



Nicor Gas and ComEd Residential New Construction Program Evaluation Report

FINAL

**Energy Efficiency / Demand Response Plan:
Gas Plan Year 5 (GPY5)
Electric Plan Year 8 (EPY8)
(6/1/2015-5/31/2016)**

**Presented to
Nicor Gas Company
Commonwealth Edison Company**

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E. EXECUTIVE SUMMARY

This report presents a summary of the findings and results from the impact and process evaluation of the GPY5/EPY8¹ Residential New Construction Program. The Residential New Construction (RNC) Program is jointly offered by Nicor Gas and Commonwealth Edison (ComEd). Nicor Gas is the lead utility as the majority of the avoided costs are from natural gas savings. Residential Science Resources (RSR) implements the program for both utilities. Although the IECC 2015 energy code came into effect in January 2016, all GPY5/EPY8 program homes were permitted prior to this date and thus built under the IECC 2012 energy code. Program participation requires a minimum efficiency of 20 percent above code for each home, and program homes are ranked in tiers based on performance:

- Tier 1: 20.00-24.99 percent above code
- Tier 2: 25.00-29.99 percent above code
- Tier 3: 30 percent or more above code

E.1 Program Savings

Table E-1 summarizes the natural gas and electricity savings from the RNC Program.

Table E-1. GPY5/EPY8 Total Program Savings²

	Energy Savings (Therms)	Energy Savings (kWh)	Average Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings ³	314,237	539,419	-	-
Ex Ante Net Savings	314,237	539,419	-	-
Verified Gross Realization Rate	94%	101%	-	-
Verified Gross Savings	296,111	547,451	62.5	276
NTGR ⁴	1.00	1.00	1.00	1.00
Verified Net Savings ⁵	296,111	547,451	62.5	276

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

¹ The GPY5/EPY8 program year began June 1, 2015 and ended May 31, 2016.

² Unless specifically noted otherwise, all energy savings presented in this report include whole-building interactive effects between electricity and natural gas. Energy savings without interactive effects are provided in the Appendix, Section 7.1.2.

³ The term "Ex Ante" refers to the forecasted savings reported by the Program Administrator that have not been independently verified through evaluation. Savings that have been independently verified by the Evaluation Contractor are referred to as "Verified".

⁴ The Net-to-Gross Ratio (NTGR) used for calculating verified net savings is deemed prospectively through a consensus process managed by the Illinois Energy Efficiency Stakeholder Advisory Group (SAG). Deemed NTGRs are available at: http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_Final_GPY5_Consensus_NTG_Value_s_2015-03-01.pdf and [ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx](http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx), which can be found on the IL SAG website here: <http://ilsag.info/net-to-gross-framework.html>

⁵ Verified Net Savings = NTGR * Verified Gross Savings

E.2 Program Savings by Home Tier Level

Table E-2 and Table E-3 summarize the natural gas and electricity savings from the RNC Program by home tier level.

Table E-2. Nicor Gas GPY5 RNC Program Natural Gas Savings by Home Tier Level

Participation Category	Ex Ante Gross Savings (Therms)	Verified Gross Realization Rate	Verified Gross Savings (Therms)	NTGR	Verified Net Savings (Therms)
Tier 1	121,263	103%	125,318	1.00 †	125,318
Tier 2	122,289	89%	108,358	1.00 †	108,358
Tier 3	70,685	88%	62,436	1.00 †	62,436
Total	314,237	94%	296,111*	1.00 †	296,111*

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

*Numbers do not sum exactly due to rounding.

† A deemed value. Source:

http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_Final_GPY5_Consensus_NTG_Values_2015-03-01.pdf and [ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx](http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx), which can be found on the IL SAG website here: <http://ilsag.info/net-to-gross-framework.html>.

Table E-3. ComEd EPY8 RNC Program Electric Savings by Home Tier Level

Participation Category	Ex Ante Gross Savings (kWh)	Ex Ante Gross Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	Verified Gross Peak Demand Reduction (kW)	NTGR	Verified Net Savings (kWh)	Verified Net Peak Demand Reduction (kW)
Tier 1	245,844	-	99%	242,337	126	1.00 †	242,337	126
Tier 2	190,752	-	98%	186,134	94.4	1.00 †	186,134	94.4
Tier 3	102,823	-	116%	118,981	55.7	1.00 †	118,981	55.7
Total	539,419	-	101%	547,451*	276	1.00 †	547,451*	276

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

*Numbers do not sum exactly due to rounding.

† A deemed value. Source:

http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_Final_GPY5_Consensus_NTG_Values_2015-03-01.pdf and [ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx](http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx), which can be found on the IL SAG website here: <http://ilsag.info/net-to-gross-framework.html>.

E.3 Program Volumetric Detail

Table E-4 presents GPY5/EPY8 program participation reported by Nicor Gas and ComEd. Detailed volumetric breakdown of the measure type and savings quantity are provided in the program-level analysis in Section 3.

Table E-4. GPY5/EPY8 RNC Program Volumetric Findings Detail

Participation Category	Joint Nicor Gas/ComEd Homes	Nicor Gas Homes	Total Homes
Tier 1	384	59	443
Tier 2	261	62	323
Tier 3	104	25	129
Total	749	146	895

Source: Navigant analysis of GPY5/EPY8 program tracking data.

