



Home Energy Efficiency Rebates Program Impact Evaluation Report

Energy Efficiency Plan: Plan Year 6 (PY6)
(6/1/2016-12/31/2017)

Presented to
Nicor Gas Company

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1. INTRODUCTION

This report presents the results of the impact evaluation of the Nicor Gas PY6 Home Energy Efficiency Rebates program. It presents a summary of the energy impacts for the total program and broken out by relevant measure and program structure details. The appendix presents the impact analysis methodology. PY6 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

The Nicor Gas Home Energy Efficiency Rebate Program provides Nicor Gas customers with rebate incentives for purchasing high-efficiency furnaces, programmable thermostats, smart thermostats, and other energy efficient measures. Participants may apply for the rebates themselves, or contractors may assist them in the rebate application process. Rebates are processed and submitted to residential customers after installation of qualified measures.

The program had 47,960 participants in PY6 and completed 52,438 projects as shown in the following table.

Table 2-1. PY6 Volumetric Summary

Participation	PY6
Participants †	47,960
Installed Projects ‡	52,438
Installed Measures	62,781
Installed Measures/Project	1.2

Source: Nicor Gas tracking data and Navigant team analysis.

† Participants are defined as unique site addresses

‡ Installed Projects are defined as unique VendorProject_ID

Table 2-2 summarizes the installed measure quantities that are the basis for verified energy savings.

Table 2-2. PY6 Installed Measure Quantities

Measure	Unit of Quantity	Installed Quantity
Boilers, >95% AFUE <300 MBH	Unit	218
BUNDLE #1 - 95% Furnace, WH, Tstat	Bundle	228
BUNDLE #2 - 97% Furnace, WH, Tstat	Bundle	60
Furnace, >95% AFUE	Unit	18,583
Furnace, >95% AFUE - Early Retire	Unit	1,570
Furnace, >97% AFUE	Unit	2,499
Furnace, >97% AFUE - Early Retire	Unit	225
Programmable Thermostat - Contractor Install	Unit	8,853
Programmable Tstats - Point of Sale	Unit	602
Smart Thermostat - Manual Baseline	Unit	16,345
Smart Thermostat - Programmable Baseline	Unit	13,583
Verified Quality Duct Sealing	Service	1
Verified Quality Install	Service	1
Verified Quality Maintenance	Service	13

Source: Nicor Gas tracking data and Navigant team analysis.

3. PROGRAM SAVINGS SUMMARY

Table 3-1 summarizes the energy savings the HEER program achieved in PY6.

Table 3-1. PY6 Annual Energy Savings Summary

Program	Ex Ante Gross Savings (Therms)	Verified Gross RR†	Verified Gross Savings (Therms)	NTGR‡	Verified Net Savings (Therms)
HEER GPY6	7,264,769	100%	7,262,706	Varies	6,201,333

Source: Nicor Gas tracking data and Navigant team analysis.

† Realization Rate (RR) is the ratio of verified gross savings to ex ante gross savings, based on evaluation research findings.

‡ Net-to-Gross Ratio (NTGR) is the ratio of verified net savings to verified gross savings. The NTGR is a deemed value. Source: Nicor_Gas_GPY6_NTG_Values_2016-02-29_Final.xlsx, which is to be found on the Illinois SAG web site: <http://ilsag.info/net-to-gross-framework.html>. The NTGR for all program measures except Smart Thermostats is 0.79.

4. PROGRAM SAVINGS BY MEASURE

The measure-level details of the program are provided in Table 4-1. The program includes 14 measures. The furnace replacement and smart thermostat measures contributed the most savings to the program, as shown in Figure 4-1.

