE_FOOTAGE, HERS_SCORE,
                ENERGY_STAR, INDIVIDUAL_REB, EARLIEST_BILL_DATE, ADDRESS1_UPR, CITY_UPR,
POSTAL)
```

```
part <- merge(part, ada_info , by.x = c("PREMISE_ID", "PARCEL"), by.y = c("PREM_ID",
"PARCEL")) # Merge

# tracking
part_tracking_dta <- rbind(part_tracking_dta, c("After matching premise ID and parcel with Ada
County Assessor info (required for matching)", length(unique(part$PREMISE_ID[part$Source ==
"2017-2018"])), length(unique(part$PREMISE_ID[part$Source == "2019"]))))

# make sure all have HERS scores
part %>% dplyr::select(PREMISE_ID, `HERS Score`, Source) %>% dplyr::distinct() %>%
dplyr::filter(!is.na(`HERS Score`)) %>% dplyr::group_by(Source) %>%
dplyr::summarise(mean_score = mean(as.numeric(`HERS Score`), na.rm = T), n = n())
part %>% dplyr::select(PREMISE_ID, HERS_SCORE, Source) %>% dplyr::distinct() %>%
dplyr::filter(!is.na(HERS_SCORE)) %>% dplyr::group_by(Source) %>% dplyr::summarise(mean_score
= mean(as.numeric(HERS_SCORE), na.rm = T), n = n())

# find differences between builder and assessor square footages
x <- part %>%
  dplyr::mutate(YEARBUILT = as.numeric(YEARBUILT)) %>%
  dplyr::select(PREMISE_ID, Source, BUILDER_YEARBUILT, YEARBUILT, BUILDER_SQUARE_FOOTAGE,
ASSESSOR_SQUARE_FOOTAGE, SITE_ADDRESS, ADDRESS1_UPR) %>%
  dplyr::distinct() %>%
  dplyr::mutate(yearbuilt_diff = BUILDER_YEARBUILT - YEARBUILT,
                sqft_diff = BUILDER_SQUARE_FOOTAGE - ASSESSOR_SQUARE_FOOTAGE)
table(x$yearbuilt_diff)
# use builder values instead of assessor values. note that they are very different
summary(x$sqft_diff)
# make sure none of the whole homes also get appliance rebates
table(part$INDIVIDUAL_REB)

# keep homes with occupancy date, and keep bills that occur only after occupancy date
part <- part %>%
  dplyr::mutate(BSEG_START_DT = as.Date(BSEG_START_DT),
                BSEG_END_DT = as.Date(BSEG_END_DT),
                OCCDATE = as.Date(OCCDATE)) %>%
  dplyr::filter(OCCDATE > as.Date("2015-01-01")) %>%
  dplyr::filter(BSEG_START_DT > OCCDATE)

# tracker
part_tracking_dta <- rbind(part_tracking_dta, c("After only keeping households with billing
data occurring after occupancy date", length(unique(part$PREMISE_ID[part$Source == "2017-
2018"])), length(unique(part$PREMISE_ID[part$Source == "2019"]))))

# see how many months are available
n_months <- part %>%
  dplyr::group_by(PREMISE_ID, ACCT_ID) %>%
  dplyr::summarise(n_months = n())
table(n_months$n_months)

# test how many unique accounts per premise
x <- part %>%
  dplyr::group_by(PREMISE_ID, YEARBUILT, BUILDER_YEARBUILT) %>%
  dplyr::summarise(n_acct = n_distinct(ACCT_ID))
table(x$n_acct)

# see year built distribution
table(x$YEARBUILT)
```

```
table(x$BUILDER_YEARBUILT)

# save fully merged participant data
part_tracking_dta <- rbind(part_tracking_dta, c("Saved full info",
length(unique(part$PREMISE_ID[part$Source == "2017-2018"])),
length(unique(part$PREMISE_ID[part$Source == "2019"]))))
part_full <- part
# save current data to match to customer later, if needed
save(part_full, file = paste(inter, "part_full.RData", sep = "/"))

# keep needed variables
part <- part %>%
  dplyr::select(-PER_ID, -SITE_ADDRESS, -SITE_CITY, -ENTITY_NAME, -ENERGY_STAR, -
INDIVIDUAL_REB, -HERS_SCORE, -ASSESSOR_SQUARE_FOOTAGE, -YEARBUILT) %>%
  dplyr::rename(START_DT = BSEG_START_DT,
                END_DT = BSEG_END_DT,
                YEARBUILT = BUILDER_YEARBUILT,
                SQFT = BUILDER_SQUARE_FOOTAGE,
                HERS_SCORE = `HERS Score`) %>%
  # assign treatment
  dplyr::mutate(trmt = 1,
                HERS_SCORE = as.numeric(HERS_SCORE))
part_tracking_dta <- rbind(part_tracking_dta, c("Saved required info",
length(unique(part$PREMISE_ID[part$Source == "2017-2018"])),
length(unique(part$PREMISE_ID[part$Source == "2019"]))))

# save participant dataset
save(part, file = paste(inter, "part.RData", sep = "/"))
save(part_tracking_dta, file = paste(inter, "part_tracking_dta.RData", sep = "/"))

# are there still premises with acct_id in original rebate application? no.
test <- part[part$ACCT_ID %in% orig_acct_ids,]

# nonparticipant data
# start tracking
nonpart_tracking_dta <- tracking_ctrl("All new homes data", length(unique(ada_info$PREM_ID)))

# merge nonparticipant billing to ada info, with HERS score and assessor SQFT (we don't have
builder HERS or SQFT)
load(paste(inter, "ada_info.RData", sep = "/"))
ada_info <- ada_info %>%
  dplyr::select(PREM_ID, PARCEL, OCCDATE, YEARBUILT, BEDROOMS, BATHROOMS, FIREPLACE, HEATING,
AC, ASSESSOR_SQUARE_FOOTAGE, NOOFDWELLI, FIREPLACE,
                HERS_SCORE, ENERGY_STAR, INDIVIDUAL_REB, EARLIEST_BILL_DATE, ADDRESS1_UPR,
CITY_UPR, POSTAL)

# find and remove nonparticipant households that participate in appliance rebate program
load(paste(inter, "all_billing_raw.RData", sep = "/"))
load(paste(inter, "rebate_participant_info_raw.RData", sep = "/"))
load(paste(inter, "rebate_participant_billing_raw.RData", sep = "/"))
load(paste(inter, "rebate_tracking_raw.RData", sep = "/"))

# remove based on IGC-provided identifier
nonpart_info <- ada_info[ada_info$ENERGY_STAR == 0 & ada_info$INDIVIDUAL_REB == 0,]

# tracking
nonpart_tracking_dta <- rbind(nonpart_tracking_dta, c("New homes that didnt have a rebate
identifier", length(unique(nonpart_info$PREM_ID))))
```

```
# remove on premise ID and address in whole homes rebate tracking data
# none found
nrow(nonpart_info[nonpart_info$PREM_ID %in% unique(homes_participant_info_raw$PREMISE_ID),])
# none found
nrow(nonpart_info[nonpart_info$ADDRESS1_UPR %in%
toupper(homes_participant_info_raw$SITE_ADDRESS),])

# remove on premise ID and address in appliance rebate tracking data
# none found
nrow(nonpart_info[nonpart_info$PREM_ID %in% rebate_participant_info_raw$PREMISE_ID,])
# 3 found
nrow(nonpart_info[nonpart_info$ADDRESS1_UPR %in%
toupper(rebate_participant_info_raw$SITE_ADDRESS),])
# none found
nrow(nonpart_info[nonpart_info$ADDRESS1_UPR %in% toupper(tracking_raw$`Site Address`),])
# 3 found, same as above 3
nrow(nonpart_info[nonpart_info$ADDRESS1_UPR %in% toupper(rebate_tracking_raw$`Site
Address`),])

# check that participant whole homes aren't also participant appliance homes
nrow(part[part$PREMISE_ID %in% rebate_participant_info_raw$PREMISE_ID,])
nrow(part[part$ADDRESS1_UPR %in% toupper(rebate_participant_info_raw$SITE_ADDRESS),])
nrow(part[part$ADDRESS1_UPR %in% toupper(rebate_tracking_raw$`Site Address`),])

# remove the 3 nonparticipants that were found in rebate info
nonpart_info_valid <- nonpart_info[!nonpart_info$ADDRESS1_UPR %in%
toupper(rebate_participant_info_raw$SITE_ADDRESS),]
nonpart_tracking_dta <- rbind(nonpart_tracking_dta, c("After removing additional homes found
in rebate data", length(unique(nonpart_info_valid$PREM_ID))))

# merge validated nonparticipant data onto full billing data
nonpart <- merge(nonpart_info_valid, all_billing_raw, by = "PREM_ID")
nonpart_tracking_dta <- rbind(nonpart_tracking_dta, c("After merging with billing data",
length(unique(nonpart$PREM_ID))))

# keep this dataset for selling analysis
sell_analysis_ctrl <- nonpart
sell_analysis_ctrl$trmt <- 0
save(sell_analysis_ctrl, file = paste(inter, "sell_analysis_ctrl.RData", sep  = "/"))

# keep only bills that occur after occupancy date
length(unique(nonpart$PREM_ID))
nonpart <- nonpart %>%
  dplyr::mutate(BSEG_START_DT = as.Date(BSEG_START_DT),
                BSEG_END_DT = as.Date(BSEG_END_DT),
                OCCDATE = as.Date(OCCDATE)) %>%
  dplyr::filter(OCCDATE > as.Date("2015-01-01")) %>%
  dplyr::filter(BSEG_START_DT > OCCDATE)
length(unique(nonpart$PREM_ID))
nonpart_tracking_dta <- rbind(nonpart_tracking_dta, c("After keeping only billing data after
occupancy date", length(unique(nonpart$PREM_ID))))

# only keep households with 1 NOOFDWELLI
nonpart <- nonpart[nonpart$NOOFDWELLI == 1,]
nonpart_tracking_dta <- rbind(nonpart_tracking_dta, c("After keeping only households with
NOOFDWELLI == 1", length(unique(nonpart$PREM_ID))))
```

```
# test unique accounts per premise ID
x <- nonpart %>%
  dplyr::group_by(PREM_ID, YEARBUILT) %>%
  dplyr::summarise(n_acct = n_distinct(ACCT_ID))
table(x$n_acct)

# keep variables we need
nonpart <- nonpart %>%
  dplyr::select(-BSEG_ID, -BILL_ID, -SA_ID, -ACCOUNTING_DATE, -ENERGY_STAR, -INDIVIDUAL_REB, -
NOOFDWELLI) %>%
  dplyr::rename(PREMISE_ID = PREM_ID,
                START_DT = BSEG_START_DT,
                END_DT = BSEG_END_DT,
                SQFT = ASSESSOR_SQUARE_FOOTAGE) %>%
  dplyr::mutate(trmt = 0) # assign treatment

# save nonparticipant billing data
save(nonpart, file = paste(inter, "nonpart.RData", sep = "/"))
save(nonpart_tracking_dta, file = paste(inter, "nonpart_tracking_dta.RData", sep = "/"))

# save tracking tables
write.csv(part_tracking_dta, paste(results, "part_tracking_dta.csv", sep = "/"))
write.csv(nonpart_tracking_dta, paste(results, "nonpart_tracking_dta.csv", sep = "/"))

# load data
load(paste(inter, "part.RData", sep = "/"))
load(paste(inter, "part_tracking_dta.RData", sep = "/"))
load(paste(inter, "nonpart.RData", sep = "/"))
load(paste(inter, "nonpart_tracking_dta.RData", sep = "/"))

# combine part and nonpart into one dataset to find zip codes
nonpart$Source <- "2017-2018"
bills <- rbind(part, nonpart)
nonpart$Source <- "2019"
bills <- rbind(bills, nonpart)

bills$zip_3 <- substr(bills$POSTAL, 0, 3)
table(bills$zip_3)

# Boise: 836, 837
# USAF Code: 726810

# read in NOAA weather data
weather_2017    <- read.csv(paste(raw_dir, "726810-2017.csv", sep = "/"), stringsAsFactors =
F)
weather_2018    <- read.csv(paste(raw_dir, "726810-2018.csv", sep = "/"), stringsAsFactors =
F)
weather_2019    <- read.csv(paste(raw_dir, "726810-2019.csv", sep = "/"), stringsAsFactors =
F)
weather_2020    <- read.csv(paste(raw_dir, "726810-2020.csv", sep = "/"), stringsAsFactors =
F)
weather_dta <- rbind(weather_2017, weather_2018, weather_2019, weather_2020)

# change hourly weather data to monthly HDD and CDD
weather_dta <- weather_dta %>%
  dplyr::select(date_local, temp) %>%
  dplyr::rename(datetime = date_local) %>%
  dplyr::mutate(date = as.Date(datetime),
```

```
                hour = hour(datetime),
                hdd = ifelse((setpoint-temp)/24>0,(setpoint-temp)/24,0),
                cdd = ifelse((temp-setpoint)/24>0,(temp-setpoint)/24,0)) %>%
  dplyr::select(-datetime)  %>%
  dplyr::group_by(date) %>%
  dplyr::summarise(temp = mean(temp, na.rm = T),
                   hdd = mean(hdd, na.rm = T)*24,
                   cdd = mean(cdd, na.rm = T)*24)

test <- weather_dta %>%
  dplyr::mutate(month = month(date),
                year = year(date)) %>%
  dplyr::group_by(month,year) %>%
  dplyr::summarise(hdd = sum(hdd, na.rm = T),
                   cdd = sum(cdd, na.rm = T))

# check annual HDD and CDD
annual <- test %>%
  dplyr::group_by(year) %>%
  dplyr::summarise(hdd = sum(hdd),
                   cdd = sum(cdd))

# save weather data
save(weather_dta, file = paste(inter, "weather_dta.RData", sep = "/"))

# load files
load(paste(inter, "part.RData", sep = "/"))
load(paste(inter, "part_tracking_dta.RData", sep = "/"))
load(paste(inter, "nonpart.RData", sep = "/"))
load(paste(inter, "nonpart_tracking_dta.RData", sep = "/"))
load(paste(inter, "weather_dta.RData", sep = "/"))

# combine participant and nonparticipant into one dataset
nonpart$Source <- "2017-2018"
bills <- rbind(part, nonpart)
nonpart$Source <- "2019"
bills <- rbind(bills, nonpart)

# get weather data for all unique billing intervals
intervals <- unique(bills[, c("START_DT", "END_DT")])
intervals_hdd_cdd <- data.frame()
for (i in 1:nrow(intervals)) {
  st <- intervals$START_DT[i]
  end <- intervals$END_DT[i]

  return_dta <- weather_dta %>%
    dplyr::filter(date >= st & date <= end) %>%
    dplyr::summarise(temp = mean(temp, na.rm = T),
                     hdd = sum(hdd, na.rm = T),
                     cdd = sum(cdd, na.rm = T)) %>%
    dplyr::mutate(START_DT = st,
                  END_DT = end)
  intervals_hdd_cdd <- rbind(intervals_hdd_cdd, return_dta)
}

# merge bills with weather data
bills <- merge(bills, intervals_hdd_cdd, by = c("START_DT", "END_DT"))
```

```
# take into account the corrections
nrow(bills)
bills <- bills %>%
  dplyr::mutate(hdd = ifelse(CONSUMPTION<0, -1*hdd, hdd),
                cdd = ifelse(CONSUMPTION<0, -1*cdd, cdd)) %>%
  dplyr::group_by(PREMISE_ID, PARCEL, ACCT_ID, Source, HERS_SCORE, SQFT, YEARBUILT, OCCDATE,
BEDROOMS, BATHROOMS, FIREPLACE, HEATING, AC, EARLIEST_BILL_DATE, ADDRESS1_UPR, CITY_UPR,
POSTAL, trmt, temp, START_DT, END_DT) %>%
  dplyr::summarise(CONSUMPTION = sum(CONSUMPTION, na.rm = T),
                   hdd = sum(hdd, na.rm = T),
                   cdd = sum(cdd, na.rm = T)) %>%
  ungroup()
nrow(bills)

# tracker
# starting cleaning steps
tracking_dta <- tracking("Starting",
                         nrow(unique(bills[bills$Source == "2017-2018" & bills$trmt == 1,
c("PREMISE_ID", "Source", "trmt")])),
                         nrow(unique(bills[bills$Source == "2019"      & bills$trmt == 1,
c("PREMISE_ID", "Source", "trmt")])),
                         nrow(unique(bills[bills$Source == "2017-2018" & bills$trmt == 0,
c("PREMISE_ID", "Source", "trmt")])),
                         nrow(unique(bills[bills$Source == "2019"      & bills$trmt == 0,
c("PREMISE_ID", "Source", "trmt")])))

# already removed the bills that overlap with occupancy date
# calendarize
raw_merge <- bills %>%
  mutate(START_DT = START_DT+1) %>%
  arrange(START_DT) %>%
  group_by(PREMISE_ID, ACCT_ID, Source, PARCEL, OCCDATE, YEARBUILT, BEDROOMS, BATHROOMS,
FIREPLACE, HEATING, AC, SQFT, HERS_SCORE, EARLIEST_BILL_DATE, ADDRESS1_UPR, CITY_UPR, POSTAL,
trmt) %>%
  mutate(bill_date = START_DT+as.numeric(END_DT-START_DT),
         last_ym = lag(bill_date),
         duration = as.numeric(END_DT-START_DT)+1) %>%
  ungroup() %>%
  mutate(month_bt = func_month_between(bill_date, last_ym),
         month_bt = ifelse(is.na(month_bt), 0, month_bt),
         year_mon = func_fd(bill_date),
         avg_therm =  CONSUMPTION/ duration,
         avg_hdd = hdd/duration,
         avg_cdd = cdd/duration)

summary(raw_merge$month_bt)
raw_temp <- as.data.frame(raw_merge)
raw_merge <- data.frame()

i <- 1
while(i > 0) {
  raw_temp <- raw_temp %>%
    mutate(day_bt = bill_date - year_mon + 1,
           day_bt = ifelse(day_bt < duration, day_bt, duration))

  raw_merge <- rbindlist(list(raw_merge, raw_temp), fill = T)

  raw_temp <- raw_temp %>%
```

```
    mutate(bill_date = bill_date - day_bt,
           duration = duration - day_bt,
           year_mon = func_fd(bill_date),
           month_bt = month_bt - 1) %>%
    filter(month_bt >= 0)

  i <- nrow(raw_temp)

}

rm(i, raw_temp)

raw_merge <- raw_merge %>%
  arrange(PREMISE_ID, ACCT_ID, Source, PARCEL, OCCDATE, YEARBUILT, BEDROOMS, BATHROOMS,
FIREPLACE, HEATING, AC, SQFT, HERS_SCORE, EARLIEST_BILL_DATE, ADDRESS1_UPR, CITY_UPR, POSTAL,
trmt, START_DT) %>%
  mutate(daily_usage = avg_therm * day_bt,
         daily_hdd = avg_hdd * day_bt,
         daily_cdd = avg_cdd * day_bt) %>%
  group_by(PREMISE_ID, ACCT_ID, Source, PARCEL, OCCDATE, YEARBUILT, BEDROOMS, BATHROOMS,
FIREPLACE, HEATING, AC, SQFT, HERS_SCORE, EARLIEST_BILL_DATE, ADDRESS1_UPR, CITY_UPR, POSTAL,
trmt, year_mon) %>%
  summarise(days = sum(day_bt),
          monthly_usage = sum(daily_usage),
          daily_usage = monthly_usage/days,
          monthly_hdd = sum(daily_hdd),
          monthly_cdd = sum(daily_cdd)) %>%
  ungroup()

nrow(unique(raw_merge[, c("PREMISE_ID", "PARCEL", "Source", "ACCT_ID")]))
nrow(unique(bills    [, c("PREMISE_ID", "PARCEL", "Source", "ACCT_ID")]))

keep_colnames <- c("PREMISE_ID", "PARCEL", "Source", "ACCT_ID",
                   "OCCDATE", "YEARBUILT", "BEDROOMS", "BATHROOMS", "FIREPLACE",
                   "HEATING", "AC", "SQFT", "HERS_SCORE", "EARLIEST_BILL_DATE",
                   "ADDRESS1_UPR", "CITY_UPR", "POSTAL", "trmt")
merge_df <- unique(bills[, keep_colnames])
bills <- merge(merge_df, raw_merge, by = c("PREMISE_ID", "PARCEL", "Source", "ACCT_ID",
"OCCDATE", "YEARBUILT", "BEDROOMS",
                                           "BATHROOMS", "FIREPLACE",
                                           "HEATING", "AC", "SQFT", "HERS_SCORE",
"EARLIEST_BILL_DATE",
                                           "ADDRESS1_UPR", "CITY_UPR", "POSTAL", "trmt"))
bills <- bills %>% ungroup()


# tracker
tracking_dta <- rbind(tracking_dta, c("After calendarizing",
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))

# see how housing char range between groups
```

```
test_var_full <- unique(bills[, c("PREMISE_ID", "BEDROOMS", "BATHROOMS", "FIREPLACE",
"HERS_SCORE", "YEARBUILT", "trmt", "Source")])
test_var_full <- test_var_full %>% dplyr::mutate(trmt = as.factor(trmt))

# keep homes within year build range for each program year
year_built_py <- bills %>%
  dplyr::filter(trmt == 1) %>%
  dplyr::group_by(Source) %>%
  dplyr::summarize(min_year_built = min(YEARBUILT),
                   max_year_built = max(YEARBUILT))
bills <- merge(bills, year_built_py, by = "Source")
bills <- bills[bills$YEARBUILT >= bills$min_year_built & bills$YEARBUILT <=
bills$max_year_built,]

# tracker
tracking_dta <- rbind(tracking_dta, c("After removing ctrl customers with year built before
min or after max trmt year built for each PY",
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))

# remove households without square footage value or doesn't have heating and cooling, like our
entire trmt group
nrow(unique(bills[is.na(bills$SQFT) | bills$SQFT == 0, c("PREMISE_ID", "ACCT_ID", "trmt",
"Source")]))

bills <- bills %>%
  dplyr::filter(!is.na(SQFT) & SQFT>0 & HEATING == "Y" & AC == "Y")

# tracker
tracking_dta <- rbind(tracking_dta, c("After removing customers that don't have heating and
cooling and SQFT",
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))

# make variables
bills <- bills %>% ungroup()
# bill month assigned from bill midpoint
bills$month <- month(bills$year_mon)
# bill year assigned from bill midoint
bills$year  <- year(bills$year_mon)
bills$heating_months <- as.integer(bills$month %in% c(10,11,12,1,2,3,4))

# remove if number billing days too few or too many
bills <- bills[bills$days >= 10 & bills$days <= 31,]

# tracker
```

```
tracking_dta <- rbind(tracking_dta, c("After removing months with less than 1 or more than 31 
days of data",
                                      nrow(unique(bills[bills$Source == "2017-2018" & 
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      & 
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2017-2018" & 
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      & 
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))


# calculate median usage
median_usage <- bills %>%
  filter(trmt == 1) %>%
  dplyr::group_by(month) %>%
  dplyr::summarise(median_usage = median(daily_usage, na.rm = T))

bills <- merge(bills, median_usage, by = c("month"), all.x = T)

bills_removed = bills[bills$daily_usage > bills$median_usage*10, ]
bills <- bills[bills$daily_usage <= bills$median_usage*10, ]

# kept this lower bound restriction to filter out unoccupied households
bills_removed = bills[bills$daily_usage < bills$median_usage/10, ]
bills <- bills[bills$daily_usage >= bills$median_usage/10, ]

# remove outliers with unrealistically high usage
bills <- bills[bills$daily_usage <= 50, ]

# tracker
tracking_dta <- rbind(tracking_dta, c("After removing outliers",
                                      nrow(unique(bills[bills$Source == "2017-2018" & 
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      & 
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2017-2018" & 
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      & 
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))

# before we restrict on sufficient post-period bills, summarize usage and average square 
footage
usage_smry <- bills %>%
  dplyr::filter(year_mon >= as.Date("2019-01-01")) %>%
  dplyr::group_by(Source, trmt, month) %>%
  dplyr::summarise(avg.daily.usage = mean(daily_usage,na.rm=T),
                   avg.daily.usage.sqft = mean(daily_usage/SQFT, na.rm = T)) %>%
  as.data.frame()
write.csv(usage_smry, paste(results, "usage.smry.before.match.csv", sep = "/"))

sqft_smry <- bills %>%
  dplyr::filter(year_mon >= as.Date("2019-01-01")) %>%
  # make unique by household, so we dont give greater weight to the homes with more bills
  dplyr::select(PREMISE_ID, ACCT_ID, YEARBUILT, SQFT, Source, trmt) %>%
  dplyr::distinct() %>%
  dplyr::group_by(Source, trmt) %>%
  dplyr::summarise(avg.sqft = mean(SQFT, na.rm = T))
```

```
write.csv(sqft_smry, paste(results, "sqft.smry.before.match.csv", sep = "/"))

# restrict earliest bill date for each groups, select a clean post period between each group
and make sure each group has
# sufficient number of customers with sufficiently full post-periods per house

# first test restrictions
# 2019
# see spread
bill_spread_before <- table(bills$year_mon, bills$trmt, bills$Source)
bills_test <- bills %>% dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>%
dplyr::mutate(min_bill = min(year_mon))

# check these restrictions
bills_test <- bills_test %>% dplyr::filter(Source == "2019" & year_mon >= as.Date("2019-07-
01") & year_mon <= as.Date("2020-02-01")) %>%
  # these are the min date ranges of the trmt customers with the above bill restrictions. Keep
same for ctrl cust
  dplyr::filter(min_bill >= as.Date("2018-12-01") & min_bill <= as.Date("2019-09-01"))
table(bills_test$year_mon, bills_test$trmt, bills_test$Source)

# check these min month restrictions
x <- bills_test %>% dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>% summarise(n_months
= n(), n_heating_months = sum(heating_months))
# 404 trmt customers have 6 months or more of post-period data here with at least 4 months of
heating months
table(x$n_months, x$n_heating_months, x$trmt)
# only 405 trmt customers have 6 months or more of post-period data here
table(x$n_heating_months, x$trmt)

# how many would we keep?
bills_test_keep <- bills_test %>% dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>%
dplyr::mutate(n_months = n(), n_heating_months = sum(heating_months)) %>%
  dplyr::filter(n_months >= 6 & n_heating_months >= 4) %>% select(PREMISE_ID, ACCT_ID, Source,
trmt) %>% distinct()
table(bills_test_keep$min_bill, bills_test_keep$trmt)

bills_test <- merge(bills_test_keep, bills_test, by = c("PREMISE_ID", "ACCT_ID", "Source",
"trmt"))
x <- bills_test %>% dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>% summarise(min_bill
= min(min_bill), n_months = n(), n_heating_months = sum(heating_months))
table(x$n_months, x$n_heating_months, x$trmt)
table(x$n_heating_months, x$trmt)
table(x$trmt)
table(x$min_bill, x$trmt)

# set 2019 bill restrictions
bill_restrictions <- data.frame(Source = "2019",
                                min_min_bill = as.Date("2018-12-01"),
                                max_min_bill = as.Date("2019-09-01"),
                                min_bill = as.Date("2019-07-01"),
                                max_bill = as.Date("2020-02-01"),
                                min_months = 6,
                                min_heating_months = 4)
keep_2019 <- bills_test_keep

# 2018 ---
# see spread
```

```
bill_spread <- table(bills$year_mon, bills$trmt, bills$Source)
bills_test <- bills %>% dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>%
dplyr::mutate(min_bill = min(year_mon))

# check these restrictions
bills_test <- bills_test %>%
  dplyr::filter(Source == "2017-2018" &
                  year_mon >= as.Date("2019-01-01") &
                  year_mon <= as.Date("2020-01-01")) %>%
  dplyr::filter(min_bill >= as.Date("2018-01-01") &
                  # keep only customers that moved in in 2018. keep same for ctrl cust
                  min_bill <= as.Date("2018-12-01"))
# this way we have a clean 2019 post-period
table(bills_test$year_mon, bills_test$trmt, bills_test$Source)

# check these min month restrictions
x <- bills_test %>% dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>% summarise(n_months
= n(), n_heating_months = sum(heating_months))
table(x$n_months, x$n_heating_months, x$trmt)
table(x$n_heating_months, x$trmt)

# how many would we keep?
bills_test_keep <- bills_test %>%
  dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>%
  dplyr::mutate(n_months = n(),
                n_heating_months = sum(heating_months)) %>%
  dplyr::filter(n_months >= 9 &
                  n_heating_months >= 8) %>%
  select(PREMISE_ID, ACCT_ID, Source, trmt) %>%
  distinct()
table(bills_test_keep$min_bill, bills_test_keep$trmt)

bills_test <- merge(bills_test_keep, bills_test, by = c("PREMISE_ID", "ACCT_ID", "Source",
"trmt"))
x <- bills_test %>%
  dplyr::group_by(PREMISE_ID, ACCT_ID, Source, trmt) %>%
  summarise(min_bill = min(min_bill),
            n_months = n(),
            n_heating_months = sum(heating_months))
table(x$n_months, x$n_heating_months, x$trmt)
# 324 trmt customers meet min requirements
table(x$n_heating_months, x$trmt)
table(x$trmt)
# all ctrl and trmt cust have the same earliest bill date ranges
table(x$min_bill, x$trmt)

# set 2018 bill restrictions
bill_restrictions <- rbind(bill_restrictions,
                           data.frame(Source = "2017-2018",
                                      min_min_bill = as.Date("2018-01-01"),
                                      max_min_bill = as.Date("2018-12-01"),
                                      min_bill = as.Date("2019-01-01"),
                                      max_bill = as.Date("2020-01-01"),
                                      min_months = 9,
                                      min_heating_months = 8))
write.csv(bill_restrictions, file = paste(results, "bill_restrictions.RData", sep = "/"))

# keep the customers and bills we tested and approved
```

```
bills <- merge(bills, bill_restrictions, by = c("Source"))
bills <- bills %>% dplyr::group_by(PREMISE_ID, ACCT_ID, trmt, Source) %>%
  dplyr::mutate(earliest_bill = min(year_mon)) %>%
  # make bill restrictions after computing earliest bill
  dplyr::filter(year_mon >= min_bill &
                  year_mon <= max_bill &
                  # make earliest bill restrictions after computing earliest bill
                  earliest_bill >= min_min_bill &
                  earliest_bill <= max_min_bill) %>%
  dplyr::ungroup()

bills <- bills %>% dplyr::group_by(PREMISE_ID, ACCT_ID, trmt, Source) %>%
  dplyr::mutate(n_months = n(),
                n_heating_months = sum(heating_months)) %>%
  # make month restrictions after filtering bills
  dplyr::filter(n_heating_months >= min_heating_months &
                  n_months >= min_months)

test <- bills %>% dplyr::select(PREMISE_ID, ACCT_ID, trmt, Source) %>% dplyr::distinct()
table(test$trmt, test$Source)

bill_spread_after <- table(bills$year_mon, bills$trmt, bills$Source)

# tracker
tracking_dta <- rbind(tracking_dta, c("Restrict post-period and move-in period in both groups
(This makes sure the post-period is similar between groups)",
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))

# keep only one account ID per premise
test <- bills %>% dplyr::group_by(PREMISE_ID, trmt, Source) %>%
  dplyr::summarise(n_ids = n_distinct(ACCT_ID)) %>%
  dplyr::filter(n_ids > 1)
# only 112 premises with more than 1 account, all in 2019

acct_most_dta <- bills %>%
  dplyr::select(PREMISE_ID, ACCT_ID, n_months, n_heating_months, trmt, Source) %>%
  dplyr::distinct() %>%
  dplyr::arrange(desc(n_heating_months)) %>%
  dplyr::group_by(PREMISE_ID, trmt, Source) %>%
  dplyr::slice(1)

bills <- merge(acct_most_dta, bills, by = c("PREMISE_ID", "ACCT_ID", "n_months",
"n_heating_months", "trmt", "Source"), all.x = T)
# TRACKER ---
tracking_dta <- rbind(tracking_dta, c("After keeping one account per premise id, the one with
the most number of heating months",
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
```

```
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))

# calculate baseload and usage per SQFT
bills <- bills %>% dplyr::group_by(PREMISE_ID, Source, trmt) %>%
  dplyr::mutate(daily_usage_sqft = daily_usage/SQFT,
                daily_hdd = monthly_hdd/days,
                daily_hdd_sqft = daily_hdd/SQFT,
                daily_therms_baseload = mean(ifelse(month %in% c(6, 7, 8), daily_usage, NA),
na.rm = T),
                daily_heating_load = pmax(0, daily_usage-daily_therms_baseload),
                daily_heating_load_sqft = daily_heating_load/SQFT,
                daily_therms_heating_hdd_sqft = daily_heating_load/daily_hdd/SQFT,
                daily_therms_baseload_hdd_sqft = daily_therms_baseload/daily_hdd/SQFT)
# none are missing summer month data
x <- unique(bills[is.na(bills$daily_heating_load), c("PREMISE_ID", "Source", "trmt")])
table(x$Source, x$trmt)

premises_without_baseload <- unique(bills[is.na(bills$daily_heating_load), c("PREMISE_ID",
"Source", "trmt")])
table(premises_without_baseload$Source, premises_without_baseload$trmt)
bills <- bills %>% anti_join(premises_without_baseload)

# tracker
tracking_dta <- rbind(tracking_dta, c("removing customers without sufficient summer months",
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 1, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2017-2018" &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")])),
                                      nrow(unique(bills[bills$Source == "2019"      &
bills$trmt == 0, c("PREMISE_ID", "Source", "trmt")]))))
tracking_dta

# full data
# make sure no addresses overlap by treatment
x <- bills %>%
  dplyr::group_by(PREMISE_ID) %>%
  dplyr::summarise(n_trmt = n_distinct(trmt))
table(x$n_trmt)

# add last variables
bills <- bills %>%
  ungroup() %>%
  dplyr::mutate(zip_3 = as.factor(substr(POSTAL, 0, 3)),
                zip_5 = as.factor(substr(POSTAL,0,5)),
                daily_hdd = monthly_hdd/days,
                YEARBUILT = as.numeric(YEARBUILT),
                trmt = as.factor(trmt),
                OCCDATE = as.Date(OCCDATE),
                PREMISE_ID = as.factor(PREMISE_ID),
                PARCEL = as.factor(PARCEL),
                n_heating_months = as.numeric(n_heating_months),
                ACCT_ID = as.factor(ACCT_ID))
```

```
# save
write.csv(tracking_dta, paste(results, "tracking_dta.csv", sep = "/"))
save(bills, file = paste(inter, "bills.RData", sep = "/"))

# keep only these columns to match on
load(paste(inter, "bills.RData", sep = "/"))
to_match_dta <- unique(bills[, c("PREMISE_ID", "PARCEL", "ACCT_ID", "trmt", "YEARBUILT",
"BEDROOMS", "BATHROOMS", "FIREPLACE",
                                 "OCCDATE",  "SQFT", "n_heating_months", "zip_3", "zip_5",
"Source")])
# merge with ada county data to get upper level sqft
load(file = paste(inter, "ada_info.RData", sep = "/"))
ada_info <- ada_info %>%
  dplyr::mutate(PREM_ID = as.factor(PREM_ID),
                PARCEL = as.factor(PARCEL),
                has_grfl = as.factor(ifelse(GRFLSQFT>0,1,0)),
                has_upstairs = as.factor(ifelse(UPFLSQFT > 0,1,0)),
                has_porch = as.factor(ifelse(PORCHSQFT>0,1,0)),
                has_patio = as.factor(ifelse(PATIOSQFT>0,1,0)),
                has_pool = as.factor(ifelse(POOLSQFT > 0,1,0)),
                has_attic = as.factor(ifelse(ATTICSQFTF > 0,1,0)),
                has_patio = as.factor(ifelse(PATIOSQFT > 0,1,0)),
                has_garage = as.factor(ifelse(CARSTORAGE > 0,1,0)),
                PATIOCOVER = as.factor(PATIOCOVER))

to_match_dta <- merge(to_match_dta, ada_info[, c("PREM_ID", "PARCEL", "BEDROOMS", "BATHROOMS",
"FIREPLACE",
                                                 "has_upstairs", "UPFLSQFT",
                                                 "has_pool", "POOLSQFT",
                                                 "has_attic","ATTICSQFTU", "ATTICSQFTF",
                                                 "has_garage", "CARSTORAGE")],
                      by.x = c("PREMISE_ID", "PARCEL", "BEDROOMS", "BATHROOMS", "FIREPLACE"),
                      by.y = c("PREM_ID", "PARCEL", "BEDROOMS", "BATHROOMS", "FIREPLACE"),
all.x = T)

# keep only full data
full <- to_match_dta[complete.cases(to_match_dta),]
paste0(round(nrow(full)/nrow(to_match_dta)*100,0), "% of premises have full matching
variables")

# save
save(to_match_dta, file = paste(inter, "to_match_dta.RData", sep = "/"))
load(paste(inter, "to_match_dta.RData", sep = "/"))

set.seed(101)
py <- c("2017-2018", "2019")
for(i in 1:2) {

  dta <- to_match_dta[to_match_dta$Source == py[i],]
  write.csv(dta, file = paste(results, paste0(py[i], ".to_match_variables.csv"), sep = "/"))

  # propensity score matching
  # define matching methods
  psm_ratio <- 1
  psm_method <- "nearest"

  # match
  nearest     <- matchit(trmt ~ YEARBUILT +
```

```
                     zip_5 +
                     BEDROOMS +
                     BATHROOMS +
                     FIREPLACE +
                     SQFT+
                     UPFLSQFT +
                     POOLSQFT+
                     ATTICSQFTF+
                     CARSTORAGE ,
                   data = dta,
                   exact = c("zip_5"),
                   method = psm_method, ratio = psm_ratio, replace = FALSE)

# summary
a <- summary(nearest)

# save
psm_ratio <- data.frame(".PSM Matching Ratio" = psm_ratio)
psm_method <- data.frame(".PSM Matching Method" = psm_method)
save(psm_ratio, file = paste(inter, paste0(py[i], ".psm_ratio.RData"), sep = "/"))
save(psm_method, file = paste(inter, paste0(py[i],".psm_method.RData"), sep = "/"))

# save matched output
df.match <- match.data(nearest)
table(df.match$trmt)

# extract matched premise IDs
matches <- data.frame(nearest$match.matrix)

# reformat
df.match <- df.match %>%
  dplyr::mutate(PREMISE_ID = as.character(PREMISE_ID),
                PARCEL = as.character(PARCEL),
                ACCT_ID = as.character(ACCT_ID),
                trmt = as.factor(trmt),
                OCCDATE = as.Date(OCCDATE),
                YEARBUILT = as.numeric(YEARBUILT),
                BEDROOMS = as.numeric(BEDROOMS),
                BATHROOMS = as.numeric(BATHROOMS),
                FIREPLACE = as.numeric(FIREPLACE),
                SQFT = as.numeric(SQFT),
                n_heating_months = as.numeric(n_heating_months),
                zip_3 = as.factor(zip_3),
                zip_5 = as.factor(zip_5),
                Source = as.character(Source))


# save matched dataset
save(df.match, file = paste(inter, paste0(py[i],".df.match.RData"), sep = "/"))

# output summaries
a$nn
a$sum.all[c(1,2,3,4)]
a$sum.matched[c(1,2,3,4)]

# print stats
table_before <- data.frame(a$sum.all)
table_after <- data.frame(a$sum.matched)
```

```
  # save output summary and stats
  match_summary <- a$nn

  save(match_summary, file = paste(inter, paste0(py[i],".summary_nn.RData"), sep = "/"))
  save(table_before, file = paste(inter, paste0(py[i],".summary_all.RData"), sep = "/"))
  save(table_after, file = paste(inter, paste0(py[i],".summary_matched.RData"), sep = "/"))

  write.csv(match_summary, file = paste(results, paste0(py[i],".summary_nn.csv"), sep = "/"))
  write.csv(table_before, file = paste(results, paste0(py[i],".summary_all.csv"), sep = "/"))
  write.csv(table_after, file = paste(results, paste0(py[i],".summary_matched.csv"), sep =
"/"))

  # reformat
  plot_groups <- df.match %>%
    dplyr::mutate(PREMISE_ID = as.logical(PREMISE_ID),
                  PARCEL = as.logical(PARCEL),
                  zip_5 = as.numeric(as.character(zip_5)),
                  zip_3 = as.numeric(as.character(zip_3)),
                  has_upstairs = as.logical(ifelse(UPFLSQFT > 0,1,0)),
                  has_pool = as.logical(ifelse(POOLSQFT > 0,1,0)),
                  has_attic = as.logical(ifelse(ATTICSQFTF > 0,1,0)),
                  has_garage = as.logical(ifelse(CARSTORAGE > 0,1,0)))

  # check propensity score matches
  # compute covariate balance after matching
  plot_groups$trmt <- as.numeric(as.character(plot_groups$trmt))
  treated <- (plot_groups$trmt==1)
  cov1 <- plot_groups[,c("YEARBUILT", "zip_5", "zip_3", "BEDROOMS", "BATHROOMS", "FIREPLACE",
"SQFT",
                         "UPFLSQFT",  "ATTICSQFTF", "CARSTORAGE",
                         "has_pool",  "has_upstairs", "has_attic", "has_garage")]
  std.diff <- apply(cov1,2,function(x) 100*(mean(x[treated])-
mean(x[!treated]))/(sqrt(0.5*(var(x[treated]) + var(x[!treated])))))  # computes standardized
difference
  std.diff <- abs(std.diff)
  write.csv(std.diff, file = paste(results, paste0(py[i],".standardized_difference.csv"), sep
= "/"))

  plot_groups <- plot_groups %>%
    dplyr::mutate(PREMISE_ID = as.factor(PREMISE_ID),
                  PARCEL = as.factor(PARCEL),
                  zip_5 = as.factor(zip_5),
                  has_upstairs = as.factor(ifelse(UPFLSQFT > 0,1,0)),
                  has_pool = as.factor(ifelse(POOLSQFT > 0,1,0)),
                  has_attic = as.factor(ifelse(ATTICSQFTF > 0,1,0)),
                  has_garage = as.factor(ifelse(CARSTORAGE > 0,1,0)))
  plot_groups$trmt <- as.integer(plot_groups$trmt)

  chi.test <- xBalance(trmt ~ YEARBUILT +
                         zip_5 +
                         BEDROOMS +
                         BATHROOMS +
                         FIREPLACE +
                         SQFT+
                         UPFLSQFT +
                         POOLSQFT+
                         ATTICSQFTF+
```

```
                         CARSTORAGE +
                         has_upstairs + has_pool + has_attic,
                       data=plot_groups, report = c("chisquare.test"))
  chi.output <- capture.output(chi.test)
  write.csv(chi.output, file = paste(results, paste0(py[i],".chi_square_test.csv"), sep =
"/"))

}


# load data
load(paste(inter, "bills.RData", sep = "/"))

py <- c("2017-2018", "2019")
for(i in 1:2) {

  # load matched data, merge to billing data
  load(paste(inter, paste0(py[i],".df.match.RData"), sep = "/"))
  reg_dta <- df.match
  reg_dta <- merge(reg_dta, bills, by = c("PREMISE_ID", "PARCEL", "ACCT_ID", "trmt", "Source",
"YEARBUILT", "BEDROOMS",
                                          "BATHROOMS", "FIREPLACE", "OCCDATE", "SQFT",
"n_heating_months", "zip_5", "zip_3"))

  # save final modeled data
  reg_dta <- reg_dta %>%
    dplyr::select(PREMISE_ID, ACCT_ID, Source, trmt, zip_5, year_mon, month,
daily_usage_sqft,days,  daily_usage, daily_hdd, SQFT, YEARBUILT, monthly_usage, monthly_hdd,
daily_hdd_sqft, daily_therms_baseload, daily_heating_load, daily_heating_load_sqft) %>%
    as.data.frame()
  write.csv(reg_dta, file = paste(results, paste0(py[i], ".reg_dta.csv"), sep = "/"))

  # compute variables
  avg_heating_load <- reg_dta %>%
    dplyr::mutate(daily_therms_baseload_hdd_sqft = daily_therms_baseload/daily_hdd/SQFT,
                  daily_therms_heating_hdd_sqft = daily_heating_load/daily_hdd/SQFT) %>%
    dplyr::group_by(Source, trmt) %>%
    dplyr::summarise(mean_daily_therms_heating_hdd_sqft = mean(daily_therms_heating_hdd_sqft),
                     mean_daily_therms_baseload_hdd_sqft =
mean(daily_therms_baseload_hdd_sqft))
  write.csv(avg_heating_load, file = paste(results, paste0(py[i], ".avg_heating_load.csv"),
sep = "/"))

  # regression model
  model_heating <- lm(daily_heating_load_sqft ~ trmt + daily_hdd + trmt*daily_hdd, data =
reg_dta)

  # model output
  coefs_heating <- summary(model_heating)$coefficients
  write.csv(coefs_heating, paste(results, paste0(py[i], ".coefs_heating.csv"), sep = "/"))
  model_output_heating <- capture.output(summary(model_heating))
  write.csv(model_output_heating, paste(results, paste0(py[i], ".model_output_heating.csv"),
sep = "/"))