E.4 Results Summary

Table E-5 summarizes the key metrics from GPY5/EPY8.

Table E-5. GPY5/EPY8 Results Summary

	Units	GPY5/EPY8
Net Savings	Therms	296,111
Gross Savings	Therms	296,111
Program Realization Rate (Gas)	%	94
Net Savings	kWh	547,451
Net Peak Demand Reduction	kW	276
Gross Savings	kWh	547,451
Gross Peak Demand Reduction	kW	276
Program Realization Rate (Electric)	%	101
Program NTG Ratio †	#	1.00
Total Homes	#	895
Joint Nicor Gas/ComEd Homes	#	749
Nicor Gas Homes	#	146
Participating Builders	#	54
Participating Raters	#	9

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

† A deemed value. Source:

http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_Final_GPY5_Consensus_NTG_Values_2015-03-01.pdf and [ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx](http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx), which can be found on the IL SAG website here: <http://ilsag.info/net-to-gross-framework.html>.

E.5 Findings and Recommendations

The following provides insight into key program findings and recommendations.⁶ The program continues to have strong participation even with higher participation requirements but has opportunities to attract builders and grow the program to meet future program goals.

Verified Gross Impacts and Realization Rate

Finding 1. The program achieved a gross savings realization rate of 94 percent for natural gas and 101 percent for electricity. The resulting verified gross savings for GPY5/EPY8 are 296,111 therms and 547,451 kWh. Billing data annual gas consumption for the sampled homes was lower than the ex ante models predicted. This led to lower gas savings despite Navigant’s models’ similar percent savings results.

Finding 3. Although program homes all exceeded code on a performance basis by at least 20 percent, Navigant observed that, on average, certain characteristics met individual code requirements more consistently than others.

Recommendation 1. Work with builders and raters to improve areas that are at or just below code, such as ceiling/roof and foundation insulation levels, as well as those that are at or just above code, such as window U-values, major appliances, and cooling equipment. Specific actions could include RSR directing raters to focus on these areas or offering targeted builder trainings on these topics. These actions could help builders improve practices in these areas and achieve higher participation tiers, and may also reduce free-ridership.

Verified Net Impacts

Finding 5. The program achieved verified net savings of 296,111 therms and 547,451 kWh for GPY5/EPY8. The electric savings exceeded the GPY5/EPY8 net savings target by 37 percent, while the gas savings fell short of the target by 17 percent.

Recommendation 3. Attract builders to the program through targeted outreach efforts or training sessions offered to both participating and non-participating builders.

Recommendation 4. Emphasize the higher efficiency tiers and encourage builders to go beyond typical improvements through program marketing and RSR outreach to individual raters and builders. These efforts could increase program savings and reduce free-ridership for the higher efficiency tiers.

Process Evaluation

Finding 8. Nicor Gas, ComEd, and RSR staff reported success and builder satisfaction with a new series of training sessions focused on sales practices.

Recommendation 5. Continue offering targeting training sessions focused on sales practices and educating consumers about the benefits of energy efficient homes. This type of training could increase participation and builder satisfaction.

⁶ The Executive Summary presents the most important of the Section 6 Findings and Recommendations. Findings and Recommendations in the Executive Summary are numbered to match Section 6 for consistent reference to individual findings and recommendations. Therefore, gaps in numbering may occur in the Executive Summary.

Recommendation 6. In addition to focusing on builder sales practices, consider expanding on efforts to directly educate consumers about the benefits of energy efficiency in new homes. These efforts could include targeted advertising as well as educating the real estate community or supporting local efforts to promote recognition of high-performance homes.

Recommendation 7. RSR should continue to improve and maintain relationships with participating builders and the greater building community. The Build Smart newsletter and sales training offerings are positive aspects of this effort. RSR should continue offering builder training to the broader building community, including non-participants. This type of training could attract new builders to the program.

1. INTRODUCTION

1.1 Program Description

This report presents a summary of the findings and results from the impact and process evaluation of the GPY5/EPY8 Residential New Construction Program. The Residential New Construction (RNC) Program is jointly offered by Nicor Gas and Commonwealth Edison (ComEd). Nicor Gas is the lead utility as the majority of the avoided costs are from natural gas savings. Residential Science Resources (RSR) implements the program for both utilities. Although the IECC 2015 energy code came into effect in January 2016, all GPY5/EPY8 program homes were permitted prior to this date and thus built under the IECC 2012 energy code. Program participation requires a minimum efficiency of 20 percent above code for each home, and program homes are ranked in tiers based on performance:

- Tier 1: 20.00-24.99 percent above code
- Tier 2: 25.00-29.99 percent above code
- Tier 3: 30 percent or more above code

RSR uses completed REM/Rate files for each home to calculate whole-house savings. The program relies on networks of builders and HERS raters to garner participation and continues to attract raters and builders to the program.

