NAVIGANT

Multi-Family Home Energy Savings Evaluation Report

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

Presented to
Nicor Gas

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1. INTRODUCTION

This report presents the results of the impact evaluation of the Nicor Gas PY6 Multi-Family Home Energy Savings (MFHES) 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 Multi-Family Program is delivered through two channels: the direct install path which provides free assessment and no-cost direct installation of measures in residential multi-family buildings with five or more living units and the prescriptive path which offers prescriptive and custom incentives to multi-family decision-makers to install energy savings measures in common areas of multi-family buildings.

The MFHES program had 301 participants in PY6 and completed 673 projects as shown in the following table.

Table 2-1. PY6 Volumetric Summary

Participation	Common Area	Direct Install	Custom	Total
Participants	173	133	3	301†
Installed Projects	199	478	3	673 ‡
Total Measures[1]	520	20,141	3	20,664

Source: Nicor Gas tracking data and Navigant team analysis.
† Unique participants: 66 customers had multiple projects.
‡Unique Installed Projects: 7 projects had measures installed through multiple program channels.

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

[1] If measure units were reported in the tracking system as linear feet or square feet, or the measure was a custom project, Navigant treated each row entry of such measure as one measure quantity in this table.

Table 2-2. PY6 Installed Measure Quantities

Measure	Quantity Unit	Installed Quantity
Bath Aerator	Each	4,932
Boiler Reset Controls	Each	15
Boiler Tune Up Process	Each	2
Boiler Tune Up Space Heating	Each	57
Custom Measures	Each	3
Efficient Boiler	Each	46
Efficient Furnace	Each	34
Kitchen Aerator	Each	3,719
Outdoor Pool Covers	Square Feet	8
Pipe Insulation	Linear Feet	89
Pre-Rinse Spray Valves	Each	1
Programmable Thermostat	Each	4,830
Showerhead	Each	6,629
Steam Trap	Each	294
Water Heater	Each	1
WH Set Back	Each	4

Source: Nicor Gas tracking data and Navigant team analysis.

3. PROGRAM SAVINGS SUMMARY

Table 3-1 summarizes the energy savings the MFHES program achieved by path in PY6.

Table 3-1. PY6 Annual Energy Savings Summary

Program Path	Ex Ante Gross Savings (Therms)	Verified Gross RR†	Verified Gross Savings (Therms)	NTGR‡	Verified Net Savings (Therms)
Common Area	330,009	101%	334,618	0.94	314,541
Direct Install	341,877	100%	341,908	0.95	324,813
Custom	56,500	95%	53,729	0.94	50,505
Total	728,386	100%	730,255	-	689,859

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: http://ilsagfiles.org/SAG_files/NTG/2016_NTG_Meetings/Final_Documents/Nicor_Gas_NTG_Summary_GPY1-6_2016-02-29_Final.pdf which is to be found on the Illinois SAG web site: http://ilsag.info/net-to-gross-framework.html.

4. Program Savings by Measure

The MFHES program includes 26[2] measures as shown in the following table. The programmable thermostat and pipe insulation measures contributed the most savings.

Table 4-1. PY6 Annual Energy Savings by Measure

Research Category	Ex Ante Gross Savings (Therms)	Verified Gross RR†	Verified Gross Savings (Therms)	NTGR‡	Verified Net Savings (Therms)
Boiler Reset Controls	14,155	100%	14,155	0.94	13,306
Boiler Tune Up, Process	913	100%	913	0.94	858
Boiler Tune Up, Space Heating	20,549	100%	20,549	0.94	19,316
Condensing Boilers, >90%	38,807	113%	43,671	0.94	41,051
Furnace, >95% AFUE - CA	2,069	100%	2,069	0.94	1,945
Furnace, >95% AFUE - MF IU	3,090	100%	3,090	0.95	2,935
HW Insulation (1') DI CA	45	101%	46	0.94	43
HW Pipe Insulation (1 ft.) DI IU MF	81	100%	81	0.95	77
Low Flow Aerator - Bath (DI) MF-CA	14	100%	14	0.94	13
Low Flow Aerator - Bath (DI) MF-IU	6,151	100%	6,150	0.95	5,842
Low Flow Aerator - Kitchen (DI) MF-CA	15	100%	15	0.94	14
Low Flow Aerator - Kitchen (DI) MF-IU	19,063	100%	19,066	0.95	18,113
MF Custom Measures	56,500	95%	53,729	0.94	50,505
Outdoor Pool Covers	14,755	100%	14,755	0.94	13,870
Pipe Insulation, Indoor Hot Water DHW	12,496	101%	12,620	0.94	11,863
Pipe Insulation, Indoor HW Space Heat	47,003	99%	46,692	0.94	43,890
Pipe Insulation, Indoor LPS Space Heat	152,338	100%	152,338	0.94	143,197
Pre-Rinse Spray Valves DI CA	183	100%	183	0.94	172
Programmable Thermostat (DI) MF-IU	194,522	100%	194,529	0.95	184,802
Programmable Thermostats - CA	259	100%	259	0.94	244
Re-Program Thermostat (DI) MF-IU	364	100%	365	0.95	346
Showerhead (DI) MF-CA	197	100%	197	0.95	187
Showerhead (DI) MF-IU	118,396	100%	118,418	0.95	112,497
Small Pipe Insulation, 3/4", Indoor DHW	89	100%	89	0.94	84
Steam Trap, Commercial	26,302	100%	26,233	0.94	24,659
Storage Water Heater, >0.67 EF	13	105%	14	0.95	13
WH Set Back - MF	16	100%	16	0.94	15
Total	728,386	100%	730,255	-	689,859