}
```

2018-2019 ENERGY EFFICIENCY PROGRAM

PROCESS EVALUATION

(200 pages)

Intermountain Gas Company 2018-2019 Energy Efficiency Program Process Evaluation

Submitted to:

INTERMOUNTAIN GAS COMPANY
A Subsidiary of MDU Resources Group, Inc.

Submitted on:
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1 Executive Summary

This report presents the process evaluation of the Intermountain Gas Company (IGC) 2018-2019 Energy Efficiency Program as specified in ADM's response to the Request for Proposals (RFP) for Energy Efficiency Process Evaluation. IGC's Energy Efficiency Program offered rebates for seven measures to residential customers in PY2017-2018 and PY2019.

IGC's Energy Efficiency Program also includes Appliance Rebates for residential customers that purchase and install qualifying high-efficiency appliances. Qualifying appliances include:

- 95% AFUE Natural Gas Furnace
- 90% Radiant Combo
- 80% AFUE Fireplace
- 70% FE Fireplace
- 0.67 Water Heater
- 0.91 Tankless Water Heater

In addition, IGC offers a Whole Home Rebate, an incentive to home builders and buyers for new construction single-family residential homes that meet energy efficiency standards of the program. The Whole Home rebate requires homes must be certified to meet the requirements of the Environmental Protection Agency (EPA) ENERGY STAR® certified homes program. In addition, the home must achieve a RESNET Home Energy Rating System (HERS) score of 75 or less with a certificate completed by a certified HERS rater.

The Evaluators conducted a process evaluation to gain deliver information to IGC staff about opportunities for program improvement through understanding of demographics, understanding of program barriers, and opportunities to streamline marketing and outreach. The focus of the process evaluation activities is to gain a better understanding of program operations, assess the overall effectiveness of program operations, and identify areas for program improvement. The key elements for the evaluation are to:

- Subtask 1 - Review current program materials;
- Subtask 2 - Review current program tracking methods;
- Subtask 3 - Collect data from staff and contractors; and
- Subtask 4 - Collect survey data from participating and non-participating customers.

1.1 Process Evaluation Results

The process evaluation examined program operations and results for the Intermountain Gas Company Energy Efficiency Program between the 2017-2018 and 2019 program years. This portion of the evaluation is designed to identify potential program improvements that may prospectively increase program efficiency or effectiveness in terms of customer participation and satisfaction levels. Conclusions and recommendations have been developed based on interview and survey findings, and overall assessment of program processes. The process evaluation findings, as well as conclusions and recommendations, are detailed by each rebate (Appliance Rebate and Whole Home) and may provide strategic advantage during future program cycles.

1.2 Conclusions

1.2.1 Cross-Cutting Findings

- **IGC launched the Energy Efficiency program in PY2017-2018 with limited design or operational changes in PY2019.** IGC received approval to launch the Appliance Rebate and Whole Home measures starting in PY2017-2018. The initial goal for the Energy Efficiency program was to increase customer awareness and participation. When IGC staff started implementing the program, they were focused on determining their logistical partners, leveraging existing relationships, and refining the rebate process.
- **IGC's Energy Efficiency program performed well during first two program years.** According to IGC staff, both measures (Appliance Rebate and Whole Home) performed well in the first two years of implementation and were on an "upward trend." The Appliance Rebate program saw a 60% increase in the number of appliances rebated and the Whole Home program saw a 70% increase in the number of homes between PY2017-2018 and PY2019. Staff also believed there was increased customer awareness and improving relations with key program stakeholders (HERS raters and HVAC contractors). The Appliance Rebate program launched online application forms and a portal for HVAC contractors.
- **Lessons learned between PY2017-2018 and PY2019 included how to effectively engage various stakeholders**. IGC staff indicated they learned various lessons about program implementation and operation since they launched. Staff stated they learned how to effectively engage with the community and to target events where program staff can reach the appropriate audience. Program staff indicated that recruitment of builders and contractors can be most effective either by phone or in-person, when possible. They also learned that attending events where builders are in attendance can be one of the most effective ways to discuss the program with them, specifically golf tournaments held by builder associations. Another lesson learned is to ensure that participating contractors are licensed with the state to perform install. Staff have kept a list of contractors' licenses with their expiration date to compare against installation. This ensures that installations are done in accordance with state permitting requirements.
- **Program changes anticipated in PY2020 and beyond.** IGC program staff indicated they do anticipate some changes to the Energy Efficiency program for the remainder of 2020 and possibly for the upcoming program year. A conservation potential assessment was conducted, and staff anticipated changes to their offerings based on the results of that study. Staff anticipated a commercial offering and wanted to add smart thermostats to their list of eligible measures. Program staff also discussed whether the HERS rating of 75 was appropriate for the Whole Home measure. Staff was concerned increasing the stringency of the HERS score as a requirement for participating homes and theorized it may be a barrier for builders who are not accustomed to building homes beyond code. Staff believed a tiered incentive system might be a future addition to the Whole Home measure. Staff would also like to increase customer education efforts about energy efficiency.
- **Broad range of marketing efforts and community outreach were used.** IGC staff utilized a broad approach to promote the availability of the Appliance Rebates and the Whole Homes measures.

Staff indicated they focused on three areas for outreach and promotion which included customers and communities, home builders, and HVAC contractors. Staff indicated that HVAC contractors are key to promoting the program to customers because they are seen as trusted experts. Marketing activities included bill inserts, digital advertising, radio campaigns, and attending community events. To promote the Whole Home program, IGC staff participated in the Parade of Homes sponsored by the Builder Contractors' Association. Promotional activities with builders included attending association meetings, expositions, and other events. IGC does not provide marketing collateral or cobranding opportunities for contractors or builders.

1.2.2 Whole Home Measure

- **Participating and nonparticipating builders both reported an increase in customer demand for energy efficient homes.** The majority (88% of participating and 83% of nonparticipating builders) believed that homebuyer demand and expectations for energy efficient homes have increased over the past few years. Both participating and nonparticipating builders indicated the strong demand for new homes in Idaho requires little to no marketing to sell.
- **Builder participation in the Whole Home measure increased due to recruitment efforts of staff. T**here was an increase in the number of participating builders from 18 to 24 between PY2017-2018 and PY2019. IGC program staff stated they are typically recruited at BCA meeting as they offer an opportunity to educate builders about the program. Staff also stated that community outreach and home buyers about the benefits of ENERGY STAR® can help drive more builders to build energy efficient homes. According to IGC, the feedback from builders has been positive and that they are grateful to receive the rebates within 1 to 2 weeks. All the participating builders who were interviewed indicated they have experience with the Whole Home measure starting in either 2018 or 2019
- **Non-HVAC measures were noted as the least costly way to help participating builders build homes with a HERS score of less than 75.** According to the builders, the least costly ways to ensure a home has a HERS score lower than 75 include implementing insulation, air sealing, and having a conditioned crawl space. Other strategies that builders discussed included implementing 90-95% AFUE furnaces, meeting all the ENERGY STAR® requirements, and following the building codes. However, these other strategies were not listed as lower cost, and the 90-95% AFUE furnaces is seen as one of the more costly ways to achieve the HERS score requirement.
- **Differentiation in the market and the program financial incentive were two factors important to builders' participation.** All participating builders stated that program financial incentive and ability to differentiate themselves in the market were the factors that went into deciding to build their homes to program-building standards in 2019.
- **All Whole Home participating builders were satisfied with their HERS rater that they worked with.** In fact, from the interviews, it was found that 50% of the HERS raters are the parties involved with the rebate application process.
- **In general, HERS raters find IGC's Energy Efficiency program to be one of the most effective in the region.** All three raters have been participating in IGC's Energy Efficiency program since 2018. Raters have also heard positive feedback from builders about the Energy Efficiency program.

Raters indicated that program requirements seem reasonable and attainable. According to one HERS rater, IGC's payment turn-around is efficient and dependable.

- **HERS raters indicated the rebate incentive was the best marketing tool for reaching most builders.** According to the HERS raters, the upfront additional costs for builders continues to be a barrier for participation. By marketing the incentive, builders were more likely try and become eligible for the rebate(s).
- **Raters use direct and indirect messaging to recruit builders to the program.** Word-of-mouth was their best direct messaging strategy, while having builders recommend the program to other builders as their indirect messaging. All raters expect the number of constructions of new homes for 2020 to remain about the same from 2019. Due to the economic downturn, raters may not see the increase in construction as they had anticipated for 2020. All HERS raters have worked as a rater in Idaho for more than two years.
- **Program requirements are broadly understood by participants and would benefit from further explanation**. HERS raters indicated that IGC could improve their outreach to builders, realtors, and homeowners about buying energy-efficient homes. Participating in events, using more marketing collateral, or sponsoring educational events may help increase program participation, according to HERS raters.
- **Nonparticipating builders were generally aware of energy efficiency practices but not the Whole Home measure.** Among the nonparticipating builders who were interviewed, they indicated they have a general understanding of energy efficiency practices and incorporate them in their new homes. Most nonparticipating builders were not aware of the IGC Whole Home measure but voiced interest in learning more and potentially participating. The builders noted experience with energy efficiency and HERS raters. Some voiced disinterest in participating in certification programs because of the time and resources required and the low perceived payoff.
- **The decision about buying a new home varied among participants.** Although many indicated that energy efficiency was important to them (86%), most stated the home's price to be of greater importance (94%). Other non-energy-efficient factors that greatly influenced the home sale include the fact that it was new construction and location.
- **Participants worked with different stakeholders when deciding on buying their homes.** Fifty percent of Whole Home survey respondents stated they worked with their own real estate agent, while 24% worked with the builder's in-house realtor. Some participants also mentioned they either worked in real estate or had worked with more than one of the stakeholders during this process.
- **Most survey respondents were aware that their homes were ENERGY STAR® certified but not necessarily part of the Whole Home measure.** Seventy-nine percent of Whole Home survey respondents were aware that their home was ENERGY STAR® certified, while 16% said they did not know. Of those who knew, 69% indicated they learned this information from the builder and 18% learned from a real estate agent. Participants also indicated that knowing their home had an ENERGY STAR® rating and had been inspected by a HERS rater influenced their decision on whether to buy the home. However, according to the builders interviewed, home buyers were generally unaware of the Whole Home measure. Five out of eight builders (62.5%) stated that

they either were unsure about the number of customers that knew about the Whole Home measure or that none of the customers knew about the measure.

- **Respondents could not recall all the home's energy efficiency features.** Thirty-eight percent of respondents stated the home's energy efficient characteristics had been clearly explained by the person who helped them purchase the home, while 25% indicated it had not been clear. Participants also reported they were unaware of the differences between homes promoted by IGC (57%) versus the other homes on the market at the time of their purchase.
- **Overall, participants indicated they were satisfied with the program.** Respondents were either satisfied or very satisfied with the energy efficiency measures in their homes (92%) and the ENERGY STAR® certified home promoted by IGC (84%). Ninety percent of respondents indicated they were either satisfied or very satisfied with IGC as their gas service provider.
- **Eight of 1,698 Whole Home Rebates were rejected across both program years.** The Evaluators found that less than 1% of the Whole Home Rebate applications were rejected. The majority (75%) of rejections were because the rebate had previously been paid out for the address in the application.

1.2.3 Appliance Rebates

- **Contractors play a crucial role in the Appliance Rebate measure.** Most survey respondents learned about the program from a contractor and selected the rebated equipment because of a contractor recommendation. Nearly half received their rebate form from their contractor. Contractors not required to be officially registered with IGC. IGC does not have an approved trade ally network but does require that contractors who participate in the program to be licensed with the state.
- **IGC provides training and educational opportunities for contractors.** IGC program staff generally communicates with contractors via email and phone. There was one training provided by IGC staff where there was information about the HVAC portal and online application. If contractors were not able to attend, IGC staff sent emails with videos of the training along with online resources. IGC also offered a $300 reimbursement for contractors to participate in an ENERGY STAR® certification course. IGC staff indicated they have received positive feedback from contractors (e.g., they like the "straight forwardness of the program" and the responsiveness of staff).
- **All contractors had experience with other energy efficiency programs and most indicated they were largely satisfied with the design and participation process.** Among the contractors interviewed, most reported general satisfaction with the Appliance Rebate measure**.** Contractors' experience included working with Idaho Power, Rocky Mountain Power, Idaho Department of Environmental Quality, and Bonneville Power. Interviewed contractors had largely positive things to say about IGC's Energy Efficiency program in comparison to their experience with other programs, citing the responsiveness of program staff and the quick turnaround time for rebates.
- **Contractors are an important source of program awareness for customers.** Most contractors reported that only a small portion of their customers know about the program before they inform them. Most contractors interviewed indicated they encourage the sale of high efficiency

equipment. Most of the contractors said their only method of encouraging the sale of high efficiency equipment was discussions with customers.

- **Customers experienced high satisfaction with IGC overall as well as the Appliance Rebate measure.** Most respondents were satisfied with their IGC rebated equipment's installation and performance. Satisfaction was also high in respect to other aspects of the program including interactions with IGC staff, amount of time to receive the rebate, and the overall quality of the contractor's work. Most respondents said their application was accepted as submitted and said they received their rebate check in a prompt and timely manner.
- **The energy efficiency and warranty/reliability of the equipment mattered most to customers.** Contractors emphasized these features as well. Though nearly half of contractors also emphasized the rebate amount, a smaller portion of customers noted that the rebate amount mattered most to them.
- **Of the rebate applications, 16% and 11% were rejected in PY2017-2018 and PY2019, respectively.** The Evaluators found the highest rejection rates for the 80% AFUE Fireplace, the 95% AFUE Natural Gas Furnace, and the 0.67 Water Heater measures. The reason applications were rejected most often included not meeting the minimum efficiency requirements, unsigned signature pages, lacking information on final invoice or application, missing permit numbers, and/or the eligibility for application submission had passed.

1.3 Recommendations

1.3.1 Cross-Cutting Recommendations

- **Codify quality assurance and control processes in a standard operating procedures (SOP) manual.** The Evaluators recommend that IGC program staff develop and operationalize all quality assurance and quality control (QA/QC) procedures. By doing so, this will help future staff understand the procedures for ensuring rebates are processed correctly and identifying gaps.
- **Increase communication opportunities with contractors, builders, and HERS raters.** Some interviewed stakeholders were not aware of the online application forms and other components to the Energy Efficiency program. The Evaluators recommend that IGC program staff to host listening sessions with each respective stakeholder group to gain insight into the challenges that they face with the Energy Efficiency program and market conditions.
- **Explore opportunities to incorporate new measures (i.e., smart thermostats) in IGC's Energy Efficiency program offerings.** Some tankless water heater contractors believe cost can be a barrier for customers and estimated a 0.91 UEF system was two to three times more expensive than a standard efficiency water heater. The Evaluators recommend exploring additional opportunities for IGC to add new measures to the Appliance Rebate and Whole Home current offerings. Specifically, the Evaluators recommend examining adding 0.82 efficiency tankless water heaters and smart thermostats to the list of available measures. IGC could work with builders to add smart thermostats to new homes. Staff could also work with contractors to use smart thermostats as a marketing tool (e.g., limited-time offers for free smart thermostats coupled with new furnace installation).

- **Consider establishing a builder and contractor approved network.** By creating an IGC-approved network of builders and contractors this could help ensure the appliances are being installed at a sufficient standard of quality and that the homes built exceed program requirements. The approved network of builders and contractors could be added to the website, which would provide legitimacy and marketing for those who are participating in the network, as well as provide assistance to customers on resources for their future home upgrades.
- **Consider standardizing the tracking database categorization of rebate status and rebate rejection reasoning.** The tracking database collected and maintained information on the status of rebate approval as well as reasoning for rebate rejection. However, the inputs for these fields were often detailed and high-level insights were difficult to parse. The Evaluators recommend setting in place a standard categorization for both the rebate status as well as rebate rejection reason in order to assist in tracking and prioritization of current rebates as well as assist in analysis of barriers to rebate completion.

1.3.2 Whole Home Measure

- **Work with builders to achieve HERS requirements at a lower cost.** Builders provided recommendations on how to achieve a lower HERS scores in a cost-effective manner. The Evaluators recommend working closely with builders who are successfully achieving the HERS requirements to identify additional opportunities to reduce overall costs (e.g., implementing non-HVAC measures such as air sealing, duct sealing, and insulation).
- **Provide builders with additional marketing materials to promote the Whole Home measure.** Builders suggested providing marketing materials such as flyers or a logo to use on their website that will help promote the Whole Home measure to home buyers. Marketing materials can be utilized to promote awareness of the Whole Home measure and to educate homebuyers about energy efficiency. The Evaluators recommend exploring all opportunities to generate marketing collateral that can be used by builders and IGC program staff at community events. Program staff could also consider co-branding marketing collateral with participating contractors who would be interested in additional materials.
- **Engage builders with company-specific reports and cost-saving estimates that builders can use with homebuyers.** Builders indicated they were reluctant to provide cost-saving estimates to homebuyers, citing liability, but believed it would be useful information to help sell and promote program-qualifying homes. The Evaluators recommend working with builders to develop generic cost-saving estimates that can be used by builders when promoting the benefits of purchasing an energy efficient home. These cost-saving estimates could also provide an educational opportunity to engage homebuyers with energy saving tips. The Evaluators also recommend creating material that will help engage participating builders, such as quarterly or biannual reports that are builder specific or quarterly newsletters with Whole Home measure statistics and upcoming events that IGC will be in attendance.
- **Continue participating in community events to recruit additional builders and generate awareness about the Whole Home measure.** Many participating builders first learned of the Energy Efficiency program through IGC-attended events where builders and HERS raters were

provided with information about the Whole Home measure. The Evaluators recommend researching additional outreach opportunities to reach nonparticipating builders with promotional activities (e.g., offer a free HERS rating to builders who have not received a rebate in the past two years).

- **Develop materials that increase knowledge of the benefits of owning an energy efficient home among IGC customers.** The homeowners who do value the idea of energy efficiency are consumers who are actively researching the latest technology or are interested in the incentives. Homeowners who do not actively seek this type of information would benefit from knowing about the incentives from a knowledgeable realtor or other stakeholders. The Evaluators also recommend developing educational materials that can be used at events where homebuyers would be in attendance (e.g., home and garden shows). Consider how program participation could improve by engaging in outreach geared at increasing homeowners' knowledge of energy efficiency.
- **Provide additional education or training opportunities for HERS raters, builders, and real estate agents.** According to the raters, builders have a significant learning curve to overcome to fully understand the benefits of energy efficiency. Builders reported they were already building above-code homes there were energy efficient and were not sure the benefits of participating. The Evaluators recommend developing trainings that can be either in person or online that builders and HERS raters can attend to increase their knowledge of the Energy Efficiency program, specifically the Whole Home measure. IGC staff could also explore creating a training or presentation for realtors. By offering continuing education credits through the Idaho Board of Realtors, real estate agents could educate homeowners about the differences between an ENERGY STAR® certified home and a HERS ratings.

1.3.3 Appliance Rebates

- **Ensure that contractors are aware of the different participation options.** A portion of contractors said that participating in the program was time consuming and burdensome. By increasing awareness of the program's online form submission option IGC could improve contractor program experience and expedite customer rebate receipt. Ensuring familiarity with participation processes may ease the burden of participation and encourage more frequent participation. The Evaluators recommend conducting direct outreach to current and past program participants (e.g., invite contractors to an online webinar or schedule individual one-on-one sessions to explain the participation process). IGC program staff should investigate and remedy barriers to participation.
- **Consider enabling contractors or customers to track the status of their rebate.** Allowing the tracking of rebate status could potentially reduce the number of customer inquiries to IGC.
- **Consider creating and distributing IGC Appliance Rebate promotional materials to contractors and/or customers directly.** The contractors suggested that IGC collateral could help them to promote the program and a large portion of customers noted that they had learned about the program from contractors. The Evaluators recommend sending contractors program material directly that could assist with their outreach and promotion of the Appliance Rebate measure.

- **Develop new educational materials and continue community outreach.** IGC program staff indicated there is not a set education budget but they have created educational materials to increase awareness of the Appliance Rebate measures and general understanding of energy efficiency. The Evaluators recommend looking for partnership opportunities to create online instructional videos and other educational materials that can be viewed by customers. The Evaluators also recommend continuing community outreach efforts with a focus on increasing customer knowledge and general understanding of energy efficiency.
- **If furnaces have difficulty meeting cost-effectiveness requirements, consider the addition of an Electronically Commutated Motor (ECM) for the furnace blower as a program requirement.** ECMs result in significant kWh savings when installed alongside a new furnace, and this additional requirement could be used to enhance the cost-effectiveness of a retrofit furnace.
- **Consider collecting application data on the condition of the replaced furnace.** The Evaluators found that 72% of survey respondents indicated that their preexisting furnace was functional. This could be used to increase energy savings estimates via early retirement (in which savings are estimated based on preexisting equipment efficiency rather than current minimum code).
- **Incorporate Avoided Replacement Cost (ARC) into tankless water heater cost-effectiveness calculations.** Tankless water heaters have a 20-year measure life, while storage tank water heaters have an 11 year measure life. The net present value (NPV) of the purchase of a second water heater starting in year 12 should be deducted from incremental cost estimates used for this measure, improving measure cost-effectiveness.
- **Consider tracking additional fields in rebate application process to assist in future energy savings estimates.** The tracking database sufficiently collects customer information, household information, and contractor information. However, additional quality assurance steps while collecting some variables can be improved upon, such as year built, square footage, appliance model brand, appliance model number, appliance serial number, and equipment size and efficiency. In addition, the Evaluators recommend adding the following information as requirements for rebate application to assist in quality control and future energy savings calculations: equipment AHRI certification number, reason for replacement (replace-on-burnout, early retirement, new construction), prior equipment input size, prior equipment efficiency, and prior equipment age. The above fields are either required or optional values as inputs to engineering equations to estimate annual energy savings for these measures.

2 Introduction and Purpose of Study

This report presents an evaluation of the performance of the Energy Efficiency Program offered by IGC in PY2017-2018 and PY2019. The purpose of the process evaluation is to gather information from a variety of sources, including program staff, contractors, program participants, and non-participants (collectively referred to as market actors) to aid in program improvement and development in future program years. To increase the validity of the findings, it is necessary to gather data from multiple sources and then "triangulate" the data or compare it across multiple groups. This methodology increases the overall validity of the findings. The Evaluators addressed a variety of issues, including:

- Program design;
- Program administration;
- Program implementation and delivery;
- Customer satisfaction; and
- Market response.

2.1 Program Offerings and Descriptions

IGC's Energy Efficiency Program includes the Whole Home and Appliance Rebate measures. The rebate offerings are summarized in Table 1 and sections below.

Table 1 IGC's Energy Efficiency Program Offerings

Program	Channel	PY2017-2018 Rebates	PY2019 Rebates	PY2017-2018 Incentives	PY2019 Incentives
Appliance Rebate	95% AFUE Natural Gas Furnace	1,334	2,066	$466,900	$723,100
	90% Radiant Combo	3	11	$3,000	$11,000
	80% AFUE Fireplace	0	0	$0	$0
	70% FE Fireplace	13	14	$1,300	$1,400
	0.67 Water Heater	9	8	$450	$400
	0.91 Tankless Water Heater	88	159	$13,200	$23,850
Whole Home		619	1,079	$742,800	$1,294,800

2.1.1 Whole Home Measure

The Whole Home measure offers incentives to home builders and buyers for new construction, single-family residential homes that meet energy efficiency standards of the program. The Whole Home measure requires homes must be certified to meet the requirements of the Environmental Protection Agency (EPA) ENERGY STAR certified homes program. In addition, the home must achieve a Residential Energy Services Network (RESNET) Home Energy Rating System (HERS) score of 75 or less with a certificate completed by a certified HERS rater. The Whole Home Rebate cannot be combined with any other appliance rebates in IGC's Energy Efficiency Program.

The objective of the Whole Home Rebate is to encourage homebuilders to include energy efficient measures in the construction of new homes built within IGC's service area. This measure provides a $1,200 rebate for new construction residential ENERGY STAR certified homes with a RESNET Home Energy Rating Score (HERS) of 75 or less.

The following are also requirements for submitting the application rebate form:

- Must be a residential customer of IGC;
- Homes must be certified by an Energy Star verifier; and
- Energy Star home rebate applications must be submitted and postmarked within 90 days following Energy Star verification.

2.1.2 Appliance Rebates

The Appliance Rebates were designed to provide financial incentives to encourage residential customers to install energy efficient appliances. This measure offers incentives for residential customers that purchase and install qualifying high-efficiency appliances including natural gas furnaces, radiant combination heating systems, fireplaces, water heaters, and tankless water heaters.

The measure requires the participant to be served on the residential rate schedule and to use natural gas exclusively for space heating. Eligible project dispositions include new construction, replacement of existing failed equipment ("normal replacement" or "replace on burnout"), replacement of existing equipment that are still functional ("early replacement) as well as equipment converted from an alternate fuel. Customers receive rebate incentives at the amounts displayed below if appliances must meet the minimum rated efficiency. Table 2 summarizes the Appliance Rebate offerings.

Table 2 Appliance Rebate Offerings

Channel	Description	Rebate Amount
95% AFUE Natural Gas Furnace	95% or greater thermal efficiency rating	$350
90% Radiant Combo	90% or greater efficiency condensing tankless combination systems for space and water heating	$1,000
80% AFUE Fireplace	Discontinued	-
70% FE Fireplace	70% fuel efficient rating or greater	$100
0.67 Water Heater	0.67 energy factor or greater	$50
0.91 Tankless Water Heater	0.91 energy factor or greater	$150

The 80% AFUE fireplace rebate was discontinued due to lack of participation. The Evaluators completed process evaluation for the above rebates in the form of contractor interviews and participant surveys.

The following are also requirements for submitting the application rebate form:

- Must be a residential customer of IGC;
- Rebate applications must be submitted and postmarked within 90 days of installation;
- Fuel for the home's heat and water heating needs must be exclusively provided by IGC for applicable space heat and water heating rebates;

- A heat pump must not be used for space heating, even if a natural gas furnace is utilized as backup. If a heat pump is installed in the home, it must be wired to the “Cool Only” setting;
- Energy-savings equipment must meet the requirements of Intermountain Gas’ Energy Efficiency Rebate Program tariff and associated Terms and Conditions effective at the date the equipment was installed; and,
- All equipment must be installed according to current code and approved by local or state inspection with the signed, approved permit attached to the newly installed equipment.

3 Process Evaluation

This chapter presents the findings of the process evaluation for Intermountain Gas Company's (IGC) Energy Efficiency Program.

3.1 Process Evaluation Objectives

The Evaluators conducted a process evaluation for each of the measures offered in the Energy Efficiency Program, which:

- Measures and finds opportunities to improve level of customer satisfaction;
- Improve understanding of target population to tailor marketing materials towards customer segments
- Refine and refocus marketing strategies and increase program effectiveness;
- Identify barriers and suggest changes to reduce barriers to program participation;
- Provide recommendations for changing the program's structure, management, administration, design, delivery, operations, or target; and
- Help program designers and managers structure programs to achieve cost-effective savings.

The process evaluations focus on documenting the effects that the program activity had on encouraging installations of the energy efficiency measure or influencing the customer to make an energy-efficiency decision. The key program metrics that have been documented in these process evaluations are:

- Documenting overall awareness as well as awareness of the program and its measures;
- Verifying installations of measures through customer surveys;
- Determining if there are significant differences between and among participant groups;
- Assessing customer satisfaction with the utility staff and the overall program;
- Identifying reasons for not participating;
- Determining if the program has led to lasting changes in customer behavior regarding energy efficiency or influencing customer decision-making; and
- Identifying areas for program improvement.

3.2 Process Evaluation Approach

The Evaluators designed the process evaluation to ensure that best practices and lessons learned could be shared and incorporated across the entire program portfolio. The findings are intended to serve to:

- Guide changes in program delivery mechanisms and marketing materials to be more effective to participant demographic;
- Identify barriers to program participation;
- Identify progress made towards achieving the objectives as required by IGC or the Public Utilities Commission; and
- Identify any issues that may need to be explored more fully in future program evaluations.

The process evaluation data collection activities included interviews with program staff, HERS raters, Energy Service Representatives (ESRs), contractors, participating builders, non-participant builders as well as surveys of IGC customers (program participants and nonparticipants). Table 3 summarizes the number of participants that responded to each interview or survey.

Table 3 Process Evaluation Activities

Activity	Number of Surveys/Interviews
Program staff interviews (including ESRs)	5
HERS rater interviews	3
Contractor interviews	23
Participating builder interviews	8
Nonparticipating builder interviews	6
Whole Home participant survey	80
Appliance Rebate participant survey	138
Nonparticipant survey	160
Total	**423**

3.2.1 Key Researchable Issues

The process evaluation focused on documenting the effects program activity had on encouraging installations of energy efficiency measures and influencing customers to make energy-efficient decisions. The key research topics that the Evaluators investigated in the process evaluation included:

- Overall awareness of the Energy Efficiency program and its measures;
- Customer satisfaction with the utility staff and the overall program;
- Program influence and lasting changes in customer behavior regarding energy efficiency or customer decision-making;
- Understand differences between and among participant groups;
- Reasons for customers not participating in the program to understand participation barriers; and
- Areas for program improvement.

3.3 Process Evaluation Findings

3.3.1 Program Staff Interviews

This section summarizes the findings of interviews conducted with IGC staff for the purposes of learning of any recent changes to the program goals, program structure, and assessing the extent to which there are future opportunities for program improvement. The Evaluators conducted interviews with two energy efficiency analysts, an energy efficiency manager, and two energy service representatives to gain insights into the 2017-2018 (PY2017-2018) and 2019 (PY2019) program years.

IGC has not made significant changes to design or operations of the Energy Efficiency program since its implementation in PY2017-2018. The program includes the Appliance Rebate and Whole Home Rebate, which exceeded program staff's expectations for the first two years of implementation. IGC program staff were focused on customer participation, community outreach and engagement, and streamlining processes for the rebates in PY2017-2018 and PY2019.

The following details the key findings of the interviews.

- **IGC launched the Energy Efficiency program in PY2017-2018 with few changes to design or operations in PY2019.** IGC received approval to launch the Appliance Rebate and Whole Home measures starting in PY2018. After approval, program staff were hired to implement the Energy Efficiency Program whose design and parameters were set prior to launch. The initial goals for the Energy Efficiency Program was to increase customer awareness and participation. When IGC staff started implementing the program they were focused on determining their logistical partners, leveraging existing relationships, and the rebate process. During the Appliance Rebate program planning phase, 80% efficient fireplace inserts were included in with other eligible measures, but staff learned the retrofit was prohibitive due to venting and condensation requirements and was later removed.
- **Energy Efficiency program goals were focused on assessing measure participation and performance in the first two program years.** Staff stated that their program offerings would be modest in the first years of implementation, that could be "easily understood by customers" and easy to implement and manage. IGC staff stated in lieu of measuring the Energy Efficiency program against a specific goal, the program is assessing trends in participation to monitor program performance and gauge customers engagement and interest. While IGC staff indicated there were no savings goals for Appliance Rebates or Whole Home measures, they did indicate there is a 5-year target for demand-side management savings target and they examine performance trends for customer participation and participating builders. They also assess market barriers that are specific to measures offered through the programs and identifying areas where participation could increase.
- **Energy Efficiency program's performance and participation exceeded expectations in the first two program years.** According to IGC staff, both the Appliance Rebate and Whole Home measures performed well in the first two years of implementation and were on an "upward trend." The furnace and Whole Home measures accounted for the largest share of the rebates. The Appliance Rebate measures saw a 60% increase in the number of appliances rebated and the Whole Home measure saw a 70% increase in the number of homes between PY2017-2018 and PY2019. There were additional participating builders and contractors. Staff also believed there was increased customer awareness and improving relations with key program stakeholders (HERS raters and HVAC contractors). The average HERS score for participating homes increased slightly from PY2017-2018 to PY2019, indicating the average participating home decreased in efficiency.
- **Online application forms and HVAC portal were developed in the first two years of implementation.** The Appliance Rebate measure launched online application forms and a portal for HVAC contractors. There have been 250 online applications completed since its launch in October 2018. In addition, a training on the portal was offered to contractors.
- **Home sales grew in Idaho during PY2017-2018 and PY2019 indicating strong demand for new homes.** IGC staff stated that there is a strong housing market in Idaho. They indicated that as a result, builders do not need to highlight energy efficiency attributes to sell homes and this could be a barrier to participant among nonparticipating builders. Staff believe that home buyers may need additional education about energy efficiency when purchasing a new home. There is not a dedicated budget for education.
- **Lessons learned between PY2017-2018 and PY2019 included how to effectively engage various stakeholders.** IGC staff indicated they learned various lessons about program implementation and

operation since they launched. One lesson learned was how to effectively engage with the community and to target events where program staff can reach the appropriate audience. Program staff indicated that recruitment of builders and contractors can be most effective either by phone or in-person, when possible. They also learned that attending events where builders are in attendance can be one of the most effective ways to discuss the program with them, specifically golf tournaments held by builder associations. Another lesson learned is to ensure that participating contractors are licensed with the state to perform install. Staff have kept a list of contractors' licenses with their expiration date to compare against installation. This ensures that installations are done in accordance with state permitting requirements. IGC staff also indicated that not exceeding the rebate budget was another important lesson learned in the first two years.

- **Energy service representatives (ESRs) actively promote the Energy Efficiency programs.** ESRs main role is to assist customers who inquire about new gas services, retrofits, and new construction projects. ESRs work with existing and new residential customers, builders, and contractors and educate them about the Energy Efficiency programs offered by IGC. ESRs provide customers with brochures and other marketing material to provide them with information about the rebated measures available. Both ESRs who were interviewed believed PY2017-2018 and PY2019 were successful years and indicated efficient furnaces were the easiest measure to promote to customers. ESRs reported that other measures, such as tankless water heaters and fireplaces, were more challenging to convince customers to adopt. ESRs also indicated they attend builder event (e.g., Building Contractors Association meetings), sent custom letters to builders and contractors, and met with stakeholders in-person to establish relationships. ESRs have a few meetings per year with the IGC Energy Efficiency program staff and mostly communicate through phone and email.
- **Continuing partnerships with Division of Building Safety and Habitat for Humanity to increase education and understanding of energy efficiency for customers.** IGC program staff partnered with Division of Building Safety (DBS) and Boise Habitat for Humanity to develop additional educational videos about energy efficiency in homes. In PY2019, IGC created an educational video about the benefits of air sealing during new home construction. The video provides a demonstration of air sealing practices and the process for properly sealing a home during construction. The video is located on the IGC YouTube channel. There also videos about the benefits of installing a programmable thermostat, ceiling fans, and general information about natural gas.
- **Program changes anticipated in PY2020 and beyond.** IGC program staff indicated they anticipate some changes to their energy efficiency programs for the remainder of 2020 and possibly for the upcoming program year. Staff anticipated changes to their offerings based on the results cost potential assessment that was conducted. Staff anticipated a commercial offering and are interested in adding smart thermostats to their list of eligible measures. Program staff also discussed whether the HERS rating of 75 was appropriate for the Whole Home measure. Staff was concerned increasing the stringency of the HERS score as a requirement for participating homes and theorized it may be a barrier for builders who are not accustomed to building homes beyond code. Staff believed a tiered incentive system might be a future addition to the Whole Home measure. Staff would also like to increase customer education efforts about energy efficiency.

- **Communication is adequate and frequent**. There were weekly update meetings in 2018 and 2019. Meeting topics included project status, rebate status, trend identification, community outreach and promotion efforts, and other program issues. Staff also indicated they communicate on an as-needed basis. All staff indicated the level of communication was appropriate and meeting the needs of the program.
- **Data management is adequate.** ICG program staff indicated they utilize Microsoft Excel to track program data. Staff upload all data from rebate applications and use batch numbers for issuing checks. They also track community outreach efforts and contractors' license information. For the Whole Home measure, staff tracks the HERS certificate and if the home has been ENERGY STAR® certified. Currently, there is not a registry to check if a home is a certified ENERGY STAR® home so program staff rely on submitted application with a HERS rater statement. Staff also indicated they are using software called ThoughtSpot to run queries and reports. The reports can be queried by service district. Staff believed data management has improved since they launched in 2018 and that it is kept current enough to effectively monitor program activity and trends. There is not a formal process for gathering feedback from participants. Staff did administer a short survey in PY2019 to gather information about participants' experience, knowledge of furnace ratings, and program awareness.
- **Broad marketing efforts and community outreach were used to increase awareness of the programs.** IGC staff utilized a broad approach to promote the availability of the Appliance Rebates and the Whole Homes measures. Staff indicated they focused on three areas for outreach and promotion: customers and communities, home builders, and HVAC contractors. Staff indicated that HVAC contractors are key to promoting the program to customers because they are trusted experts. Marketing activities included bill inserts, digital advertising, radio campaigns, and attending community events. To promote the Whole Home measure, IGC staff participated in the Parade of Homes sponsored by the Builder Contractors' Association. Promotional activities with builders included attending association meetings, expositions, and other events. IGC does not provide marketing collateral or cobranding opportunities for contractors or builders.
- **Social media and digital platforms are used broadly.** IGC staff indicated they utilize social media (e.g., Facebook, Instagram, and YouTube) and other digital platforms to increase awareness of the energy efficiency programs. Some social media promotions have been paid. Staff stated there are plans to update the website once the programs have been changed and expanded.
- **Development of codified QA/QC procedures for the program.** At the time of the interviews, IGC staff did not indicate there were codified quality assurance or control procedures. Although staff reviews applications and home rebates, the program lacks standardized quality assurance guidance. Program staff indicated they review applications to ensure there are not duplicate rebates submitted by checking serial numbers. IGC requires that the final invoice include the model name, brand, and serial number and that the installation goes through a permit process. The permit process will vary depending on the jurisdiction. ICG staff search for the permit to ensure it passed final inspection.
- **Builder participation increased due to recruitment efforts of staff.** IGC staff indicated there was an increase in the number of participating builders from 18 to 24 over the two-year period (2018-2019). Staff stated they are typically recruited at BCA meeting as they offer an opportunity to educate builders about the program. Program staff engaged in community and home buyer

outreach to inform them of the benefits of ENERGY STAR certified new homes. The intent of that outreach was to increase market interest in the hopes of affecting builder interest in the program. According to IGC, the feedback from builders has been positive and that they are grateful to receive the rebates within 1 to 2 weeks.

- **HERS raters are an integral component to the Whole Home measure.** The number of participating homes increased between PY2018-2018 and PY2019. IGC staff stated that HERS raters assist with outreach to builders and recruitment efforts. There were no additional HERS raters recruited into the program in PY2019. There were no training opportunities or informational sessions for HERS raters in PY2018 or PY2019. IGC staff generally communicates with HERS raters via email and phone. Program staff indicated they have received positive feedback about the Whole Home measure from HERS raters and that they like the quick turnaround for rebates.
- **IGC program staff uses various communication tools to engage with contractors.** Contractors who install program-qualifying equipment are not required to be officially registered with IGC. IGC does not have an approved trade ally network but does require that contractors who participate in the program to be licensed with the state. IGC program staff generally communicates with contractors via email and phone. There was one training provided by IGC staff where there was information about the HVAC portal and online application. If contractors were not able to attend, IGC staff sent emails with videos of the training along with online resources. The online contractor portal training is available on IGC's YouTube channel. IGC also offered a $300 reimbursement for contractors to participate in an ENERGY STAR® certification course. IGC staff indicated they have received positive feedback from contractors (e.g., they like the "straightforwardness of the program" and the responsiveness of staff).
- **IGC would like to see more electronic submissions of applications and increasing awareness of Energy Efficiency program.** IGC staff stated that they would like to see an increase the number of applications submitted electronically by contractors as they believe this would help streamline their application process. Staff would also like to get rid of the HERS rater statement in which the HERS rater must verify and confirm that the home is HERS certified. They would instead like to have another way to certify if the home meets the ENERGY STAR® requirements for the Whole Home measure. Program staff would also like to improve customer education and engagement. They are exploring adding online tools to their website, along with self-directed resources for customers to increase their energy efficiency knowledge. Increasing community outreach and trying new approaches were also mentioned as ways to improve the program and increase awareness.

3.3.2 HERS Rater Interviews

This section summarizes the findings of HERS rater interviews conducted for the purposes of learning of the HERS raters' experience with the program, feedback, and assessing the extent to which there are future opportunities for program improvement. The Evaluators conducted the interview with HERS raters to gain insights into the PY2017-2018 and PY2019 program years.

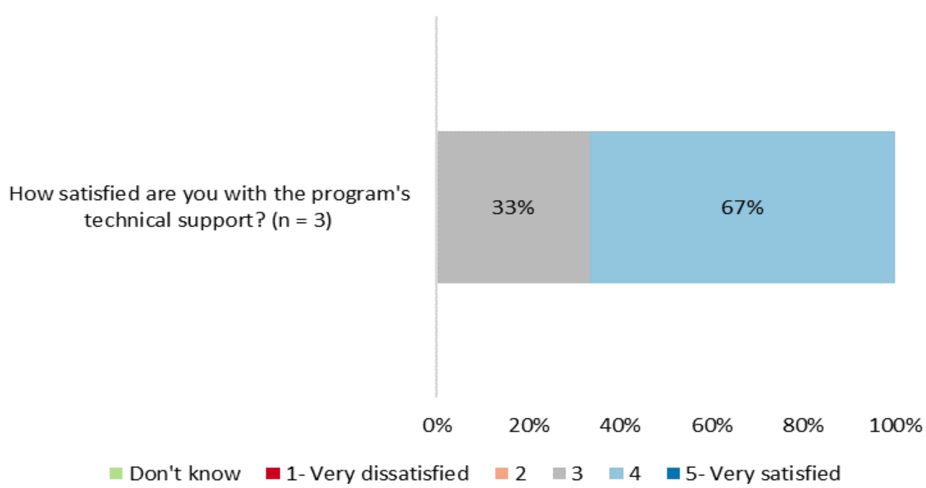
All three interviewees have worked as a rater in Idaho for more than a few years and all three stated they have participated in the Whole Home Rebate since inception. Each rater has worked with a different number of builders (range of 3 up to 70 builders total). In addition to rating homes, their companies also offer services in HVAC design, code testing, or general home auditing. Additionally, they offer ENERGY STAR® home rating consultation and training services.

The HERS raters were generally satisfied with the Energy Efficiency Program. According to the raters, the incentives are paid in a timely manner and program requirements are attainable. Raters also indicated the communication with program staff is sufficient but could improve in some areas. All HERS raters believe that offering more educational trainings and events could greatly increase understanding about energy efficiency among builders, realtors, and homeowners. More awareness of energy efficiency benefits could increase program participation and market competitiveness.

The following details key findings of the in-depth interviews.

- **Overall, the raters indicated being satisfied with IGC's Energy Efficiency Program.** Raters received positive feedback from builders about energy efficiency programs and indicated that the program's requirements seem reasonable and attainable. According to one HERS rater, IGC's payment turn-around is efficient and dependable.
- **In general, raters find IGC's energy efficiency programs to be one of the most effective in the region.** All the raters indicated they have participated in multiple energy efficiency programs sponsored by other utility companies. One HERS rater praised IGC as being the best in paying the incentives in a timely manner and working with other stakeholders to improve program implementation.
- **HERS raters were mostly satisfied with IGC's technical support and few issues were reported.** IGC staff were primarily responsible for providing information to HERS raters. According to the raters, most of the information about the program is provided by IGC staff. Two of the three raters gave a score of four out of five regarding program technical support. The other rater gave the rating a three out of five because of the issues they have had with the data processing system (see Figure 1). The rater who rated the technical support a three stated they had experienced many IT problems when trying to file reports and input important data for IGC.

Figure 1 Satisfaction with Technical Support



- **The perceived sufficiency of communication between HERS raters and IGC varied.** According to the raters, communication with IGC program staff varies depending on the rater. One rater described how IGC has invited raters in the past to participate in the planning of program implementation. The collaboration was effective because the program addressed concerns and issues that HERS raters normally face when participating in these types of incentive programs. Additionally, the other raters indicated they would be interested in having more communication with program staff than just receiving emails.
- **Raters use direct and indirect messaging to recruit builders to the program.** The most successful strategy for recruiting builders has been word-of-mouth. The HERS raters indicated they have informed the builders and real estate agents about the different rebate programs. Raters have also learned that other builders or contractors have been encouraging other builders to join.
- **Program requirements are broadly understood by participants and would benefit from further explanation**. The raters stated that IGC's incentive programs are easy to understand because they are based primarily on the ENERGY STAR® criteria. However, they have noticed that builders do not understand the importance of energy efficiency. According to the raters, builders have a significant learning curve to overcome. One rater suggested that IGC create a detailed checklist of the specific objectives the builders need to meet. The document should also include the amount of money it could cost the builder to meet those requirements.