1.2 Evaluation Objectives

The evaluation team identified the following key researchable questions for GPY5/EPY8:

1.2.1 Impact Evaluation

1. What are the gross and net annual energy and demand savings induced by the program?
2. Did the program meet its energy and demand savings targets? If not, why not?
3. What changes are recommended to the Implementation Contractor's ex ante estimation approach or Navigant's gross impact evaluation approach to improve the consistency and predictability of the annual gross realization rates?
4. How do energy savings and realization rates vary by program tier?

1.2.2 Process Evaluation and Other Research Topics

1. Are builders and raters satisfied with the program? What improvements, if any, would builders and raters like to see implemented?
2. How can the program be improved?

2. EVALUATION APPROACH

This section provides an overview of the data collection methods, gross and net impact evaluation approaches, and process evaluation approaches that occurred for the GPY5/EPY8 evaluation.

2.1 Overview of Data Collection Activities

The core data collection activities included in-depth interviews with program managers and leveraging program and utility billing data from both Nicor Gas and ComEd. The primary data collection activities are shown in the following table.

Table 2-1. Primary Data Collection Activities and Samples in GPY5/EPY8

What	Subject	Target Completes	Completes Achieved	When	Comments
In Depth Interviews	ComEd, Nicor Gas, and RSR Staff	2	2	August 2016	Interview program staff and IC staff
Tracking Data Review	GPY5/EPY8 Tracking Data	All	All	October 2016	
BEopt Calibrated Simulation	GPY3/EPY6, GPY4/EPY7, and GPY5/EPY8 Program Homes	1,556	710*	November 2016 – January 2017	All homes built to IECC 2012 code and at least 20% above code with sufficient billing data. Some homes excluded from sample due to incomplete billing data.

Source: Navigant.

*Of the 1,556 homes, Nicor Gas provided gas billing data for 982 homes and ComEd provided electric billing data for 1,089 homes. Navigant completed the analysis with 710 homes that overlapped between the billing data provided by Nicor Gas and ComEd.

Table 2-2. Additional Resources

Reference Source	Application	Gross Impacts
International Energy Conservation Code 2012	Reference for code baseline	X

2.2 Verified Savings Parameters

2.2.1 Verified Gross Program Savings Analysis Approach

The GPY2/EPY5 and GPY4/EPY7 evaluations used a rigorous approach of calibrated energy simulation to determine gross realization rates for gas and electric savings. Due to the variability in realization rates between these program years, Navigant revisited the calibrated energy simulation to calculate gross impacts for GPY5/EPY8. Navigant used data from program REM/Rate files to build six energy models which represent average program homes based on tier level and home type:

- Tier 1, One Story
- Tier 1, Two+ Story
- Tier 2, One Story
- Tier 2, Two+ Story
- Tier 3, One Story
- Tier 3, Two+ Story

For each category, Navigant compiled average home characteristics from all homes in that sample category to determine the model inputs. The team used the Building Energy Optimization interface tool (BEopt, version 2.7) created by the National Renewable Energy Laboratory (NREL) to build these models in EnergyPlus (version 8.6), a modeling software also developed by NREL. For each “energy efficient” model built using program data, Navigant developed a corresponding “base case” scenario based on Illinois energy code.⁷

After the models were built, Navigant used actual billing data from program homes to calibrate the “energy efficient” home scenario to consumption to date and then ran the “base case” scenario to determine gas and electric savings. The team used billing data from all homes in each sample category to calibrate the models. For example, the Tier 2, Two+ Story model incorporated characteristics and billing data from all Tier 2, Two+ Story homes in that sample category. Navigant extrapolated the results to the rest of the GPY5/EPY8 population using HERS score and floor area.

Table 2-3 presents the parameters used in the verified gross and net savings calculations and indicates which were examined through evaluation activities and which were deemed.

Table 2-3. GPY5/EPY8 Verified Gross Savings Parameter Data Sources

Parameter	Data Source	Deemed or Evaluated?
Evaluated Model Inputs	Program REM/Rate files, gas and electric billing data	Evaluated
Evaluated Model Results	Navigant calibrated energy simulation	Evaluated
Verified Gross Realization Rate	Program tracking data, Navigant calibrated energy simulation	Evaluated
NTG – Electric and Gas	Illinois Stakeholder Advisory Group	Deemed

2.2.2 Verified Net Program Savings Analysis Approach

Verified net energy and demand savings were calculated by multiplying the verified gross savings estimates by a deemed net-to-gross ratio (NTGR). In GPY5/EPY8, the NTGR estimates used to calculate the verified net savings were based on past evaluation research and approved through a consensus

⁷ A code baseline is not always appropriate if code compliance studies provide data to support adjustments to the “base case” code baseline scenario. Navigant concluded in GPY4/EPY7 that the IECC 2012 code compliance study did not provide data in a format that could support evaluation adjustments to the code baseline.

process managed through the Illinois Energy Efficiency Stakeholder Advisory Group (SAG)⁸. Table 2-4 presents the deemed NTGR.

Table 2-4. Net-to-Gross Ratios for Evaluation of the GPY5/EPY8 RNC Program

Program Path	GPY5/EPY8 Deemed NTG Value
Residential New Construction	1.00

Source: Documents available on the Illinois Energy Efficiency Stakeholder Advisory Group web site.

