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SUBMITTED TO: CASCADE NATURAL GAS

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ACRONYMS/ABBREVIATIONS

Table 1 Commonly Used Acronyms and Abbreviations

Acronym	Term
AC	Air Conditioner
AOH	Annual Operating Hours
C&I	Commercial and Industrial
CEE	Consortium for Energy Efficiency
CF	Coincidence factor
CFL	Compact Fluorescent Lamp (bulb)
CFM	Cubic feet per minute
DI	Direct Install
DLC	Design Lights Consortium
EER	Energy efficiency ratio
EFLH	Equivalent Full-Load Hours
EISA	Energy Independence and Security Act
EL	Efficiency loss
EM&V	Evaluation, Measurement, and Verification
EPP	Efficient Products Pathway
EUL	Estimated Useful Life
ES	ENERGY STAR®
FR	Free-rider
FVR	Field Verification Rate
GPM	Gallons per Minute
HDD	Heating Degree Days
HID	High Intensity Discharge
HOU	Hours of Use
HP	Heat pump
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilation, and Air Conditioning
IEF	Interactive Effects Factor
IEM	Independent Evaluation Monitor
IEER	Integrated Energy Efficiency Ratio
IPLV	Integrated Part Load Value
ISR	In-service rate
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light Emitting Diode
M&V	Measurement and Verification
NC	New Construction
NEB	Non-Energy Benefit
MW	Megawatt
MWh	Megawatt-hour
PCT	Participant Cost Test
PY	Program Year
QA	Quality Assurance
QC	Quality Control
RCA	Refrigerant charge adjustment

Acronym	Term
RIM	Ratepayer Impact Measure
ROB	Replace on Burnout
SEER	Seasonal Energy Efficiency Ratio
SO	Spillover
TRM	Technical Reference Manual
UCT	Utility Cost Test
VFD	Variable Frequency Drive

1 EXECUTIVE SUMMARY

This report is a summary of the Cascade Natural Gas Company (CNGC) Impact Evaluation for the custom, space heating, water heating, envelope, and food service measures offered to CNGC commercial customers. The evaluation was administered by ADM Associates, Inc. (herein referred to as the “Evaluators”).

The Evaluators found the impact evaluation results for the food service, space heating, water heating, and custom measures offered align with similar natural gas measure findings offered in the Pacific Northwest region. The impact evaluation resulted in 95% realization rate, which meets the typical realization for similar measures, between 80% and 110%. The envelope measures displayed higher realization rates (146%) due to varied evaluation methodologies employed. The Evaluators provide recommendations for improving program documentation, savings algorithm applications, and recommended unit energy savings to reference moving forward to improve accuracy of claimed savings through the program.

In addition, the Evaluators found the vast majority of responding customers were satisfied or very satisfied with the program overall (93%) as well as CNGC as their natural gas provider (95.5%). The Evaluators conclude that the program is running smoothly and delivers sufficient energy efficiency options to customers. The Evaluators provide recommendations for improving estimation of savings for these measures in future program years as well as recommended changes to program offerings due to changing energy efficiency landscapes.

1.1 Evaluation Findings

The Evaluators conducted an impact and process evaluation for CNGC’s custom, space heating, water heating, envelope, and food service measures between program years 2018 and 2022 (PY2018-PY2022). The total verified savings amounted to 1,557,895 Therms with a 94.47% realization rate. The Evaluators summarize the end-use and measure-level verified savings in Table 1-1 and Table 1-2.

Table 1-1: CNGC Verified Impact Savings by End Use, PY2018-PY2022

End Use	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
Envelope	215,511.81	313,693.59	145.56%
Food Service	125,466.00	117,243.00	93.45%
Space Heating	399,625.21	398,999.48	99.84%
Water Heating	79,941.31	68,514.20	85.71%
Custom	828,597.25	659,444.75	79.59%
Total	**1,649,141.58**	**1,557,895.02**	**94.47%**

The tables below outline results by end use, by year.

Table 1-2: Custom Verified Impact Savings by End Use and Measure, by year

Program Year	Projects	Incentive	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
2019	8	$214,519	153,377	140,974	91.91%
2020	8	$58,611	32,351	29,125	90.03%
2021	9	$762,536	544,080	394,228	72.46%
2022	14	$143,804	98,789	95,118	96.28%
Total	**39**	**$1,179,470**	**828,597**	**659,445**	**79.59%**

Table 1-3: Space Heating Verified Impact Savings by End Use and Measure, by year

Program Year	Projects	Incentive	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
2018	49	$459,778	54,258	61,303	112.99%
2019	100	$657,625	67,583	75,604	111.87%
2020	107	$812,887	65,639	65,458	99.72%
2021	132	$2,237,369	142,918	142,147	99.46%
2022	59	$2,661,407	69,229	54,487	78.71%
Total	**447**	**$6,829,066**	**399,625**	**398,999**	**99.84%**

Table 1-4: Water Heating Verified Impact Savings by End Use and Measure, by year

Program Year	Projects	Incentive	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
2018	33	$587,988	7,142	5,374	75.24%
2019	56	$544,110	15,994	12,855	80.38%
2020	60	$539,524	12,410	16,574	133.56%
2021	48	$761,684	10,033	14,634	145.86%
2022	51	$1,779,180	33,907	19,077	56.26%
Total	**248**	**$4,212,486**	**79,485**	**68,514**	**85.71%**

Table 1-5: Envelope Verified Impact Savings by End Use and Measure, by year

Program Year	Projects	Incentive	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
2018	5	$22,382	2,756	2,229	80.89%
2019	37	$748,726	66,433	106,768	160.71%
2020	36	$489,755	56,205	91,848	163.42%
2021	102	$796,413	49,199	64,278	130.65%
2022	18	$440,090	40,919	48,571	118.70%
Total	**198**	**$2,497,366**	**215,512**	**313,694**	**145.56%**

The Evaluators were unable to separate out food service by year with the data provided. The total results by measure are found below.

Table 1-6: Food Service Verified Impact Savings by End Use and Measure

Measure	Number of Units	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
Dishwashers	15	6,720.00	6,720.00	100.00%
Fryers	136	93,160.00	83,152.00	89.26%
Griddles	3	819	819	100.00%
Ovens	40	22,408.00	24,187.00	107.94%
Steamers	3	2,359.00	2,365.00	100.25%
Total	**197**	**125,466.00**	**117,243.00**	**93.45%**

The Evaluators conducted the following evaluation tasks for the measure offerings impact and process evaluation:

- Impact Evaluation: Database review; Survey verification; Deemed savings review and application review; and Billing analysis.
- Process Evaluation: Participant surveys

1.2 Conclusions and Recommendations

The Evaluators provide the following conclusions and recommendations regarding evaluated measures. Recommendations are listed by channel.

Table 1-7: Custom Recommendations

Equipment	Recommendations
All Measures	1. Added QC checks for Custom projects- Additional QC check would greatly benefit the projects completed in the custom channel. One project completed in the program year accounted for 62% of the total channel savings and received a 72% realization rate. And added QC check of reviewing project savings claims against facility annual consumption could have shown the errors in ex ante calculation methods. 2. Use TMY3 weather data for weather dependent measures – Several projects completed were using actual weather data to calculate savings and weather dependent variables/run times. The problem with this approach is it allows for extreme weather years to either overestimate or underestimate savings. Using TMY3 weather data will avoid any one-off weather years influence on savings. 3. Improve tracking data details – There is conflicting information in the project tracking data where there are two columns that show savings. One is claimed as project savings and the other appears to be the measure level savings. The project level savings are not necessary and just add clutter and confusion. 4. Provide more detail in project documentation – There were project documents submitted that did not include the savings calculations used for the expected savings estimate and listed the expected savings expected savings estimate as a hard coded value making project review difficult. Providing the expected savings calculations will allow the Evaluators to make better recommendations and provide more insight into why realization rates are off.

Table 1-8: Space Heating Recommendations

Equipment	Recommendations
All Space Heating Measures	1. Include two additional identifier columns to the tracking data. Premise ID or installation address would allow for more accurate verification of savings and the ability to ensure accurate EFLH calculations. 2. Include square footage of the installation address in tracking data (more specifically, tracking the square footage of the building in which the boilers/furnaces are installed). This data would assist with verification efforts of capacity of efficient heating technology and allow for assurance that the billing consumption data is requested for the correct gas meter. 3. If CNGC could provide the Evaluators with documentation verifying measure installation, the veracity of reported measure capacity could be determined.
Radiant Heaters	To estimate expected savings for radiant heaters, the Evaluators recommend CNGC multiply the verified facility capacity with the daily usage per Btu/h value (0.0000299 Therms per Btu/h) resulting from impact analysis for this measure, shown in Table 3-12.
Furnaces	To estimate expected savings for furnaces, the Evaluators recommend CNGC multiply the verified facility capacity with the daily usage per Btu/h value (0.0000797 Therms per Btu/h) resulting from impact analysis for this measure, shown in Table 3-13.
Boilers	To estimate expected savings for boilers, the Evaluators recommend CNGC multiply the verified facility capacity with the daily usage per Btu/h value (0.0000787 Therms per Btu/h) resulting from impact analysis for this measure, shown in Table 3-14.

Table 1-9: Water Heating Recommendations

Equipment	Recommendations
All Water Heating Measures	1. Include complete data for the following fields. This will allow for mitigated assumptions and increased accuracy of estimated savings: • Efficient UEF • Facility type • Efficient equipment AFUE • Water heater location • Baseline UEF • Baseline tank size for projects which converted to tankless water heaters • Efficient water heater AHRI reference number • Facility square footage 2. Use region-specific water temperature research developed by the RTF UES workbooks[1] for the purpose of estimating storage tank and tankless water heater savings. For other assumptions, use National Renewable Energy Laboratory inputs[2], such as: • Hot water load per 1,000 SQFT • Days in use per year 3. The largest contributing factor to discrepancy in realization rate is due to the characterization of the facility type and square footage. Including square footage of the facility in which the efficient water heater was installed will greatly increase accuracy of savings. The Evaluators recommend CNGC provide further detail of each project's facility type, square footage, and number of units (number of students in an elementary school or number of rooms in a hotel) for each participating building.

[1] RTF Residential Aerators https://nwcouncil.box.com/v/Aeratorsv1-1
[2] Osman S, & Koomey, J. G J1995, National Laboratory 1995. *Technology Data Characterizing Water Heating in Commercial Buildings: Application to End-Use Forecasting.* December.

Table 1-10: Envelope Recommendations

Equipment	Recommendations
All Envelope Measures	This evaluation methodology should be revisited as more customers participate in insulation programs. Higher participation allows for more robust estimation of savings through regression analyses.
Floor Insulation	Until higher participation allows for additional billing data analysis, the Evaluators recommend floor insulation measure savings are estimated through deemed savings values.
Wall Insulation	Until higher participation allows for additional billing data analysis, the Evaluators recommend wall insulation measure savings are estimated through deemed savings values.
Attic Insulation	The estimate presented in Table 3-23 can be reasonably used to calculate the savings associated with attic insulation (-0.00371 Therms per SQFT insulation per R-value). The estimate simply needs to be multiplied by -1, project-level delta R-value, and the square footage of insulation installed.
Roof Insulation	The estimate presented in Table 3-23 can be reasonably used to calculate the savings associated with attic insulation (-0.0223 Therms per SQFT insulation per R-value). The estimate simply needs to be multiplied by -1, project-level delta R-value, and the square footage of insulation installed.
Windows	Until higher participation allows for billing data analysis, the Evaluators recommend window measure savings are estimated through deemed savings values.

Table 1-11: Food Service Recommendations

Equipment	Recommendations
Fryers	1. Reincorporate fryers into the program, using a pre-defined "premium efficiency" list. This will require specific tailoring to ensure that eligible units can provide savings. Suggested requirements: • Standard Vat: <6,000 idle BTU, > 55% cooking efficiency • Large Vat: <9,500 idle BTU, > 55% cooking efficiency 2. Ensure that savings calculations capture the number of vats when calculating savings for multi-vat fryers. The same base equipment can range from 1-5 vats, with a slight change in model number. ENERGY STAR and FSTC performance tests denominate on a per-vat basis, and this scale could be lost. Incentives should also align with the number of vats, rather than the number of systems installed.
Convection Ovens	1. Reincorporate convection ovens into the program, using a pre-defined "premium efficiency" list. This will require specific tailoring to ensure that eligible units can provide energy savings. Suggested requirements: • <9,000 idle BTU 1. Ensure that savings calculations capture the number of oven cavities when calculating savings for double ovens. The same base equipment can be a single or double oven. Energy Star and FSTC performance tests denominate on a per-cavity, and this scale could be lost. Incentives should also align with the number of cavities, rather than the number of systems installed.
Conveyor Ovens	1. Incentivize conveyor ovens in the program using the last known ENERGY STAR standard. This system type is not included in the new standards. However, conveyor ovens are still the common practice in pizza restaurants. 2. Revisit technical assumptions to identify needed areas for updates. The Evaluators found 940% realization for this measure. The typical performance standard for this equipment as-tested by the FSTC is: • Preheat: 22,410 BTU • Idle: 40,270 BTU • Cooking Efficiency: 46.1% • 692 average Therms
Rack Ovens	This measure is unlikely to be cost-effective under the new code requirements. Further, this measure has limited applicability and participation. The Evaluators recommend deprioritizing review of this measure over higher-volume measures such as fryers and convection ovens.
New Measures	Develop rebates for conveyor broilers and underfire broilers. Characterize measures as follows: Underfire: savings/rebate per linear foot, delineating between infrared and power burners; and Conveyor: Single incentive,

Equipment	Recommendations
	applicable to all three size categories (< 20”, 20”-26”, >26”)

2 GENERAL METHODOLOGY

The Evaluators completed an impact evaluation on each of the measures summarized in Table 1-2. Our activities estimate and verify annual savings and identify whether the program is meeting its goals. Our activities also provide conclusions to inform changes to the methodology towards claiming savings for each measure evaluated. This is aimed to provide guidance for continuous program improvement.

The Evaluators used the following approaches to accomplish the impact-related research goals listed above and calculate impacts defined by the International Performance Measurement and Verification Protocols (IPMVP)[3] and the Uniform Methods Project (UMP)[4]:

- Simple verification (web-based surveys supplemented with phone surveys)
- Document verification (review project documentation)
- Deemed savings (RTF UES input values and engineering algorithms developed by ASHRAE, Energy Star, and other industry bodies)
- Pre/Post billing analysis
- EFLH estimation
- Facility-level desk review

The Evaluators conducted program staff interviews and participant surveys to accomplish the process-related research goals and complete the research objectives identified by CNGC for the program.

The methodologies are determined by the methodologies employed in similar programs in the region as well as the relative contribution of a given measure to the overall impacts. In addition to drawing on IPMVP, the Evaluators reviewed relevant information on infrastructure, framework, and guidelines set out for EM&V work in several guidebook documents that have been published over the past several years. These include the following:

- Northwest Power & Conservation Council Regional Technical Forum (RTF)[5]
- Regional Technical Forum (RTF) Workbooks[6]
- National Renewable Energy Laboratory (NREL), United States Department of Energy (DOE) The Uniform Methods Project (UMP): Methods for Determining Energy Efficiency Savings for Specific Measures, April 2013
- IPMVP maintained by the Efficiency Valuation Organization (EVO) with sponsorship by the U.S. Department of Energy (DOE)[7]
- Energy Star
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)

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[3] https://www.nrel.gov/docs/fy02osti/31505.pdf
[4] https://www.nrel.gov/docs/fy18osti/70472.pdf
[5] https://rtf.nwcouncil.org/measures
[6] https://rtf.nwcouncil.org/measures
[7] Core Concepts: International Measurement and Verification Protocol. EVO 100000 – 1:2016, October 2016.

- National Renewable Energy Laboratory (NREL)

The Evaluators kept data collection instruments, calculation spreadsheets, programming code, and survey data available for CNGC records. As part of the impact evaluation, the Evaluators also conducted additional billing analyses for measures in which prominent interactive effects are expected. These billing analyses comply with the IPMVP Option C procedures.

2.1 Glossary of Terminology

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

- Deemed Savings – An estimate of a savings outcome 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.
- Expected Savings – Calculated savings used for program and portfolio planning purposes.
- Verified Savings – Savings estimates after the unit-level savings values have been updated and impact evaluation has been completed, integrating results from billing analyses and appropriate RTF UES and New Mexico TRM values.
- Pre-Period – The period of time prior to installation of energy efficient equipment or upgrade.
- Post-Period – The period of time after installation of energy efficient equipment or upgrade.
- HDD – Heating degree days (HDD) are a measurement used to estimate the amount of energy required to heat a building or space during a specific period, typically a day or a month. It is primarily used in regions with cold climates to assess the demand for heating and to evaluate energy consumption.
- TMY –A Typical Meteorological Year (TMY) is a synthesized set of weather data representing the long-term climatic conditions for a specific location. It is constructed using historical weather data collected over a period of at least 20 years, typically obtained from weather stations in the vicinity of the location of interest. The purpose of a TMY is to provide a standardized dataset that represents the "typical" weather conditions for a particular location.
- Dummy variable - A dummy variable, also known as an indicator variable or binary variable, is a categorical variable that takes on one of two values to represent the presence or absence of a characteristic or condition. It is commonly used in statistical analysis and regression modeling to represent qualitative factors and typically takes the value of 0 or 1, where 0 represents the absence or reference category, and 1 represents the presence or alternative category.

2.2 Summary of Approach

This section presents our approach to accomplishing the impact and process evaluation of CNGC's measures listed in Table 1-2. This chapter is organized by evaluation objective. Section 2.2.4 describes the Evaluators' measure-specific impact evaluation methods and results in further detail and Section 2.2.5 describes the Evaluators' process evaluation methods and results.