- **According to the HERS raters, some builders perceive the costs outweigh the benefits of participating in the Whole Home program.** The HERS raters noted that some builders consider the costs of upgrading to more energy efficient standards to be burdensome. Other builders did not find the requirements a barrier because they already build to this standard. According to the raters, the different perceptions among builders depend on local building codes as well as local market demand. For example, one rater said that some builders who only needed to make minor changes to become eligible for the incentive were more likely to make the upgrades and apply for the rebate.
- **HERS raters indicated the rebate incentive as the best marketing tool for reaching most builders.** Currently, builders know what they need to accomplish to obtain the incentive but lack the understanding of why they should meet the requirements. According to one rater, builders should be aware that the initial costs may be higher, but the cost decreases once the energy efficiency upgrades become part of the builder's services. Raters reported that former program builder participants have seen an improvement in the quality of their plumbing and insulation installation.
- **Program budget could become more cost effective if staff uses a pay-to-performance method (pay scale).** One HERS rater suggested that IGC pay builders according to the actual energy savings they achieve. In some counties, builders in Idaho are scoring a 53 or 52, when the minimum score for the Whole Home measure rebate is significantly higher. According to one HERS rater, these builders should be paid more than the builders in other counties or from other companies who may be meeting the minimum requirements. He stated that by paying according to actual savings, program staff could see a more effective use of their program funding.
- **Program training for realtors may increase participation.** Raters indicated that realtors may be the key stakeholder to improving program participation among builders because they have direct contact with homeowners. By developing a course that offers continuing education credits through the Idaho Board of Realtors, real estate agents could better educate homeowners on the

benefits of owning an ENERGY STAR® certified home. They could market the homes that are HERS certified and increase competition within the housing industry.

- **Raters indicated that IGC could improve their outreach to homeowners about buying energy-efficient homes**. Although more homeowners are inquiring over certified energy-efficient homes, the majority do not understand the value of ENERGY STAR® certified homes. Homeowners who do value the idea of energy efficiency are consumers who are actively researching the latest technology or are interested in the incentives, according to one rater.
- **HERS raters expect the number of new homes for 2020 will remain consistent from 2019**. Raters noted that construction depended on changes in the market. The sudden economic downturn due to the pandemic has significantly affected company profits for 2020. Earlier calculations in the year, however, had indicated an increase in home construction for all the HERS raters, which would have surpassed PY2019 numbers.

3.3.3 IGC Contractor Interviews

This section summarizes the findings of interviews conducted with Idaho contractors. The purpose of the interviews was to explore contractors' business and energy efficiency practices, program experience, satisfaction, and opportunities for program improvement. The Evaluators conducted the interview with 23 contractors that have participated in IGC's Appliance Rebate measure to gain insights into the 2017-2018 (PY2017-2018) or 2019 (PY2019) program years.

The Evaluators contacted 119 contractors through 92 phone calls and 145 emails. Of the 23 interviewed contractors the Evaluators interviewed 20 participated for furnace rebates, 9 for tankless water heater, and 2 for fireplace rebates. Seven of the contractors interviewed participated for the furnace and tankless water heater rebate programs. Table 4 displays contractor interviewees' roles or titles.

Table 4 Contractors' Roles or Titles

Role or Title	n
Owner	12
Sales Manager/Coordinator	5
Office Manager/Admin	3
General Manager	2
President	1

The contractors stated that their residential work was primarily with single family homes, though seven contractors said that 10% or more of their residential work was at multifamily properties. Nineteen of the contractors mentioned that their company also did commercial work, while seven stated that they did very little commercial work.

Interviews indicated that the participating contractors had experience selling high efficiency equipment through various programs and noted that the IGC Appliance Rebate measure was easy and straightforward. Most contractors reported that there is sufficient support from IGC and that the Energy Efficiency program was running smoothly.

The following details key findings of the in-depth interviews.

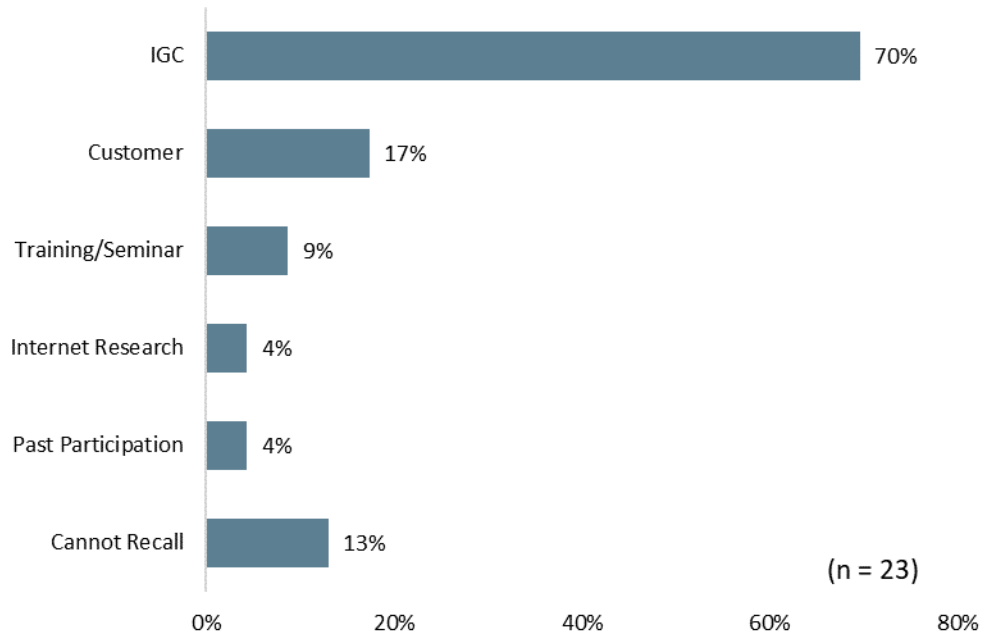
- **All participating contractors encourage the sale of high efficiency equipment.** Most of the contractors said their only method of encouraging the sale of high efficiency equipment was through discussions with customers. Four contractors mentioned other methods of encouraging the sale of high efficiency equipment including social media, newspaper, radio, and television ads.
- **Higher cost of energy efficient equipment is occasionally a challenge for some contractors.** Thirteen of the contractors (57%) interviewed said the higher cost of higher energy efficiency equipment made selling it a challenge. Two contractors mentioned that customers' understanding of the benefits and the documentation for higher efficiency equipment was another challenge to selling higher efficiency measures. Ten contractors (43%) said there were no challenges when trying to sell high efficiency equipment.
- **Contractors primarily utilize in-person discussions with customers to promote energy efficiency equipment.** Sixteen of the twenty-three contractors (70%) said that discussing the reduction in monthly energy use or utility bills was a successful strategy for encouraging customers to choose high efficiency equipment over standard efficiency equipment. Two contractors said that they do not offer lower energy efficiency equipment in their bids or proposals to customers. Two interviewees could not identify successful strategies to selling high efficiency equipment. One contractor stated that customers care most about the upfront cost and whether an incentive will cover the difference between standard and higher efficiency equipment. The final contractor stated that simply explaining the options to customers and educating them on the differences is enough to encourage the sale of high efficiency equipment.
- **All contractors had experience with energy efficiency programs.** Thirteen of the contractors said they had previous experience with Idaho Power and their rebate programs for energy saving measures such as heat pumps and thermostats. Four contractors mentioned working with Rocky Mountain Power's energy efficiency rebate programs. Four contractors mentioned other experiences including ENERGY STAR® ratings for new construction, the Idaho Department of Environmental Quality (DEQ)'s rebate program for wood fireplace replacement, working with Bonneville Power, and other energy efficiency programs that incentivized heat pumps. Five contractors either could not recall the details of their past participation in energy efficiency programs or were unable to elaborate on their experience. Table 5 displays interviewees' experience with energy efficiency programs (some contractors reported having experience with more than one program).

Table 5 Contractors' Past Experience

Experience	n
Idaho Power	13
Rocky Mountain Power	4
Other Experience	4
Cannot Recall	5

- **Contractor program awareness comes from a variety of sources, but primarily from IGC.** Sixteen contractors recalled learning of the Appliance Rebate measure from IGC through direct contact with a representative or an email, flyer, or promotion sent in the mail from IGC. Other sources of program awareness included customers, occupational trainings or seminars, past participation, or through internet research (see Figure 2). Three contractors could not recall how they learned about the program. Nineteen of the contractors reported having participated in the program since 2018; four said they had participated for a year or less.

Figure 2 Contractors' Sources of Program Awareness



- **Customer awareness of the IGC Appliance Rebate program is generally low.** On average, contractors estimated that less than 20% of their customers know about the program before they tell them about it. Two contractors estimated that about half of their customers knew about the program before they informed them.
- **Marketing and program promotion vary among contractors.** Sixteen of the 23 contractors (70%) said they actively marketed the program to their customers through in-person interactions. Three of these contractors stated that they included the rebate in their customers' quotes or project proposals. Two contractors mentioned other forms of promoting the program including advertising on their website, emails, and in newspapers.
- **Most contractors reported that they had not received marketing collateral, though some thought it might be helpful.** Most contractors (19 of the 23 or 83%) reported that they had not received marketing collateral from IGC. Eleven of the contractors (48%) that had not received IGC promotional collateral said that promotional assistance or marketing materials may be helpful. One contractor suggested that IGC provide a canned ad to insert into their own TV ads. Three of the four contractors that had received marketing collateral noted that they did not find it to be helpful; the fourth contractor said they would appreciate additional materials.
- **Strong program communications and sufficient contractor support.** Eighteen of the contractors (78%) said program communications were adequate, that they were sufficiently able you relay information to their customers, or they did not think there was any need to improve program

communication. Seven of the contractors (30%) noted that their company had received program training in either 2018 or 2019. Four contractors had in-person training and three had online training or attended webinars regarding the program. All seven contractors that had program training said that it had been helpful. Five of the contractors suggested that there was room for IGC to improve communication through additional emails, flyers, newsletters, or training for contractors explaining the program.

- **Furnace contractors typically replace non-functioning furnaces and encourage the installation of high-efficiency equipment.** The Evaluators asked nineteen furnace rebate program participants specific questions designed to better understand furnace projects. One furnace rebate contractor did not answer these questions as he was unable to complete the survey. Furnace rebate contractors provided estimated proportions of their projects that were either replacing fully functional, near failure, or non-functional furnaces. Table 6 displays the results from the nineteen furnace rebate contractors.

Table 6 Furnace Contractor Replacement Project Types

Operational Status	Average Percent (n = 19)
Non-functioning	41%
Near failure	37%
Fully Functional	22%

- **Replacement projects are driven by both air conditioners and furnaces.** All nineteen of the furnace contractors interviewed said some percentage of their customers are simultaneously replacing a furnace and air conditioner. Most (79%) of the interviewed furnace contractors indicated that in 50% or more of their projects they are simultaneously replacing a furnace and air conditioner. When the Evaluators asked for the primary reason of the simultaneous replacement projects, eight contractors said the reason for replacement was equally driven by air conditioners and furnaces, six of these contractors said most of the replacements are driven by furnaces, and two said replacements were primarily driven by air conditioners. Some contractors believed they are more likely to replace the entire HVAC unit in the summer compared to the winter months. Three contractors did not know which replacement was the primary driver of simultaneous replacements or referred to how seasonality affects their replacement projects.
- **Condensing furnaces typically do not cause significant challenges.** Sixteen of the furnace contractors (84%) said that they do not often face substantial difficulties installing the needed venting and drainage to support the installation of a condensing furnace (rated based on a scale from 1 (never) to 5 (very often). Nine contractors (47%) said that sometimes customers inquire about a condensing furnace, but then install standard efficiency because of the costs of venting and drainage. However, only two of these contractors stated that this happens frequently (rated based on similar scale as described previously).
- **Contractors who install tankless water heaters believe cost can be a barrier for customers.** Eight of the nine tankless water heater rebate contractors (89%) said they had not installed any systems that were below .91 UEF in the last year (n = 9). Five tankless water heater contractors estimated that a 0.91 UEF system was two to three times more expensive than a standard efficiency water

heater. Two contractors explained that there were many variables involved and the additional cost varied. Four of the contractors said they had customers inquire about a .91 UEF tankless system, but then choose not to install it because of the costs of venting and drainage; however, three of these contractors said this happened infrequently. Two of the four contractors said a customer would be likely to purchase a storage tank system in this scenario and two said they would be likely to purchase a .82 UEF tankless system.

Five contractors (56%) said that if IGC offered a rebate for 0.82 UEF systems it would not increase how many applications they submit to the program. Three contractors (33%) believed it would increase the number of applications they submit, and one (11%) did not know how the change would affect their number of applications.

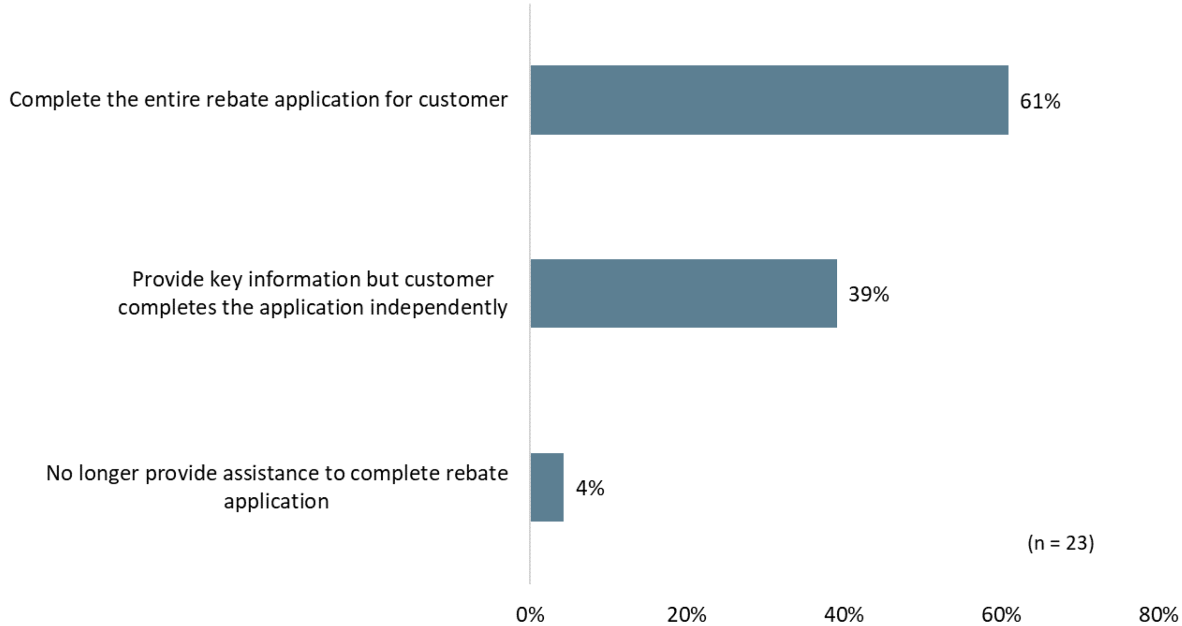
- **Opportunities to expand participation.** Eight of the 23 contractors (35%) said that they have completed energy efficiency projects that would qualify for the program but did not apply for a rebate. Table 7 summarizes the reasons contractors did not apply for a rebate for program-qualifying equipment.

Table 7 Reasons Contractors Did Not Submit Rebate Application

Response	n
Time and resources required to apply	3
Lack of program knowledge or understanding	2
Forgetfulness	1
Only completing the application upon customer request	1
Customers not wanting inspectors in home	1

- **Contractors see the program design as straightforward and operations as running smoothly.** Thirteen contractors (57%) said they did not find anything challenging about the program. Regarding the application process, all but one interviewee said they helped their customers complete the required program paperwork, though the extent to which they assisted with the paperwork varied. The following figure displays the extent to which the Contractors assisted with customers' applications (see Figure 3) Most contractors said they offer to complete the whole application process for the customer and only required the customer to sign it.

Figure 3 Contractor Assistance with Application Process



- **Contractors are largely satisfied with the program design and participation process, with some offering suggestions for improvement.** Most contractors that were interviewed indicated they are satisfied with the participation process and program design. Nine contractors did not have any suggestions to improve the program and did not find challenges with program participation. Other contractors noted challenges or ways in which the program might improve (see below).
    - **Some contractors felt that program participation was burdensome.** Eight contractors emphasized the challenge of allocating time and resources to the program and suggested simplifying or easing the process if possible.
    - **Some contractors said there was room to improve communications and/or training.** Six of the contractors suggested that there was room for IGC to improve communication or promotion through additional emails, flyers, newsletters for contractors and customers as well as training for contractors explaining the program. Furthermore, eleven contractors stated that promotional material provided by IGC would be helpful.
    - **Three contractors noted challenges with rebate form submission and suggested allowing rebate form submittal online or via email.** Three contractors said they felt the process of printing and mailing the form was onerous and suggested digital methods to submit the rebate form.[1]

[1] This may indicate an opportunity to better inform contractors regarding application submission options as three other contractors explained that they utilized an online form to submit their rebate applications and appreciated its ease of use.

- One contractor noted missing the opportunity to apply for rebates because of the limited time frame and suggested expanding the time window to apply for the rebate.
- Two contractors reported being contacted about the status of customer rebates and suggested that IGC enable them to track the status of rebate payment.
- **Some contractors provided recommendations regarding participation requirements and features.** Contractors offered suggestions regarding the program's design and participation requirements. Contractors offered the following recommendations:

Table 8 Contractor Recommendations

Recommendation	n
Higher incentive for eligible measures	2
Revisit boiler incentive[2]	2
Eliminate permit requirements for the program; instead only require that contractors be licensed	1
Require contractors to register with IGC and qualify to participate in the program	1
Provide a "kickback" or payment to the installing dealer to compensate them for promoting the program and completing the application	1

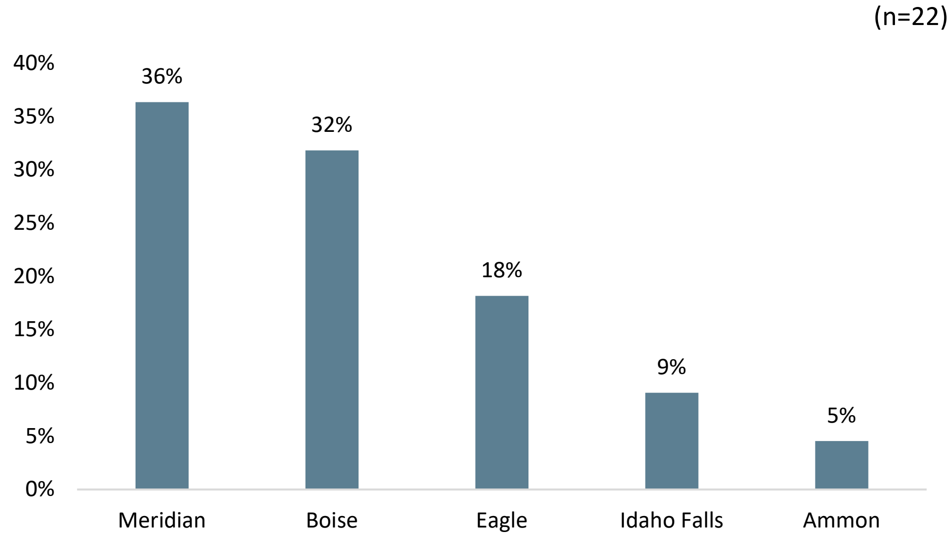
3.3.4 Participating Builder Interviews

This section summarizes the findings of participating builder interviews conducted with Idaho builders. The Evaluators conducted interviews with 22 participating builders to gain insights into the PY2017-2018 and PY2019 program years. The builders were contacted both through email and phone at a maximum of four contact attempts. The purpose of these interviews was to understand the builder home characteristics and efficiency levels, the level of awareness their customers had about the Energy Efficiency Program and the Whole Home measure, and builder satisfaction and feedback.

As shown in the figure below, most of the builders (68%) contacted had businesses in Meridian and Boise in Idaho. The other participating builders (32%) were dispersed between Eagle, Idaho Falls, and Ammon.

[2] One contractor stated that when they are installing high efficiency boilers, the only way they qualify is if they are combination systems (heating and water heating). That contractor suggested that high efficiency boilers should qualify regardless of whether they are water and home heating systems.

Figure 4 Builders Who Participated in an Interview by Territory

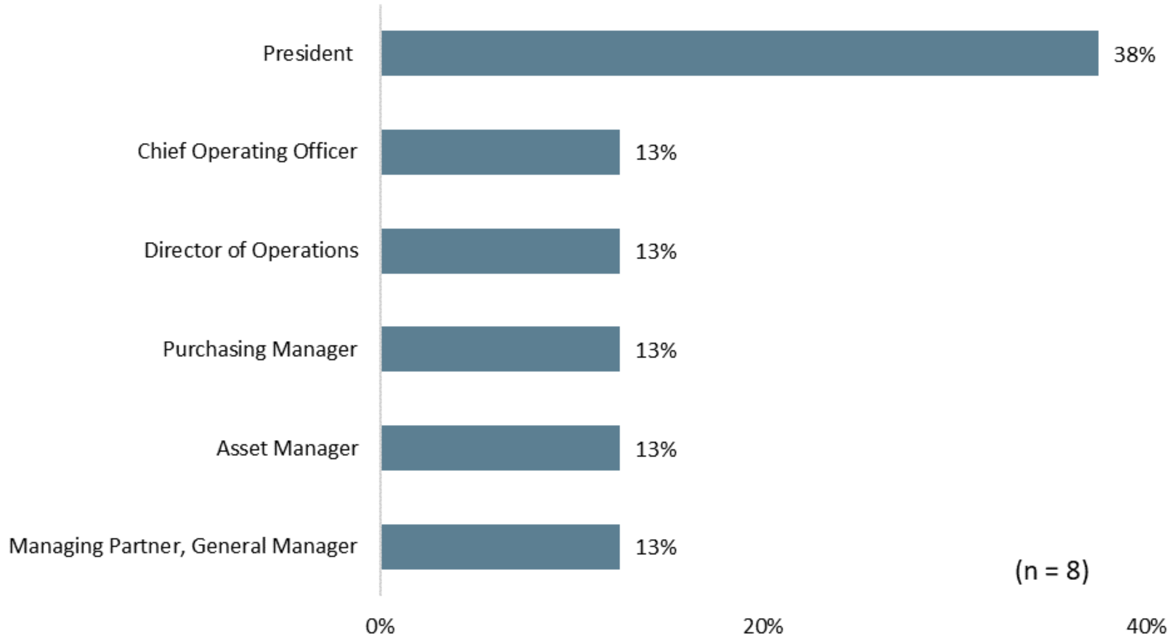


Evaluators followed up with phone calls to builders who had not responded by email. Interviews were completed for eight builders who responded to the request for an interview. Out of the eight builders who responded, six (75%) were in Meridian, Idaho. Many of these respondents built production homes rather than custom built homes. Overall, all builders interviewed were satisfied with Intermountain Gas Company's Energy Efficiency program (Whole Home measure). According to the builders interviewed, the two main factors that went into deciding to build homes to program-building standards included program financial incentive and ability to differentiate themselves in the market.

The following details the key findings of the in-depth interviews.

- **Most interviewed builders were leaders at their company.** Thirty-eight percent of respondents held the title of President of their company. The other respondents had management roles including director of operations, chief operating officer, managing partner, asset manager, and purchasing manager. Results are summarized in Figure 5 below.

Figure 5 Leadership Position



- **Most interviewed builders (75%) were the primary decision maker in terms of participating in the Energy Efficiency program (Whole Home measure).** One respondent stated that they were not the primary decision maker, but that they were one of three decision makers regarding their involvement in the Energy Efficiency program. The other respondent stated that the President of the company made the decision to participate in the program.
- **All responding builders participated in the Energy Efficiency program (Whole Home Rebate) for at least one year.** The builders all mentioned that they have participated in the program since either PY2017-2018 or PY2019.
- **Custom homes were not common among builders.** Builders provided feedback about how often they build production homes (homes with pre-existing floor plans) versus custom homes. Most builders reported that they typically built production homes. Three builders stated that they do not have any custom homes. However, two builders stated that they mostly received rebates for custom built homes (one builder at 75% and the other at 100%, respectively). Two other responses included 20% custom built and 30% custom built.
- **Builders who attended Energy Efficiency Program (Whole Home measure) marketing events found the information presented to be helpful.** Fifty percent of builders interviewed attended events where an IGC program representative provided information about the program. This included information at a Contractors Association meeting and discussions held by Building Energy. Three out of four builders that attended these meetings stated that the information was helpful to them and that they would attend these events in the future.
- **All participating builders interviewed stated that program financial incentive and ability to differentiate themselves in the market were the factors that went into deciding to build their homes to program-building standards in PY2018 and PY2019.** Fifty percent of respondents stated

that there was a customer demand for energy efficient homes, and 38% stated that additional program assistance was a factor for them to participate in the program. Thirty-eight percent of respondents also stated there were other factors that went into deciding to build homes that happened to qualify for the program, which included the building codes that are changing.

- **All participating builders built homes with a HERS score of less than 75.** Some of the strategies builders currently implement to achieve a lower HERS scores are installing air infiltration, installing 95% AFUE furnaces, meeting all the ENERGY STAR® requirements, and following the building codes. High efficiency HVAC systems, such as the 95% AFUE furnaces, were mentioned as one of the more expensive ways to get a lower HERS score. The builders also listed a variety of ways that are the least costly to get a lower HERS score. Implementing non-HVAC measures such as air sealing, duct sealing, and insulation were noted as some of the least costly ways to ensure that a home met the program required HERS score of 75 or lower.

- **Builders generally do not actively promote the Whole Home Rebate to homebuyers.** Sixty-three percent of builders stated that they do not provide marketing messages or materials to their customers about the Whole Home measure. One reason for not promoting the rebate program to homeowners was that the Whole Homes measure is advertised to builders and not homeowners, so that is not the focus group. This marketing material comes in the form of information on the builder's website, flyers, or advertisements about the lifestyle of these energy efficient homes.

- **Home buyers are generally unaware of the Whole Home measure according to builders.** Builders provided feedback on the proportion of the customers who were aware of the Whole Home measure before they began working with them to build or buy a home. Five out of eight builders either did not know if their customers were aware of the program or stated that their customers were unaware about the Whole Home measure. Three out of eight builders stated that their customers knew about the Whole Home measure. Results are summarized in Table 9 using the parameters of "Don't Know," "Yes," and "None."

Table 9 Home Buyer Awareness

Respondents	Responses (n=8)
Builder 1	Do not know
Builder 2	Do not know
Builder 3	None
Builder 4	Yes
Builder 5	Yes
Builder 6	Do not know
Builder 7	None
Builder 8	Yes

- **There are not many challenges when marketing a program-qualifying home.** Seven out of eight builders expressed that there are not challenges when marketing a program qualifying home. In fact, two of these seven builders expressed that people are more environmentally conscious and keen on energy efficient homes. The one builder that expressed concern stated that as a builder they have been hesitant to discuss utility bills with the buyer and would rather have a third party take that liability.

- **Customers viewed lower energy bills and increased comfort as benefits of a program qualifying home.** All interviewed builders reported that their customers found various benefits when purchasing a program qualifying home with the Whole Home measure. Benefits included lower utility bills, increased comfort in the home (due to measures such as air sealing), and a better environmental impact.
- **Most builders believe homebuyer demand and expectations for energy efficient homes has increased in recent years.** Seven out of the eight builders interviewed (88%) believed that the demand has changed. The seven builders believe concern for the environment and expectations for energy efficiency standards in homes has changed. The one builder that stated demand has not changed stated that most of their customers are focused on price and lower energy bills.
- **Non-HVAC measures were noted as the least costly way to help participating builders build homes with a HERS score of less than 75.** According to the builders, the least costly ways to ensure a home has a HERS score lower than 75 include implementing insulation, air sealing, and having a conditioned crawl space. Other strategies that builders discussed included implementing 95% AFUE furnaces, meeting all the ENERGY STAR® requirements, and following the building codes. However, these other strategies were not listed as lower cost, and the 95% AFUE furnaces are seen as one of the more costly ways to achieve the HERS score requirement.
- **Builders recommended that IGC increase marketing for and provide cost savings data for homes.** Suggestions included providing builders with additional flyers, increasing advertising (e.g., radio commercials), and cobranding opportunities (e.g., providing a logo for the builders to use on their website that would associate the energy efficient homes with the Energy Efficiency program). One builder recommended that IGC should do studies using empirical data that show the cost savings from energy efficient homes.
- **Overall, builders are satisfied with their HERS rater that they worked with in this program.** Using a scale from 1 (very dissatisfied) to 5 (very satisfied), 100% of the builders stated that they were very satisfied with the HERS rater they worked with in the program. Interviewed builders reported that 50% of the HERS raters apply for the rebate on behalf of the builder.
- **All builders interviewed were satisfied with IGC's Whole Home Rebate.** All builders who were interviewed stated that they were satisfied with the program and they would continue to participate in the Energy Efficiency program.

3.3.5 Nonparticipant Builder Interviews

The Evaluators conducted interviews with six builders that have built homes in IGC's service territory but are not active participants in the Energy Efficiency Program. The Evaluators compiled a list of nonparticipating builders and interviewed six nonparticipating builders after contacting 63 unique builders with 79 phone calls and 54 emails.

The Evaluators spoke with one owner, one co-owner, and four managing partners or members. All six interviewees said that they were the primary decisionmaker in determining the level of energy efficiency in their companies' homebuilding. Two of the nonparticipant builders said they primarily build homes that use an existing floorplan, while the remaining four builders said they principally build custom homes.

All six builders estimated that most of their homes (85% or more) were plumbed with natural gas. The builders were based in different parts of the state (see Table 10).

Table 10 Nonparticipant Builder Locations

Respondents	Responses (n=6)
Ketchum	2
Idaho Falls	2
Fruitland	1
Hailey	1

The nonparticipating builders were generally unaware of the IGC Energy Efficiency Program and the Whole Home Rebate though they were interested in learning more. Interviews indicated that there is strong demand for new homes and some builders feel there is also strong demand for energy efficient homes. In general, the nonparticipating builders indicated that they were satisfied with IGC as their gas service provider.

The following details key findings of the in-depth interviews.

- **Most nonparticipating builders were not aware of IGC's Energy Efficiency program, specifically the Whole Home measure.** Three builders stated they were unfamiliar with the program. Two builders noted that their companies participated in IGC's Appliance Rebate measure but were not familiar with the Whole Home program. One of the interviewees said they were familiar with the IGC Whole Home program and said that they were considering participation in IGC's Whole Home Rebate and that they are in the process of becoming an ENERGY STAR® new home builder.
- **Interest in learning more about the program and future participation.** Four builders (67%) stated that more information about program requirements would help them participate in the program in the future. Two builders noted that for their company to participate in the program the benefits of the program must outweigh the costs, that the building requirements must not be too difficult to achieve, and that the program paperwork and process must not be too onerous. One builder stated that they build homes infrequently but if they did construct another new home, they would consider participation in the program, depending on its requirements. The remaining builder said they had immediate plans to participate and were in the process of researching the program.
- **Energy efficient practices and features are common among new homes from nonparticipating builders.** Four interviewees said that all their homes have more energy efficient features than are required by Idaho building code. The two exceptions reported that about 90% of their homes have more energy efficient features than are required by the Idaho building code. The nonparticipating builders interviewed said they chose to build above-code and energy efficient homes because of an internal company directive/mission, homebuyers with capital and desire for "add-ons" or top of the line/best choices, or local code guidelines being above the Idaho state building code (e.g. in Hailey and Blaine County).
- **Diverging views regarding homebuyer demand for energy efficiency.** The nonparticipating builders shared a range of perceptions regarding homebuyer actual awareness or interest in

energy efficiency features. Five of the builders said that homebuyers are willing to pay more for energy efficient homes. Similarly, 83% of builders shared that they felt homebuyer demand and expectations for energy efficient homes have increased over the past few years. Despite this, three builders said most of their homebuyers do not ask about the energy efficiency of their new homes. Three builders also noted that including energy efficient features in their new homes did not help their homes sell more quickly and cited various reasons:

- Localities have above-code energy requirements. Builders noted that some municipalities and counties have standards or required features that are above the national or state building code (e.g. in Hailey and Blaine County);
- Realtors are unaware of energy efficient features or decide not to mention energy efficiency in their sales strategy;
- Homebuyers placing higher value on square footage, cosmetics, and "curb appeal" rather than energy efficiency.

- **Strong demand for new homes in Idaho with little or no marketing required.** Four builders stated that there is currently significant demand for new homes and that marketing was not required or was not a challenge. None of the builders noticed any challenges in marketing their homes. Two builders noted that they are not involved in marketing homes. One builder stated a realtor handles marketing. The other noted that homebuyers come to them and that they do not market the energy efficiency aspects of their homes.
- **Most builders have experience with HERS raters and were generally satisfied with their performance.** All builders had previously worked with HERS raters. One builder said that none of his companies' homes had a HERS rating but he had worked with another subcontractor's HERS rater. Three builders said that all their houses were HERS rated and one said that about 80% of their homes were rated. The sixth builder noted that in total, less than 1% of their homes had been HERS rated and were not aware of a HERS rater working in his company's area. Five said they had been satisfied with the performance of the HERS rater they had worked with; the other builder noted that it had been several years since they had worked with a HERS rater and could not recall how satisfied they were with their experience. Three builders noted that the HERS raters they had worked with mentioned the IGC Whole Home measure.
- **General satisfaction and only one minor issue with IGC service.** During the Evaluator's interviews with nonparticipating builders, five of the six did not have any additional comments or feedback regarding building homes in IGC's service territory or IGC in general. However, one builder noted that they had difficulty working with IGC to schedule running gas lines to home they were building. The builder stated that on occasion it took five to six months. He shared that IGC's local salesperson in Twin Falls might have been overworked and that he had found a workaround by contacting IGC's subcontractor directly to run line to his new homes.
- **Reasons for not participating in the Whole Home Rebate included lack of awareness and understanding of cost and benefits.** In general, there were three reasons that nonparticipating builders were not participating in the IGC Whole Homes Rebate.
  - Most nonparticipating builders did not know the details of the program and indicated they were interested in learning more (n=5)

- Some of the nonparticipating builders were concerned about the cost and amount of effort the program might take and the lack of payoff they would receive (n=3)
- Some builders felt that they are already building above-code houses or houses that are energy efficient and were not sure what the benefit of the program would be for their business (n=3)

3.3.6 Whole Home Measure Participant Survey

The Evaluators conducted a survey with IGC customers who purchased a new home that received a rebate in PY2017-2018 or PY2019. Out of 110 survey participants, 80 people completed the survey.

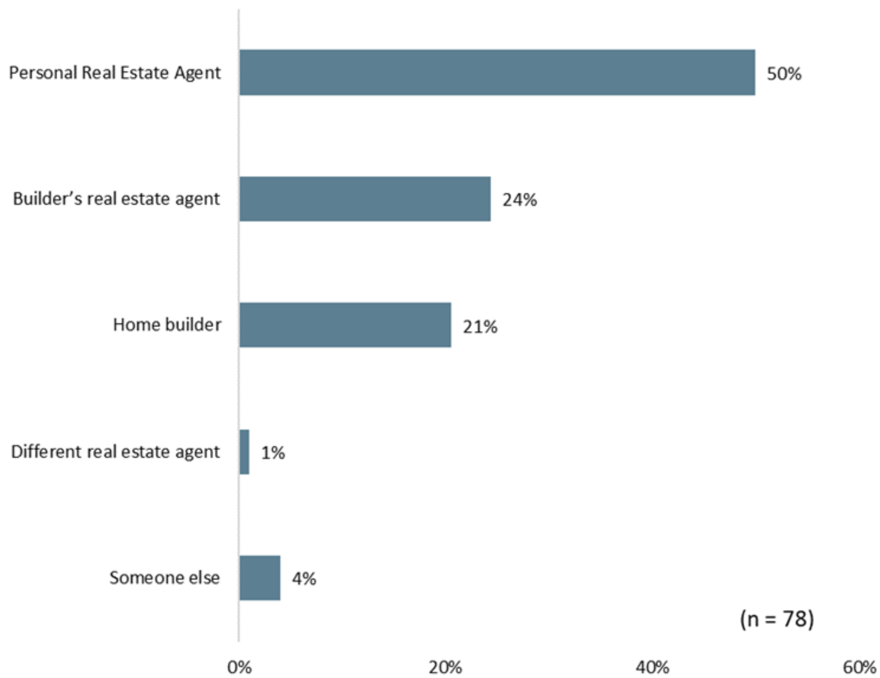
In general, participants indicated they were satisfied with the program. Although respondents were not fully aware of all the home's energy efficiency features, they were satisfied with the energy efficiency measures installed in the home. Some of the factors that greatly influenced the participant's decision to buying the home include house price, being ENERGY STAR® certified, and having a HERS rater give the home a score. Regarding attitudes about energy efficiency, most respondents believe that energy efficiency saves money.

The following section summarizes key information about program awareness, experience, and satisfaction as well as participant demographics.

Program Awareness

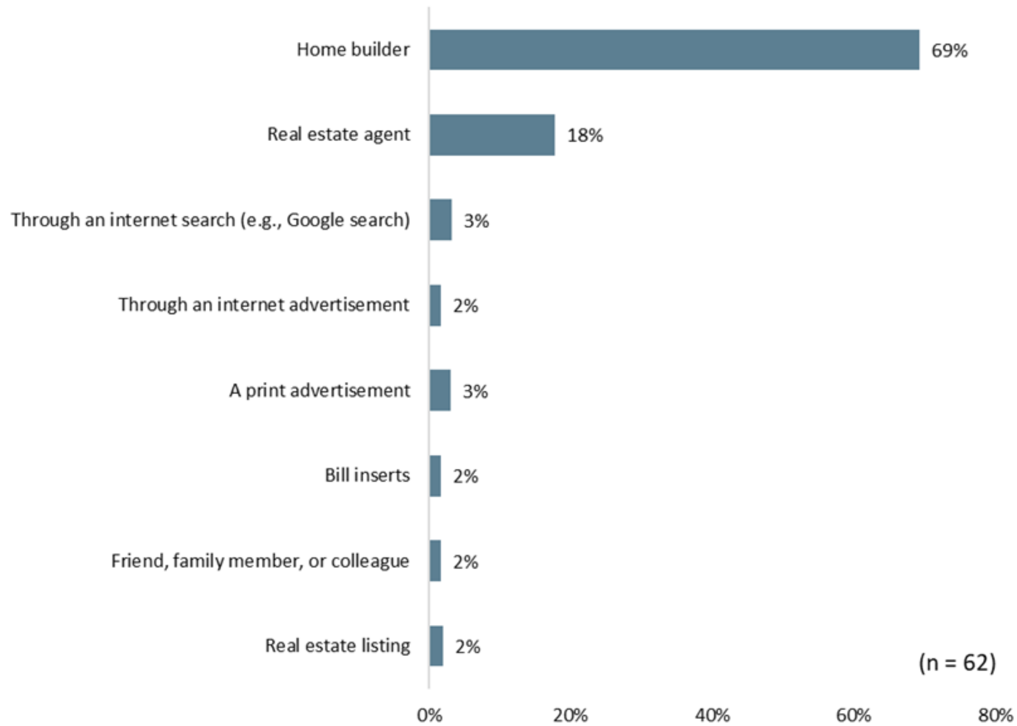
Participants worked with different stakeholders when deciding on buying their homes. Fifty percent stated they worked with their own real estate agent, while 24% worked with the builder's in-house realtor. Figure 6 provides a summary of all other stakeholders. Some participants also mentioned they worked in real estate or worked with more than one of the stakeholders below during this process.

Figure 6 List of Home Buying Stakeholder Support



Seventy-nine percent were aware that their home was ENERGY STAR® certified, while 16% said they did not know. Five percent stated they could not recall if they had been aware of their home's certification at the time. Of those who knew, 69% indicated they learned this information from the builder and 18% learned from a real estate agent (see Figure 7 for more details).

Figure 7 Primary Source of Information Regarding Home Being ENERGY STAR® Certified



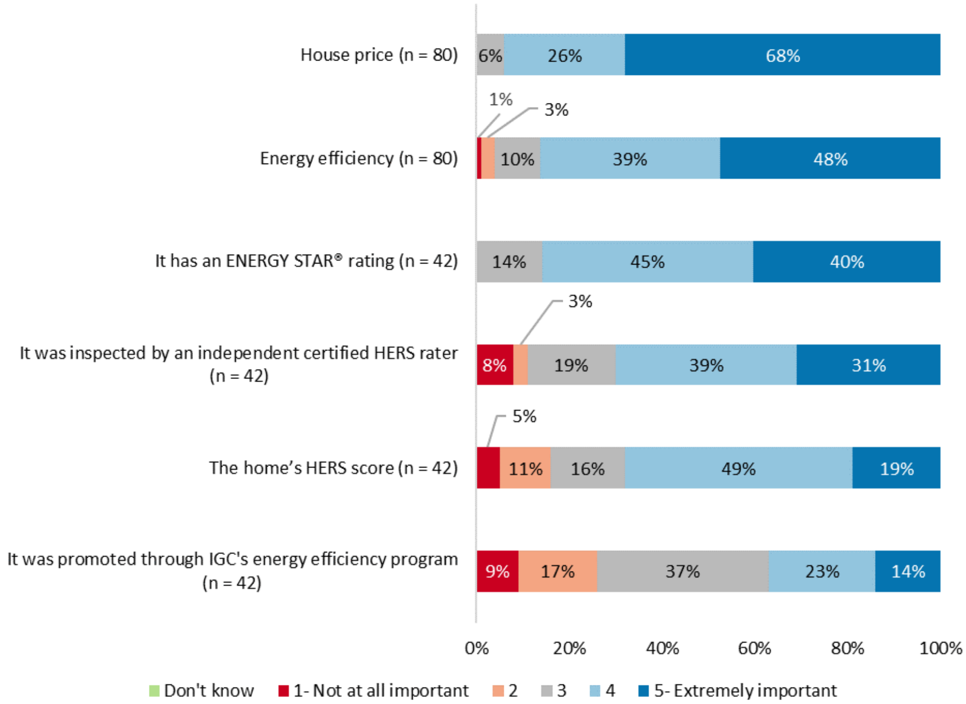
Builders and real estate agents were the main source of information for many of the survey respondents learned about the home's ENERGY STAR® rating (63%), how the home was promoted by IGC's Energy Efficiency Program (47%), and of the home's HERS score (38%) given by a certified HERS rater (42%). See Table 11 for more details.

Table 11 Information about the Home Provided by Builders or Real Estate Agents

Description	ENERGY STAR® Rating (n = 79)	Home Promoted by IGC (n = 77)	Home certified by HERS Rater (n = 77)	Home's HERS Score (n = 77)
Knew it before I contacted the builder or real estate agent about buying the home	11%	8%	4%	4%
I learned about it from the builder or real estate agent before I bought the home	63%	47%	38%	38%
I learned about it after buying the home	8%	8%	12%	12%
I did not know about it before being invited to take this survey	16%	30%	36%	36%
I don't know when I learned about it	1%	8%	10%	10%

The factors to buy the home varied among participants. Although many indicated that energy efficiency was either important or extremely important to them (86%), most stated the home's price to be of greater importance (94%). Participants also indicated that knowing their home had an ENERGY STAR® rating and had been inspected by a HERS rater influenced their decision to purchase the home (85% and 70% respectively, based on a 5-point scale). Between the number of respondents who indicated that the ENERGY STAR® rating and the HERS score were influential, there is a 17 percentage-point difference, with the home's HERS score being less influential (68%). See Figure 8 for more details.

Figure 8 Factors that Influenced Decision on Purchasing the Home

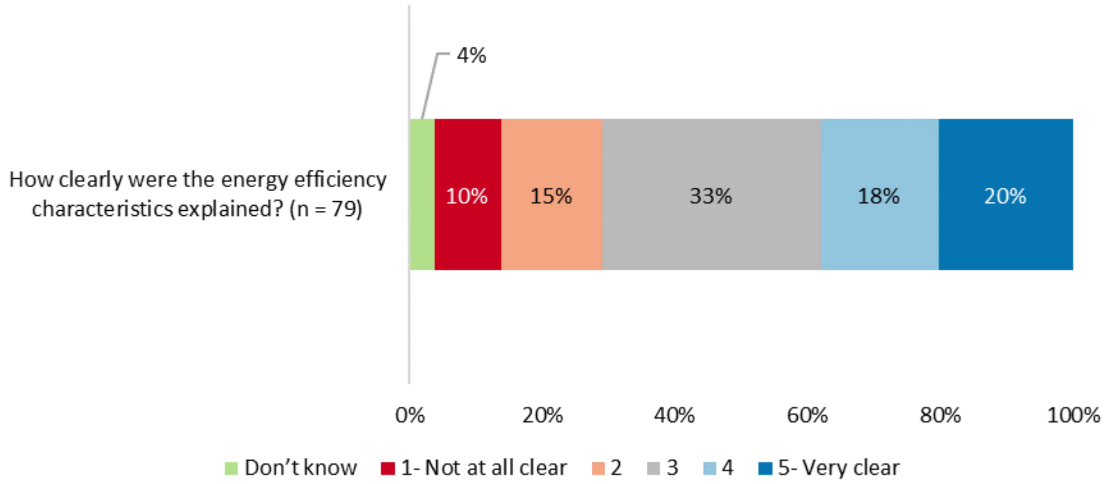


Other non-energy-efficient factors that greatly influenced the sale of the home include the location and the fact that it was newly built. Below are some of the verbatim comments shared by respondents.

- *"Great house and location. Fit our [family's] needs."*
- *"We bought the house based on the location and home features."*
- *"We liked the location, specific neighborhood, and the layout of the house. The fact that it was new and more energy-efficient, so lower bills, helped a lot."*
- *"We knew it had some [energy-efficient] features and we were happy about that. I don't think we knew all of it though. We liked the neighborhood and the design of the house."*

Though energy efficiency appeared to be an important factor when buying the home, some respondents recalled not being fully aware of the home's energy efficiency features. Thirty-eight percent of respondents stated the home's energy efficient characteristics had been clearly explained by the person who helped them purchase the home, while 25% indicated it had not been clear (see Figure 9). Participants also reported they were unaware of the differences between homes promoted by IGC (57%) versus the other homes on the market at the time of their purchase.

Figure 9 Participants Understanding of Home's Energy Efficiency Features



The Evaluators also inquired about the heating and cooling systems installed in the energy-efficient homes. Most respondents stated they had not made any changes to the heating (93%) or cooling (96%) systems since they moved into their new homes. Of the respondents who did make changes, they shared the following:

- "[We] [m]oved the A/C unit to the other side of the home. It was obstructing the walkway. For example, we had to take the garbage cans and [lawnmower] through the garage instead of the outside gate. [We are] considering circulated hot water to the kitchen."
- "[Added a] programmable remote[ly] accessible thermostat."
- "We added a garage heater and also heated master bath floors."

Ten percent of respondents also indicated they changed the appliances included with the home. Clothes washers (n = 3), clothes dryers (n = 2), and refrigerators (n = 2) were the appliances that homebuyers changed the most. Others indicated they had to buy new appliances because they were not part of the home purchase.

Energy Efficiency Knowledge and Attitudes

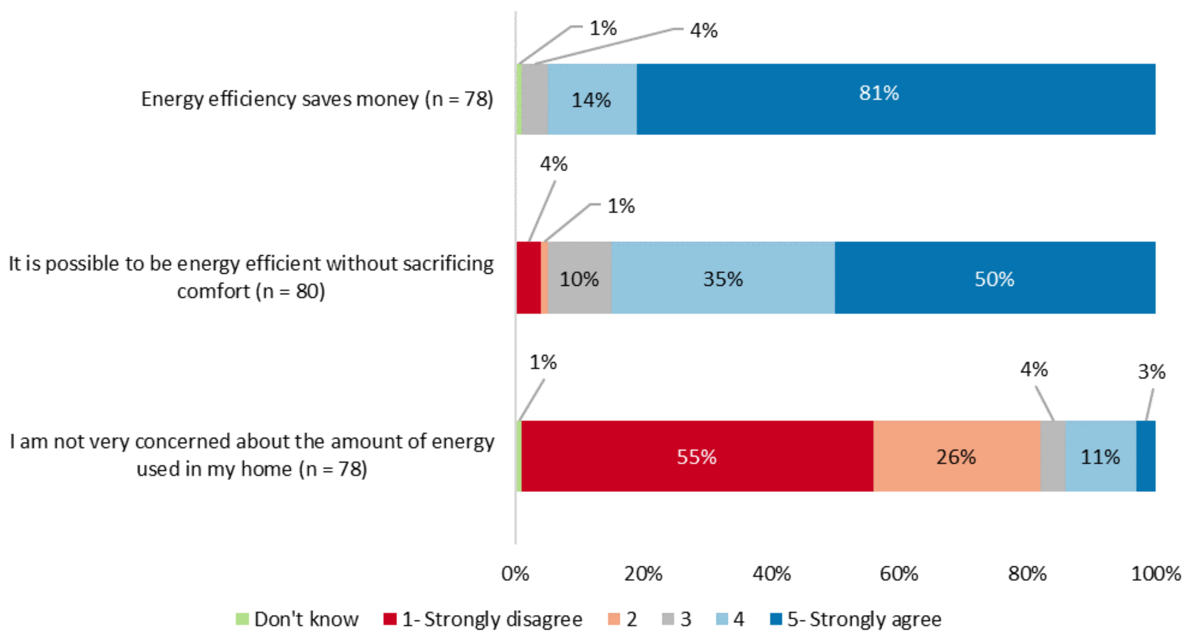
Table 12 summarizes how well informed the respondents perceive themselves regarding energy efficiency practices and improvements for their homes, with most indicating they are very well informed or somewhat informed.

Table 12 Perception of Energy Efficiency Comprehension

Rating	Percent (n = 80)
5- Very well informed	18%
4	36%
3	29%
2	14%
1- Not very well informed	4%

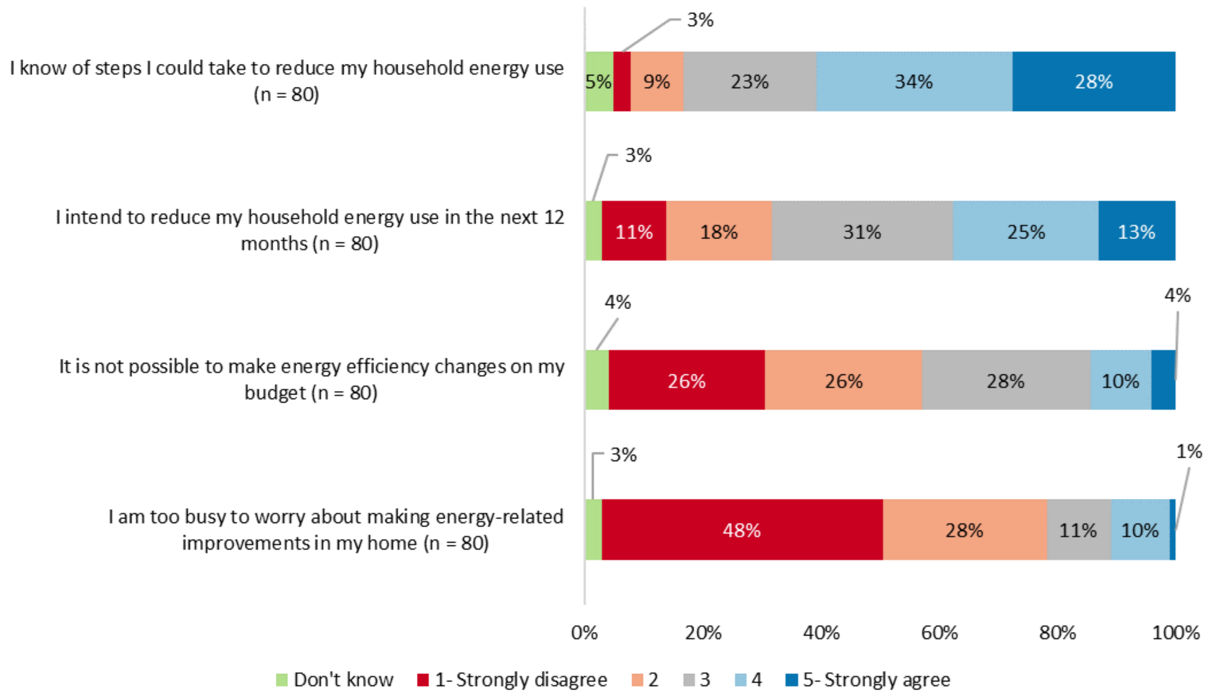
Respondents also rated their level of agreement with statements regarding their attitudes towards energy efficiency initiatives and practices. Most participants stated that energy efficiency saves money (95%, based on a 5-point scale), while 85% indicated that it was possible to be energy efficient without sacrificing comfort. Ninety-one percent are very concerned with the amount of energy they use at home (see Figure 10).

Figure 10 Attitudes towards Energy Efficiency



Participants also agreed that they knew of steps to take to reduce their household energy use (62%, based on a 5-point scale), and 38% intended to reduce household energy use in the next 12 months. On the contrary, 52% disagreed with the statement that it was not possible to make energy efficiency changes on their budget, or they were too busy about making energy-related improvements (73%). Figure 11 summarizes their responses.

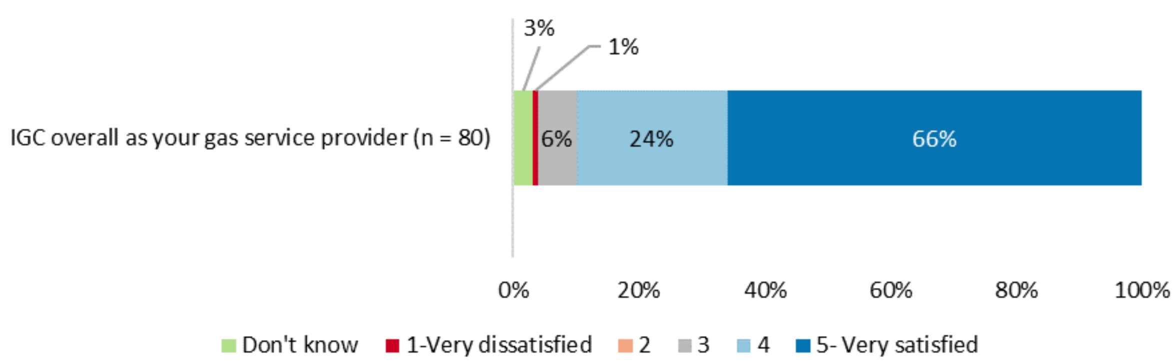
Figure 11 Willingness to take Energy Efficiency Actions in the Home



Program Satisfaction

Overall, participants indicated they were satisfied with the program. Respondents were either satisfied or very satisfied with the energy efficiency measures in their homes (92%) and the ENERGY STAR® certified home promoted by IGC (84%). Ninety percent of respondents indicated they were either satisfied or very satisfied with IGC as their gas service provider (see Figure 12). They noted that IGC was a trustworthy source for information about saving energy (84%, based on a 5-point Likert scale).

Figure 12 Satisfaction with IGC as Participant's Gas Service Provider



Participant Demographics

Most of the participants stated that their source for electricity came from Idaho Power (91%), and they owned their home (99%) (see table). They also stated they live in with four other people or less (91%) and earn an annual household income of $50,000 or more (67%). The participant who completed the survey was 50 years or older (51%) and had completed a bachelor's degree or higher (73%). See Table 13 for more details.

Table 13 Home Demographics

Question	Response	Percent
Source of Electricity (n = 80)	Idaho Power Company	91%
	Rocky Mountain Power	6%
	Fall River Rural Electric Cooperative	0%
	Idaho County Light and Power	0%
	Other (Please specify)	0%
	Do not know/Prefer not to state	3%
Home Ownership (n = 80)	Own	99%
	Rent	1%

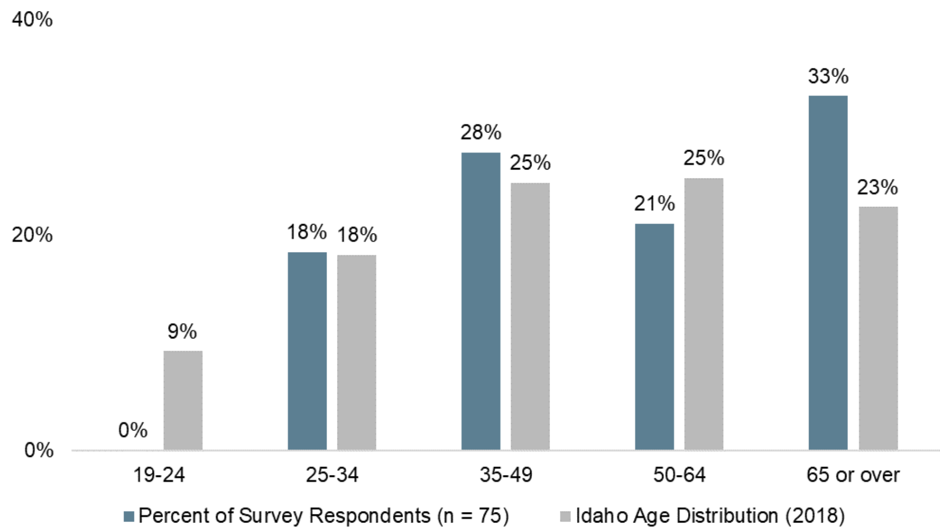
Table 14 Participant Demographics

Question	Response	Percent
Household Income (n = 79)	Less than $10,000	0%
	$10,000 to less than $20,000	0%
	$20,000 to less than $30,000	3%
	$30,000 to less than $40,000	3%
	$40,000 to less than $50,000	1%
	$50,000 to less than $60,000	8%
	$60,000 to less than $70,000	9%
	$70,000 to less than $80,000	4%
	$80,000 to less than $90,000	5%
	$90,000 to less than $100,000	5%
	$100,000 to less than $150,000	15%
	$150,000 to less than $200,000	9%
	$200,000 or more	13%
	Do not Know/Prefer not to state	27%
Highest Level of Education Completed (n = 80)	Some High school	0%
	High school or GED equivalent	1%
	Some college	11%
	Associate degree	9%
	Bachelor's college degree	34%
	Master's degree	31%
	Professional degree (MD, JD, DDO, DDS)	6%
	Doctorate (Ph.D., D.Sc.)	1%
	Do not know/Prefer not to state	6%
Age (n = 80)	19-24	0%
	25-34	18%
	35-49	26%
	50-64	20%
	65 or over	31%
	Do not know/Prefer not to state	5%
Household size (n = 80)	One	13%
	Two	44%
	Three	8%
	Four	9%
	Five	19%
	Six	4%
	Seven	4%
	Do not know/Prefer not to state	1%

The Evaluators compared survey demographics Idaho census data from 2018 to examine the distribution among age, educational attainment, and income. The figures below provide a comparison of survey respondents age and education compared to Idaho residents (see Figure 13 and Figure 14). According to

U.S. Census data, the Idaho median income is $53,089.[3] Eighty-one percent of survey respondents said their income was greater than $60,000, while 19% said their income was less than $60,0000 (see Table 14).

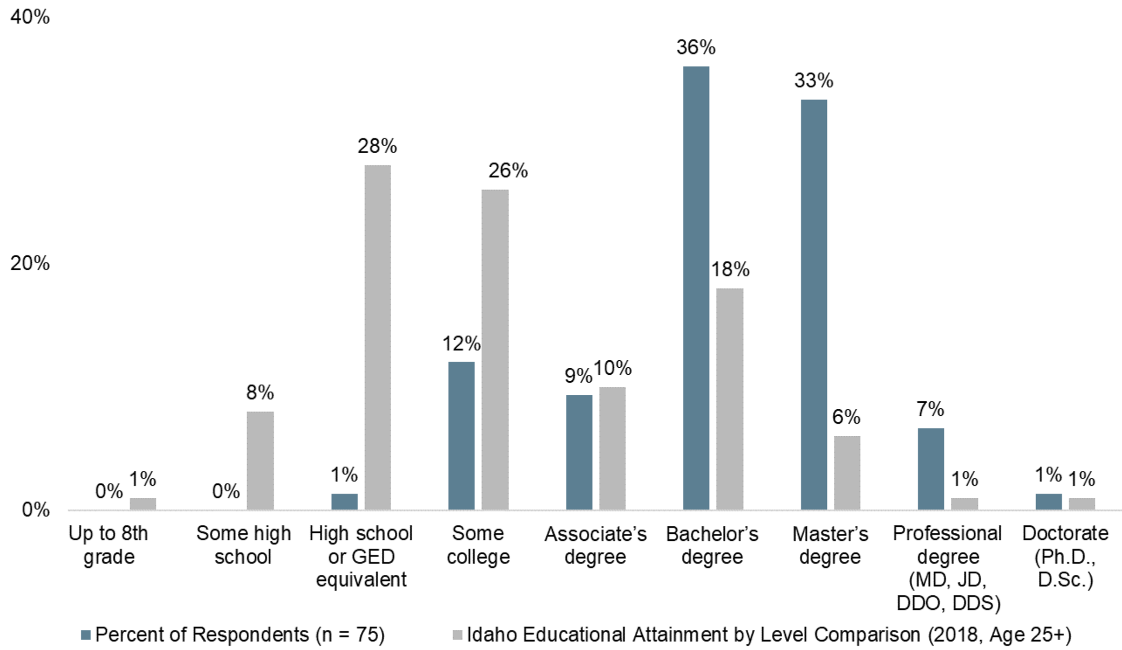
Figure 13 Age Distribution of Survey Respondents Compared to Idaho Census Data



* Excluding "prefer not to answer" and "do not know" responses.

[3] U.S. Department of Commerce. (2018). QuickFacts: Idaho. Retrieved May 26, 2020, from https://www.census.gov/quickfacts/ID

Figure 14 Educational Attainment[4] of Survey Respondents and Idaho Residents



3.3.7 Appliance Rebate Measure Participant Survey

The Evaluators conducted a survey with IGC customers who received a rebate in PY2017-2018 or PY2019. Out of 110 survey participants, 80 people completed the survey. A random sample of 572 IGC Appliance Rebate measure participants (82 Tankless WH, 13 Fireplace, 8 Water Heater, 10 Radiant Combo, 459 Furnace) were selected to participate in the survey. A total of 138 IGC Appliance Rebate measure program participants completed the survey. Table 15 displays the number of responses by appliance type.

Survey results indicate that customers are satisfied with the Appliance Rebate measure as well as their rebated appliances. The Appliance Rebate measure survey also indicated that contractors play an important role in the successful implementation of the program. Respondents noted that their appliances' energy efficiency and warranty/reliability were the most important factors in their purchase decision.

Table 15 Survey Responses by Application Type

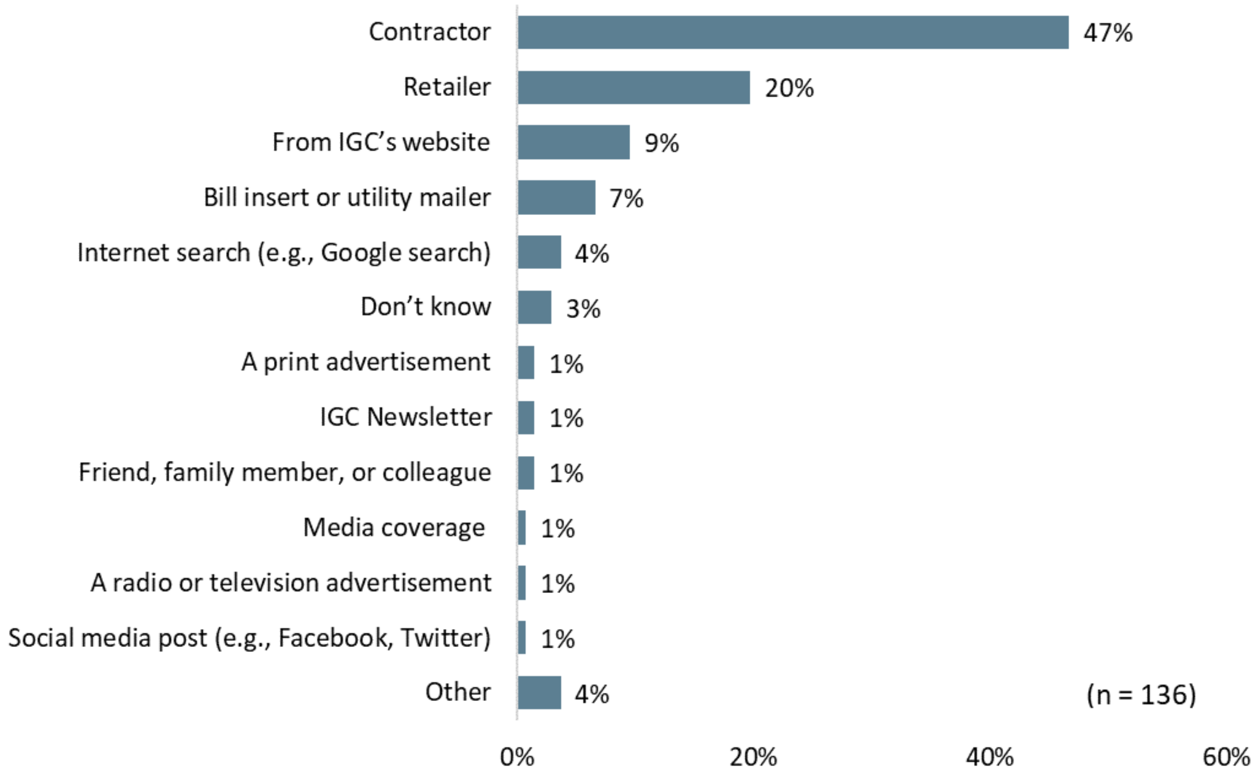
Appliance	n
95% Furnace	80
Tankless Water Heater	40
Water Heater	6
Radiant Combo	6
Fireplace	5
Total	**137**

[4] U.S. Census Bureau; American Community Survey (2018)

Program Awareness and Decision-making

Nearly half of the respondents said they first learned of the program through their contractor. The next most common source of program awareness was a retailer. Figure 15 displays how survey respondents learned about IGC's appliance rebate.

Figure 15 Source of Awareness of IGC's Appliance Rebate



*Respondents could provide more than one source of awareness.

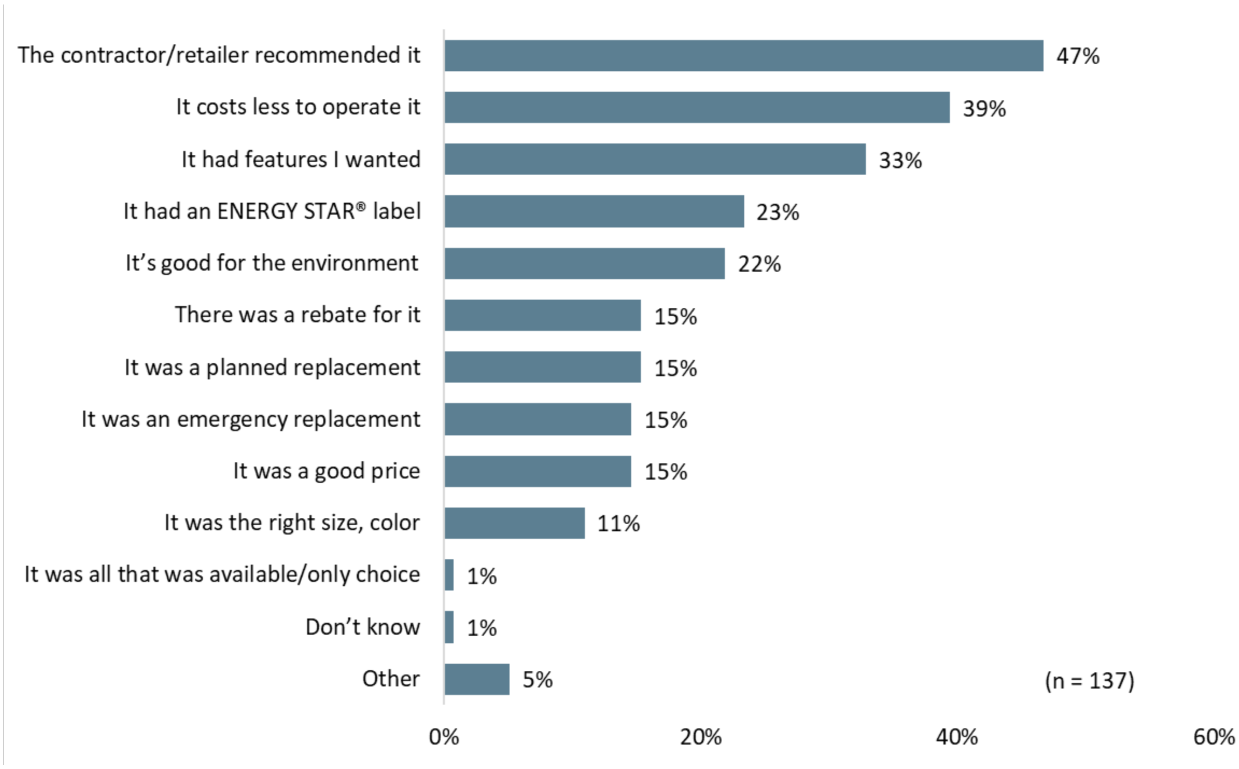
Regarding the timing of when survey respondents learned about the rebate, about one-third (32%) said they learned about the rebate after they decided to purchase their appliance. Table 16 displays when respondents learned about IGC's appliance rebate.

Table 16 When Respondents Learned About the Rebate

Response	Percent of Respondents (n = 136)
After deciding to purchase the appliance	32%
At the time you made the purchase decision	26%
Before starting the process of purchasing the appliance	23%
After researching the product but before deciding to purchase	14%
Do not know	6%

Nearly half of survey respondents (47%) noted that a contractor/retailer recommendation was a reason they purchased the model or type of appliance they chose. Figure 16 displays the reasons survey respondents chose the specific model or type of appliance. Eleven respondents (5%) provided "other" reasons (eight tankless water heater, two furnace, and one fireplace respondent). Tankless water heater respondents' "other" responses included the new water heater providing on demand water, an IGC recommendation, internet search, better maintenance, and no need for an additional gas line. The fireplace participant wrote in that the fireplace they chose fit well. The two furnace write-in responses referred to their need to replace their furnace and the model being the best, most efficient model.

Figure 16 Reason for Purchasing Appliance Model or Type[5]



*Respondents could provide more than one reason.

Rebate Process and Participants' Experience

About half of respondents (47%) said they obtained their rebate application from the contractor they worked with. Forty-three percent of respondents said they obtained their rebate application from IGC. Other ways that respondents noted obtaining an application included in a retail store (4%), from another website (1%), and from the gas line installation crew (1%). Four percent of respondents could not recall how they obtained their application.

Most respondents said their application was accepted as submitted (81%) or could not recall if IGC had followed up with them for clarifications or further information (7%). Twelve percent of respondents said their application required follow-up from IGC. These respondents either noted needing to revise the information they had provided in their application by including photos, city inspector certification, invoices, signatures, or other information that they did not provide initially or did not recall the specific

[5] n = 137.

circumstances of IGC following up. One respondent said that IGC followed up with them and informed them that their water heater was not eligible for a rebate.

Ninety percent of survey respondents said they received their rebate check in a prompt and timely manner; 7% of respondents could not recall if they received it in a timely manner and 3% said they did not receive their check in a prompt or timely manner.

All survey respondents reported that the appliance they received a rebate for was still installed and working. The Evaluators also inquired about whether their previous system was functional. Table 17 displays if the appliance replaced were functional. Regarding fireplace rebate survey respondents, four respondents noted that they previously had a wood-burning fireplace and did not have gas plumbed to it and the fifth said they previously did not have a fireplace and had relied on electric heating for their home.

Table 17 Appliance Status at Time of Replacement

Appliance Type	Functional	Non-functional	Could not recall
Tankless Water Heater (n = 40)	58%	42%	0%
Water Heater (n = 6)	67%	33%	0%
Radiant Combo (n = 5)	60%	40%	0%
Furnace (n = 75)	72%	27%	1%
Total (n = 122)	**67%**	**32%**	**1%**

Survey respondents provided feedback about whether the installation of the new equipment was part of a larger project; most of respondents said that their appliance rebate went toward a stand-alone replacement or installation project (see Table 18).

Table 18 Appliance Rebate Project Type

Appliance Type	Part of a larger replacement of my heating system	Part of a newly constructed home	Part of a remodeling project	Stand-alone replacement	Other	Do not know
Tankless Water Heater (n = 40)	18%	0%	10%	68%	3%	3%
Water Heater (n = 6)	17%	0%	0%	83%	0%	0%
Fireplace (n = 5)	0%	0%	20%	80%	0%	0%
Radiant Combo (n = 6)	33%	17%	17%	33%	0%	0%
Furnace (n = 80)	33%	1%	9%	54%	3%	1%
Total (n = 137)	**26%**	**1%**	**9%**	**59%**	**3%**	**1%**

The systems that were replaced were on average 18 years old. Table 19 displays the average age of the equipment that survey respondents replaced.

Table 19 Equipment Age at Time of Replacement

Appliance	Average Pre-retrofit Equipment Age (years)
Tankless Water Heater (n = 30)	13
Water Heater (n = 5)	14
Radiant Combo (n = 4)	17
Furnace (n = 62)	21
Average (n = 101)	18

Contractor Experience

The vast majority (93%) of respondents noted that they hired a contractor to install their rebated appliance. Seven percent of respondents said they installed it (6%) or a friend or family member installed it (1%). The remaining respondent (1%) could not recall who installed their rebated appliance.

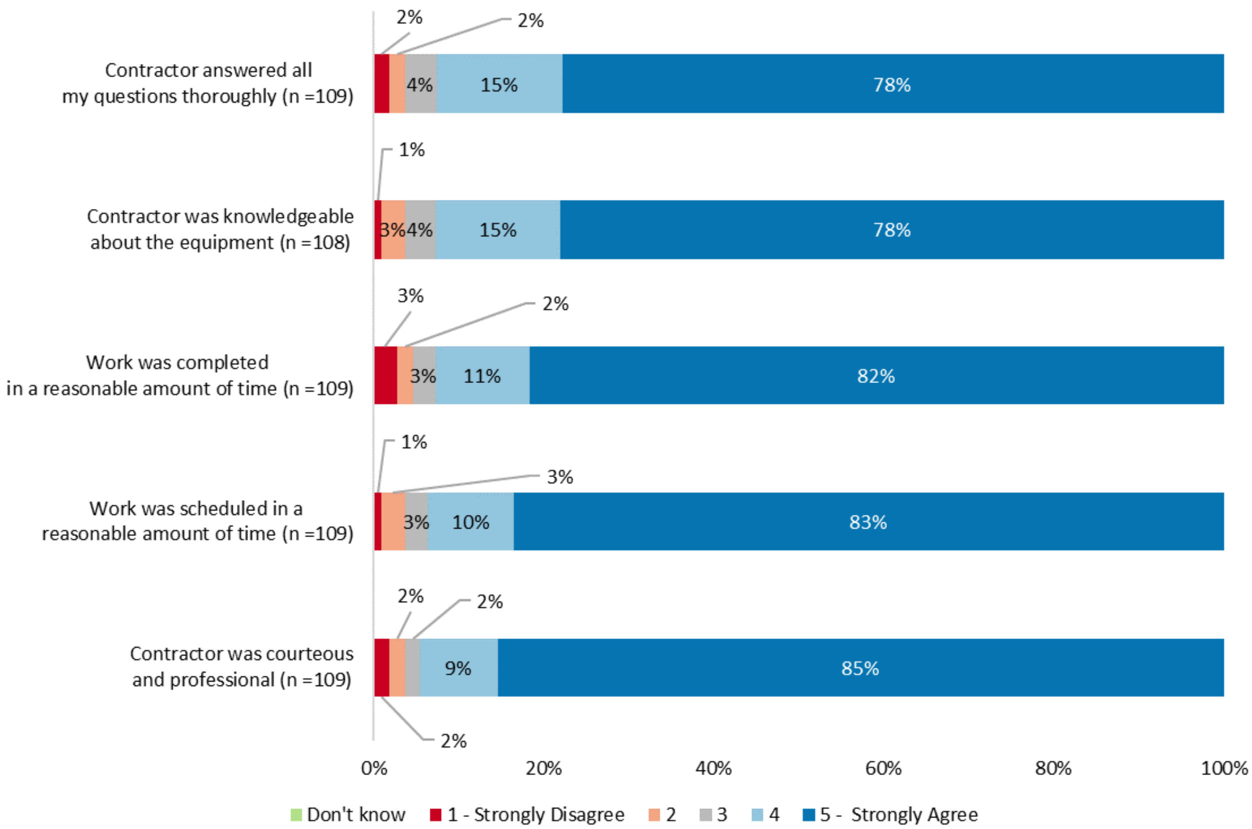
The six percent of respondents (8 respondents) who installed the appliance themselves noted that they had learned how to install the appliance through prior occupational knowledge (3 respondents) or through being self-taught (5 respondents).

Forty-six percent of respondents (n = 109) said they had hired the contractor they worked with previously. Twenty respondents who hired a contractor were not asked this question because they selected "Other (please specify)" and wrote in the name of their contractor when asked who installed their appliance. The remaining respondents said they selected their contractor through online research (23%), a retailer recommendation (16%), or a friend or family member recommendation (16%).

Most customers (71%) spoke to one or two contractors before choosing one to install their appliance. Twenty-nine percent of customers spoke to three or four contractors before choosing one to install their appliance.

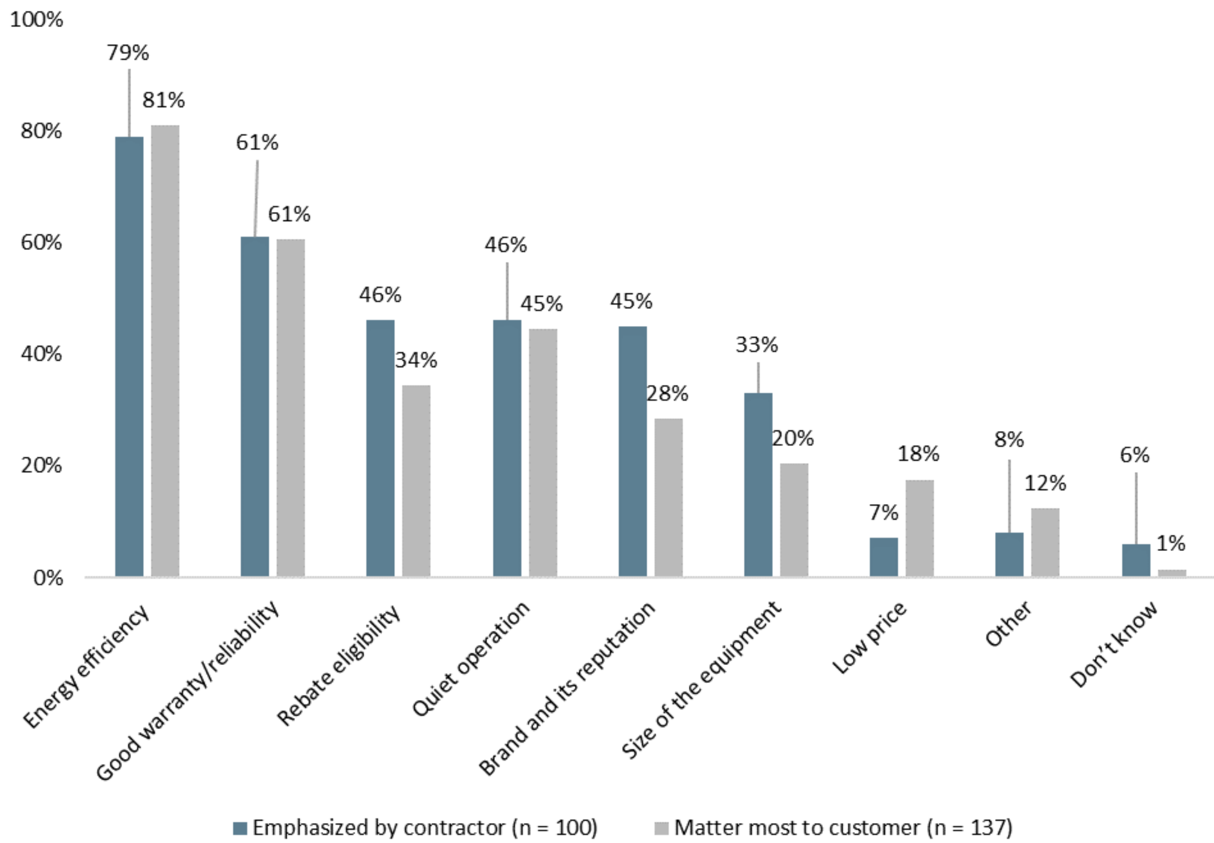
Respondents were largely satisfied with their contractor experience (see Figure 17).

Figure 17 Agreement with Statements regarding Contractor



Most survey respondents noted that their contractor emphasized energy efficiency and the new equipment's warranty and reliability. Similarly, most customers also related that the equipment's energy efficiency and good warranty/reliability mattered most to them. Figure 18 displays the features that matter most to survey respondents and the features that respondents recall their contractor emphasizing. "Other" responses included having hot water on demand, the size of the new equipment, not using a pilot light/having electric ignition, and the comfort their new equipment provides.

Figure 18 Equipment Features Contractors Emphasized and Mattered Most to Customers

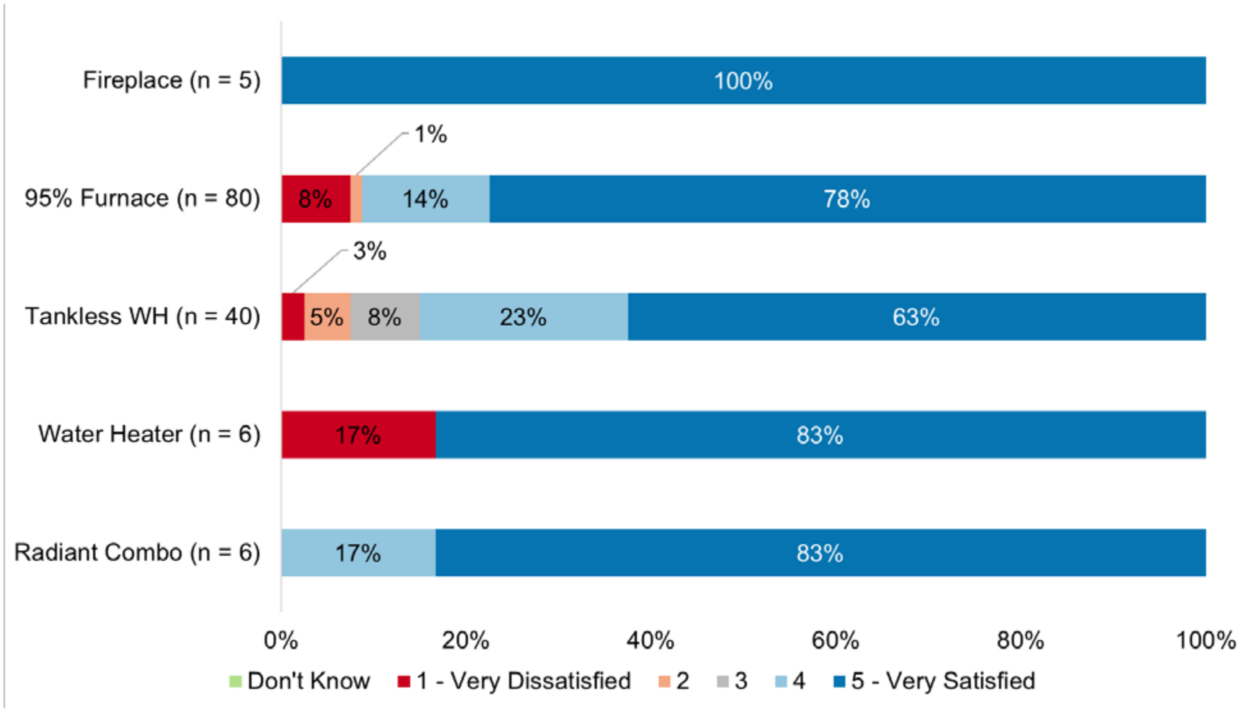


*Percentage may exceed more than 100%. Respondents could choose more than one response.

Program Satisfaction

Most appliance rebate program participants were satisfied with their rebated appliance as well as their overall participation experience. Figure 19 and Figure 20 display respondents' satisfaction with their rebated appliance and various aspects of their program participation, as well as their overall satisfaction with IGC as their gas service provider. In addition to being satisfied with their overall program experience, most respondents also said that their participation had also increased their satisfaction with IGC. Seventy-eight percent of survey respondents rated how their experience with the Appliance Rebate measure affected their satisfaction a 4 or 5 on a scale from 1 (greatly decreased satisfaction) to 5 (greatly increased satisfaction).

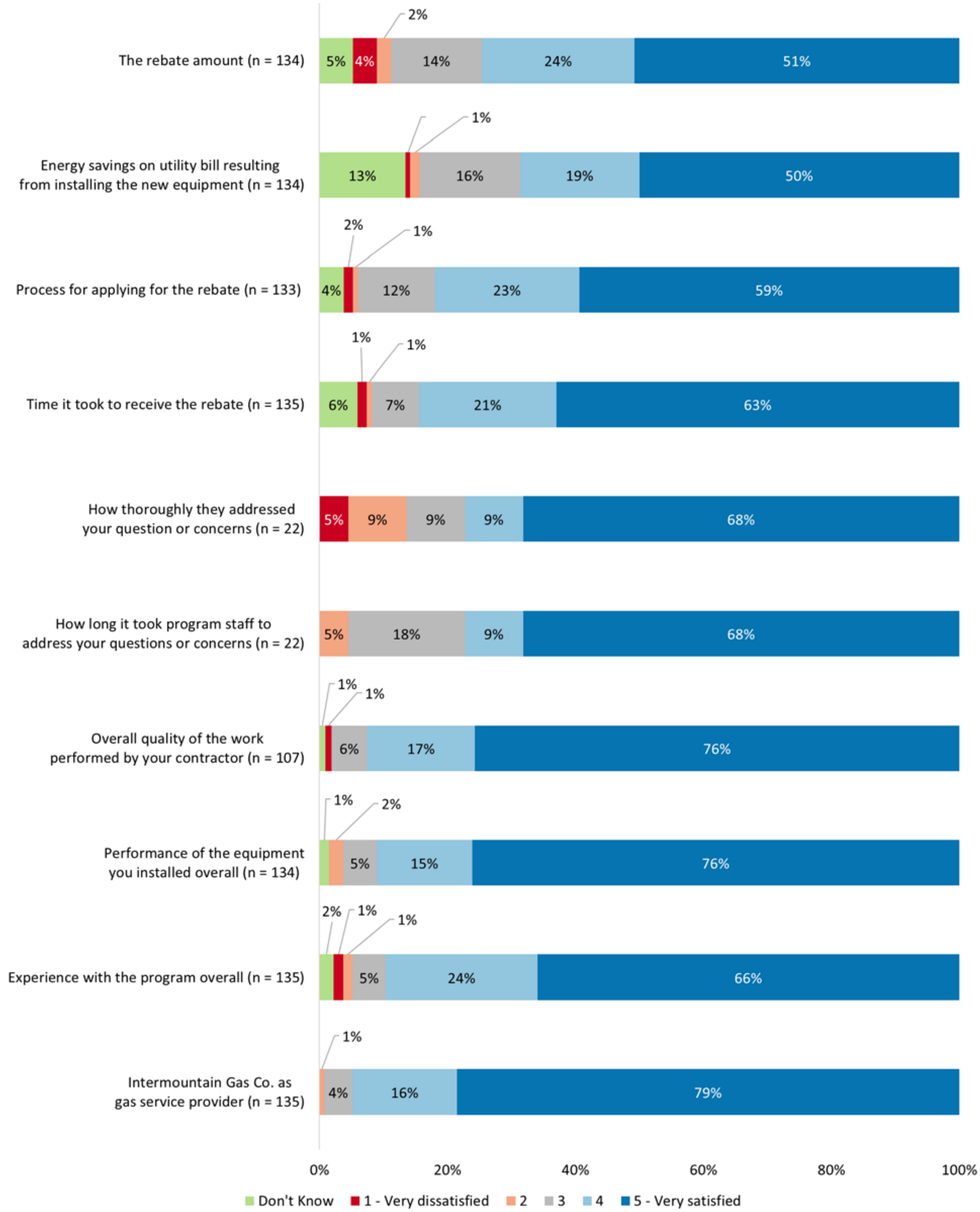
Figure 19 Satisfaction with Rebated Appliance



Seventeen percent of survey respondents noted that they had contacted IGC with questions about their rebate application. The majority of these respondents reported that their questions were answered thoroughly and in a satisfactory amount of time (see Figure 20).

Ten survey respondents (7%) provided written comments regarding a specific aspect of their dissatisfaction with the Appliance Rebate Program. Two respondents mentioned dissatisfaction with conversations with IGC staff; another respondent was unsure of the status of their rebate and was dissatisfied with program communication. Five respondents stated that the rebate was not sufficient compared to the cost of the equipment or were dissatisfied with the rebate qualifications. One respondent said they were dissatisfied with their equipment's installation and contractor's work. Another respondent was dissatisfied with their tankless water heater's performance.

Figure 20 Appliance Rebate Program Satisfaction

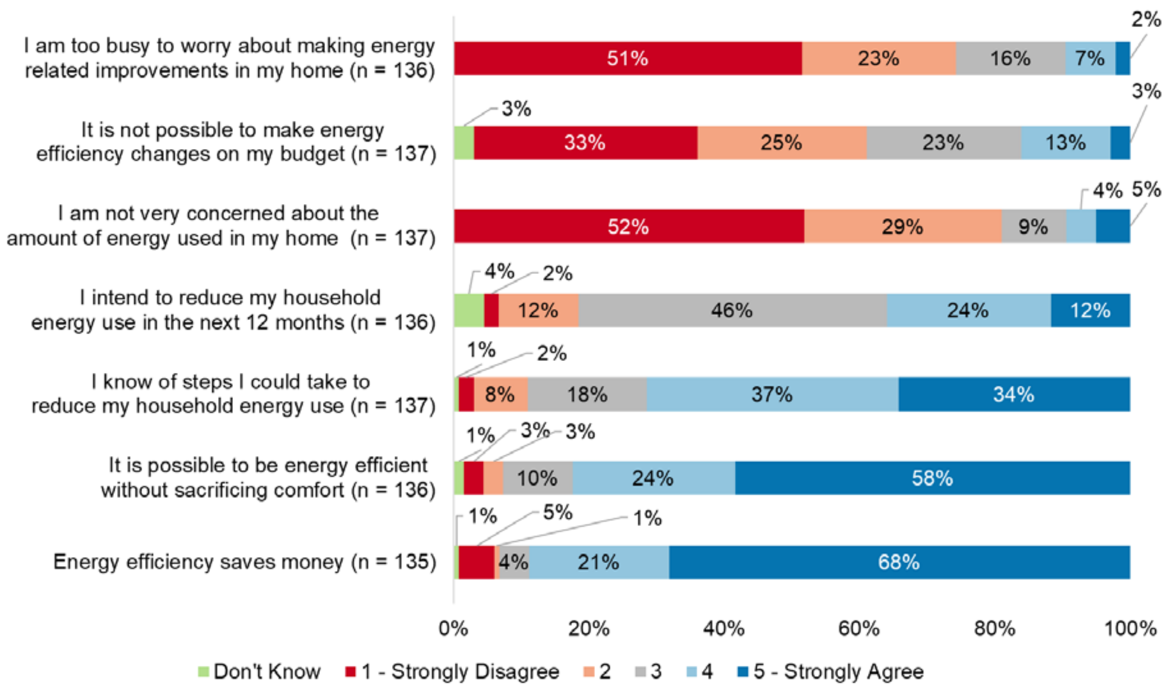


Energy Efficiency Attitudes

Two-thirds of survey respondents said that they were informed about energy efficiency practices and energy efficient products/improvement options for their household (rated themselves based on a 5-point Likert scale).

The Evaluators inquired with respondents regarding their agreement with various statements about energy efficiency (see Figure 21). Most respondents agreed with the statements that energy efficiency saves money and that it is possible to be energy efficient without sacrificing comfort. A smaller portion of respondents agreed with the statements that they knew the steps they could take to reduce energy use in their household and that they intend to reduce energy use in the next twelve months.

Figure 21 Respondent Agreement with Statements Regarding Energy Efficiency



Eighty-seven percent of survey respondents said that IGC was a trustworthy source of information about saving energy in their home (based on a 5-point scale).