Table 4-1. PY6 Annual Energy Savings by Measure

Measure	Ex Ante Gross Savings (Therms)	Verified Gross RR†	Verified Gross Savings (Therms)	NTGR‡	Verified Net Savings (Therms)
Furnace, >95% AFUE	3,184,908	100%	3,184,917	0.79	2,516,084
Smart Thermostat - Manual Baseline	1,444,660	100%	1,444,660	NA§	1,444,660
Smart Thermostat - Programmable Baseline	763,892	100%	763,892	NA§	763,892
Furnace, >95% AFUE - Early Retire	621,418	100%	621,418	0.79	490,920
Programmable Thermostat - Contractor Install	546,498	100%	546,498	0.79	431,734
Furnace, >97% AFUE	462,376	100%	462,373	0.79	365,275
Furnace, >97% AFUE - Early Retire	92,005	100%	92,005	0.79	72,684
BUNDLE #1 - 95% Furnace, WH, Tstat	64,131	98%	62,690	0.79	49,525
Boilers, >95% AFUE <300 MBH	44,700	100%	44,483	0.79	35,142
Programmable Tstats -Point of Sale	20,952	100%	20,952	0.79	16,552
BUNDLE #2 - 97% Furnace, WH, Tstat	17,340	97%	16,865	0.79	13,324
Verified Quality Maintenance	1,648	100%	1,648	0.79	1,302
Verified Quality Install	178	140%	250	0.79	197
Verified Quality Duct Sealing	62	85%	53	0.79	42
Total GPY6	7,264,769	100%	7,262,706	Varies	6,201,333

Source: Nicor Gas tracking data and Navigant team analysis.

† Realization Rate (RR) is the ratio of verified gross savings to ex ante gross savings, based on evaluation research findings.

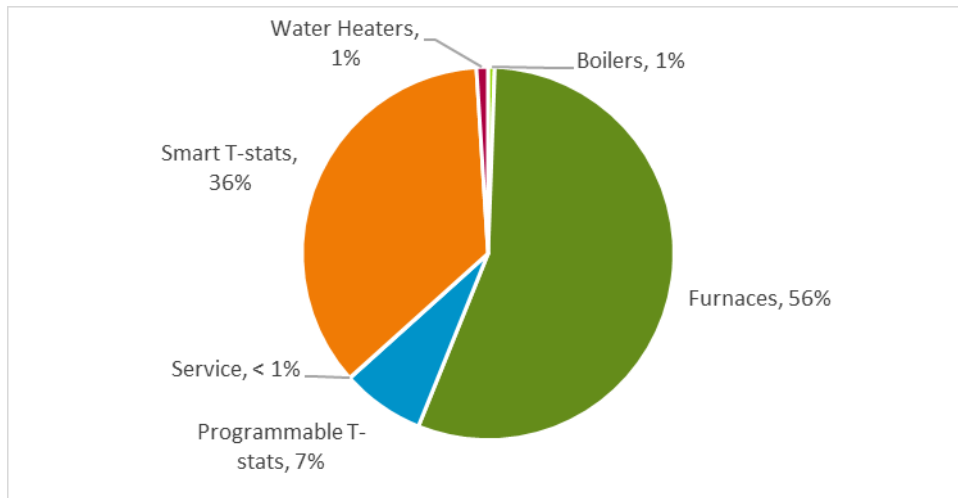
‡ Net-to-Gross Ratio (NTGR) is the ratio of verified net savings to verified gross savings. The NTGR is a deemed value.

Source: Nicor_Gas_GPY6_NTG_Values_2016-02-29_Final.xlsx, which is to be found on the Illinois SAG web site:

<http://ilsag.info/net-to-gross-framework.html>.

§ The IL TRM algorithm calculates net savings for thermostats.

Figure 4-1. PY6 Net Savings by Measure Type



Source: Program Tracking Data provided by Nicor Gas and Navigant analysis.

5. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

5.1 Impact Parameter Estimates

Table 5-1 shows the unit savings and realization rate findings by measure from our review. The realization rate is the ratio of the verified savings to the ex ante savings. Following the table, we provide findings and recommendations, including discussion of all measures with realization rates above or below 100 percent. Appendix 1 provides a description of the impact analysis methodology.