The Evaluators outline the approach for verifying, measuring, and reporting the residential portfolio impacts as well as summarizing potential program and portfolio improvements. The primary objective of the impact evaluation is to determine verified savings and to recommend unit energy savings (UES) values for claiming measure-level savings in future program cycles. On-site verification and equipment monitoring was not conducted during this impact evaluation.

The Evaluators employed the following approach to complete impact evaluation activities for the program. The Evaluators define four major approaches to determining net savings:

- A *Deemed Savings* approach involves using stipulated savings for energy conservation measures for which savings values are well-known and documented. These prescriptive savings may also include an adjustment for certain measures, such as lighting measures in which site operating hours may differ from RTF values.
- A *Billing Analysis* approach involves using monthly consumption bills within a regression analysis to estimate the average daily heating load decrease in consumption due to the installation of the energy efficiency upgrade equipment.
- An *Equivalent Full Load Heating Hours (EFLH) Estimation* involves calculating EFLH from monthly consumption bills and employing a TRM-based engineering equation to calculate average heating equipment savings.
- A *Custom Desk Review* approach involves a thorough desk review of all relevant project documentation for a single facility within the custom channel offerings. This involves verifying facility-level inputs and engineering algorithms used to estimate expected and verified savings for each measure and facility. This method is in accordance with the IPMVP.

The Evaluators accomplished the following quantitative goals as part of the impact evaluation:

- Verify savings with 10% precision at the 90% confidence level;
- Where appropriate, apply the RTF values or engineering algorithms to verify measure impacts; and,
- Where appropriate, conduct billing analysis with Pre/Post consumption data or EFLH estimation to estimate measure savings.

The Evaluators calculated verified savings for each measure based on the engineering algorithms or based on billing analysis results in combination with the results from document review.

The Evaluators also completed billing analyses to support estimation of savings for the space heating and envelope measures in which interactive effects are prominent. Further methodology for the additional research objectives for these measures are provided in each of the channel-level sections in Section 3.1.

2.2.1 DATA COLLECTION

To complete the objectives defined for this work, the Evaluators requested the following documents from CNGC:

- Tracking databases for PY2018 through PY2022 for each of the measures being evaluated
- Facility-level monthly billing consumption data between 2017 and 2022
- Customer contact information for survey efforts
- A list of documents/key assumptions included in expected savings calculations

The Evaluators also conducted the process evaluation surveys. For this data collection effort, the Evaluators contacted customers via a web survey to gather feedback on program and utility satisfaction, as well as firmographics information.

2.2.2 DATABASE REVIEW

At the outset of the evaluation, the Evaluators reviewed the databases to ensure that each program tracking database conforms to industry standards and adequately tracks key data required for evaluation.

Measure-level net savings were evaluated primarily by reviewing measure algorithms and values in the tracking system to assure that they are appropriately applied using the appropriate unit energy savings and engineering algorithms defined in CNGC's program plan and in accordance with industry best practices. The Evaluators then aggregated and cross-checked program and measure totals.

The Evaluators reviewed program application documents for the census of Custom channel incented measures to verify the tracking data accurately represents the program documents. The Evaluators ensured the facility installed measures that meet or exceed program efficiency standards.

2.2.3 VERIFICATION METHODOLOGY

The Evaluators verified a sample of participating households for detailed review of the installed measure documentation and development of verified savings. The Evaluators verified tracking data by reviewing invoices for the census of participant customer facilities for the Custom channel.

The following sections describe the Evaluators' methodology for conducting document-based verification and survey-based verification.

2.2.3.1 Document-Based Verification

The Evaluators requested rebate documentation for a census of Custom channel participants. These documents included invoices, project applications and worksheets, and AHRI certifications for each measure in the programs evaluated.

This census of documents was used to cross-verify tracking data inputs for the Custom channel. In cases where the Evaluators found any deviations between the tracking data and application values, the Evaluators reported and summarized those differences in the measure-level results in Section 3.1 for each measure type.

2.2.4 IMPACT APPROACH

The Evaluators employed a *deemed savings* approach to quantify program impacts. The Evaluators completed the steps outlined below to complete the impact evaluation.

1. Deliver a detailed data request outlining the information we require for each rebated equipment type.
2. Complete a thorough and comprehensive summary of program tracking data.
3. Validate the appropriate inputs to deemed savings and engineering algorithms were used for each measure.
4. Verify the gross energy (Therms) savings that are a result of the program.
5. Summarize and integrate the impact evaluation findings into the final report.

The Evaluators completed the validation for specific measures across each program using the RTF unit energy savings (UES) values, where available. The Evaluators ensured the proper measure unit savings were recorded and used in the calculation of expected measure savings. The Evaluators requested and used the RTF workbooks and engineering algorithms during calculation of expected measure savings. The Evaluators documented any cases where recommend values differed from the specific unit energy savings workbooks used by CNGC. The Evaluators reviewed and applied savings values derived from the following TRMs/workpapers:

- ASHRAE and NREL for engineering algorithms
- RTF for region-specific inputs (water source temperature, etc.)

The Evaluators detail measure-specific impact evaluation methodologies in Section 3.1.

2.2.4.1 Deemed Savings

This section summarizes the deemed savings analysis method the Evaluators employed for the evaluation of a subset of measures for each offering. The Evaluators completed the validation for specific measures across each program using industry standard engineering algorithms with RTF regional inputs, where available. The Evaluators ensured the proper measure unit savings were recorded and used in the calculation of CNGC's expected measure savings. The Evaluators documented any cases where recommend values differed from the specific unit energy savings workbooks used by CNGC.

2.2.4.2 Billing Analysis

This section describes the billing analysis methodology employed by the Evaluators as part of the impact evaluation and measurement of energy savings for measures with sufficient participation. The Evaluators performed billing analyses using pre-period and post-period data. The pre-period identifies the period prior to measure installation while the post-period refers to the period following measure installation.

For the purposes of this analysis, a household is considered a treatment household if it has received a program incentive. To isolate measure impacts, treatment households are eligible to be included in the billing analysis if they installed only one measure during PY2022. Isolation of individual measures is necessary to provide valid measure-level savings. Households that installed more than one measure may display interactive energy savings effects across multiple measures that are not feasibly identifiable. Therefore, instances where households installed isolated measures are used in the billing analyses.

After matching based on these variables, the billing data for treatment group's pre-period and post-period are compared, as detailed in IPMVP Option C. The Evaluators fit regression models to estimate weather-dependent daily consumption differences for each facility between the period of time prior to the efficiency upgrade, and the period of time after the efficiency upgrade has been installed.

2.2.4.2.1 Cohort Creation

The Evaluators created each measure cohort by compiling billing data from the census of participants for each measure between PY2018 and PY2022. This allowed the Evaluators to evaluate the maximum number of participants within the service territory. With this information, the Evaluators conducted cleaning steps to ensure sufficient data is displayed for each participant.

After cohort creation and data cleaning, the Evaluators calculated heating load consumption (total gas usage for space heating end uses) for each facility and ran the following regression models for each measure: Pre/Post billing analysis[8]

Further details on regression model specifications can be found below.

2.2.4.2.2 Data Collected

The following lists the data collected for the billing analysis:

1. Monthly billing data for program participants (treatment customers)
2. Program tracking data, including customer identifiers, address, square footage of facility, Btu/h of equipment (if applicable), and date of measure installation
3. National Oceanic and Atmospheric Administration (NOAA) weather data between January 1, 2017, and December 31, 2022)
4. Typical Meteorological Year (TMY3) data

Billing and weather data were obtained for the entire evaluation period and for one year prior to measure install dates (2017-2022). Weather data was obtained from the nearest weather station with complete data during the analysis years for each customer by mapping the weather station location with the customer zip code.

TMY weather stations were assigned to NOAA weather stations by geocoding the minimum distance between each set of latitude and longitude points. This data is used for extrapolating savings to long-run, 30-year average weather.

2.2.4.2.3 Data Preparation

The following steps were taken to prepare the billing data:

1. Gathered billing data for facilities that participated in the program.

[8] National Renewable Energy Laboratory (NREL) Uniform Methods Project (UMP) Chapter 17 Section 4.4.7.

2. Excluded bills missing address information.
3. Removed bills missing fuel type/Unit of Measure (UOM).
4. Removed bills missing usage, billing start date, or billing end date.
5. Remove bills with outlier durations (<9 days or >60 days).
6. Excluded bills with consumption indicated to be outliers.
7. Calendarized bills (recalculates bills, usage, and total billed such that bills begin and end at the start and end of each month).
8. Obtained weather data from nearest NOAA weather station using 5-digit zip code per household.
9. Computed Heating Degree Days (HDD) and Cooling Degree Days (CDD) for a range of setpoints. The Evaluators assigned a setpoint of 65°F for both HDD and CDD. The Evaluators tested and selected the optimal temperature base for HDDs and CDDs based on model *R*-squared values.
10. Selected treatment customers with only one type of measure installation during the analysis years and combined customer min/max install dates with billing data (to define pre- and post-periods).
11. Restricted to treatment customers with install dates in specified range (typically January 1, 2022 through June 30, 2022) to allow for sufficient post-period billing data.
12. Removed customers with incomplete post-period bills (<5 months total, <2 months of bills in winter).
13. Removed customers with incomplete pre-period bills (<5 months total, <2 months of bills in winter).
14. Calculate baseload consumption by averaging summer month gas consumption
15. Calculate heating load consumption by removing baseload from winter month consumption

2.2.4.2.4 Regression Model

The Evaluators ran the Pre/Post regression model for each cohort for each measure with sufficient participation. The results of each cohort regression model were summarized and utilized for extrapolation of verified savings for each participant. The following equation displays the model specification to estimate the average daily savings due to the measure evaluated.

Equation 2-1: Pre/Post Regression Model Specification

$$ADC_{it} = \alpha_0 + \beta_1(Post)_{it} + \beta_2(HDD)_{it} + \beta_3(Post \times HDD)_{it} + \beta_4(COVID19)_i + \beta_5(Customer\ Dummy)_i + \varepsilon_{it}$$

Where,

i = the *i*th household

t = the first, second, third, etc. month of the post-treatment period

ADC_{it} = Average daily heating load consumption for month *t* for household *i*

$Post_{it}$ = A dummy variable indicating pre- or post-period designation during period *t* at facility *i*

HDD_{it} = Average heating degree days (base with optimal Degrees Fahrenheit) during period *t* at facility *i*

$COVID19$ = a dummy variable indicating COVID-19 shelter-in-place orders are in effect
$Customer\ Dummy_i$ = a customer-specific dummy variable isolating individual household effects
ε_{it} = The error term
α_0= The model intercept
β_{1-5} = Coefficients determined via regression

The Average Daily Consumption (ADC) is calculated as the total heating load usage divided by the duration of the bill month. This value is then divided by the square footage of the facility and the BTU/h of the equipment in order to standardize consumption across facilities. β_2 and β_3 the change in weather-related heating load consumption in between the pre-period and post-period. Typical annual heating load consumption savings were estimated by extrapolating the β_1 by number of days per year and β_3 coefficients with Typical Meteorological Year (TMY) HDD data.

The equation below displays how savings were extrapolated for a full year utilizing the coefficients in the regression model and TMY data. TMY data is weighted by the number of households assigned to each weather station.

Equation 2-2: Savings Extrapolation

$$Annual\ Savings = \beta_1 * 365.25 + \beta_3 * TMY\ HDD$$

2.2.4.3 EFLH Analysis

The Evaluators estimated EFLH for gas space heating participants in the post-period. An EFLH estimate provides a way to estimate Therms savings for each space heating measure (e.g., 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 IPMVP maintained by the EVO with sponsorship by the U.S. DOE[9]. It is often used to calculate deemed savings for gas furnace retrofits.

2.2.4.3.1 Data Collection

CNGC provided the Evaluators with the necessary data to compute EFLH estimates for the space heating equipment installed within the CNGC service territory. The EFLH was estimated separately for each facility because facility-level space heating runtimes vary depending on facility operations and weather zone and associated heating degree days (HDDs). The information required to conduct this analysis included:

- Efficient furnace capacity
- Efficient furnace AFUE
- Monthly billing data for radiant heater, furnace, and boiler participants

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

- Heating Degree Days from local weather stations

2.2.4.3.2 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 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 facilities, the following 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 code-level efficiency value is used for prior space heating equipment efficiency.

The equation for estimating gas furnace savings with EFLH in puts is shown below[10]:

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

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

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 removed projects from inclusion in EFLH estimation that did not have sufficient bills to calculate average summertime baseload. Only post-period (post-installation) billing data was used in this estimation.

2.2.5 PROCESS APPROACH

The process evaluation of the CNGC measure offerings was designed to accomplish the following research objectives:

- Evaluate program design including program mission, logic, and use of industry best practices;
- Evaluate program implementation including quality control, operational practice, outreach, and ease of customer participation;
- Evaluate program administration including program oversight, staffing, management, training, documentation, and reporting;
- Report findings, observations, and recommendations to enhance program effectiveness;
- Refine and refocus marketing strategies and increase program effectiveness;
- 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 research objectives in these process evaluations are:

- Document overall awareness of the program and its measures;
- Determine if there are significant differences between and among participant groups;
- Assess customer satisfaction with the utility and the program;
- Identify barriers for not participating, areas for program improvement;
- Identify efficiencies in program implementation;
- Identify gaps in program participation for customers;
- Document energy efficiency motivations among participants;
- Identify patterns in how participants interact with measures;
- Assess contractor engagement;
- Identify gaps in participation for contractors;
- Characterize participating contractor practices for projects completed within and outside of the program;

- Understand how customers are interacting with the measures incentivized through the program;
- Assess contractor views of the program and barriers to participation; and
- Review trade ally management best practices and provide recommendations as appropriate.

The process evaluation was designed to ensure that best practices and lessons learned from individual programs are then shared and incorporated across the entire program portfolio. In-depth interviews and customer participant surveys contain a standard set of questions to be addressed to facilitate evaluation among and between programs. To achieve these objectives, the Evaluation team engaged in the research activities described in the sections below.

2.2.5.1 Participant Survey

The Evaluators administered a survey to customers who participated in the program between 2018-2022. The objective of the survey was to collect data on the following components:

- Sources of program awareness and motivations for participating;
- Customer experiences with the program and overall satisfaction;
- Measure specific questions related to how the installed equipment was utilized; and
- Facility characteristics.

The Evaluators developed the survey guide in conjunction with CNGC staff to address the above objectives through various questions to the participating customers. The survey questions are provided in Appendix A: Participant Survey Instrument and Tabulations.

3 IMPACT AND PROCESS EVALUATION RESULTS

The following sections summarize findings for the electric impact evaluation in each of the channels within the Washington and Oregon service territory. The Evaluators used data collected and reported in the tracking database, online application forms, applicable TRM and workpapers to evaluate savings. Table 3-1 summarizes verified impact savings by end use and measure offering.

Table 3-1: CNGC Channel and Offering Verified Impact Savings

End Use	Measure	Number of Units	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
Envelope	Attic Insulation	229,882	72,263	33,635	46.6%
Envelope	Floor Insulation	20,070	1,124	1,204	107.1%
Envelope	Roof Insulation	314,037	112,377	235,322	209.4%
Envelope	Wall Insulation	127,934	23,555	37,297	158.3%
Envelope	Windows	5,805	6,194	6,236	100.7%
Food Service	Dishwashers	15	6,720	6,720	100.0%
Food Service	Fryers	136	93,160	83,152	89.3%
Food Service	Griddles	3	819	819	100.0%
Food Service	Ovens	40	22,408	24,187	107.9%
Food Service	Steamers	3	2,359	2,365	100.3%
Space Heating	Direct-fired Radiant Heating	14,165	61,334	27,220	44.4%
Space Heating	High-Eff. Con. Furnace	24,574	21,478	33,179	154.5%
Space Heating	High-Eff. Con Boiler	203,519	316,813	338,600	106.9%
Water Heating	Condensing Tank	32,664	46,198	34,480	74.6%
Water Heating	ENERGY STAR Tankless	981	33,743	34,034	100.9%
Custom	All Measures	14,002	828,597	659,445	79.6%
Total		**987,830**	**1,649,142**	**1,557,895**	**94.5%**

Between 2018 and 2022, CNGC completed and provided incentives under the custom, space heating, water heating, envelope, and food service channels. The programs reported total savings of 1,649,142 Therms and the Evaluators verified 1,557,895 Therms. The attic insulation, fryers, radiant heaters, condensing tanks, and overall custom offering did not meet expected savings, leading to an overall achievement of 95% of the expected savings for the program. Further details of the impact evaluation results by program are provided in the sections following.

The Evaluators also conducted billing analyses to support estimation of savings for the space heating and water heating channels. The Evaluators define these additional research objectives in Section 3.1.2 and Section 0.

3.1 Measure-Level Evaluation Results

The Evaluators summarize the channel and offer-specific activities, results, conclusions, and recommendations in the section below.

3.1.1 CUSTOM

The Custom Program Channel is directed at developing and incentivizing custom energy efficiency projects for which deemed values are not applicable or feasible.

3.1.1.1 Overview

The 2019-2022 program period had an expected savings of 828,597 Therms with verified savings of 659,445 Therms, leading to an 80% realization rate. The table below shows the savings associated with each year withing the program period.

Table 3-2: Custom Channel Savings by Year

Program Year	Projects	Incentive	Expected Savings (Therms)
2019	8	$214,519	153,377
2020	8	$58,611	32,351
2021	9	$762,536	544,080
2022	14	$143,804	98,789
Total	**39**	**$1,179,470**	**828,597**

The 2021 program year accounted for 66% of the total program period savings despite only contributing 23% of the program period's total number of projects. The below table highlights the project participation for the program period.