2.3 Process Evaluation

Navigant conducted in-depth interviews with ComEd, Nicor Gas, and RSR program staff and reviewed the program tracking system.

⁸ Source: Deemed NTGR values are available on the Illinois Energy Efficiency Stakeholder Advisory Group web site: http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_Final_GPY5_Consensus_NTG_Values_2015-03-01.pdf and [ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx](http://ilsagfiles.org/SAG_files/NTG/2016_02_26_Final_EMV_Recommendations.xlsx), which can be found on the IL SAG website here: <http://ilsag.info/net-to-gross-framework.html>

3. GROSS IMPACT EVALUATION

Navigant’s review of the RNC Program utility tracking data found ex ante gross savings of 314,237 therms and 539,419 kWh for GPY5/EPY8. The RNC Program achieved verified gross savings realization rates of 94 percent for natural gas savings and 101 percent for electricity savings and also accrued 276 kW of coincident demand savings. The resulting verified gross savings for GPY5/EPY8 are 296,111 therms and 547,451 kWh. The results in this section are presented by home tier level. Detailed results by model bin are shown in the Appendix.

3.1 Program Volumetric Findings

As shown in Table 3-1, the RNC Program completed a total of 895 homes in GPY5/EPY8, representing about 90 percent of the overall target of 1,000 homes set for this program year. Of these homes, 84 percent were in joint Nicor Gas and ComEd service territory, while the remaining 16 percent were in Nicor Gas territory only. Fifty-four builders and nine HERS rating companies were active in the program year, with 45 builders and eight raters completing homes. Table 3-1 shows the number of homes in each tier.

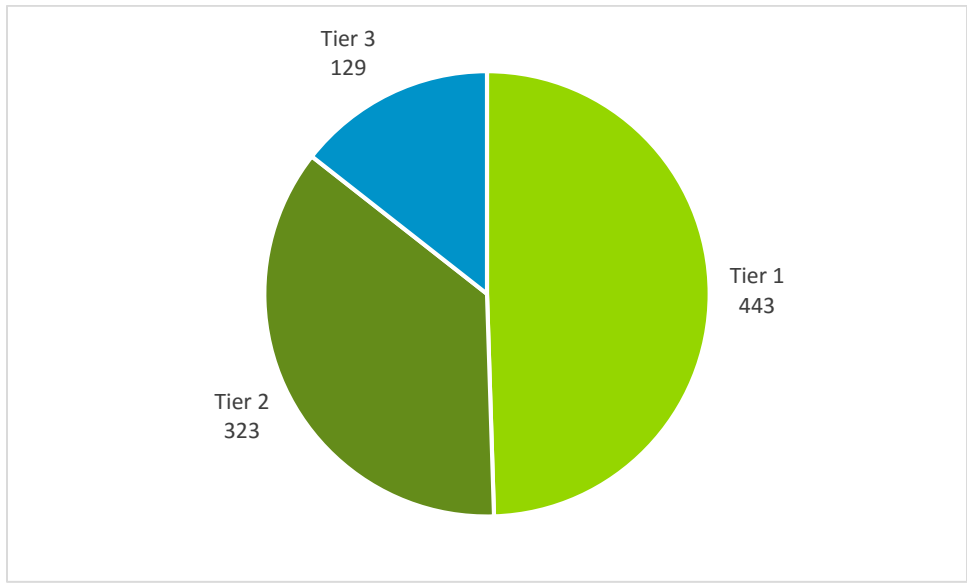
Table 3-1. GPY5/EPY8 RNC Program Volumetric Findings Detail

Participation Category	Joint Nicor Gas/ComEd Homes	Nicor Gas Homes	Total Homes
Tier 1	384	59	443
Tier 2	261	62	323
Tier 3	104	25	129
Total	749	146	895

Source: Navigant analysis of GPY5/EPY8 program tracking data.

Figure 3-1 shows the total number of homes in each tier in GPY5/EPY8. Similar to GPY4/EPY7, about 50 percent of homes were in the higher two efficiency tiers (at least 25 percent above code). However, the share of homes in Tier 3 decreased from 18% in GPY4/EPY7 to 14% in GPY5/EPY8. The comparison between GPY4/EPY7 and GPY5/EPY8 is shown in Table 3-2.

Figure 3-1. Number of Homes by Tier



Source: Navigant analysis of GPY5/EPY8 program tracking data.

Table 3-2. GPY5/EPY8 and GPY4/EPY7 Comparison

Participation Category	GPY5/EPY8 Total Homes	GPY5/EPY8 Share of Total*	GPY4/EPY7 Total Homes	GPY4/EPY7 Share of Total*
Tier 1	443	49%	440	50%
Tier 2	323	36%	273	31%
Tier 3	129	14%	161	18%
Total	895	100%	874	100%

Source: Navigant analysis of GPY5/EPY8 and GPY4/EPY7 program tracking data.

*Values may not sum to 100% due to rounding.

3.2 Verified Gross Program Impact Results

Table 3-3 and Table 3-4 show the resulting gas and electric calibrated model outputs for the program homes and corresponding IECC 2012 baseline models. These results reflect the use of a Typical Meteorological Year 3 (TMY3) weather file for the Chicago O'Hare Airport. The weighted average results reflect the contribution of each model bin to the total program savings. Navigant included lighting and appliances in the electric total consumption in both the baseline and efficient model case. All savings values account for interactive effects.