Table 5-1. Verified Gross Savings Parameters

Measure	Unit Basis	Ex Ante Gross (therms/unit)	Verified Gross (therms/unit)	Realization Rate	Data Source(s)*†
Boilers, >95% AFUE <300 MBH‡	Unit	205.05	205.05	100%	Nicor Gas Program Tracking Data (PTD), Illinois TRM, v5.0, Section 5.3.6
BUNDLE #1 - 95% Furnace, WH, Tstat	Bundle	281.28	274.96	98%	PTD, Illinois TRM, v5.0, Sections 5.3.7, 5.3.11 and 5.4.2
BUNDLE #2 - 97% Furnace, WH, Tstat	Bundle	289	281.09	97%	PTD, Illinois TRM, v5.0, Sections 5.3.7, 5.3.11 and 5.4.2
Furnace, >95% AFUE‡	Unit	171.39	171.39	100%	PTD, Illinois TRM, v5.0, Section 5.3.7
Furnace, >95% AFUE - Early Retire‡	Unit	395.81	395.81	100%	PTD, Illinois TRM, v5.0, Section 5.3.7
Furnace, >97% AFUE‡	Unit	185.02	185.02	100%	PTD, Illinois TRM, v5.0, Section 5.3.7
Furnace, >97% AFUE - Early Retire‡	Unit	408.91	408.91	100%	PTD, Illinois TRM, v5.0, Section 5.3.7
Programmable Thermostat - Contractor Install‡	Unit	61.73	61.73	100%	PTD, Illinois TRM, v5.0, Section 5.3.11
Programmable Tstats - Point of Sale‡	Unit	34.8	34.80	100%	PTD, Illinois TRM, v5.0, Section 5.3.11
Smart Thermostat - Manual Baseline‡	Unit	88.39	88.39	100%	PTD, Illinois TRM, v5.0, Section 5.3.16
Smart Thermostat - Programmable Baseline‡	Unit	56.24	56.24	100%	PTD, Illinois TRM, v5.0, Section 5.3.16
Verified Quality Duct Sealing‡	Service	62.07	53.37	86%	PTD, Illinois TRM, v5.0, Section 5.3.4
Verified Quality Install‡	Service	178.25	249.53	140%	PTD, Illinois TRM, v6.0, Section 5.3.7
Verified Quality Maintenance‡	Service	126.79	126.79	100%	PTD, Illinois TRM, v5.0, Section 5.3.13

* Program Tracking Data (PTD) provided by Nicor Gas, extract dated January 30, 2018.

† State of Illinois Technical Reference Manual version 5.0 from <http://www.ilsaq.info/technical-reference-manual.html>.

‡ The measure savings vary by climate zone, the values provided for this measure are weighted average values for the program year.

5.2 Other Findings and Recommendations

5.2.1 Tracking Data

Finding. Installations of Verified Quality Duct Sealing and Verified Quality Maintenance did not have an installation date provided in the tracking data. The implementation team provided this information in the updated tracking data.

Recommendation 1. Navigant recommends that installation date information continue to be provided for all projects and measures.

5.2.2 Boiler Replacement

Finding. One project reported as a boiler replacement installation (MC-4124413) involved a condensing tankless water heater. Water heater replacement is not a measure in this program, unless bundled with a new furnace and thermostat. Navigant removed the savings for the water heater replacement from the verified gross savings.

5.2.3 Measures in Bundles

Finding. There are 45 projects that show a water heater efficiency of 100% in the tracking data. The water heater model numbers for these measures have been reviewed and a verified water heater efficiency¹ has been used to calculate the verified savings.

Recommendation 2. Navigant recommends verifying equipment efficiency with the Air-Conditioning, Heating, & Refrigeration Institute (AHRI) Certified Products Directory. This resource provides certified efficiency values for boilers, furnaces and water heaters.

5.2.4 Furnace Replacement

Finding. For one project, the furnace replacement installation (MC-3383952) uses a Furnace Heating Load value of 561 therms which corresponds to climate zone 5. However, the tracking data identifies the climate zone of this project as climate zone 2. This discrepancy results in an adjustment to the realization rate.

Finding. One furnace replacement installation (MC-2217974) lists an efficiency of 97 percent in the tracking data. However, the ex ante savings reflects an AFUE value of 97.4 percent.

Recommendation 3. Navigant recommends that the tracking data include the input values used to calculate the ex ante savings.

Finding. The initial tracking data did not include the custom baseline efficiency values used to calculate the ex ante savings for 130 installations of the early retirement furnace replacement measures. The implementation team provided the baseline efficiencies in the updated tracking data. This resolved all 130 instances of this finding.

Recommendation 4. Navigant recommends that the tracking data continue to include the actual baseline efficiency values when they are applied.