Table 3-3: Custom Channel Participation Summary

Project Number	Facility Type	Measure	Expected Savings (Therms)	Program Year
007926	Industrial - Other	Crawl Space Insulation	184	2020
008377	Office - Other	MZ to VAV Conversion	625	2021
008524	Houses of Worship	Custom boiler	641	2022
008547	Industrial/Manufacturing	Rafter insulation	836	2022
008473	Warehouse	High Speed RU Door	848	2021
007718	Restaurant - Full Service	Custom Other	1,024	2019
008001	Education - Large	Custom Air Handling Units	1,070	2020
008531	Government/Schools	Energy Recovery Ventilators	1,146	2022
008499	Office	Steam trap rebuild	1,333	2022
008286	Education - Large	AHU Heat Recovery	1,467	2020
008459	Education - Large	Recovery Ventilation	1,470	2021
008503	Government/Schools	Kitchen MUA DCV	2,178	2022
007733	All Other	Custom Other	2,200	2019
008521	Government/Schools	Heat Recovery Units	2,675	2022
008460	Education - Large	Recovery Ventilation	2,695	2021
008304	Education - Large	HVAC Control Optimization	2,745	2020
007777	Education - Large	Custom Boilers	5,600	2019
007773	Education - Large	Custom Boilers	8,400	2019

008011	Education - Large	Hood MUA DCV Control	3,445	2020
007897	Lodging	Ozone Injection System	4,678	2020
008477	Government/Schools	DOAS & RTUs	5,968	2021
008420	Industrial - Other	Steam boiler economizer	6,584	2021
008512	Industrial/Manufacturing	Steam Boiler	6,766	2022
008339	Education - Large	DOAS units	7,004	2020
008406	Education - Large	Rooftop Heat Recovery Units	7,945	2021
008405	Education - Large	Rooftop Heat Recovery Units	7,945	2021
007834	Education - Large	Boilers	9,600	2019
008555	Grocery and Convenience	Refrigerated case doors	9,955	2022
008556	Grocery and Convenience	Refrigerated case doors	10,736	2022
008554	Grocery and Convenience	Refrigerated case doors	11,110	2022
008553	Grocery and Convenience	Refrigerated case doors	11,606	2022
007857	Education - Large	Custom DDC Controls	11,758	2020
008550	Grocery and Convenience	Refrigerated case doors	12,639	2022
008551	Grocery and Convenience	Refrigerated case doors	12,960	2022
007828	Grocery and Convenience	Medium Temp Case Doors	14,040	2019
008552	Grocery and Convenience	Refrigerated case doors	14,208	2022
007781	Education - Other	make up AHU w heat recovery	20,533	2019
007844	Industrial - Other	Condensing Hot Water Boiler	91,980	2019
008476	Industrial - Other	Regenerative Thermal Oxidizer	510,000	2021

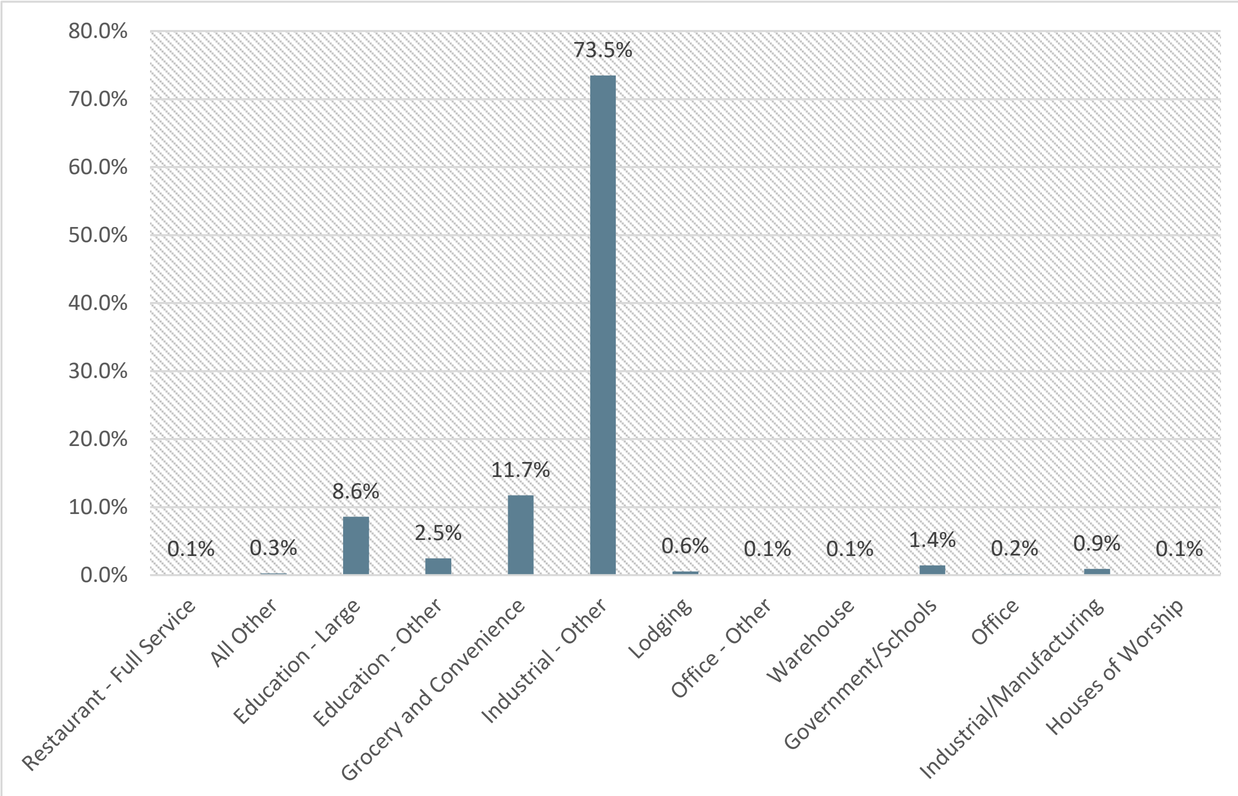

Figure 3-1: Custom Savings by Facility type

The custom channel provided incentives for a total of 39 projects across 13 building types. 74% of ex ante savings were attributed to the building type "Industrial – Other". Sixty-two percent of the custom channel expected savings are attributed to one project which claimed an expected savings of 510,000 Therms.

3.1.1.2 Analysis

This section provides a brief overview of the data collection activities and gross impact calculation methodologies that the Evaluators employed in the evaluation of the custom channel. Data for the study was collected through a review of program materials and billing data. Based on program tracking data provided, a sample design was developed for site-specific analysis. The sample size is to provide gross impact estimates with 10% precision or better at the 90% confidence level for the channel. The table below shows the sample design that was used for evaluating the custom offering.

Table 3-4: Custom Offering Sampling Plan

Lower Savings Range (Therms)	Upper Savings Range (Therms)	Stratum	Count of Stratum	Standard Deviation of Therms	Coefficient of Variation	Total Therms	Sample	Precision
>80,000	Max	4	2	295,585	0.98	601,980	2	0%
>10,000	80,000	3	9	2,976	0.22	119,590	1	35%
>1,000	10,000	2	23	3,006	0.67	103,893	5	43%
0	1,000	1	5	269	0.43	3,134	2	39%
Total			**39**	**81,642**	**3.84**	**828,597**	**10**	**7%**

Projects were split into four strata based on the project's savings. Strata were constructed using program tracking data spanning PY2019 through PY2022. With the tracking data information, the Evaluators sampled projects through the following processes:

- Projects were ordered from smallest to largest in terms of Therms savings then the cumulative share of savings was calculated for this ordered list.
- Project sizes were reviewed to identify the most suitable divisions that would facilitate the pairing of projects with similar sizes, ensuring that comparable projects were grouped together.
- The highest savings projects were compiled into a separate certainty stratum. The projects within this stratum would only represent themselves and would not be extrapolated out to represent other projects.
- Projects within each stratum would be randomly sampled for further review.

Each sampled project was evaluated with a desk review of all relevant project documentation and in accordance with the IPMVP. The individual project evaluation reports with evaluation methodologies can be found in the appendix. The table below shows the verified savings results at the stratum level of all sampled projects.

Table 3-5: Stratum Level Sampled Project Results

Strata	# of Projects	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
1	2	1,032	1,239	120%
2	5	19,989	16,691	84%
3	1	10,736	10,736	100%
4	2	601,980	449,339	75%
Total	**10**	**633,737**	**478,005**	**75%**

These stratum level realization rates were then extrapolated out to the rest of the respective stratum. These extrapolated results are shown in the table below.

Table 3-6: Stratified Population Results

Strata	# of Projects	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
1	5	3,134	3,764	120%
2	23	103,893	86,752	84%
3	9	119,590	119,590	100%
4	2	601,980	449,339	75%
Total	**39**	**828,597**	**659,445**	**80%**

Below are the verified project level results of the sampled projects along with a brief description on the cause of the variance in realization rate.

Table 3-7: Cause for Variance in Savings by Project ID

Project ID	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate	Cause for Variance in Savings
7718	1,024	1,142	112%	Updated hourly bins based off TMY3 weather data closest to site.
7777	5,600	4,000	71%	Boiler efficiency and capacity updated to match AHRI spec sheets.
7834	9,600	8,400	88%	Boiler efficiency was updated to match provided documentation
7844	91,980	84,008	91%	Boiler efficiency was updated to match provided documentation
7926	184	189	103%	Updated hourly bins based off TMY3 weather data closest to site.
8001	1,070	1,029	96%	Updated hourly bins based off TMY3 weather data closest to site.
8460	2,695	2,120	79%	Updated hourly bins based on TMY3 weather data closest to the site.
8473	848	1,050	124%	Expected Therms calculations used a 3-year average for monthly temperature. The Evaluators estimated verified savings using TMY3 weather for the average monthly temperature.
8476	510,000	365,331	72%	Expected Therms estimate was higher than the facilities' total annual usage; therefore, the Evaluators used a different evaluation methodology to estimate verified savings. Verified Therms savings using an energy intensity (Therms/ft^3 of VOC) for the pre and post systems using the annual billing data and annual volume of VOC processed. This energy intensity was used to calculate the avoided energy usage between the baseline system and the new system.
8556	10,736	10,736	100%	No variance in savings displayed.

3.1.1.3 Findings

The table below summarizes realization rates for the custom offering by program year.

Table 3-8: Total Custom Offering Verified Savings

Program Year	# of Projects	Expected Savings (Therms)	Verified Savings (Therms)	Realization Rate
2019	8	153,377	140,974	92%
2020	8	32,351	29,125	90%
2021	9	544,080	394,228	72%
2022	14	98,789	95,118	96%
Total	**39**	**828,597**	**659,445**	**80%**

3.1.1.4 Conclusions and Recommendations

The Evaluators provide our overall conclusions and recommendations for the custom channel in the table below.

Table 3-9: Custom Recommendations

Equipment	Recommendations
All Measures	1. *Added QC checks for Custom projects*- Additional QC check would greatly benefit the projects. One project completed in the program year accounted for 62% of the total channel savings and received a 72% realization rate. And added QC check of reviewing project savings claims against facility annual consumption could have shown the errors in *ex ante* calculation methods. 2. *Use TMY3 weather data for weather dependent measures* – Several projects completed were using actual weather data to calculate savings and weather dependent variables/run times. The problem with this approach is it allows for extreme weather years to either overestimate or underestimate energy savings. Using TMY3 weather data will avoid any one-off weather years influence on energy savings. 3. *Improve tracking data details* – There is conflicting information in the project tracking data where there are two columns that show energy savings. One is claimed as project energy savings and the other appears to be the measure level energy savings. The project level energy savings are not necessary and just add clutter and confusion. 4. *Provide more detail in project documentation* – There were project documents submitted that did not include the energy savings calculations used for the expected savings estimate and listed the expected savings expected savings estimate as a hard coded value making project review difficult. Providing the expected savings calculations will allow the Evaluators to make better recommendations and provide more insight into why realization rates are off.

3.1.2 SPACE HEATING

CNGC offers customers incentives to upgrade three types of space heating measures: radiant heaters, furnaces, and boilers. To be eligible for a furnace rebate, customers must install a high efficiency condensing furnace with a minimum AFUE (annual fuel utilization efficiency) of 91%. To be eligible for a boiler rebate, commercial boilers must have a thermal efficiency of at least 90% and have a 199 kBtu/h input.

The Evaluators conducted a thorough analysis of gas savings associated with these measures and developed a methodology to utilize in future savings estimates. To calculate savings for each of these the Evaluators employed a post-only, EFLH estimation methodology. The outline of the calculation process, findings, and general recommendations below. The following subsections present the Evaluators' methodology and findings as well as key recommendations based on the analyses.

3.1.2.1 Overview

The following subsections outline the methodology the Evaluators employed to calculate gas savings associated with the space heating measures. Prior to exploring the savings calculation methodology, the Evaluators summarize the expected Therms usage by program year and measure for the space heating channel below.

Table 3-10: Space Heating Channel Savings by Program Year

Program Year	Projects	Incentives	Expected Savings (Therms)
2018	49	$459,778	54,258
2019	100	$657,625	67,583
2020	107	$812,887	65,639
2021	132	$2,237,369	142,918
2022	59	$2,661,407	69,229
Total	**447**	**$6,829,066**	**399,625**

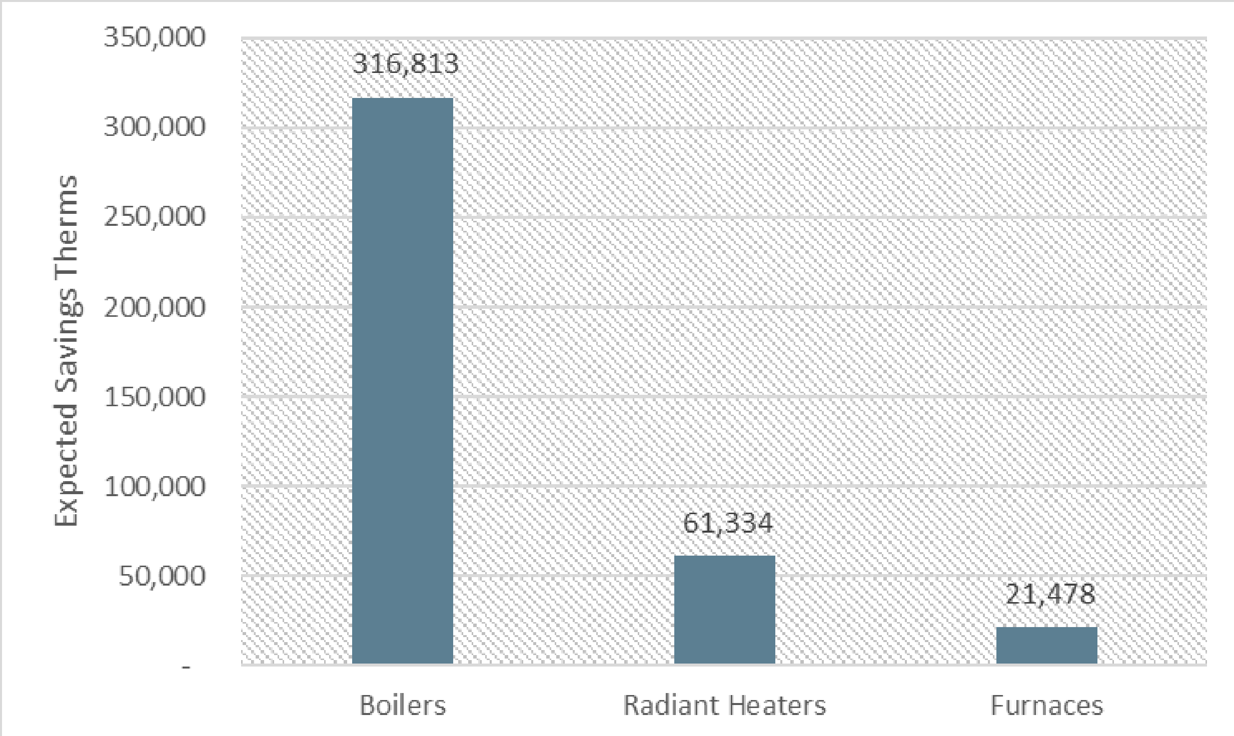

Figure 3-2: Space Heating Channel Ex-Ante Savings by Measure

3.1.2.1.1 Data Received

The Evaluators received tracking data and billing data. The tracking data included all relevant information on commercial rebate measures installed between January 1, 2018, and December 31, 2022. The dataset included data such as measure type, installation date, kBtu/h, facility site name and facility site address. The billing data tracked monthly commercial gas usage between November 28, 2018, and December 30, 2022, across 752 unique premise IDs and premise addresses.

The Evaluators' approach estimated the impacts of the conversion for each space heating measure. Table 3-11 displays customer counts for customers considered for billing analysis and identifies measures that met the requirements for a billing analysis.

Table 3-11: Space Heating Measures Considered for Billing Analysis

Measure	Measure Considered for Billing Analysis	Number of Customers w/ Installations	Sufficient Participation for Billing Analysis
Radiant Heaters	✓	21	✓
Furnaces	✓	71	✓
Boilers	✓	54	✓

3.1.2.1.2 Preprocessing

While the tracking and billing datasets contained nearly all data necessary for the Evaluators to conduct savings calculations, minor preprocessing was necessary. First, the Evaluators pulled and applied the nearest United States Air Force (USAF) codes to the billing dataset based on facility zip code. USAF codes are 6-digit codes that correspond to USAF stations. USAF stations are used by the National Oceanic and

Atmospheric Administration (NOAA) for weather data collection. Evaluators used publicly available NOAA temperature data to calculate the average daily HDDs across each billing period.