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: http://ilsagfiles.org/SAG_files/NTG/2016_NTG_Meetings/Final_Documents/Nicor_Gas_NTG_Summary_GPY1-6_2016-02-29_Final.pdf which is to be found on the Illinois SAG web site: http://ilsag.info/net-to-gross-framework.html.

[2] Excluding "Custom Project" measures, which represent multiple measures installed.

5. Impact Analysis Findings and Recommendations

Parameter Estimates

Table 5-1 shows the unit therm 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)
Boiler Reset Controls	Unit	Varies	Varies	100%	Illinois TRM, v5.0† (TRM), Section 4.4.4
Boiler Tune Up, Process	Unit	Varies	Varies	100%	TRM Section 4.4.3
Boiler Tune Up, Space Heating	Unit	Varies	Varies	100%	TRM Section 4.4.2
Condensing Boilers, >90%	Unit	Varies	Varies	113%	TRM Section 4.4.10
Furnace, >95% AFUE - CA	Unit	Varies	Varies	100%	TRM Section 4.4.11
Furnace, >95% AFUE - MF IU	Unit	Varies	Varies	100%	TRM Section 5.3.7
HW Insulation (1') DI CA	Linear Ft.	5.02	5.07	101%	TRM Section 4.4.14
HW Pipe Insulation (1 ft.) DI IU MF	Linear Ft.	1.05	1.05	100%	TRM Section 4.4.14
Low Flow Aerator - Bath (DI) MF-CA and IU	Unit	1.25	1.25	100%	TRM Section 5.4.4
Low Flow Aerator - Kitchen (DI) MF-CA and IU	Unit	5.13	5.13	100%	TRM Section 5.4.4
MF Custom Measures	Project(s)	Varies	Varies	95%	PTD & Evaluation
Outdoor Pool Covers	Sq. Ft.	1.01	1.01	100%	TRM Section 4.3.4
Pipe Insul., Indoor Hot Water DHW	Linear Ft.	3.51	3.55	101%	TRM Section 4.4.14
Pipe Insul., Indoor HW Space Heat	Linear Ft.	Varies	Varies	99%	TRM Section 4.4.14
Pipe Insul., Indoor LPS Space Heat	Linear Ft.	Varies	Varies	100%	TRM Section 4.4.14
Pre-Rinse Spray Valves DI CA	Unit	183.38	183.38	100%	TRM Section 4.2.11
Programmable Thermostat (DI) MF-IU	Unit	40.5	40.5	100%	TRM Section 5.3.11
Programmable Thermostats - CA	Unit	14.4	14.4	100%	TRM Section 4.4.25
Re-Program Thermostat (DI) MF-IU	Unit	40.5	40.5	100%	TRM Section 5.3.11
Showerhead (DI) MF-CA and IU	Unit	17.89	17.89	100%	TRM Section 5.4.5
Small Pipe Insul., 3/4", Indoor DHW	Linear Ft.	0.49	0.49	100%	TRM Section 4.4.14
Steam Trap, Commercial	Unit	89.46	89.23	100%	TRM Section 4.4.16
Storage Water Heater, >0.67 EF	Unit	13.48	14.11	105%	TRM Section 5.4.2
WH Set Back - MF	Unit	4.07	4.07	100%	TRM Section 5.4.6

* Program Tracking Data (PTD) provided by Nicor Gas, extract dated January 29, 2018.
† State of Illinois Technical Reference Manual version 5.0 from http://www.ilsag.info/technical-reference-manual.html.

The "Boiler Reset Controls" measure had seven records where the ex ante per-unit savings were half of the savings calculated using the inputs provided in the tracking data and TRM. Upon further request,

Nicor Gas provided supplemental data of the actual capacity of the installed boilers. Navigant verified the ex ante savings were consistent with the TRM. The measure had 100% gross realization rate.