Table 3-3. Average Gross Ex Post Gas Savings per Home by Home Tier Level

Participation Category	Baseline Model Gas Consumption (TMY)	Efficient Model Gas Consumption (TMY)	Gross Ex Post Therm Savings	Gross Ex Post Percent Savings
Tier 1	1,300	1,027	273	21%
Tier 2	1,351	1,038	313	23%
Tier 3	1,612	1,170	442	27%
Weighted Average	1,363	1,052	312	23%

Source: Navigant team analysis.

Table 3-4. Average Gross Ex Post Electric Savings per Home by Home Tier Level

Participation Category	Baseline Model kWh Consumption (TMY)	Efficient Model kWh Consumption (TMY)	Gross Ex Post kWh Savings	Gross Ex Post Percent Savings
Tier 1	8,821	8,219	603	7%
Tier 2	9,564	8,897	668	7%
Tier 3	11,750	10,707	1,043	9%
Weighted Average	9,487	8,800	686	7%

Source: Navigant team analysis.

Table 3-5 shows the ex ante savings, realization rates, and verified gross savings for GPY5/EPY8. The overall realization rate was 94 percent for gas energy savings and 101 percent for electric energy savings. ComEd did not claim any ex ante demand savings; Navigant estimated coincident peak demand savings using hourly model outputs. As in GPY2/EPY5 and GPY4/EPY7, billing data annual gas consumption for the sampled homes was lower than the ex ante models predicted. This led to lower gas savings despite Navigant’s models’ similar percent savings results.

Table 3-5. GPY5/EPY8 RNC Program Impact Results

	Sample Size	Gross Energy Savings (Therms)	Gross Energy Savings (kWh)	Gross Peak Demand Savings (kW)
Tier 1				
Ex Ante Gross Savings		121,263	245,844	-
Verified Gross Realization Rate	364	103%	99%	-
Verified Gross Savings		125,318	242,337	126
Tier 2				
Ex Ante Gross Savings		122,289	190,752	-
Verified Gross Realization Rate	224	89%	98%	-
Verified Gross Savings		108,358	186,134	94.4
Tier 3				
Ex Ante Gross Savings		70,685	102,823	-
Verified Gross Realization Rate	122	88%	116%	-
Verified Gross Savings		62,436	118,981	55.7
Total				
Ex Ante Gross Savings		314,237	539,419	-
Verified Gross Realization Rate	710	94%	101%	-
Verified Gross Savings		296,111	547,451	276

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

Although program homes all exceeded code on a performance basis by at least 20 percent, Navigant observed that, on average, certain characteristics met individual code requirements more consistently than others. These average trends are shown in Table 3-6, where “above” code means more efficient than code and “below” code means less efficient than code. Significantly above code areas are indicated with green shading. Similar to previous years, program homes gained the most savings from air sealing, duct sealing, and heating equipment efficiency. The gains from above-code characteristics exceeded the losses from below-code components enough for all homes to still achieve net energy savings of at least 20 percent beyond code.

Table 3-6. Average Program Home Characteristics⁹

Category	Program Homes Relative to IECC 2012 and Current Standards
Wall Insulation	At or just above code
Ceilings/Roofs	At or just below code
Foundation/Floor Insulation	At or just below code
Window U-values	Equal to code
Air Sealing	Significantly above code
Major Appliances	At or just above standards
Lighting	Above code
Heating Equipment	Significantly above standard
Cooling Equipment	At or just above standard
Duct Sealing	Significantly above code
Duct Insulation	At or just above code
Water Heating	Above standard

Source: Navigant team analysis. Code reference is IECC 2012 with Illinois modifications.

Due to the variability in realization rates between the GPY2/EPY5 and GPY4/EPY7 evaluations, Navigant revisited the calibrated energy simulation to calculate gross impacts for GPY5/EPY8. Table 3-7 summarizes realization rates and energy savings by program year.

Table 3-7. Realization Rates and Energy Savings by Program Year

Program Year	Gas Realization Rate	Energy Savings (therms)	Electric Realization Rate	Energy Savings (kWh)	Impact Approach
GPY1/EPY4	n/a	n/a	n/a	n/a	n/a
GPY2/EPY5	91%	220,300	90%	250,645	Calibrated Simulation
GPY3/EPY6	91%	232,557	92%	507,943	Applied Realization Rates by Home Type from GPY2/EPY5
GPY4/EPY7	76%	232,651	123%	647,072	Calibrated Simulation
GPY5/EPY8	94%	314,237	101%	547,451	Calibrated Simulation

Source: Navigant team analysis.

The following factors likely contribute to the variability in realization rates:

- For the GPY2/EPY5 evaluation, Navigant did not have a full summer of data and could not accurately calibrate the non-heating gas load to characterize monthly use. The team calibrated the models based on the total gas consumption billed for all months between October 2012 and June 2013, which covered the majority of the heating season when the bulk of residential gas use

⁹ These averages are based on the evaluation team's gross impact modeling sample.

occurs. For the GPY5/EPY8 evaluation, Navigant received a full year of gas billing data and calibrated the models to match monthly loads.