After adding daily HDDs to the dataset, the Evaluators also calculated average daily Therms usage by dividing monthly bills by bill duration. The final preprocessing step was to use those daily bills and daily HDDs to calculate weather-normalized Therms usage. To do so the Evaluators first added HDDs from a typical meteorological year (TMY) to the dataset. This TMY data is an average across multiple years and represents normal weather patterns for a particular region.

The Evaluators then ran a linear regression model on each customer in the billing data to determine the impact of HDDs on average daily usage in Therms to estimate weather-normalized average daily consumption. This weather-normalized average daily consumption was parsed into baseload and heating load. Baseload was defined by isolating average daily consumption in summer months (June, July, August). Heating load is defined by the remainder of daily consumption in the winter months, above baseload estimates. Heating load is utilized by the Evaluators in the analysis methodology, further defined in the section below.

3.1.2.2 Analysis

The Evaluators employed a post-only, EFLH estimation methodology to estimate verified savings for each of the three space heating technologies. When employing this analysis methodology, EFLH is calculated by dividing heat load (described above) from facility-level billing data by facility-level Btus/h documented in CNGC tracking data. For this analysis, documented Btu data for each facility is critical for providing accurate savings estimates. If reported Btus are substantially lower than expected for a certain facility, EFLH will be substantially higher than expected, leading to an overestimation of savings. In contrast if Btus are higher than expected, EFLH and savings will be underestimated. To address this issue, the Evaluators employed two distinct strategies.

1. First, the Evaluators noted that in the radiant heater calculations several customers had very low EFLH values. As such, for EFLH values lower than expected (less than 2 hours/day), the Evaluators compared tracking and billing data to identify potential mismatches. For example, if the billing address referenced a single suite (as opposed to a warehouse), but tracking data indicated multiple radiant heaters were installed, the Evaluators assumed additional heaters were likely installed at other addresses. If that was the case, the Btus/h of a single radiant heater were employed in the EFLH calculation (as opposed to the Btus/h of all radiant heaters combined). As the tracking data only includes parent site address, not measure installation address, such assumptions were necessary.
2. Second, the Evaluators identified higher than expected EFLH values (greater than 10 hours/day) for several customers in both the furnace and boiler datasets. The Evaluators used facility square footage to estimate the Btus/h necessary to heat each facility based on facility type. The Evaluators collected square footage data using Google maps distance tool to extract square footage values for facilities with higher than expected EFLH values. To calculate necessary Btus/h, Evaluators multiplied square footage by 45.

From there, the Evaluators divided reported Btus/h by necessary Btus/h to determine the reported Btu proportion. The Evaluators used this value as an adjustment factor to estimate adjusted heating load and adjusted EFLH for outlier EFLH facilities.

Therms savings were calculated using the methodology presented in the EFLH Methodology section in Section 2.2.4.3. This involved calculating the difference in Therms usage between the efficient technology and an assumed baseline to determine savings. The Evaluators summarize efficiency assumptions utilized in this analysis below:

- Per ASHRAE[11], radiant heaters were assumed to have 100% efficiency and baseline heater being replaced was assumed to have 85% efficiency.
- In alignment with applicable code at the time of retrofit, if AFUE was unreported for efficient furnaces and boilers it was assumed to be 95% and baseline furnaces and boilers were assumed to have an AFUE of 80%.

With these EFLH adjustments implemented, the Evaluators multiplied the updated overall savings per Btus/h by the output Btus/h per tracking data to calculate overall daily savings for each measure installed. Daily savings were multiplied by 365.25 days per year to estimate annual savings. The Evaluators then aggregated all project-level annual savings to produce the program year savings for PY2018 through PY2022.

3.1.2.3 Findings

In this section, the Evaluators summarize findings for each of the three space heating measures evaluated below.

3.1.2.3.1 Radiant Heaters

After conducting the post-only analysis, the Evaluators found that on average each facility that installed a radiant heater used 443,889 Btus/h. Applying this average Btus/h value to the calculated daily usage per Btu/h and daily savings per Btu/h yielded an average yearly usage of 4,847 Therms and average yearly savings of 853 Therms. This indicates that radiant heater adoption was associated with an 18% decrease in Therms usage on average. Table 3-12 displays comprehensive per-customer summary statistics based on the radiant heater analysis.

Table 3-12: Radiant Heater Per Unit Summary Statistics

Summary Statistics	Value
Average Capacity (Btus/h)	443,889
Daily Usage per Btu/h (Therms)	0.0000299
Daily Usage per Average Btus/h (Therms)	13.3
Yearly Usage per Average Btus/h (Therms)	4,847

[11] Values determined by testing as per 2016 ASHRAE® HANDBOOK: Heating, Ventilating, and Air-Conditioning SYSTEMS AND EQUIPMENT, Inch-Pound Edition, Chapter 16, pg. 16.1, “Energy Conservation,” 2016, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta, GA.

Daily Savings per Btu/h (Therms)	0.00000526
Daily Savings per Average Btus/h (Therms)	2.33
Yearly Savings per Average Btus/h (Therms)	853
Savings as a Percent of Therms Usage (%)	17.6%

In order to estimate expected savings for radiant heaters, the Evaluators recommend CNGC multiply the verified facility capacity with the daily usage per Btu/h value (0.0000299 Therms per Btu/h) resulting from impact analysis for this measure.

When aggregating per-customer savings, the Evaluators found that 122 radiant heaters installed across 21 customers yielded 27,220 verified savings and a realization rate of 44%. These findings are presented below in Table 3-13. Based on the billing data provided for the participants, the Evaluators concluded that many of the participants did not demonstrate sufficient annual energy usage to fully benefit from the energy efficient equipment upgrade. Additionally, for many facilities, it is unclear in the tracking data the specific location of the installed space heating equipment. The Evaluators recommend that in future tracking data installation address and other premise-specific identifiers are documented in order for future savings analyses to be completed more precisely.

3.1.2.3.2 Furnaces

The Evaluators found that the average customer installed a 203,243 Btu/h furnace. When this average Btus/h value was multiplied by the average daily usage per Btu/h and average daily savings per Btu/h it yielded average yearly usage of 5,916 Therms and average yearly savings of 363 Therms (or 6.14% savings). Table 3-13 displays the per-customer summary statistics based on the furnace billing data analysis.

Table 3-13: Furnace Per-customer Summary Statistics

Summary Statistics	Value
Average Capacity (Btus/h)	203,243
Daily Usage per Btu/h (Therms)	0.0000797
Daily Usage per Average Btus/h (Therms)	16.2
Yearly Usage per Average Btus/h (Therms)	5,916
Daily Savings per Btu/h (Therms)	0.00000490
Daily Savings per Average Btus/h (Therms)	1.00
Yearly Savings per Average Btus/h (Therms)	363
Savings as a Percent of Annual Therms Usage (%)	6.14%

To estimate expected savings for furnaces, the Evaluators recommend multiplying the verified facility capacity with the daily usage per Btu/h value (0.0000797 Therms per Btu/h) resulting from impact analysis for this measure.

When aggregating per-customer savings, the Evaluators found that 188 furnaces installed across 71 customers yielded 33,179 verified savings and a realization rate of 155%. These findings are presented below in Table 3-15. The Evaluators recommend that in future tracking data facility square footage and sourcing documentation to verify the Btus/h of installed furnaces are documented in order for future savings analyses to be completed more precisely. Square footage data would allow the Evaluators to determine the likely Btus/h necessary to heat the space of interest which would help pinpoint outlier furnaces. Documentation would help the Evaluators verify that the reported Btus/h in the tracking data are accurate. Collectively such steps would improve the accuracy of the EFLH estimation and consequent savings calculations.

3.1.2.3.3 Boilers

The Evaluators found that the average customer installed a 2,565,799 Btu/h boiler. This large boiler capacity was likely driven by the fact that multiple penitentiaries (and other large facilities) were included in the boiler dataset. When this average Btus/h value was multiplied by the average daily usage per Btu/h and average daily savings per Btu/h it yielded average yearly usage of 73,767 Therms and average yearly savings of 4,324 Therms (or 6% savings). Table 3-14 displays the per-customer summary statistics based on the boiler billing data analysis.

Table 3-14: Boiler Per-customer Summary Statistics

Summary Statistics	Value
Average facility capacity (Btus/h)	2,565,799
Daily Usage per Btu/h (Therms)	0.0000787
Daily Usage per average facility (Therms)	202
Yearly Usage per average facility (Therms)	73,767
Daily Savings per Btu/h (Therms)	0.00000461
Daily Savings per average facility (Therms)	11.8
Yearly Savings per average facility (Therms)	4,324
Savings as a percent of annual Therms usage (%)	5.86%

To estimate expected savings for boilers, the Evaluators recommend multiplying the verified facility capacity with the daily usage per Btu/h value (0.0000787 Therms per Btu/h) resulting from impact analysis for this measure.

When aggregating per-customer savings, the Evaluators found that 137 boilers installed across 54 customers yielded 338,600 verified savings and a realization rate of 107%. These findings are presented below in Table 3-15. As with furnaces, tracking installed address square footage and sourcing boiler installation documentation could improve future savings calculations.

Table 3-15: Space Heating Verified Savings by Measure

Measure	Customers	Measures Installed	Ex Ante Savings (Therms)	Ex Post Savings (Therms)	Realization Rate
Radiant Heaters	21	122	61,334	27,220	44.4%
Furnaces	71	188	21,478	33,179	154.5%
Boilers	54	137	316,813	338,600	106.9%

3.1.2.4 Conclusions and Recommendations

The Evaluators provide our overall conclusions and recommendations for the space heating channel in the table below.

Table 3-16: Space Heating Recommendations

Equipment	Recommendations
All Space Heating Measures	1. Include two additional identifier columns to the tracking data. Premise ID or installation address would allow for more accurate verification of savings and the ability to ensure accurate EFLH calculations. 2. Include square footage of the installation address in tracking data (more specifically, tracking the square footage of the building in which the boilers/furnaces are installed). This data would assist with verification efforts of capacity of efficient heating technology and allow for assurance that the billing consumption data is requested for the correct gas meter. 3. If CNGC could provide the Evaluators with documentation verifying measure installation, the veracity of reported measure capacity could be determined.
Radiant Heaters	4. To estimate expected savings for radiant heaters, the Evaluators recommend CNGC multiply the verified facility capacity with the daily usage per Btu/h value (0.0000299 Therms per Btu/h) resulting from impact analysis for this measure, shown in Table 3-12.
Furnaces	5. To estimate expected savings for furnaces, the Evaluators recommend CNGC multiply the verified facility capacity with the daily usage per Btu/h value (0.0000797 Therms per Btu/h) resulting from impact analysis for this measure, shown in Table 3-13.
Boilers	6. To estimate expected savings for boilers, the Evaluators recommend CNGC multiply the verified facility capacity with the daily usage per Btu/h value (0.0000787 Therms per Btu/h) resulting from impact analysis for this measure, shown in Table 3-14.

3.1.3 WATER HEATING

CNGC offers incentives towards tankless water heaters and high efficiency storage tank water heaters. The Evaluators conducted an impact evaluation analysis for all incentivized tankless water heaters and storage tank water heaters between the program years of 2018 and 2022. This section provides further details of the Evaluators' objectives, data collection, methodology, and findings for this offering. Prior to exploring savings calculation methodologies, the Evaluators provide an outline of expected savings by year and measure below.

Table 3-17: Water Heating Channel Savings by Year

Program Year	Projects	Incentive	Expected Savings (Therms)
2018	33	$587,988	7,142
2019	56	$544,110	15,994
2020	60	$539,524	12,410
2021	48	$761,684	10,033
2022	51	$1,779,180	33,907
Total	**248**	**$4,212,486**	**79,485**

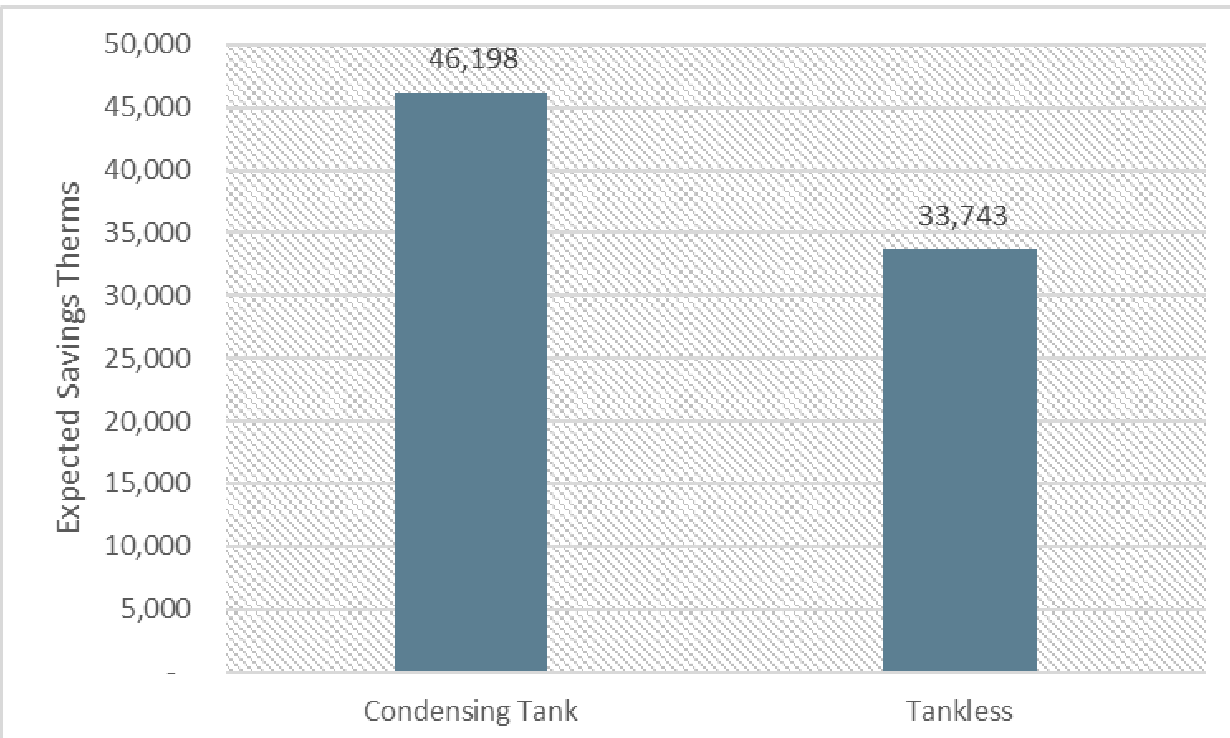

Figure 3-3: Water Heating Channel Ex-Ante Savings by Measure

3.1.3.1 Data Collection

The Evaluators estimated verified measure-level energy savings through an engineering algorithm approach across all tankless and storage tank water heater upgrades incented between program year

2018 and 2022. Engineering algorithms were referenced from industry standard sources, including documentation from ASHRAE and Energy Star.

The tracking data provided for tankless and storage tank water heaters includes the following relevant fields:

- Uniform energy factor (UEF)
- Facility type
- Quantity of water heaters installed
- Expected Therms savings for each project
- Efficient equipment annual fuel utilization efficiency (AFUE)
- Facility type

The following fields are missing from the tracking data:

- Water heater location
- Baseline UEF
- Baseline tank size for projects which converted to tankless water heaters
- Efficient water heater AHRI reference number

3.1.3.2 Tracking Data Review

As part of the impact evaluation work, the Evaluators reviewed and verified all tracking data inputs for the water heating offering. The Evaluators found the following fields were incomplete for a number of facilities in the tracking data:

- Efficient UEF
- Facility type
- Efficient equipment AFUE

The Evaluators also found that the following fields were not documented in the tracking data:

- Water heater location
- Baseline UEF
- Baseline tank size for projects which converted to tankless water heaters
- Efficient water heater AHRI reference number
- Facility square footage

The Evaluators were unable to verify the above missing fields and therefore supplemented our impact analysis with assumptions. The Evaluators recommend including the fields referenced above in future program data collection efforts in order to mitigate assumptions and increase accuracy of estimated expected savings for the measures moving forward.

3.1.3.3 Impact Analysis Methodology

The results of the billing analysis for the tankless water heater conversion and the storage tank water heater measures are provided in this section. The Evaluators used the engineering algorithm to calculate savings for the water heater measures*:*

Equation 3-1: Water Heater Retrofit Annual Savings Equation

$$Therms\ Savings = \frac{p * Cp * V * \left(T_{Setpoint} - T_{Supply}\right) * \left(\frac{1}{UEF_{Baseline}} - \frac{1}{UEF_{Efficient}}\right)}{100{,}000}$$

Where,

p = Water density = 8.33 lb/gal

Cp = Specific heat of water = 1 BTU/lb °F

V = Estimated annual hot water use (gal)[12]

$T_{Setpoint}$ = Water heater set point (default value = 120°F)

T_{Supply} = Average supply water temperature[13]

$UEF_{Baseline}$ = Baseline Uniform Energy Factor[14]

$UEF_{Efficient}$ = Uniform Energy Factor of new water heater

$100{,}000$ = Conversion Factor Btu/Therm

The Evaluators used the following assumptions as inputs to the water heater engineering algorithms when estimating verified savings. The Evaluators found the heating zone for each facility using the facility zip code and RTF climate zone workbook[15] used in RTF UES calculations. The Evaluators included additional assumptions regarding water temperature supply, which was sourced from discontinued RTF UES faucet aerator workbooks[16]. Although the faucet aerators no longer produce active RTF UES savings, the region-specific water temperature research is employed here for the purpose of estimating tankless water heater savings.