Demographics and Background

The Evaluators asked questions about participants' demographics and background.

Ninety-three percent of Appliance Rebate Program survey respondents (n = 135) said their home electric service was provided by Idaho Power Company. Other respondents said their electric service was provided by Rocky Mountain Power (3%) or Idaho Falls Power (3%). One respondent (1%) did not know their electric service provider.

About half of respondents' homes were built before 1990 (see Table 20).

Table 20 Year Home was Built

Response	Percent of Respondents (n = 136)
Before 1960	17%
1960 to 1969	8%
1970 to 1979	16%
1980 to 1989	10%
1990 to 1999	22%
2000 to 2009	22%
2010 to 2019	3%
Do not know/Prefer not to say	2%

The majority of survey participants said their home's square footage was between 1,000 and 2,999 square feet (see Table 21).

Table 21 Square Footage of Homes

Response	Percent of Respondents (n = 142)
Less than 1,000 square feet	4%
1000-1999 square feet	47%
2000-2999 square feet	33%
3000-3999 square feet	10%
4000 square feet or greater	4%
Prefer not to say	1%

Most respondents said they used natural gas to heat their home (96%) and water (80%). Slightly over half of respondents said their home relied on electricity for cooking (56%). Nearly all respondents (n = 136) reported owning their home (99%). Similarly, 96% of respondents said they lived in a single-family house that was detached from any other house; 3% of respondents said they lived in a house that was attached to another home and 1% of respondents said they lived in a mobile home.

Table 22 displays Appliance Rebate survey respondents' income, education, age, and household size.

Table 22 Appliance Rebate Respondent Home Characteristics & Demographics

Question	Response	Percent
Household Income (n = 136)	Less than $10,000	1%
	$10,000 to less than $20,000	0%
	$20,000 to less than $30,000	5%
	$30,000 to less than $40,000	7%
	$40,000 to less than $50,000	10%
	$50,000 to less than $60,000	10%
	$60,000 to less than $70,000	8%
	$70,000 to less than $80,000	8%
	$80,000 to less than $90,000	3%
	$90,000 to less than $100,000	4%
	$100,000 to less than $150,000	13%
	$150,000 to less than $200,000	6%
	$200,000 or more	7%
	Do not know/Prefer not to answer	17%
Highest Level of Education Completed (n = 137)	Some high school	1%
	High school or GED equivalent	7%
	Some college	21%
	Associate degree	6%
	Bachelor's college degree	34%
	Master's degree	18%
	Professional degree (MD, JD, DDO, DDS)	4%
	Doctorate (Ph.D., D.Sc.)	3%
	Do not know/Prefer not to answer	6%
Age (n = 137)	19-24	1%
	25-34	9%
	35-49	18%
	50-64	26%
	65 or over	42%
	Do not know/Prefer not to answer	4%
Household Size (n = 137)	One	16%
	Two	50%
	Three	15%
	Four	10%
	Five	4%
	Six	2%
	Seven	1%
	Do not know/Prefer not to answer	1%

The Evaluators compared survey demographics to Idaho census data to examine the distribution among age, educational attainment, and income. "Prefer not to answer" and "Do not know" responses were excluded for analytical purposes. Figure 23 and Figure 23 provide a comparison of survey respondents age and education compared to Idaho residents. According to U.S. Census data, the Idaho median income is $53,089. Forty percent of survey respondents indicated their income was under $60,000 per year and the other 60% of respondents said their income was $60,000 or greater.

Figure 22 Age Distribution of Survey Respondents Compared to Idaho Census Data

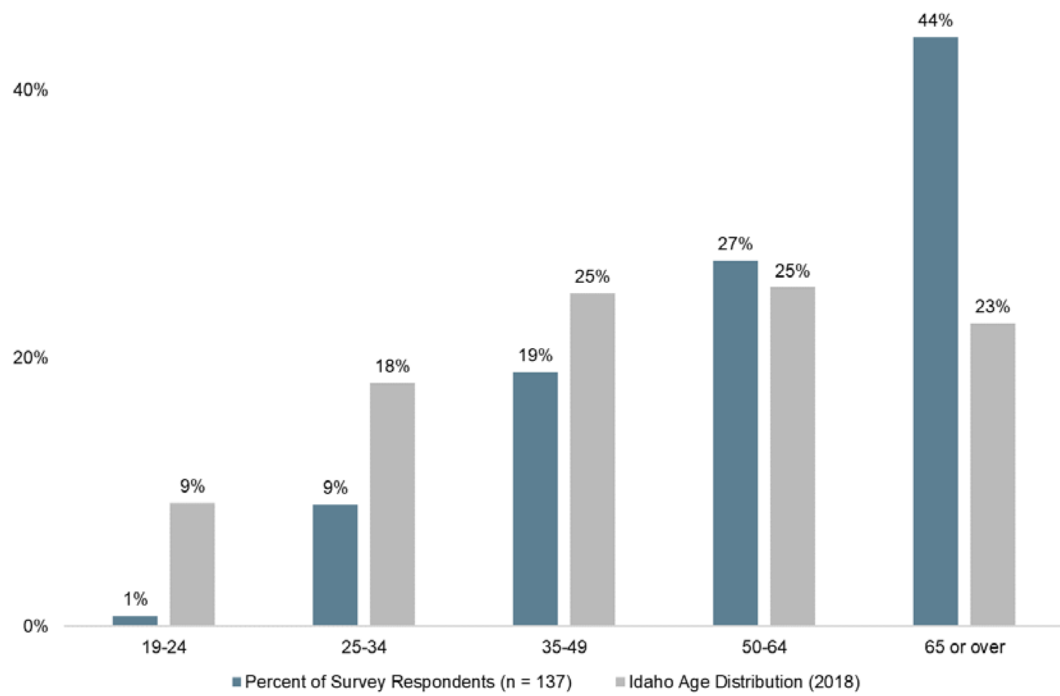
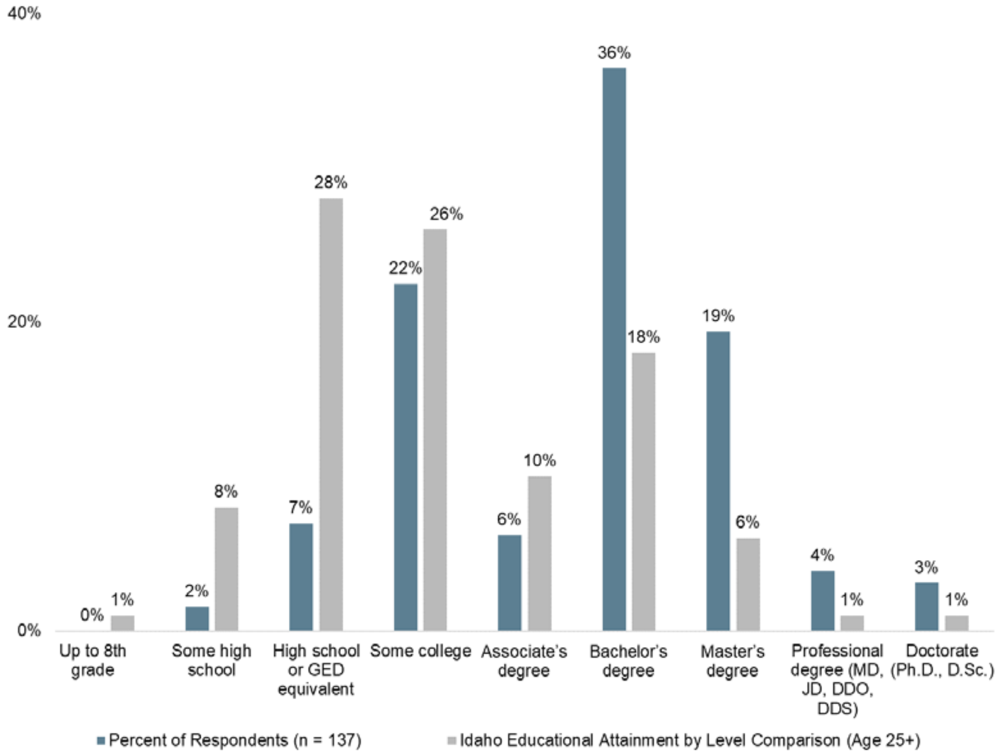


Figure 23 Educational Attainment of Survey Respondents and Idaho Residents



3.3.8 Nonparticipant Survey

The Evaluators conducted a survey with IGC customers who have not previously participated in either the Appliance Rebate or Whole Home programs. A list of nonparticipating customers was provided by IGC. The customers were sent emails soliciting their participation in an online survey. A total of 696 IGC customers were contacted by email between April and May 2020. A total of 160 customers completed the nonparticipant survey.

Most survey participants (88%) had not received any rebates in the last five years from their electricity service provider, while 5% indicated they had received a rebate from their electricity service provider and another 7% could not recall. Most nonparticipant survey respondents (91%) were not aware of rebates for energy efficient equipment and home improvements offered by gas or electric utility providers. Less than half (43%) of survey respondents reported they were knowledgeable about how to save energy in their homes. Survey respondents reported the energy-saving activities they were most likely to follow through with to reduce their utility bills by cleaning or changing furnace filters once a month during heating season, adding weather stripping or caulking around doors and windows, and conducting regular maintenance of central heating or cooling system. The following details the key findings of the nonparticipant surveys.

Energy Efficiency Actions

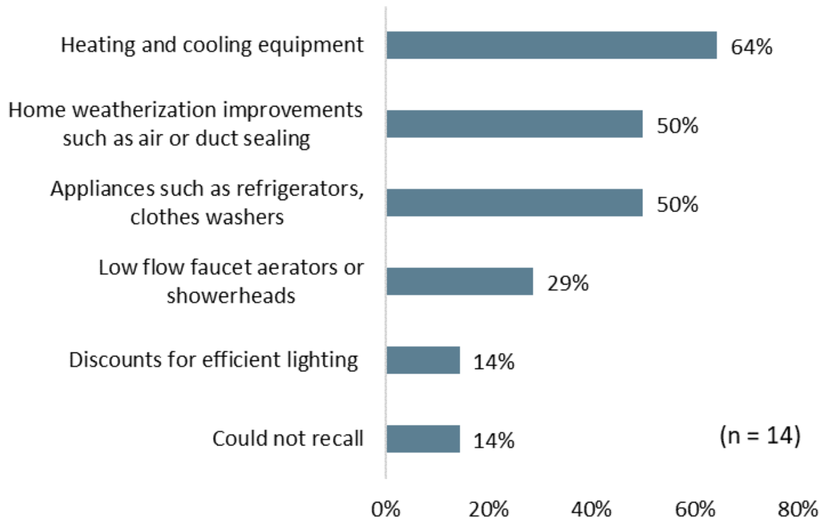
Survey respondents provided feedback about household purchases and equipment that had been installed in the past three years. The majority (72%) had not done any of the home improvements listed in the survey (see Table 23). Among those who indicated they had installed the equipment, 57% indicated they installed an ENERGY STAR® furnace, while none of the other equipment installed was certified or high efficiency.

Table 23 Home Improvements in the Past Three Years

Response	n	Percent of Respondents
95% AFUE Natural Gas Furnace	7	4%
Combination Radiant Heat System	0	0%
80% AFUE Fireplace	3	2%
70% FE Fireplace	1	1%
0.67 Water Heater	8	5%
0.91 Tankless Water Heater	1	1%
I have not done any of these	113	72%
Other	1	1%
Could not recall	29	18%

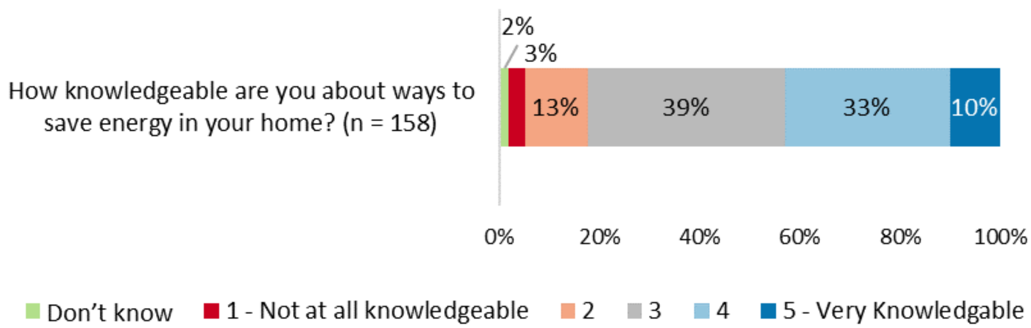
Most survey respondents (91%) were not aware of rebates for energy efficient equipment and home improvements offered by gas or electric utility providers, with 9% indicating they were aware. Among those who were aware, six respondents indicated Idaho Power as a utility who offers rebates and two recalled rebates offered by Intermountain Gas Company. The most common response for the type of rebate survey respondents recalled was heating and cooling equipment. A utility bill was the most common way respondents learned about the rebate (64%), followed by information that came in the mail (21%), email (21%), utility website (21%), utility program staff (21%), word-of-mouth (14%), community event (14%), social media (7%), and Intermountain Gas YouTube channel (7%) (n = 14).

Figure 24 Types of Rebate Survey Respondents Recalled



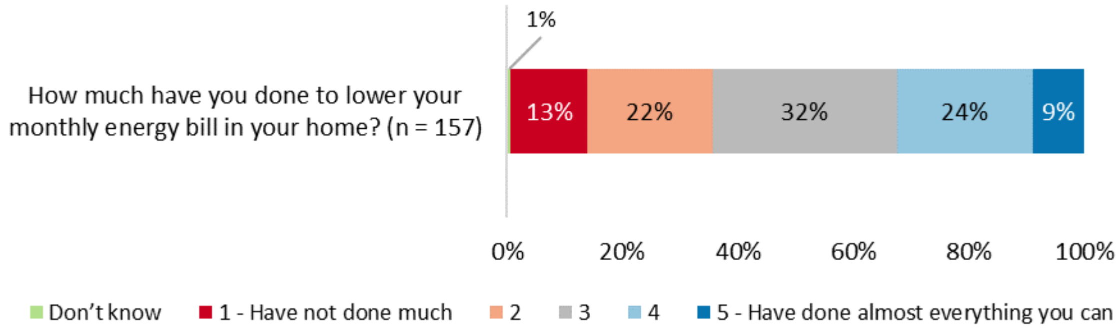
Using a 5-point scale, customers provided feedback on how knowledgeable they are on ways to save energy in their homes. Forty-three percent of survey respondents reported they were extremely or somewhat knowledgeable on ways to save energy in their homes (see Figure 25).

Figure 25 Customers' Self-Reported Knowledge of Ways to Save Energy



Using a 5-point scale, survey respondents provided feedback on how much they have done to lower their monthly energy bills. Twenty-four percent of customers indicated they have done almost everything they can, while 13% indicated they have not done much (see Figure 26).

Figure 26 Customer Engagement in Lowering Monthly Energy Bills



Survey respondents had varying degrees of interest on home improvements. Thirty-two percent of respondents were extremely or somewhat interested in improving their health, safety, and comfort by using appliances powered by natural gas. Thirty-five percent of respondents were extremely or somewhat interested in increasing their homes' energy efficiency by using appliances that are powered by natural gas.

Figure 27 Customer Interest in Home Improvements

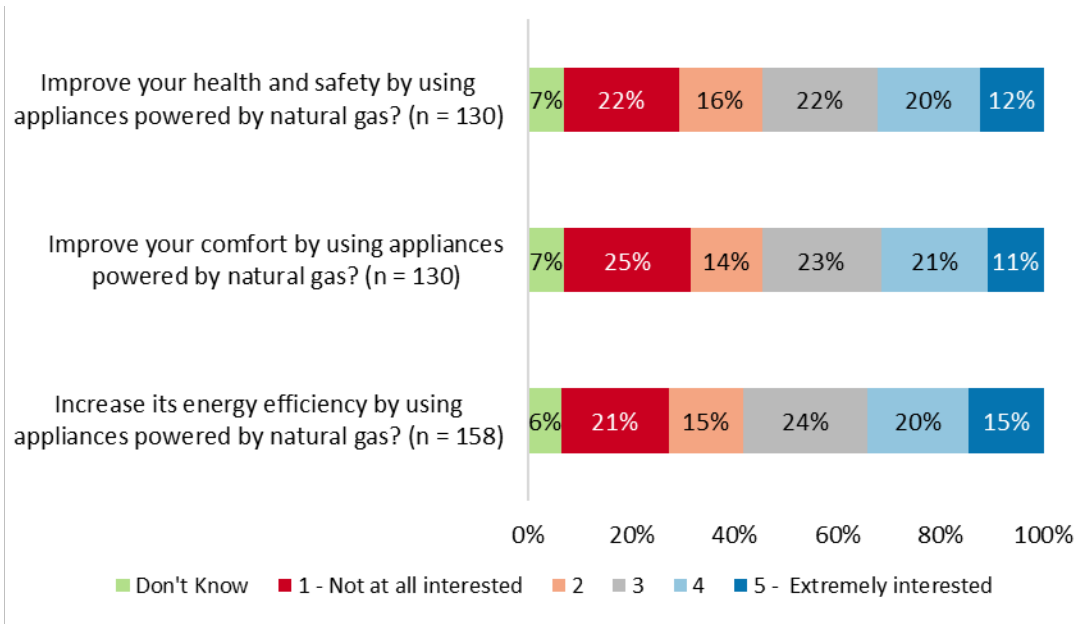


Table 24 summarizes survey respondents' feedback on how they would find out ways to reduce their monthly energy bills. The most common responses included internet search (66%), followed by friends or family (56%), and utility website (42%).

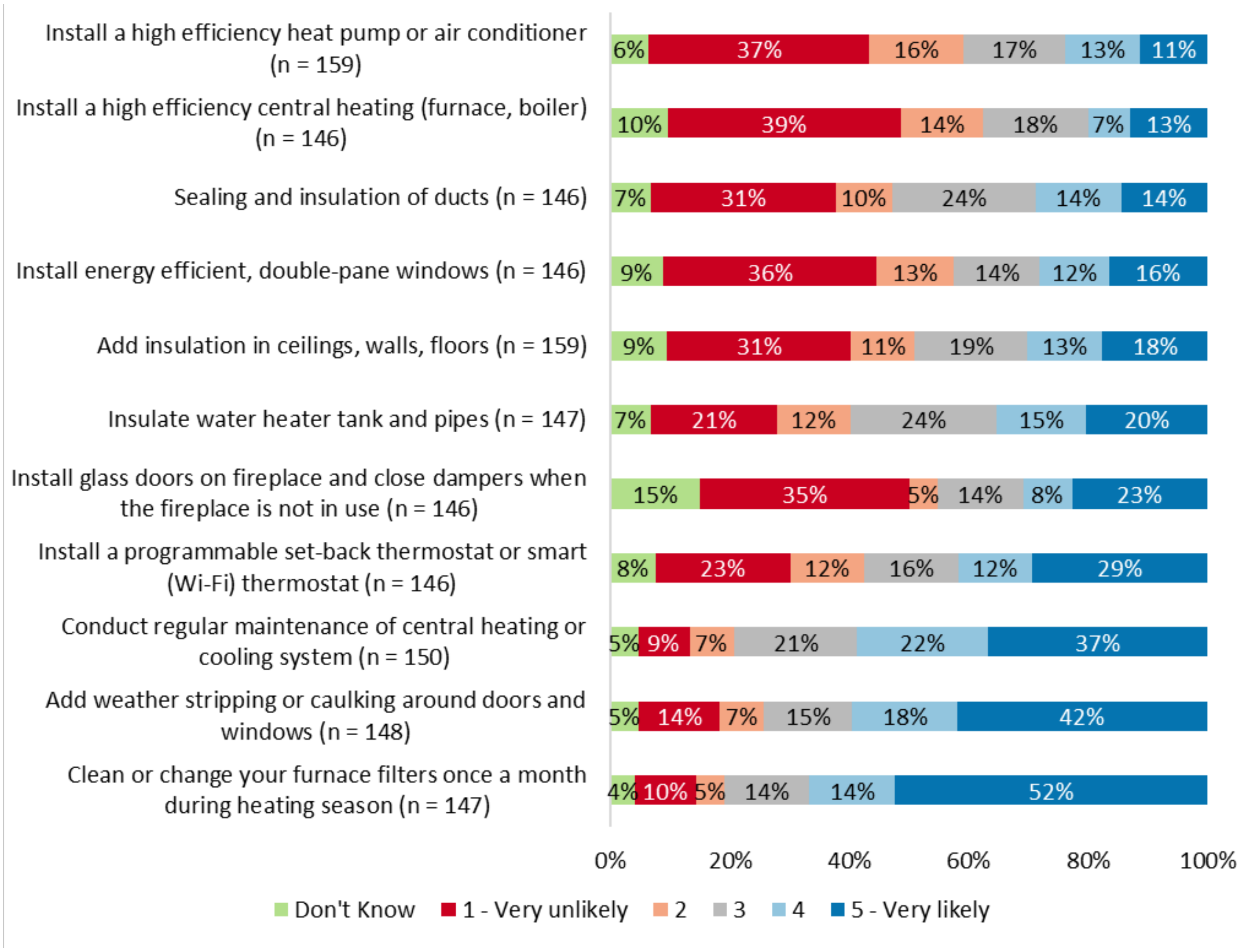
Table 24 Ways Customers Learned How to Reduce Their Monthly Energy Bills

Response	n	Percent of Respondents
Internet search	104	66%
Friends, family, or colleagues	89	56%
Utility website	66	42%
ENERGY STAR® website	47	30%
Social media	37	23%
Information from a retail store	33	21%
Magazines/newspapers/television/radio	28	18%
From the utility customer service line	24	15%
Government information	21	13%
Home energy audit	21	13%
Other	3	2%
Did not know	22	14%

Energy Efficient Improvement Plans

Survey respondents provided feedback on whether they planned to make any energy efficient improvements in the next year and the likelihood of doing various installations and low or no cost activities. Most survey respondents (50%) indicated they did not have plans to make any energy efficiency improvements in the next year, followed by 34% who stated they were unsure and 16% who reported they did have plans. Figure 28 summarize customers’ responses to the likelihood of installing high efficiency equipment or other energy-saving measures to reduce their utility bills.

Figure 28 Likelihood Customers Would Install High Efficiency Equipment or Other Measures



Survey respondents reported the energy-saving activities they were most likely to follow through with to reduce their utility bills by cleaning or changing furnace filters once a month during heating season, adding weather stripping or caulking around doors and windows, and conducting regular maintenance of central heating or cooling system. Installing a high efficiency heat pump or central heating system appeared to the equipment that would be least likely for customers to install.

Closing the drapes or cover windows to reduce heat gain or loss, adjusting thermostat settings, and installing efficient lighting were the low or no cost energy-efficient activities that survey respondents indicated they were most likely to do in their home to save energy. Using low-flow showerheads or faucet aerators and turning down water heater temperatures appeared to be the activities respondents were least likely to do.

Figure 29 Likelihood Customers Would do Low- or No-Cost Activities to Reduce Monthly Utility Bill

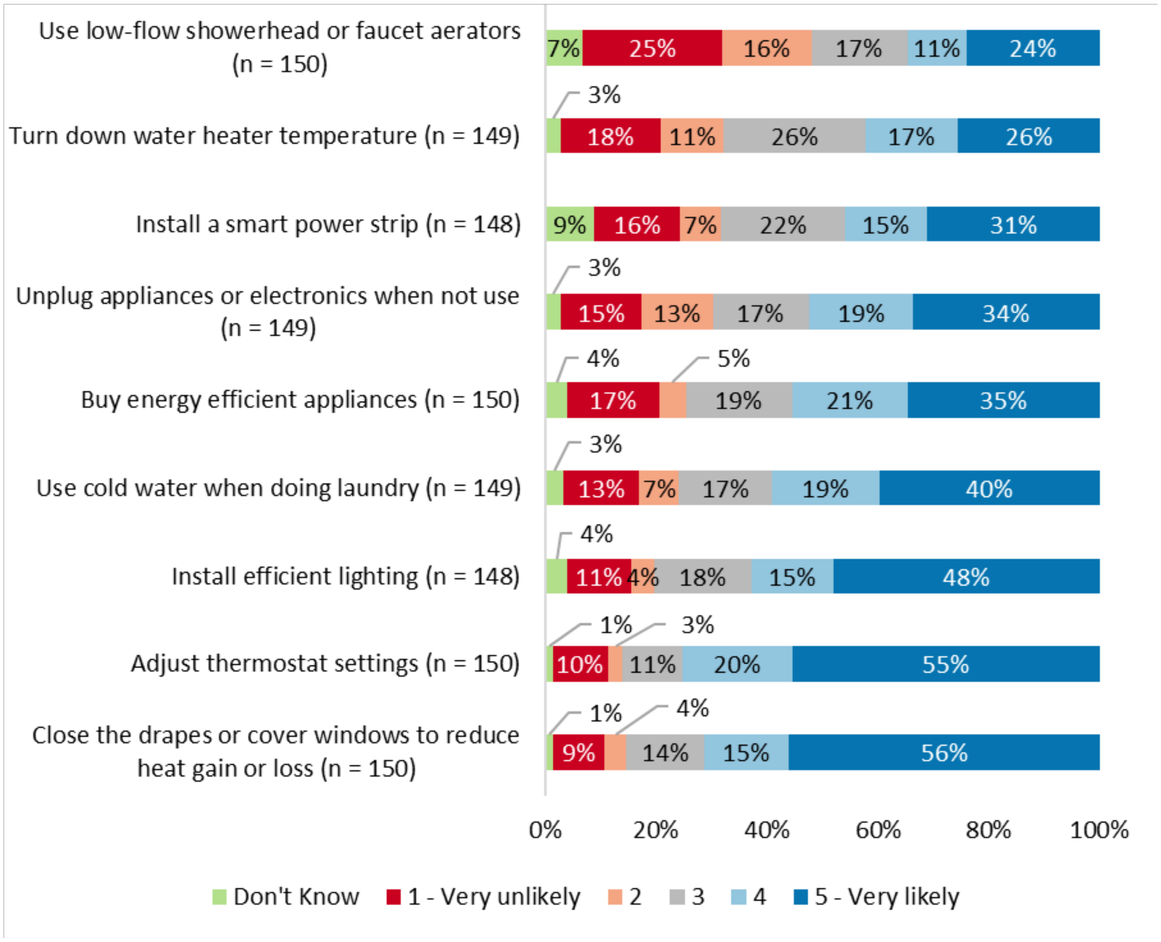
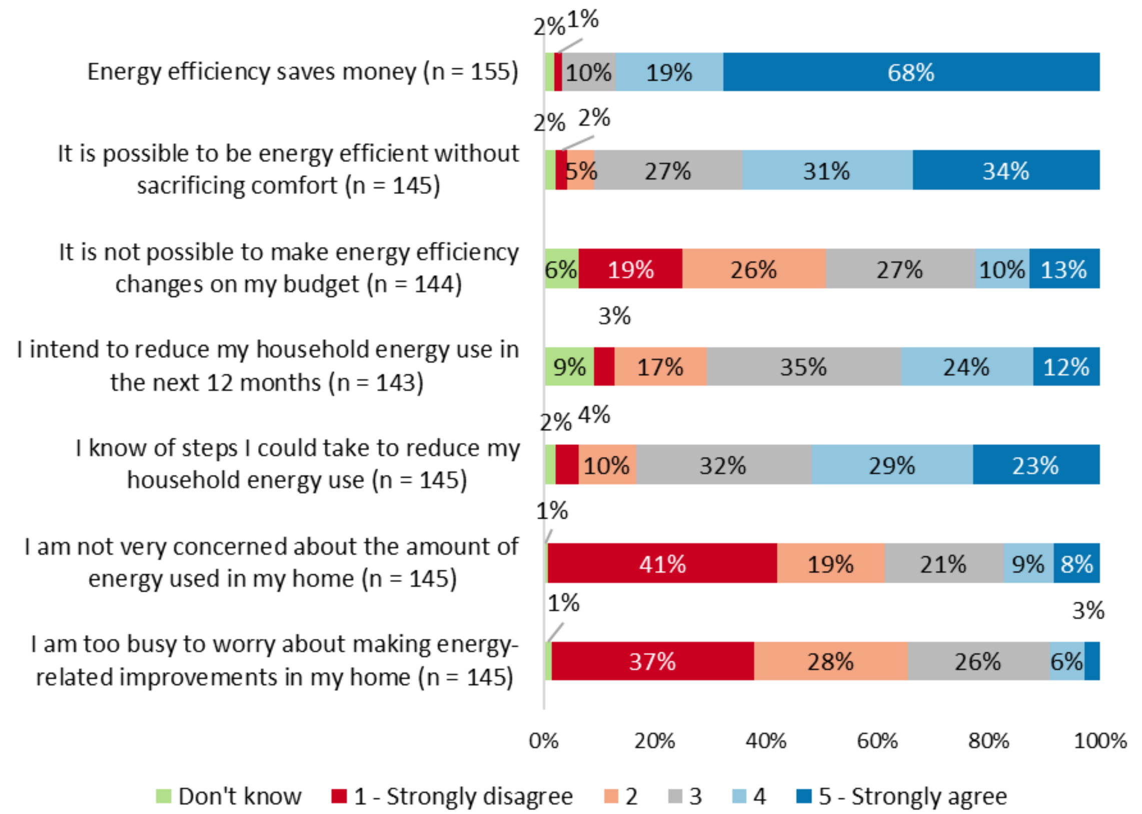


Figure 30 Respondent Agreement with Statements Regarding Energy Efficiency



Customer Perceptions of Intermountain Gas Company

The majority (70%) of survey respondents indicated they were very satisfied with Intermountain Gas Company as their natural gas service provider, followed by 20% who were somewhat satisfied. Many respondents find IGC to be very or somewhat trustworthy as a source of information about saving energy in their home (see Table 25).

Table 25 How Trustworthy is Intermountain Gas Company as a Source of Energy-Saving Information

Response	n	Percent of Respondents
Very trustworthy	94	59%
4	28	18%
3	17	11%
2	1	1%
Not at all trustworthy	0	0%
Did not know	19	12%

More than half of respondents were very or somewhat interested in receiving additional information on energy saving tips and rebate programs offered by IGC (see Table 26).

Table 26 Interest in Receiving Energy Saving Tips and Rebates Offered by Intermountain Gas Company

Response	n	Percent of Respondents
1- Very interested	48	31%
4	41	26%
3	25	16%
2	21	14%
5- Not at all interested	15	10%
Did not know	5	3%

Home Characteristics and Participant Demographics

Most survey respondents used natural gas in their homes (96%), lived in a single-family house (88%), and owned their home (81%) (see Table 27).

Table 27 Home Characteristics

Response	n	Percent of Respondents
Single-family house detached from any other house	137	88%
Single family house attached to one or more other houses (duplex, row house, condominium, or townhome)	8	5%
Apartment in a building with 4 or more units	5	3%
Manufactured of mobile home	6	4%
Own	118	81%
Rent	26	18%
Own and rent to someone else	1	1%

Twenty-three percent of survey respondents indicated their home was built between 2010 and 2019, followed by 22% who reported their home was built between 2000 and 2009 (see Table 28). Based on the responses from this survey, it appears that most customers live in newer homes.

Table 28 Year Home was Built

Response	n	Percent of Respondents
Before 1960	23	16%
1960 to 1969	11	8%
1970 to 1979	9	6%
1980 to 1989	4	3%
1990 to 1999	22	15%
2000 to 2009	32	22%
2010 to 2019	33	23%
Could not recall	10	7%

The majority of survey participants reported their home's square footage to be between 1,000 and 2,999 square feet (see Table 29). Eighty-six percent (86%) of survey respondents indicated that natural gas is their home's main fuel, followed by 12% who reported electricity and 2% who did not know.

Table 29 Square Footage of Homes

Response	n	Percent of Respondents
Less than 1,000 square feet	7	5%
1,000 – 1,999 square feet	58	41%
2,000 – 2,999 square feet	46	32%
3,000 – 3,999 square feet	17	12%
4,000 square feet or greater	5	4%
Could not recall	9	6%

Most survey respondents (87%) utilize a central forced air furnace for their main heating equipment, followed by 1% who use a heat pump and 4% who indicated something else. Those who reported other types of heating equipment included gas fired boiler for radiant floor heating, gas stoves or fireplaces, gas water heater to heat exchanger, and cadet heaters. A plurality of survey respondents (28%) indicated their heating systems were 5 to 9 years old, followed by 14% who reported their systems to be 10 to 14 years old and 13% who reported less than 2 years old. A summary is provided in Table 30.

Table 30 Age of Heating System

Response	n	Percent of Respondents
Less than 2 years old	19	13%
2 to 4 years	16	11%
5 to 9 years	41	28%
10 to 14 years	20	14%
15 to 19 years	11	8%
20 or more years old	20	14%
Could not recall	18	12%

Seventy-five percent of survey respondents indicated their water heater's main fuel source was natural gas, followed by 16% who indicated electricity and 8% who could not recall. Twenty-six percent of survey respondents indicated their water heater system was 5 to 9 years old, followed by 21% who stated 10 to 14 years old and 20% who reported 2 to 4 years old (see Table 31).

Table 31 Age of Water Heating System

Response	n	Percent of Respondents
Less than 2 years old	20	14%
2 to 4 years	29	20%
5 to 9 years	38	26%
10 to 14 years	31	21%
15 to 19 years	12	8%
20 or more years old	9	6%
Could not recall	14	10%

More than half (54%) of survey respondents indicated the main fuel source for cooking in their home was electricity, followed by 45% who reported natural gas. Fifty-two percent indicated their home has an existing fireplace with a gas line connection. Among those who indicated they have a fireplace (n = 54), 63% reported their fireplace has a pilot light (constant or intermittent).

Survey respondents mainly receive electric services from Idaho Power (87%), followed by 10% who stated Rocky Mountain Power and Fall River Rural Electric Cooperative (1%). Almost half (49%) of respondents indicated that two or less people reside in their household year-round and 47% reported making $80,000 or less per year (see Table 32).

Table 32 Survey Participants' Demographics

Question	Response	Percent of Respondents
Household Income (n = 142)	$10,000 or less	4%
	$10,000 to less than $20,000	4%
	$20,000 to less than $30,000	8%
	$30,000 to less than $40,000	6%
	$40,000 to less than $50,000	3%
	$50,000 to less than $60,000	11%
	$60,000 to less than $70,000	4%
	$70,000 to less than $80,000	6%
	$80,000 to less than $90,000	5%
	$90,000 to less than $100,000	2%
	$100,000 to less than $150,000	13%
	$150,000 to less than $200,000	7%
	$200,000 or greater	4%
	Do not know/Prefer not to state	21%
Highest Level of Education Completed (n = 139)	Up to 8th grade	1%
	Some high school	1%
	High school or GED equivalent	8%
	Some college	24%
	Associate degree	9%
	Bachelor's college degree	32%
	Master's degree	13%
	Professional degree (MD, JD, DDO, DDS)	1%
	Doctorate (Ph.D., D.Sc.)	4%
	Do not know/Prefer not to state	7%
Age (n = 145)	19-24	3%
	25-34	13%
	35-49	28%
	50-64	35%
	65 or over	19%
	Do not know/Prefer not to state	1%
Household Size (n = 147)	One	15%
	Two	34%
	Three	18%
	Four	13%
	Five	10%
	Six	6%
	Seven	1%
	Eight or more	1%
	Do not know/Prefer not to answer	1%

Evaluators compared survey demographics to Idaho census data to examine the distribution among age, educational attainment, and income. "Prefer not to answer" and "Do not know" responses were excluded. The figures below provide a comparison of survey respondents age and education compared to Idaho residents (see Figure 31 and Figure 32). According to U.S. Census data, the Idaho median income is

$53,089. Less than half (46%) of survey respondents indicated their income was under $60,000 per year and 54% reported an income greater than $60,000 (see Table 32).

Figure 31 Age Distribution of Survey Respondents Compared to Idaho Census Data

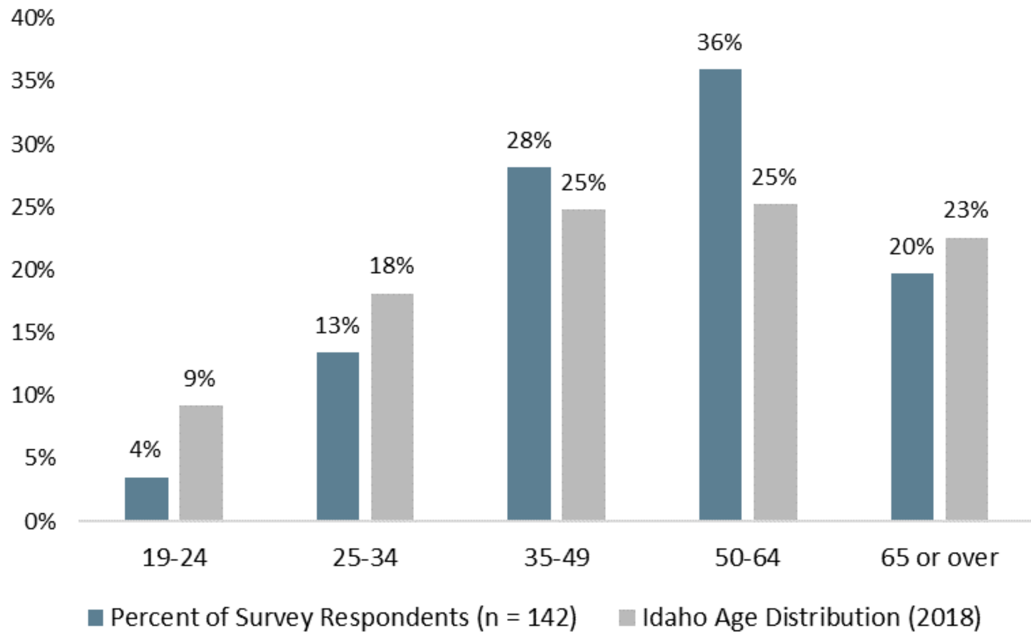
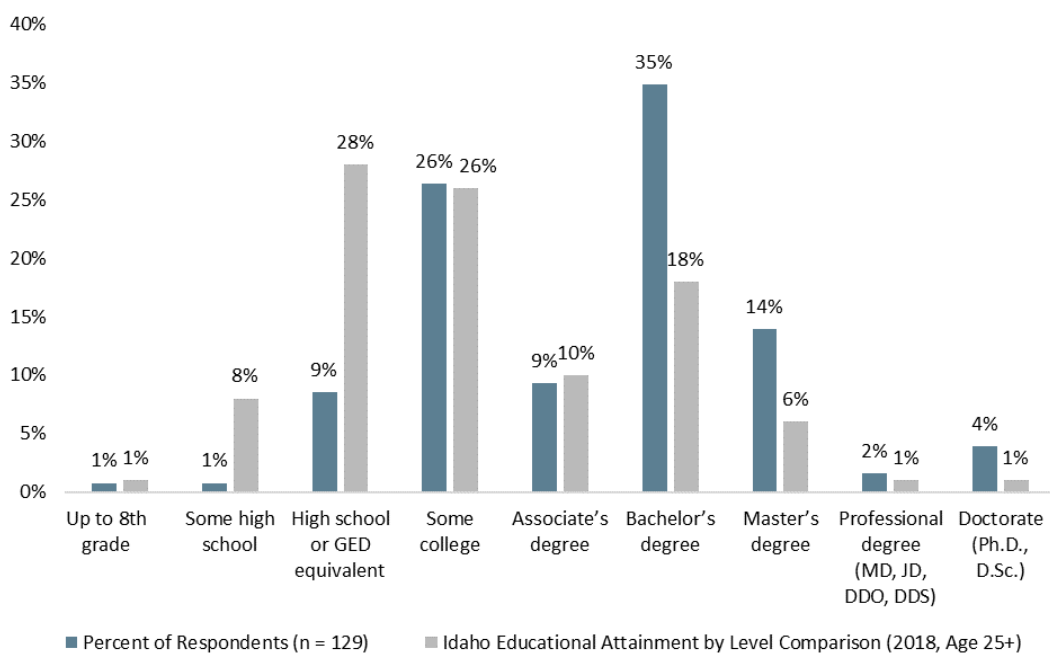


Figure 32 Educational Attainment of Survey Respondents and Idaho Residents



3.3.9 Survey Respondent Attitude and Satisfaction Comparison

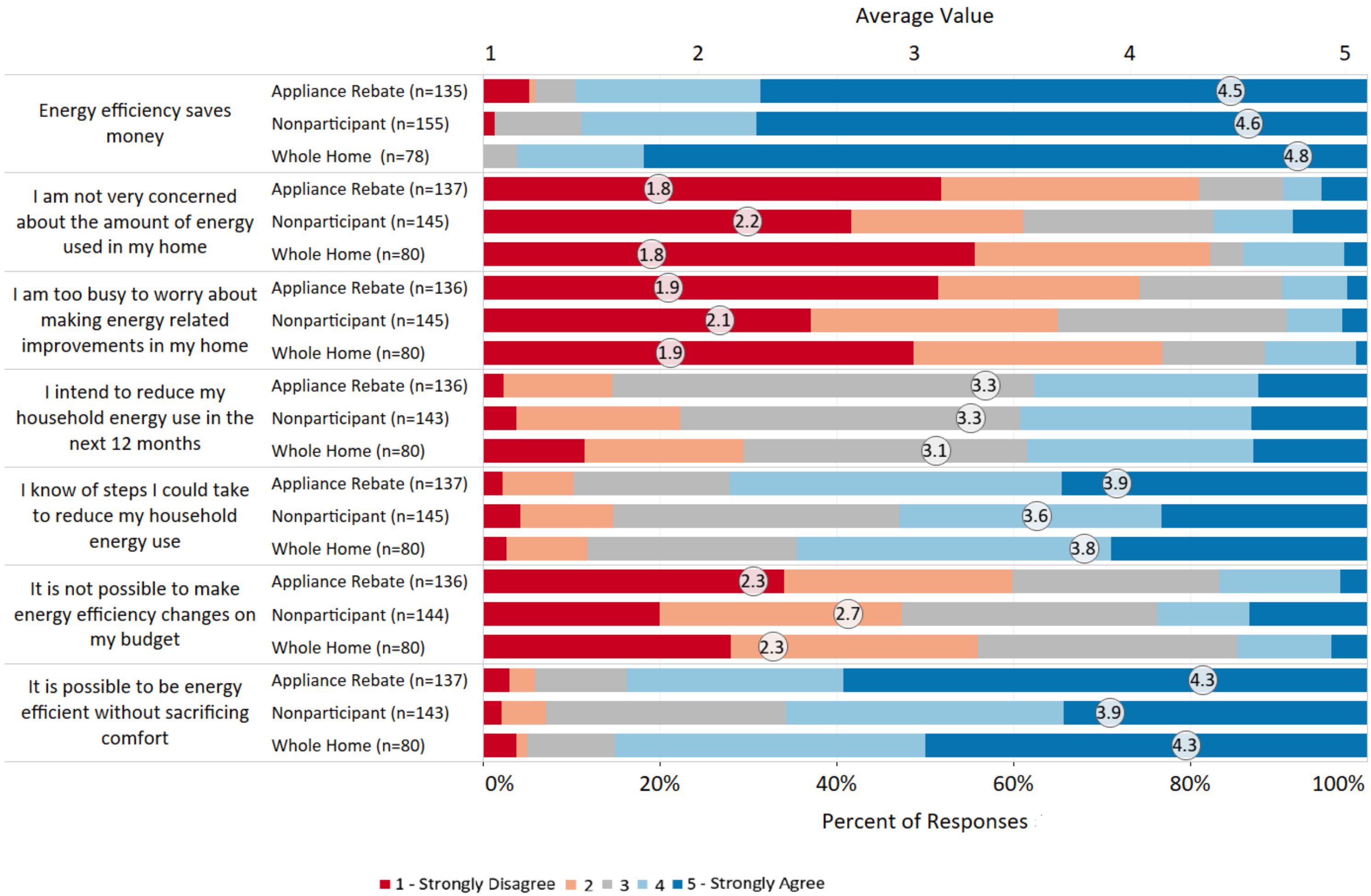
The Evaluators asked all survey respondents questions regarding their energy efficiency attitudes as well as their overall satisfaction with IGC and the level of trustworthiness they associate with IGC.

Figure 33 shows the respondents' level of agreement with various statements regarding energy efficiency, with average ratings displayed in grey circles. There were significant differences between groups for most of the questions. The two exceptions that did not display significant differences were the following phrases: "energy efficiency saves money" and "I intend to reduce my household energy use in the next 12 months".[6] The most notable differences in attitudes included:

- A higher portion of Appliance Rebate measure and Whole Home measure survey respondents disagreed with the statement that they are not very concerned about the amount of energy used in their home (81% of Appliance Rebate and Whole Home participants compared to 61% of nonparticipants; based on a 5-point scale).
- About three-quarters of the Appliance Rebate measure and Whole Home measure survey participants said they were not too busy to worry about making energy efficiency related improvements to their home, compared to 64% of nonparticipant survey respondents.
- Over 80% of the Appliance Rebate measure and Whole Home rebate measure survey respondents agreed that it was possible to be energy efficient without sacrificing comfort. This compares to 64% of nonparticipant survey respondents (based on a 5-point scale).
- About half of nonparticipant survey takers said they knew of the steps they could take to reduce their households' energy use whereas 72% of Appliance Rebate measure respondents and 61% of Whole Home rebate measure respondents said they knew what steps they could take to reduce their households' energy use.

[6] Differences noted here were significant at the 95% confidence interval with an alpha less than 0.05. The Evaluators conducted two tailed z tests for two proportions (comparing the nonparticipant group against the whole home and appliance rebate participants). The test's purpose was to see if there is a significant difference between the different surveys' responses. Alpha is the significance level, which is the probability of rejecting the null hypothesis when it is true (the null hypothesis is that there is no difference between the proportions). Here a significance level of 0.05 indicates a 5% risk of concluding that a difference exists when there is no actual difference

Figure 33 Respondent Agreement with Statements Regarding Energy Efficiency [7]



[7] Don't Know responses are not displayed in this figure. The percentage "don't know" from top to bottom of the Figure 33, were: "Energy efficiency saves money" (AR 1%, NP 2%, WH 1%), "I am not very concerned…" (AR 0%, NP 1%, WH 1%), "I am too busy…" (AR 0%, NP 1%, WH 3%), "I intend to reduce…" (AR 4%, NP 9%, WH 3%), "I know of steps…" (AR, 1%, NP 2%, WH 5%), "It is not possible" (AR 3%, NP 6%, WH 6%), "It is possible…" (AR 1%, NP 2%, WH 0%)

The Evaluators also compared survey respondents' overall level of satisfaction with IGC and how trustworthy the respondents' rated IGC as a source of information for saving energy. Ninety percent of appliance rebate measure survey respondents said they were satisfied with IGC compared to 90% of whole home measure and nonparticipant survey respondents. Eighty-seven percent of appliance rebate measure survey respondents and 84% of whole home measure survey respondents said they trusted IGC as a source of information about saving energy compared to 77% of nonparticipant survey respondents (based on a 5-point scale).

3.3.10 Tracking Database Review

The Evaluators reviewed the quality of program tracking data to assess whether the data allowed for complete evaluation. The following sections detail the results of tracking database review for both the Appliance Rebates and the Whole Home Rebates.

Appliance Rebate Tracking Database

The tracking system in the database requires some modifications to meet energy calculation standards. These bullets below show a summary of how well the program tracking systems meets the requirements to calculate energy savings via engineering equations.

- **Participating Customer and Household Information** – includes all information required including customer contact information, customer identifier (account number), location of building, heating and cooling type, date of install completion, and date of check issued.
- **Installing Contractor Information** – includes all information required including company name and contact information, installer name, and location of company. There were, however, some issues with consistency of contractor company name.
- **Measure Specific Information** – includes type and quantity of measures installed. The tracking data was found to contain some of the information required to calculate energy savings. Tracking includes appliance brand, appliance model number, and appliance serial number as well as sizing and efficiency. However, project data should be modified to also require reason for installing (replace on burnout, early retirement, new construction), and it is suggested to include collecting prior efficiency of equipment as well.

The tracking data included a separate row for each measure installed. However, not every household had a unique incentive identifier. The Evaluators recommend requiring this as an input in the tracking database in order to streamline rebate lookup activities.

The tracking data provided values of efficient equipment input sizes and efficiency. The Evaluators found some equipment input sizes collected to be equipment output sizes. The Evaluators recommend performing quality control on the collection of equipment input and equipment output sizing during data collection. The database does not require reason for equipment replacement (replace-on-burnout, early retirement, or new construction), which is required for use in engineering calculations to estimate energy savings. The Evaluators recommend updating data collection to collect reason for equipment replacement as well as efficiency of prior equipment, as it can be used in energy savings calculations as well.

The tracking database included home type (single family, apartment, town home), but inputs were not standardized and included many variations. The tracking database included square footage of home and year built, although there were instances where this information was not collected or seem to not be verified. A number of line items included home vintage that were unlikely or impossible, such as years greater than 2020. The Evaluators recommend standardizing and employing quality control on this data collection process.

The tracking database does not currently collect AHRI certification numbers for its appliance measures. The Evaluators recommend requesting this information in the appliance rebate form to assist with quality control of verified appliance efficiency.

Included in the tracking database is an IGC comments section in which the status of the rebate is noted. The Evaluators recommend standardizing the inputs in this column to assist with proper categorization and tracking of rebate status. Similar issues are found in the rebates that have been rejected. IGC thoroughly notes the reason for rebate rejection. However, an additional, standardized category or rejection reasons would aid in the analysis of barriers to rebate completion.

The following list encompasses the Evaluator’s recommendations on improving data collection in the tracking database:

- Track AHRI certification number for all rebates;
- Assign unique rebate identifier for all rebates;
- Track appliance input size, reason for replacement (replace-on-burnout, early retirement, new construction), prior equipment input size, prior equipment efficiency, prior equipment age for all equipment;
- Track storage volume and draw pattern for water heaters;
- Perform quality control on year built and square footage of home; and
- Standardize categorization of rebate status as well as rejection reasoning.

Whole Home Rebate Tracking Database

The tracking system in the database conforms well to required data collection standards. These bullets below show a summary of how well the program tracking systems meets energy efficiency calculation standards.

- **Participating Customer and Household Information** – includes all information required including customer contact information, customer identifier (account number), location of building, heating and cooling type, date of install completion, and date of check issued.
- **Builder Contractor Information** – includes all information required including company name and contact information, installer name, location of company. There were some issues with consistency of contractor company name.

- **Rater Information** – includes all information required including company name and contact information, rater name, RESNET rater ID, ENERGY STAR registry ID, and location of company.
- **Installing Contractor Information** – includes all information required including company name and contact information, installer name, and location of company. There were some issues with consistency of contractor company name.
- **Household Rating Information** – includes household verified HERS score as well as home certification date.
- **Appliance Specific Information** – includes information on furnace and water heater appliances installed in the home.

The evaluation began with a review of program tracking data. The tracking data included a separate row for each measure installed. Every household had a unique incentive identifier. The tracking database included home type (single family, apartment, town home), but inputs were not standardized and included many variations. The tracking database also included square footage of home and year built.

The tracking data provided values of efficient equipment input sizes and efficiency. Also included in the tracking database is an IGC comments section in which the status of the rebate is noted. The Evaluators recommend standardizing the inputs in this column to assist with proper categorization and tracking of rebate status. Similar issues are found in the rebates that have been rejected. IGC thoroughly notes the reason for rebate rejection. However, an additional, standardized category or rejection reasons would aid in the analysis of barriers to rebate completion.

The following list encompasses the Evaluators' recommendations on improving data collection in the tracking database:

- Standardize categorization of rebate status as well as rejection reasoning.

3.3.11 Rebate Rejection Analysis

The Evaluators examined rejected rebate applications for the Appliance Rebate and Whole Home measures. In PY2017-2018 and PY2019, there were a total of one and seven rejected applications, respectively (see Table 33).

Table 33 Rejection Rates for PY2017-2018 and PY2019

Program	PY2017-2018 Total Number of Rejections	PY2019 Total Number of Rejections	PY2017-2018 Percent of Rejections Among all Rebates	PY2017-2018 Total Number of Rebate Applications (including rejections)	PY2019 Percent of Rejections Among all Rebates	PY2019 Total Number of Rebate Applications (including rejections)
Whole Home	1	7	0.2%	620	0.6%	1086

Less than 1% of the rebate applications submitted for the Whole Home measure were rejected and the majority (75%) were rejected because the rebated had previously been paid out (see Table 34).

Table 34 Reason for Rejection

Channel	Description	Percent (n = 8)
Whole Home	Home previously rated	13%
	ENERGY STAR® registry ID missing	13%
	Rebate has already been paid out to builder	75%

Among the Application Rebate measure, the measure most often rejected was the 80% AFUE fireplace at 100% rejection rate due to lack of required information on the rebate application or the equipment did not meet minimum efficiency. Furnaces had the lowest reject rate at 7% and 6% for PY2017-2018 and PY2019, respectively (see Table 35). The reason applications were rejected most often included not meeting the minimum efficiency requirements, unsigned signature pages, lacking information on final invoice or application, missing permit numbers, and/or the eligibility for application submission had passed.

Table 35 IGC's Energy Efficiency Program Offerings

Channel	PY2017-2018 Total Number of Rejections	PY2019 Total Number of Rejections	PY2017-2018 Percent of Rejections Among all Rebates	PY2017-2018 Total Number of Rebate Applications (including rejections)	PY2019 Percent of Rejections Among all Rebates	PY2019 Total Number of Rebate Applications (including rejections)
95% AFUE Natural Gas Furnace	106	125	7%	1440	6%	2191
90% Radiant Combo	2	2	40%	5	15%	13
80% AFUE Fireplace	15	7	100%	15	100%	7
70% FE Fireplace	63	28	83%	76	67%	42
0.67 Water Heater	77	108	90%	86	93%	116
0.91 Tankless Water Heater	15	17	15%	103	10%	176
Total	**278**	**287**	**16%**	**1725**	**11%**	**2545**

4 Conclusions and Recommendations

The Evaluators provides the following conclusions and recommendations to improve the program and the evaluation of the program in future years.

4.1 Conclusions

4.1.1 Cross-Cutting Findings

- **IGC launched the Energy Efficiency program in PY2017-2018 with limited design or operational changes in PY2019.** IGC received approval to launch the Appliance Rebate and Whole Home measures starting in PY2017-2018. The initial goal for the Energy Efficiency program was to increase customer awareness and participation. When IGC staff started implementing the program, they were focused on determining their logistical partners, leveraging existing relationships, and refining the rebate process.
- **IGC's Energy Efficiency program performed well during first two program years.** According to IGC staff, both measures (Appliance Rebate and Whole Home) performed well in the first two years of implementation and were on an "upward trend." The Appliance Rebate program saw a 60% increase in the number of appliances rebated and the Whole Home program saw a 70% increase in the number of homes between PY2017-2018 and PY2019. Staff also believed there was increased customer awareness and improving relations with key program stakeholders (HERS raters and HVAC contractors). The Appliance Rebate program launched online application forms and a portal for HVAC contractors.
- **Lessons learned between PY2017-2018 and PY2019 included how to effectively engage various stakeholders**. IGC staff indicated they learned various lessons about program implementation and operation since they launched. Staff stated they learned how to effectively engage with the community and to target events where program staff can reach the appropriate audience. Program staff indicated that recruitment of builders and contractors can be most effective either by phone or in-person, when possible. They also learned that attending events where builders are in attendance can be one of the most effective ways to discuss the program with them, specifically golf tournaments held by builder associations. Another lesson learned is to ensure that participating contractors are licensed with the state to perform install. Staff have kept a list of contractors' licenses with their expiration date to compare against installation. This ensures that installations are done in accordance with state permitting requirements.
- **Program changes anticipated in PY2020 and beyond.** IGC program staff indicated they do anticipate some changes to the Energy Efficiency program for the remainder of 2020 and possibly for the upcoming program year. A cost potential assessment was conducted, and staff anticipated changes to their offerings based on the results of that study. Staff anticipated a commercial offering and wanted to add smart thermostats to their list of eligible measures. Program staff also discussed whether the HERS rating of 75 was appropriate for the Whole Home measure. Staff was concerned increasing the stringency of the HERS score as a requirement for participating homes and theorized it may be a barrier for builders who are not accustomed to building homes beyond

code. Staff believed a tiered incentive system might be a future addition to the Whole Home measure. Staff would also like to increase customer education efforts about energy efficiency.

- **Broad range of marketing efforts and community outreach were used.** IGC staff utilized a broad approach to promote the availability of the Appliance Rebates and the Whole Homes measures. Staff indicated they focused on three areas for outreach and promotion which included customers and communities, home builders, and HVAC contractors. Staff indicated that HVAC contractors are key to promoting the program to customers because they are seen as trusted experts. Marketing activities included bill inserts, digital advertising, radio campaigns, and attending community events. To promote the Whole Home program, IGC staff participated in the Parade of Homes sponsored by the Builder Contractors' Association. Promotional activities with builders included attending association meetings, expositions, and other events. IGC does not provide marketing collateral or cobranding opportunities for contractors or builders.

4.1.2 Whole Home Measure

- **Participating and nonparticipating builders both reported an increase in customer demand for energy efficient homes.** The majority (88% of participating and 83% of nonparticipating builders) believed that homebuyer demand and expectations for energy efficient homes have increased over the past few years. Both participating and nonparticipating builders indicated the strong demand for new homes in Idaho requires little to no marketing to sell.
- **Builder participation in the Whole Home measure increased due to recruitment efforts of staff.** There was an increase in the number of participating builders from 18 to 24 between PY2017-2018 and PY2019. IGC program staff stated they are typically recruited at BCA meeting as they offer an opportunity to educate builders about the program. Staff also stated that community outreach and home buyers about the benefits of ENERGY STAR® can help drive more builders to build energy efficient homes. According to IGC, the feedback from builders has been positive and that they are grateful to receive the rebates within 1 to 2 weeks. All the participating builders who were interviewed indicated they have experience with the Whole Home measure starting in either 2018 or 2019
- **Non-HVAC measures were seen as the least costly way to help participating builders build homes with a HERS score of less than 75.** According to the builders, the least costly ways to ensure a home has a HERS score lower than 75 include implementing insulation, air sealing, and having a conditioned crawl space. Other strategies that builders discussed included implementing 95% AFUE furnaces, meeting all the ENERGY STAR® requirements, and following the building codes. However, these other strategies were not listed as lower cost, and the 95% AFUE furnaces is seen as one of the more costly ways to achieve the HERS score requirement.
- **Differentiation in the market and the program financial incentive were two factors important to builders' participation.** All participating builders stated that program financial incentive and ability to differentiate themselves in the market were the factors that went into deciding to build their homes to program-building standards in 2019.

- **All Whole Home participating builders were satisfied with their HERS rater that they worked with.** In fact, from the interviews, it was found that 50% of the HERS raters are the parties involved with the rebate application process.
- **In general, HERS raters find IGC's Energy Efficiency program to be one of the most effective in the region.** All three raters have been participating in IGC's Energy Efficiency program since 2018. Raters have also heard positive feedback from builders about the Energy Efficiency program. Raters indicated that program requirements seem reasonable and attainable. According to one HERS rater, IGC's payment turn-around is efficient and dependable.
- **HERS raters indicated the rebate incentive was the best marketing tool for reaching most builders.** According to the HERS raters, the upfront additional costs for builders continues to be a barrier for participation. By marketing the incentive, builders were more likely try and become eligible for the rebate(s).
- **Raters use direct and indirect messaging to recruit builders to the program.** Word-of-mouth was their best direct messaging strategy, while having builders recommend the program to other builders as their indirect messaging. All raters expect the number of constructions of new homes for 2020 to remain about the same from 2019. Due to the economic downturn, raters may not see the increase in construction as they had anticipated for 2020. All HERS raters have worked as a rater in Idaho for more than two years.
- **Program requirements are broadly understood by participants and would benefit from further explanation**. HERS raters indicated that IGC could improve their outreach to builders, realtors, and homeowners about buying energy-efficient homes. Participating in events, using more marketing collateral, or sponsoring educational events may help increase program participation, according to HERS raters.
- **Nonparticipating builders were generally aware of energy efficiency practices but not the Whole Home measure.** Among the nonparticipating builders who were interviewed, they indicated they have a general understanding of energy efficiency practices and incorporate them in their new homes. Most nonparticipating builders were not aware of the IGC Whole Home measure but voiced interest in learning more and potentially participating. The builders noted experience with energy efficiency and HERS raters. Some voiced disinterest in participating in certification programs because of the time and resources required and the low perceived payoff.
- **The decision about buying a new home varied among participants.** Although many indicated that energy efficiency was important to them (86%), most stated the home's price to be of greater importance (94%). Other non-energy-efficient factors that greatly influenced the home sale include the fact that it was new construction and location.
- **Participants worked with different stakeholders when deciding on buying their homes.** Fifty percent of Whole Home survey respondents stated they worked with their own real estate agent, while 24% worked with the builder's in-house realtor. Some participants also mentioned they either worked in real estate or had worked with more than one of the stakeholders during this process.

- **Most survey respondents were aware that their homes were ENERGY STAR® certified but not necessarily part of the Whole Home measure.** Seventy-nine percent of Whole Home survey respondents were aware that their home was ENERGY STAR® certified, while 16% said they did not know. Of those who knew, 69% indicated they learned this information from the builder and 18% learned from a real estate agent. Participants also indicated that knowing their home had an ENERGY STAR® rating and had been inspected by a HERS rater influenced their decision on whether to buy the home. However, according to the builders interviewed, home buyers were generally unaware of the Whole Home measure. Five out of eight builders (62.5%) stated that they either were unsure about the number of customers that knew about the Whole Home measure or that none of the customers knew about the measure.
- **Survey respondents could not recall all the home's energy efficiency features.** Thirty-eight percent of respondents stated the home's energy efficient characteristics had been clearly explained by the person who helped them purchase the home, while 25% indicated it had not been clear. Participants also reported they were unaware of the differences between homes promoted by IGC (57%) versus the other homes on the market at the time of their purchase.
- **Overall, participants indicated they were satisfied with the program.** Respondents were either satisfied or very satisfied with the energy efficiency measures in their homes (92%) and the ENERGY STAR® certified home promoted by IGC (84%). Ninety percent of respondents indicated they were either satisfied or very satisfied with IGC as their gas service provider.
- **Eight of 1,698 Whole Home Rebates were rejected across both program years.** The Evaluators found that less than 1% of the Whole Home Rebate applications were rejected. The majority (75%) of rejections were because the rebate had previously been paid out for the address in the application.

4.1.3 Appliance Rebates

- **Contractors play a crucial role in the Appliance Rebate measure.** Most survey respondents learned about the program from a contractor and selected the rebated equipment because of a contractor recommendation. Nearly half received their rebate form from their contractor. Contractors not required to be officially registered with IGC. IGC does not have an approved contractor network but does require that contractors who participate in the program to be licensed with the state.
- **IGC provides training and educational opportunities for contractors.** IGC program staff generally communicates with contractors via email and phone. There was one training provided by IGC staff where there was information about the HVAC portal and online application. If contractors were not able to attend, IGC staff sent emails with videos of the training along with online resources. IGC also offered a $300 reimbursement for contractors to participate in an ENERGY STAR® certification course. IGC staff indicated they have received positive feedback from contractors (e.g., they like the "straight forwardness of the program" and the responsiveness of staff).
- **All contractors had experience with other energy efficiency programs and most indicated they were largely satisfied with the design and participation process.** Among the contractors interviewed, most reported general satisfaction with the Appliance Rebate measure**.** Contractors'

experience included working with Idaho Power, Rocky Mountain Power, Idaho Department of Environmental Quality, and Bonneville Power. Interviewed contractors had largely positive things to say about IGC's Energy Efficiency program in comparison to their experience with other programs, citing the responsiveness of program staff and the quick turnaround time for rebates.

- **Contractors are an important source of program awareness for customers.** Most contractors reported that only a small portion of their customers know about the program before they inform them. Most contractors interviewed indicated they encourage the sale of high efficiency equipment. Most of the contractors said their only method of encouraging the sale of high efficiency equipment was discussions with customers.
- **Customers experienced high satisfaction with IGC overall as well as the Appliance Rebate measure.** Most respondents were satisfied with their IGC rebated equipment's installation and performance. Satisfaction was also high in respect to other aspects of the program including interactions with IGC staff, amount of time to receive the rebate, and the overall quality of the contractor's work. Most respondents said their application was accepted as submitted and said they received their rebate check in a prompt and timely manner.
- **The energy efficiency and warranty/reliability of the equipment mattered most to customers.** Contractors emphasized these features as well. Though nearly half of contractors also emphasized the rebate amount, a smaller portion of customers noted that the rebate amount mattered most to them.
- **Of the rebate applications, 16% and 11% were rejected in PY2017-2018 and PY2019, respectively.** The Evaluators found the highest rejection rates for the 80% AFUE Fireplace, the 95% AFUE Natural Gas Furnace, and the 0.67 Water Heater measures. The reason applications were rejected most often included not meeting the minimum efficiency requirements, unsigned signature pages, lacking information on final invoice or application, missing permit numbers, and/or the eligibility for application submission had passed.

4.2 Recommendations

4.2.1 Cross-Cutting Recommendations

- **Codify quality assurance and control processes in a standard operating procedures (SOP) manual.** The Evaluators recommend that IGC program staff develop and operationalize all quality assurance and quality control (QA/QC) procedures. By doing so, this will help future staff understand the procedures for ensuring rebates are processed correctly and identifying gaps.
- **Increase communication opportunities with contractors, builders, and HERS raters.** Some interviewed stakeholders were not aware of the online application forms and other components to the Energy Efficiency program. The Evaluators recommend that IGC program staff to host listening sessions with each respective stakeholder group to gain insight into the challenges that they face with the Energy Efficiency program and market conditions.
- **Explore opportunities to incorporate new measures (i.e., smart thermostats) in IGC's Energy Efficiency program offerings.** Some tankless water heater contractors believe cost can be a barrier for customers and estimated a 0.91 UEF system was two to three times more expensive

than a standard efficiency water heater. The Evaluators recommend exploring additional opportunities for IGC to add new measures to the Appliance Rebate and Whole Home current offerings. Specifically, the Evaluators recommend examining adding 0.82 efficiency tankless water heaters and smart thermostats to the list of available measures. IGC could work with builders to add smart thermostats to new homes. Staff could also collaborate with contractors to use smart thermostats as a marketing tool (e.g., limited-time offers for free smart thermostats coupled with new furnace installation).

- **Consider establishing a builder and trade ally approved network.** By creating an IGC-approved network of builders and contractors this could help ensure the appliances are being installed at a sufficient standard of quality and that the homes built exceed program requirements. The approved network of builders and contractors could be added to the website, which would provide legitimacy and marketing for those who are participating in the network, as well as provide assistance to customers on resources for their future home upgrades.
- **Consider standardizing the tracking database categorization of rebate status and rebate rejection reasoning.** The tracking database collected and maintained information on the status of rebate approval as well as reasoning for rebate rejection. However, the inputs for these fields were often detailed and high-level insights were difficult to parse. The Evaluators recommend setting in place a standard categorization for both the rebate status as well as rebate rejection reason in order to assist in tracking and prioritization of current rebates as well as assist in analysis of barriers to rebate completion.

4.2.2 Whole Home Measure

- **Work with builders to achieve HERS requirements at a lower cost.** Builders provided recommendations on how to achieve a lower HERS scores in a cost-effective manner. The Evaluators recommend working closely with builders who are successfully achieving the HERS requirements to identify additional opportunities to reduce overall costs (e.g., implementing non-HVAC measures such as air sealing, duct sealing, and insulation).
- **Provide builders with additional marketing materials to promote the Whole Home measure.** Builders suggested providing marketing materials such as flyers or a logo to use on their website that will help promote the Whole Home measure to home buyers. Marketing materials can be utilized to promote awareness of the Whole Home measure and to educate homebuyers about energy efficiency. The Evaluators recommend exploring all opportunities to generate marketing collateral that can be used by builders and IGC program staff at community events. Program staff could also consider co-branding marketing collateral with participating contractors who would be interested in additional materials.
- **Engage builders with company-specific reports and cost-saving estimates that builders can use with homebuyers.** Builders indicated they were reluctant to provide cost-saving estimates to homebuyers, citing liability, but believed it would be useful information to help sell and promote program-qualifying homes. The Evaluators recommend working with builders to develop generic cost-saving estimates that can be used by builders when promoting the benefits of purchasing an energy efficient home. These cost-saving estimates could also provide an educational opportunity

to engage homebuyers with energy saving tips. The Evaluators also recommend creating material that will help engage participating builders, such as quarterly or biannual reports that are builder specific or quarterly newsletters with Whole Home measure statistics and upcoming events that IGC will be in attendance.

- **Continue participating in community events to recruit additional builders and generate awareness about the Whole Home measure.** Many participating builders first learned of the Energy Efficiency program through IGC-attended events where builders and HERS raters were provided with information about the Whole Home measure. The Evaluators recommend researching additional outreach opportunities to reach nonparticipating builders with promotional activities (e.g., offer a free HERS rating to builders who have not received a rebate in the past two years).
- **Develop materials that increase knowledge of the benefits of owning an energy efficient home among IGC customers.** The homeowners who do value the idea of energy efficiency are consumers who are actively researching the latest technology or are interested in the incentives. Homeowners who do not actively seek this type of information would benefit from knowing about the incentives from a knowledgeable realtor or other stakeholders. The Evaluators also recommend developing educational materials that can be used at events where homebuyers would be in attendance (e.g., home and garden shows). Consider how program participation could improve by engaging in outreach geared at increasing homeowners' knowledge of energy efficiency.
- **Provide additional education or training opportunities for HERS raters, builders, and real estate agents.** According to the raters, builders have a significant learning curve to overcome to fully understand the benefits of energy efficiency. Builders reported they were already building above-code homes there were energy efficient and were not sure the benefits of participating. The Evaluators recommend developing trainings that can be either in person or online that builders and HERS raters can attend to increase their knowledge of the Energy Efficiency program, specifically the Whole Home measure. IGC staff could also explore creating a training or presentation for realtors. By offering continuing education credits through the Idaho Board of Realtors, real estate agents could educate homeowners about the differences between an ENERGY STAR® certified home and a HERS ratings.

4.2.3 Appliance Rebates

- **Ensure that contractors are aware of the different participation options.** A portion of contractors said that participating in the program was time consuming and burdensome. By increasing awareness of the program's online form submission option IGC could improve contractor program experience and expedite customer rebate receipt. Ensuring familiarity with participation processes may ease the burden of participation and encourage more frequent participation. The Evaluators recommend conducting direct outreach to current and past program participants (e.g., invite contractors to an online webinar or schedule individual one-on-one sessions to explain the participation process). IGC program staff should investigate and remedy barriers to participation.

- **Consider enabling contractors or customers to track the status of their rebate.** Allowing the tracking of rebate status could potentially reduce the number of customer inquiries to IGC.
- **Consider creating and distributing IGC Appliance Rebate promotional materials to contractors and/or customers directly.** The contractors suggested that IGC collateral could help them to promote the program and a large portion of customers noted that they had learned about the program from contractors. The Evaluators recommend sending contractors program material directly that could assist with their outreach and promotion of the Appliance Rebate measure.
- **Develop new educational materials and continue community outreach.** IGC program staff indicated there is not a set education budget but they have created educational materials to increase awareness of the Appliance Rebate measures and general understanding of energy efficiency. The Evaluators recommend looking for partnership opportunities to create online instructional videos and other educational materials that can be viewed by customers. The Evaluators also recommend continuing community outreach efforts with a focus on increasing customer knowledge and general understanding of energy efficiency.
- **If furnaces have difficulty meeting cost-effectiveness requirements, consider the addition of an Electronically Commutated Motor (ECM) for the furnace blower as a program requirement.** ECMs result in significant kWh savings when installed alongside a new furnace, and this additional requirement could be used to enhance the cost-effectiveness of a retrofit furnace.
- **Consider collecting application data on the condition of the replaced furnace.** The Evaluators found that 72% of survey respondents indicated that their preexisting furnace was functional. This could be used to increase energy savings estimates via early retirement (in which savings are estimated based on preexisting equipment efficiency rather than current minimum code).
- **Incorporate Avoided Replacement Cost (ARC) into tankless water heater cost-effectiveness calculations.** Tankless water heaters have a 20-year measure life, while storage tank water heaters have an 11-year measure life. The net present value (NPV) of the purchase of a second water heater starting in year 12 should be deducted from incremental cost estimates used for this measure, improving measure cost-effectiveness.
- **Consider tracking additional fields in rebate application process to assist in future energy savings estimates.** The tracking database sufficiently collects customer information, household information, and contractor information. However, additional quality assurance steps while collecting some variables can be improved upon, such as year built, square footage, appliance model brand, appliance model number, appliance serial number, and equipment size and efficiency. In addition, the Evaluators recommend adding the following information as requirements for rebate application to assist in quality control and future energy savings calculations: equipment AHRI certification number, reason for replacement (replace-on-burnout, early retirement, new construction), prior equipment input size, prior equipment efficiency, and prior equipment age. The above fields are either required or optional values as inputs to engineering equations to estimate annual energy savings for these measures.

5 Appendix

5.1 Survey Instruments

5.1.1 Whole Home Measure Participant Survey

INTRODUCTION

1. According to our records, you purchased the home located at [ADDRESS]. Is this correct?
    1. Yes
    2. No [TERMINATE SURVEY]
    98. Don't know [TERMINATE SURVEY]

[DISPLAY IF Q1 = 1]

2. To buy your home, did you work directly with the builder, the builder's real estate agent, a personal real estate agent, a different real estate agent, or someone else?
    1. Home builder
    2. Builder's real estate agent
    3. Personal Real Estate Agent
    4. Different real estate agent
    96. Someone else (Please specify)
    98. Don't know

PROGRAM AWARENESS AND DECISION MAKING

3. Did you know the home you purchased was an ENERGY STAR® certified home promoted by IGC's energy efficiency program?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q4 IF Q3=1]

4. How did you first learn that your home is ENERGY STAR® certified? [**RANDOMIZE 1-11**]
    1. Home builder
    2. Real estate agent
    3. From IGC's website
    4. Friend, family member, or colleague
    5. Communication with IGC staff
    6. IGC newsletter
    7. Social media post (e.g., Facebook, Twitter, Flickr)
    8. Through an internet search (e.g., Google search)
    9. Through an internet advertisement
    10. A radio or television advertisement
    11. A print advertisement

12. Previous experience with IGC programs
13. Bill inserts
14. Intermountain Gas YouTube Channel
15. Community event
16. Media coverage (segment on TV, radio, vlog, blog, article, etc.)