Recommendation 1. Ensure that supplemental and clarification information collected from customers are readily transferred into the tracking system and readily available for evaluation.

Ex ante savings calculations for the "Condensing Boilers, >90%" measure assume all condensing boiler units have a baseline efficiency of 0.82. However, the TRM deems a 0.80 baseline thermal efficiency for retrofit units with heating capacities more than 300 kBtu/hr.

Recommendation 2. Use a baseline thermal efficiency of 0.80 when calculating savings for condensing boilers with heating capacities more than 300 kBtu/hr, as specified in the TRM.

The "Storage Water Heater, >0.67 EF" measure had one record in the tracking data, and the ex ante savings of 13.48 do not match tracking system inputs. Navigant calculated per-unit verified savings of 14.11 therms using the provided inputs and TRM section 5.4.2.

Recommendation 3. Check for errors in the algorithm and inputs used to calculate ex ante savings in the tracking data for storage water heaters.

The tracking system did not provide all the inputs needed to verify the ex ante savings from certain pipe insulation measures, including tracking the heat loss and EFLH assumptions for "HW Pipe Insulation (1 ft.) DI IU MF" and "Small Pipe Insulation, 3/4-inch, Indoor DHW". Navigant calculated pipe insulation savings using deemed inputs from the TRM (v5.0). The measures had realization rates slightly above or below 100 percent, mainly due to rounding.

After Navigant presented this finding in the early impact memo, Nicor Gas indicated that they plan to make the requested changes for the 2018 program year.[3] The recommendation is repeated below.

Recommendation 4. Provide all the heat loss ("Qbase" and "Qeff") algorithm inputs in the tracking data used to calculate savings for pipe insulation measures ("bare pipe heat loss" field and "insulated pipe heat loss" field respectively in the tracking system).

Recommendation 5. Update the tracking system to include a field that specifies when the project heating system was year-round recirculation, seasonal recirculation or non-recirculation, and track the associated EFLH value provided in the TRM (there is already a field for EFLH).

Other Findings and Recommendations

For Project PRJ-866899, savings were claimed for an installed modulating burner with a 5:1 turndown. The definition of efficient high turndown burners in the IL TRM is a burner with turndown greater than or equal to 10:1. The installed burner did not meet the IL TRM's efficient equipment requirements, and thus the savings attributed to the installed burner were removed from the project.

Recommendation 6. Navigant recommends that custom project measures claiming savings using IL TRM algorithms should meet the efficient equipment standards in the IL TRM. If the equipment does not meet the IL TRM requirements, a custom calculation approach should be used.

[3] Nicor GPY6 Multi-Family Program Tracking Database Review Interim Findings Memo 2017-09-26.docx

The baseline boiler efficiencies for both projects PRJ-866899 and PRJ-939597 were adjusted to meet the IL TRM baseline value (adjusted from 80% to 77%). Justification for these adjustments is referenced in the building code (IECC 2015), which specifies that the baseline equipment is a natural draft boiler.

Recommendation 7. Navigant recommends that all custom calculations use the proper measure-level efficiency values to reflect the baseline and efficient equipment.

The proposed efficiencies for both boilers was also updated from 83.7% to 83.1%. This adjustment was made to reflect the thermal efficiency (instead of combustion efficiency), which is how the baseline equipment is defined.

Recommendation 8. Navigant recommends that efficiency values are equivalent terms (i.e., thermal vs. combustion vs. AFUE efficiencies) when comparing baseline to efficient conditions.

All three custom Multi-Family project's (PRJ-866899, PRJ-939597, and PRJ-1381437) energy savings calculations involved the use of weather data (heating degree days (HDD) or typical meteorological year (TMY)). Recommendations regarding the use of weather data in natural gas energy savings calculations are detailed below.

Recommendation 9. Navigant recommends using data from the nearest weather station to the project's location when using weather data, unless a geographic feature justifies otherwise (e.g., Lake Michigan).

Recommendation 10. Navigant recommends that energy savings calculations which incorporate historical facility gas usage be normalized to historical weather data for that location.

6. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

Navigant determined verified gross savings for each program measure by:

1. Reviewing the savings algorithm inputs in the tracking data for agreement with the TRM or evaluation research for non-deemed measures.
2. Validating that the savings algorithm was applied correctly.
3. Cross-checking per-unit savings values in the tracking data with the verified values in the measure workbook or in Navigant's calculations if the workbook did not agree with the TRM.
4. Multiplying the verified per-unit savings value by the quantity reported in the tracking data.

The deemed savings verification approach was supplemented by engineering file review of the 3 custom Multi-Family projects. Navigant verified the measures installed and the savings reported for these projects.