- Square footage is estimated from Google maps tools
- Hot water load per 1,000 SQFT is referenced using assumed building type
- Days in use per year sourced from NREL[17]
- T setpoint is 120F for all
- Assumed 100,000 BTU/h for each unit

The Evaluators provide the results for the above retrofit engineering algorithm in the section below.

---

[12] Osman S, & Koomey, J. G J1995, National Laboratory 1995. *Technology Data Characterizing Water Heating in Commercial Buildings: Application to End-Use Forecasting.* December.
[13] RTF Residential Aerators, (https://nwcouncil.box.com/v/Aeratorsv1-1)
[14] IECC2009 Zone 4 water input temperature
[15] RTF Climate Zone Calculation Workbook v3.2 (https://nwcouncil.box.com/v/rtfclimteznecalcv3-2)
[16] RTF Residential Aerators, (https://nwcouncil.box.com/v/Aeratorsv1-1)
[17] Osman S, & Koomey, J. G J1995, National Laboratory 1995. *Technology Data Characterizing Water Heating in Commercial Buildings: Application to End-Use Forecasting.* December.

3.1.3.4 Findings

Based on the results in Table 3-18, the Evaluators found that the realization rate for the 2022 tankless water heater conversions is at 148% and the total realization rate from 2018-2022 is at 102%. Over the course of the four evaluation years listed below, the realization has increased by an average of 25%.

Table 3-18: Tankless Water Heater Verified Savings by Program Year

Evaluation Year	Number of Projects	Number of Tankless Water Heaters	Expected Therms	Verified Therms	Realization Rate
2018	6	12	3,787.00	1,745.71	46.1%
2019	15	31	11,869.14	8,651.31	72.9%
2020	13	21	4,552.40	5,524.83	121.4%
2021	14	20	5,868.20	7,585.15	129.3%
2022	11	15	7,210.52	10,527.23	146.0%
Total	**59**	**99**	**33,287.26**	**34,034.23**	**102.2%**

Based on the results in Table 3-19, the Evaluators found that the realization rate for the 2022 storage tank water heater conversions is at 32% and the total realization rate from 2018-2022 is at 75%. The Evaluators have also concluded that the facility type has a large influence on savings.

Table 3-19: Storage Tank Water Heater Verified Savings by Program Year

Evaluation Year	Number of Projects	Number of Tankless Water Heaters	Expected Savings	Verified Savings	Realization Rate
2018	8	21	3,355.11	3,627.86	108.1%
2019	12	25	4,124.51	4,203.71	101.9%
2020	17	39	7,857.17	11,049.43	140.6%
2021	16	26	4,164.79	7,049.30	169.3%
2022	12	36	26,696.47	8,549.66	32.0%
Total	**65**	**147**	**46,198.05**	**34,479.97**	**74.6%**

The largest contributing factor to discrepancy in realization rate is due to the characterization of the facility type. The water heating load is heavily dependent on the facility type, square footage, and number of units (number of students in an elementary school or number of rooms in a hotel) for each participating building. The Evaluators collected square footage data based on Google maps distance tools, as well as public business information identifying number of students per school. Using these assumptions, the Evaluators updated engineering algorithm inputs to adjust water heating load associated with building functions. These changes resulted in realization rates that ranged between 32% and 170% across program years for the water heating measures under this channel.

3.1.3.5 Conclusions and Recommendations

The Evaluators provide our overall conclusions and recommendations for the water heating channel in the table below.

Table 3-20: Water Heating Recommendations

<table>
<tr><th>Equipment</th><th>Recommendations</th></tr>
<tr><td>All Water Heating Measures</td><td>1. Include complete data for the following fields. This will allow for mitigated assumptions and increased accuracy of estimated savings:
• Efficient UEF
• Facility type
• Efficient equipment AFUE
• Water heater location
• Baseline UEF
• Baseline tank size for projects which converted to tankless water heaters
• Efficient water heater AHRI reference number
• Facility square footage
2. Use region-specific water temperature research developed by the RTF UES workbooks[18] for the purpose of estimating storage tank and tankless water heater savings. For other assumptions, use National Renewable Energy Laboratory inputs[19], such as:
• Hot water load per 1,000 SQFT
• Days in use per year
1. The largest contributing factor to discrepancy in realization rate is due to the characterization of the facility type and square footage. Including square footage of facility in which the efficient water heater was installed will greatly increase accuracy of savings. The Evaluators recommend CNGC provide further detail of each project's facility type, square footage, and number of units (number of students in an elementary school or number of rooms in a hotel) for each participating building.</td></tr>
</table>

[18] RTF Residential Aerators https://nwcouncil.box.com/v/Aeratorsv1-1

[19] Osman S, & Koomey, J. G J1995, National Laboratory 1995. *Technology Data Characterizing Water Heating in Commercial Buildings: Application to End-Use Forecasting.* December.

3.1.4 ENVELOPE

CNGC offers its customers incentives to upgrade five types of envelope measures: attic insulation, roof insulation, floor insulation, wall insulation, and window upgrades. For commercial customers to receive a rebate, they must install a minimum of R-30 for floor, roof, and attic insulation and a minimum of R-19 for wall insulation. The Evaluators conducted a thorough analysis of gas savings associated with these measures and in so doing developed a methodology to utilize in future savings estimates. The following subsections present the Evaluators' methodology and findings as well as key recommendations based on the analyses.

3.1.4.1 Overview

The tracking data delivered to the Evaluators encompassed four different types of insulation: attic, roof, floor, and wall. Attic insulation is installed above an interior ceiling, while roof insulation is installed underneath the roof deck and above/below rafters. In addition to variation by insulation type, the tracking data also included various R-values which represent the thickness of insulation installed. Before exploring the methodology employed to calculate savings, please find an outline of expected savings by year and measure below.

Table 3-21: Envelope Channel Savings by Year

Program Year	Projects	Incentive	Expected Savings (Therms)
2018	5	$22,382	2,756
2019	37	$748,726	66,433
2020	36	$489,755	56,205
2021	102	$796,413	49,199
2022	18	$440,090	40,919
Total	**198**	**$2,497,366**	**215,512**

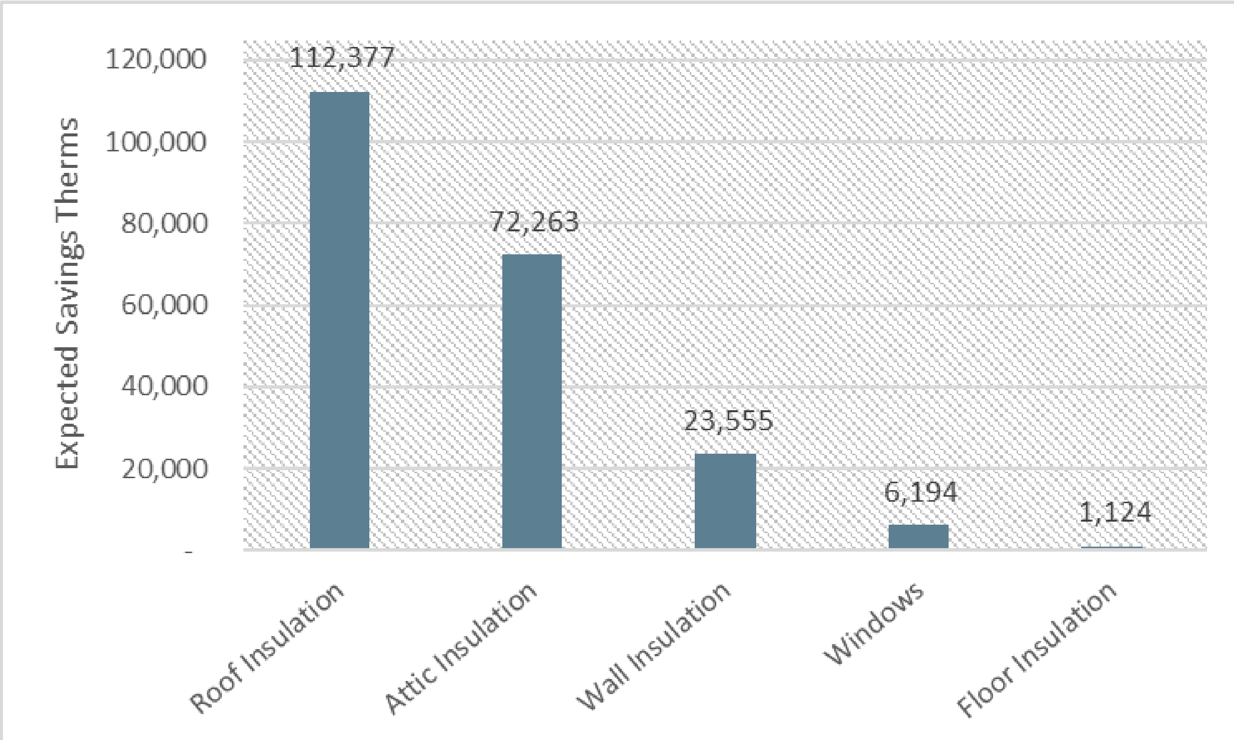

Figure 3-4: Envelope Channel Ex-Ante Savings by Measure

The Evaluators measured verified savings using two approaches:

- Billing Analysis (Section 2.2.4.2)
- Deemed Savings (Section 2.2.4.12.2.4.1)

The Evaluators estimated verified windows upgrade savings using the RTF UES workbook for Commercial Secondary Glazing Systems (v3.0)[20]. For insulation measures in which sufficient participation is present and statistically significant measure savings are demonstrated, the Evaluators measured verified savings using a Pre/Post billing analysis. For the remaining insulation measures, the Evaluators verified savings using deemed insulation values from CNGC reference documents.

3.1.4.2 Preprocessing

The Evaluators conducted a number of preprocessing cleaning steps prior to performing the Pre/Post linear regression detailed in Section 2.2.4.2. First, billing data were subset to only include customers who installed insulation per the tracking data. Billing data were then split based on insulation type into four subcategories (attic, wall, roof, and floor). Regressions were conducted on each of these subgroups. The Evaluators tested regressions with all relevant interaction terms (e.g., the interaction between installing attic AND wall insulation) included. Separate regressions were run for each insulation type to determine the impact of independent variables on daily Therms per square foot of insulation installed.

[20] https://rtf.nwcouncil.org/measure/commercial-secondary-glazing-systems/

The regression model included the following independent variables: insulation R-value, HDD, the interaction between R-value and HDD, and a dummy variable controlling for the impact of COVID-19 effects. The coefficients estimated through these regressions were used to calculate verified savings via the methodology outlined in Section 2.2.4.2, Equation 2-2. The attic and roof regressions were statistically significant, while the floor and wall ones were not. As such, a deemed savings methodology was employed to calculate the savings associated with floor and wall insulation.

Window savings meanwhile were estimated using a deemed savings approach. Building type was estimated based on the tracking data the Evaluators received and savings were calculated based on the RTF UES measure workbook v5. The Evaluators summarize the measures considered for billing analysis in the table below.

Table 3-22: Measures Considered for Billing Analysis

Measure	Measure Considered for Billing Analysis	Number of Customers w/ Installations	Number of Measures	Sufficient Participation for Billing Analysis
Attic Insulation	✓	34	42	✓
Wall Insulation	✓	22	29	✓
Roof Insulation	✓	20	23	✓
Floor Insulation	✓	6	6	✓

The Evaluators provide further detail of analysis methodology in the sections below.

3.1.4.3 Analysis

The data preprocessing the Evaluators conducted for insulation is essentially identical to the preprocessing for space heating. Please reference the Preprocessing section above for details on daily HDD calculation and weather-normalization. In this section, the Evaluators provide an outline of the analysis process, which varies between insulation types.

The Evaluators ran a Pre/Post linear regression with weather-normalized average daily Therms per square foot as the dependent variable and insulation R-value, HDDs, the interaction between R-value and HDD (i.e., R-value:HDD), and a COVID-19 dummy variable (to control for the impact of the pandemic) as the independent variables. In addition, facility-specific fixed effects were included in each model in order to control for facility-specific behaviors demonstrated in the pre-period and post-period. The Evaluators tested a variety of model specifications to conduct a sensitivity analysis for each insulation measure.

The Evaluators determined that the increased precision of including R-value in each model led to an increased confidence in verified savings results. As such the Evaluators ran four individual regressions for each insulation type with R-value as the key independent variables and no interaction terms between different insulation types. Please find the generalized formula for each regression outlined below.

$$Therms = Rvalue + HDD + COVID + Rvalue * HDD \mid Facility$$

Where,

$Therms$ = Average daily Therms usage per square foot of insulation installed

$Rvalue$ = The difference between pre period R-value and post period R-value. In most cases the pre period R value was 0

$COVID$ = A binary variable tracking the COVID-19 pandemic. If a bill fell between 3/17/2020 and 3/22/2022 COVID equaled 1

$Facility$ = The building or facility at the reported address. This is a fixed effect in each model, allowing the regression to account for company-specific variation in energy usage

After running each regression, the Evaluators used a savings extrapolation method to calculate an estimate of the yearly impact of an increase in R-value of one on daily Therms per square foot of insulation installed.

Deemed savings approaches for both wall and floor insulation savings are outlined below. The Evaluators conducted research to identify savings per square foot values for both wall and roof insulation. The Regional Technical Forum does not demonstrate deemed savings values for the nonresidential sector, rather their Unit Energy Savings (UES) measure documents focus broadly on school and multi-family weatherization. Therefore, the Evaluators used CNGC estimates in verifying energy savings for these measures.

Floor insulation was associated with 0.06 Therms/SQFT installed, while wall insulation was associated with 0.278 and 0.305 Therms/SQFT for R-13 and a R-23 insulation respectively. For wall insulation, the Therms/SQFT value used was weighted based on the R-values reported in the tracking data.

Window savings were calculated in a similar manner to the deemed savings approach employed for floor and wall insulation. Window savings were determined based on the secondary glazing system measure in the RTF Commercial Secondary Glazing Systems workbook (v3.0)[21]. The building and business type data included in the CNGC tracking data were used to assign an RTF commercial building type to each customer. These commercial building types as well as the reported heating zones were used to assign deemed Therms/SQFT values to each project. These deemed values were multiplied by the square footage of windows installed yielding the following verified savings.

3.1.4.4 Findings

Using the methods defined in the sections above, the Evaluators summarizes the insulation measure billing analysis results in the table below.

[21] https://rtf.nwcouncil.org/measure/commercial-secondary-glazing-systems/

Table 3-23: Insulation Regression Linear Hypothesis Results

Insulation Type	Customer Count	Estimate (Therms Savings/SQFT Insulation/R-value Per Year)	Lower Estimate (Therms Savings/SQFT Insulation/R-value Per Year)	Upper Estimate (Therms Savings/SQFT Insulation/R-value Per Year)	P-value	Adjusted R-Squared
Attic	24	-0.00371	-0.00662	-0.000794	0.0126	0.573
Roof	13	-0.0223	-0.0422	-0.00240	0.0280	0.605

The attic and roof regressions were statistically significant, demonstrated by the p-value less than 0.05. Therefore, the Evaluators measured verified savings for these measures using the billing analysis results.

The floor and wall insulation regression results lacked statistical significance and therefore verified savings estimates were calculated using deemed savings values. Window savings were estimated using a deemed savings approach referencing the RTF UES measure workbook. The savings for each insulation measure based on both regressions and deemed savings approaches are outlined below in Table 3-24.

Table 3-24: Insulation Verified Savings

Envelope Measure Type	Ex Ante Natural Gas Savings (Therms)	Ex Post Natural Gas Savings (Therms)	Gross Realization Rate (%)	Verified Savings Methodology
Attic	72,263	33,635	46.5%	Regression
Floor	1,124	1,204	107.1%	CNGC deemed
Roof	112,377	235,322	209.4%	Regression
Wall	23,555	37,297	158.3%	CNGC deemed
Window	6,194	6,236	100.7%	RTF UES Workbook[22]

The realization rate for the attic and roof insulation measures differ from 100% realization due to savings demonstrated through billed consumption data. The regression results demonstrate the observed savings in consumption bills across PY2018 through PY2022 participants. It is not uncommon for billing data to demonstrate savings that differ largely from deemed savings. The Evaluators recommend that CNGC estimate expected savings for the attic and roof measures using the Therms/SQFT/R-value estimate detailed in Table 3-23.

The remaining measures were verified using deemed savings. The floor and wall insulations demonstrated realization rates close to or equaling 100%. However, the wall insulation measure demonstrated verified savings at 158% of the value of expected savings for the measure. The discrepancy between the expected savings and verified savings for wall insulation seems to be due to

[22] https://rtf.nwcouncil.org/measure/commercial-secondary-glazing-systems/

CNGC utilizing "Attic Knee Wall Insulation" values to calculate expected savings, rather than wall insulation values. This discrepancy led to higher than expected realization rates for the measure.

3.1.4.5 Conclusions and Recommendations

The Evaluators provide our overall conclusions and recommendations for the envelope channel in the table below.

Table 3-25: Envelope Recommendations

Equipment	Recommendations
All Envelope Measures	This evaluation methodology should be revisited as more customers participate in insulation programs. Higher participation allows for more robust estimation of savings through regression analyses.
Floor Insulation	Until higher participation allows for additional billing data analysis, the Evaluators recommend floor insulation measure savings are estimated through deemed savings values.
Wall Insulation	Until higher participation allows for additional billing data analysis, the Evaluators recommend wall insulation measure savings are estimated through deemed savings values.
Attic Insulation	The estimate presented in Table 3-23 can be reasonably used to calculate the savings associated with attic insulation (-0.00371 Therms per SQFT insulation per R-value). The estimate simply needs to be multiplied by -1, project-level delta R-value, and the square footage of insulation installed.
Roof Insulation	The estimate presented in Table 3-23 can be reasonably used to calculate the savings associated with attic insulation (-0.0223 Therms per SQFT insulation per R-value). The estimate simply needs to be multiplied by -1, project-level delta R-value, and the square footage of insulation installed.
Windows	Until higher participation allows for billing data analysis, the Evaluators recommend window measure savings are estimated through deemed savings values.