- For the GPY2/EPY5 evaluation, Navigant determined that the electric billing data sample size was too small to calibrate the electric usage. Additionally, billing data was not available for all homes for the full cooling season. The team used the electricity consumption outputs from the calibrated gas models to estimate electric savings, introducing uncertainty in the electric results. For the GPY5/EPY8 evaluation, Navigant received a full year of electric billing data and calibrated the models to match both electricity and gas consumption.
- In GPY4/EPY7, billing data annual gas consumption for the sampled homes was lower than the ex ante models predicted. This led to lower gas savings despite the evaluation team's models' similar percent therm savings results.
- Relative to other program years, there were fewer attached homes in GPY4/EPY7. The small number of GPY4/EPY7 homes in the billing data sample (most were from GPY3/EPY6) may have reduced the accuracy of the extrapolation method Navigant used to estimate GPY4/EPY7 savings. The team did not pursue an alternative approach due to the small size of these model bins. Due to the small number of attached homes completed in GPY4/EPY7, the team included homes below the 20 percent requirement in the Attached Single Story bin.
- For the GPY4/EPY7 evaluation, Navigant used four model bins based on home type (one or two story, detached or attached), similar to the GPY2/EPY5 evaluation. Although each model was based on average home characteristics for all homes of that type, the models did not directly represent the variation in home characteristics by home tier level. As a result, there was a wide range of efficiency across each model bin.
- In the GPY5/EPY8 evaluation, Navigant created models based on home tier levels and calibrated each model using a full year of both gas and electric billing data. Grouping homes by tier level reduces the uncertainty in the extrapolation method because there is a smaller range of efficiency levels across each model bin when compared to grouping homes by only home type (one or two story, detached or attached).

4. NET IMPACT EVALUATION

Verified net energy savings were calculated by multiplying the verified gross savings estimates by a net-to-gross ratio. As noted in Section 2, the NTGR used to calculate the net verified savings for the GPY5/EPY8 RNC Program was deemed through a consensus process managed by the Illinois SAG. Table 4-1 below presents the NTGR used to calculate the program-level net savings.

Table 4-1. GPY5/EPY8 RNC Program NTGR Values

Program Path	GPY5/EPY8 Deemed NTGR	NTGR Source
Residential New Construction	1.00	SAG‡

‡ Deemed NTGR values are available on the Illinois Energy Efficiency Stakeholder Advisory Group web site: http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_Final_GPY5_Consensus_NTG_Values_2015-03-01.pdf and *ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx*, which can be found on the IL SAG website here: <http://ilsag.info/net-to-gross-framework.html>

Table 4-2 summarizes the gas and electric savings from the GPY5/EPY8 RNC program by home tier level.

Table 4-2. GPY5/EPY8 RNC Verified Net Impact Savings Estimates

	Gross Energy Savings (Therms)	Gross Energy Savings (kWh)	Gross Peak Demand Savings (kW)
Tier 1			
Ex Ante Gross Savings	121,263	245,844	-
Verified Gross Realization Rate	103%	99%	-
Verified Gross Savings	125,318	242,337	126
NTG	1.00	1.00	1.00
Verified Net Savings	125,318	242,337	126
Tier 2			
Ex Ante Gross Savings	122,289	190,752	-
Verified Gross Realization Rate	89%	98%	-
Verified Gross Savings	108,358	186,134	94.4
NTG	1.00	1.00	1.00
Verified Net Savings	108,358	186,134	94.4
Tier 3			
Ex Ante Gross Savings	70,685	102,823	-
Verified Gross Realization Rate	88%	116%	-
Verified Gross Savings	62,436	118,981	55.7
NTG	1.00	1.00	1.00
Verified Net Savings	62,436	118,981	55.7
Total			
Ex Ante Gross Savings	314,237	539,419	-
Verified Gross Realization Rate	94%	101%	-
Verified Gross Savings	296,111	547,451	276
NTG	1.00	1.00	1.00
Verified Net Savings	296,111	547,451	276

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

5. PROCESS EVALUATION

Navigant conducted in-depth interviews with ComEd, Nicor Gas, and RSR program staff and reviewed the program tracking system. The tracking system is collecting all of the data necessary to support program operations, quality assurance and quality control (QA/QC) procedures, and evaluation activities.

The process evaluation specifically sought to investigate two questions:

1. Are builders and raters satisfied with the program? What improvements, if any, would builders and raters like to see implemented?
2. How can the program be improved?

5.1 Builder and Rater Satisfaction and Relationship to Program

In GPY5/EPY8, the program offered a series of training sessions focused on sales practices for high-performance homes where builders learned how to effectively communicate the benefits of energy efficiency to consumers. Nicor Gas, ComEd, and RSR staff reported success and builder satisfaction with these training sessions and are working to make them even more accessible and available to a larger number of builders. These efforts should improve satisfaction and relationships with program builders and could attract non-participating builders to the program.