¹ Water heater efficiency was verified using the AHRI Directory (ahridirectory.org) or manufacturer spec sheets.

5.2.5 Programmable and Smart Thermostats

Finding. One thermostat installation (MC-3474196) did not include a bundle identifier in the tracking data despite being a part of a bundled project (PRJ-1427104).

Recommendation 5. Navigant recommends identifying all measures that are part of a bundle in the tracking data.

5.2.6 Verified Quality Maintenance

Finding. One verified quality maintenance measure (MC-3843004) indicated that the efficiency decreased as a result of the maintenance.

Recommendation 6. Navigant recommends that savings not be claimed for Verified Quality Maintenance projects that do not result in an increase in efficiency.

5.2.7 Verified Quality Installation

Finding. The tracking database includes one furnace quality installation (MC-3567066). The IL TRM, version 5.0 does not include the furnace quality installation measure, but the IL TRM version 6.0 does. IL TRM, version 6.0 was used to verify the savings for this measure. The ex ante savings value does not match what the tracking data inputs and IL TRM algorithm produces. The discrepancy was investigated but a cause could not be determined. The realization rate for this measure is 140 percent.

Recommendation 7. Navigant recommends that CLEAResult review the algorithms and inputs used to calculate ex ante savings for the quality installation measure.

5.2.8 Verified Quality Duct Sealing

Finding. The tracking database includes one duct sealing project (MC-3922789). The ex ante savings does not match what the tracking data inputs and IL TRM algorithm produces. The discrepancy was investigated but a cause could not be determined. The realization rate for this measure is 86 percent.

Recommendation 8. Navigant recommends that CLEAResult review the algorithms and inputs used to calculate ex ante savings for the duct sealing measure.

5.3 Recommended TRM Updates

Finding. Several of the installed boilers are “combination boilers,” or units with the ability to satisfy HVAC and domestic hot water (DHW) loads. There are no DHW savings being captured in the current program tracking data. Additionally, the Illinois TRM does not have a measure that handles combination boilers.

Recommendation 9. Navigant has proposed that the Residential Gas Boiler measure in the IL TRM be updated to include combination boilers. If accepted, this update would apply to the seventh version of the IL TRM.

6. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

6.1 Gas High Efficiency Boiler²

$$\Delta \text{therms} = \text{GasBoilerLoad} * HF * \left(\frac{1}{AFUE_{base}} - \frac{1}{AFUE_{eff}} \right)$$

Where:

Gas Boiler Load = Estimate of annual household load for gas boiler, therms
HF = Household factor
AFUE_{base} = Baseline boiler annual fuel utilization efficiency rating (AFUE)
AFUE_{eff} = Efficient boiler annual fuel utilization efficiency rating (AFUE)

Table 6-1. Gas High Efficiency Boiler Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
Varies by Climate Zone	Gas Boiler Load	IL TRM v5.0, 5.3.6	Deemed
100% (single family)	HF	IL TRM v5.0, 5.3.6	Deemed
82%	AFUE _{base}	IL TRM v5.0, 5.3.6	Deemed
Actual	AFUE _{eff}	PTD	Custom

6.2 Gas Water Heater (part of Bundle)³

$$\Delta \text{therms} = \left(\frac{1}{EF_{base}} - \frac{1}{EF_{efficient}} \right) * \frac{GPD * Household * 365.25 * \gamma_{water} * (T_{out} - T_{in}) * 1.0}{100,000}$$

$$EF_{base} = 0.675 - 0.0015 * \text{Tank size}$$

Where:

EF_{base} = Energy factor rating for baseline equipment
EF_{efficient} = Energy factor rating for efficient equipment
GPD = Gallons per day of hot water use per person
Household = Average number of people per household
365.25 = Days per year, on average
γ_{water} = Specific weight of water, lb_m/gal
T_{out} = Tank temperature, °F
T_{in} = Incoming water temperature from well or municipal system, °F
1.0 = Specific heat capacity, Btu/lb-°F
100,000 = Btu/therm conversion factor
Tank size = Size of water heat tank, gal