96. Other (Please specify)
98. Don't know

[DISPLAY Q5 IF Q0 = 12]

5. What previous experience do you have with IGC programs?
   [OPEN-ENDED]

6. IGC would like to understand what buyers knew about the ENERGY STAR® certified new homes. For each of the following items, please select the response that best describes when you learned about it. [**INSERT MATRIX WITH FIVE RESPONSE OPTIONS FOR EACH ITEM: 1 = KNEW IT BEFORE I CONTACTED THE BUILDER OR REAL ESTATE AGENT ABOUT BUYING THE HOME; 2 = I LEARNED ABOUT IT FROM THE BUILDER OR REAL ESTATE AGENT BEFORE I BOUGHT THE HOME; 3 = I LEARNED ABOUT IT AFTER BUYING THE HOME; 4 = I DID NOT KNOW ABOUT IT BEFORE BEING INVITED TO TAKE THIS SURVEY, WITH 98 = I DON'T KNOW WHEN I LEARNED ABOUT IT**]
   1. The house was promoted by IGC's energy efficiency program
   2. The house has an ENERGY STAR® rating
   3. The house was inspected by an independent certified Home Energy Rating System (HERS)
   4. The house has a HERS score of [HERS_SCORE]

[DISPLAY IF Q6(4) = 1 or 2]

7. Did knowing that your home had a HERS score of [HERS_SCORE] influence your decision to purchase?
   1. Yes
   2. No
   98. Don't know

8. Please tell me briefly your decision-making process for purchasing your home located at [ADDRESS].

   1. [OPEN-ENDED]

9. Using the scale below, please rate the importance of the following factors in your decision to buy this home. [**RANDOMIZE 1 - 11] [INSERT 1-5 SCALE, 1 = NOT AT ALL IMPORTANT AND 5 = EXTREMELY IMPORTANT, WITH 98 = DON'T KNOW**]
   1. Energy efficiency
   2. House price
   3. [**DISPLAY IF Q6(1) = 1 OR 2**] It was promoted through IGC's energy efficiency program

4. [**DISPLAY IF Q6(2) = 1 OR 2**] It has an ENERGY STAR® rating
5. [**DISPLAY IF Q6(3) = 1 OR 2**] It was inspected by an independent certified HERS rater
6. [**DISPLAY IF Q6(3) = 1 OR 2**] The home's HERS score

10. Are there any other important features or reasons you chose your new home? If yes, could you please share them here and rate their importance on the same scale.
    1. [OPEN-ENDED]

11. Are you aware of any differences between homes promoted by IGC's energy efficiency program and other homes?
    7. Yes
    8. No
    98. Don't know

[DISPLAY Q12 IF Q11 = 1]

12. What were the differences that were explained to you?
    2. [OPEN-ENDED]

13. Using the scale below, how clearly were the energy efficient characteristics of the home explained to you by the person you worked with when purchasing your home? [**INSERT 1-5 SCALE 1 = NOT AT ALL CLEAR, 5 = VERY CLEAR, 98 = DON'T KNOW**]

MEASURE PERSISTENCE

Now we would like to ask about any changes you may have made to your home since you bought it.

14. Have you made any changes to the heating system equipment that was originally installed in your new home?
    1. Yes
    2. No
    98. Don't know

[DISPLAY IF Q0 = 1]

15. What changes did you make to your heating system?
    1. [OPEN-ENDED]

16. Have you made any changes to the cooling system that was originally installed in your new home?
    1. Yes
    2. No
    98. Don't know

[DISPLAY IF Q16 = 1]

17. What changes did you make to your cooling system?
    1. [OPEN-ENDED]

18. Have you changed out any large appliances such as furnaces, water heaters, refrigerators, clothes washers, and dishwashers that came with the home?
    1. Yes
    2. No
    98. Don't know

[DISPLAY IF Q18 = 1]

19. What appliances did you change out?
    1. [OPEN-ENDED]

ENERGY EFFICIENCY KNOWLEDGE, ATTITUDES, AND INTENTIONS

20. Using the scale below, how informed would you say you are about energy efficiency practices and energy efficient products or improvement options for your household?

[**INSERT 1-5 SCALE 1 = NOT WELL INFORMED, 5 = VERY WELL INFORMED, WITH 98 = DON'T KNOW**]

21. Using the scale below, how trustworthy is Intermountain Gas Company as a source of information about saving energy in your home?

[**INSERT 1-5 SCALE 1 = NOT VERY TRUSTWORTHY, 5 = VERY TRUSTWORTHY, WITH 98 = DON'T KNOW**]

22. Using the scale below, please rate your level of agreement or disagreement with these statements.

[**INSERT 1-5 SCALE 1 = STRONGLY DISAGREE, 5 = STRONGLY AGREE, WITH 98 = DON'T KNOW**] [**RANDOMIZE 1-7**]
    1. Energy efficiency saves money.
    2. I am not very concerned about the amount of energy used in my home
    3. I am too busy to worry about making energy-related improvements in my home
    4. It is possible to save energy without sacrificing comfort by being energy efficient.
    5. I know of steps I could take to reduce my household energy use.
    6. I intend to reduce my household energy use in the next 12 months.
    7. It is not possible to make energy efficiency changes on my budget.

Using the scale below, how satisfied or dissatisfied are you with the following? [**INSERT 1-5 SCALE 1 = VERY DISSATISFIED, 5 = VERY SATISFIED, WITH 98 = DON'T KNOW**]
    1. IGC's marketing efforts to promote its discounts on energy efficient products.
    2. IGC overall as your gas service provider.
    3. The ENERGY STAR® certified home promoted by IGC's energy efficiency program that you purchased in [YEAR].

4. Energy efficient measures of the home purchased.

[DISPLAY Q23 IF Q0(3) <3]

23. Why are you not satisfied?
    1. [OPEN-ENDED]

24. Are there any additional comments you would like to share with us about your experience in the program?
    1. [OPEN-ENDED]

DEMOGRAPHICS

This last set of questions will help Intermountain Gas Company develop more effective programs that may best serve the needs of the community. Your answers will remain anonymous, and you also have the option of not answering these questions.

25. Who provides your home with electric service?
    1. Idaho Power Company
    2. Rocky Mountain Power
    3. Fall River Rural Electric Cooperative
    4. Idaho County Light and Power
    5. Other (Please specify)
    6. Don't know
    7. Prefer not to state

26. Do you own or rent the home in which you live?
    1. Own
    2. Rent
    98. Don't know
    99. Prefer not to state

27. Including yourself, how many people currently live in your home?
    1. 1
    2. 2
    3. 3
    4. 4
    5. 5
    6. 6
    7. 7
    8. 8
    9. 9 or more
    98. Do not know
    99. Prefer not to answer

28. Which of the following brackets contains your age?

1. 19-24
2. 25-34
3. 35-49
4. 50-64
5. 65 or over
98. Don't know
99. Prefer not to state

29. What is your approximate total household income?
    1. Less than $10,000
    2. $10,000 to less than $20,000
    3. $20,000 to less than $30,000
    4. $30,000 to less than $40,000
    5. $40,000 to less than $50,000
    6. $50,000 to less than $60,000
    7. $60,000 to less than $70,000
    8. $70,000 to less than $80,000
    9. $80,000 to less than $90,000
    10. $90,000 to less than $100,000
    11. $100,000 to less than $150,000
    12. $150,000 to less than $200,000
    13. $200,000 or more
    98. Don't know
    99. Prefer not to state

30. What's the highest level of education you've completed?
    1. Up to 8th grate
    2. Some high school
    3. High school or GED equivalent
    4. Some college
    5. Associate's degree
    6. Bachelor's college degree
    7. Master's degree
    8. Professional degree (MD, JD, DDO, DDS)
    9. Doctorate (Ph.D., D.Sc.)
    98. Don't know
    99. Prefer not to state

5.1.2 Appliance Rebate Measure Participant Survey

INTRODUCTION

1. According to our records you received a rebate through IGC's [PROGRAM] program for installing [MEASURE] at [LOCATION] in [YEAR]. Is that correct?
    1. Yes
    2. No [TERMINATE SURVEY]
    98. Don't know [TERMINATE SURVEY]

To begin, we have a few questions about how you learned about the rebate for the [MEASURE].

2. How did you *first* learn about IGC's rebates for the [MEASURE]? **[RANDOMIZE 1-15]**
    1. Friend, family member, or colleague
    2. Contractor
    3. Retailer
    4. Bill insert or utility mailer
    5. Email from IGC
    6. IGC Newsletter
    7. From IGC's website
    8. Social media post (e.g., Facebook, Twitter)
    9. Intermountain Gas Company YouTube channel
    10. Through an internet search (e.g., Google search)
    11. Through an internet advertisement
    12. A radio or television advertisement
    13. A print advertisement
    14. Media coverage (segment on TV, radio, podcast, vlog, article, etc.)
    15. Community event
    98. Other (please specify)
    99. Don't know

PROGRAM AWARENESS

3. When did you first learn about IGC's Energy Efficiency Rebate Program? Was it…
    1. Before starting the process of purchasing the [MEASURE].
    2. At the time you made the purchase decision.
    3. After researching the product but before deciding to purchase.
    4. After deciding to purchase [MEASURE].
    98. Don't know

4. Why did you purchase the model or type of [MEASURE_SHORT]? [MULTISELECT] [RANDOMIZE]
    1. It was all that was available/only choice.
    2. The contractor/retailer recommended it.
    3. It was an emergency replacement.

4. It had an ENERGY STAR® label.
5. It was a planned replacement.
6. It's good for the environment.
7. It was the right size, color.
8. There was a rebate for it.
9. It costs less to operate it.
10. It had features I wanted.
11. It was a good price.
12. Other (Please specify)
98. Don't know

5. Where did you obtain the rebate application?
    1. From the IGC website
    2. From another website
    3. In a retail store
    4. From a contractor
    5. Other (Please specify)
    98. Don't know

6. Was your application accepted as-submitted, or did IGC follow up with you for clarifications or further information?
    1. Accepted as-submitted
    2. Required follow-up
    98. Don't know

[DISPLAY Q7 IF Q6 = 2]

7. What type of follow-up did your application require?
    1. [OPEN-ENDED]

8. Did you receive your rebate check in a prompt and timely manner?
    1. Yes
    2. No
    98. Don't know

9. Do you have any comments as to how the application process could be made easier for customers like you?
    1. [OPEN-ENDED]

MEASURES

[ASK Q10 THROUGH Q19 IF MEASURE_SHORT = 95% Furnace]

10. Was this new installation part of a larger project?
    1. Yes, it was part of a larger replacement of my heating system
    2. Yes, it was part of a newly constructed home.

3. Yes, it was part of a remodeling project.
4. No, it was a stand-alone replacement.
5. Other (Please specify)
98. Don't know

11. What type of fuel source does your home's water heater use?
    1. Natural Gas
    2. Electricity
    3. Propane
    4. Other (Please specify)
    98. Don't Know

12. What kind of water heater does your home have?
    1. Tank water heater
    2. Tankless water heater
    3. Heat pump water heater
    4. Solar powered water heater
    98. Don't know

13. How old is your home's water heater?
    1. Less than 2 years old
    2. 2 to 4 years
    3. 5 to 9 years
    4. 10 to 14 years
    5. 15 to 19 years
    6. 20 or more years old
    98. Don't know

14. What type of thermostat does your home have?
    1. Manual thermostat
    2. Programmable thermostat
    3. Smart thermostat
    4. None
    98. Don't know

15. Is the new [MEASURE_SHORT] that you received a rebate for currently installed and working?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q16 IF Q15 = 2]

16. Why is it not installed or working?
    1. [OPEN-ENDED]

[DISPLAY Q17 IF Q10 = 1, 3, OR 4]

17. Was the equipment that you replaced still functioning at the time you replaced it?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q17 IF Q10 = 1, 3, OR 4]

18. How old was the equipment that you replaced at the time you replaced it?
    1. ___ # Years
    98. Don't know

19. Using the scale below, how satisfied are you with the performance of your new [MEASURE_SHORT]? [**INSERT 1-5 SCALE. 1 = VERY DISSATISFIED AND 5 = VERY SATISFIED, WITH 98 = DON'T KNOW]**
    1. Very Dissatisfied
    2.
    3.
    4.
    5. Very Satisfied
    98. Don't know

[ASK Q20 THROUGH Q25 IF MEASURE_SHORT = RADIANT COMBO

20. Was this new installation part of a larger project?
    1. Yes, it was part of a larger replacement of my heating system.
    2. Yes, it was part of a newly constructed home.
    3. Yes, it was part of a home remodeling project.
    4. No, it was a stand-alone replacement.
    5. Other (Please specify)
    98. Don't know

21. Is the new [MEASURE_SHORT] that you received a rebate for currently installed and working?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q22 IF Q21 = 2]

22. Why is it not installed or working?
    1. [OPEN-ENDED]

[DISPLAY Q23 IF Q20 = 1, 3, OR 4]

23. Was the equipment that you replaced still functioning at the time you replaced it?

1. Yes
2. No
98. Don't know

[DISPLAY Q24 IF Q20 = 1, 3, OR 4]

24. How old was the equipment that you replaced at the time you replaced it?
    1. ___ # Years
    98. Don't know

25. Using the scale below, how satisfied are you with the performance of your new [MEASURE_SHORT]? [**INSERT 1-5 SCALE. 1 = VERY DISSATISFIED AND 5 = VERY SATISFIED, WITH 98 = DON'T KNOW]**
    1. Very Dissatisfied
    2.
    3.
    4.
    5. Very Satisfied
    98. Don't know

[ASK Q26 THROUGH Q31 IF MEASURE_SHORT = FIREPLACE]

26. Was this new installation part of a larger project?
    1. Yes, it was part of a larger replacement of my heating system.
    2. Yes, it was part of a newly constructed home.
    3. Yes, it was part of a home remodeling project.
    4. No, it was a stand-alone replacement.
    5. Other (Please specify)
    98. Don't know

27. Is the new [MEASURE_SHORT] that you received a rebate for currently installed and working?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q28 IF Q27 = 2]

28. Why is it not installed?
    1. [OPEN-ENDED]

29. Did you have natural gas plumbed to this fireplace before the installation of your [MEASURE_SHORT]?
    1. Yes
    2. No [SKIP Q30]
    98. Don't know

30. What type of system did you have in place before installing your [MEASURE_SHORT]?
    1. Wood burning with a gas burner to help ignite the fire
    2. Gas logs, with a pilot light that was "always on"
    3. Gas logs, with an ignition that you would control (via a push-button, remote, or other control type)
    98. Don't know

31. Using the scale below, how satisfied are you with the performance of your new [MEASURE_SHORT]? [**INSERT 1-5 SCALE. 1 = VERY DISSATISFIED AND 5 = VERY SATISFIED, WITH 98 = DON'T KNOW]**
    1. Very Dissatisfied
    2.
    3.
    4.
    5. Very Satisfied
    98. Don't know

[ASK Q32 THROUGH Q37 IF MEASURE_SHORT = WATER HEATER]

32. Was this new installation part of a larger project?
    1. Yes, it was part of a larger replacement of my water heating system.
    2. Yes, it was part of a newly constructed home.
    3. Yes, it was part of a home remodeling project.
    4. No, it was a stand-alone replacement.
    5. Other (Please specify)
    98. Don't know

33. Is the new [MEASURE_SHORT] that you received a rebate for currently installed and working?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q34 IF Q33 = 2]

34. Why is it not installed?
    1. [OPEN-ENDED]

[DISPLAY Q35 IF Q32 = 1, 3, OR 4]

35. Was the equipment that you replaced still functioning at the time you replaced it?
    1. Yes
    2. No
    98. Don't know

[[DISPLAY Q36 IF Q32 = 1, 3, OR 4]

36. How old was the equipment that you replaced at the time you replaced it?
    1. ___ # Years
    2. Don't know
37. Using the scale below, how satisfied are you with the performance of your new [MEASURE_SHORT]? [**INSERT 1-5 SCALE. 1 = VERY DISSATISFIED AND 5 = VERY SATISFIED, WITH 98 = DON'T KNOW]**
    1. Very Dissatisfied
    2.
    3.
    4.
    5. Very Satisfied
    98. Don't know

[ASK Q38 THROUGH Q43 IF MEASURE_SHORT = TANKLESS WATER HEATER]

38. Was this new installation part of a larger project?
    1. Yes, it was part of a larger replacement of my water heating system.
    2. Yes, it was part of a newly constructed home.
    3. Yes, it was part of a home remodeling project.
    4. No, it was a stand-alone replacement.
    5. Other (Please specify)
    98. Don't know
39. Is the new [MEASURE_SHORT] that you received a rebate for currently installed and working?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q40 IF Q39 = 2]

40. Why is it not installed?
    1. [OPEN-ENDED]

[DISPLAY Q41 IF Q38 = 1, 3, OR 4]

41. Was the equipment that you replaced still functioning at the time you replaced it?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q42 IF Q38 = 1, 3, OR 4]

42. How old was the equipment that you replaced at the time you replaced it?
    1. ___ # Years
    98. Don't know

43. Using the scale below, how satisfied are you with the performance of your new [MEASURE_SHORT]? [**INSERT 1-5 SCALE. 1 = VERY DISSATISFIED AND 5 = VERY SATISFIED, WITH 98 = DON'T KNOW]**
    1. Very Dissatisfied
    2.
    3.
    4.
    5. Very Satisfied
    98. Don't know

MEASURE INSTALLATION

44. Who installed the [MEASURE_SHORT]?
    1. I installed it.
    2. A friend or family member installed it.
    3. I hired a contractor to install it.
    4. Other (Please specify)
    98. Don't know

[DISPLAY Q45 IF Q44 =1]

45. How did you learn to install the [MEASURE_SHORT]?
    1. Prior occupational knowledge
    2. Went to a workshop
    3. Self-taught (You-tube videos, home courses, etc.)
    4. Other (Please specify)

[DISPLAY Q46 and Q47 IF Q44 =3]

46. How did you select the contractor who installed the [MEASURE_SHORT]?
    1. I have hired this contractor for other work in the past.
    2. The retailer recommended the contractor.
    3. I researched online.
    4. Friend or family member recommended the contractor.

47. In total, how many contractors did you speak with before choosing one to install your [MEASURE_SHORT]?
    6. [OPEN-ENDED]

[DISPLAY Q48 IF Q44 =3]

48. Using the scale below, please indicate how much you disagree or agree with the following statements regarding your experience with the contractor that installed the new [MEASURE_SHORT]:

	1 – Strongly Disagree	2	3	4	5 – Strongly Agree	DON'T KNOW

a. The contractor was courteous and professional	1	2	3	4	5	98
b. The work was scheduled in a reasonable amount of time	1	2	3	4	5	98
c. The work was completed in a reasonable amount of time	1	2	3	4	5	98
d. The contractor was knowledgeable about the [MEASURE_SHORT]	1	2	3	4	5	98
e. The contractor answered all my questions thoroughly.	1	2	3	4	5	98

[DISPLAY Q49 IF Q48 < 3]

49. Please elaborate regarding your dissatisfaction.
    1. [OPEN-ENDED]

[DISPLAY Q50 IF Q48d > 3]

50. What features of your new [MEASURE_SHORT] did your contractor emphasize to you? **[MULT-SELECT] [RANDOMIZE]**
    1. Energy Efficiency
    2. Low price
    3. Rebate eligibility
    4. Good warranty/reliability
    5. Quiet operation
    6. Emphasis on the brand and its reputation
    7. Size of the equipment
    8. Other (Please specify)
    98. Don’t know

51. What feature of your new [MEASURE_SHORT] matter the most to you? **[MULT-SELECT] [RANDOMIZE]**
    1. Energy Efficiency
    2. Low price
    3. Rebate eligibility
    4. Good warranty/reliability
    5. Quiet operation
    6. Emphasis on the brand and its reputation
    7. Size of the equipment
    8. Other (Please specify)
    98. Don’t know

ENERGY EFFICIENCY KNOWLEDGE, ATTITUDES, INTENTIONS

52. Using the scale below, how informed would you say you are about energy efficiency practices and energy efficient products/improvement options for your household? [**INSERT 1-5 SCALE 1 = NOT WELL INFORMED, 5 = VERY WELL INFORMED, WITH 98 = DON'T KNOW**]

53. Using the scale below, how trustworthy is IGC as a source of information about saving energy in your home? [**INSERT 1-5 SCALE 1 = NOT VERY TRUSTWORTHY, 5 = VERY TRUSTWORTHY, WITH 98 = DON'T KNOW**]

54. Using the scale below, please rate your level of agreement or disagreement with these statements. [**INSERT 1-5 SCALE 1 = STRONGLY DISAGREE, 5 = STONGLY AGREE, WITH 98 = DON'T KNOW**] [**RANDOMIZE 1-7**]
    1. Energy efficiency saves money.
    2. I am not very concerned about the amount of energy used in my home
    3. I am too busy to worry about making energy-related improvements in my home.
    4. It is possible to be energy efficient without sacrificing comfort
    5. I know of steps I could take to reduce my household energy use.
    6. I intend to reduce my household energy use in the next 12 months.
    7. It is not possible to make energy efficiency changes on my budget.

CUSTOMER SATISFACTION

55. Did someone in your household contact a program staff member from IGC with questions about your rebate application (this question does not pertain to your interaction with the contractor)?
    1. Yes
    2. No
    98. Don't know

56. Using the scale below, please rate how dissatisfied or satisfied you are with each of the following …

	1 – Very dissatisfied	2	3	4	5 – Very satisfied	DON'T KNOW
a. **[DISPLAY IF Q55 = 1]** how long it took program staff to address your questions or concerns	1	2	3	4	5	98
b. **[DISPLAY IF Q55 = 1]** how thoroughly they addressed your question or concerns	1	2	3	4	5	98
c. the performance of the equipment you installed overall	1	2	3	4	5	98
d. the energy savings on your utility bill resulting from installing the new [MEASURE_SHORT]	1	2	3	4	5	98

e. the rebate amount	1	2	3	4	5	98
f. the process for applying for the rebate	1	2	3	4	5	98
g. [**DISPLAY IF 44 = 3**] the overall quality of the work performed by your contractor	1	2	3	4	5	98
h. the time it took to receive the rebate	1	2	3	4	5	98
i. the experience with the program overall	1	2	3	4	5	98
j. Intermountain Gas Co. as your gas service provider	1	2	3	4	5	98

[DISPLAY Q57 IF ANY IN Q56 <3]

57. You indicated some dissatisfaction. Why were you dissatisfied?
    1. [OPEN-ENDED]

58. Using the scale below, how would you say your participation in the Appliance Rebate program has affected your satisfaction with Intermountain Gas Company? [**INSERT 1-5 SCALE, 1 = GREATLY DECREASED YOUR SATISFACITON EITH IGC AND 5 = GREATLY INCREASED YOUR SATISFACITON EITH IGC, WITH 98 = DON'T KNOW]**
    1. Greatly decreased your satisfaction with IGC
    2.
    3.
    4.
    5. Greatly increased your satisfaction with IGC
    98. Don't know

59. Are there any additional comments you would like to share with us about your experience in the program?
    1. [OPEN-ENDED]

HOME DEMOGRAPHICS

This last set of questions will help Intermountain Gas Company develop more effective programs that may best serve the needs of the community. Your answers will remain anonymous, and you also have the option of not answering these questions.

60. Who provides your home with electric service?
    1. Idaho Power Company
    2. Rocky Mountain Power
    3. Fall River Rural Electric Cooperative
    4. Idaho County Light and Power
    5. Other (Please specify)
    98. Don't know

99. Prefer not to state

61. Do you own or rent the home in which you live?
    1. Own
    2. Rent
    98. Don't know
    99. Prefer not to state

62. Which best describes this building?
    1. Single-family house detached from any other house
    2. Single-family house attached to one or more other houses (e.g., duplex, condominium, townhouse)
    3. Mobile or manufactured home
    4. Apartment with 2 or 3 units
    5. Apartment with 4 or more units
    6. Other (Please specify)
    98. Do not know
    99. Prefer not to answer

63. About when was this building first built?
    1. Before 1960
    2. 1960 to1969
    3. 1970 to 1979
    4. 1980 to 1989
    5. 1990 to 1999
    6. 2000 to 2009
    7. 2010 to 2019
    98. Do not know
    99. Prefer not to answer

64. Please provide the estimated square footage of your house.
    1. Less than 1,000 square feet
    2. 1,000 to 1,999 square feet
    3. 2,000 to 2,999 square feet
    4. 3,000 to 3,999 square feet
    5. 4,000 square feet or greater
    98. Do not know
    99. Prefer not to answer

65. What is the main fuel used for heating your home?
    1. Natural Gas
    2. Electricity
    3. Propane
    4. Other (Please specify)

98. Do not know
99. Prefer not to answer

66. What fuel does your main water heater use?
    1. Natural Gas
    2. Electricity
    3. Propane
    4. Other (Please specify)
    98. Do not know
    99. Prefer not to answer

67. What is the main fuel used for cooking in your home?
    1. Natural Gas
    2. Electricity
    3. Propane
    4. Other (Please specify)
    98. Do not know
    99. Prefer not to answer

68. Including yourself, how many people currently live in your home?
    1. 1
    2. 2
    3. 3
    4. 4
    5. 5
    6. 6
    7. 7
    8. 8
    9. 9 or more
    98. Do not know
    99. Prefer not to answer

69. Which of the following brackets contains your age?
    1. 19-24
    2. 25-34
    3. 35-49
    4. 50-64
    5. 65 or over
    98. Don’t know
    99. Prefer not to state

70. What is your approximate total household income?
    1. Less than $10,000
    2. $10,000 to less than $20,000

3. $20,000 to less than $30,000
4. $30,000 to less than $40,000
5. $40,000 to less than $50,000
6. $50,000 to less than $60,000
7. $60,000 to less than $70,000
8. $70,000 to less than $80,000
9. $80,000 to less than $90,000
10. $90,000 to less than $100,000
11. $100,000 to less than $150,000
12. $150,000 to less than $200,000
13. $200,000 or more
98. Don't know
99. Prefer not to state

71. What's the highest level of education you've completed?
    1. Up to 8th grate
    2. Some high school
    3. High school or GED equivalent
    4. Some college
    5. Associate's degree
    6. Bachelor's college degree
    7. Master's degree
    8. Professional degree (MD, JD, DDO, DDS)
    9. Doctorate (Ph.D., D.Sc.)
    98. Don't know
    99. Prefer not to state

5.1.3 Nonparticipant Survey

1. According to our records, Intermountain Gas Company provides the natural gas service at your residence located at [ADDRESS]. Is that correct?
    1. Yes
    2. No [TERMINATE SURVEY]
    3. The location is not a residence [TERMINATE SURVEY]
    98. Don't know [TERMINATE SURVEY]

[DISPLAY Q2 IF Q5.1.3 = 1]

2. In the last five years, have you received a rebate from Intermountain Gas Company or your electricity service provider for installing energy efficient equipment or making energy efficiency improvements for the residence located at [ADDRESS]?
    1. No, I have not received any rebates
    2. Yes, from Intermountain Gas Company [TERMINATE]
    3. Yes, from my electricity service provider

4. Yes, from both [TERMINATE]
98. Don't know

[DISPLAY Q3 IF Q2 = 2 OR 4]

3. You mentioned you received a rebate from IGC. What energy efficient equipment did you receive a rebate for?
    1. Tank water heater
    2. Fireplace
    3. Furnace
    4. Tankless water heater
    5. Combination radiant heat system
    6. Efficient whole home new construction
    7. Other (specify)
    98. Don't know

[DISPLAY Q4 IF Q2 = 3 OR 4]

4. You mentioned you received a rebate from your electric service provider. Can you provide further detail?
    1. [OPEN-ENDED]

HOME CHARACTERISTICS

5. Do you use natural gas in your home located at [ADDRESS]?
    1. Yes
    2. No
    98. Don't know

6. Which of the following best describes your home?
    1. Single-family house detached from any other house
    2. Single family house attached to one or more other houses (duplex, row house, condominium, or townhome)
    3. Apartment in a building with 2 to 3 units
    4. Apartment in a building with 4 or more units
    5. Manufactured or mobile home
    6. Other (Please specify)
    98. Don't know

7. Do you own, rent, or own and rent to someone else the property located at [LOCATION]?
    1. Own
    2. Rent
    3. Own and rent to someone else
    98. Don't know

8. About when was the home first built?
    1. Before 1960
    2. 1960 to1969
    3. 1970 to 1979
    4. 1980 to 1989
    5. 1990 to 1999
    6. 2000 to 2009
    7. 2010 to 2019
    98. Don't know

9. Please provide the estimated square footage of your house.
    1. Less than 1,000 square feet
    2. 1,000 to 1,999 square feet
    3. 2,000 to 2,999 square feet
    4. 3,000 to 3,999 square feet
    5. 4,000 square feet or greater
    98. Don't know

10. What is the main fuel used for heating your home?
    1. Natural Gas
    2. Electricity
    3. Propane
    4. Other (Please specify)
    98. Don't know

11. What is the main type of heating equipment used to provide heat for your home?
    1. Heat pump
    2. Central forced air furnace
    3. Room or space heater
    4. Something else (Please specify)
    98. Don't know

12. How old is your heating system equipment? Your best estimate is fine.
    1. Less than 2 years old
    2. 2 to 4 years
    3. 5 to 9 years
    4. 10 to 14 years
    5. 15 to 19 years
    6. 20 or more years old
    98. Don't know

13. What fuel does your main water heater use?
    1. Natural Gas
    2. Electricity

3. Propane
4. Other (Please specify)
98. Don't know

14. How old is your main water heater? Your best estimate is fine.
    1. Less than 2 years old
    2. 2 to 4 years
    3. 5 to 9 years
    4. 10 to 14 years
    5. 15 to 19 years
    6. 20 or more years old
    98. Don't know

15. What is the main fuel used for cooking in your home?
    1. Natural Gas
    2. Electricity
    3. Propane
    4. Other (Please specify)
    98. Don't know

16. Does your home have an existing fireplace with a gas line connection?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q17 IF Q16 = 1]

17. Does your home's fireplace have a constant pilot light or an intermittent pilot light?
    1. Constant pilot light
    2. Intermittent pilot light
    98. Don't know

ENERGY SAVING ACTIONS

18. In the past three years, have you or anyone else in your household purchased, installed or implemented any of the following equipment or home improvements at this residence? [RANDOMIZE]
    1. 95% AFUE Natural Gas Furnace
    2. Combination Radiant Heat System
    3. 80% AFUE Fireplace
    4. 70% FE Fireplace
    5. 0.67 Water Heater
    6. 0.91 Tankless Water Heater
    7. I have not done any of these
    8. Other (Please specify)

98. Don't know

19. Was the following item(s) that you mentioned ENERGY STAR® certified or high efficiency? **[SCALE: 1 = Yes, 2 = No, 98 = DON'T KNOW]**
    1. [DISPLAY IF Q18 = 1] 95% AFUE Natural Gas Furnace
    2. [DISPLAY IF Q18 = 2] Combination Radiant Heat System
    3. [DISPLAY IF Q18 = 3] 80% AFUE Fireplace
    4. [DISPLAY IF Q18 = 4] 70% FE Fireplace
    5. [DISPLAY IF Q18 = 5] 0.67 Water Heater
    6. [DISPLAY IF Q18 = 6] 0.91 Tankless Water Heater
    7. Other (specify)
    98. Don't know

PROGRAM AWARENESS

20. Are you aware of any rebates for energy efficient equipment and home improvements or other services offered by a gas or electric utility?
    1. Yes
    2. No
    98. Don't know

[DISPLAY IF Q20= 1]

21. Which utilities provide the rebates that you recall hearing about?
    1. [OPEN-ENDED]

[DISPLAY IF Q20= 1]

22. What types of rebates do you recall hearing about? **[MULTI-SELECT] [RANDOMIZE]**
    1. Heating and cooling equipment
    2. Appliances such as refrigerators, clothes washers
    3. Home weatherization improvements such as air or duct sealing
    4. Discounts for efficient lighting
    5. Low flow faucet aerators or showerheads
    6. Other (Please specify)
    98. Don't know

[DISPLAY IF Q20= 1]

23. How did you learn of these rebates or services? **[MULTI-SELECT] [RANDOMIZE]**
    1. Information that came in the mail
    2. Email
    3. Newspaper or magazine article
    4. Contractor
    5. Word of mouth from friends, relatives, or others
    6. TV ad

7. Radio ad
8. Social media (Facebook, Twitter)
9. Utility bill message
10. Utility website
11. Intermountain Gas YouTube channel
12. Other website
13. Utility program staff
14. Community event
15. Other (Please specify)
98. Don't know

ENERGY EFFICIENCY KNOWLEDGE, ATTITUDES, AND INTENTIONS

24. Using the scale below, how knowledgeable are you about ways to save energy in your home? **[SCALE: 1 (Not at all knowledgeable) – 5 (Very knowledgeable, 98 = DON'T KNOW]**

25. Using the scale below, how much have you done to lower your monthly energy bill in your home? [SCALE: 1 (You have not done much) – 5 (You have done almost everything you can), 98 = DON'T KNOW]

26. Using the scale below, how interested are you in making improvements to your home that would... **[SCALE: 1 (Not at all interested) – 5 (Extremely interested), 98 = DON'T KNOW]**
    1. Increase its energy efficiency by using appliances powered by natural gas?
    2. Improve your comfort by using appliances powered by natural gas?
    3. Improve your health and safety by using appliances powered by natural gas?

27. How would you find out ways to reduce your monthly energy bills? **[MULTI-SELECT]**
    1. From the utility customer service line
    2. Utility website
    3. Internet search
    4. Social media
    5. Government information
    6. ENERGY STAR website
    7. Friends, family, or colleagues
    8. Information from a retail store
    9. Magazines/newspapers/television/radio
    10. Home energy audit
    11. Other (Please specify)
    98. Don't know

28. Using the scale below, how likely is it that you would do any of the following in your home to reduce your utility bill? **[SCALE: 1 (Very unlikely) – 5 (Very likely), 98 = DON'T KNOW]**

1. Add insulation in ceilings, walls, floors
2. Add weather stripping or caulking around doors and windows
3. Install energy efficient, double-pane windows
4. Insulate water heater tank and pipes
5. Install a programmable set-back thermostat or smart (Wi-Fi) thermostat
6. Sealing and insulation of ducts
7. Install a high efficiency central heating (furnace, boiler)
8. Clean or change your furnace filters once a month during heating season
9. Install glass doors on fireplace and close dampers when the fireplace is not in use
10. Install a high efficiency heat pump or air conditioner
11. Conduct regular maintenance of central heating or cooling system
12. Use low-flow showerhead or faucet aerators
13. Adjust thermostat settings
14. Buy energy efficient appliances
15. Close the drapes or cover windows to reduce heat gain or loss
16. Turn down water heater temperature
17. Install efficient lighting
18. Unplug appliances or electronics when not use
19. Install a smart power strip
20. Use cold water when doing laundry

29. Are you planning to make any energy efficient updates in your home in the next year?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q30 IF Q29 = 1]

30. Please describe what energy efficient improvements you plan to make to your home in the upcoming year.
    1. [OPEN-ENDED]

31. Using the scale below, how trustworthy is Intermountain Gas Company as a source of information about saving energy in your home?
    1. 1- Not at all trustworthy
    2. 2
    3. 3
    4. 4
    5. 5- Very trustworthy
    98. Don't know

32. Using the scale below, how interested are you in receiving additional information on energy saving tips and rebate programs offered by Intermountain Gas Company? Would you say…
    1. 1- Not at all interested
    2. 2
    3. 3
    4. 4
    5. Very interested
    98. Don't know

[DISPLAY Q33 IF Q32>3]

33. What would be the best way for Intermountain Gas Company to provide information on rebates for energy saving equipment and improvements?
    1. Email
    2. Utility Website
    3. Bill inserts
    4. Utility newsletter
    5. Telephone call
    6. Text messages
    7. None, I prefer to not receive information
    8. Other (Please specify)
    98. Don't know

34. Please rate your level of agreement or disagreement with these statements using the scale below. There are no right or wrong answers, we just want your opinion. **[SCALE: 1 (Strongly disagree) – 5 (Strongly agree), 98 = DON'T KNOW] [RANDOMIZE ORDER]**
    1. Energy efficiency saves money.
    2. I know of steps I could take to reduce my household energy use.
    3. It is possible to be energy efficient without sacrificing comfort.
    4. I am not very concerned about the amount of energy used in my home.
    5. I am too busy to worry about making energy-related improvements in my home.
    6. It is not possible to make energy efficiency changes on my budget.
    7. I intend to reduce my household energy use in the next 12 months.

SATISFACTION

35. Using a scale below, how satisfied are you with Intermountain Gas Company as your natural gas service provider? **[SCALE: 1 (Very dissatisfied) – 5 (Very satisfied), 98 = DON'T KNOW]**

[DISPLAY IF Q35<3]

36. Why are you dissatisfied?

1. [OPEN-ENDED]

DEMOGRAPHICS

This last set of questions will help Intermountain Gas Company develop more effective programs that may best serve the needs of the community. Your answers will remain anonymous, and you also have the option of not answering these questions.

37. Who provides your home with electric service?
    1. Idaho Power Company
    2. Rocky Mountain Power
    3. Fall River Rural Electric Cooperative
    4. Idaho County Light and Power
    5. Other (Please specify)
    98. Don't know
    99. Prefer not to state
38. Including yourself, how many people currently live in your home?
    1. 1
    2. 2
    3. 3
    4. 4
    5. 5
    6. 6
    7. 7
    8. 8
    9. 9 or more
    98. Don't know
    99. Prefer not to answer
39. Which of the following brackets contains your age?
    1. 19-24
    2. 25-34
    3. 35-49
    4. 50-64
    5. 65 or over
    98. Don't know
    99. Prefer not to state
40. What is your approximate total household income?
    1. Less than $10,000
    2. $10,000 to less than $20,000
    3. $20,000 to less than $30,000
    4. $30,000 to less than $40,000

5. $40,000 to less than $50,000
6. $50,000 to less than $60,000
7. $60,000 to less than $70,000
8. $70,000 to less than $80,000
9. $80,000 to less than $90,000
10. $90,000 to less than $100,000
11. $100,000 to less than $150,000
12. $150,000 to less than $200,000
13. $200,000 or more
14. Don’t know
15. Prefer not to state

41. What’s the highest level of education you’ve completed?
    1. Up to 8th grate
    2. Some high school
    3. High school or GED equivalent
    4. Some college
    5. Associate’s degree
    6. Bachelor’s college degree
    7. Master’s degree
    8. Professional degree (MD, JD, DDO, DDS)
    9. Doctorate (Ph.D., D.Sc.)
    98. Don’t know
    99. Prefer not to state

5.2 Interview Guides

5.2.1 IGC Program Staff Interview Guide

ROLES AND RESPONSIBILITIES

1. Can you describe your role and responsibilities as it relates to IGC's Whole Home Rebate and Appliance Rebate Program?

2. How long have you been at your current role with IGC?

3. Have there been any changes to your responsibilities this program year?

PROGRAM DESIGN AND GOALS

4. Intermountain Gas Company first launched its EE programs in 2018. What was the outcome of the 2018 program year for both high efficiency appliances and residential new construction? How did these outcomes influence decisions made in implementing the 2019 Whole Home Rebate and Appliance Rebate Programs?

5. What were the participation and savings goals of IGC's Whole Home Rebate and Appliance Rebate Program for PY2019? Have these goals changed since PY2018? How have they changed?

6. How did IGC's Whole Home Rebate and Appliance Rebate Program perform in PY2019 relative to its goals? Can you speak to each component of the program separately?
    1. Whole Home Rebate Program
    2. Appliance Rebate Program

7. What are some lessons learned after two years of implementing the Whole Home Rebate and Appliance Rebate programs?

8. Were there any changes to the incentive amounts from PY2018 to PY2019 for the Whole Home Rebate and Appliance Rebate Programs?

9. Are there any planned or anticipated changes to the Whole Home Rebate and Appliance Rebate Programs for the remainder of the year or the upcoming program year?

10. Were minimum efficiency requirements for measures other than furnaces (such as fireplaces and water heaters) lowered from PY2018 to PY2019 due to lower than expected savings results in PY2018?

COMMUNICATION

11. What is the general method of communication between internal IGC program staff? How many people are involved in internal meetings/calls, and how often do they take place? What topics are covered?

12. Do you believe there could be improvements to communication with regards to the Whole Home Rebate and Appliance Rebate Programs? Have there been changes made from PY2018 to PY2019 that have improved communication efforts?

DATA MANAGEMENT

13. Please explain your program data management. What kind of database system or software is used for program tracking?

14. Were there any substantial changes to your data management system from 2018 to 2019?

15. Are there any improvements you would to see to the current data management system?

16. Are there any formal quality assurance and quality control procedures for either program? Can you describe them?

17. Do you believe your data is kept current enough to effectively monitor the programs?

18. Is there any system for gathering feedback from participants such as survey efforts or customer interaction?

MARKETING AND OUTREACH

19. What were the main marketing and outreach activities in PY2019? Did any of those vary for each component of the Whole Home Rebate and Appliance Rebate Programs?

20. Were there increased marketing efforts for the Whole Home Rebate and Appliance Rebate Programs compared to other programs in the portfolio? Did this change from PY2018 to PY2019?

21. Have there been any significant changes to the marketing and outreach approach in PY2019?

22. Are there any planned or anticipated changes to marketing and outreach for the remainder of the year or the upcoming program year?

23. Is marketing targeted to certain customers or territories? Is there any effort done to target underserved or hard to reach customers?

24. What has been the most successful way of marketing the Whole Home Rebate and Appliance Rebate Programs in PY2019?

25. How are marketing efforts different for customers, contractors, home builders, and home energy raters? Which have proven to be successful and which are less successful?

26. Are there plans to update the website? Do you use social media as part of your marketing approach? Do you monitor the impact of various marketing activities?

27. Please explain the special partnership project that took place with Boise Valley Habitat for Humanity, and future plans for similar projects.

BUILDERS

28. In PY2018, IGC was able to increase the amount of ENERGY STAR builders from 5 to 18. Has IGC been successful in adding more ENERGY STAR builders to the program in PY2019?

29. How does IGC recruit builders? Are there special trainings or informational sessions conducted by IGC staff?

30. How does a contractor get ENERGY STAR certified? Does IGC provide any assistance with certification (for example, notifying about training sessions)?

31. Have HERS scores increased from PY2018 to PY2019?

32. What feedback have you gotten from purchasers and builders on the general performance and satisfaction of the Whole Home Rebate Program?

HERS RATERS

33. What is the general method of communication between IGC and HERS raters?

34. How are HERS raters recruited by IGC to participate in the Whole Homes program?

35. Does IGC conduct any trainings or informational sessions with or for HERS Raters? (if yes) How many were trained a year by IGC staff? Are there contractor incentives?

36. What kind of feedback, if any, have you received from HERS raters that have participated in the Whole Home Rebate Program?

CONTRACTORS

37. What is the general method of communication between IGC and contractors?

38. Are contractors required to be officially registered by IGC to participate in the program?

39. Does IGC conduct any trainings or informational sessions with contractors? (if yes) How many contractors are trained a year by IGC staff? Are there contractor incentives?

40. What kind of feedback, if any, have you received from contractors that have participated in the Energy Efficiency Rebate Program?

CONCLUSION

41. What do you think most needs to be changed or improved to the IGC Whole Home Rebate and Appliance Rebate Programs?

42. What do you believe the IGC program staff need to do in the upcoming program year to increase awareness of the program?

43. What specific concerns do you have about the IGC Whole Home Rebate and Appliance Rebate Programs?

44. What would you like to learn from our evaluation report?

45. Those are all the questions I have for you. Do you have anything else you want to mention to me in regards to the program?

5.2.2 HERS Raters Interview Guide

INTRODUCTION AND BUSINESS SCOPE

I'd like to start with some general information about you and the company you work for.

1. How long have you been working as a HERS rater in Idaho?
2. Besides rating homes, what other services does your company offer to builders or their contractors, if any? (E.g., HVAC installation/commissioning, Duct sealing/testing, Lighting, Permitting, Inspections for other building programs, General construction consulting, Green/EE construction consulting)
3. When did you first begin participating in the program?
4. Approximately how many total new homes did your company work with in Idaho in 2018 and 2019 as a rater?
    1. And how many of these homes received a rebate from Intermountain Gas Whole Homes program?
    2. And about how many different Idaho home builders did you work with in 2018 and 2019?
5. Do you think your new homes business in Idaho will increase, decrease, or remain about the same in 2020? Why?

PROGRAM REQUIREMENTS

Now I'd like to ask you about the program requirements.

6. Are any program requirements unclear to you?
    1. If YES: Which ones?
7. Do you have any recommended changes to any of the program's requirements? (If needed: These changes could pertain to the equipment requirements, HERS ratings, or rebate amounts, for instance.)
8. What are your biggest challenges as a home rater?
9. Do the builders and their subcontractors understand program requirements?
    1. What don't they understand?
    2. Do they need additional training?
    3. YES: Who should provide this? Why?
    4. What are builders' most common challenges that may limit program participation?
10. How satisfied are you with the program's technical support?
    1. PROBE: What kind of support does IGC provide? (Confirm if this help is from IGC or someone else)
    2. How important is this support for your participation in the program?

11. Are you aware of other "green" or energy efficiency related programs for new homes in Idaho?
    1. If YES: Do you also work with builders on these types of homes?
    2. If YES: How do you think homebuyers perceive homes built to IGC's requirements compared to other green homebuilding programs?
    3. What other rebate programs do builders take advantage of?

MARKETING

Now I'd like to ask you about program marketing.

12. Do you actively promote the program to builders?
13. Have you recruited any new builders to the program?
14. How do builders typically learn about this program?
15. Do you work with builder or real estate sales staff to help them promote the energy efficiency of these program homes? Other groups?
    1. IF YES: What do you do? (Probe to see if info on website, calling builders, presentations, etc.)
    2. Which benefits of energy efficient homes do you promote?
    3. Could you provide me with the name of the realtor you use?
16. Do you think builders/realtors understand the advantages of IGC program homes?
17. Do you think builders/realtors are adequately promoting the advantages of these homes?
18. Do you believe builders are changing their practices due to experience participating in the program?
19. Which program features seem to be most beneficial/valuable to the homebuyers? What about to builders? How about the least beneficial/valuable?
20. Are there certain energy efficient measures builders avoid due to the cost regardless of the program's rebates? Are there measures that are under-installed by builders because the rebate amount is not sufficient to make these measures cost effective?
21. Have you received more or less inquiries about certifying energy efficient homes in the past year? Why do you think that is?
22. What do you think IGC should do to effectively market the benefits of their program homes
23. Do program-qualified homes provide a sales advantage in the current housing market?

PROGRAM INTERACTIONS

Now I have a few questions about your interactions with other program actors and program tools.

24. Who do you get most of your program information from (e.g., IGC staff or website, a State or National Energy organization, program implementation staff, etc.)? By program information, I mean updates on new home requirements, rebate levels, trainings being offered, etc.
    1. Who do you mostly work with at IGC?

25. What is the most critical support the program could provide to Raters in the near future? (Probe to see if technical/field support, consumer marketing, subcontractor training, other preferred.) Why do you say that?

26. Tell me about your collaboration/relationship with your builders in certifying homes.
    1. What is the process?
    2. What is going well?
    3. What improvements could be made?
    4. Are there any builders who have consistent issues with homes failing the certification process? What are these issues and how should these be addressed?

27. How efficiently is the home certification process performing? Could this be improved in any way? Are there different stages of the certification process that work better than others?

28. How do you work with the program providers who certify the homes and conduct quality assurance inspections?
    1. What is the process?
    2. What is going well?
    3. What improvements could be made?

OVERALL PROGRAM

I just have a few final questions about the program.

29. Given everything we've discussed, what has been the biggest challenge for you in being a Rater for IGC's Whole Homes Rebate Program? For builders?
    1. (If needed) Are the incremental costs of building more energy efficient homes a challenge for your builders, even after IGC's rebates are considered?
    2. Are appraisals of your builder's homes an issue?

30. What do you think are the biggest challenges for constructing and/or selling energy efficient homes going forward? Do you have any suggestions for overcoming these challenges?

31. On a scale of 1 to 5, where 1 is very dissatisfied and 5 is extremely satisfied, how would you rate your satisfaction with IGC's Whole Homes Rebate Program?

32. What feedback have you received from customers, builders, and other raters (positive and negative)? Do they have any suggestions for improving the program? [Probe for measure specific feedback]
33. Those are all the questions I have for you. Do you have anything else you want to mention to me in regards to the program?

5.2.3 Builders Interview Guide

BUILDER BACKGROUND GENERAL

I'd like to start with some general information about you and the company you work for.

1. Can you please confirm your name and the name of your company?
2. What is your title?

[DISPLAY Q3 IF PARTICIPATING?=Y]

3. What is your specific role for participating in the IGC Whole Homes program?
4. Are you the primary decision maker at your company in determining how energy efficient your homes are?

NON-PARTICIPANT

Now I'd like to ask you some questions about your awareness of the program.

[DISPLAY Q5-Q11 IF PARTICIPATING?=N]

5. Are you familiar with the Whole Homes program?

[DISPLAY Q6 IF Q5=Y]

6. What was the reason for not participating in the program?

[DISPLAY Q7 IF Q5=Y]

7. Was this a company decision or a customer decision? (Probe: is it due to certification, increased cost, increased building time, HERS rater availability, customer interest, etc.)
8. Has your company participated in other utility sponsored energy efficiency programs in the past?
9. Are you familiar with the code and HERS standards for which homes can qualify for the Whole Homes program?

[DISPLAY Q10 IF Q9=Y]

10. Does your company build any homes that meet the efficiency standards of the Whole Home program?
11. What from IGC would help you participate in the Whole Homes program?

PROGRAM PARTICIPATION EXPERIENCE WITH PARTICIPANTS

Now I'd like to ask you some questions about your experience participating in the program.

[DISPLAY Q12-Q31 IF PARTICIPATING?=Y]

12. Were you also the primary decision maker in terms of participating in the Whole Homes program or was that someone else?
13. How did you learn about the program?
14. When did your company first begin participating in the program?
15. Have you attended any events where a program representative provided information about the program? (This might include home builder association meetings, lunch & learns.)

[DISPLAY Q16 IF Q15=N]

16. Please elaborate.

[DISPLAY Q17-Q19 IF Q15=Y]

17. Please elaborate. What types of events? What information did you receive?
18. Was the information helpful?
19. Would you attend more events in the future?
20. How many of the homes you have built received a rebate from the Whole Homes programs in 2018 or 2019?
21. How many homes did not receive a rebate?

[DISPLAY Q22 IF Q21>0]

22. Why didn't those homes receive incentives? (Probe: did they know some homes would not quality, or did they just choose not to have a HERS rating or submit an application?)

[DISPLAY Q23 IF Q21>0]

23. Are the homes that did not participate in the program built differently than program standards?

[DISPLAY Q24 IF Q23=Y]

24. How do they differ from homes that do participate?

[DISPLAY Q25 IF Q23=Y]

25. Can you summarize why these homes did not participate in the program?

[DISPLAY Q26 IF Q23=Y]

26. How many of these homes were within IGC's natural gas service territory?
27. Looking at your past participation in the program, your homes have had an average HERS score of [AVG_HERS_SCORE]. On average, how much more does it cost to build a home to this level than to build an otherwise comparable home at 100 HERS? An answer in dollars, or in percentage terms is fine.
28. What area accounts for most of the additional cost? (Probe: materials, HVAC systems, insulation, labor costs, HERS rater costs)
29. What have you found to be the least costly way to ensure a home has a HERS score lower than 75?
30. What do you do to reach your HERS score of [AVG_HERS_SCORE] in your homes?
31. Compared to a home with a HERS score of [AVG_HERS_SCORE], what would you need to do differently to reach a HERS score of [HERS_GOAL]? [CALCULATE: HERS_GOAL: AVG_HERS_SCORE – 10, ROUND TO NEAREST 5.]
32. What factors go into deciding to build homes to the program building standards in 2019?
    1. Ability to differentiate yourself in the market?
    2. Program financial incentive?
    3. Customer demand for energy efficient homes?
    4. Other program assistance?
    5. Other factor (please write in)
    6. Don't Know

PARTICIPATING CUSTOMER PROGRAM AWARENESS AND MARKETING

I'd like to ask you a couple of questions about how you as the builder and the eventual homebuyer engage with the program.

[DISPLAY Q33-Q43 IF PARTICIPATING?=Y]

33. Looking at the [BUILDER COUNT] homes you've received rebates for, what percent of them were custom built, versus using a pre-existing floorplan? For homes that

had minor modifications to suit a build site, count those as a “pre-existing floorplan”.

34. What percent of your homes in the program had a buyer arranged before construction was complete?

35. Do the energy efficient features of your program-qualified homes help them sell more quickly?

36. To the best of your ability, could you estimate what proportion of the customers knew about the program before they began working with you to build or buy a home?

37. Does your company provide marketing messages or materials to your customers about IGC’s Whole Homes programs?

[DISPLAY Q38 IF Q37=Y]

38. What kinds of marketing material or messages? Please elaborate.

39. What are your biggest challenges when marketing a program-qualifying home?

40. How can the marketing process by IGC be improved if at all?

41. How satisfied are you with the performance of the HERS raters you have worked with in this program?

42. Are you applying what you have learned through participating in this program to other homes that may not participate in the program?

[DISPLAY Q43 IF Q42=Y]

43. In what ways is your practice changing due to experience in the program?

44. In what ways is your practice changing due to market changes?

NONPARTICIPATING CUSTOMER PROGRAM AWARENESS AND MARKETING

[DISPLAY Q45-Q59 IF PARTICIPATING?=N]

45. What percent of your homes are custom built, versus using a pre-existing floorplan? For homes that had minor modifications to suit a build site, count those as a “pre-existing floorplan”.

46. What proportion of your homes have more energy efficient features than a home built to Idaho building codes?

47. Do those homes sell more quickly?

48. What percent of your homes do buyers arrange to buy before construction was complete?
49. Do the energy efficient features of your homes help them sell more quickly?
50. To the best of your ability, could you estimate what proportion of your customers that ask about energy efficient features of your built homes?
51. Does your company provide marketing messages or materials to your customers about the energy efficiency features of your homes?

[DISPLAY Q52 IF Q51=Y]

52. What kinds of marketing material or messages? Please elaborate.
53. What are your biggest challenges when marketing one of your homes?
54. Have you worked with HERS raters?

[DISPLAY Q55 IF Q54=Y]

55. How satisfied are you with the performance of the HERS raters you have worked with?

[DISPLAY Q56 IF Q54=Y]

56. What proportion of your homes has been rated by a HERS rater?

[DISPLAY Q57 IF Q54=Y]

57. Did any of them mention the program?

[DISPLAY Q58 IF Q57=Y]

58. What did they say about the program?
59. In what ways is your practice changing due to market changes?

CUSTOMER PROGRAM AWARENESS AND MARKETING

I'd like to ask you a couple of questions about how you as the builder and the eventual homebuyer engage with the program.

60. Do you think homebuyers are willing to pay more for energy efficient homes?
61. What aspects of homes do your customers find most beneficial? (Probe: increased comfort, lower energy use, lower utility bills, environmental impact, higher home value)

62. Do you believe homebuyer demand and expectations for energy efficient homes have changed over the past few years?

[DISPLAY Q63 IF Q62=Y]

63. How? Please elaborate.
64. What percent of your homes are plumbed with natural gas?

PROGRAM FEEDBACK GENERAL

I just have a few final questions about the program…

[DISPLAY Q65-Q74 IF PARTICIPATING?=Y]

65. To what extent did you interact with IGC program staff?