5.2 Customer Awareness and Marketing

The program is focusing on training and marketing. In GPY4/EPY7, builders found the program moderately effective at building homeowner awareness and gave varied responses on the effectiveness of the program at raising awareness of energy efficiency among other builders. In addition to focusing on builder sales practices, RSR, Nicor Gas, and ComEd should also consider other channels such as online, bill inserts, direct mail, radio, or television advertising to directly educate consumers and market the benefits of energy efficiency in new homes.

5.3 Energy Code Change

The IECC 2015 energy code with Illinois-specific amendments went into effect on January 1, 2016. All GPY5/EPY8 homes were built under the previous IECC 2012 energy code. The transition to the IECC 2015 code did not have a large impact on program operations and is expected to have a minor impact on energy efficiency. RSR made updates to the HouseRater software to reflect changes in the Illinois energy code.

6. FINDINGS AND RECOMMENDATIONS

This section summarizes the key impact and process findings and recommendations for the joint RNC program. The program continues to have strong participation even with higher participation requirements but has opportunities to attract builders and grow the program to meet future program targets. Navigant offers the following findings and recommendations to further improve the program in the future.

Verified Gross Impacts and Realization Rate

Finding 1. The program achieved a gross savings realization rate of 94 percent for natural gas and 101 percent for electricity. The resulting verified gross savings for GPY5/EPY8 are 296,111 therms and 547,451 kWh. Billing data annual gas consumption for the sampled homes was lower than the ex ante models predicted. This led to lower gas savings despite Navigant's models' similar percent savings results.

Finding 2. The evaluation team estimated peak demand impacts of 276 kW for GPY5/EPY8.

Finding 3. Although program homes all exceeded code on a performance basis by at least 20 percent, Navigant observed that, on average, certain characteristics met individual code requirements more consistently than others.

Recommendation 1. Work with builders and raters to improve areas that are at or just below code, such as ceiling/roof and foundation insulation levels, as well as those that are at or just above code, such as window U-values, major appliances, and cooling equipment. Specific actions could include RSR directing raters to focus on these areas or offering targeted builder trainings on these topics. These actions could help builders improve practices in these areas and achieve higher participation tiers, and may also reduce free-ridership.

Finding 4. The implementation team is fully justified in using REM/Rate as a tool to estimate ex ante savings for heating, cooling, and water heating end-uses while adding prescriptive savings estimates for lighting and appliances.

Recommendation 2. RSR should continue to accurately track and report lighting and appliance specifications to ensure accurate savings estimates for these end-uses. The evaluation team will continue to use modeled savings from lighting and appliances to fully capture interactive effects.

Verified Net Impacts

Finding 5. The program achieved verified net savings of 296,111 therms and 547,451 kWh for GPY5/EPY8. The electric savings exceeded the GPY5/EPY8 net savings target by 37 percent, while the gas savings fell short of the target by 17 percent.

Recommendation 3. Attract builders to the program through targeted outreach efforts or training sessions offered to both participating and non-participating builders.

Recommendation 4. Emphasize the higher efficiency tiers and encourage builders to go beyond typical improvements through program marketing and RSR outreach to individual raters and builders. These efforts could increase program savings and reduce free-ridership for the higher efficiency tiers.

Program Volumetric Findings

Finding 6. The RNC Program completed a total of 895 homes in GPY5/EPY8, falling short of the overall target of 1,000 homes set for this program year.

Recommendation 3. Attract builders to the program through targeted outreach efforts or training sessions offered to both participating and non-participating builders.

Finding 7. Similar to GPY4/EPY7, about 50 percent of homes were in the higher two efficiency tiers (at least 25 percent above code). However, the share of Tier 2 homes increased from 31% in GPY4/EPY7 to 36% in GPY5/EPY8 while the share of Tier 3 homes decreased from 18% to 14%.

Recommendation 4. Emphasize the higher efficiency tiers and encourage builders to go beyond typical improvements through program marketing and RSR outreach to individual raters and builders. These efforts could increase program savings and reduce free-ridership for the higher efficiency tiers.

Process Evaluation

Finding 8. Nicor Gas, ComEd, and RSR staff reported success and builder satisfaction with a new series of training sessions focused on sales practices.

Recommendation 5. Continue offering targeting training sessions focused on sales practices and educating consumers about the benefits of energy efficient homes. This type of training could increase participation and builder satisfaction.

Recommendation 6. In addition to focusing on builder sales practices, consider expanding on efforts to directly educate consumers about the benefits of energy efficiency in new homes. These efforts could include targeted advertising as well as educating the real estate community or supporting local efforts to promote recognition of high-performance homes.

Recommendation 7. RSR should continue to improve and maintain relationships with participating builders and the greater building community. The Build Smart newsletter and sales training offerings are positive aspects of this effort. RSR should continue offering builder training to the broader building community, including non-participants. This type of training could attract new builders to the program.

7. APPENDIX

7.1 Detailed Impact Approaches and Findings

7.1.1 Rationale for Use of BEopt in Gross Impact Evaluation

Navigant typically uses hourly simulation software for evaluations that require building modeling, both residential and commercial. In recent evaluations, the team used the EnergyPlus engine with NREL's Building Energy Optimization (BEopt) software as a front-end user interface. BEopt allows the user to run multiple building scenarios simultaneously and simplifies the data entry process. BEopt can also be used with the DOE-2 engine, which is used in many industry standard tools such as eQUEST.