² IL TRM v5.0, 5.3.6 Gas High Efficiency Boiler

³ IL TRM v5.0, 5.4.2 Gas Water Heater

Table 6-2. Gas Water Heater Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
Varies by Size (in gallons)	EF _{base}	PTD	Custom
Actual	EF _{efficient}	PTD	Custom
17.6	GPD	IL TRM v5.0, 5.4.2	Deemed
2.56	Household	IL TRM v5.0, 5.4.2	Deemed
125	T _{out}	IL TRM v5.0, 5.4.2	Deemed
54	T _{in}	IL TRM v5.0, 5.4.2	Deemed
Actual	Tank size	PTD	Custom

6.3 Gas High Efficiency Furnace⁴

Time of sale:

$$\Delta \text{therms} = \text{GasFurnaceHeatingLoad} * HF * \left(\frac{1}{AFUE_{base}} - \frac{1}{AFUE_{eff}} \right)$$

Early Replacement:

$$\Delta \text{therms} = \text{GasFurnaceHeatingLoad} * HF * \left(\frac{1}{AFUE_{exist}} - \frac{1}{AFUE_{eff}} \right)$$

Where:

GasFurnaceHeatingLoad = Estimate of annual household load for gas furnace, therms
HF = Household factor
AFUE_{base} = Baseline furnace annual fuel utilization efficiency rating (AFUE)
AFUE_{eff} = Efficient furnace annual fuel utilization efficiency rating (AFUE)
AFUE_{exist} = Existing furnace annual fuel utilization efficiency rating (AFUE)

Table 6-3. Gas High Efficiency Furnace Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
Varies by Climate Zone	Gas Furnace Heating Load	IL TRM v5.0, 5.3.7	Deemed
100% (single family)	HF	IL TRM v5.0, 5.3.7	Deemed
80%	AFUE _{base}	IL TRM v5.0, 5.3.7	Deemed
Actual	AFUE _{eff}	Actual	Custom
80% (Beyond Repair)	AFUE _{exist}	IL TRM v5.0, 5.3.7	Deemed
64.4% (Fully Functional)			

6.4 Programmable and Advanced Thermostats⁵

$$\Delta \text{therms} = \%FossilHeat * GasHeatingLoad * HeatingReduction * HF * Eff_ISR$$

⁴ IL TRM v5.0, 5.3.7 Gas High Efficiency Furnace

⁵ IL TRM v5.0, 5.3.11 Programmable Thermostats; 5.3.16 Advanced Thermostats

Where:

- %FossilHeat* = Percentage of heating savings assumed to natural gas
- GasHeatingLoad* = Estimate of annual household gas heating consumption, therms
- HeatingReduction* = Assumed percentage heating reduction
- HF* = Household factor
- Eff_ISR* = Effective In-service rate

Table 6-4. Programmable and Advanced Thermostat Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
100%	%Fossil Heat	IL TRM v5.0, 5.3.11	Deemed
Varies by Climate Zone	Gas Heating Load	IL TRM v5.0, 5.3.11	Deemed
6.2% (Programmable)	Heating Reduction	IL TRM v5.0, 5.3.11	Deemed
5.6% (Smart/Advanced Programmable Baseline)			
8.8% (Smart/Advanced Manual Baseline)			
100% (single family)	HF	IL TRM v5.0, 5.3.11	Deemed
100% (Prog. – Direct Install)	Eff_ISR	IL TRM v5.0, 5.3.11	Deemed
56% (Prog. - Point of Sale)			
100% (Smart – Direct Install)			
100% (Smart - Point of Sale)			

6.5 Duct Sealing and Insulation⁶

$$\Delta \text{therms} = \left(\frac{DE_{\text{after}} - DE_{\text{before}}}{DE_{\text{after}}} \right) * FLH_{\text{heat}} * InputCapacityHeat * TRF_{\text{heat}} * \frac{\eta_{\text{equipment}}}{\eta_{\text{system}} * 100,000}$$

Where:

- DE_{after}* = Distribution efficiency after duct sealing
- DE_{before}* = Distribution efficiency before duct sealing
- FLH_{heat}* = Full load heating hours
- InputCapacityHeat* = Heating input capacity, Btu/hr
- TRF_{heat}* = Thermal regain factor for heating by space type
- η_{equipment}* = Heating equipment efficiency
- η_{system}* = Pre-duct sealing heating system efficiency
- 100,000* = Btu/therm conversion factor