3.1.5 FOOD SERVICE

CNGC offers incentives for customers to install various food service measures, including fryers, ovens, steamers, griddles, and dishwashers. For commercial customers to receive a rebate, they must install measures that meet ENERGY STAR efficiency requirements, the CEE requirements, or the Food Service Technology Center requirements. The Evaluators conducted a thorough analysis of verified savings associated with these measures and developed a methodology for CNGC to utilize in future savings estimates. The following subsections present the Evaluators' methodology and findings as well as key recommendations based on the analyses.

3.1.5.1 Overview

An outline of incentive totals and expected savings by year is outlined below.

Table 3-26: Food Service Channel Savings by Year

Program Year	Projects	Incentive	Expected Savings (Therms)
2018	20	$65,878	24,962
2019	31	$47,337	21,574
2020	20	$29,750	21,351
2021	41	$62,093	44,695
2022	20	$41,950	12,884
Total	**132**	**$247,008**	**125,466**

For the 2019-2022 program period, the CNGC program provided incentives for:

- Fryers
- Convection ovens
- Conveyor ovens
- Rack ovens
- Steamers
- Griddles
- Dishwashers

The Evaluators present the participation rate as well as savings contributions towards the 2018 through 2022 program years for each of the measures listed above.

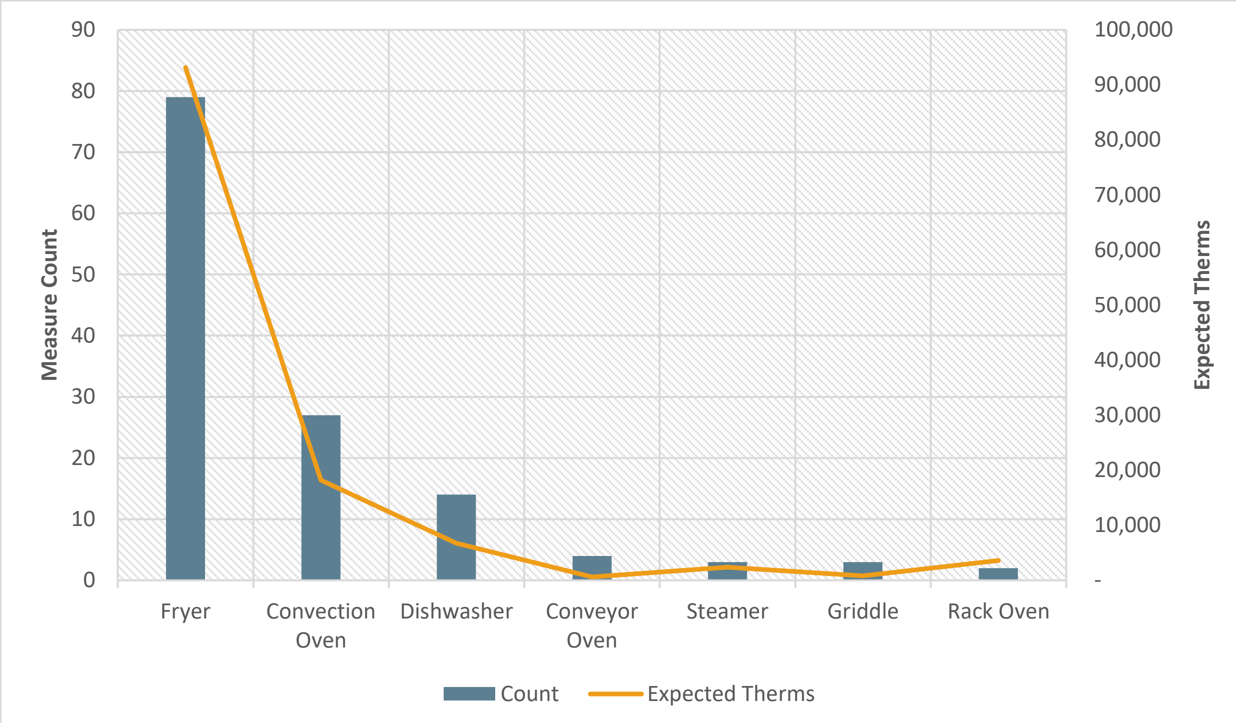

Figure 3-5: Food Service Participation Summary

3.1.5.2 Analysis

The Evaluators' impact evaluation approach is to characterize savings across each unique model rebated in the program. Energy savings from food service equipment are in general calculated using the lowest efficiency required to qualify. By taking an equipment-specific approach, the savings estimates align more accurately with equipment-specific parameters as tested by ENERGY STAR, CEE, or FSTC. In this analysis, the Evaluators reviewed, but did not revise hours of use assumptions by facility type.

3.1.5.3 Determining Eligibility Under New Code Requirements

As part of this study, the Evaluators reviewed the landscape of food service equipment to determine the following:

1) What models of equipment covered under applicable State of Washington codes and standards[23] have high enough efficiency ratings to still yield energy savings?
2) What classes of equipment are not covered under the new code but have tested and reliable energy saving?

[23] https://app.leg.wa.gov/rcw/default.aspx?cite=19.260.040

3.1.5.3.1 Fryers

Fryers have had efficiency standards affected by code updates, requiring that fryers at a minimum meet efficiency levels specified in Energy Star 2.2[24]. The affected updates are summarized in Table 3-27 below.

Table 3-27: Fryer Standards Updates

Equipment Class	Parameter	Pre-2022 Code Requirement	New Code Requirement
Standard Sized	Preheat BTU	16,000	15,500
	Idle BTU	14,000	9,000
	Cooking Efficiency	35%	50%
Large Vat	Preheat BTU	21,000	16,500
	Idle BTU	16,000	12,000
	Cooking Efficiency	35%	50%

3.1.5.3.1.1 Summary of Code Impacts on Rebated Units

Figure 3-6 below summarizes the impact of the updated code on fryer savings. Overall, the code reduced unit energy savings by 81% (based on a weighted average by measure).

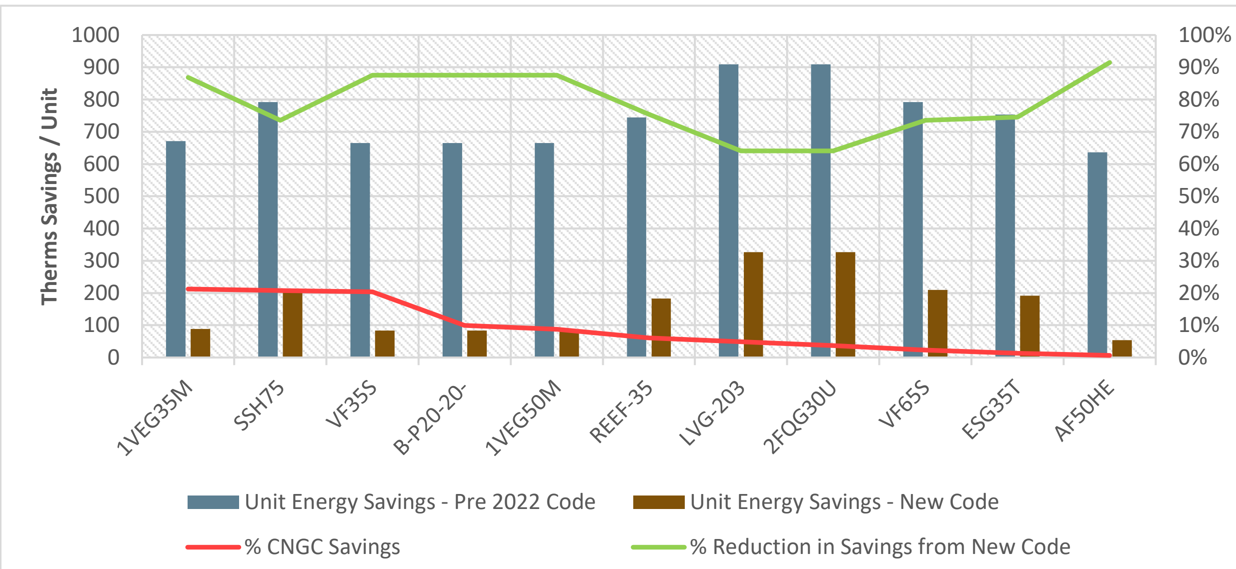

Figure 3-6: Code Impact by Fryer Model

Figure 3-7 summarizes the impact of codes on equipment rebates in the program in terms of contribution to savings by equipment component. For both standard and large vat fryers, idle BTU rate increases in prevalence in terms of contribution to unit energy savings. The code update had a more significant impact on the savings potential from increased cooking efficiency.

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24 https://www.energystar.gov/ia/partners/prod_development/revisions/downloads/commercial_fryers/Final_Draft_V2.0_Furnace_Spec.pdf

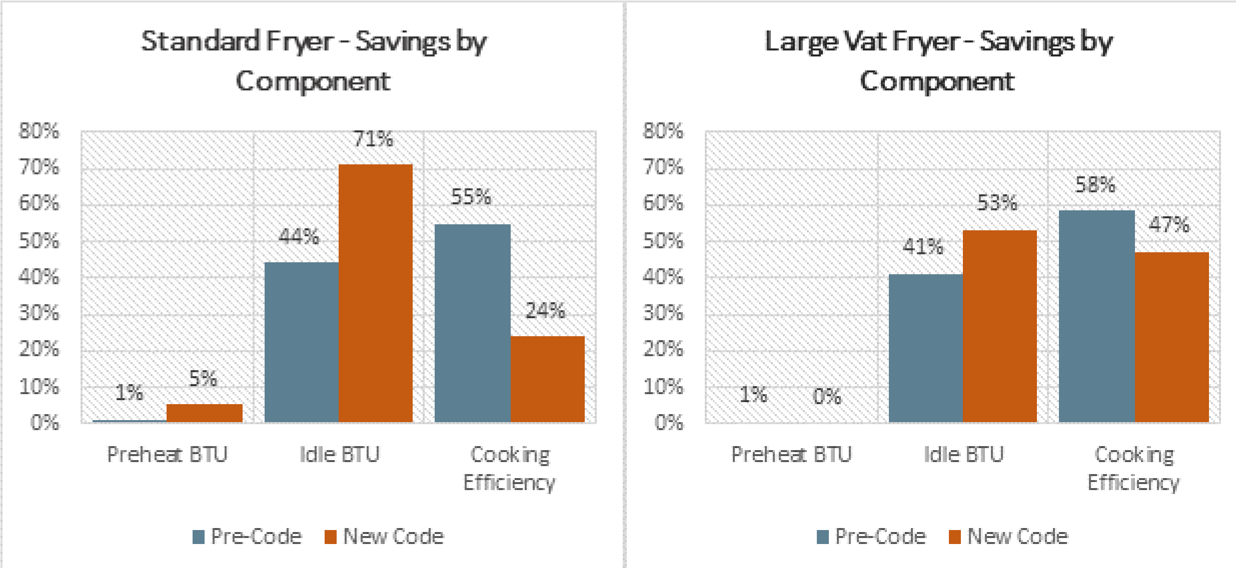


Figure 3-7: Contribution to Savings by Equipment Component – Fryers Pre- and Post-Code Change

3.1.5.3.1.2 Availability of Qualifying Equipment

The Evaluators reviewed the performance criteria of 52 standard size fryers and 28 large vat fryers (excluding models that are multiple-vat versions of the same core performance criteria). Savings were calculated assuming 12 hours a day of operation.

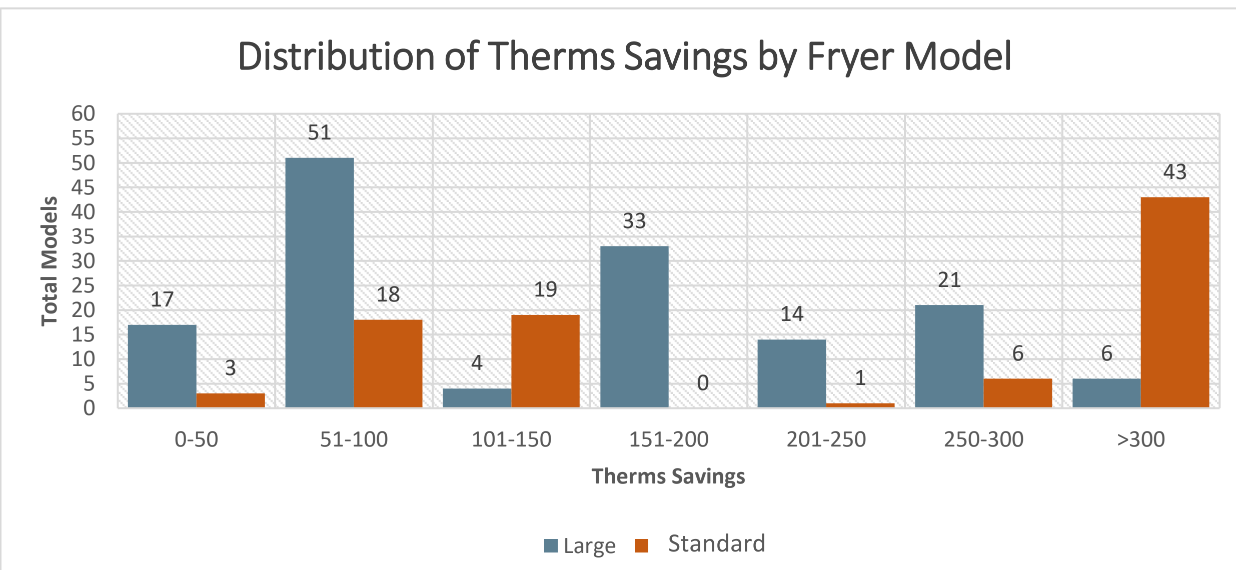
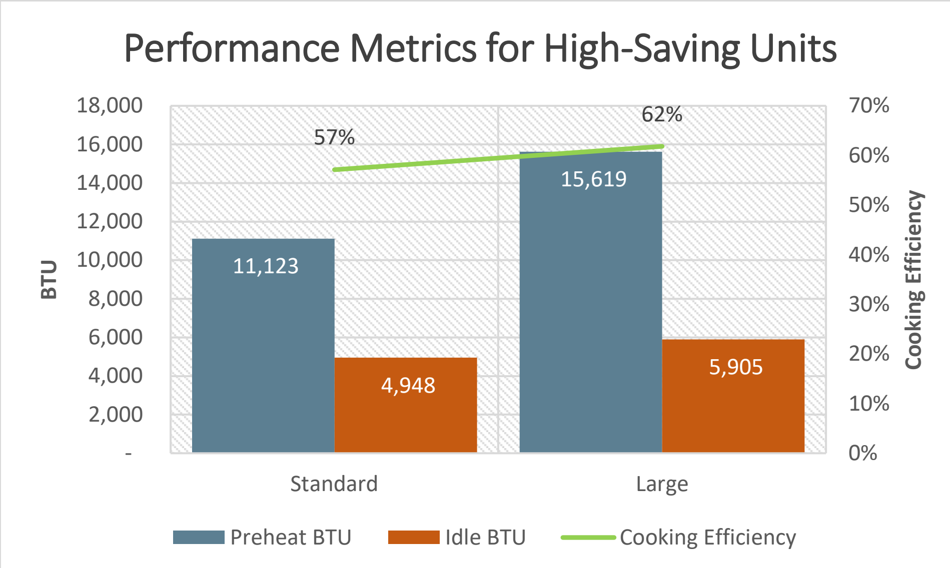


Figure 3-8: Distribution of Therms Savings by Fryer Model

The Evaluators then focused on models with at least 150 Therms under these hours of use parameters, summarized in Figure 3-9. This figure also provides example program criteria that would produce this level of savings. To simplify potential for program implementation, product criteria were established assuming no preheat BTU savings. Preheat BTU contributes less than 1% to unit energy savings, and implementation would be simpler with fewer product criteria to meet.



Example program requirements for 150 Therms per unit:

Standard Vat:

- <6,000 Idle BTU
- >55% Cooking eff.

Large Vat:

- <9,500 Idle btu
- >55% Cooking eff.

Figure 3-9: Performance Characteristics of High-Saving Units

In total, the product list that saves at least 150 Therms per unit comprises:

- 11 manufacturers
  - Three brands account for 63% of the list (Frymaster, Ultrafryer Systems, and Vulcan)
  - The brand with the greatest volume of past participation has no models in the list (Pitco)
- 43 total models
  - 25 standard vat
  - 18 large vat

3.1.5.3.1.3 Verified Savings for Study Period - Fryers

The Evaluators provide the verified savings for dryers in the table below.

Table 3-28: Fryer Realized Savings

Equipment Class	Expected Therms	Realized Therms	Realization Rate
Standard Sized	76,658	60,591	79.0%
Large Vat	25,052	22,561	90.1%
Total	**101,710**	**83,152**	**81.8%**

3.1.5.3.2 Convection Ovens

The program provided rebates for 30 convection ovens for 27 projects. Convection ovens are required to meet Energy Star 2.2 criteria[25]. This is summarized in Table 3-29 below.