66. How were your interactions with the program staff?
67. Were you satisfied with the overall interactions? Please use a scale from 1 (very dissatisfied) to 5 (very satisfied).
68. Do you have any suggestions for streamlining or improving the participation process?
69. In general, how long does it take for you to receive feedback or approval of a project application?
70. When construction is complete, after you've submitted paperwork about how long does it take you to receive your incentive check?
71. Did you have any concerns with the timing or amount of incentive?
72. Overall, are you satisfied with the Whole Homes program?
73. Do you have any recommendations for changes to the program?
74. Are there any gaps or unaddressed issues the program should consider?
75. Do you plan to participate in the IGC's Whole Homes program in the future? And if not, why not?

[DISPLAY Q76 IF PARTICIPATING?=Y]

76. Those are all the questions I have for you. Do you have anything else you want to mention to me in regards to the program?

[DISPLAY Q77 IF PARTICIPATING?=N]

77. Those are all the questions I have for you. Do you have anything else you want to mention to me in regards to your work building homes in IGC's service territory?

5.2.4 Contractors Interview Guide

INTRODUCTION AND BUSINESS SCOPE

I'd like to start with some general information about you and the company you work for.

1. What is your role at your company?

2. Could you please describe your organization?
    1. What services do you offer?
    2. How many staff do you have?

3. Has your company worked with energy efficiency programs before?
    1. Yes
    2. No
    98. Don't Know

[DISPLAY Q4 IF Q3=1]

4. What is your past experience with energy efficiency programs?

5. What percent of your home energy efficiency improvement projects are at residential single -family homes? What percentage are at multifamily homes?

6. Do you do any commercial projects?

PROGRAM AWARENESS & INVOLVEMENT

Now I'd like to ask you program awareness.

7. How did you first hear about IGC's Energy Efficiency rebate program?

8. How long have you been active in the program?

9. Why did you decide to participate in the program?

10. Do you feel that the program communications are adequate and help you relay information to your customers?
    1. Yes
    2. No

11. Do you have suggestions on how they can be improved?

12. Did you or employees receive any program training in the 2018 or 2019 program years? These include any webinars by the utility or in person trainings.

1. Yes
2. No

[DISPLAY Q13 IF Q12=1]

13. Could you please describe the training?

[DISPLAY Q14 IF Q12=1]

14. Were they helpful?
15. Do you have any suggestions for how the program could be improved in terms of program design or operations?

CUSTOMER INTERACTION

I'd like to ask you about customer interaction.

16. What percent of your customers already know about the program before being told about it by you?
17. What do you think are the main benefits your customers receive by participating in the Energy Efficiency program?
18. In customer interactions, did you actively market the IGC Energy Efficiency program to your customers during the 2018 and 2019 Program years?
19. Could you please explain a bit more or elaborate on how you actively marketed IGC's Energy Efficiency program to your customers?
20. Do you provide assistance with completing the rebate applications for customers?
    1. Yes
    2. No
21. What kind of assistance do you provide with completing the rebate applications?
22. Do you have any suggestions for improving the application process?

MARKETING

Now I'd like to ask you about program marketing.

23. Have you done some high efficiency projects that would qualify for the program; but did not apply for the incentive?
    1. Yes
    2. No

[DISPLAY Q24 IF Q2341=1]

24. Of the energy efficiency projects or equipment installations you do that would qualify for the program; approximately what percentage do not apply for the incentive?

[DISPLAY Q43 IF Q41=1]

25. Why not?

26. Does your organization encourage the sale of high efficiency equipment?
    1. Yes
    2. No

[DISPLAY Q45 IF Q4441=1]

27. What are some examples of equipment that is encouraged?

[DISPLAY Q28 IF Q4441=1]

28. In what ways does your organization encourage the sale of high efficiency equipment?

[DISPLAY Q29 IF Q2841=1]

29. Are there challenges when trying to sell this equipment to customers?

30. What are their main concerns?

31. Has IGC provided you with marketing collateral to use with customers?
    1. Yes
    2. No

[DISPLAY Q32 IF Q3141=2]

32. Do you think those would be helpful?

[DISPLAY Q33 IF Q3141=1]

33. What type of collateral? Is it helpful?

34. What has been a successful strategy/approach in encouraging customers to choose high efficiency equipment over standard efficiency equipment?

FURNACE QUESTIONS

Now I'd like to ask you about your experience installing furnaces.

35. I'd like to ask you about the condition of furnaces you've replaced. Let's say there's three categories for the replaced furnaces: Fully functional, functioning but near-failure, and non-functioning. What percent of your projects fall into each of the

three categories? [REPEAT CATEGORIES AS NEEDED. ENSURE SUM TO 100%. REQUEST CLARIFICATION IF SUM DIFFERS]

36. In what percent of your projects are you simultaneously replacing a furnace and air conditioner?

37. [IF > 0%]: In these projects where you are replacing both systems, how often is the need for replacement driven by a failed furnace versus a failed air conditioner?

38. What barriers do homes face in installing a condensing furnace?

39. How often do you face substantial difficulties in installing the needed venting and drainage to support the installation of a condensing furnace?

40. Please elaborate.

41. Have you had any customers inquire about a condensing furnace, but then install standard efficiency because of the costs of venting and drainage?
    1. Yes
    2. No

[DISPLAY Q4226 IF Q4141=1]

42. How many times has this happened?

WATER HEATER QUESTIONS

43. The program requires a minimum of .90 UEF to qualify for rebates. Have you installed any tankless systems that are below .90 UEF in the last year? This would include systems that range from .82 to .89 UEF.
    1. Yes
    2. No

44. How much more does a .90 UEF tankless system cost to install than a .90 UEF system?

45. Have you had any customers inquire about a .90 UEF tankless system, but then choose not to install it because of the costs of venting and drainage?
    1. Yes
    2. No

[DISPLAY Q4626 IF Q4541=1]

46. About how many times has this happened?

[DISPLAY Q47 IF Q45=1]

47. When this happens what is the customer more likely to purchase- a storage tank system, or a .82 UEF tankless system?
    1. Storage Tank System
    2. .82 EUF Tankless System
    3. Other (Write In)

48. If a rebate were offered for .82 UEF systems, would it increase how many applications you submit to the program?
    1. Yes
    2. No
    98. Don't Know

[DISPLAY Q49 IF Q48=1]

49. What percent of these customers would have otherwise installed a storage tank?

[DISPLAY Q50 IF Q48=1]

50. What percent of these customers would have installed a .82 UEF tankless system anyway?

OVERALL PROGRAM

I just have a few final questions about the program.

51. What, if anything, do you find challenging about participating in this program?
52. What suggestions do you have to improve the IGC Energy Efficiency rebate program?
53. What feedback have you received from customers (positive and negative)? Do they have any suggestions for improving the program? [Probe for measure specific feedback]
54. Those are all the questions I have for you. Do you have anything else you want to mention to me in regards to the program?

5.3 Tabulations

5.3.1 Whole Home Measure Participant Survey Results

	Response	(n = 80)	Percent of Respondents
According to our records, you purchased the home located at [ADDRESS]. Is this correct?	Yes	80	100%
	No	0	0%
	Don't Know	0	0%

	Response	(n = 78)	Percent of Respondents
To buy your home, did you work directly with the builder, the builder's real estate agent, a personal real estate agent, a different real estate agent, or someone else?	Home builder	16	21%
	Builder's real estate agent	19	24%
	Personal Real Estate Agent	39	50%
	Different real estate agent	1	1%
	Someone else (Please specify)	3	4%
	Don't know	0	0%

	Response	(n = 80)	Percent of Respondents
Did you know the home you purchased was an ENERGY STAR® certified home promoted by IGC's energy efficiency program?	Yes	63	79%
	No	13	16%
	Don't Know	4	5%

	Response	(n = 62)	Percent of Respondents
How did you first learn that your home is ENERGY STAR® certified?	Home builder	43	69%
	Real estate agent	11	18%

	From IGC's website	0	0%
	Friend, family member, or colleague	1	2%
	Communication with IGC staff	0	0%
	IGC newsletter	0	0%
	Social media post (e.g., Facebook, Twitter, Flickr)	0	0%
	Through an internet search (e.g., Google search)	2	3%
	Through an internet advertisement	1	2%
	A radio or television advertisement	0	0%
	A print advertisement	2	3%
	Previous experience with IGC programs	0	0%
	Bill inserts	1	2%
	Intermountain Gas YouTube Channel	0	0%
	Community event	0	0%
	Media coverage (segment on TV, radio, vlog, blog, article, etc.)	0	0%
	Other (Please specify)	1	2%
	Don't know	0	0%

IGC would like to understand what buyers knew about the ENERGY STAR® certified new homes. For each of the following items, please select the response that best describes when you learned about it.	Response	n	Percent of Respondents
The house was promoted by IGC's energy efficiency program	(n = 77)		
	Knew It Before I Contacted the Builder or Real Estate Agent About Buying the Home	6	8%

	I Learned About It from The Builder or Real Estate Agent Before I Bought the Home	36	47%
	I Learned About It After Buying the Home	6	8%
	I Did Not Know About It Before Being Invited to Take This Survey	23	30%
	I Don't Know When I Learned About It	6	8%
The house has an ENERGY STAR® rating	(n = 79)		
	Knew It Before I Contacted the Builder or Real Estate Agent About Buying the Home	9	11%
	I Learned About It from The Builder or Real Estate Agent Before I Bought the Home	50	63%
	I Learned About It After Buying the Home	6	8%
	I Did Not Know About It Before Being Invited to Take This Survey	13	16%
	I Don't Know When I Learned About It	1	1%
The house was inspected by an independent certified Home Energy Rating System (HERS)	(n = 77)		
	Knew It Before I Contacted the Builder or Real Estate Agent About Buying the Home	4	5%
	I Learned About It from The Builder or Real Estate Agent Before I Bought the Home	32	42%
	I Learned About It After Buying the Home	10	13%
	I Did Not Know About It Before Being Invited to Take This Survey	18	23%
	I Don't Know When I Learned About It	13	17%
The house has a HERS score of [HERS_SCORE]	(n = 77)		
	Knew It Before I Contacted the Builder or Real Estate Agent About Buying the Home	3	4%

	I Learned About It from The Builder or Real Estate Agent Before I Bought the Home	29	38%
	I Learned About It After Buying the Home	9	12%
	I Did Not Know About It Before Being Invited to Take This Survey	28	36%
	I Don't Know When I Learned About It	8	10%

Did knowing that your home had a HERS score of [HERS_SCORE] influence your decision to purchase?	Response	(n = 31)	Percent of Respondents
	Yes	16	52%
	No	14	45%
	Don't Know	1	3%

Using the scale below, please rate the importance of the following factors in your decision to buy this home.	Response	n	Percent of Respondents
		(n = 80)	
Energy efficiency	1 - Not at all important	1	1%
	2	2	3%
	3	8	10%
	4	31	39%
	5 - Extremely important	38	48%
	Don't Know	0	0%
		(n = 80)	
House price	1 - Not at all important	0	0%
	2	0	0%
	3	5	6%

	4	21	26%
	5 - Extremely important	54	68%
	Don't Know	0	0%
		(n = 42)	
It was promoted through IGC's energy efficiency program	1 - Not at all important	3	9%
	2	6	17%
	3	13	37%
	4	8	23%
	5 - Extremely important	5	14%
	Don't Know	0	0%
		(n = 42)	
It has an ENERGY STAR® rating	1 - Not at all important	0	0%
	2	0	0%
	3	6	14%
	4	19	45%
	5 - Extremely important	17	40%
	Don't Know	0	0%
		(n = 42)	
It was inspected by an independent certified HERS rater	1 - Not at all important	3	8%
	2	1	3%
	3	7	19%
	4	14	39%
	5 - Extremely important	11	31%
	Don't Know	0	0%

		(n = 42)	
The home's HERS score	1 - Not at all important	2	5%
	2	4	11%
	3	6	16%
	4	18	49%
	5 - Extremely important	7	19%
	Don't Know	0	0%

Are you aware of any differences between homes promoted by IGC's energy efficiency program and other homes?	**Response**	**(n = 80)**	**Percent of Respondents**
	Yes	15	19%
	No	45	57%
	Don't know	20	25%

Using the scale below, how clearly were the energy efficient characteristics of the home explained to you by the person you worked with when purchasing your home?	**Response**	**(n = 79)**	**Percent of Respondents**
	1- Not at all clear	8	10%
	2	12	15%
	3	26	33%
	4	14	18%
	5- Very clear	16	20%
	Don't know	3	4%

Have you made any changes to the heating system equipment that was originally installed in your new home?	**Response**	**(n = 80)**	**Percent of Respondents**
	Yes	6	8%

	No	74	93%
	Don't Know	0	0%

	Response	(n = 80)	Percent of Respondents
Have you made any changes to the cooling system that was originally installed in your new home?	Yes	3	4%
	No	77	96%
	Don't Know	0	0%

	Response	(n = 80)	Percent of Respondents
Have you changed out any large appliances such as furnaces, water heaters, refrigerators, clothes washers, and dishwashers that came with the home?	Yes	8	10%
	No	72	90%
	Don't know	0	0%

	Response	(n = 80)	Percent of Respondents
Using the scale below, how informed would you say you are about energy efficiency practices and energy efficient products or improvement options for your household?	1- Not well informed	3	4%
	2	11	14%
	3	23	29%
	4	29	36%
	5- Very well informed	14	18%
	Don't know	0	0%

	Response	(n = 80)	Percent of Respondents
Using the scale below, how trustworthy is Intermountain Gas Company as a	1- Not very trustworthy	0	0%

source of information about saving energy in your home?	2	2	3%
	3	5	6%
	4	22	28%
	5- Very trustworthy	45	56%
	Don’t know	6	8%

Using the scale below, please rate your level of agreement or disagreement with these statements.	**Response**	**n**	**Percent of Respondents**
		(n = 78)	
Energy efficiency saves money	1	0	0%
	2	0	0%
	3	3	4%
	4	11	14%
	5	63	81%
	Don't Know	1	1%
		(n = 78)	
I am not very concerned about the amount of energy used in my home	1	44	55%
	2	21	26%
	3	3	4%
	4	9	11%
	5	2	3%
	Don't Know	1	1%
		(n = 80)	
	1	38	48%

I am too busy to worry about making energy-related improvements in my home	2	22	28%
	3	9	11%
	4	8	10%
	5	1	1%
	Don't Know	2	3%
		(n = 80)	
It is possible to be energy efficient without sacrificing comfort	1	3	4%
	2	1	1%
	3	8	10%
	4	28	35%
	5	40	50%
	Don't Know	0	0%
		(n = 80)	
I know of steps I could take to reduce my household energy use	1	2	3%
	2	7	9%
	3	18	23%
	4	27	34%
	5	22	28%
	Don't Know	4	5%
		(n = 80)	
I intend to reduce my household energy use in the next 12 months	1	9	11%
	2	14	18%
	3	25	31%
	4	20	25%

	5	10	13%
	Don't Know	2	3%
		(n = 80)	
It is not possible to make energy efficiency changes on my budget	1	21	26%
	2	21	26%
	3	22	28%
	4	8	10%
	5	3	4%
	Don't Know	5	6%

Using the scale below, please rate how dissatisfied or satisfied you are with each of the following …	Response	n	Percent of Respondents
		(n = 80)	
IGC's marketing efforts to promote its discounts on energy efficient products.	1 - Very dissatisfied	2	3%
	2	5	6%
	3	22	28%
	4	14	18%
	5 - Very satisfied	16	20%
	Don't Know	21	26%
		(n = 80)	
IGC overall as your gas service provider.	1 - Very dissatisfied	1	1%
	2	0	0%
	3	5	6%

	4	19	24%
	5 - Very satisfied	53	66%
	Don't Know	2	3%
		(n = 79)	
The ENERGY STAR® certified home promoted by IGC's energy efficiency program that you purchased in [YEAR].	1 - Very dissatisfied	2	3%
	2	0	0%
	3	7	9%
	4	21	27%
	5 - Very satisfied	45	57%
	Don't Know	4	5%
		(n = 80)	
Energy efficient measures of the home purchased.	1 - Very dissatisfied	1	1%
	2	0	0%
	3	3	4%
	4	17	21%
	5 - Very satisfied	57	71%
	Don't Know	2	3%

	Response	**(n = 80)**	**Percent of Respondents**
Who provides your home with electric service?	Idaho Power Company	73	91%
	Rocky Mountain Power	5	6%
	Fall River Rural Electric Cooperative	0	0%
	Idaho County Light and Power	0	0%
	Other (Please specify)	0	0%

	Don’t know	2	3%
	Prefer not to state	0	0%

Do you own or rent your home?	Response	(n = 80)	Percent of Respondents
	Own	79	99%
	Rent	1	1%
	Don’t know	0	0%
	Prefer not to state	0	0%

Including yourself, how many people currently live in your home year-round?	Response	(n = 80)	Percent of Respondents
	1	10	13%
	2	35	44%
	3	6	8%
	4	7	9%
	5	15	19%
	6	3	4%
	7	3	4%
	8	0	0%
	9 or more	0	0%
	Don't know	0	0%
	Refused	1	1%

Which of the following brackets contains your age?	Response	(n = 80)	Percent of Respondents

	19-24	0	0%
	25-34	14	18%
	35-49	21	26%
	50-64	16	20%
	65 or over	25	31%
	Don't know	0	0%
	Prefer not to state	4	5%

	Response	**(n = 79)**	**Percent of Respondents**
What is your approximate household income?	Less than $10,000	0	0%
	$10,000 to less than $20,000	0	0%
	$20,000 to less than $30,000	2	3%
	$30,000 to less than $40,000	2	3%
	$40,000 to less than $50,000	1	1%
	$50,000 to less than $60,000	6	8%
	$60,000 to less than $70,000	7	9%
	$70,000 to less than $80,000	3	4%
	$80,000 to less than $90,000	4	5%
	$90,000 to less than $100,000	4	5%
	$100,000 to less than $150,000	12	15%
	$150,000 to less than $200,000	7	9%
	$200,000 or more	10	13%
	Don't know	0	0%
	Prefer not to state	21	27%

	Response	(n = 80)	Percent of Respondents
What's the highest level of education you've completed?	Up to 8th grate	0	0%
	Some high school	0	0%
	High school or GED equivalent	1	1%
	Some college	9	11%
	Associate's degree	7	9%
	Bachelor's college degree	27	34%
	Master's degree	25	31%
	Professional degree (MD, JD, DDO, DDS)	5	6%
	Doctorate (Ph.D., D.Sc.)	1	1%
	Don't know	0	0%
	Prefer not to state	5	6%

5.3.2 Appliance Rebate Measure Participant Survey Results

	Response	(n = 137)	Percent of Respondents
According to our records you received a rebate through IGC's [PROGRAM] program for installing [MEASURE] at [LOCATION] in [YEAR]. Is that correct?	Yes	137	100%
	No	0	0%
	Don't Know	0	0%

	Response	(n = 136)	Percent of Respondents
How did you first learn about IGC's rebates for [MEASURE]s?	Friend, family member, or colleague	2	1%
	Contractor	64	47%

	Retailer	27	20%
	Bill insert or utility mailer	9	7%
	Email from IGC	0	0%
	IGC Newsletter	2	1%
	From IGC's website	13	10%
	Social media post (e.g., Facebook, Twitter)	1	1%
	Intermountain Gas Company YouTube channel	0	0%
	Through an internet search (e.g., Google search)	5	4%
	Through an internet advertisement	0	0%
	A radio or television advertisement	1	1%
	A print advertisement	2	1%
	Media coverage (segment on TV, radio, podcast, vlog, article, etc.)	1	1%
	Community event	0	0%
	Other (please specify)	5	4%
	Don't know	4	3%

	Response	**(n = 137)**	**Percent of Respondents**
When did you first learn about IGC's Energy Efficiency Rebate Program? Was it…	Before starting the process of purchasing the [MEASURE]	31	23%
	At the time you made the purchase decision.	36	26%
	After researching the product but before deciding to purchase.	19	14%
	After deciding to purchase [MEASURE]	43	31%
	Don't know	8	6%

	Response	(n = 137)	Percent of Respondents
Why did you purchase the model or type of [MEASURE]?	It was all that was available/only choice.	2	1%
	The contractor/retailer recommended it.	64	47%
	It was an emergency replacement.	21	15%
	It had an ENERGY STAR® label.	32	23%
	It was a planned replacement.	20	15%
	It's good for the environment.	30	22%
	It was the right size, color.	15	11%
	There was a rebate for it.	21	15%
	It costs less to operate it.	54	39%
	It had features I wanted.	45	33%
	It was a good price.	20	15%
	Other (Please specify)	6	4%
	Don't know	1	1%

	Response	(n = 137)	Percent of Respondents
Where did you obtain the rebate application?	From the IGC website	59	43%
	From another website	1	1%
	In a retail store	5	4%
	From a contractor	64	47%
	Other (Please specify)	2	1%
	Don't know	6	4%

Was your application accepted as-submitted, or did IGC follow up with you for clarifications or further information?	Response	(n = 137)	Percent of Respondents
	Accepted as submitted	111	81%
	Required follow up	17	12%
	Don't know	9	7%

Did you receive your rebate check in a prompt and timely manner?	Response	(n = 137)	Percent of Respondents
	Yes	123	90%
	No	4	3%
	Don't know	10	7%

Was this 95% furnace installation part of a larger project?	Response	(n = 80)	Percent of Respondents
	Yes, it was part of a larger replacement of my heating system.	26	33%
	Yes, it was part of a newly constructed home.	1	1%
	Yes, it was part of a remodeling project.	7	9%
	No, it was a stand-alone replacement.	43	54%
	AC and furnace	2	3%
	Furnace and Water Heater	1	1%
	Don't know	0	0%

What type of fuel source does your home's water heater use?	Response	(n = 80)	Percent of Respondents
	Natural Gas	58	73%
	Electricity	21	26%

	Propane	0	0%
	Other (Please specify)	0	0%
	Don't know	1	1%

What kind of water heater does your home have?	**Response**	**(n = 80)**	**Percent of Respondents**
	Tank water heater	72	90%
	Tankless water heater	4	5%
	Heat Pump water heater	1	1%
	Solar Powered water heater	0	0%
	Condensing water heater	0	0%
	Don't know	3	4%

How old is your home's water heater?	**Response**	**(n = 80)**	**Percent of Respondents**
	Less than 2 years old	25	31%
	2 to 4 years	13	16%
	5 to 9 years	16	20%
	10 to 14 years	11	14%
	15 to 19 years	7	9%
	20 or more years old	5	6%
	Don't know	3	4%

What type of thermostat does your home have?	**Response**	**(n = 80)**	**Percent of Respondents**
	Manual thermostat	4	5%

	Programmable thermostat	39	49%
	Smart thermostat	36	45%
	None	0	0%
	Don’t know	1	1%

Is the new 95% Furnace that you received a rebate for currently installed and working?	**Response**	**(n = 80)**	**Percent of Respondents**
	Yes	80	100%
	No	0	0%
	Don’t know	0	0%

Was the equipment that you replaced still functioning at the time you replaced it?	**Response**	**(n = 75)**	**Percent of Respondents**
	Yes	54	72%
	No	20	27%
	Don’t know	1	1%

Using the scale below, how satisfied are you with the performance of your new [95% Furnace]?	**Response**	**(n = 80)**	**Percent of Respondents**
	1 - Very Dissatisfied	6	8%
	2	1	1%
	3	0	0%
	4	11	14%
	5 - Very Satisfied	62	78%
	Don't Know	0	0%

	Response	(n = 6)	Percent of Respondents
Was this new radiant combo installation part of a larger project?	Yes, it was part of a larger replacement of my heating system.	2	33%
	Yes, it was part of a newly constructed home.	1	17%
	Yes, it was part of a remodeling project.	1	17%
	No, it was a stand-alone replacement.	2	33%
	Other (Please specify)	0	0%
	Don't know	0	0%

	Response	(n = 6)	Percent of Respondents
Is the new radiant combo that you received a rebate for currently installed and working?	Yes	6	100%
	No	0	0%
	Don't know	0	0%

	Response	(n = 5)	Percent of Respondents
Was the equipment that you replaced still functioning at the time you replaced it?	Yes	3	60%
	No	2	40%
	Don't know	0	0%

	Response	(n = 6)	Percent of Respondents
Using the scale below, how satisfied are you with the performance of your new radiant combo?	1 - Very Dissatisfied	0	0%
	2	0	0%
	3	0	0%

	4	1	17%
	5 - Very Satisfied	5	83%
	Don't Know	0	0%

	Response	(n = 5)	Percent of Respondents
Was this new fireplace installation part of a larger project?	Yes, it was part of a larger replacement of my heating system.	0	0%
	Yes, it was part of a newly constructed home.	0	0%
	Yes, it was part of a remodeling project.	1	20%
	No, it was a stand-alone replacement.	4	80%
	Other (Please specify)	0	0%
	Don't know	0	0%

	Response	(n = 5)	Percent of Respondents
Is the new Fireplace that you received a rebate for currently installed and working?	Yes	3	60%
	No	2	40%
	Don't know	0	0%

	Response	(n = 5)	Percent of Respondents
Did you have natural gas plumbed to this fireplace before the installation of your fireplace?	Yes	0	0%
	No	5	100%
	Don't know	0	0%

	Response	(n = 5)	Percent of Respondents
Using the scale below, how satisfied are you with the performance of your new fireplace?	1 - Very Dissatisfied	0	0%
	2	0	0%
	3	0	0%
	4	0	0%
	5 - Very Satisfied	5	100%
	Don't Know	0	0%

	Response	(n = 6)	Percent of Respondents
Was this new water heater installation part of a larger project?	Yes, it was part of a larger replacement of my heating system.	1	17%
	Yes, it was part of a newly constructed home.	0	0%
	Yes, it was part of a remodeling project.	0	0%
	No, it was a stand-alone replacement.	5	83%
	Other (Please specify)	0	0%
	Don’t know	0	0%

	Response	(n = 6)	Percent of Respondents
Is the new water heater that you received a rebate for currently installed and working?	Yes	6	100%
	No	0	0%
	Don’t know	0	0%

	Response	(n = 6)	Percent of Respondents

Was the water heater that you replaced still functioning at the time you replaced it?	Yes	4	67%
	No	2	33%
	Don't know	0	0%

Using the scale below, how satisfied are you with the performance of your new water heater?	**Response**	**(n = 6)**	**Percent of Respondents**
	1 - Very Dissatisfied	1	17%
	2	0	0%
	3	0	0%
	4	0	0%
	5 - Very Satisfied	5	83%
	Don't Know	0	0%

Was this new tankless water heater installation part of a larger project?	**Response**	**(n = 40)**	**Percent of Respondents**
	Yes, it was part of a larger replacement of my heating system.	7	18%
	Yes, it was part of a newly constructed home.	0	0%
	Yes, it was part of a remodeling project.	4	10%
	No, it was a stand-alone replacement.	27	68%
	Other (Please specify)	1	3%
	Don't know	1	3%

Is the new tankless water heater that you received a rebate for currently installed and working?	**Response**	**(n = 40)**	**Percent of Respondents**
	Yes	40	100%

	No	0	0%
	Don't know	0	0%

	Response	**(n = 36)**	**Percent of Respondents**
Was the equipment that you replaced still functioning at the time you replaced it?	Yes	21	58%
	No	15	42%
	Don't know	0	0%

	Response	**(n = 40)**	**Percent of Respondents**
Using the scale below, how satisfied are you with the performance of your new water heater?	1 - Very Dissatisfied	1	3%
	2	2	5%
	3	3	8%
	4	9	23%
	5 - Very Satisfied	25	63%
	Don't Know	0	0%

	Response	**(n = 137)**	**Percent of Respondents**
Who installed the [MEASURE_SHORT]?	I installed it.	8	6%
	A friend or family member installed it.	1	1%
	I hired a contractor to install it.	127	93%
	Other (Please specify)	0	0%
	Don't Know	1	1%

	Response	(n = 8)	Percent of Respondents
How did you learn to install the [MEASURE_SHORT]?	Prior occupational knowledge	3	38%
	Went to a workshop	0	0%
	Self-taught (You-tube videos, home courses, etc.)	5	63%
	Other (Please specify)	0	0%

	Response	(n = 109)	Percent of Respondents
How did you select the contractor who installed the [MEASURE_SHORT]?	I have hired this contractor for other work in the past.	50	46%
	The retailer recommended the contractor.	17	16%
	I researched online.	25	23%
	Friend or family member recommended the contractor.	17	16%

Using the scale below, please indicate how much you disagree or agree with the following statements regarding your experience with the contractor that installed the new [MEASURE_SHORT]:	Response	n	Percent of Respondents
		(n = 109)	
The contractor was courteous and professional	1 - Strongly Disagree	3	3%
	2	2	2%
	3	3	3%
	4	12	11%
	5 - Strongly Agree	89	82%
	Don't Know	0	0%
		(n = 109)	

The work was scheduled in a reasonable amount of time	1 - Strongly Disagree	2	2%
	2	2	2%
	3	2	2%
	4	10	9%
	5 - Strongly Agree	93	85%
	Don't Know	0	0%
		(n = 109)	
The work was completed in a reasonable amount of time	1 - Strongly Disagree	1	1%
	2	3	3%
	3	3	3%
	4	11	10%
	5 - Strongly Agree	91	83%
	Don't Know	0	0%
		(n = 108)	
The contractor was knowledgeable about the [MEASURE_SHORT]	1 - Strongly Disagree	2	2%
	2	2	2%
	3	4	4%
	4	16	15%
	5 - Strongly Agree	84	78%
	Don't Know	0	0%
		(n = 109)	
The contractor answered all my questions thoroughly.	1 - Strongly Disagree	1	1%
	2	3	3%
	3	4	4%
	4	16	15%

	5 - Strongly Agree	85	78%
	Don't Know	0	0%

	Response	(n = 100)	Percent of Respondents
What features of your new [MEASURE_SHORT] did your contractor emphasize to you?	Energy Efficiency	79	79%
	Low price	7	7%
	Rebate eligibility	46	46%
	Good warranty/reliability	61	61%
	Quiet operation	46	46%
	Emphasis on the brand and its reputation	45	45%
	Size of the equipment	33	33%
	Other (Please specify)	8	8%
	Don’t know	6	6%

	Response	(n = 137)	Percent of Respondents
What feature of your new [MEASURE_SHORT] matters most to you?	Energy Efficiency	111	81%
	Low price	24	18%
	Rebate eligibility	47	34%
	Good warranty/reliability	83	61%
	Quiet operation	61	45%
	Emphasis on the brand and its reputation	39	28%
	Size of the equipment	28	20%
	Other (Please specify)	17	12%
	Don’t know	2	1%

	Response	(n = 137)	Percent of Respondents
Using the scale below, how informed would you say you are about energy efficiency practices and energy efficient products/improvement options for your household?	1	1	1%
	2	7	5%
	3	35	26%
	4	56	41%
	5	36	26%
	Don't know	2	1%

	Response	(n = 135)	Percent of Respondents
Using the scale below, how trustworthy is IGC as a source of information about saving energy in your home?	1	0	0%
	2	3	2%
	3	6	4%
	4	42	31%
	5	76	56%
	Don't know	8	6%

Using the scale below, please rate your level of agreement or disagreement with these statements.	Response	n	Percent of Respondents
		(n = 135)	
Energy efficiency saves money.	1	7	5%
	2	1	1%
	3	6	4%
	4	28	21%

	5	92	68%
	Don't Know	1	1%
		(n = 137)	
I am not very concerned about the amount of energy used in my home.	1	71	52%
	2	40	29%
	3	13	9%
	4	6	4%
	5	7	5%
	Don't Know	0	0%
		(n = 136)	
I am too busy to worry about making energy-related improvements in my home.	1	70	51%
	2	31	23%
	3	22	16%
	4	10	7%
	5	3	2%
	Don't Know	0	0%
		(n = 137)	
It is possible to be energy efficient without sacrificing comfort.	1	4	3%
	2	4	3%
	3	14	10%
	4	33	24%
	5	80	58%
	Don't Know	2	1%
		(n = 137)	

I know of steps I could take to reduce my household energy use.	1	3	2%
	2	11	8%
	3	24	18%
	4	51	37%
	5	47	34%
	Don't Know	1	1%
		(n = 136)	
I intend to reduce my household energy use in the next 12 months.	1	3	2%
	2	16	12%
	3	62	46%
	4	33	24%
	5	16	12%
	Don't Know	6	4%
		(n = 136)	
It is not possible to make energy efficiency changes on my budget.	1	45	33%
	2	34	25%
	3	31	23%
	4	18	13%
	5	4	3%
	Don't Know	4	3%

Did someone in your household contact a program staff member from IGC with questions about your rebate application (this question does not pertain to your interaction with the contractor)?	**Response**	**(n = 137)**	**Percent of Respondents**
	Yes	23	17%
	No	102	74%

	Don't Know	12	9%

Using the scale below, please rate how dissatisfied or satisfied you are with each of the following …	Response	n	Percent of Respondents
		(n = 22)	
How long it took program staff to address your questions or concerns	1 - Very dissatisfied	0	0%
	2	1	5%
	3	4	18%
	4	2	9%
	5 - Very satisfied	15	68%
	Don't Know	0	0%
		(n = 22)	
How thoroughly they addressed your question or concerns	1 - Very dissatisfied	1	5%
	2	2	9%
	3	2	9%
	4	2	9%
	5 - Very satisfied	15	68%
	Don't Know	0	0%
		(n = 134)	
The performance of the equipment you installed overall	1 - Very dissatisfied	0	0%
	2	3	2%
	3	7	5%
	4	20	15%
	5 - Very satisfied	102	76%

	Don't Know	2	1%
		(n = 134)	
The energy savings on your utility bill resulting from installing the new [MEASURE_SHORT]	1 - Very dissatisfied	1	1%
	2	2	1%
	3	21	16%
	4	25	19%
	5 - Very satisfied	67	50%
	Don't Know	18	13%
		(n = 134)	
The rebate amount	1 - Very dissatisfied	5	4%
	2	3	2%
	3	19	14%
	4	32	24%
	5 - Very satisfied	68	51%
	Don't Know	7	5%
		(n = 133)	
The process for applying for the rebate	1 - Very dissatisfied	2	2%
	2	1	1%
	3	16	12%
	4	30	23%
	5 - Very satisfied	79	59%
	Don't Know	5	4%
		(n = 107)	
	1 - Very dissatisfied	1	1%

The overall quality of the work performed by your contractor	2	0	0%
	3	6	6%
	4	18	17%
	5 - Very satisfied	81	76%
	Don't Know	1	1%
		(n = 135)	
The time it took to receive the rebate	1 - Very dissatisfied	2	1%
	2	1	1%
	3	10	7%
	4	29	21%
	5 - Very satisfied	85	63%
	Don't Know	8	6%
		(n = 135)	
The experience with the program overall	1 - Very dissatisfied	2	1%
	2	2	1%
	3	7	5%
	4	32	24%
	5 - Very satisfied	89	66%
	Don't Know	3	2%
		(n = 135)	
Intermountain Gas Co. as your gas service provider	1 - Very dissatisfied	0	0%
	2	1	1%
	3	6	4%
	4	22	16%
	5 - Very satisfied	106	79%

	Don't Know	0	0%

	Response	(n = 137)	Percent of Respondents
Using the scale below, how would you say your participation in the Appliance Rebate program has affected your satisfaction with Intermountain Gas Company?	1- Greatly decreased your satisfaction with IGC	2	1%
	2	0	0%
	3	24	18%
	4	68	50%
	5- Greatly increased your satisfaction with IGC	39	28%
	Don't Know	4	3%

	Response	(n = 135)	Percent of Respondents
Who provides your home with electric service?	Idaho Power Company	126	93%
	Rocky Mountain Power	4	3%
	Fall River Rural Electric Cooperative	0	0%
	Idaho County Light and Power	0	0%
	Idaho Falls Power	4	3%
	Don't know	1	1%

	Response	(n = 136)	Percent of Respondents
Do you own or rent your home?	Own	135	99.3%
	Rent	0	0.0%
	Don't know	0	0.0%
	Prefer not to state	1	0.7%

	Response	(n = 137)	Percent of Respondents
Which best describes this building?	Single-family house detached from any other house	132	96%
	Single-family house attached to one or more other houses (e.g., duplex, condominium, townhouse)	4	3%
	Mobile or manufactured home	1	1%
	Apartment with 2 or 3 units	0	0%
	Apartment with 4 or more units	0	0%
	Other (Please specify)	0	0%
	Do not know	0	0%
	Prefer not to answer	0	0%

	Response	(n = 137)	Percent of Respondents
When was your home built?	Before 1960	23	17%
	1960 to1969	11	8%
	1970 to 1979	22	16%
	1980 to 1989	14	10%
	1990 to 1999	30	22%
	2000 to 2009	30	22%
	2010 to 2019	4	3%
	Do not know	1	1%
	Prefer not to answer	2	1%

	Response	(n = 136)	Percent of Respondents
About how many square feet is your home? If you are unsure, an estimate is OK.	Less than 1,000 square feet	5	4%
	1000-1999 square feet	64	47%
	2000-2999 square feet	45	33%
	3000-3999 square feet	13	10%
	4000 sq. ft or greater	6	4%
	Don't know	2	1%
	Prefer not to answer	1	1%

	Response	(n = 137)	Percent of Respondents
What is the main fuel used for heating your home?	Natural Gas	132	96%
	Electricity	4	3%
	Propane	0	0%
	Other (Please specify)	0	0%
	Do not know	1	1%
	Prefer not to answer	0	0%

	Response	(n = 137)	Percent of Respondents
What fuel does your main water heater use?	Natural Gas	109	80%
	Electricity	24	18%
	Propane	0	0%
	Other (Please specify)	0	0%
	Do not know	3	2%

	Prefer not to answer	1	1%

	Response	(n = 137)	Percent of Respondents
What is the main fuel used for cooking in your home?	Natural Gas	59	43%
	Electricity	77	56%
	Propane	0	0%
	Other (Please specify)	0	0%
	Do not know	1	1%
	Prefer not to answer	0	0%

	Response	(n = 137)	Percent of Respondents
Including yourself, how many people currently live in your home year-round?	1	22	16%
	2	68	50%
	3	21	15%
	4	14	10%
	5	6	4%
	6	3	2%
	7	1	1%
	8	0	0%
	9 or more	0	0%
	Don't know	0	0%
	Refused	2	1%

	Response	(n = 137)	Percent of Respondents
Which of the following brackets contains your age?	19-24	1	1%
	25-34	12	9%
	35-49	25	18%
	50-64	36	26%
	65 or over	58	42%
	Don't know	0	0%
	Prefer not to state	5	4%

	Response	(n = 136)	Percent of Respondents
What is your approximate household income?	Less than $10,000	2	1%
	$10,000 to less than $20,000	0	0%
	$20,000 to less than $30,000	7	5%
	$30,000 to less than $40,000	10	7%
	$40,000 to less than $50,000	13	10%
	$50,000 to less than $60,000	13	10%
	$60,000 to less than $70,000	11	8%
	$70,000 to less than $80,000	11	8%
	$80,000 to less than $90,000	4	3%
	$90,000 to less than $100,000	6	4%
	$100,000 to less than $150,000	18	13%
	$150,000 to less than $200,000	8	6%
	$200,000 or more	9	7%
	Don't know	2	1%

	Prefer not to state	22	16%

	Response	(n = 137)	Percent of Respondents
What's the highest level of education you've completed?	Up to 8th grate	0	0%
	Some high school	2	1%
	High school or GED equivalent	9	7%
	Some college	29	21%
	Associate's degree	8	6%
	Bachelor's college degree	47	34%
	Master's degree	25	18%
	Professional degree (MD, JD, DDO, DDS)	5	4%
	Doctorate (Ph.D., D.Sc.)	4	3%
	Don't know	1	1%
	Prefer not to state	7	5%

5.3.3 Nonparticipant Survey Results

	Response	(n = 159)	Percent of Respondents
According to our records, Intermountain Gas Company provides the natural gas service at your residence located at [ADDRESS]. Is that correct?	Yes	159	100%
	No	0	0%
	Don't Know	0	0%

	Response	(n = 148)	Percent of Respondents
In the last five years, have you received a rebate from Intermountain Gas Company			

or your electricity service provider for installing energy efficient equipment or making energy efficiency improvements for the residence located at [ADDRESS]?	No, I have not received any rebates	130	88%
	Yes, from Intermountain Gas Company [TERMINATE]	0	0%
	Yes, from my electricity service provider	7	5%
	Yes, from both [TERMINATE]	0	0%
	Don't know	11	7%

You mentioned you received a rebate from IGC. Which of the following?	**Response**	**(n = 0)**	**Percent of Respondents**
	Tank Water heater	0	#DIV/0!
	Fireplace	0	#DIV/0!
	Furnace	0	#DIV/0!
	Tankless water heater	0	#DIV/0!
	Combination radiant heat system	0	#DIV/0!
	Efficient Whole Home new construction	0	#DIV/0!
	Other (specify)	0	#DIV/0!
	Don't know	0	#DIV/0!

Do you use natural gas in your home located at [ADDRESS]?	**Response**	**(n = 155)**	**Percent of Respondents**
	Yes	149	96%
	No	2	1%
	Don't Know	4	3%

Which of the following best describes your home?	**Response**	**(n = 156)**	**Percent of Respondents**

	Single-family house detached from any other house	137	88%
	Single family house attached to one or more other houses (duplex, row house, condominium, or townhome)	8	5%
	Apartment in a building with 2 to 3 units	0	0%
	Apartment in a building with 4 or more units	5	3%
	Manufactured or mobile home	6	4%
	Other (Please specify)	0	0%
	Don't know	0	0%

	Response	(n = 145)	Percent of Respondents
Do you own, rent, or own and rent to someone else the property located at [LOCATION]?	Own	118	81%
	Rent	26	18%
	Own and rent to someone else	1	1%
	Don't know	0	0%

	Response	(n = 144)	Percent of Respondents
About when was the home first built?	Before 1960	23	16%
	1960 to1969	11	8%
	1970 to 1979	9	6%
	1980 to 1989	4	3%
	1990 to 1999	22	15%
	2000 to 2009	32	22%
	2010 to 2019	33	23%

	Do not know	10	7%

	Response	(n = 142)	Percent of Respondents
Please provide the estimated square footage of your house.	Less than 1,000 square feet	7	5%
	1000-1999 square feet	58	41%
	2000-2999 square feet	46	32%
	3000-3999 square feet	17	12%
	4000 square feet or greater	5	4%
	Don’t know	9	6%

	Response	(n = 158)	Percent of Respondents
What is the main fuel used for heating your home?	Natural Gas	136	86%
	Electricity	19	12%
	Propane	0	0%
	Other (Please specify)	0	0%
	Do not know	3	2%
	Prefer not to answer	0	0%

	Response	(n = 150)	Percent of Respondents
What is the main type of heating equipment used to provide heat for your home?	Heat pump	2	1%
	Central forced air furnace	138	87%
	Room or space heater	0	0%
	Something else (Please specify)	7	4%

	Don’t know	3	2%

	Response	(n = 145)	Percent of Respondents
How old is your heating system equipment? Your best estimate is fine.	Less than 2 years old	19	13%
	2 to 4 years	16	11%
	5 to 9 years	41	28%
	10 to 14 years	20	14%
	15 to 19 years	11	8%
	20 or more years old	20	14%
	Don’t know	18	12%

	Response	(n = 158)	Percent of Respondents
What fuel does your main water heater use?	Natural Gas	119	75%
	Electricity	25	16%
	Propane	0	0%
	Other (Please specify)	1	1%
	Do not know	13	8%
	Prefer not to answer	0	0%

	Response	(n = 153)	Percent of Respondents
How old is your main water heater? Your best estimate is fine.	Less than 2 years old	20	14%
	2 to 4 years	29	20%
	5 to 9 years	38	26%

	10 to 14 years	31	21%
	15 to 19 years	12	8%
	20 or more years old	9	6%
	Don't know	14	10%

	Response	(n = 146)	Percent of Respondents
What is the main fuel used for cooking in your home?	Natural Gas	66	45%
	Electricity	79	54%
	Propane	0	0%
	Other (Please specify)	0	0%
	Do not know	1	1%
	Prefer not to answer	0	0%

	Response	(n = 146)	Percent of Respondents
Does your home have an existing fireplace with a gas line connection?	Yes	76	52%
	No	69	47%
	Don't know	1	1%

	Response	(n = 54)	Percent of Respondents
Does your home's fireplace have a constant pilot light or an intermittent pilot light?	Yes	34	63%
	No	15	28%
	Don't know	5	9%

	Response	(n = 7)	Percent of Respondents
In the past three years, have you or anyone else in your household purchased, installed, or implemented any of the following equipment or home improvements at this residence?	95% AFUE Natural Gas Furnace	7	4%
	Combination Radiant Heat System	0	0%
	80% AFUE Fireplace	3	2%
	70% FE Fireplace	1	1%
	0.67 Water Heater	8	5%
	0.91 Tankless Water Heater	1	1%
	I have not done any of these	113	72%
	Other (Please specify)	1	1%
	Don’t know	29	18%

	Response	(n = 4)	Percent of Respondents
Was the following item(s) that you mentioned ENERGY STAR® certified or high efficiency?	95% AFUE Natural Gas Furnace	4	57%
	Combination Radiant Heat System	0	0%
	80% AFUE Fireplace	0	0%
	70% FE Fireplace	0	0%
	0.67 Water Heater	0	0%
	0.91 Tankless Water Heater	0	0%

	Response	(n = 158)	Percent of Respondents
Are you aware of any rebates for energy efficient equipment and home improvements or other services offered by a gas or electric utility?	Yes	14	9%
	No	117	74%
	Don’t know	27	17%

	Response	(n = 9)	Percent of Respondents
What types of rebates do you recall hearing about?	Heating and cooling equipment	9	64%
	Appliances such as refrigerators, clothes washers	7	50%
	Home weatherization improvements such as air or duct sealing	7	50%
	Discounts for efficient lighting	2	14%
	Low flow faucet aerators or showerheads	4	29%
	Other (Please specify)	0	0%
	Don't know	2	14%

	Response	(n = 3)	Percent of Respondents
How did you learn of these rebates or services	Information that came in the mail	3	21%
	Email	3	21%
	Newspaper or magazine article	0	0%
	Contractor	0	0%
	Word of mouth from friends, relatives, or others	2	14%
	TV ad	0	0%
	Radio ad	0	0%
	Social media (Facebook, Twitter)	1	7%
	Utility bill message	9	64%
	Utility website	3	21%
	Intermountain Gas YouTube channel	1	7%
	Other website	0	0%
	Utility program staff	3	21%

	Community event	2	14%
	Other (Please specify)	0	0%
	Don't know	1	7%

Using the scale below, how knowledgeable are you about ways to save energy in your home?	Response	(n = 158)	Percent of Respondents
	1 - Not at all knowledgeable	5	3%
	2	20	13%
	3	62	39%
	4	52	33%
	5 - Very Knowledgeable	16	10%
	Don't know	3	2%

Using the scale below, how much have you done to lower your monthly energy bill in your home?	Response	(n = 157)	Percent of Respondents
	1 - You have not done much	21	13%
	2	34	22%
	3	50	32%
	4	37	24%
	5 - You have done almost everything you can	14	9%
	Don't know	1	1%

Using the scale below, how interested are you in making improvements to your home that would...	Response	(n = 158)	Percent of Respondents
	1 - Not at all interested	33	21%
	2	23	15%

Increase its energy efficiency by using appliances powered by natural gas?	3	38	24%
	4	31	20%
	5 - Extremely interested	23	15%
	Don't Know	10	6%
		(n = 130)	
Improve your comfort by using appliances powered by natural gas?	1 - Not at all interested	32	25%
	2	18	14%
	3	30	23%
	4	27	21%
	5 - Extremely interested	14	11%
	Don't Know	9	7%
		(n = 130)	
Improve your health and safety by using appliances powered by natural gas?	1 - Not at all interested	29	22%
	2	21	16%
	3	29	22%
	4	26	20%
	5 - Extremely interested	16	12%
	Don't Know	9	7%

How would you find out ways to reduce your monthly energy bills?	**Response**	**(n = 24)**	**Percent of Respondents**
	From the utility customer service line	24	15%
	Utility website	66	42%
	Internet search	104	66%

	Social media	37	23%
	Government information	21	13%
	ENERGY STAR website	47	30%
	Friends, family, or colleagues	89	56%
	Information from a retail store	33	21%
	Magazines/newspapers/television/radio	28	18%
	Home energy audit	21	13%
	Other (Please specify)	3	2%
	Don't know	22	14%

Using the scale below, how likely is it that you would do any of the following in your home to reduce your utility bill?	**Response**	**(n = 159)**	**Percent of Respondents**
Add insulation in ceilings, walls, floors	1 - Very unlikely	49	31%
	2	17	11%
	3	30	19%
	4	20	13%
	5 - Very likely	28	18%
	Don't Know	15	9%
		(n = 148)	
Add weather stripping or caulking around doors and windows	1 - Very unlikely	20	14%
	2	11	7%
	3	22	15%
	4	26	18%
	5 - Very likely	62	42%

	Don't Know	7	5%
		(n = 146)	
Install energy efficient, double-pane windows	1 - Very unlikely	52	36%
	2	19	13%
	3	21	14%
	4	17	12%
	5 - Very likely	24	16%
	Don't Know	13	9%
		(n = 147)	
Insulate water heater tank and pipes	1 - Very unlikely	31	21%
	2	18	12%
	3	36	24%
	4	22	15%
	5 - Very likely	30	20%
	Don't Know	10	7%
		(n = 146)	
Install a programmable set-back thermostat or smart (Wi-Fi) thermostat	1 - Very unlikely	33	23%
	2	18	12%
	3	23	16%
	4	18	12%
	5 - Very likely	43	29%
	Don't Know	11	8%
		(n = 146)	
Sealing and insulation of ducts	1 - Very unlikely	45	31%

	2	14	10%
	3	35	24%
	4	21	14%
	5 - Very likely	21	14%
	Don't Know	10	7%
		(n = 146)	
Install a high efficiency central heating (furnace, boiler)	1 - Very unlikely	57	39%
	2	20	14%
	3	26	18%
	4	10	7%
	5 - Very likely	19	13%
	Don't Know	14	10%
		(n = 147)	
Clean or change your furnace filters once a month during heating season	1 - Very unlikely	15	10%
	2	7	5%
	3	21	14%
	4	21	14%
	5 - Very likely	77	52%
	Don't Know	6	4%
		(n = 146)	
Install glass doors on fireplace and close dampers when the fireplace is not in use	1 - Very unlikely	51	35%
	2	7	5%
	3	21	14%

	4	12	8%
	5 - Very likely	33	23%
	Don't Know	22	15%
		(n = 159)	
Install a high efficiency heat pump or air conditioner	1 - Very unlikely	59	37%
	2	25	16%
	3	27	17%
	4	20	13%
	5 - Very likely	18	11%
	Don't Know	10	6%
		(n = 150)	
Conduct regular maintenance of central heating or cooling system	1 - Very unlikely	13	9%
	2	11	7%
	3	31	21%
	4	33	22%
	5 - Very likely	55	37%
	Don't Know	7	5%
		(n = 150)	
Use low-flow showerhead or faucet aerators	1 - Very unlikely	38	25%
	2	24	16%
	3	26	17%
	4	16	11%
	5 - Very likely	36	24%
	Don't Know	10	7%

		(n = 150)	
Adjust thermostat settings	1 - Very unlikely	15	10%
	2	4	3%
	3	16	11%
	4	30	20%
	5 - Very likely	83	55%
	Don't Know	2	1%
		(n = 150)	
Buy energy efficient appliances	1 - Very unlikely	25	17%
	2	7	5%
	3	29	19%
	4	31	21%
	5 - Very likely	52	35%
	Don't Know	6	4%
		(n = 150)	
Close the drapes or cover windows to reduce heat gain or loss	1 - Very unlikely	14	9%
	2	6	4%
	3	21	14%
	4	23	15%
	5 - Very likely	84	56%
	Don't Know	2	1%
		(n = 149)	

Turn down water heater temperature	1 - Very unlikely	27	18%
	2	17	11%
	3	38	26%
	4	25	17%
	5 - Very likely	38	26%
	Don't Know	4	3%
		(n = 148)	
Install efficient lighting	1 - Very unlikely	17	11%
	2	6	4%
	3	26	18%
	4	22	15%
	5 - Very likely	71	48%
	Don't Know	6	4%
		(n = 149)	
Unplug appliances or electronics when not use	1 - Very unlikely	22	15%
	2	19	13%
	3	26	17%
	4	28	19%
	5 - Very likely	50	34%
	Don't Know	4	3%
		(n = 148)	
Install a smart power strip	1 - Very unlikely	23	16%
	2	11	7%

	3	33	22%
	4	22	15%
	5 - Very likely	46	31%
	Don't Know	13	9%
		(n = 149)	
Use cold water when doing laundry	1 - Very unlikely	20	13%
	2	11	7%
	3	25	17%
	4	29	19%
	5 - Very likely	59	40%
	Don't Know	5	3%

Are you planning to make any energy efficient updates in your home in the next year?	**Response**	**(n = 158)**	**Percent of Respondents**
	Yes	26	16%
	No	79	50%
	Don't know	53	34%

Using the scale below, how trustworthy is Intermountain Gas Company as a source of information about saving energy in your home?	**Response**	**(n = 159)**	**Percent of Respondents**
	1- Not at all trustworthy	0	0%
	2	1	1%
	3	17	11%
	4	28	18%
	5- Very trustworthy	94	59%
	Don't know	19	12%

	Response	(n = 155)	Percent of Respondents
Using the scale below, how interested are you in receiving additional information on energy saving tips and rebate programs offered by Intermountain Gas Company? Would you say…	1- Not at all interested	15	10%
	2	21	14%
	3	25	16%
	4	41	26%
	5- Very interested	48	31%
	Don't know	5	3%

	Response	(n = 79)	Percent of Respondents
Who provides your home with electric service?	Email	46	29%
	Utility Website	9	6%
	Bill insert	15	10%
	Utility newsletter	7	4%
	Telephone call	1	1%
	Text messages	0	0%
	None, I prefer to not receive information	1	1%
	Other (Please specify)	0	0%
	Don't know	0	0%

Using the scale below, please rate your level of agreement or disagreement with these statements.	Response	(n = 155)	Percent of Respondents
	1	2	1%
	2	0	0%

Energy efficiency saves money	3	15	10%
	4	30	19%
	5	105	68%
	Don't Know	3	2%
		(n = 145)	
I am not very concerned about the amount of energy used in my home	1	60	41%
	2	28	19%
	3	31	21%
	4	13	9%
	5	12	8%
	Don't Know	1	1%
		(n = 145)	
I am too busy to worry about making energy-related improvements in my home	1	53	37%
	2	40	28%
	3	37	26%
	4	9	6%
	5	4	3%
	Don't Know	2	1%
		(n = 145)	
It is possible to be energy efficient without sacrificing comfort	1	3	2%
	2	7	5%
	3	38	27%
	4	44	31%
	5	48	34%

	Don't Know	3	2%
		(n = 145)	
I know of steps I could take to reduce my household energy use	1	6	4%
	2	15	10%
	3	46	32%
	4	42	29%
	5	33	23%
	Don't Know	3	2%
		(n = 143)	
I intend to reduce my household energy use in the next 12 months	1	5	3%
	2	24	17%
	3	50	35%
	4	34	24%
	5	17	12%
	Don't Know	13	9%
		(n = 144)	
It is not possible to make energy efficiency changes on my budget	1	27	19%
	2	37	26%
	3	39	27%
	4	14	10%
	5	18	13%
	Don't Know	9	6%

	Response	(n = 159)	Percent of Respondents
Using a scale below, how satisfied are you with Intermountain Gas Company as your natural gas service provider?	1 - Very dissatisfied	0	0%
	2	1	1%
	3	11	7%
	4	32	20%
	5- Very satisfied	111	70%
	Don't Know	4	3%

	Response	(n = 159)	Percent of Respondents
Who provides your home with electric service?	Idaho Power Company	137	87%
	Rocky Mountain Power	15	10%
	Fall River Rural Electric Cooperative	1	1%
	Idaho County Light and Power	0	0%
	Other (Please specify)	3	2%
	Don't know	1	1%

	Response	(n = 147)	Percent of Respondents
Including yourself, how many people currently live in your home year-round?	1	22	15%
	2	50	34%
	3	27	18%
	4	19	13%
	5	14	10%
	6	9	6%

	7	2	1%
	8	2	1%
	9 or more	0	0%
	Don't know	0	0%
	Refused	2	1%

	Response	(n = 145)	Percent of Respondents
Which of the following brackets contains your age?	19-24	5	3%
	25-34	19	13%
	35-49	40	28%
	50-64	51	35%
	65 or over	28	19%
	Don’t know	0	0%
	Prefer not to state	2	1%

	Response	(n = 142)	Percent of Respondents
What is your approximate household income?	Less than $10,000	6	4%
	$10,000 to less than $20,000	6	4%
	$20,000 to less than $30,000	12	8%
	$30,000 to less than $40,000	9	6%
	$40,000 to less than $50,000	4	3%
	$50,000 to less than $60,000	15	11%
	$60,000 to less than $70,000	6	4%
	$70,000 to less than $80,000	9	6%

	$80,000 to less than $90,000	7	5%
	$90,000 to less than $100,000	3	2%
	$100,000 to less than $150,000	19	13%
	$150,000 to less than $200,000	10	7%
	$200,000 or more	6	4%
	Don't know	0	0%
	Prefer not to state	30	21%

	Response	(n = 139)	Percent of Respondents
What's the highest level of education you've completed?	Up to 8th grade	1	1%
	Some high school	1	1%
	High school or GED equivalent	11	8%
	Some college	34	24%
	Associate's degree	12	9%
	Bachelor's college degree	45	32%
	Master's degree	18	13%
	Professional degree (MD, JD, DDO, DDS)	2	1%
	Doctorate (Ph.D., D.Sc.)	5	4%
	Don't know	0	0%
	Prefer not to state	10	7%

EXHIBIT NO. 6

CASE NO. INT-G-20-06

INTERMOUNTAIN GAS COMPANY

2019 Energy Efficiency Cost-Effectiveness

(8 pages)

2019 Energy Efficiency Cost-Effectiveness

Introduction

Intermountain's Energy Efficiency Program (EE Program) offers individual customers a way to lower their usage and monthly energy bills. It additionally benefits all customers by ensuring resources are used efficiently which delays the need for expensive system upgrades and additional supply contracts, thereby keeping costs low for everyone. Cost-effectiveness testing is vital to ensuring the Company's EE Program is in fact a least-cost resource, and is integral to the design, implementation and success of the EE Program.

Intermountain initially launched the EE Program as a modest residential rebate offering. The original program allowed Intermountain to gauge customer interest in installing high-efficiency natural gas equipment and served as a starting point to refine and further develop cost-effective, relevant program offerings.

Following the launch of the EE Program, Intermountain commissioned an independent 3rd party to conduct a comprehensive Conservation Potential Assessment (CPA) to quantify energy efficiency resources available within the Company's service territory, to support both short-term energy efficiency planning and long-term resource planning activities, and to provide the most up-to-date market data for both the residential and commercial sectors. This study serves as the basis for modifications to current rebates that underperformed and was used to design new rebates and programs.

To improve the two most popular rebates, Intermountain also commissioned an Evaluation, Measurement and Verification (EM&V) study. The EM&V study provided data on actual savings related to the EE Program as well as insights that could be used to further refine and improve both the furnace and whole home rebates.

Cost-Effectiveness and Methodology

Intermountain's objective is for all rebates is to have benefit/cost ratios greater than one for the Utility Cost Test (UCT). The UCT measures cost-effectiveness from the utility company's perspective and takes into consideration avoided supply costs, program administration costs and incentives paid by the utility. Rebates undergo cost tests at several stages: preliminary design, implementation, and an annual review. For a different perspective, cost-effectiveness of rebates is also evaluated based on the customer's perspective using avoided supply costs, program administration costs and net participant costs, or the Total Resource Cost Test (TRC), but this is not the primary cost test used for decisions regarding the inclusion or exclusion of rebate offerings. In calculating the UCT and TRC, Intermountain relies on the calculations outlined in the *California Standard Practice Manual* and the National Action Plan for Energy Efficiency's (NAPEE) *Understanding Cost Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*.

Rebate characteristics such as estimated useful life, deemed therm savings, and incremental cost used for cost-effectiveness testing are provided by the CPA study for all rebates other than the furnace and whole home. Estimated therm savings for the furnace rebate and whole home are based on the EM&V impact evaluation. The rebate count used in the cost-effectiveness calculation is the actual number of rebates paid for the program year.

Cost-effectiveness of EE Program rebates is reviewed annually. The results are reported in the annual report and reviewed with the Energy Efficiency Stakeholder Committee (EESC). Rebate performance, cost-effectiveness, market insights and lessons learned, are taken into consideration when deciding whether to continue, revise or retire a rebate.

Assumptions

In calculating cost-effectiveness for each rebate and for the program as a whole, the Company relied upon several assumptions as well as studies provided by independent third-party sources. The section below discusses the key inputs in calculating cost-effectiveness under the UCT and the assumptions and sources used.

Energy Savings

Energy savings for each rebate are calculated by multiplying each rebate's gross annual therm savings by the total number of rebates issued. The energy savings are then valuated based on the Company's Avoided Cost. The Avoided Cost is used both to economically evaluate the present value of the therms saved over the life span of a rebate and to track the performance of the program as a whole. A more in-depth discussion of the Avoided Cost calculation and its components can be found in Case No. INT-G-20-06, Exhibit No. 3.

Rebate Costs

Total rebate costs are calculated by multiplying the value of each rebate by the number of rebates issued for the year.

Equipment & Installation Cost

The incremental equipment and installation costs are inputs to the TRC cost test and were provided by the CPA. These costs represent the incremental purchase and installation costs the participant will pay between a base case measure and a higher efficient alternative. These costs are not offset by the amount of the rebate received by the participant.

Program Delivery & Administration

Program delivery and administration costs are allocated to each rebate based on the percentage of the total annual portfolio of therm savings that rebate represents. Any cost incurred solely for a particular rebate will be directly assigned to that rebate.

Real Discount Rate

The real discount rate is used to account for the time-value of money and accurately compare costs. The real discount rate is based on the Company's tax-affected weighted average cost of capital. The calculation of the real discount rate can be found in Case No. INT-G-20-06, Exhibit No. 3, Page 17.

Inflation Rate

An inflation assumption is used in cost-effectiveness testing to convert nominal, forward-looking costs into real dollars. The company assumes an inflation rate of 2.0%, which is a standard value tied to the Consumer Price Index (CPI).

Net-to-Gross

Net-to-gross (NTG) is a ratio that adjusts the therm savings of rebates and/or programs, so they solely reflect energy efficiency gains that are the direct result of energy efficiency programs. The NTG deducts therm savings resulting from free-ridership, or savings that would have occurred regardless of the program. It also increases therm savings to account for spillover, or savings that occurred but were not counted by the program, as well as therm savings resulting from market transformation. Unfortunately, estimates of net savings require making sweeping assumptions to model a theoretical scenario where the EE Program did not exist. Because of the difficulty in accurately calculating NTG percentages, the Company used an NTG of 100% for all rebate and program cost-effectiveness analysis. Intermountain also performs a sensitivity analysis for each rebate that determines the minimum allowable NTG ratio where the rebate would remain (or become) cost effective under the Utility Cost Test.

Results