⁶ IL TRM v5.0, 5.3.4 Duct Sealing and Insulation

Table 6-5. Duct Sealing and Insulation Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
Actual	DE _{after}	PTD	Custom
Actual	DE _{before}	PTD	Custom
Varies by Climate Zone	FLH _{heat}	IL TRM v5.0, 5.3.4	Deemed
Actual	Input Capacity Heat	PTD	Custom
0.40 (Semi-conditioned space) 1.0 (Unconditioned space)	TRF _{heat}	IL TRM v5.0, 5.3.4	Deemed
83%	η _{equipment}	IL TRM v5.0, 5.3.4	Deemed
70%	η _{system}	IL TRM v5.0, 5.3.4	Deemed

6.6 Verified Quality Maintenance (found in the Gas High Efficiency Furnace)⁷

$$\Delta \text{therms} = \text{GasFurnaceLoad} * HF * \left(\frac{1}{AFUE_{base} * (1 - Derating_{base})} - \frac{1}{AFUE_{ee} * (1 - Derating_{ee})} \right)$$

Where:

<i>GasFurnaceLoad</i>	= Estimate of annual household heating load
<i>HF</i>	= Household factor
<i>AFUE_{base}</i>	= Baseline furnace annual fuel utilization efficiency rating
<i>Derating_{base}</i>	= Baseline furnace AFUE derating
<i>AFUE_{ee}</i>	= Efficient baseline furnace annual fuel utilization efficiency rating
<i>Derating_{ee}</i>	= Efficient furnace AFUE derating

Table 6-6. Furnace Tune-Up Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
Varies by Climate Zone	Gas Furnace Load	IL TRM v5.0, 5.3.13	Deemed
100% (single family)	HF	IL TRM v5.0, 5.3.13	Deemed
Actual	AFUE _{base}	PTD	Custom
6.4%	Derating _{base}	IL TRM v6.0, 5.3.7	Deemed
Actual	AFUE _{ee}	PTD	Custom
0%	Derating _{ee}	IL TRM v6.0, 5.3.7	Deemed

⁷ IL TRM v6.0, 5.3.7 Gas High Efficiency Furnace

7. APPENDIX 2. PROGRAM-SPECIFIC INPUTS FOR THE ILLINOIS TRC

The Total Resource Cost (TRC) variable table only includes cost-effectiveness analysis inputs available at the time of finalizing this PY6 impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to evaluation later. Detail in this table (e.g., EULs) other than final PY6 savings and program data are subject to change and are not final.

Table 7-1. Total Resource Cost Savings Summary

Research Category (e.g., Measure)	Units	Quantity	Effective Useful Life (years)	Ex Ante Gross Savings (therms)	Verified Gross Savings (therms)	Verified Net Savings (therms)
Boilers, >95% AFUE <300 MBH	Unit	218	25	44,700	44,483	35,142
BUNDLE #1 - 95% Furnace, WH, Tstat	Bundle	228	13	64,131	62,690	49,525
BUNDLE #2 - 97% Furnace, WH, Tstat	Bundle	60	13	17,340	16,865	13,324
Furnace, >95% AFUE	Unit	18,583	20	3,184,908	3,184,917	2,516,084
Furnace, >95% AFUE - Early Retire	Unit	1,570	6	621,418	621,418	490,920
Furnace, >97% AFUE	Unit	2,499	20	462,376	462,373	365,275
Furnace, >97% AFUE - Early Retire	Unit	225	6	92,005	92,005	72,684
Programmable Thermostat - Contractor Install	Unit	8,853	5	546,498	546,498	431,734
Programmable Tstats -Point of Sale	Unit	602	5	20,952	20,952	16,552
Smart Thermostat - Manual Baseline	Unit	16,345	10	1,444,660	1,444,660	1,444,660
Smart Thermostat - Programmable Baseline	Unit	13,583	10	763,892	763,892	763,892
Verified Quality Duct Sealing	Service	1	20	62	53	42
Verified Quality Install	Service	1	20	178	250	197
Verified Quality Maintenance	Service	13	2	1,648	1,648	1,302
Total		62,781		7,264,769	7,262,706	6,201,333