Table 3-29: Convection Oven Standards Updates

25 https://www.energystar.gov/sites/default/files/asset/document/Commercial%20Ovens%20Final%20Version%202.2%20Specification.pdf

Parameter	Pre-2022 Code Requirement	New Code Requirement
Preheat BTU	19,000	12,500
Idle BTU	15,100	12,000
Cooking Efficiency	44%	46%

The Evaluators found that most units rebated were only minimally meeting program requirements, and as a result the impact of the new code on convection oven savings was significant.

Table 3-30: Convection Oven Code Impacts

Descriptor	Therms
Ex Ante	18,180
Verified Therms – Old Code	13,319
Verified Therms – New Code	601
Realization Rate for Study Period	73.6%
% Savings Lost in from Code Change	95.5%

The Evaluators found that many convection ovens had low realization rates due to a number of assumptions. The Evaluators provide more details in the subsections below.

3.1.5.3.2.1 Single vs. Double Ovens

The Evaluators found that savings were identical for both single and double oven models. Double ovens contributed to 37% of the models rebates in the program. Savings were calculated for these models as if they were two distinct ovens. The Evaluators conclude that double oven models should receive incentives on a per-cavity basis, as this aligns with the volume of energy use from the same customer installing two single-cavity ovens.

3.1.5.3.2.2 New Measure Eligibility

For units in the program, 88% of all verified Therms stem from improved idle rate, while 9% result from improved cooking efficiency. The Evaluators screened ovens that produce at least 100 Therms savings under an assumed 12 hours a day of operation and identified 20 qualifying models (most of which also have double-oven versions). Within this group, 89% of all savings were from idle BTU improvements. From this, the Evaluators conclude that CNGC could consider a program option for convection ovens in which preheat BTU and cooking efficiency meet minimum code requirements, as long as idle BTU is no greater than 9,000 BTU. 83% of all listed ovens that meet this idle BTU requirement also have cooking efficiencies greater than 50%, which would marginally increase savings as well.

3.1.5.3.3 Conveyor Ovens

The program provided rebates for eight conveyor ovens. Ovens were deemed at 77 Therms per unit.

Table 3-31: Convection Oven Standards Updates

Parameter	Minimum Standard	Average Program Model	Average Model on FSTC List
Preheat BTU	35,000	18,378	22,410
Idle BTU	57,000	39,694	40,270
Cooking Efficiency	42.0%	43.5%	46.1%

This measure was not addressed in the code update, and revisions to this measure. As seen in Table 3-32 below, conveyor ovens had 941% gross realization.

Table 3-32: Conveyor Realized Savings

Expected Therms	Realized Therms	Realization Rate
616	5,796	941%

The Evaluators cannot discern the cause of this broad discrepancy in savings. It is possible that conveyor oven savings estimates were calculated by comparing them against another equipment's code requirements (such as a convection oven).

3.1.5.3.3.1 Conveyor Oven Recommendations

As conveyor ovens are not addressed in new code updates, they can remain in the program without changes in eligibility. However, deemed savings should be revised to align with the average values found in the FSTC product list. This would mean assumed values of:

- 22,410 Preheat BTU
- 40,270 Idle BTU
- 46.1% Cooking efficiency
- 692 Therms savings

3.1.5.3.4 Rack Ovens

The program provided rebates for two double ovens. Ovens were deemed at 1,806 Therms per unit.

Table 3-33: Rack Oven Standards Updates

Descriptor	Therms
Ex Ante	3,612
Verified Therms – Old Code	5,072
Verified Therms – New Code	393
Realization Rate for Study Period	140.4%
Percent Savings Lost Due to Code Change	92.2%

3.1.5.3.4.1 New Measure Eligibility

Rack ovens are generally low-volume measures – their use case for bulk batch-baking limits their applicability in most food service facilities. Rack ovens are now required to meet Energy Star 2.2 performance levels. With this, more than 50% of their savings potential is from cooking efficiency gains (compared to convection ovens, where 92% of savings potential is from improved idle rate). As a result, the Evaluators conclude that this measure is unlikely to be cost-effective when targeting premium efficiency equipment. If it is to be included, the Evaluators recommend that rack ovens include criteria for both idle rate and cooking efficiency:

- Cooking efficiency > 55%
- Idle BTU rate < 20,000 for single rack, < 25,000 for double rack
- Savings of:
    - Single Rack: 283 Therms
    - Double Rack: 277 Therms

All single-rack ovens and five of the eight double rack ovens in the FSTC list qualify under these criteria.

3.1.5.3.4.2 Other Measures

The Evaluators reviewed the unit energy savings from griddles, dishwashers, and steamers, and found no basis for revision of savings.

3.1.5.3.5 New FSTC Measures

The Evaluators found that the FSTC has certified two classes of equipment that have not been included in the program and are not addressed by current codes and standards:

- Conveyor Broilers
- Underfire Broilers

3.1.5.3.5.1 Conveyor Broilers

Baseline and efficiency standards are provided in Table 3-34. This measure does not have a test requirement value for pre-heat BTU; savings are derived from idle BTU and cooking efficiency improvements.

Table 3-34: Conveyor Broiler Efficiency Requirements

Parameter	Baseline	Efficient
Idle BTU	< 20”: 40,000 ≥ 20” and ≤ 26”:60,000 > 26: 70,000	<20”: < 30,000 ≥ 20” and ≤ 26”: < 55,000 >26: < 68,000:
Cooking Efficiency	25%	35%

The average unit energy savings by size category for this measure is:

- < 20”: 656 Therms
- ≥ 20” and ≤ 26”: 553 Therms
- > 26”: 556 Therms

3.1.5.3.5.2 Underfire Broilers

Underfire broilers have savings calculated based solely on cooking energy consumption. Broilers are assumed to be under constant operation, with energy use unaffected by the volume of food cooked. Efficiency ratings for underfire broilers are on a per-linear foot basis.

Table 3-35: Underfire Broiler Efficiency Requirements

Parameter	Baseline	Efficient
Cooking BTU per Linear Foot	25,000	<20,000

Based on the average performance from the product list, unit energy savings for this measure are:

- Infrared Burner: 230 Therms per linear foot
- Power Burner: 418 Therms per linear foot

3.1.5.4 Findings

The table below summarizes program-level realization rates for the study period.

Table 3-36: Food Service Realized Savings

Equipment Class	Expected Therms	Realized Therms	Realization Rate
Fryers	101,710	83,152	81.8%
Convection Ovens	18,180	13,319	72.3%
Conveyor Ovens	616	5,796	941.0%
Rack Ovens	3,612	5,072	140.4%
Dishwashers	6,720	6,720	100.0%
Griddles	819	819	100.0%
Steamers	2,365	2,365	100.0%
Total	**134,022**	**117,243**	**87.5%**

All food service measures met or exceeded CNGC expected savings except the fryers and the convection ovens. For the total food service channel, the overall realization rate is 88%, demonstrating 117,243 Therms verified savings.

3.1.5.5 Conclusions and Recommendations

The Evaluators provide our overall conclusions and recommendations for the food service channel in the table below.

Table 3-37: Food Service Recommendations

Equipment	Recommendations
Fryers	1. Reincorporate fryers into the program, using a pre-defined "premium efficiency" list. This will require specific tailoring to ensure that eligible units can provide energy savings. Suggested requirements: • Standard Vat: <6,000 idle BTU, > 55% cooking efficiency • Large Vat: <9,500 idle BTU, > 55% cooking efficiency 2. Ensure that savings calculations capture the number of vats when calculating savings for multi-vat fryers. The same base equipment can range from 1-5 vats, with a slight change in model number. Energy Star and FSTC performance tests denominate on a per-vat basis, and this scale could be lost. Incentives should also align with the number of vats, rather than the number of systems installed.
Convection Ovens	2. Reincorporate convection ovens into the program, using a pre-defined "premium efficiency" list. This will require specific tailoring to ensure that eligible units can provide energy savings. Suggested requirements: • <9,000 idle BTU 3. Ensure that savings calculations capture the number of oven cavities when calculating savings for double ovens. The same base equipment can be a single or double oven. Energy Star and FSTC performance tests denominate on a per-cavity, and this scale could be lost. Incentives should also align with the number of cavities, rather than the number of systems installed.
Conveyor Ovens	1. Incentivize conveyor ovens in the program using the last known Energy Star standard. This system type is not included in the new standards. However, conveyor ovens are still the common practice in pizza restaurants. 2. Revisit technical assumptions to identify needed areas for updates. The Evaluators found 940% realization for this measure. The typical performance standard for this equipment as-tested by the FSTC is: • Preheat: 22,410 BTU • Idle: 40,270 BTU • Cooking Efficiency: 46.1% • 692 average Therms
Rack Ovens	This measure is unlikely to be cost-effective under the new code requirements. Further, this measure has limited applicability and participation. The Evaluators recommend deprioritizing review of this measure over higher-volume measures such as fryers and convection ovens.

Equipment	Recommendations
New Measures	1. Develop rebates for conveyor broilers and underfire broilers. Characterize measures as follows: • Underfire: savings/rebate per linear foot, delineating between infrared and power burners • Conveyor: Single incentive, applicable to all three size categories (< 20”, 20”-26”, >26”)

3.2 Process Evaluation Results – Participant Survey

The Evaluators conducted a brief survey asking respondents to report on their program awareness, experience, and satisfaction, as well as assess the impacts COVID-19 shelter-in-place orders had on their business practices between 2019-2022.

The survey was administered via email in May 2023. 286 customers received an initial outreach email; two reminder emails were sent out to customers. In total, 55 respondents completed the survey with a response rate of 19%. Of the 55 respondents, 44 remembered receiving energy efficient equipment upgrades from CNGC and were able to speak about their experience of the program (Table 3-38).

Table 3-38: Survey Respondents

Description	n
Initial recruitment email	286
Responses	55
Completes	44
Response Rate	19.2%

3.2.1 PROGRAM SATISFACTION

Respondents learned about the program through a variety of avenues including contractor recommendation (38%, n=17), CNGC representative (27%, n=12), and a bill insert (18%, n=8). All but one respondent indicated they would recommend the Commercial Efficiency program to others (98%, n=43) and half noted they planned to start another energy efficiency improvement project in the next year (Figure 3-10).

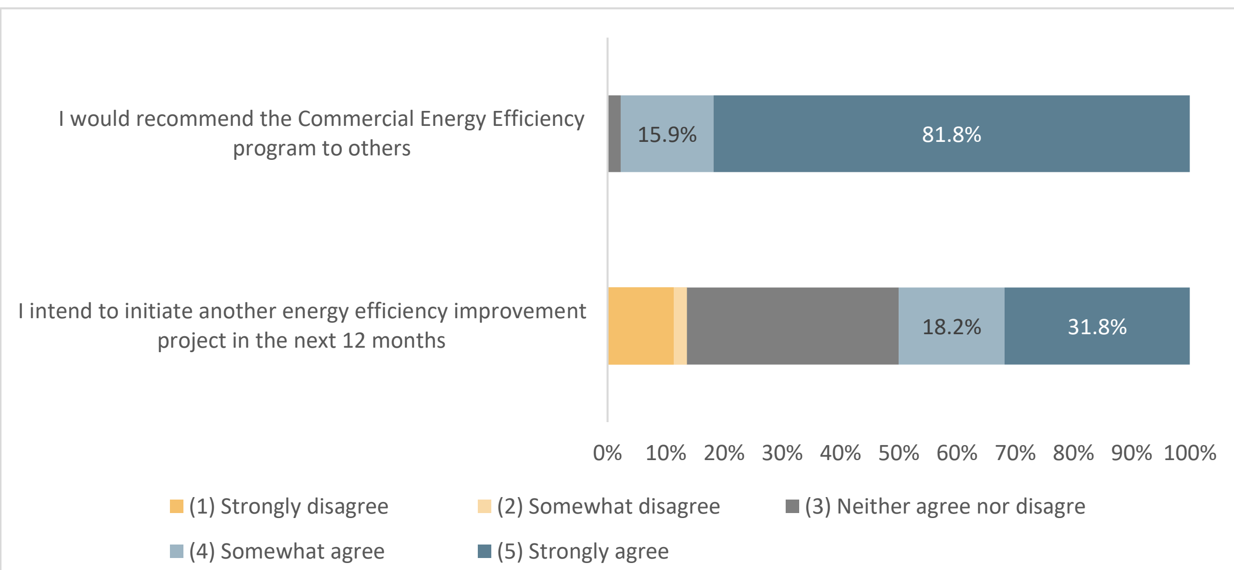


Figure 3-10: Program Participation (n=44)

Respondents were generally satisfied with the program and measures received (Figure 3-11). Most respondents were satisfied with the program overall (93%, n=41) as well as CNGC as their natural gas provider (96%, n=42). Among the two respondents who expressed some dissatisfaction, both indicated their rebate was lower than expected.

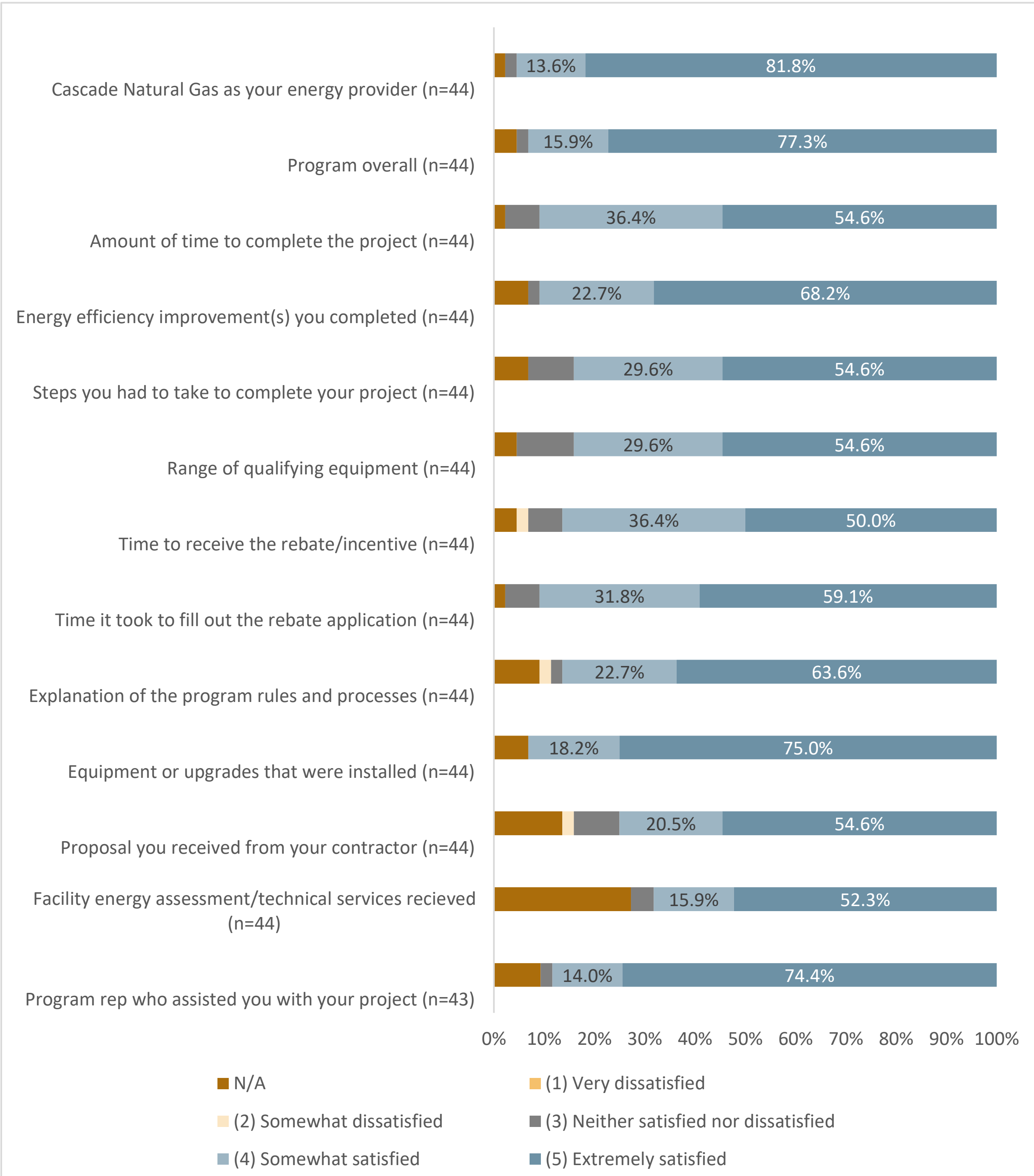


Figure 3-11: Program Satisfaction (n varies)

3.2.2 COVID-19 IMPACTS

Just over three-quarters of respondents noted that their business experienced some disruptions due to the COVID-19 pandemic (77%, n=34). Among these respondents, the most frequent disruptions were those related to inflation and supply chain delays (Figure 3-12).