Engineering Review of Project Files

Additionally, the evaluation team conducted engineering desk file review of the three custom projects installed in PY6, to verify project savings that were not based on measures specified in the TRM.

For each project, an in-depth application review is performed to assess the engineering methods, parameters and assumptions used to generate all ex ante impact estimates. For each measure in the sampled project, engineers estimated ex post gross savings based on their review of documentation and engineering analysis.

To support this review, the implementation contractor provided project documentation in electronic format for each sampled project. Documentation included some or all scanned files of hardcopy application forms and supporting documentation from the applicant (invoices, measure specification sheets, and vendor proposals), pre-inspection reports and photos (when required), post-inspection reports and photos (when conducted), and calculation spreadsheets.

7. Appendix 2. Impact Analysis Supplemental Information

Table 7-1 provides a summary of M&V results for the census sample of three custom projects reviewed by Navigant.

Table 7-1. PY6 Summary of Custom M&V Results

Project ID (PRJ-)	Measure Description	Ex Ante Gross Savings (Therms)	Gross Realization Rate	Verified Gross Savings (Therms)	Summary of Adjustment
866899	Boiler and Burner Replacement	1,839	102%	1,870	Updated boiler baseline efficiency and turndown values. High-turndown burner savings were removed.
939597	Boiler and Burner Replacement	3,440	84%	2,899	Updated normalized annual heating usage, baseline efficiency, and proposed efficiency values.
1381437	Boiler and Water Heater Replacement	51,221	96%	48,961	Updated billing, weather data, and usage data.

Source: Navigant analysis of program data.

8. Appendix 3. Program-Specific Inputs for the Illinois TRC

Table 8-1, the Total Resource Cost (TRC) variable table, only includes cost-effectiveness analysis inputs available at the time of finalizing the PY6 MFHES Program impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in the tables and will be provided to evaluation later. Detail in the TRC tables (e.g., EULs), other than final PY6 savings and program data, are subject to change and are not final.

Table 8-1. Total Resource Cost Savings Summary

Measure	Units	Quantity	Effective Useful Life*	Ex Ante Gross Savings (Therms)	Verified Gross Savings (Therms)	Verified Net Savings (Therms)
Boiler Reset Controls	Unit	15	20	14,155	14,155	13,306
Boiler Tune Up, Process	Unit	2	3	913	913	858
Boiler Tune Up, Space Heating	Unit	57	3	20,549	20,549	19,316
Condensing Boilers, >90%	Unit	46	20	38,807	43,671	41,051
Furnace, >95% AFUE - CA	Unit	7	16.5	2,069	2,069	1,945
Furnace, >95% AFUE - MF IU	Unit	27	20	3,090	3,090	2,935
HW Insulation (1') DI CA	Linear Ft.	1	15	45	46	43
HW Pipe Insulation (1 ft.) DI IU MF	Linear Ft.	35	15	81	81	77
Low Flow Aerator - Bath (DI) MF-CA	Unit	11	9	14	14	13
Low Flow Aerator - Bath (DI) MF-IU	Unit	4,921	9	6,151	6,150	5,842
Low Flow Aerator - Kitchen (DI) MF-CA	Unit	3	9	15	15	14
Low Flow Aerator - Kitchen (DI) MF-IU	Unit	3,716	9	19,063	19,066	18,113
MF Custom Measures	Project	3	13	56,500	53,729	50,505
Outdoor Pool Covers	Sq. Ft.	8	6	14,755	14,755	13,870
Pipe Insulation, Indoor Hot Water DHW	Linear Ft.	5	15	12,496	12,620	11,863
Pipe Insulation, Indoor HW Space Heat	Linear Ft.	23	15	47,003	46,692	43,890
Pipe Insulation, Indoor LPS Space Heat	Linear Ft.	24	15	152,338	152,338	143,197
Pre-Rinse Spray Valves DI CA	Unit	1	5	183	183	172
Programmable Thermostat (DI) MF-IU	Unit	4,803	4	194,522	194,529	184,802
Programmable Thermostats - CA	Unit	18	4	259	259	244
Re-Program Thermostat (DI) MF-IU	Unit	9	4	364	365	346
Showerhead (DI) MF-CA	Unit	11	10	197	197	187
Showerhead (DI) MF-IU	Unit	6,618	10	118,396	118,418	112,497
Small Pipe Insulation, 3/4", Indoor DHW	Linear Ft.	1	15	89	89	84
Steam Trap, Commercial	Unit	294	6	26,302	26,233	24,659
Storage Water Heater, >0.67 EF	Unit	1	13	13	14	13
WH Set Back - MF	Unit	4	2	16	16	15
Total			10	728,386	730,255	689,859

*State of Illinois Technical Reference Manual version 5.0 from http://www.ilsag.info/technical-reference-manual.html.