As stated previously, Intermountain uses the UCT as the primary measure for determining cost-effectiveness for each rebate offering and for the entire program. In its original filing of Case No. INT-G-20-06, the 2019 Energy Efficiency Program was not cost-effective, with a UCT of 0.87 (see the 2019 Annual Report, Page 9). After meeting with the EESC, the Company decided to amend its original filing of Case No. INT-G-20-06 to incorporate the final results of its EM&V study. This led to an update of the Whole Home and Furnace cost-effectiveness tests based on the results of the EM&V study.

As seen on Exhibit No. 6, Page 6, the UCT ratio for the 2019 Energy Efficiency Program increased to a cost-effectiveness of 1.3 (from the previously reported 0.87) as a result of incorporating the final results of the EM&V study. The UCT ratios for all rebates, as shown on Exhibit No. 6, Page 6, also changed from the ratios previously reported. These changes in cost-effectiveness are entirely related to the increase in annual therm savings (as determined in the EM&V study) for the Whole Home and Furnace rebates, and the resulting re-allocation of overhead costs based on therm savings. The updated cost-effectiveness results for the Whole Home and Furnace rebates are presented on Exhibit No. 6, Pages 7-8.

INTERMOUNTAIN GAS COMPANY

Residential Energy Efficiency Program

Program Year 2019 Cost-Effectiveness

Benefits

Lifetime Energy Savings by Rebate	Therm Savings	$ Savings (PV)
Whole Home	7,391,150	$ 1,979,645
Combi Radiant Heat System	26,103	7,490
Furnace	5,536,880	1,617,207
70% Fireplace	2,800	818
Water Heater	3,952	1,315
Tankless Water Heater	258,375	69,203
Total Energy Savings	**13,219,260**	**$ 3,675,678**

Costs

Costs by Rebate	# Rebates	Rebate Costs	Incremental Costs
Whole Home	1,079	$ 1,294,800	$ 2,284,243
Combi Radiant Heat System	11	11,000	38,742
Furnace	2,066	723,100	2,700,262
70% Fireplace	14	1,400	1,498
Water Heater	8	400	3,120
Tankless Water Heater	159	23,850	286,200
Total Rebate & Incremental Costs		**$ 2,054,550**	**$ 5,314,065**

Program Delivery & Administration Costs	Cost
Total Program Delivery & Administration Costs	**$ 748,795**

Cost-Effectiveness

Program Cost-Effectiveness	Benefit	Cost	Ratio
Utility Cost Test	$ 3,675,678	$ 2,803,345	1.3
Total Resource Cost Test	3,675,678	6,062,860	0.6

Utility Cost Test by Rebate	Benefit	Cost	Ratio
Whole Home	$ 1,979,645	$ 1,673,540	1.2
Combi Radiant Heat System	7,490	12,592	0.6
Furnace	1,617,207	1,077,754	1.5
70% Fireplace	818	1,579	0.5
Water Heater	1,315	789	1.7
Tankless Water Heater	69,203	37,090	1.9

INTERMOUNTAIN GAS COMPANY

Residential Energy Efficiency Program

Whole Home - 2019 Cost-Effectiveness

Benefits

Energy Savings		
Annual Energy Savings (therms)		295,646
Lifetime Energy Savings (therms)		7,391,150
Present Value of Energy Savings	S	**$ 1,979,645**

Costs

Rebate Costs		
Rebate Amount		$ 1,200
Rebate Count		1,079
Total Rebate Costs	R	**$ 1,294,800**
Equipment & Installation Costs		
Incremental Cost Per Unit		$ 2,117
Total Equipment & Installation Costs	I	**$ 2,284,243**
Program Delivery & Administration		
Overhead Expenses[1]		$ 378,740
Direct Costs		$ -
Total Program Delivery & Administration Costs	A	**$ 378,740**

Cost-Effectiveness Tests

	Benefits	Costs	Ratio
Utility Cost Test	$ 1,979,645	$ 1,673,540	1.2
Total Resource Cost Test	$ 1,979,645	$ 2,662,983	0.7

Equations & Assumptions

Utility Cost Test	= S x NTG ÷ (R + A)
Total Resource Cost Test	= S x NTG ÷ (I x NTG + A)
Real Discount Rate	4.68%
Inflation Rate	2.00%
Net-to-Gross (NTG)	100%
Net-to-Gross Sensitivity[2]	85%

NOTES

[1]Allocated based on percentage of annual portfolio therm savings.

[2]Minimum NTG value where rebate remains cost-effective under UCT.

INTERMOUNTAIN GAS COMPANY

Residential Energy Efficiency Program

Furnace - 2019 Cost-Effectiveness

Benefits

Energy Savings		
Annual Energy Savings (therms)		276,844
Lifetime Energy Savings (therms)		5,536,880
Present Value of Energy Savings	S	**$ 1,617,207**

Cost-Effectiveness Tests

	Benefits	Costs	Ratio
Utility Cost Test	$ 1,617,207	$ 1,077,754	1.5
Total Resource Cost Test	$ 1,617,207	$ 3,054,916	0.5

Costs

Rebate Costs		
Rebate Amount		$ 350
Rebate Count		2,066
Total Rebate Costs	R	**$ 723,100**
Equipment & Installation Costs		
Incremental Cost Per Unit		$ 1,307
Total Equipment & Installation Costs	I	**$ 2,700,262**
Program Delivery & Administration		
Overhead Expenses[1]		$ 354,654
Direct Costs		$ -
Total Program Delivery & Administration Costs	A	**$ 354,654**

Equations & Assumptions

Utility Cost Test	= S x NTG ÷ (R + A)
Total Resource Cost Test	= S x NTG ÷ (I x NTG + A)
Real Discount Rate	4.68%
Inflation Rate	2.00%
Net-to-Gross (NTG)	100%
Net-to-Gross Sensitivity[2]	67%

NOTES

[1]Allocated based on percentage of annual portfolio therm savings.

[2]Minimum NTG value where rebate remains cost-effective under UCT.

EXHIBIT NO. 7

CASE NO. INT-G-20-06

INTERMOUNTAIN GAS COMPANY

Proposed Residential Energy Efficiency Program Revisions

(9 pages)

Intermountain Gas Company

Proposed Residential EE Program Revisions

Based on the recommendations from the EM&V study (see Exhibit No. 5) performed by ADM Associates, Inc. (ADM), input from the Energy Efficiency Stakeholder Committee (EESC) (see Exhibit No. 4), and other resources such as the 2019 Idaho Residential Energy Code Field Study (see Exhibit No. 8), the ADM "Residential Whole Home Modeling Results" memorandum (see Exhibit No. 8), the Idaho Code Collaborative, and upcoming energy code changes, the Company plans to update its Residential Energy Efficiency Program (EE Program) by retiring, adding to and revising its current set of rebates. Following is an outline of the proposed program in detail.

No changes:

- **Furnace** -The only rebate offering that remains unchanged is the furnace rebate of $350 for a natural gas furnace with a 95% AFUE minimum efficiency rating. The EM&V impact evaluation of the furnace rebate found savings of 134 therms per rebate based on the Equivalent Full Load Hours for Heating (EFLH) approach recommended by ADM (see Exhibit No. 5, page 84). The EM&V study recommended that additional information be required on the furnace rebate application to determine the efficiency of the equipment being replaced as well as the reason for replacement, such as replace-on-burnout, early retirement, or new construction. The EM&V study also identified HVAC sizing as an area for contractor training as over-sizing, a common practice in Climate Zone 5, negatively affects program savings (see Exhibit No. 5, page 32). Additionally, the EESC suggested collecting the size of the equipment being replaced (see Exhibit No. 4, page 10). Collecting these additional data points should help provide a more complete picture from which to evaluate savings attributed to the furnace rebate in the future. The billing analysis conducted by ADM provided measurable savings, "However, the observable energy savings through billing analysis are much lower than expected equipment savings. Billing analyses include any changes in household behavior, equipment, or occupancy, and therefore may include factors other than the impact of improved equipment efficiency" (see Exhibit No. 5, page 32). Because of the large variation in therm savings between the Billing Analysis approach and the EFLH approach, the Company has decided to collect the additional information noted above to help provide a more refined EM&V analysis in the future. In the meantime, Intermountain will use the 2019 Conservation Potential Assessment (CPA) annual therm saving estimate of 87 therms as a conservative therm savings estimate for this rebate. The furnace rebate has shown consistent growth year-over-year, and the amount of furnace rebates year-to-date for 2020 has already exceeded the 2,066 rebates issued in 2019. The cost-effectiveness tests were based on an estimate of 2,500 rebates for 2021.

Retirements:

- **70% Fireplace** -The 70% FE Fireplace rebate had very low participation over the life of the offering with 13 and 14 units installed in 2018 and 2019, respectively. While some customers may use a fireplace insert as a substitute heat source, fireplace inserts are designed to be a decorative feature and are therefore not normally rated for energy efficiency, or if rated, there is not a standard efficiency rating applied to all fireplace inserts. Based on the findings of the CPA, updated annual therm savings were reduced from 56 therms to 10 therms, and to be cost-effective only a minimal incentive could be offered which would make this an ineffective offering. When presented to the EESC in the October 27 meeting, the Committee had no objections to Intermountain's proposal to retire this rebate (Exhibit No. 4, Page 13).

Additions:

The Company proposes the addition of three new rebates to its Residential EE Program. Unless specifically stated, all rebate inputs for cost-effectiveness testing were based on the 2019 CPA.

- **Smart Thermostat** – The smart thermostat has consistently been the most frequently requested appliance rebate by HVAC contractors, customers, and members of the EESC. It was also included as a recommended program addition in the Company's EM&V study (see Exhibit No. 5, Page 143). The proposed rebate is $100 for a wi-fi enabled smart thermostat with estimated annual savings of 44 therms per appliance. Discussions with the EESC at the September 16 committee meeting revealed the CPA estimated useful life (EUL) of 8 years for the appliance was far too low, and ADM recommended an EUL of 11 years (see Exhibit No. 4, Page 11). The Company believes the smart thermostat will complement other space heating rebates, and therefore the Company used a participation estimate of 2,500 thermostat rebates in 2021 for cost-effectiveness testing.

- **Boiler** – Based on customer and HVAC contractor feedback, the addition of a residential boiler rebate will provide a high-efficient space heating option for those customers that do not have a forced air furnace, and cannot utilize the combination space and water heat system rebate because water used for domestic purposes cannot also be used for space heat. The EESC supported adding this equipment rebate when it was presented at the October 27 meeting (see Exhibit No. 4, Page 13). The proposed rebate is for $800, requires a minimum efficiency of 95% AFUE, and has an estimated annual savings of 159 therms. As a first time offering, the Company estimated 25 rebate applications in 2021 for cost-effectiveness testing.

- **Tankless Water Heater – Tier II** – One of the recommendations of the EM&V study was to explore opportunities to add a tankless water heater at a lower price point than the current offering (see Exhibit No. 5, Page 143). An additional tankless water heater rebate will provide customers another high-efficient water heating option at a slightly lower estimated incremental cost of $1,152 for an 0.87 UEF tankless water heater compared to the 0.91 UEF tankless water heater with an estimated incremental cost of $1,800 that is currently included in the Company's program. The proposed rebate is for $300, requires a minimum efficiency of 0.87 UEF, and has an estimated annual savings of 58 therms. The Company estimated a participation level of 200 rebates in 2021 for cost-effectiveness testing.

Revisions:

Intermountain proposes to revise the following four rebates.

- **Storage** W**ater Heater** – Based on the 2019 CPA, annual therm savings for this rebate have increased from 22 therms to 38 therms while EUL has decreased from 16 years to 13 years. The Company proposes to increase the 0.68 UEF (previously 0.67 EF) water heater rebate from $50 to $115 and anticipates that this increase will encourage more participation from the 2019 level of 8 rebates. The Company estimated 50 rebates in 2021 for cost-effectiveness testing. The efficiency rating will be updated from Energy Factor (EF) to Uniform Energy Factor (UEF) to be consistent with the Department of Energy's industry standard for measuring energy efficiency in water heaters. This new standard required new testing procedures that resulted in consistent standards for measuring energy efficiency performance, a better reflection of real-world results that impact energy efficiency ratings, apples-to-apples-comparison of water heaters, and a simplified water heater selection process.

- **Tankless Water Heater-Tier I –** Based on increased estimated annual therm savings (from 58 to 65 therms) and increased EUL (from 18 years to 25 years) identified in the CPA, the Company proposes to increase this rebate from $150 to $325. Due to offering an additional tankless water heating option, the number of rebates estimated for 2021 is lower than the number of rebates paid in 2019 or during 2020. The Company estimated 100 rebates will be paid in 2021 for cost-effectiveness testing. The efficiency rating will be updated from EF to UEF for the reasons outlined above.

- **Combination Boiler for Space and Water Heat** - This equipment rebate, with a requirement of "90% or greater efficiency condensing tankless combo system for space and water heat," has had low participation, 3 and 11 rebates in 2018 and 2019, respectively, and has been one of the more misunderstood offerings, both from an equipment standpoint and application standpoint. Intermountain has received applications where HVAC contractors have installed two tankless appliances, negating the minimum requirement of one appliance serving both space *and* water heat. The Company has also received applications where a boiler was installed, negating the tankless requirement. Since a combination system can be served by either a tankless water heater, or a combination boiler, the Company proposes to clarify this rebate by requiring a combination boiler, designed for both space and water heat. The proposed rebate is for $800, requires a minimum efficiency of 95% AFUE, and has an estimated annual therms savings of 155 therms. The Company estimated a participation level of 25 rebates in 2021 for cost-effectiveness testing.

- **Whole Home** - The new construction rebate, Whole Home, is the Company's most revised rebate offering proposal. Restructuring of the rebate was based on EM&V recommendations to increase efficiency requirements to keep up with code improvements and to isolate the therm saving features in new construction. The Company also considered therm saving opportunities identified in the evaluation of current building practices in the 2019 Idaho Residential Energy Code Field Study (see Exhibit No. 8), the energy code requirements that will become effective January 2021, and feedback from the EESC. In addition, Intermountain commissioned a follow-up study by ADM to identify potential therm savings of a variety of therm saving requirements (see Exhibit No. 8). One of the more significant changes to the rebate is the retirement of the Energy Star Certification. The EM&V study recommended removing the ENERGY STAR certification requirement as it "seems to be a barrier to builder participation" (Exhibit No. 5, p. 12). Due to code improvements to be implemented in January 2021, therm savings for the proposed offering are reduced from the estimated 274 therm savings identified in the EM&V study (see Exhibit No. 5, Page 85). Subsequently the rebate amounts have also been reduced from $1,200 to $900 for the proposed Tier I rebate and $700 for the proposed Tier II rebate.

Under the current program, new construction and appliance rebates are mutually exclusive. The Company proposes to allow Whole Home participants to layer on the smart thermostat and/or water heating rebates to capture additional therm savings. The Company proposes the following two-tiered new construction offering with specific requirements:

Whole Home Tier I - $900 (Estimated annual therm savings of 161)

- HERS rated
- Air sealing at or below 3 ACH at 50 Pa
- Ceiling insulation at or above R-49
- Ducts and air handler located inside conditioned space or duct leakage to outside of less than 4 CFM25/100 ft2 CFA
- Furnace efficiency at or above 97% AFUE

Whole Home Tier II - $700 (Estimated annual therm savings of 128)

- HERS rated
- Air sealing at or below 4 ACH at 50 Pa
- Ducts and air handler located inside conditioned space or duct leakage to outside of less than 4 CFM25/100 ft2 CFA
- Furnace efficiency at or above 95% AFUE

Both tiers of the rebate will require the home to be HERS scored, but no specific HERS threshold is required. Since the EM&V evaluation found a lower HERS score did not correlate with more therm savings and lower HERS scores could be achieved by implementing non-energy saving measures, setting a specific HERS threshold requirement appeared to not be directly related to therm savings (see Exhibit No. 5, Page 74). While the HERS score threshold is not related to exact therm savings, requiring that the home be HERS scored is important. The HERS score is a way for builders to quantify and certify a home's energy performance, and it is a simple, transparent way for consumers to easily compare homes based on energy efficiency performance, much like comparing cars based on a miles-per-gallon formula. Builders having homes HERS scored, one indication of energy efficient home building, is not yet a common building practice in Idaho. According to RESNET, in 2019 only 14% of all new home starts received a HERS score. Intermountain believes the requirement to have the home HERS scored will help to educate both customers and builders on energy efficient building. Requiring a HERS certificate will also provide an efficient and reliable process for the Company to verify compliance with the proposed program requirements that do affect therm savings. A HERS score can only be obtained by a certified home energy rater, who is subject to certification, quality control, and quality assurance by the governing body RESNET. In addition, the specific requirements added to the proposed rebate are all components of a HERS score and will not require additional tests be conducted or additional documentation be provided by the builder to enable Intermountain to verify that the rebate requirements have been met.

The proposed specific requirements will be an above-code stretch for builders since the 2018 amended IECC Idaho code will require 5 ACH, R-38 insulation, and 4 CFM25/100 ft2 CFA. Standard equipment efficiency for furnaces is still 80% AFUE. While not a building code requirement, the 95% and 97% AFUE furnace requirements proposed by Intermountain are significant high-efficient equipment upgrades from the standard. In the Residential Whole Home Modeling Results Memo by ADM, evaluators found “the individual component that contributes the largest magnitude of savings is the movement of ducts and air handler to conditioned space” (Exhibit 8, page 9). The EESC and the 2019 Idaho Residential Energy Code Field Study (Field Study) identified ACH and duct leakage as energy saving opportunities for Idaho residential building. Due to some of the builder challenges inherent in moving HVAC systems to conditioned space, and current building practices of locating the furnace in the garage rather than in conditioned space, the Company and the EESC agreed it was important to provide builders with an option for reducing duct leakage to outside. When moving the entire HVAC systems into conditioned space is not an option, an alternative energy saving route is provided by setting an above code duct leakage target of “less than 4 CFM25/100 ft2 CFA for duct leakage to outside.” It is important to specify duct leakage to outside (LTO) versus total duct leakage (TL). Idaho code currently only tests for total duct leakage. Minimizing total duct leakage allows for management of static pressures and controlling designed air flows, which are essentially comfort issues. While homeowner comfort is important, leakage to outside keeps unconditioned air outside and conditioned air inside, which is an energy saving and cost issue.

The duct leakage requirement will not only incent energy and cost savings for homeowners, as much as 22 therms per home based on statewide annual measure-level savings according to the Field Study (Exhibit No.8, p. 58), but also promote improved building practices in general. In addition to the highest total energy and cost savings potential, the Field Study found "reductions in duct leakage represent a significant area for improvement and should be given increased attention in future training and enforcement" (Exhibit No 8, Page 54) as the majority of observations did not meet code requirement.

Increased air sealing measured by Air Change per Hour (ACH) was the second largest incremental savings identified by ADM and contributes 10 to 30% of total household energy savings (Exhibit No. 8, Page 9). Tier I will require a more energy efficient air change target of 3 ACH and Tier II will require 4 ACH. Both proposed ACH requirements are above the 2021 building code requirement of 5 ACH.

The next largest contributor of therm savings is ceiling insulation (see Exhibit No. 8, Page 9). Only the highest therm saving rebate offering, Tier I, will require the installation of R-49 ceiling insulation. Currently, Idaho Code only requires R-38 ceiling insulation and only in Climate Zone 6. ADM's analysis found the R-49 ceiling insulation upgrade, as part of an integrated energy efficient home design, contributed an estimated 10 therms to total savings. For those builders that do not want to invest in a ceiling insulation upgrade, the Tier II rebate will still provide a rebate opportunity for energy efficient home building.

This two-tiered approach will provide two rebate options for new construction of energy efficient homes. The Tier I whole home rebate has an estimated annual therm savings of 161 therms, while Tier II has 128 as calculated by ADM (see Exhibit No. 8, page 10). The EUL of 25 years and $2,117 estimated incremental cost of energy efficient new construction provided by the CPA will be used in cost-effectiveness calculations. High level calculations estimate that retiring the ENERGY STAR certification requirement and instead implementing the specific rebate requirements outlined here, are equitable incremental costs. For cost-effectiveness testing, an estimate of 600 rebates each was used for Tier I and Tier II participation. It is anticipated that alleviating a market barrier to participation by retiring ENERGY STAR certification will result in an increase in participation. The estimate of 1,200 total homes in 2021, is conservatively greater than 2019 participation of 1,079 homes, but less than 2020 year-to-date participation numbers.

Conclusion

The resulting proposed Residential EE Program, including cost-effectiveness, can be seen on Exhibit No. 7, Page 9. As proposed in the Commercial EE Program filing, the Company estimates that its program delivery and administration costs will be approximately $848,000 to be split 80% to the residential program and 20% to the proposed commercial program (which is currently before the Commission as Case No. INT-G-20-04). The Company estimates that 2021 rebate costs will be approximately $2.2M as seen on Exhibit No. 7, Page 9, Column (h). Intermountain measures the cost-effectiveness of the proposed program using the Utility Cost Test (UCT). As seen on Exhibit No. 7, Page 9, Column (i), all proposed rebates, as well as the proposed Residential EE Program in total, are cost-effective with UCT ratios of 1 or greater.

INTERMOUNTAIN GAS COMPANY
Proposed Residential Energy Efficiency Program

Line No.	Rebate	Rebate Type	Minimum Efficiency Rating	Forecasted Rebates	Annual Therm Savings per Rebate	Total Annual Therm Savings	Proposed Incentive	Total Rebate Costs	Estimated UCT
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	Whole Home Tier I	New Construction	TIER I[1]	600	161	96,600	$ 900	$ 540,000	1.0
2	Whole Home Tier II	New Construction	TIER II[2]	600	128	76,800	700	420,000	1.0
3	Combination Boiler for Space and Water Heat	Space Heating	95% AFUE	25	155	3,875	800	20,000	1.0
4	Furnace	Space Heating	95% AFUE	2,500	87	217,500	350	875,000	1.1
5	Boiler	Space Heating	95% AFUE	25	159	3,975	800	20,000	1.1
6	Storage Water Heater	Water Heating	.68 UEF	50	38	1,900	115	5,750	1.0
7	Tankless Water Heater Tier I	Water Heating	.91 UEF	100	65	6,500	325	32,500	1.1
8	Tankless Water Heater Tier II	Water Heating	.87 UEF	200	58	11,600	300	60,000	1.0
9	Smart Thermostat	Thermostat	Wi-Fi Enabled	2,500	44	110,000	100	250,000	1.1
10	Total			6,600		528,750		$ 2,223,250	1.0

NOTES

[1] Tier I requirements: HERS rated
Air sealing at or below 3 ACH at 50 Pa
Ceiling insulation at or above R-49
Ducts and air handler located inside conditioned space *or* duct leakage to outside of less than 4 CFM25/100 ft2 CFA
Furnace efficiency at or above 97% AFUE

[2] Tier II requirements: HERS rated
Air sealing at or below 4 ACH at 50 Pa
Ducts and air handler located inside conditioned space *or* duct leakage to outside of less than 4 CFM25/100 ft2 CFA
Furnace efficiency at or above 95% AFUE

EXHIBIT NO. 8

CASE NO. INT-G-20-06

INTERMOUNTAIN GAS COMPANY

Residential Energy Efficiency Program Design Support

(76 pages)

RESIDENTIAL WHOLE HOME MODELING RESULTS

(10 pages)

Memorandum: Residential Whole Home Modeling Results

Prepared for:
Intermountain Gas Company

November 17, 2020

Prepared by:

ADM Associates, Inc.

A. Whole Home Analysis

This memorandum summarizes an exploratory analysis for Intermountain Gas Company (IGC) Whole Home program. The Evaluators sought to estimate savings for the program with baseline building codes updated to reflect those of which will be in effect in the upcoming program year. In addition, the Evaluators explored a range of additional program requirements that could be enforced to increase per-household savings.

This analysis was requested to explore program requirements for future program years in hopes of increasing savings per household, as well as increasing program cost effectiveness. In this analysis, the Evaluators compared simulated savings with several component requirements that are easy to test, measure, and enforce.

The Evaluators provide a recommendation of a two-tiered rebate offering in which program household requirements are incrementally increased to increase program savings. The Evaluators believe the provided recommendations will increase program savings and cost effectiveness, leading to the success of the program.

The Evaluators recommend the following combination of requirements as the first-tier rebate offering in future program years:

- Air sealing at or below (3 ACH at 50 Pa)
- Ceiling insulation at or above (R49)
- Ducts and air handler located inside conditioned space
- Furnace efficiency at or above 97% AFUE
- Change rebate incentive to $1,000

An incentive of $1,000 would allow IGC to produce sufficient UCT benefits to pass the UCT based on IGC's commodity costs and WACC specified in their 2019-2023 Integrated Resource Plan (IRP). This rebate offering will also allow suitable budget for home outreach and administration costs.

The Evaluators recommend the following combination of requirements as the second-tier rebate offering in future program years:

- Air sealing at or below (4 ACH at 50 Pa)
- Ducts and air handler located inside conditioned space
- Furnace efficiency at or above 95% AFUE
- Change rebate incentive to $800

An incentive of $800 would allow IGC to produce sufficient UCT benefits to pass the UCT based on IGC's commodity costs and WACC specified in their 2019-2023 IRP. This rebate offering will also allow suitable budget for home outreach and administration costs.

A.1. Program Summary

The Whole Home program had previously undergone an evaluation for the 2018 and 2019 program years. A billing analysis was used to estimate household program savings. A simulation analysis was completed to compare to the results of the billing analysis. The billing analysis resulted in significantly lower household savings than the program had anticipated.

In addition, on January 1, 2020, the Idaho Division of Building Safety had accepted the 2018 International Energy Conservation Code (IECC) with Idaho Amendments to replace the current 2012 IECC with Idaho Amendments residential building code, effective January 1, 2021. Due to these results and changes, the

Evaluators explored simulated household savings against this new baseline to project household savings in the next program year. Table A-1 presents the overall ex ante, ex post, and projected savings by analysis type.

Table A-1 Ex Ante and Ex Post Program Home Savings by Analysis Type

Incentive per Rebate	Ex Ante Savings per Rebate (Therms)	Billing Analysis Savings per Rebate (Therms)	2012 IECC Simulated Savings per Rebate (Therms)	2018 IECC Simulated Savings per Rebate (Therms)	First Tier Requirements Savings per Rebate (Therms)	Second Tier Requirements Savings per Rebate (Therms)
$1,200	204	58	264	85*	161*	128*

*A weighted average, based on distribution of number of floors in sample

A.2. Methodology

The Evaluators present the simulation method used for deriving projected savings from the Whole Homes measure. This approach complies with the International Performance Measurement and Verification Protocol (IPMVP) maintained by the Efficiency Valuation Organization (EVO) with sponsorship by the U.S. Department of Energy (DOE) [1].

The Evaluators estimated savings in this exploratory analysis using simulation analyses. This method compares the HERS Rater's modeling files to a User Defined Reference Home (UDRH) specific to Idaho's residential building code requirements. The UDRH was updated from 2012 IECC residential building code with Idaho amendments to 2018 IECC residential building code with Idaho amendments to reflect the building code in the upcoming program year.

The results of the updated simulation analysis are used to inform recommendations to change program incentive levels and program requirements. These recommendations are made to increase the likelihood of future program years' cost effectiveness.

A.2.1. User Defined Reference Home

This approach involves the comparison of participating homes with a User Defined Reference Home (UDRH). The UDRH represents a home built to meet the state of Idaho's current minimum energy efficiency code requirements.

Idaho has accepted the 2018 International Energy Conservation Code (IECC) with amendments[2] for newly constructed residential homes on January 1, 2020. The 2018 IECC will be effective one year from the accepted date, on January 1, 2021. The Evaluators used the residential 2018 IECC with Idaho-specific amendments efficiency values when creating the UDRH in REM/Rate. This comparison provides an accurate simulation of a newly constructed minimum efficient code residential home to compare against efficient, program-participating homes for the upcoming program year.

The 2018 IECC with Idaho amendments is referenced from the Idaho Administrative Code, Division of Building Safety, IDAPA 07.03.01 – Rules of Building Safety. The UDRH incorporates the required minimum efficiency values for insulation, fenestration, air leakage, and lighting for Idaho. The minimum requirements for each building components are shown in the table below. For air leakage, a building must have less than five air changes per hour (ACH) when tested with a blower door at 50 Pascals. For lighting, a building must have at least 75% percent efficient lights.

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[1] Core Concepts: International Measurement and Verification Protocol. EVO 100000 – 1:2016, October 2016.

[2] https://www.energycodes.gov/adoption/states/idaho

Table A-2 presents the insulation and fenestration requirements by component in the 2018 IECC with Idaho amendments.

Table A-2 Insulation and Fenestration Requirements by Component

Climate Zone	Fenestration U-Factor	Skylight U-Factor	Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall R-Value	Floor R-Value	Basement Wall R-Value	Slab R-Value & Depth	Crawlspace Wall R-Value
5	0.32	0.55	38	20 or 13+5	13/17	30	15/19	10, 2ft	15/19
6	0.3	0.55	49	22 or 13+5	15/20	30	15/19	10, 4ft	15/19

A.2.2. Simulated Analysis Calculation

The Evaluators utilized the whole building energy modeling program REM/Rate for this analysis. REM/Rate is software used by organizations to conduct HERS Ratings. REM/Rate files were reviewed for a sample of four participating homes that represented average home characteristics. Energy savings was calculated per-home with the following calculation:

Equation A-1 Simulation Savings

$$Therm\ Savings = Consumption_{UDRH} - Consumption_{EFFICIENT}$$

Where,

$Consumption_{UDRH}$ = Simulated energy consumption values from REM/Rate for a household under the UDRH efficient code standards

$Consumption_{EFFICIENT}$ = Simulated energy consumption from REMRate for a household built referencing the HERS certification values and additional tested household requirements

The Evaluators also tested differences in consumption between homes with altered design. This requires a slightly different methodology than the simulated savings portrayed above. In order to quantify energy savings between a home with duct and air handlers located outside of conditioned space and a home with duct and air handlers located inside of conditioned space, the Evaluators employed the following equation:

Equation A-2 Simulation Savings with Duct/Air Handler Location Change

$$Therm\ Savings = Consumption_{UDRH} - Consumption_{EFFICIENT\ with\ Altered\ Design}$$

Where,

$Consumption_{UDRH}$ = Simulated energy consumption values from REM/Rate for a household under the UDRH efficient code standards. This UDRH is built with the ducts and air handlers located outside of conditioned space.

$Consumption_{EFFICIENT\ with\ Altered\ Design}$ = Simulated energy consumption from REMRate for a household built referencing the HERS certification values and duct and air handlers located inside conditioned space with additional tested household requirements if applicable.

A.2.3. Selected Homes

The Evaluator received a sample of energy models from program HERS raters as well as application materials via IGC. The Evaluators identified homes in the program that were representative of the participating homes, based on home square footage, HERS score, number of bedrooms, and Therm savings. The Evaluator selected (2) one story homes and (2) two story homes for this analysis. The table below shows the four selected homes compared to the average home in the program.

Table A-3 Sample Home Comparison

House	# of Stories	Square Footage	Number of Bedrooms	HERS Score	2012 IECC Therm Savings
House 1, One-Story	1	2,160	3	68	223
House 2, One-Story	1	2,207	3	63	255
House 1, Two-Story	2	2,959	3	60	353
House 2, Two-Story	2	2,988	5	61	296
Average One-story house	1	2,199	3	62	248
Average Two+-story house	2.1	2,804	4	62	318
Average house	1.3	2,388	3	62	262*

*A weighted average, based on distribution of number of floors in sample

The average household savings value is a weighted average, based on the distribution of the number of floors in the sample. The Evaluators verified 72% of households in the sample are one-story households. Therefore, the average household savings for one-story households is more indicative of the projected program savings.

A.3. Results

The following section details the Evaluator's impact evaluation findings in this exploratory analysis. Table A-4 displays the average annual UDRH and rebated home Therm values for space heating, water heating, lighting, and appliances for homes with one story and homes with two stories. These values represent the results of the simulation model against the 2018 IECC UDRH without any additional component requirements.

Table A-4 2018 IECC UDRH and Whole Home Modeled Annual Therm Usage

Number of Stories	UDRH				Program Homes			
	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)
1	596	150	31	777	544	130	31	705
2	645	192	36	855	545	171	36	734
Average*	610	162	32	799	544	141	32	713

*A weighted average, based on distribution of number of floors in sample

Table A-5 displays the average of the per-home difference between UDRH and participating home annual usage. Both program years display a zero savings value for lighting and appliances. The simulated participating one-story homes saved an average of 72 Therms per home and the simulated participating two-story homes saved an average of 121 Therms per home. The weighted average savings per home across both categories is 86 Therms.

The occupancy and home characteristics between the UDRH modeled simulation and the program modeled simulation remain constant, which means the program home, with all else constant, uses less energy to heat the space of the home than the code-built efficient home, leading to savings for those categories. The majority of the savings (98%) are displayed in space heating due to higher home sealing and more efficient HVAC equipment.

Table A-5 Average Modeled Therm Savings per Home

Number of Stories	Space Heating (Therms)	Water Heating (Therms)	Lights & Appliances (Therms)	Total (Therms)
1	52	20	0	72
2	100	21	0	121
Average	65	20	0	86

A.3.1. Program Requirements Explored

The Evaluators updated the efficient home building specifications to explore the incremental impacts of additional requirements the program may enforce. The goal of this analysis is to identify additional program requirements that are projected to increase the average home's energy savings. The Evaluators selected building requirements that would be relatively easy to test, measure, and enforce in addition to being relatively low-cost for builders.

The following component requirements were tested on simulated homes for total and incremental impact individually and in combination with one another.

- Increase duct sealing requirement to 0.03 CFM25/cfa
- Increase duct sealing requirement to 0.02 CFM25/cfa
- Increase air sealing requirement to 4 ACH at 50 Pa
- Increase air sealing requirement to 3 ACH at 50 Pa
- Change location of ducts and air handler to inside conditioned space
- Increase furnace efficiency requirement to 95 AFUE
- Increase furnace efficiency requirement to 97 AFUE
- Require gas (.94 UEF min) tankless water heater
- Increase ceiling insulation requirement from R-38 to R-49

The table below summarizes the above components for the 68 households in which REM/Rate files were delivered.

Table A-6 Summary Statistics for Sampled Home Components

Number of Stories	Attic Insulation R-value	Furnace efficiency AFUE	Gas Water Heater UEF	Air Sealing ACH	Duct Leakage CFM25/cfa
Minimum	38	92.1	0.60	1.7	0.0000
First Quartile	38	95	0.62	3.3	0.0162
Median	38	95.5	0.64	3.5	0.0237
Third Quartile	42	96	0.64	4.3	0.0283
Maximum	50	96	0.96	5.9	0.0457

The following table displays the average total and average incremental Therms savings for each potential program requirement, by story of home.

Table A-7 Potential Program Requirement Savings

Potential requirement	Average Total Savings (Therms)		Average Incremental Savings (Therms)	
	One-Story	Two-Story	One-Story	Two-Story
New baseline (IECC 2018 with Idaho Amendments)	72	121	-	-
New baseline Increased duct sealing (0.03 CFM25)	72	121	0	0
New baseline Increased duct sealing (0.02 CFM25)	76	123	4	2
New baseline Increased air sealing (4 ACH)	88	121	16	0
New baseline Increased air sealing (3 ACH)	102	134	30	13
New baseline Ducts and air handler in conditioned space	121*	147	35*	26
New baseline Increased furnace efficiency (97% AFUE)	81	129	9	9
New baseline Increased ceiling insulation (R-49)	83	131	11	10
New baseline Increased air sealing (3 ACH) Increased furnace efficiency (97% AFUE)	107	142	35	21
New baseline Increased air sealing (3 ACH) Increased duct sealing (0.03 CFM25)	106	135	34	15

Potential requirement	Average Total Savings (Therms)		Average Incremental Savings (Therms)	
	One-Story	Two-Story	One-Story	Two-Story
New baseline **Increased air sealing (3 ACH)** **Increased duct sealing (0.03 CFM25)** **Increased ceiling insulation (R-49)**	116	146	44	25
New baseline **Increased air sealing (4 ACH)** **Increased duct sealing (0.03 CFM25)** **Increased furnace efficiency (95% AFUE)**	88	121	16	0
New baseline **Increased air sealing (3 ACH)** **Increased duct sealing (0.03 CFM25)** **Increased ceiling insulation (R-49)** **Increased furnace efficiency (97% AFUE)**	110	141	38	21
New baseline **Increased air sealing (4 ACH)** **Ducts and air handler in conditioned space** **Increased furnace efficiency (95% AFUE)**	121*	147	35*	26
New baseline **Increased air sealing (3 ACH)** **Ducts and air handler in conditioned space** **Increased furnace efficiency (97% AFUE)**	155*	178	69*	57

*These values are modeled from one of the one-story sampled homes

The individual component that contributes the largest magnitude of savings is the movement of ducts and air handler to conditioned space. This single restriction increased household savings by 35 and 26 Therms per year for one-story and two-story homes, respectively. The Evaluators note that the movement of location of the ducts and air handler provides much more savings for homes that have higher duct and air sealing leakage. Conversely, the movement of location of the ducts and air handler would not provide much more incremental benefits for homes that already display stringent air and duct sealing values.

The next component displaying large incremental savings is increased air sealing, with a restriction increasing from 5 ACH as required by the building code, to 3 ACH. This single restriction increased household saving by 30 Therms per year and 13 Therms per year for one-story homes and two-story homes, respectively, and constitutes 10 to 30% of total household energy savings.

Reducing the air sealing restriction to 4 ACH instead of 3 ACH displays an additional savings of 16 Therms per year for one-story homes and 0 Therms per year for two-story homes. This lower restriction in air sealing was considered to reduce the cost burden on builders for this component while still increasing efficiency relative to the building code, however, three out of the four sampled homes had already met or exceeded the efficiency requirements of 4 ACH. Therefore, the incremental savings is low compared to 3 ACH.

The next largest contributor is ceiling insulation, increasing from R-38 to R-49. The largest contributor after ceiling insulation is increased duct sealing. The Evaluators tested two levels of restriction for duct sealing. The Evaluators found that all four sampled homes already meet or exceed the 0.03 CFM25 duct sealing restriction and therefore display no incremental savings for this level of duct sealing restriction. However, a duct sealing restriction of 0.02 CFM25 results in an additional 4 Therms and 2 Therms saved per year for one- and two-story homes, respectively.

In addition, the Evaluators found that program-qualifying homes already largely have 95% AFUE furnaces. However, increasing the furnace efficiency to 97 AFUE leads to a reasonable amount of incremental savings (9 Therms per year for both one- and two-story homes).

A.3.2. Associated Rebate Incentive

In addition to the simulation analysis for projected savings, the Evaluators have calculated projected Whole Home Rebate incentives that align with the first-tier and second-tier household program requirements. IGC provided the Evaluators with the utility's avoided cost values and discount rate from its 2017 IRP filing. Avoided cost is the avoided natural gas commodity cost. Discount rate is the after-tax weighted average cost of capital (WACC).

The Evaluators have calculated the following rebate incentive levels with the projected household savings to meet program effectiveness.

- Rebate amount for first tier program requirements: $1,000
- Rebate amount for second tier program requirements: $800

Provided the avoided costs remain constant, and no additional benefits are identified, the above rebate values are the highest amount the utility can reasonably provide to customers with the projected energy savings for each restriction level.

A.3.3. Recommendations

This section outlines the Evaluator's recommendations for future program requirements, based on the simulation analysis above. The Evaluators identified the 95% furnace efficiency to be common in program-participating homes. However, there is currently no restriction on furnace efficiency for the Whole Home Rebate. Therefore, in order to reduce variation in savings, the Evaluators recommend including 95% or 97% furnace efficiency as a minimum requirement for the program.

The following sections details two options for future program requirements in addition to the 95% or 97% furnace efficiency requirement. These options were identified as a combination of the highest cumulative impact energy savings compared to the Idaho building code with consideration of builder feasibility and cost-effectiveness in mind.

The following table displays the average household simulated savings with the 2012 IECC baseline, with the 2018 IECC baseline, and with the first-tier and second-tier program requirements presented above.

Table A-8 Average Program Home Savings by Analysis Type

2012 IECC Simulated Savings per Rebate (Therms)	2018 IECC Simulated Savings per Rebate (Therms)	First-Tier Requirements Savings per Rebate (Therms)	Second-Tier Requirements Savings per Rebate (Therms)
264	86*	161*	128*

*A weighted average, based on distribution of number of floors in sample

A.3.3.1. First-Tier Program Restriction

The Evaluators have identified component requirements for a first-tier restriction to increase program savings. Various combinations were tested and are displayed in Table A-7. The Evaluators recommend the following combination of requirements as the first-tier rebate offering in future program years:

- Air sealing at or below (3 ACH at 50 Pa)

- Ceiling insulation at or above (R49)
- Ducts and air handler located inside conditioned space
- Furnace efficiency at or above 97% AFUE
- Change rebate incentive to $1,000

Requiring these four metrics, the Evaluators estimate that 155 Therms will be saved in a one-story home and 178 Therms will be savings in a two-story home, detailed in the final row in Table A-7. The average home in the program, weighted by number of stories, is projected to save 161 Therms with these requirements.

An incentive of $1,000 would allow IGC to produce sufficient UCT benefits to pass the UCT based on IGC's commodity costs and WACC specified in their 2019-2023 IRP. This rebate offering will also allow suitable budget for home outreach and administration costs.

A.3.3.2. Second-Tier Program Restriction

The Evaluators have also defined an alternative to the above program requirements, defined as the second-tier program restriction. This alternative removes the restriction for R-49 ceiling insulation, as this component requires high builder costs and may discourage builders from applying for a rebate.

The Evaluators recommend the following combination of requirements as the second-tier rebate offering in future program years:

- Air sealing at or below (4 ACH at 50 Pa)
- Ducts and air handler located inside conditioned space
- Furnace efficiency at or above 95% AFUE
- Change rebate incentive to $800

Requiring these three metrics, the Evaluators estimate that 121 Therms will be saved in a one-story home and 147 Therms will be savings in a two-story home, detailed in the final row in Table A-7. The average home in the program, weighted by number of stories, is projected to save 128 Therms with these requirements.

The Evaluators note that three of the four sampled homes already meet or exceed the 4 ACH air sealing requirement. However, as shown in Table A-6, some program homes do not meet the 4 ACH air sealing requirement and annual energy savings may increase from this additional requirement. The Evaluators recommend this set of restrictions to facilitate additional savings from households applying to the program with a lower efficiency than the average program household and requiring a lower cost to builders than the first tier recommendation in the section above.

An incentive of $800 would allow IGC to produce sufficient UCT benefits to pass the UCT based on IGC's commodity costs and WACC specified in their 2019-2023 IRP. This rebate offering will also allow suitable budget for home outreach and administration costs.

IDAHO RESIDENTIAL ENERGY CODE FIELD STUDY

(64 pages)

PNNL-28380

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Idaho Residential Energy Code Field Study

February 2019

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M Halverson
Y Xie

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

A research project in the state of Idaho identified opportunities to reduce homeowner energy costs in residential single-family new construction by increasing compliance with the current state energy code. The study was initiated in January 2018; data collection began in March 2018 and continued through June 2018. During this period, research teams visited 127 homes during various stages of construction, resulting in a collection of data based on observations made directly in the field. Analysis of the data has led to a better understanding of the energy features present in homes and indicates nearly $500,000 in potential annual savings to Idaho homeowners that could result from increased compliance with the Idaho Energy Conservation Code.

Methodology

The project team was led by David Freelove, Idaho Energy Code Circuit Rider, with support from Cadmus, the Idaho Association of Building Officials, and the Northwest Energy Efficiency Alliance. The team applied a methodology that was previously developed and tested by the U.S. Department of Energy (DOE). The methodology identified the energy code-required building components that have the largest direct impact on energy consumption. These key items are a focal point of the study, and provide the data used in the analysis and savings estimates. The project team implemented an Idaho-specific sampling plan representative of new construction within the state. This sampling plan was developed by Pacific Northwest National Laboratory (PNNL).

Following data collection, PNNL conducted three stages of analysis on the resulting data set (Figure ES.1). The first stage identified compliance trends within the state based on the field observations for each key item. The second stage modeled energy consumption of the homes observed in the field relative to what would be expected if sampled homes just met minimum code requirements. The third stage then calculated the potential energy savings and consumer cost savings associated with increased code compliance. Together, these findings provide valuable insight on challenges facing energy code implementation and enforcement, and are intended to inform future energy code education, training and outreach activities.

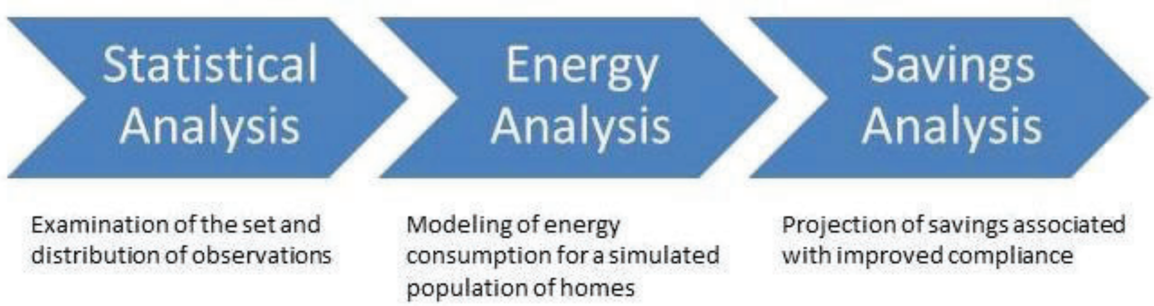

Figure ES.1. Stages of Analysis Applied in the Study

Results

The key items with the greatest potential for savings in Idaho are presented in Table ES.1. The estimates presented in the table represent the savings associated with each measure and are extrapolated based on projected new construction. These items may be considered during consideration of compliance-improvement programs within the state, including energy code education, training and outreach initiatives.

Table ES.1. Estimated Annual Statewide Savings Potential in Idaho

Measure	Total Energy Savings (MMBtu)	Total Energy Cost Savings ($)
Duct Leakage	27,966	307,201
Exterior Wall Insulation	17,088	167,182
Foundation Insulation	1,383	5,436
TOTAL	**46,436 MMBtu**	**$479,819**

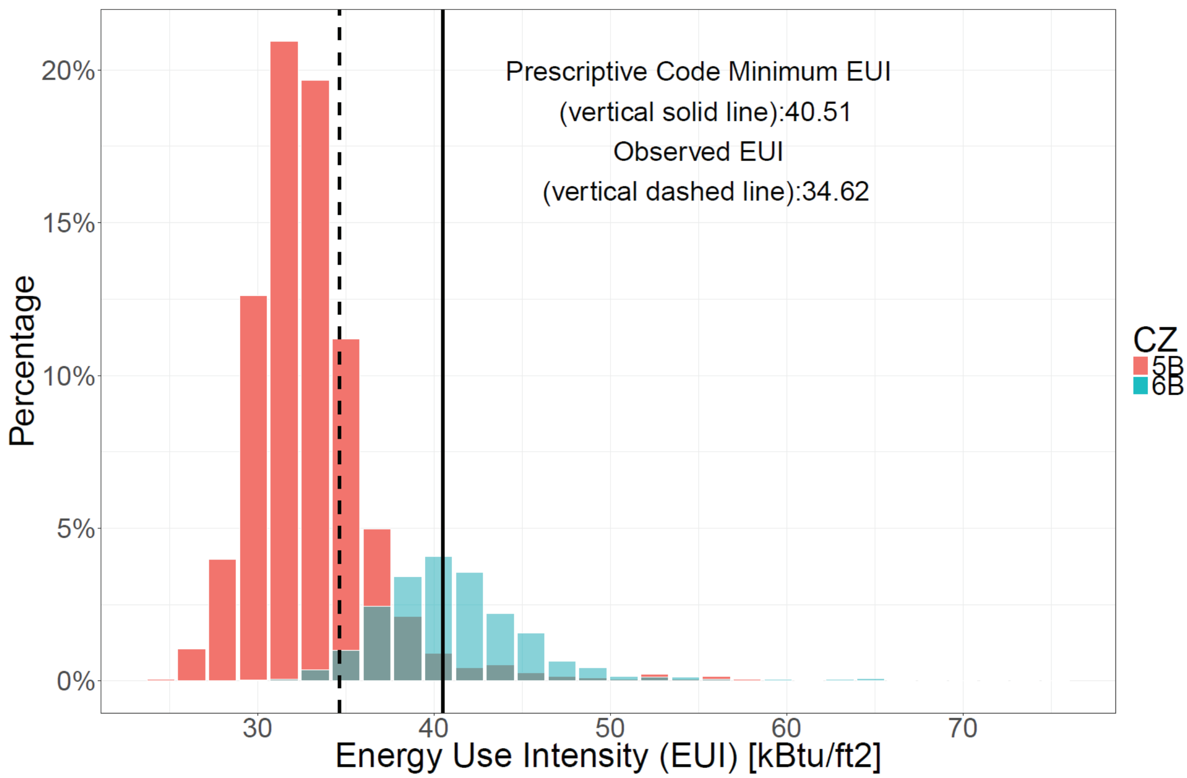

Figure ES.2. Modeled distribution of regulated EUI (kBtu/ft^2/year) in Idaho

In terms of overall energy consumption, the analysis shows that homes within the state use *less* energy than would be expected relative to homes built to the current minimum state code requirements (Figure ES.2). Analysis of the collected field data indicates average regulated energy use intensity (EUI) of 34.62 kBtu/ft^2-yr statewide compared to 40.51 kBtu/ft^2-yr for homes exactly meeting minimum *prescriptive* energy code requirements. This suggests that on average the typical home in the state is about 15% better than code.

Note that in an EUI analysis, items found to be better than code offset savings from items found to be worse than code. These below-code items represent a savings opportunity regardless of the above-code items. In this study, a significant portion of homes were found to not meet code in several key areas impacting energy use, durability, and comfort. Thus, there is still a significant energy savings opportunity (estimated at $500,000 annually) from energy code compliance enhancement activities in Idaho.

Acknowledgments

The following members comprised the Idaho project team:

- David Freelove, *Idaho Energy Code Circuit Rider*
- Jerica Stacey and Jolyn Green, *Cadmus*

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- Bing Liu, Steve Phoutrides, Dulane Moran and Christina Steinhoff, NEEA
- Sharon Grant and Ken Baker, Idaho Energy Code Collaborative group
- John Chatburn and Katie Pegan, Idaho Office of Energy and Mineral Resources

Northwest Energy Efficiency Alliance

NEEA is a non-profit organization working to effect market transformation through the acceleration and adoption of energy-efficient products, services and practices. NEEA is an alliance of more than 140 Northwest utilities and energy efficiency organizations working on behalf of more than 13 million energy consumers. For more information, visit neea.org.

Idaho Association of Building Officials

The Idaho Association of Building Officials (IDABO) was first recognized as a State organization in 1958. IDABO's mission is to promote public health and welfare by facilitating safe and accessible buildings and by educating citizens and elected officials on Idaho codes and standards. See more information on IDABO at http://www.idabo.org/.

Cadmus

The Cadmus Group LLC was founded in 1983 in Watertown, MA. They provide services in the areas of energy, climate, water, public health, international development, transportation, and safety, security, and resiliency. See more information on Cadmus at https://www.cadmusgroup.com/.

Acronyms and Abbreviations

AC	air conditioning
ACCA	Air Conditioning Contractors of America
ACH	air changes per hour
AFUE	annual fuel utilization efficiency
AIA	American Institute of Architects
Btu	British thermal unit
cfm	cubic feet per minute
CZ	climate zone
DOE	U.S. Department of Energy
EDC	electric distribution company
EERE	Office of Energy Efficiency and Renewable Energy
EUI	energy use intensity
FOA	funding opportunity announcement
HERS	home energy rating system
HSPF	heating season performance factor
ICC	International Code Council
ID	Idaho
IDABO	Idaho Association of Building Officials
IECC	International Energy Conservation Code
kBtu	thousand British thermal units
MMBtu	million British thermal units
NA	not applicable
NEEA	Northwest Energy Efficiency Alliance
PNNL	Pacific Northwest National Laboratory
RESNET	Residential Energy Services Network
RFI	request for information
SHGC	solar heat gain coefficient

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Figures

Tables

1.0 Introduction

A research project in the state of Idaho investigated the energy code-related aspects of unoccupied, newly constructed, single family homes across the state. The study followed a DOE-developed and tested methodology, which allowed the project team to build an empirical collection of data based on observations made directly in the field. The data was then analyzed to identify compliance trends, their impact on statewide energy consumption, and calculate savings that could be achieved through increased code compliance.

The Idaho field study was initiated in January 2018; data collection began in March 2018 and continued through June 2018. During this period, research teams visited 127 homes across the state during various stages of construction. At the time of the study, the state had the Idaho Energy Conservation Code effective from January 1, 2015. The study methodology, data analysis and resulting findings are presented throughout this report.

1.1 Background

This project was built upon the U.S. Department of Energy (DOE)'s field study, "Strategies to Increase Residential Energy Code Compliance Rates and Measure Results".[1] The purpose of this study is to gather field data on energy code measures, as installed and observed in actual homes and through the subsequent analysis to identify trends and issues, which eventually can inform energy code training and other compliance- improvement programs.

Energy codes for residential buildings have advanced significantly in recent years, with today's model codes approximately 30% more efficient than codes adopted by the majority of U.S. states.[2,3] Hence, the importance of ensuring code-intended energy savings, so that consumers reap the benefits of improved codes—something which will happen only through high levels of compliance. More information on overall DOE interest in compliance is available on the DOE Building Energy Codes Program website.[4]

1.2 Project Team

David Freelove, the Idaho Energy Code Circuit Rider, led the Idaho project team and collected the field data; Cadmus and the Idaho Association of Building Officials (IDABO) provided support to Mr. Freelove throughout the project. The Pacific Northwest National Laboratory (PNNL) defined the methodology, conducted data analysis, and provided technical assistance to the project team. Funding for the project was provided by the Northwest Energy Efficiency Alliance (NEEA), with technical analysis provided by PNNL funded by DOE. More information on the organizations comprising the project team is included in the Acknowledgements section of this report.

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[1] Available at https://www.energycodes.gov/compliance/residential-energy-code-field-study

[2] *National Energy and Cost Savings for New Single- and Multifamily Homes: A Comparison of the 2006, 2009, and 2012 Editions of the IECC*, available at http://www.energycodes.gov/development

[3] Available at http://www.energycodes.gov/adoption/states

[4] Available at https://www.energycodes.gov/compliance

1.3 Stakeholder Interests

The project started with the formation of a stakeholder group comprised of interested and affected parties within the state. Following an initial kickoff meeting, the project team maintained active communication with the stakeholders throughout the course of the project. Stakeholders were sought from the following groups:

- Building officials
- Homebuilders
- Energy efficiency advocates
- Utilities