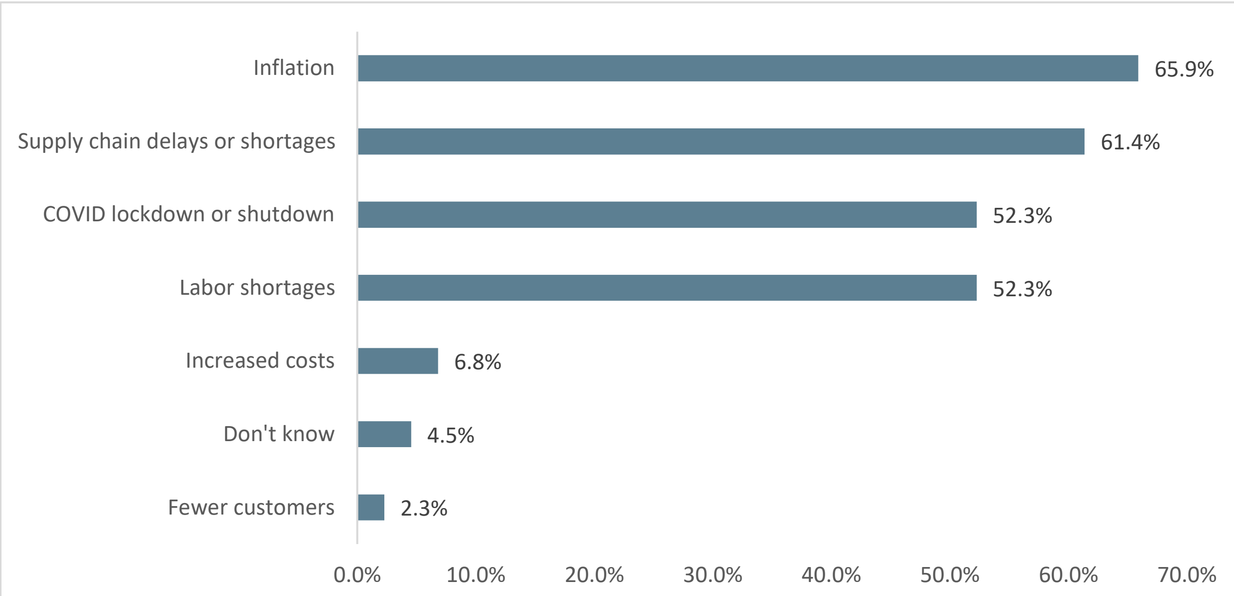


Figure 3-12: COVID-19 Disruptions (n=44)

The majority of respondents (91%, n=40) began observing the effects of COVID-19 by April 2020 and just under one-third are still experiencing the impact of the pandemic on their business (30%, n=13). Among the approximately three-quarters of respondents who answered a question related to COVID-aid (73%, n=32), just over half of reported receiving COVID-19 related aid (53.1%, n=17).

3.2.3 FIRMOGRAPHICS

Three quarters of respondents represented businesses that owned the facility where the upgrades were made (76%, n=32). Respondents represented a wide range of business types including office buildings, restaurants, and schools (Figure 3-13).

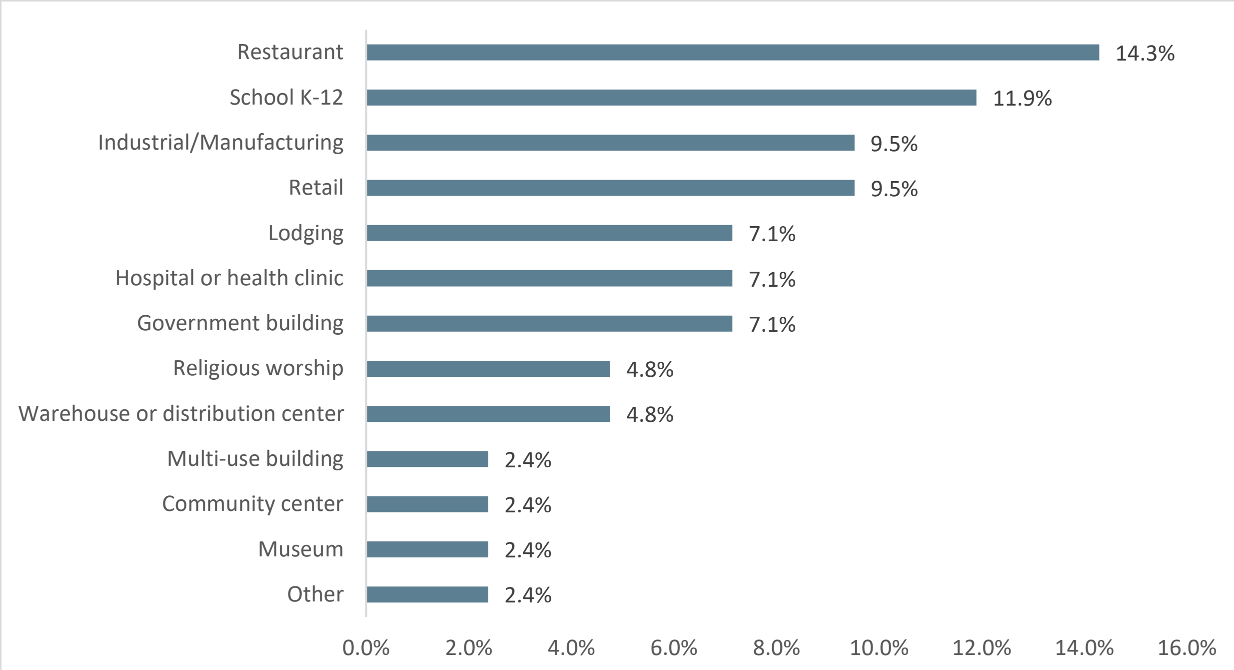


Figure 3-13: Business Type (n=42)

The square footage of represented facilities ranged from 900-215,000ft^2, with a median square footage of 4,000ft^2. Most respondents heat their facility using natural gas (88%, n=37). The businesses represented employed between one to 100 full-time equivalent employees; the median number of full-time employee equivalents was 6.5. About half of the business operated for 41-80 hours (46%, n=19) (Table 3-39).

Table 3-39: Operating Hours (n=41)

Number of Hours	Percent
Less than 10 hours	0.0%
10-20 hours	2.4%
21-30 hours	2.4%
31-40 hours	9.8%
41-50 hours	17.1%
51-60 hours	12.2%
61-80 hours	17.1%
81-120 hours	14.6%
More than 120 hours	19.5%
Don't know	4.9%

4 APPENDIX A: PARTICIPANT SURVEY INSTRUMENT AND TABULATIONS

4.1 Survey Instrument

CNGC_Year1

Start of Block: Introduction

Q24 Welcome! Thank you for taking this survey to tell us about your experience with Cascade Natural Gas Corporation. Your feedback is very important to us and will help us improve programs for customers like you. This survey should take no more than 5 minutes. Your responses are confidential and will be used for research purposes only.

End of Block: Introduction

Start of Block: Screening

Q1 Program records indicate that your business, **${e://Field/BUSINESS}**, completed a **${e://Field/PROJECT_DESC}** upgrade through Cascade Natural Gas' Commercial Energy Efficiency Program at **${e://Field/ADDRESS}**. Is this correct?

- Yes (1)
- Yes, but this information is incorrect (2)
- No (3)

Skip To: End of Survey If Program records indicate that your business, ${e://Field/BUSINESS}, completed a ... = No

Display This Question:

If Program records indicate that your business, ${e://Field/BUSINESS}, completed a ... = Yes, but this information is incorrect

Q2 What do you believe should be corrected in these records?

____

Q3 How did you first learn about Cascade's Energy Efficiency Programs?

- Bill insert / mailer (1)
- Email from CNGC (2)
- Social media advertisement (3)
- My contractor that installed the ${e://Field/PROJECT_DESC} (4)
- Friends, relatives, or colleagues (5)
- Cascade representative (6)
- Don't know (7)

End of Block: Screening

Start of Block: Satisfaction

Q4 Using a scale of 1 through 5 where 1 means “very dissatisfied” and 5 means “very satisfied”, how satisfied are you with each of the following statements:

	(1) Very dissatisfied (1)	(2) Somewhat dissatisfied (2)	(3) Neither satisfied nor dissatisfied (3)	(4) Somewhat satisfied (4)	(5) Extremely satisfied (5)
The program representative who assisted you with your project (1)	■	■	■	■	■
The facility energy assessment or other technical services received from the program staff person (2)	■	■	■	■	■
The proposal you received from your contractor (3)	■	■	■	■	■
The equipment or upgrades that were installed (4)	■	■	■	■	■
The explanation of the program rules and processes (5)	■	■	■	■	■
The time it took to fill out the rebate application (6)	■	■	■	■	■

The amount of time it took to receive the rebate or incentive after the completed application was submitted (7)	▪	▪	▪	▪	▪
The range of qualifying equipment (8)	▪	▪	▪	▪	▪
The steps you had to take to complete your project (9)	▪	▪	▪	▪	▪
The energy efficiency improvement(s) you completed (10)	▪	▪	▪	▪	▪
The amount of time to complete the project (11)	▪	▪	▪	▪	▪
The program overall (12)	▪	▪	▪	▪	▪
Cascade Natural Gas as your energy provider (13)	▪	▪	▪	▪	▪

Display This Question:

If Using a scale of 1 through 5 where 1 means “very dissatisfied” and 5 means “very satisfied”, how... = (1) Very dissatisfied

Or Using a scale of 1 through 5 where 1 means “very dissatisfied” and 5 means “very satisfied”, how... = (2) Somewhat dissatisfied

Q5 You indicated some dissatisfaction, why were you dissatisfied?

____

____

____

____

____

Q6 On a scale of 1 through 5, with “1” being strongly disagree and “5” being strongly agree, please rate how much you agree or disagree with the following statements:

	(1) Strongly disagree (1)	(2) Somewhat disagree (2)	(3) Neither agree nor disagree (3)	(4) Somewhat agree (4)	(5) Strongly agree (5)
I intend to initiate another energy efficiency improvement project in the next 12 months (1)	■	■	■	■	■
I would recommend the Commercial Energy Efficiency program to others (2)	■	■	■	■	■

End of Block: Satisfaction

Start of Block: COVID-19

Q7 Did your business experience any impacts related to the COVID-19 pandemic?

- ■ Yes (1)
- ■ No (2)
- ■ Don't know (3)

Display This Question:

If Did your business experience any impacts related to the COVID-19 pandemic? = Yes

Q8 Did your business experience any of the following? (select all that apply)

- Supply chain delays or shortages (1)
- Inflation (2)
- Labor shortages (3)
- COVID lockdown or shutdown (4)
- Other – please describe (5) ____
- Don’t know (6)

Display This Question:

If Did your business experience any impacts related to the COVID-19 pandemic? = Yes

Q9 For what period of time did your business have COVID-related impacts:

- Start (mm/dd/yyyy format. Enter "01" for the first month if you do not know exact date) (1) ____
- End (mm/dd/yyyy format. Enter "01" for the last month if you do not know exact date. Enter today's date if still ongoing). (2) ____

Display This Question:

If Did your business experience any of the following? (select all that apply) = Inflation

Or Did your business experience any of the following? (select all that apply) = Labor shortages

Q10 Did your business receive any COVID-related aid?

- Yes (1)
- No (2)
- Don't know (3)

End of Block: COVID-19

Start of Block: Firmographics

Q11 Does your company rent, own and occupy, or own and rent the facility to someone else at this location?

- Rent (1)
- Own and occupy (2)
- Own and rent to someone else (3)
- Don't know (4)

Q12 What type of building is the facility where your organization completed the projects?

- Industrial/Manufacturing (1)
- Agricultural (2)
- Warehouse or distribution center (3)
- College (4)
- School K-12 (5)
- Government building (6)
- Restaurant (7)
- Grocery (8)
- Hospital or health clinic (9)
- Office building (10)
- Lodging (11)
- Religious worship (12)
- Retail (13)
- Parking garage (14)
- Vacant lot (15)
- Other – please describe (16) ____
- Don't know (17)

Q13 What is the approximate conditioned square footage of this facility?

____

Q14 What is the main fuel used for heating this facility?

- Natural gas (1)
- Electricity (2)
- Propane (3)
- Don't heat the building (4)
- Other – please describe (5) ____
- Don't know (6)
- Prefer not to answer (7)

Display This Question:

If PROJECT_DESC = high efficiency boiler

Q15 Which of the following is your boiler used for? (select all that apply)

- Space heating (1)
- Water Heating (2)
- A manufacturing process (3)
- Other – please describe (4) ____
- Don't know (5)

Display This Question:

If PROJECT_DESC = high efficiency boiler

Q16 What was the condition of the boiler you replaced?

- Previous boiler was broken (1)
- Previous boiler was working (2)
- There was no previous boiler, this was a new construction project (3)

Q17 How many full-time equivalent employees work at this facility?

____

Q18 How many hours per week is your facility operating?

- Less than 10 hours (1)
- 10 – 20 hours (2)
- 21 – 30 hours (3)
- 31 – 40 hours (4)
- 41 – 50 hours (5)
- 51 – 60 hours (6)
- 61 – 80 hours (7)
- 81 – 120 hours (8)
- More than 120 hours (9)
- Don't know (10)

End of Block: Firmographics

Start of Block: Block 4

Q19 Thank you for participating in our survey. Please specify the email address where you would like to receive your gift card:

____

Q21 Did You Know? You may now register for CNGC's Online Account Services to enroll in automatic payments, view your latest statements, manage multiple accounts, and visualize the historical energy usage of your business. Log in to www.cngc.com to register and learn more!

End of Block: Block 4

4.2 Survey Tabulations

Table 4-1: Program Awareness Source

Source	%	n
My contractor that installed the ${e://Field/PROJECT_DESC}	38.6%	17
Cascade representative	27.3%	12
Bill insert / mailer	18.2%	8
Friends, relatives, or colleagues	4.6%	2
Email from CNGC	2.3%	1
Social media advertisement	0.0%	0
Don't know	9.1%	4
Total	**100.0%**	**44**

Table 4-2: Program Satisfaction

Question	(1) Very dissatisfied		(2) Somewhat dissatisfied		(3) Neither satisfied nor dissatisfied		(4) Somewhat satisfied		(5) Extremely satisfied		N/A	
Program representative who assisted you with your project (n=43)	0.0%	0	0.0%	0	2.3%	1	14.0%	6	74.4%	32	9.3%	4
Facility energy assessment or other technical services received from the program staff person (n=44)	0.0%	0	0.0%	0	4.6%	2	15.9%	7	52.3%	23	27.3%	12
Proposal you received from your contractor (n=44)	0.0%	0	2.3%	1	9.1%	4	20.5%	9	54.6%	24	13.6%	6
Equipment or upgrades that were installed (n=44)	0.0%	0	0.0%	0	0.0%	0	18.2%	8	75.0%	33	6.8%	3
Explanation of the program rules and processes (n=44)	0.0%	0	2.3%	1	2.3%	1	22.7%	10	63.6%	28	9.1%	4
Time it took to fill out the rebate application (n=44)	0.0%	0	0.0%	0	6.8%	3	31.8%	14	59.1%	26	2.3%	1
Amount of time it took to receive the rebate or incentive after the completed application was submitted (n=44)	0.0%	0	2.3%	1	6.8%	3	36.4%	16	50.0%	22	4.6%	2
Range of qualifying equipment (n=44)	0.0%	0	0.0%	0	11.4%	5	29.6%	13	54.6%	24	4.6%	2
Steps you had to take to complete your project (n=44)	0.0%	0	0.0%	0	9.1%	4	29.6%	13	54.6%	24	6.8%	3
Energy efficiency improvement(s) you completed (n=44)	0.0%	0	0.0%	0	2.3%	1	22.7%	10	68.2%	30	6.8%	3
Amount of time to complete the project (n=44)	0.0%	0	0.0%	0	6.8%	3	36.4%	16	54.6%	24	2.3%	1
Program overall (n=44)	0.0%	0	0.0%	0	2.3%	1	15.9%	7	77.3%	34	4.6%	2
Cascade Natural Gas as your energy provider (n=44)	0.0%	0	0.0%	0	2.3%	1	13.6%	6	81.8%	36	2.3%	1

Table 4-3: Future with Program (n=44)

Question	(1) Strongly disagree		(2) Somewhat disagree		(3) Neither agree nor disagree		(4) Somewhat agree		(5) Strongly agree	
I intend to initiate another energy efficiency improvement project in the next 12 months	11.4%	5	2.3%	1	36.4%	16	18.2%	8	31.8%	14
I would recommend the Commercial Energy Efficiency program to others	0.0%	0	0.0%	0	2.3%	1	15.9%	7	81.8%	36

Table 4-4: COVID-19 Disruptions

	Percent	n

Impacts (n=44)		
Inflation	6.9%	29
Supply chain delays or shortages	61.4%	27
Labor shortages	52.3%	23
COVID lockdown or shutdown	52.3%	23
Increased costs	6.8%	3
Don't know	4.5%	2
Fewer customers	2.3%	1
Time Range		
Start	01/01/2019-01/01/2022	
End	04/30/2020-Present	
Received COVID related aid (n=32)		
Yes	53.1%	17
No	25.0%	8
Don’t know	21.9%	7

Table 4-5: Firmographics

Description	Percent	n
Facility Ownership (n=42)		
Rent	11.9%	5
Own and occupy	59.5%	25
Own and rent to someone else	16.7%	7
Don't know	11.9%	5
Rent	11.9%	5
Business Type (n=42)		
Restaurant	14.3%	6
Office building	14.3%	6
School K-12	11.9%	5
Retail	9.5%	4
Industrial/Manufacturing	9.5%	4
Government building	7.1%	3
Hospital or health clinic	7.1%	3
Lodging	7.1%	3
Warehouse or distribution center	4.8%	2
Religious worship	4.8%	2
Other	2.4%	1
Museum	2.4%	1
Community center	2.4%	1
Multi-use building	2.4%	1
Conditioned Square Footage (n=33)		
Range	900-215,000ft^2	
Heating Fuel (n=42)		
Natural gas	88.1%	37
Electricity	4.8%	2

Mixed	4.8%	2
Full Time Employee Equivalents (n=36)		
Range		1-100 FTE
Operating Hours Per Week (n=41)		
Less than 10 hours	0.0%	0
10-20 hours	2.4%	1
21-30 hours	2.4%	1
31-40 hours	9.8%	4
41-50 hours	17.1%	7
51-60 hours	12.2%	5
61-80 hours	17.1%	7
81-120 hours	14.6%	6
More than 120 hours	19.5%	8
Don't know	4.9%	2