- Other important entities identified by the project team

Members of these and other groups are critical to the success of the project, as their buy-in to the results is necessary for future activities. Such stakeholders hold important information (e.g., building officials have the lists of homes under construction and are therefore key to the sampling process), control access to homes needed for site visits, and are targets for training. The Idaho team most frequently communicated with building officials and homebuilders, including the members of local IDABO chapters; local building associations; and state and local building officials. Utilities were also identified as a crucial stakeholder and were updated regularly on the progress of the study.

2.0 Methodology

2.1 Overview

The Idaho field study was based on a methodology developed by DOE to identify savings opportunities associated with increased energy code compliance. This methodology involves gathering field data on energy code measures, as installed and observed in actual homes. In the subsequent analysis, trends and issues are identified, which can inform energy code training and other compliance- improvement programs.

Highlights of the methodology:

- Focuses on **individual code requirements** within **new single-family homes**
- Based on a **single site visit** to reduce burden and minimize bias
- Prioritizes **key items** with the greatest impact on energy consumption
- Designed to produce **statistically significant results**
- **Data confidentiality** built into the experiment—no occupied homes were visited, and no personal data shared
- Results based on an **energy metric** and reported at the **state level**

PNNL identified the code-requirements (and associated energy efficiency measures) with the greatest direct impact on residential energy consumption. [1] These *key items* drive sampling, data analysis, and eventual savings projections:

1. Envelope tightness (ACH at 50 Pascals)
2. Windows (U-factor & SHGC)
3. Wall insulation (assembly U-factor)
4. Ceiling insulation (R-value)
5. Lighting (% high-efficacy)
6. Foundation insulation (R-value)[2]
7. Duct tightness (expressed in cfm per 100 ft^2 of conditioned floor area at 25 Pascals)

PNNL evaluated the variability associated with each key item and concluded that a minimum of 63 observations would be needed for each one to produce statistically significant results at the state level. Both the key items themselves and the required number of observations were prescribed in the DOE methodology.

The following sections describe how the methodology was implemented as part of the Idaho study, including sampling, data collection, and resulting data analysis. More information on the full DOE

[1] Based on the *mandatory* and *prescriptive* requirements of the International Energy Conservation Code (IECC).
[2] Floor insulation, basement wall insulation, crawlspace wall insulation, and slab insulation were combined into a single category of foundation insulation.

protocol and PNNL analysis is published separately from this report (DOE 2018) and is available on the DOE Building Energy Codes Program website.[3]

2.2 State Study

The prescribed methodology was customized for Idaho to reflect circumstances unique to the state, such as state-level code requirements and regional construction practices. Customization also ensured that the results of the study would have credibility with stakeholders.

2.2.1 Sampling

PNNL developed a statewide sampling plan statistically representative of recent construction activity within the state. The samples were apportioned to jurisdictions across the state in proportion to their average level of construction compared to the overall construction activity statewide. This approach is a proportional random sample, which PNNL based on the average of the three most recent years of Census Bureau permit data.[4] The plan specified the number of key item observations required in each selected jurisdiction (totaling 63 of each key item across the entire project coverage area).

2.2.2 Data Collection

Following confirmation of the sample plan, the project team began contacting local building departments to identify homes currently in the permitting process. Code officials responded by providing lists of homes at various stages of construction within their jurisdiction. These lists were then sorted using a random number generator and utilized by the team's field personnel to contact builders to gain site access. As prescribed by the methodology, each home was visited only once to avoid any bias associated with multiple site visits. Only installed items directly observed by the field teams during site visits were recorded. If access was denied for a particular home on the list, field personnel moved onto the next home on the list.

2.2.2.1 Data Collection Form

The field teams relied on a data collection form customized to the *mandatory* and *prescriptive* requirements of the state energy code, the Idaho Energy Conservation Code.[5] The final data collection form is available in spreadsheet format on the DOE Building Energy Codes Program website.[6] The form included all energy code requirements (i.e., not just the eight key items), as well as additional items required under the prescribed methodology. For example, the field teams were required to conduct a blower door test and duct leakage test on every home where such tests could be conducted, using RESNET[7] protocols.

The information beyond the key items was used during various phases of the analysis, or to supplement the overall study findings. For example, insulation installation quality impacts the energy-efficiency of insulation was used to modify that key item during the energy modeling and savings calculation.

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[3] Available at https://www.energycodes.gov/compliance/residential-energy-code-field-study.
[4] Available at http://censtats.census.gov/ (select the "Building Permits" data).
[5] Available at https://dbs.idaho.gov/rules/2018/2018_Building_Statutes_Rules_pkt.pdf.
[6] Available at https://www.energycodes.gov/compliance/residential-energy-code-field-study and based on the forms typically used by the RES*check* compliance software.
[7] See http://www.resnet.us/standards/RESNET_Mortgage_Industry_National_HERS_Standards.pdf

Equipment, including fuel type and efficiency rating, and basic home characteristics (e.g., foundation type) helped validate the prototype models applied during energy simulation. Other questions, such as whether the home participated in an above-code program, can assist in understanding whether other influencing factors are at play beyond the code requirements.

The data collected were the energy values observed, rather than the compliance status. For insulation, for example, the R-value was collected, for windows the U-factor. The alternative, such as was used in DOE's older work, simply stated whether an item did or did not comply. The current approach provides an improved understanding of how compliance equates to energy consumption and gives more flexibility during analysis since the field data can be compared to any energy code.

2.2.2.2 Data Management and Availability

Once the data collection effort was complete, the project team conducted a thorough quality assurance review. This included an independent check of raw data compared to the information provided to PNNL for analysis, and helped to ensure completeness, accuracy and consistency across the inputs. Prior to submitting the data to PNNL, the team also removed all personally identifiable information, such as project site locations and contact information. The final dataset is available in spreadsheet format on the DOE Building Energy Codes Program website[8].

2.3 Data Analysis

All data analysis in the study was performed by PNNL, and was applied through three basic stages:

1. **Statistical Analysis:** Examination of the data set and distribution of observations for individual measures
2. **Energy Analysis:** Modeling of energy consumption for a simulated population of homes
3. **Savings Analysis:** Projection of savings associated with improved compliance

The first stage identified compliance trends within the state based on what was observed in the field for each key item. The second stage modeled energy consumption (of the homes observed in the field) relative to what would be expected if sampled homes just met minimum code requirements. The third stage then calculated the potential energy savings and consumer cost savings associated with increased code compliance. Together, these findings provide valuable insight on challenges facing energy code implementation and enforcement, and are intended to inform future energy code education, training and outreach activities.

The following sections provide an overview of the analysis methods applied to the field study data, with the resulting state-level findings presented in Section 3.0, State Results.

2.3.1 Statistical Analysis

Standard statistical analysis was performed with distributions of each key item plotted by climate zone. This approach enables a better understanding of the range of data and provides insight on what energy-efficiency measures are most commonly installed in the field. It also allows for a comparison of installed values to the applicable code requirement, and for identification of any problem areas where potential for

[8] Available at https://www.energycodes.gov/compliance/residential-energy-code-field-study.

improvement exists. The graph below represents a sample key item distribution and is further explained in the following paragraph.

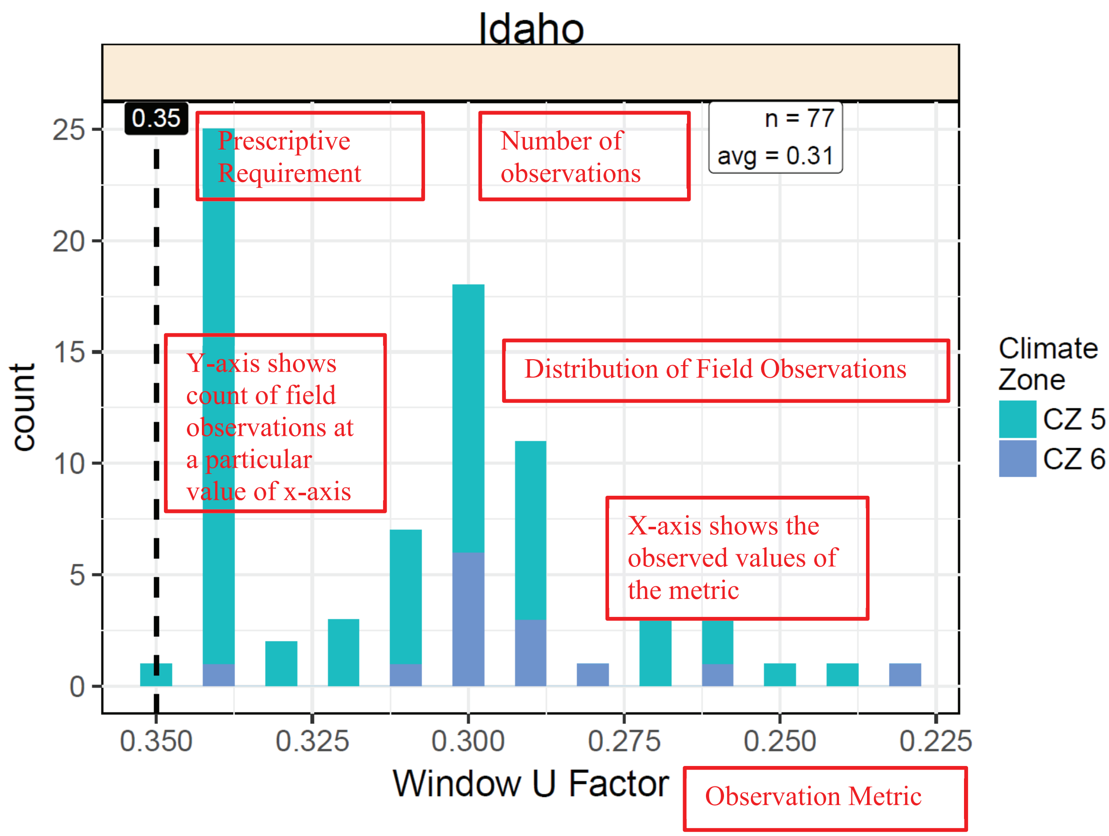

Figure 2.1. Sample Graph

Each graph is set up in a similar fashion, identifying the *state*, *climate zone*, and specific item being analyzed. The total *sample size* (n) is displayed in the top left or right corner of the graph, along with the distribution *average*. The *metric* associated with the item is measured along the horizontal axis (e.g., window U-factor is measured in Btu/ft2-hr-F), and a *count* of the number of observations is measured along the vertical axis. A vertical line is imposed on the graph representing the applicable code requirement (e.g., the prescriptive requirement in climate zone 4 is 0.35)—values to the right-hand side of this line are *better than code*. Values to the left-hand side represent areas for improvement.

For walls and foundations, two graphs are included – one for R-value observations and another for U-factor observations. The R-value graphs show whether or not homes are being constructed with the required amount of insulation for the climate zone. The U-factor graphs indicate whether or not the combination of installed R-value and insulation installation quality meets the U-factor requirements in the climate zone. The combination of these two graphs can be used to determine if there is an issue with the amount of insulation, insulation installation quality, or both.

2.3.2 Energy Analysis

The next phase of the analysis leveraged the statistical analysis results to model average statewide energy consumption. A consequence of the field study methodology allowing only one site visit per home to minimize bias is that a full set of data cannot be gathered on any single home, as not all energy-efficiency measures are in place or visible at any given point during the home construction process. This lack of complete data for individual homes creates an analytical challenge, because energy modeling and simulation protocols require a complete set of inputs to generate reliable results. To address this challenge, a series of "pseudo homes" were created, comprised of over 1,500 models encompassing most of the possible combinations of key item values found in the observed field data. In aggregate, the models provide a statistical representation of the state's population of newly constructed homes. This approach is known in statistics as a Monte Carlo analysis.

Energy simulation was then conducted using the EnergyPlus™ software.[9] Each of the 1,500 models was run multiple times, to represent each combination of heating systems and foundation types commonly found in the state. This resulted in upwards of 30,000 simulation runs for each climate zone within the state. An EUI was calculated for each simulation run and these results were then weighted by the frequency with which the heating system/foundation type combinations were observed in the field data. Average EUI was calculated based on regulated end uses (heating, cooling, lighting and domestic hot water) for two sets of homes—one *as-built* set based on the data collected in the field, and a second *code-minimum* set (i.e., exactly meeting minimum code requirements). Comparing these values shows whether the population of newly constructed homes in the state is using more or less energy than would be expected based on minimum code requirements.

Further specifics of the energy analysis are available in the methodology report (DOE 2018).

2.3.3 Savings Analysis

To begin the third phase, each of the key items was examined individually to determine which had a significant number of observed values that did not meet the associated code requirement[10]. For these items, additional models were created to assess the savings potential, comparing what was observed in the field to a scenario of full compliance (i.e., where all worse-than-code observations for a particular item exactly met the corresponding code requirement)[11]. This was done by individually upgrading each worse-than-code observation to the corresponding *prescriptive* code requirement, resulting in a second set of models (*full compliance*) that could be compared to the first (*as-built*). All other components were maintained at the corresponding prescriptive code value, allowing for the savings potential associated with a key item to be evaluated in isolation.

All variations of observed heating systems and foundation types were included, and annual electric, gas and total EUIs were extracted for each building. To calculate savings, the differences in energy use calculated for each case were weighted by the corresponding frequency of each observation to arrive at an average energy savings potential for each climate zone. Potential energy savings for each climate zone were further weighted using construction starts in that zone to obtain the average statewide energy savings potential. State-specific construction volumes and fuel prices were used to calculate the maximum energy savings potential for the state in terms of *energy* (MMBtu) and *energy cost* ($).

Note that this approach results in the maximum theoretical savings potential for each measure as it does not take "interaction effects" into account such as the increased amount of heating needed in the winter

[9] *See* https://energyplus.net/
[10] "Significant" was defined as 15% or more of the observed values not meeting the associated code requirement. Only the items above this threshold were analyzed.
[11] Better-than-code items were not included in this analysis because the intent was to identify the maximum savings potential for each measure. The preceding energy analysis included both better-than-code and worse-than-code results, allowing them to offset each other.

when energy efficient lights are installed. A building's energy consumption is a dynamic and interactive process that includes all the building components present within a given home. In a typical real building, the savings potential might be higher or lower; however, additional investigation indicated that the relative impact of such interactions is very small, and could safely be ignored without changing the basic conclusions of the analysis.

2.4 Limitations

The following sections address limitations of the project, some of which are inherent to the methodology, itself, and other issues as identified in the field.

2.4.1 Applicability of Results

An inherent limitation of the study design is that the results (key item distributions, EUI, and measure-level savings) can be considered statistically significant only at the state level. Other results, such as analysis based on climate zone level, or reporting of non-key items (such as gas furnace efficiency), are included but should not be considered statistically representative.

2.4.2 Determination of Compliance

The field study protocol is based upon a single site visit, which makes it impossible to know whether a particular home complies with the energy code as not enough information can be gathered in a single visit to know whether all code requirements have been met. For example, homes observed during the earlier stages of construction often lack key features (e.g., walls with insulation), and in the later stages many of these items may be covered and therefore unobservable. To gather all the data required in the sampling plan, field teams therefore needed to visit homes in various stages of construction. The analytical implications of this are described above in Section 2.3.2

2.4.3 Sampling Substitutions

As is often the case with field-based research, substitutions to the state sampling plan were sometimes needed to fulfill the complete data set. If the required number of observations in a jurisdiction could not be met because of a lack of access to homes or an insufficient number of homes (as can be the case in rural areas), substitute jurisdictions were selected by the project team. In all cases, the alternative selection was comparable to the original in terms of characteristics such as the level of construction activity and general demographics. More information on the sampling plan and any state-specific substitutions are discussed in Appendix B.

2.4.4 Site Access

Site access was purely voluntary and data was collected only in homes where access was granted, which can be characterized as a self-selection bias. While every effort was made to limit this bias (i.e., sampling randomization, outreach to builders, reducing the burden of site visits, etc.), it is inherent due to the voluntary nature of the study. The impacts of this bias on the overall results are not known.

2.4.5 Analysis Methods

All energy analysis was conducted using prototype models; no individually visited homes were modeled, as the self-imposed, one-visit-per-home limitation meant that not all necessary modeling inputs could be collected from a single home. Thus, the impact of certain field-observable factors such as size, height, orientation, window area, floor-to-ceiling height, equipment sizing, and equipment efficiency were not included in the analysis. In addition, duct leakage was modeled separately from the other key items due to limitations in the EnergyPlus™ software used for analysis. It should also be noted that the resulting energy consumption and savings projections are based on modeled data, and not on utility bills or actual home energy usage.

2.4.6 Presence of Tradeoffs

Field teams were able to gather only a minimal amount of data regarding which code compliance paths were being pursued for homes included in the study; all analyses therefore assumed that the prescriptive path was used. The project team agreed that this was a reasonable approach. The overall data set was reviewed in an attempt to determine if common tradeoffs were present, but the ability to do this was severely limited by the single site-visit principle which did not yield complete data sets for a given home. To the extent it could be determined, it did not appear that there was a systematic presence of tradeoffs.

3.0 State Results

3.1 Field Observations

The key items form the basis of the study and are therefore the focus of this section. Idaho is comprised of multiple climate zones; zone 5 (CZ 5) and zone 6 (CZ 6). Both climate zones are represented in the sampling, data collection, and resulting analysis and statewide savings calculations. A discussion of other findings is also covered in this section, including a description of how certain observations, such as insulation installation quality, are used to modify key items. (See Section 2.3.1 for a sample graph and explanation of how they should be interpreted.)

3.1.1 Key Items

The field study and underlying methodology are driven by *key items* that have a significant direct impact on residential energy efficiency. The graphs presented in this section represent the key item results for the state based on the measures observed in the field. Note that these key items are also the basis of the results presented in the subsequent *energy* and *savings* phases of analysis.

The following key items were found applicable within the state:

1. Envelope tightness (ACH at 50 Pascals)
2. Window SHGC
3. Window U-factor
4. Exterior wall insulation (assembly U-factor)
5. Ceiling insulation (R-value)
6. Lighting (% high-efficacy)
7. Foundations – basement walls and floors (assembly U-factor)
8. Duct tightness (expressed in cfm per 100 ft^2 of conditioned floor area at 25 Pascals)

The three main foundation types observed in Idaho were floors over vented crawlspaces (82 observations), heated basements (22 observations), and unvented crawlspaces. In addition there were four slab observations, but due to that small number, a graphic is not provided for slabs. Note that these counts are for the number of homes observed to have these foundation types. The graphs below report the observed foundation insulation values and the number of observations will be less than or equal to the number of homes that have a particular foundation type.

3.1.1.1 Envelope Tightness

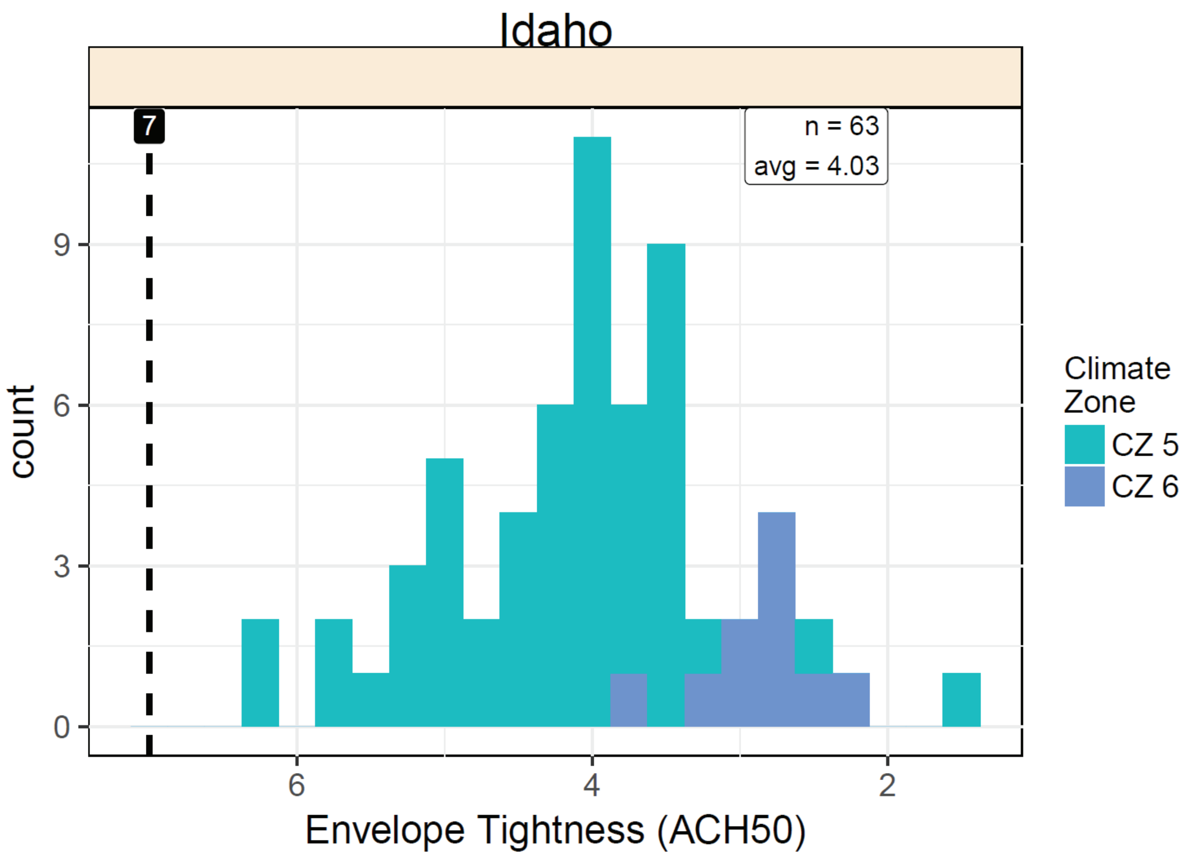

Figure 3.1. Envelope Tightness (ACH50)

Table 3.1. Envelope Tightness (ACH50)

Climate Zone	CZ5	CZ6	Statewide
Number	53	10	63
Range	1.4 to 6.4	2.3 to 3.8	1.4 to 6.4
Average	4.2	2.9	4.0
Requirement	7	7	7
Compliance Rate	53 of 53 (100%)	10 of 10 (100%)	63 of 63 (100%)

- **Interpretations:**
  - Overall, the distribution exhibits significantly lower air leakage than expected based on the current code requirement.
  - All the observations met or exceeded the prescriptive code requirement.

3.1.1.2 Window SHGC

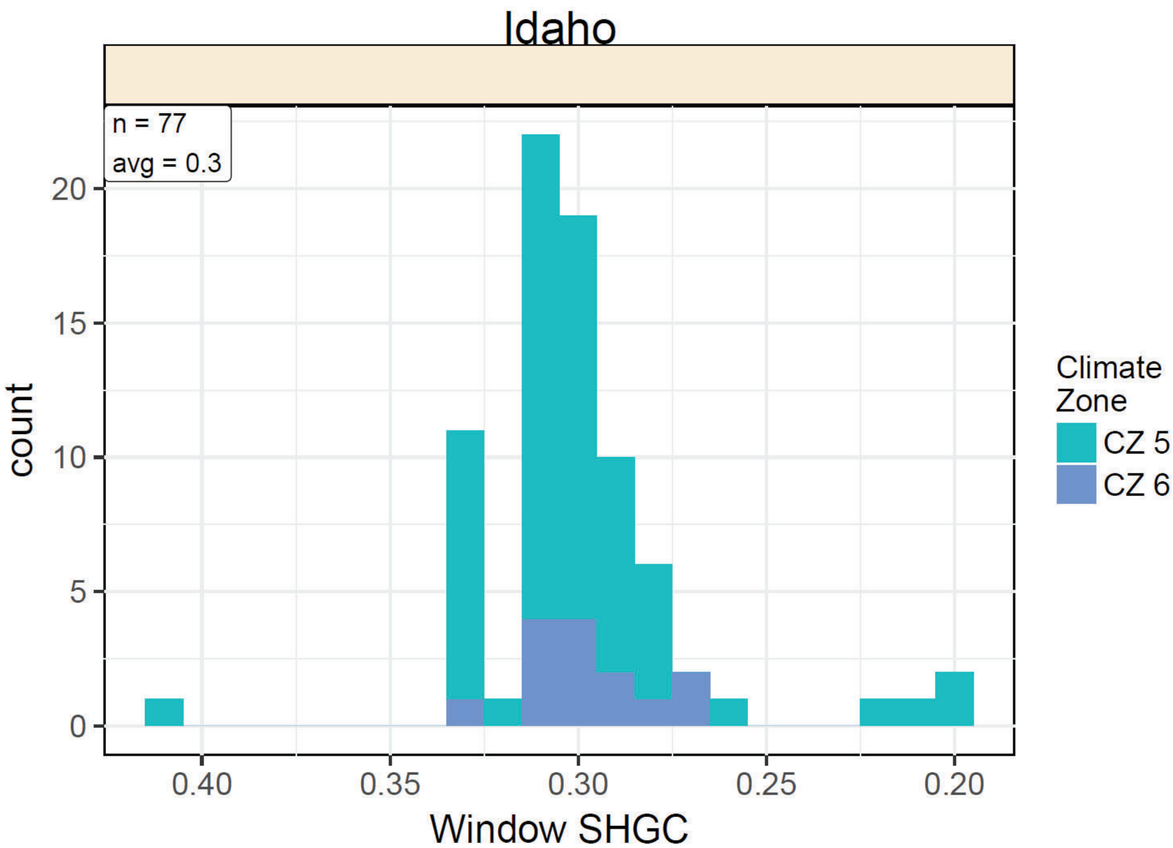

Figure 3.2. Window SHGC

Table 3.2. Window SHGC

Climate Zone	CZ5	CZ6	Statewide
Number	63	14	77
Range	0.20 to 0.41	0.27 to 0.33	0.20 to 0.41
Average	0.30	0.30	0.306
Requirement	NA	NA	NA
Compliance Rate	NA	NA	NA

- **Interpretations:**
  - SHGC values were very consistent, and nearly meet the prescriptive requirement for Climate Zones 1-3, even though there are no SHGC requirements in Climate Zones 5 and 6.
  - The vast majority of the observations were in the 0.26 to 0.34 SHGC range.

3.1.1.3 Window U-Factor

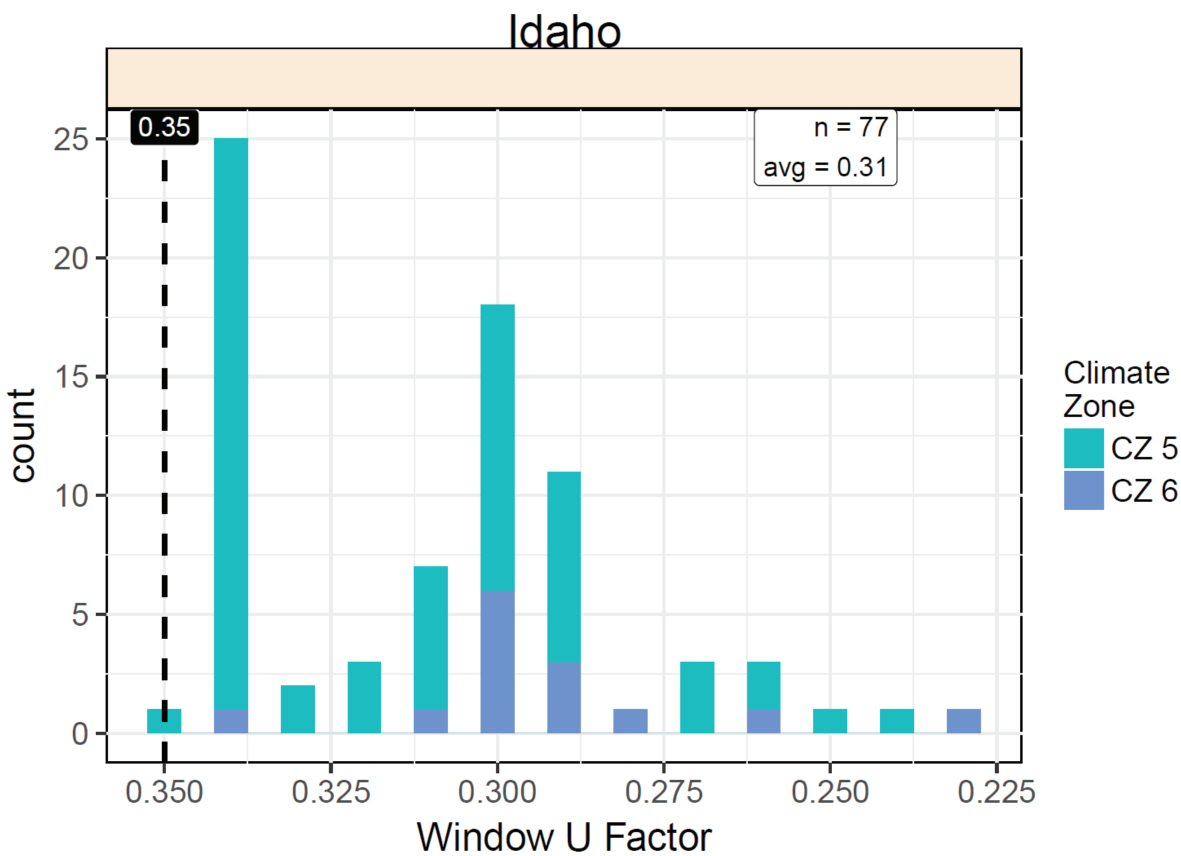

Figure 3.3. Window U-Factor

Table 3.3. Window U-Factor

Climate Zone	CZ5	CZ6	Statewide
Number	63	14	77
Range	0.24 to 0.35	0.23 to 0.34	0.23 to 0.35
Average	0.31	0.29	0.31
Requirement	0.35	0.35	0.35
Compliance Rate	63 of 63 (100%)	14 of 14 (100%)	77 of 77 (100%)

- **Interpretations:**
  - There is an extremely high rate of compliance for fenestration products.
  - This represents one of the most significant findings of the field study, with all of the observations at or above the code requirement.
  - Window U-factor requirements appear to have been implemented with a high rate of success.

3.1.1.4 Wall Insulation

Two graphs are shown for each climate zone for walls, cavity and continuous insulation (R-value) and binned wall assembly (U-factor). The R-value graphs show both the cavity and continuous insulation R-values observed, sorted in order of increasing cavity insulation R-value. The binned U-factor graphs indicate the U-factor of the wall assembly, including both cavity and continuous insulation layers, framing, and considering insulation installation quality, as observed in the field. The U-factors are binned to reduce the number of bars in the chart as individual U-factor observations may be only slightly different.

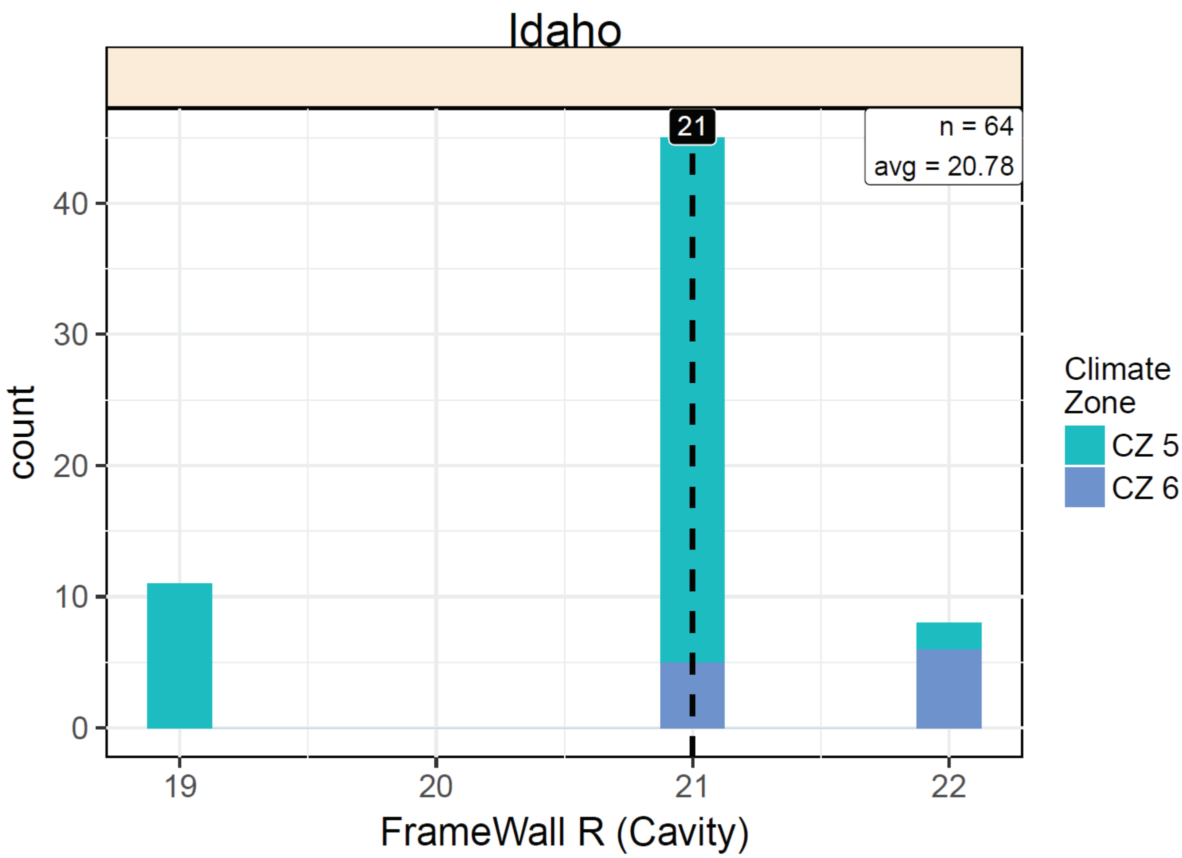

Figure 3.4. Wall R-Values

Table 3.4. Wall R-Value

Climate Zone	CZ5	CZ6	Statewide
Number	53	11	64
Range	R-19 to R-22	R-21 to R-22	R-19 to R-22
Average	R-20.6	R-21.6	R-20.8
Requirement	R-21	R-21	R-21
Compliance Rate	42 of 53 (21%)	11 of 11 (100%)	53 of 64 (83%)

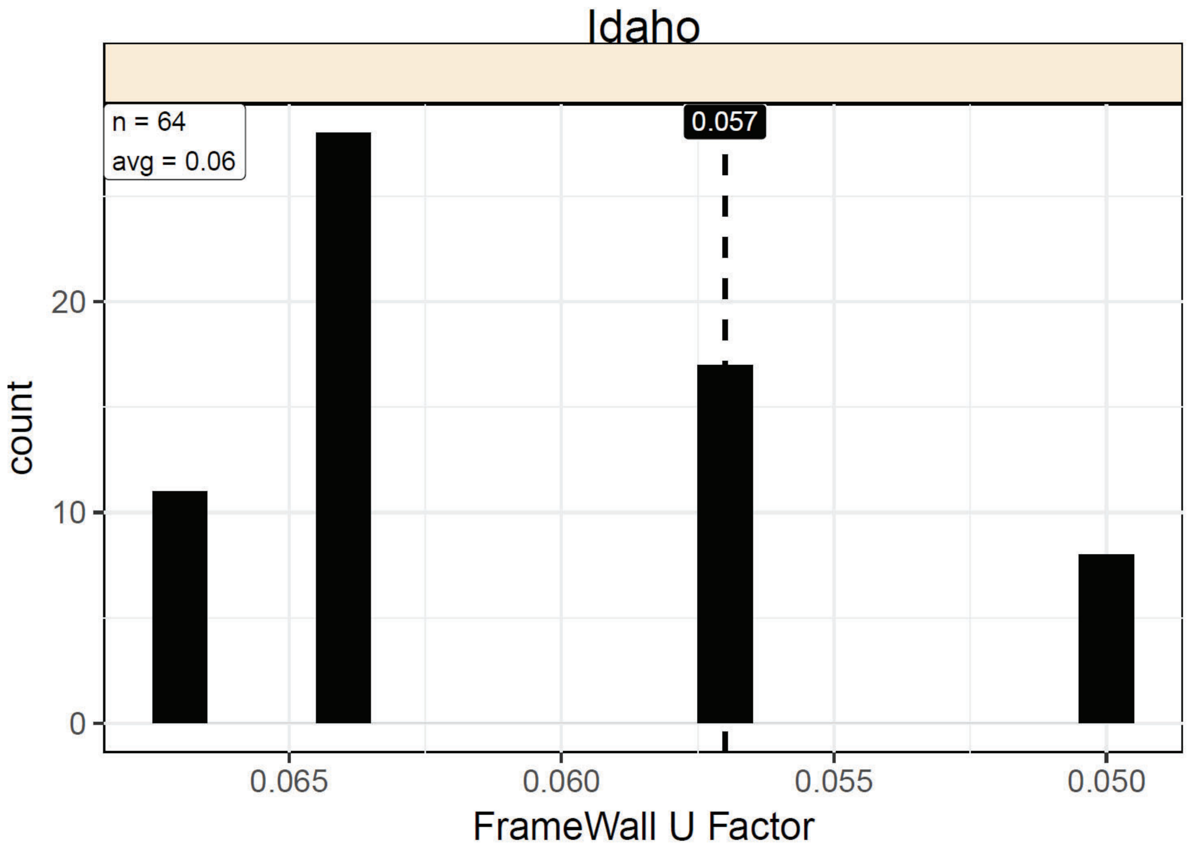

Figure 3.5. Wall Assembly Performance, including Wall Insulation Installation Quality

Table 3.5. Wall U-Factor, including Wall Insulation Installation Quality

Climate Zone	CZ5	CZ6	Statewide
Number	53	11	64
Range	0.067 to 0.050	0.064 to 0.050	0.067 to 0.050
Average	0.062	0.054	0.061
Assembly U-Factor (expected)	0.057	0.057	0.057
Rate	16 of 53 (30%)	9 of 11 (82%)	25 of 64 (39%)

- **Interpretations:**
  - Looking at the R-values, most of the observations in CZ5 met or exceeded the prescriptive code requirement, and all in CZ6 did, indicating that the only issue with the amount of insulation are the homes with R-19 insulation in CZ5.
  - In more than half of the above-grade wall observations, the insulation installation quality was rated as Grade II, indicating an issue that should be addressed.

3.1.1.5 Ceilings

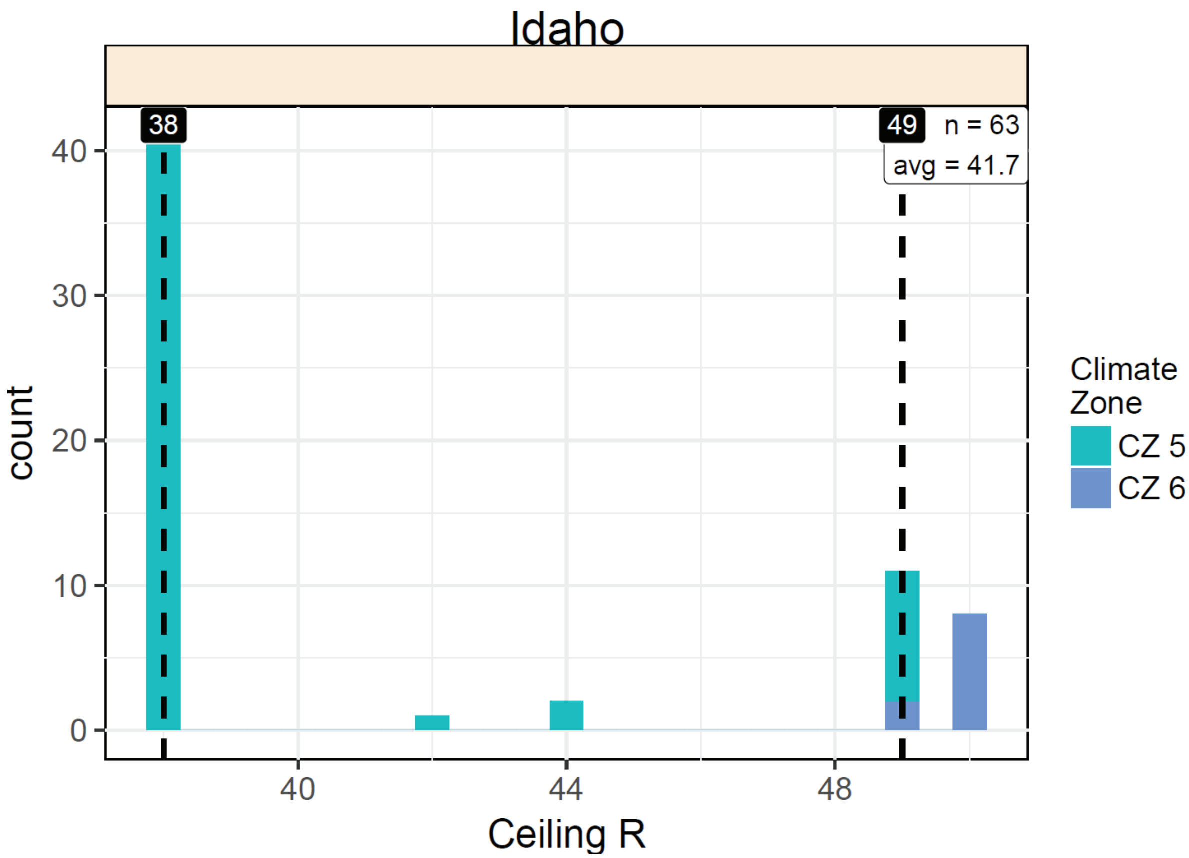

Figure 3.6. Ceiling R-Value

Table 3.6. Ceiling R-Value

Climate Zone	CZ5	CZ6	Statewide
Number	53	10	63
Range	R-38 to R-49	R-49 to R-50	R-38 to R-50
Average	R-40.2	R-49.8	R-41.7
Requirement	R-38	R-49	Varies
Compliance Rate	53 of 53 (100%)	10 of 10 (100%)	63 of 63 (100%)

- **Interpretations:**
  - The vast majority of observations met the code requirement exactly.
  - All of the roof cavity insulation installation quality observations were Grade I, indicating that roofs are well insulated in Idaho.

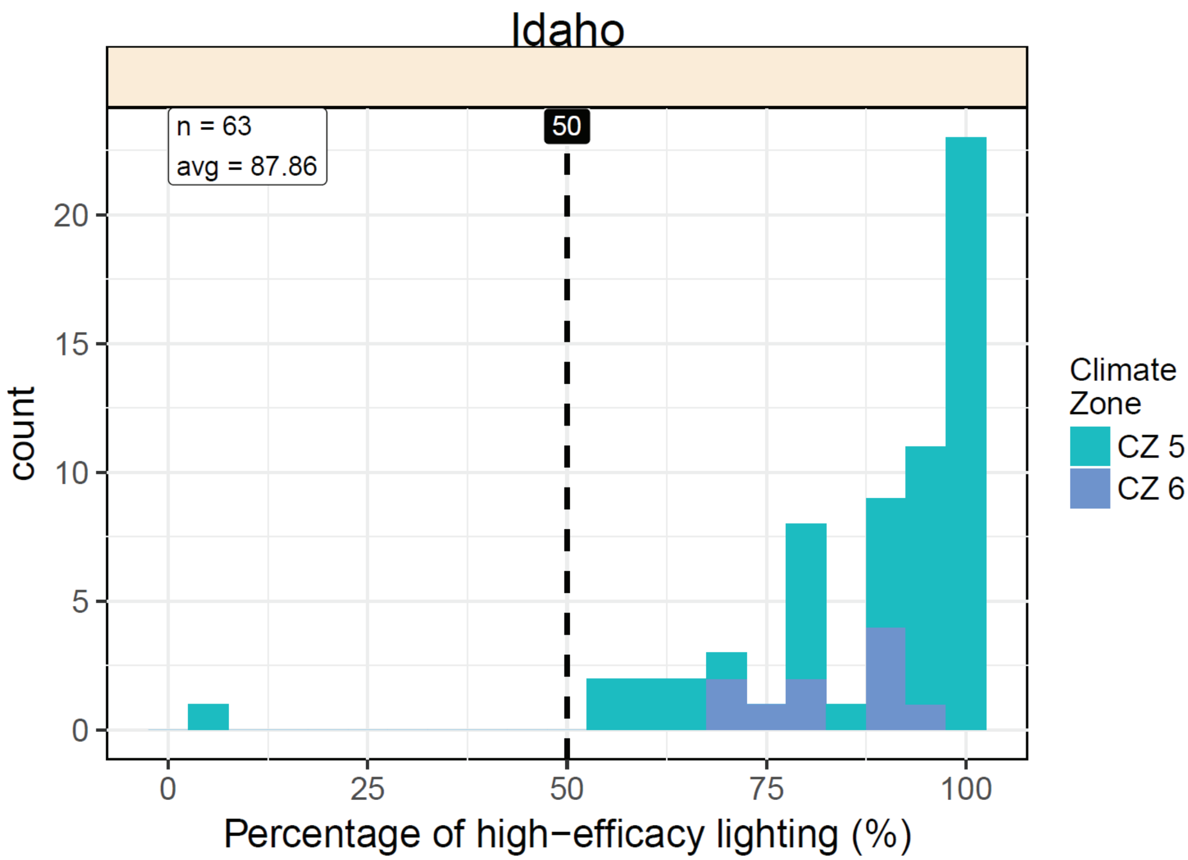

Figure 3.7. High-efficacy Lighting Percentage

Table 3.7. High-efficacy Lighting Percentage

Climate Zone	CZ5	CZ6	Statewide
Number	53	10	63
Range	4 to 100	70 to 96	4 to 100
Average	89	83	88
Requirement	50	50	50
Compliance Rate	52 of 53 (98%)	10 of 10 (100%)	62 of 63 (98%)

- **Interpretations:**
  - Nearly all of the field observations met the requirement.

3.1.1.6 Foundation Assemblies

There were three predominant foundation types observed in Idaho, heated basements, floors over vented crawlspaces and unvented crawlspaces. Two graphs are shown for each climate zone for foundations, insulation (R-value) and binned assembly (U-factor). The R-value graphs show the insulation R-values observed. The binned U-factor graphs indicate the U-factor of the assembly, including both cavity and continuous insulation layers, framing, and considering insulation installation quality, as observed in the field. The U-factors are binned to reduce the number of bars in the chart as individual U-factor observations may be only slightly different.

While initially combined into a single key item (i.e., foundation assemblies), the variety of observed foundation types are disaggregated in this section, as described above. This approach helps to portray the combinations of cavity and continuous insulation employed across each foundation type and climate zone, which is anticipated to be of value for energy code training programs. From a savings perspective, results are calculated for both the aggregated perspective and for individual foundation types (presented later in Section 3.3), however; only the aggregated observations should be considered statistically representative at the statewide level.

Basement Wall Insulation (Conditioned Basements)

For basement wall R-values, the R-value plot shows only the cavity insulation observations. There are an additional 5 homes that have only continuous insulation and these homes are not shown on Figure 3.8. These 5 homes are shown in the U-factor plot (Figure 3.9).

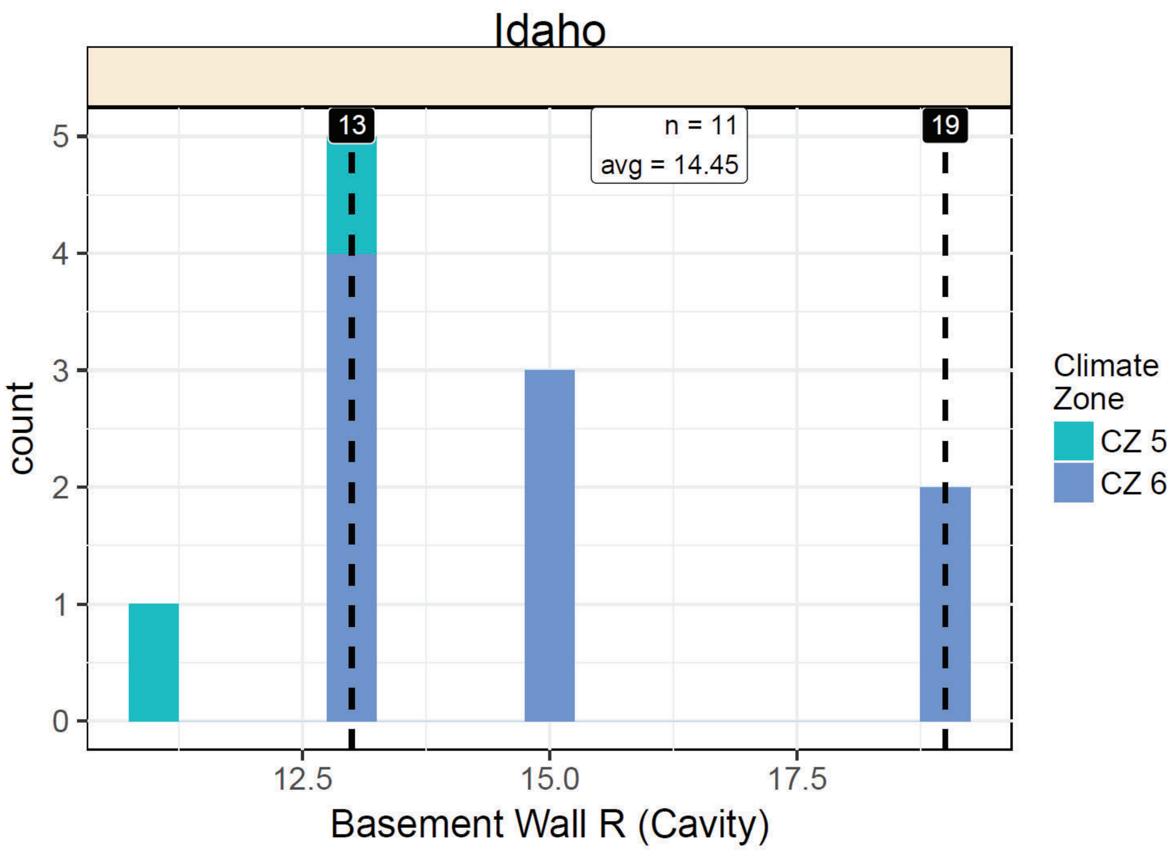

Figure 3.8. Basement Wall Cavity R-Values

Table 3.8. Basement Wall Cavity R-Values

Climate Zone	CZ5	CZ6	Statewide
Number	2	9	11
Range	R-11 to R-13	R-13 to R-19	R-11 to R-19
Average	R-12	R-15	R-14.5
Assembly U-Factor (expected)	R-13	R-19	R-13 in CZ5 and R-19 in CZ6
Rate	1 of 2 (50%)	2 of 9 (22%)	3 of 11 (27%)

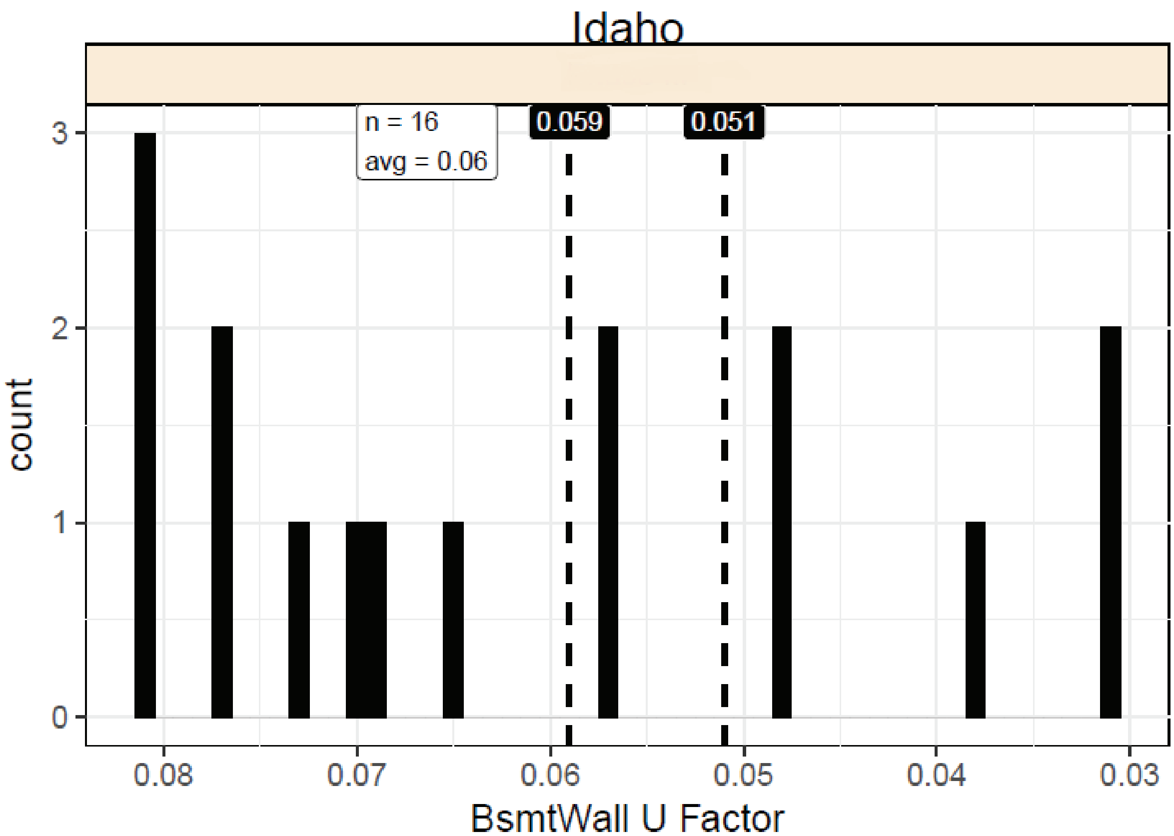

Figure 3.9. Basement Wall Assembly Performance, including Wall Insulation Installation Quality

Table 3.9. Basement Walls U-Factor

Climate Zone	CZ5	CZ6	Statewide
Number	4	12	16
Range	0.069 to 0.031	0.081 to 0.038	0.081 to 0.031
Average	0.049	0.065	0.061
Assembly U-Factor (expected)	0.059	0.051	0.059 in CZ5 and 0.051 in CZ6
Rate	2 of 4 (50%)	3 of 12 (25%)	5 of 16 (31%)

- **Interpretations:**
  - Comparison of the U-factor and R-value graphs for CZ5 indicates that insulation installation quality may be an issue for basement walls with cavity insulation in CZ5. However, the two homes with basement walls with continuous insulation did meet code. The sample size for CZ5 is very small.
  - Comparison of the U-factor and R-value charts for CZ6 indicates that the main reason for the poor performance on the U-factor chart is the amount of insulation. In CZ6, the presence of three homes with continuous basement insulation again provided all of the homes that meet the code requirement. This implies that for the two homes that meet the cavity insulation R-value, the insulation installation quality for those homes raised their U-factor.

Insulation in Floors over Unconditioned Spaces

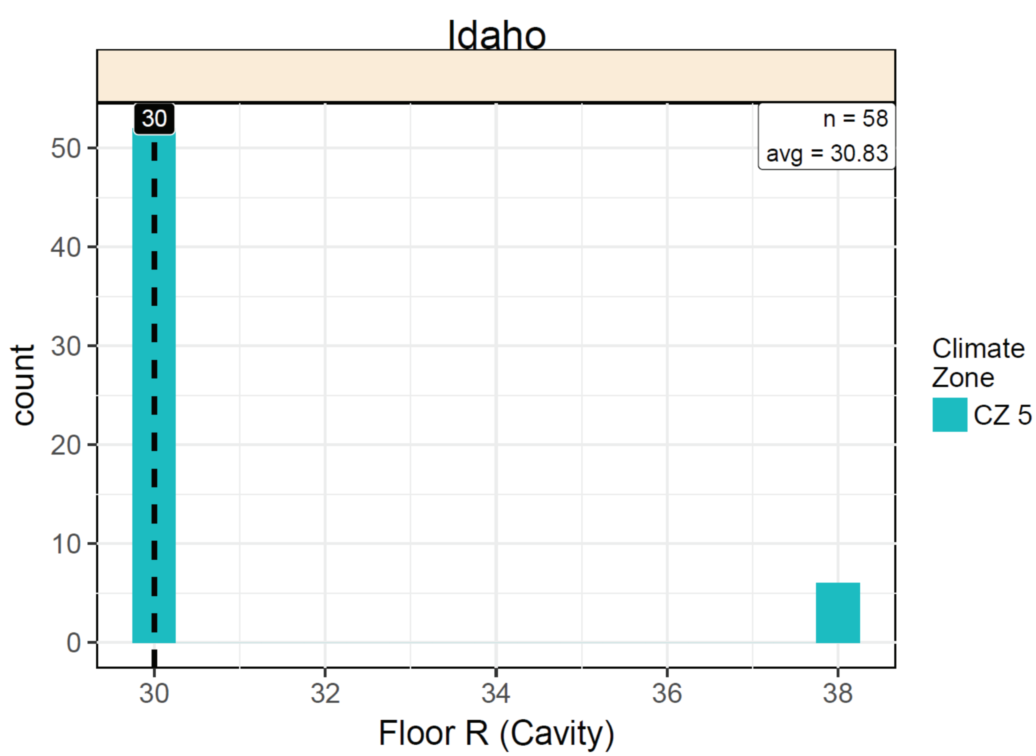

Figure 3.10. Floor R-Values

Table 3.10. Floor R-Value

Climate Zone	CZ5	CZ6	Statewide
Number	58	0	58
Range	30 to 38	NA	30 to 38
Average	30.8	NA	30.8
Assembly U-Factor (expected)	30	30	30
Rate	58 of 58 (100%)	NA	58 of 58 (100%)

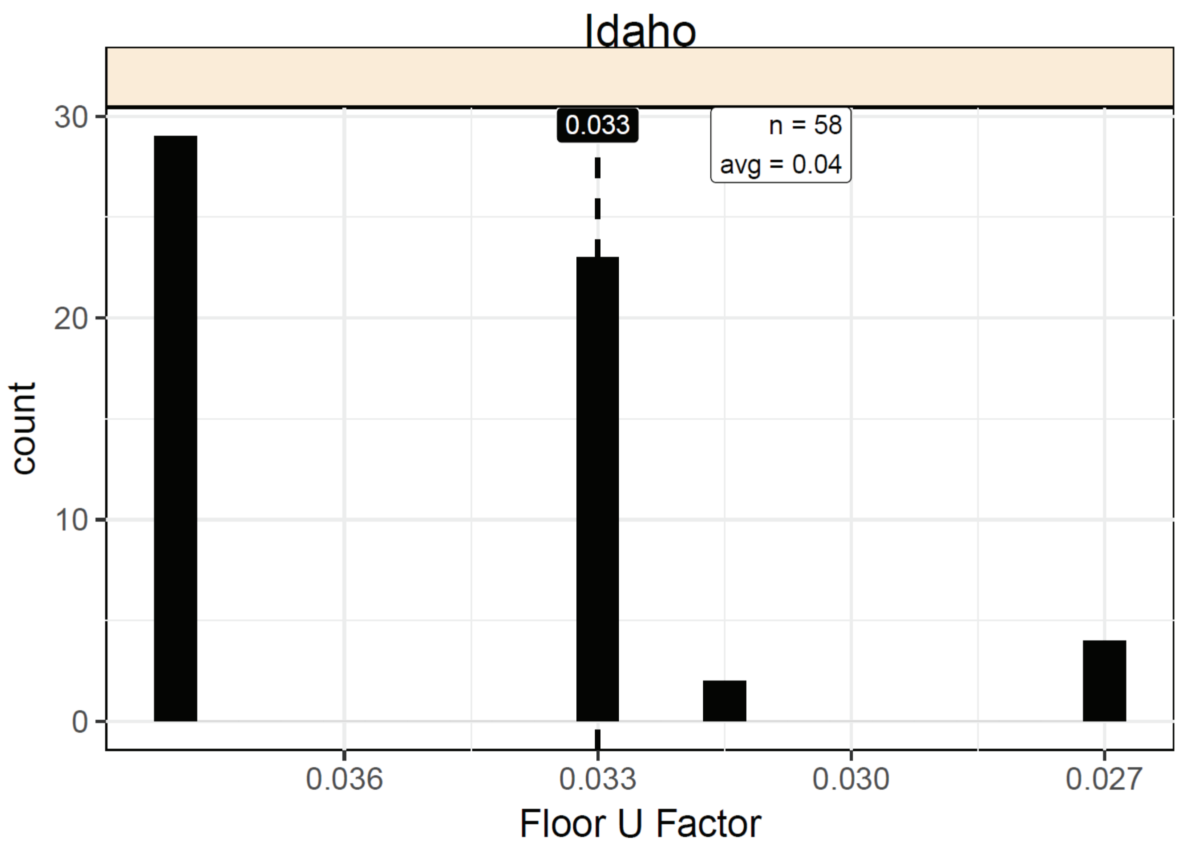

Figure 3.11. Floor Assembly Performance, including Insulation Installation Quality

Table 3.11. Floor U-Factor

Climate Zone	CZ5	CZ6	Statewide
Number	58	0	58
Range	0.040 to 0.028	NA	0.040 to 0.028
Average	0.035	NA	0.035
Assembly U-Factor (expected)	0.033	0.033	0.033
Rate	29 of 58 (50%)	NA	29 of 58 (50%)

- **Interpretations:**
  – Comparison of the U-factor and R-value charts for CZ5 indicates that insulation installation quality is an issue for floors in CZ5. The R-values all meet or exceed the code requirement, but only half of the U-factors meet or exceed the code requirement.

Insulation in Walls of Unvented Crawlspaces

For this assembly, the majority of observations involved continuous insulation, so the R-value plot shown is for vented crawlspace wall continuous R-value. There are an additional three observations of crawlspace walls with cavity insulation, all of which meet prescriptive R-value requirements. These observations are included in the vented crawlspace wall U-factor plot below.

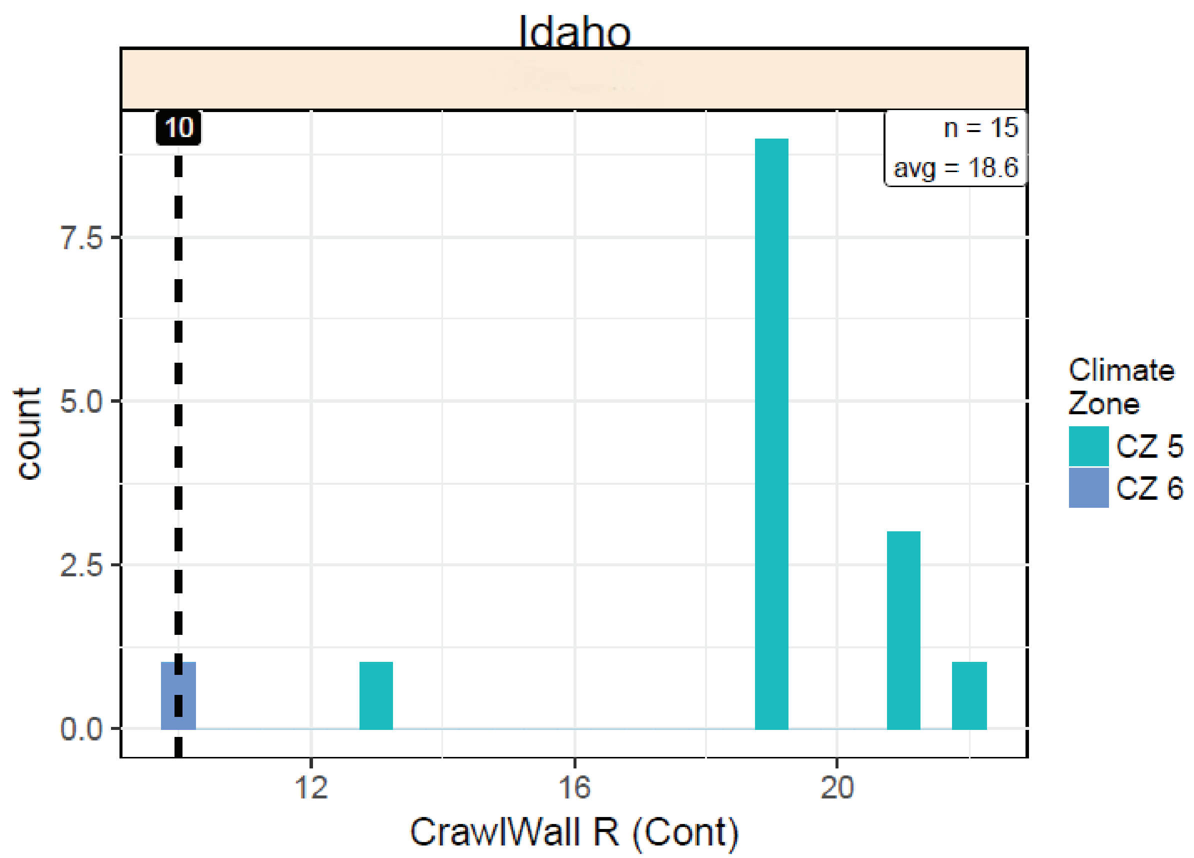

Figure 3.12. Unvented Crawlspace Wall Continuous Insulation R-Value

Table 3.12. Unvented Crawlspace Wall Continuous R-Value

Climate Zone	CZ5	CZ6	Statewide
Number	14	1	15
Range	R-13 to R-22	R-10	R-10 to R-22
Average	R-19.2	R-10	R-18.6
Assembly U-Factor (expected)	R-10	R-10	R-10
Rate	14 of 14 (100%)	1 of 1 (100%)	15 of 15 (100%)

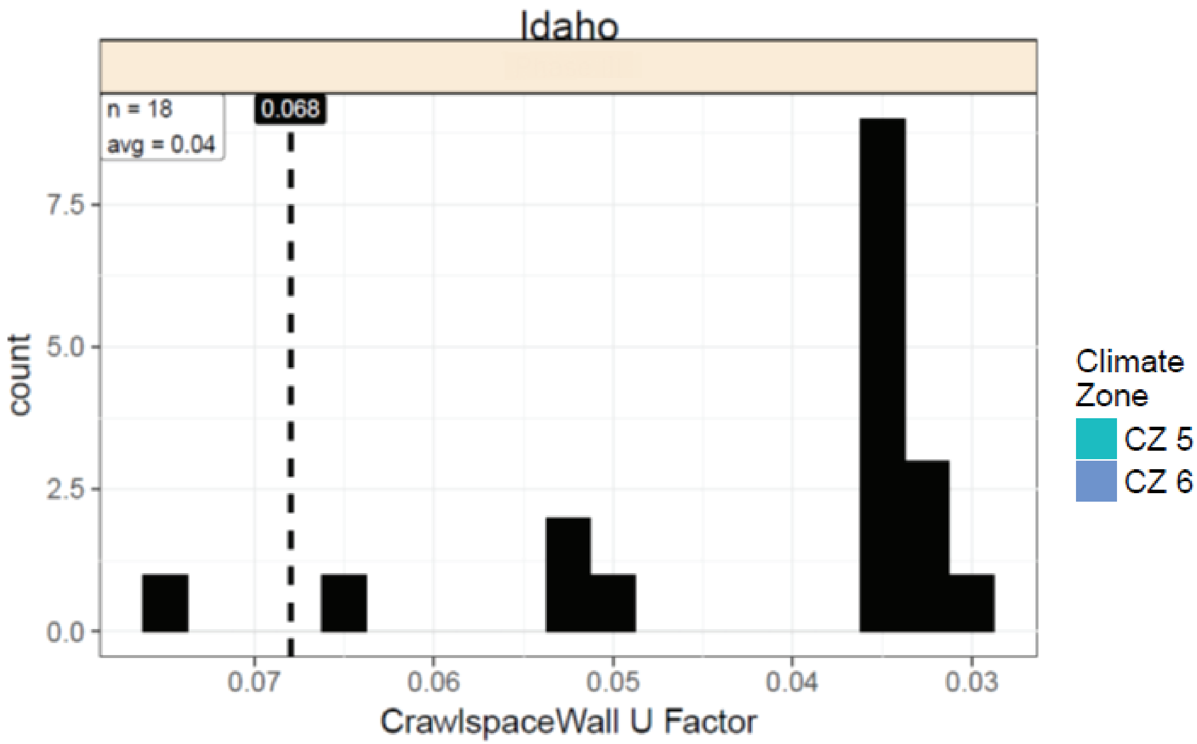

Figure 3.13. Unvented Crawlspace Wall Assembly Performance, including Insulation Installation Quality

Table 3.13. Unvented Crawlspace Wall U-Factor

Climate Zone	CZ5	CZ6	Statewide
Number	17	1	18
Range	0.065 to 0.032	0.065	0.065 to 0.032
Average	0.040	0.065	0..041
Assembly U-Factor (expected)	0.068	0.068	0.068
Rate	16 of 17 (94%)	1 of 1 (100%)	18 of 18 (100%)

- **Interpretations:**
  - All but one unvented crawlspace wall observation met the code requirement.

3.1.1.7 Duct Tightness

For ducts, this report presents both raw duct leakage and adjusted duct leakage. Raw duct leakage is simply the values of duct leakage observed in the field. Adjusted duct leakage looks at the location of the ducts and adjusts the leakage values for any ducts which are entirely in conditioned space by setting the leakage of those ducts to zero (0). The adjustment reflects the fact that duct leakage tests are not required if the ducts are entirely in conditioned space.

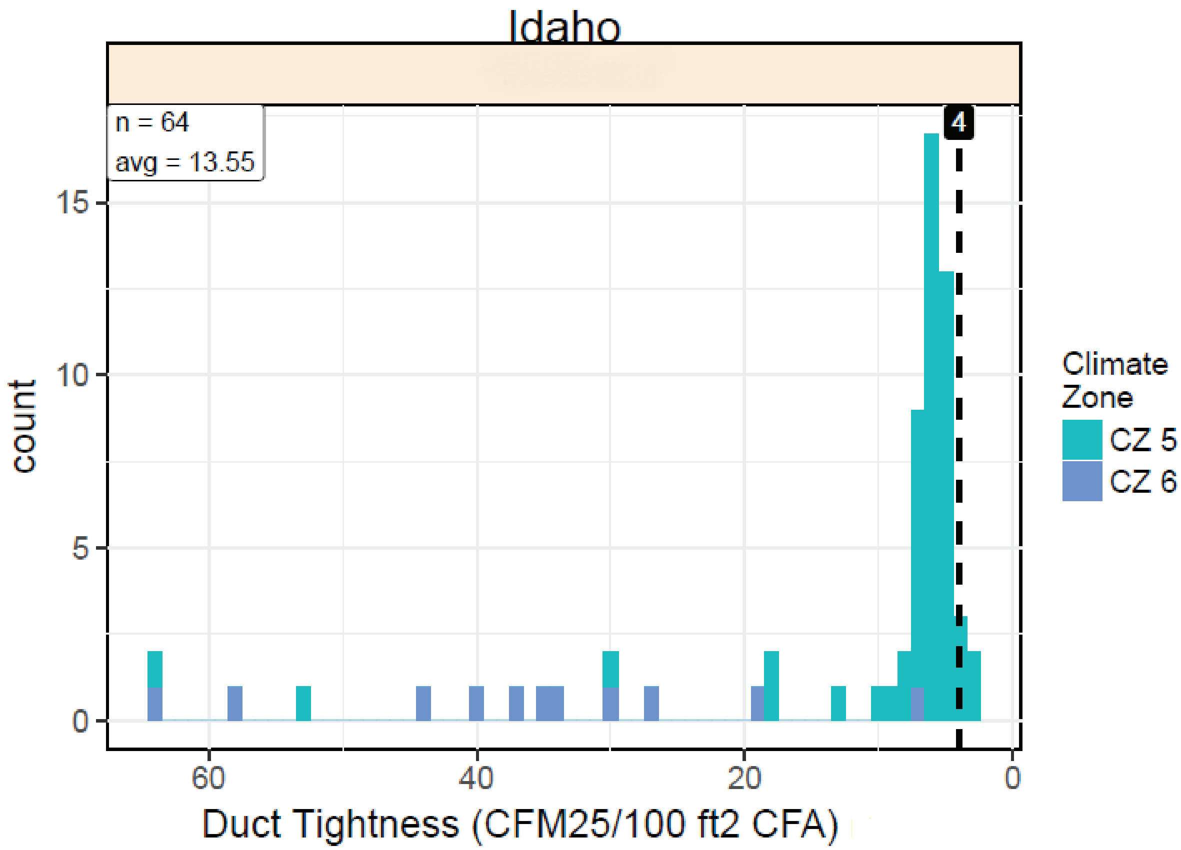

Figure 3.14. Raw Duct Tightness (CFM25/100ft2 CFA)

Table 3.14. Raw Duct Tightness (CFM25/100ft2 CFA)

Climate Zone	CZ5	CZ6	Statewide
Number	53	11	64
Range	3.2 to 64.0	6.9 to 63.6	3.24 to 64.0
Average	8.9	35.9	13.6
Requirement	4	4	4
Compliance Rate	3 of 53 (6%)	0 of 11 (0%)	3 of 64 (5%)

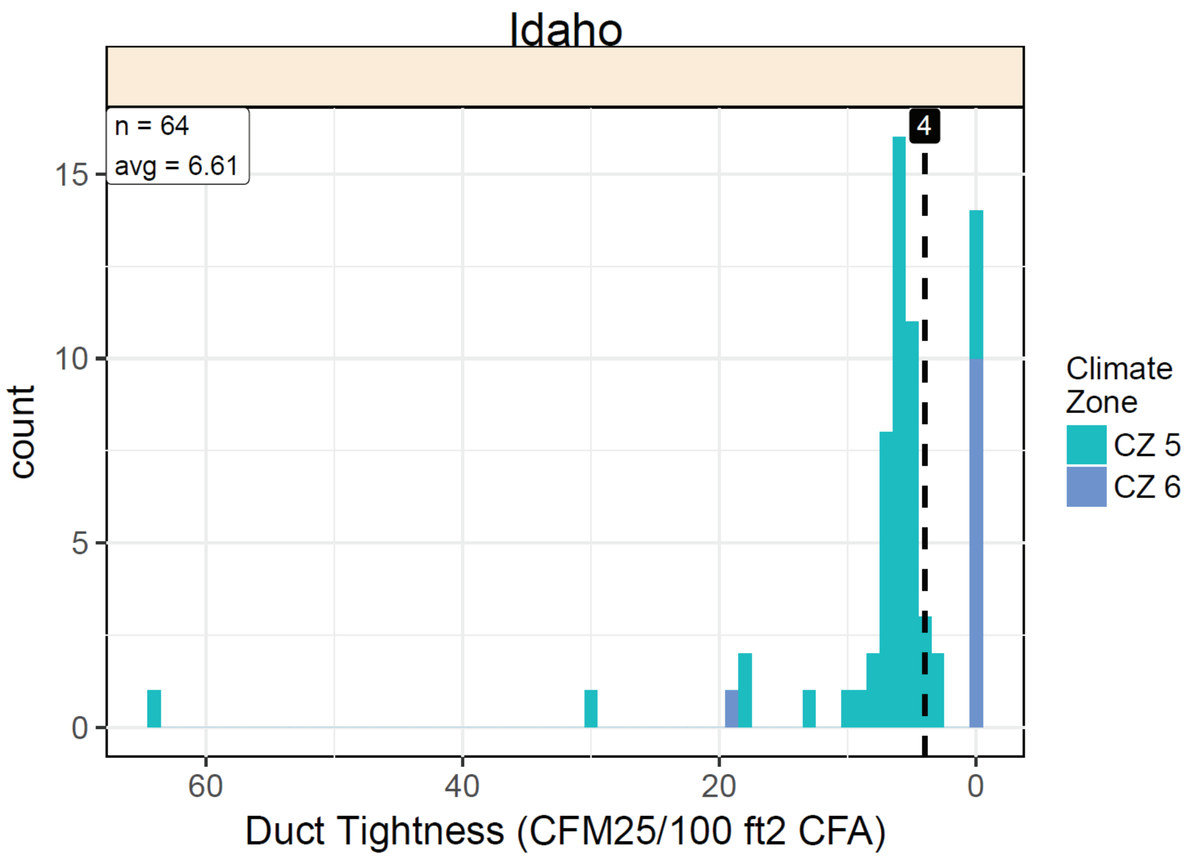

Figure 3.15. Adjusted Duct Tightness (CFM25/100ft2 CFA)

Table 3.15. Adjusted Duct Tightness (CFM25/100ft2 CFA)

Climate Zone	CZ5	CZ6	Statewide
Number	53	11	64
Range	0.0 to 64.0	0.0 to 63.61	3.24 to 64.0
Average	7.6	1.72	6.6
Requirement	4	4	4
Compliance Rate	17 of 53 (32%)	10 of 11 (91%)	26 of 64 (37%)

- **Interpretations:**
  - The average total duct leakage is 8.5 CFM 25/100 ft2 for the 50 systems with ducts in unconditioned space, and 31.8 CFM 25/100 ft2 for the 14 systems located entirely in conditioned space.
  - The majority of raw observations do not meet the Idaho code requirement for duct leakage.
  - The majority of adjusted observations do not meet the Idaho code requirement for duct leakage. However, nearly all adjusted duct leakage values in CZ6 meet the requirement, indicating that many homes in CZ6 are installing ducts entirely in conditioned space.

– Reductions in duct leakage represent a significant area for improvement and should be given increased attention in future training and enforcement.

3.1.1.8 Impact of Insulation Installation Quality

While insulation installation quality is not an explicit energy code requirement, at the start of DOE's FOA projects, it was noted as a particular concern among project teams and stakeholders, as it plays an important role in the energy performance of envelope assemblies. Insulation installation quality was therefore collected by the project team whenever possible and applied as a *modifier* in the analyses for applicable key items (i.e., ceiling insulation, wall insulation, and foundation insulation). The team followed the RESNET[1] assessment protocol which has three grades, Grade I being the best quality installation and Grade III being the worst.

Table 3.16 shows the insulation installation quality levels for framed envelope assemblies, as observed in the state. A slight majority of the observations (1247 of 243) were classified as Grade I, with remainder Grade II, indicating that there is some improvement needed in insulation installation quality. Roof insulation installation quality was all Grade I, but other assemblies show the majority of observations to be Grade II.

Table 3.16. Insulation Installation Quality

Assembly	Grade I	Grade II	Grade III	Total Observations
Roof Cavity	63	0	0	**63**
Floor	27	31	0	**58**
Above Grade Wall	25	39	0	**64**
Basement Wall	2	9	0	**11**
Crawlspace Wall	0	3	0	**3**
Knee Wall	7	35	2	**44**

3.1.2 Additional Data Items

The project team collected data on all code requirements within the state as well as other areas to inform the energy simulation and analysis for the project (e.g., home size, installed equipment systems, etc.). While these items were not the focal point of the study, and many are not considered statistically representative, they do provide some insight surrounding the energy code and residential construction within the state.

The following represents a summary of this data and outlines some of the more significant findings, in many cases including the observation or compliance rate associated with the specified item. A larger selection of the additional data items collected as part of the state field study is contained in Appendix B.

3.1.2.1 Average Home

- Size: 2,486 ft^2 and 1.35 stories

[1] See http://www.resnet.us/standards/RESNET_Mortgage_Industry_National_HERS_Standards.pdf

3.1.2.2 Compliance

- Almost all homes (98%) were permitted under the Idaho Energy Conservation Code. Two percent selected the 2015 edition of the International Energy Conservation Code to meet the local jurisdiction requirements. (n=127)
- Nine homes were noted as participating in an above-code program.

3.1.2.3 Envelope

- **Profile:**
  - Walls: All were wood-framed walls with 2x6" studs
  - Foundations: Mix of vented crawlspaces (65%), basements (17%), unvented crawlspaces (15%), and slab on grade (3%).
- **Successes (percentage of observations that complied):**
  - Insulation labeled (100%)
  - IC-rated light fixtures sealed (100%)
  - Utility penetrations sealed (98%)
- **Areas for Improvement:**
  - Attic access openings complied (54%)
  - Knee walls sealed (55%)
  - Envelope areas behind bathroom tubs & showers sealed (39%)
  - Rim joists sealed (27%)
  - Dropped ceilings sealed (49%)

3.1.2.4 Duct & Piping Systems

- **Profile:**
  - Ducts were generally located within conditioned space (percentage of duct system):
    - Supply: 41% (35 homes with 37 duct systems entirely within conditioned space)
    - Return: 31% (25 homes with 27 duct systems entirely within conditioned space)
  - About 28% of duct systems located *supply* ducts entirely within conditioned space
  - About 21% of duct systems located *return* ducts entirely within conditioned space
  - About 19% of duct systems had the *entire* system within conditioned space.
  - Pipe Insulation (R-value): 2.7
- **Successes:**
  - Air handlers sealed (88%)

3.1.2.5 HVAC Equipment

- **Profile:**
  - Heating: Mostly gas furnaces with an average efficiency of 90 AFUE.
  - Cooling: Mostly central AC with an average efficiency of 13.1 SEER
  - Water Heating: Mix of gas (92%) and electric (8%) storage (98%) with an average capacity of 50 gallons and average efficiency rating of EF 0.65.
- **Successes:**
  - User manuals for mechanical systems provided (100%)

3.2 Energy Intensity

The statewide energy analysis results are shown in the figure below, which compares the weighted average energy consumption of the observed data set to the weighted average consumption based on the state energy code. The observed data set (as gathered in the field) was compared against the same set of homes meeting prescriptive code requirements. In terms of overall energy consumption, the average home in Idaho appears to use *less* energy than would be expected relative to a home built to the current minimum state code requirements.

Analysis of the collected field data indicates an average regulated EUI (dashed line in Figure 3.16) of approximately 34.62 kBtu/ft^2-yr compared to 40.51 kBtu/ft^2-yr for homes exactly meeting minimum *prescriptive* energy code requirements (black line in Figure 3.16). This suggests the EUI for a “typical” home in the state is about 15% better than code.

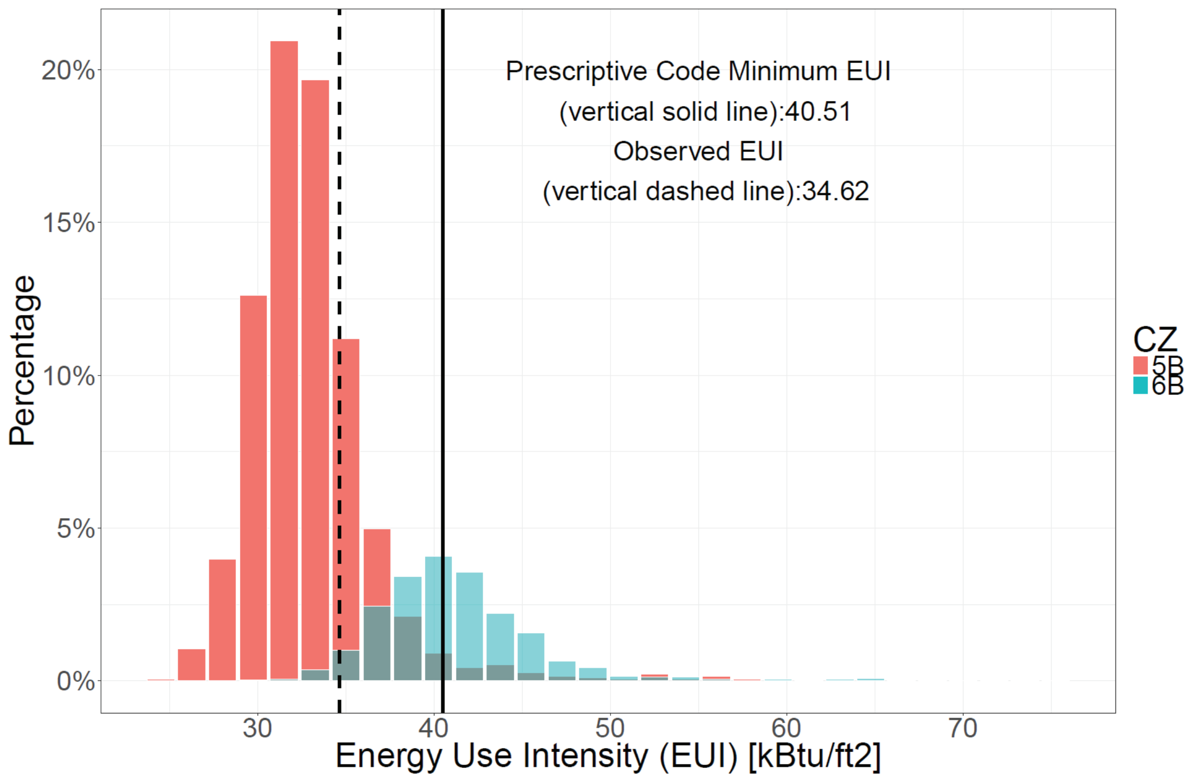

Figure 3.16. Statewide EUI Analysis for Idaho

3.3 Savings Potential

Those key items with the greatest potential,[1] shown below followed by the percent that did not meet code, were analyzed further to calculate the associated savings potential, including energy and cost savings.

- Duct Leakage (63% of adjusted observations),
- Exterior Wall Insulation (61%),
- Foundations
  - Basement Wall Insulation (69%), and
  - Floor Insulation (50%).

For analytical details refer to Section 2.3.3 (Savings Analysis) or the DOE methodology document (2018).
Estimated savings resulting from the analysis are shown below in order of highest to lowest total energy and cost savings (Table 3.17). As can be seen, there are significant savings opportunities, with the greatest total savings potential associated with these measures. In addition,

[1] Defined here as those with more than 15% of observations not meeting the prescriptive code requirement. For insulated assemblies, the U-factor observations are used.

Table 3.19 shows the total savings reductions that will accumulate over 5, 10, and 30 years of construction.

Table 3.17. Statewide Annual Measure-Level Savings for Idaho

Measure	Climate Zone	Electricity Savings (kWh/ home)	Natural Gas Savings (therms/ home)	Total Savings (kBtu/ home)	Number of homes	Total Energy Savings (MMBtu)	Total Energy Cost Savings ($)
Duct Leakage	5B	107	21	2,430	8,760	21,281	237,040
	6B	107	26	2,959	2,259	6,684	70,161
	State Total	**107**	**22**	**2,538**	**11,019**	**27,966**	**307,201**
Exterior Wall Insulation	5B	42	13	1,477	8,760	12,939	128,174
	6B	41	17	1,837	2,259	4,149	39,008
	State Total	**42**	**14**	**1,551**	**11,019**	**17,088**	**167,182**
Foundation Insulation*	5B	-13	3	240	NA	814	2,474
	6B	-30	12	1,112	NA	570	2,962
	State Total	**-16**	**5**	**418**	**NA**	**1,383**	**5,436**
TOTAL		**133**	**41**	**4,507**	**11,019**	**46,436**	**479,819**

* Negative values mean that savings or reductions decrease if the measure is brought up to code.
**See Table 3.18 for annual measure-level savings results by foundation type.

Table 3.18. Statewide Annual Measure-Level Savings by Foundation Type for Idaho

Measure	Climate Zone	Electricity Savings (kWh/ home)	Natural Gas Savings (therms/ home)	Total Savings (kBtu/ home)	Number of homes	Total Energy Savings (MMBtu)	Total Energy Cost Savings ($)
Heated Basement Wall*	5B	-6	1	119	1,460	173	660
	6B	-23	10	959	377	361	2,043
	State Total	**-9**	**3**	**291**	**1,837**	**534**	**2,703**
Floor*	5B	-7	1	121	5,293	641	1,815
	6B	-6	2	153	1,365	209	918
	State Total	**-7**	**2**	**128**	**6,657**	**849**	**2,733**
TOTAL		**-16**	**5**	**418**	**NA**	**1,383**	**5,436**

*For basement wall insulation and floor over unvented insulation, note that while total energy savings are positive, electricity savings are negative. This is the result of increased insulation leading to lower natural gas usage in the winter, but higher electricity usage in the summer.
** For foundation measures, the total number of homes is multiplied by the foundation share for each foundation type and is therefore smaller than the total number of homes shown for other measures.

Table 3.19. Five-years, Ten-years, and Thirty-years Cumulative Annual Statewide Savings for Idaho

Measure	Total Energy Savings (MMBtu)			Total Energy Cost Savings ($)		
	5yr	10yr	30yr	5yr	10yr	30yr
Duct Leakage	419,483	1,538,104	13,003,973	4,608,019	16,896,069	142,848,583
Exterior Wall Insulation	256,313	939,815	7,945,707	2,507,730	9,195,009	77,739,624
Foundation Insulation	20,748	76,077	643,197	81,541	298,985	2,527,781
TOTAL	**696,544**	**2,553,996**	**21,592,877**	**$7,197,290**	**$26,390,063**	**$223,115,988**

4.0 Conclusions

The Idaho field study provides an enhanced understanding of statewide code implementation and suggests that potential savings are available through increased compliance. From a statewide perspective, the average home in Idaho uses about 15% less energy than a home exactly meeting the state energy code. However, savings potential remains through increased compliance with targeted measures. Potential statewide annual energy savings are 46,436 MMBtu, which equates to $479,819 in cost savings. Over a 30-year period, these impacts grow to 21.6 million MMBtu and $223 million.

Several key measures directly contribute to these savings, and should be targeted through future education, training and outreach activities. The savings associated with each are shown in Table 4.1 below.

Table 4.1. Annual Statewide Savings Potential in Idaho

	Annual Savings	
Key Measure	**Energy** (MMBtu)	**Cost** ($)
Duct Leakage	27,966	307,201
Exterior Wall Insulation	17,088	167,182
Foundation Insulation	1,383	5,436
Total	**46,436 MMBtu**	**$479,819**

5.0 References

Census Bureau. 2017. Censtats Building Permits Database. http://censtats.census.gov/

DOE. 2012. *National Energy and Cost Savings for New Single- and Multifamily Homes: A Comparison of the 2006, 2009, and 2012 Editions of the IECC*, available at http://www.energycodes.gov/development

DOE Building Energy Codes Program's residential field study website is available at https://www.energycodes.gov/compliance/residential-energy-code-field-study (accessed August 8, 2016).

DOE/PNNL 2018. "Residential Building Energy Code Field Study: Data Collection & Analysis Methodology" Available at https://www.energy.gov/sites/prod/files/2018/06/f52/bto-Res-Field-Study-Methodology-060618-2.pdf

EnergyPlus. https://energyplus.net/.

Residential Energy Services Network. 2013. "Mortgage Industry National Home Energy Rating System Standards." Residential Energy Services Network, Oceanside, CA. www.resnet.us.

Appendix A

State Sampling Plan

Appendix A

State Sampling Plan

A.1 State Sampling Plan

Table A.1. State Sampling Plan

Location (Place, County)	Sample	Actual
Kootenai County Unincorporated Area, Kootenai	4	4
Coeur d'Alene, Kootenai	3	3
Post Falls, Kootenai	4	4
Hayden, Kootenai	2	2
Rathdrum, Kootenai	1	1
Latah County Unincorporated Area, Latah	1	1
Ada County Unincorporated Area, Ada	5	5
Meridian, Ada	7	7
Eagle, Ada	5	5
Boise, Ada	3	3
Kuna, Ada	2	2
Star, Ada	1	1
Canyon County Unincorporated Area, Canyon	2	2
Nampa, Canyon	4	4
Caldwell, Canyon	2	2
Middleton, Canyon	1	1
Mountain Home, Elmore	1	1
Valley County Unincorporated Area, Valley	1	1
Bonneville County Unincorporated Area, Bonneville	1	1
Idaho Falls, Bonneville	2	2
Ammon, Bonneville	1	1
Jefferson County Unincorporated Area, Jefferson	1	1
Pocatello, Bannock	1	1
Chubbuck, Bannock	2	2
Rexburg, Madison	4	4
Fremont County Unincorporated Area, Fremont	1	1
Twin Falls, Twin Falls	1	1
Total	**63**	**63**

A.2 Substitutions

No substitutions to the state sampling plan were required.

Appendix B

Additional Data

Appendix B

Additional Data

B.1 Additional Data Collected by Field Teams

The project team made observations on several energy efficiency measures beyond the key items alone. The majority of these additional items are based on code requirements within the state, while others were collected to inform the energy simulation and analysis for the project (e.g., installed equipment, whether the home participated in an above-code program, etc.). While these items were not the focal point of the study, and many are not considered statistically representative, they do provide some additional insight surrounding the energy code and residential construction within the state.

The following is a sampling of the additional data items collected as part of the Idaho field study. Each item is presented, along with a brief description and statistical summary based on the associated field observations. The full data set is available on the DOE Building Energy Codes Program website.[1]

B.1.1 General

The following represents the general characteristics of the homes observed in the study:

B.1.1.1 Average Home

- Size (n=127): 2486 ft^2
- Number of Stories (n=127): 1.35

Table B.1. Conditioned Floor Area (ft^2)

Conditioned Floor Area (ft^2)	< 1000	1000 to 1999	2000 to 2999	3000 to 3999	4000+
Percentage	1%	35%	42%	17%	5%

Table B.2. Number of Stories

No. of Stories	1	2	3	4+
Percentage	65%	35%	0%	0%

B.1.1.2 Wall Profile

- Framing Type (n=127):
  - *All* were framed construction (100%)
- Framing Material (n=127):
  - Wood (100%)

[1] Available at https://www.energycodes.gov/compliance/residential-energy-code-field-study

  - Steel (0%)
- Framing Depth (n=127):
  - 6" (100%)

B.1.1.3 Foundation Profile

- Foundation Type (n=127):
  - Heated Basement (17%)
  - Slab on Grade (3%)
  - Unvented Crawlspace (15%)
  - Vented Crawlspace (65%)

B.1.2 Compliance

The following summarizes information related to compliance, including the energy code associated with individual homes, whether the home was participating in an above-code program, and which particular programs were reported. The percentages provided in the sections below represent percentages of total observations or the percentage of observations that complied.

B.1.2.1 Energy Code Used (n=127):

Table B.3, Energy Code Used

Energy Code	Idaho Energy Conservation Code	2015 IECC
Percentage	98%	2%

- Was the home participating in an above-code program (n=102)?
  - Yes (9%)
  - No (91%)

B.1.3 Envelope

The following list of questions focus on average characteristics of the thermal envelope:

B.1.3.1 Insulation Labels

- Was insulation labeled (n=12)?
  - Yes (100%)
  - No (0%)

B.1.3.2 Ceilings

- Did the attic hatch/door exhibit the correct insulation value (n=8)?

- Yes (100%)
- No (0%)

B.1.3.3 Air Sealing[1]

- Thermal envelope sealed (n=64) (97%)
- Openings around windows and doors sealed (n=64) (100%)
- Utility penetrations sealed (n=95) (98%)
- Dropped ceilings sealed (n=39) (49%)
- Knee walls sealed (n=53) (55%)
- Garage walls and ceilings sealed (n=68) (100%)
- Envelope behind tubs and showers sealed (n=64) (39%)
- Common walls sealed (n=0) (0%)
- Attic access openings sealed (n=35) (54%)
- Rim joists sealed (n=30) (27%)
- Other sources of infiltration sealed (n=63) (97%)
- IC-rated light fixtures sealed (n=127) (100%)

B.1.4 Duct & Piping Systems

The following represents an average profile of observed air ducting and water piping systems, followed by a list of additional questions related to such systems:

B.1.4.1 System Profile

- Duct Location in Conditioned Space (percentage):
  - *Supply* (n=131): 28% (37 homes with systems located entirely within conditioned space)
  - *Return* (n=131): 21% (27 homes with systems located entirely within conditioned space)
- Duct Insulation (R-value):
  - *Supply* (n=61): 7.93
  - *Return* (n=15): 6.8
- Air ducts sealed (n=114) (88%)
- Air handlers sealed (n=123) (98%)
- Filter boxes sealed (n=114) (94%)

[1] Note that results in this section are from checklist items that are addressed via visual inspection. When comparing these visual results with the actual tested results, it is clear that there can be significant differences in the two methods.

B.1.5 HVAC Equipment

The following represents an average profile of observed HVAC equipment, followed by:

B.1.5.1 Heating

- Fuel Source (n=127):
  - Gas (96%)
  - Electricity (4%)
- System Type (n=122):
  - Furnace (97%)
  - Heat Pump (3%)
- System Capacity (n=124):
  - Furnace: 69,639 Btu
  - Heat Pump: 38,800 Btu
- System Efficiency (n=124):
  - Furnace: 90 AFUE (many furnaces listed as 80 AFUE)
  - Heat Pump: 8.3 HSPF

B.1.5.2 Cooling

- System Type (n=110):
  - Central AC (96%)
  - Heat Pump (4%)
- System Capacity (n=110):
  - 33,350 (Btu/hr)
- System Efficiency (n=64):
  - 13.1 SEER (observations ranged from 13 to 14.5 SEER)

B.1.5.3 Water Heating

- Fuel Source (n=127):
  - Gas (92%)
  - Electric (8%)
- System Type (n=126):
  - Storage (98%)
  - Tankless (2%)
- System Capacity (n=63):
  - 52 gallons (observations ranged from 50 to 100 gallons)

Table B.4. Water Heating System Storage Capacity Distribution

Capacity	< 50 gal	50-59 gal	60-69 gal	70-79 gal	80-89 gal	90+ gal
Percentage	0%	98%	0%	0%	0%	2%

- System Efficiency (n=63):
  - EF 0.65 (range from EF 0.62 to EF 0.92)

B.1.5.4 Ventilation

- System Type (n=127):
  - Exhaust Only (55%)
  - AHU Integrated (45%)
- Exhaust Fan Type (n=70):
  - Dedicated Exhaust (4%)
  - Bathroom Fan (96%)

B.1.5.5 Other

- Mechanical manuals provided (n=54) (100%)

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EXHIBIT NO. 9

CASE NO. INT-G-20-06

INTERMOUNTAIN GAS COMPANY

Proposed Tariff – Legislative and Clean

(6 pages)

PROPOSED TARIFF

(Legislative Format)

(2 pages)

I.P.U.C. Gas Tariff
Rate Schedules
~~Original~~ First Revised Sheet No. 16 (Page 1 of 2)
Name of Utility **Intermountain Gas Company**

IDAHO PUBLIC UTILITIES COMMISSION
Approved Effective
~~Sept. 27, 2017~~ ~~Oct. 1, 2017~~
~~Per O.N. 33879, 33887 & 33888~~
Diane M. Hanian Secretary

Rate Schedule EE -RS
RESIDENTIAL ENERGY EFFICIENCY REBATE PROGRAM

AVAILABILITY:

The Intermountain Gas Company Energy Efficiency Rebate Program (EE Program) is available throughout Intermountain's service territory to eligible residential account holders served under the Company's Rate Schedule RS.

PROGRAM DESCRIPTION:

The purpose of the program is to encourage upgrades to, or use of, high efficiency natural gas equipment. This will be achieved through the use of rebates, offered towards the purchase and installation of qualified energy-efficient natural gas equipment and construction of ~~Energy Star certified~~ energy efficient new homes.

ELIGIBILITY:

To qualify for ~~incentives,~~ rebates customers must meet the end-use qualifications identified in the ~~Measures/Incentive~~ Rebates Table below. All equipment must use natural gas as the fuel source. The customer must also comply with the current program Terms and Conditions.

To qualify for space heating rebates, a dwelling must use natural gas as the sole heat source upon installation of rebate-qualified equipment.

To qualify for water heating rebates, a dwelling must utilize natural gas for water heating upon installation of rebate-qualified equipment.

~~Rebates for furnaces and water heating equipment for new construction~~ Space Heating rebates may not be combined with ~~the Energy Star whole home package~~ New Construction rebates. Water Heating and Thermostat rebates may be combined with New Construction rebates.

Issued by: **Intermountain Gas Company**
By: ~~Michael P. McGrath~~ Lori A. Blattner Title: Director – Regulatory Affairs
Effective: ~~October 1, 2017~~ March 1, 2021

I.P.U.C. Gas Tariff Rate Schedules ~~First~~ Revised Second	Sheet No. 16 (Page 2 of 2)
Name of Utility	**Intermountain Gas Company**

IDAHO PUBLIC UTILITIES COMMISSION
Approved **Effective**
~~**Feb. 4, 2020**~~ ~~**March 1, 2020**~~
Diane M. Hanian Secretary

Rate Schedule EE -RS
RESIDENTIAL ENERGY EFFICIENCY REBATE PROGRAM
(Continued)

~~MEASURES/INCENTIVES:~~ REBATES:

Whole Home Package (for new construction)	**Description**	**Rebate Amount**
Energy Star Certified Home	Energy Star Verified Home with Natural Gas Space and Water Heat	$1,200
Stand Alone Measures (for new & existing construction)	**Description**	**Energy Efficiency Rebate**
95% AFUE Natural Gas Furnace	95% or Greater Thermal Efficiency Rating	$350
High Efficiency Combination Radiant Heat System	90% or Greater Efficiency Condensing Tank-less Combo System For Space and Water Heat	$1,000
70% FE Natural Gas Fireplace Insert	70% FE Rating or Greater	$100
.67 EF Natural Gas Water Heater	.67 Energy Factor or Greater	$50
.91 EF Condensing Tank-less Water Heater	.91 Energy Factor or Greater	$150

GENERAL PROVISIONS:

All installations of equipment must comply with all codes and permit requirements applicable in the state of Idaho and must be properly inspected, if required, by appropriate agencies. Customers must submit required documentation of purchase and installation to the Company under the terms and ~~instructions~~ Conditions of the current rebate ~~form.~~ program The Company reserves the right to verify installation prior to the payment of any rebates.

Rebate	Rebate Type	Minimum Efficiency Rating	Rebate Amount
Whole Home Tier I	New Construction	Tier I Requirements: • HERS rated • Air sealing at or below 3 ACH at 50 Pa • Ceiling insulation at or above R-49 • Ducts and air handler located inside conditioned space *or* duct leakage to outside of less than 4 CFM25/100 ft2 CFA • Furnace efficiency at or above 97% AFUE	$900
Whole Home Tier II	New Construction	Tier II Requirements: • HERS rated • Air sealing at or below 4 ACH at 50 Pa • Ducts and air handler located inside conditioned space *or* duct leakage to outside of less than 4 CFM25/100 ft2 CFA • Furnace efficiency at or above 95% AFUE	$700
Combination Boiler for Space and Water Heat	Space Heating	95% AFUE	$800
Furnace	Space Heating	95% AFUE	$350
Boiler	Space Heating	95% AFUE	$800
Storage Water Heater	Water Heating	.68 UEF	$115
Tankless Water Heater Tier I	Water Heating	.91 UEF	$325
Tankless Water Heater Tier II	Water Heating	.87 UEF	$300
Smart Thermostat	Thermostat	Wi-Fi Enabled	$100

Issued by: **Intermountain Gas Company**
By: Lori A. Blattner Title: Director – Regulatory Affairs
Effective: ~~March 1, 2020~~ March 1, 2021

PROPOSED TARIFF

(Clean Format)

(2 pages)

Rate Schedule EE-RS
RESIDENTIAL ENERGY EFFICIENCY REBATE PROGRAM

AVAILABILITY:

The Intermountain Gas Company Energy Efficiency Rebate Program (EE Program) is available throughout Intermountain's service territory to eligible residential account holders served under the Company's Rate Schedule RS.

PROGRAM DESCRIPTION:

The purpose of the program is to encourage upgrades to, or use of, high-efficiency natural gas equipment. This will be achieved through the use of rebates offered towards the purchase and installation of qualified energy efficient natural gas equipment and construction of energy efficient new homes.

ELIGIBILITY:

To qualify for rebates, customers must meet the end-use qualifications identified in the Rebates Table below. All equipment must use natural gas as the fuel source. The customer must also comply with the current program Terms and Conditions.

To qualify for Space Heating rebates, a dwelling must use natural gas as the sole heat source upon installation of rebate-qualified equipment.

To qualify for Water Heating rebates, a dwelling must utilize natural gas for water heating upon installation of rebate-qualified equipment.

Space Heating rebates <u>may not</u> be combined with New Construction rebates. Water Heating and Thermostat rebates may be combined with New Construction rebates.

Rate Schedule EE-RS
RESIDENTIAL ENERGY EFFICIENCY REBATE PROGRAM
(Continued)

REBATES:

Rebate	Rebate Type	Minimum Efficiency Rating	Rebate Amount
Whole Home Tier I	New Construction	Tier I Requirements: • HERS rated • Air sealing at or below 3 ACH at 50 Pa • Ceiling insulation at or above R-49 • Ducts and air handler located inside conditioned space *or* duct leakage to outside of less than 4 CFM25/100 ft2 CFA • Furnace efficiency at or above 97% AFUE	$900
Whole Home Tier II	New Construction	Tier II Requirements: • HERS rated • Air sealing at or below 4 ACH at 50 Pa • Ducts and air handler located inside conditioned space *or* duct leakage to outside of less than 4 CFM25/100 ft2 CFA • Furnace efficiency at or above 95% AFUE	$700
Combination Boiler for Space and Water Heat	Space Heating	95% AFUE	$800
Furnace	Space Heating	95% AFUE	$350
Boiler	Space Heating	95% AFUE	$800
Storage Water Heater	Water Heating	.68 UEF	$115
Tankless Water Heater Tier I	Water Heating	.91 UEF	$325
Tankless Water Heater Tier II	Water Heating	.87 UEF	$300
Smart Thermostat	Thermostat	Wi-Fi Enabled	$100

GENERAL PROVISIONS:

All installations of equipment must comply with all codes and permit requirements applicable in the state of Idaho and must be properly inspected, if required, by appropriate agencies. Customers must submit required documentation of purchase and installation to the Company under the Terms and Conditions of the current rebate program. The Company reserves the right to verify installation prior to the payment of any rebates.