Navigant believes the implementation team is fully justified in using REM/Rate as a tool to estimate ex ante savings for homes in the Residential New Construction Program: it is the industry standard for home rating, is widely used by HERS raters across the country, and provides reasonably accurate savings estimates. However, as an evaluator, Navigant's aim is to provide the most accurate savings estimates possible, and the team believes using software which is capable of hourly simulation is the best option for the impact analysis. The Department of Energy's Building America Research program gives the following explanation for using an hourly simulation:

An hourly simulation is often necessary to fully evaluate the time-dependent energy impacts of advanced systems used in Building America houses. Thermal mass, solar heat gain, and wind-induced air infiltration are examples of time-dependent effects that can be accurately modeled only by using a model that calculates heat transfer and temperature in short time intervals. An hourly simulation program is also necessary to accurately estimate peak energy loads.¹⁰

7.1.2 Gross Impact Findings

Navigant analyzed homes by grouping them into six "model bins." Table 7-1 shows the total number of homes and gross ex ante savings associated with each model bin, as well as the number of homes included in the analysis. Navigant attempted to include all homes from GPY3/EPY6, GPY4/EPY7, and GPY5/EPY8 which meet the following criteria:

1. **Homes must be completed by September 2015.** This ensured that all homes in the calibration sample had one year of billing data available for the calibration analysis.
2. **Homes must be built to IECC 2012.** This eliminated GPY3/EPY6 homes built to IECC 2009 and made the sample more representative of future participants.
3. **Homes must meet or exceed the GPY5/EPY8 requirement of 20 percent above code.** This made the sample more representative of GPY5/EPY8 and future years' participation.

¹⁰ Wilson et al. "2014 Building America House Simulation Protocols." National Renewable Energy Laboratory, March 2014. https://energy.gov/sites/prod/files/2014/03/f13/house_simulation_protocols_2014.pdf

Table 7-1. Distribution of Total Program Homes and Analysis Sample by Model Bin

Model Bin	Total GPY5/EPY8 Homes	Total Sampled Homes	Total Sampled GPY5/EPY8 Homes	Total Ex Ante Gross Therm Savings	Mean Ex Ante Gross Therms per Home	Total Ex Ante Gross kWh	Mean Ex Ante Gross kWh per Home
Tier 1, One Story	85	57	14	20,343	239	24,251	476
Tier 1, Two+ Story	358	307	72	100,920	282	221,593	665
Tier 2, One Story	46	15	4	14,868	323	10,910	606
Tier 2, Two+ Story	277	209	57	107,421	388	179,842	740
Tier 3, One Story	9	17	2	3,502	389	2,627	657
Tier 3, Two+ Story	120	105	20	67,183	560	100,196	1,002
Total	895	710	169	314,237	351	539,419	720

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

Navigant extracted all home characteristics for the sampled homes from the final REM/Rate files. The team then built models for each bin incorporating average home characteristics such as floor area, R-values, infiltration rates, and equipment specifications. Where REM/Rate did not contain data on the characteristics needed for the BEopt model inputs, Navigant defaulted to built-in Building America Benchmark data for new construction. Navigant calibrated each model to the corresponding billing data from program homes in each bin, excluding the consecutive “zero” readings prior to each home becoming occupied.

Table 7-2 and Table 7-3 show the results of the calibration adjustments for natural gas and electricity for each model bin. Navigant calibrated each model to within less than one percent of the billing data energy consumption. For the calibration modeling, Navigant used an actual weather file for the Chicago O’Hare airport for September 2015 – August 2016.

Table 7-2. Calibrated Gas Results by Model Bin

Model Bin	Ex Ante Consumption* (Therms)	Billed Calibration Period Consumption (Therms)	Modeled Calibration Period Consumption (Therms)	Difference (Therms)	Percent Difference
Tier 1 One Story	904	773	774	1.2	0.16%
Tier 1 Two+ Story	1,037	823	821	-1.6	-0.19%
Tier 2 One Story	919	690	695	5.0	0.73%
Tier 2 Two+ Story	1,068	836	841	5.3	0.63%
Tier 3 One Story	911	724	726	1.5	0.20%
Tier 3 Two+ Story	1,117	945	942	-3.2	-0.34%

*Includes all end uses

Source: Navigant team analysis.

Table 7-3. Calibrated Electric Results by Model Bin

Model Bin	Ex Ante Consumption* (kWh)	Billed Calibration Period Consumption (kWh)	Modeled Calibration Period Consumption (kWh)	Difference (kWh)	Percent Difference
Tier 1 One Story	8,889	8,007	8,028	21.0	0.26%
Tier 1 Two+ Story	9,381	8,857	8,815	-41.6	-0.47%
Tier 2 One Story	9,666	7,922	7,957	34.4	0.43%
Tier 2 Two+ Story	10,259	9,517	9,529	11.7	0.12%
Tier 3 One Story	9,353	7,597	7,605	7.6	0.10%
Tier 3 Two+ Story	11,192	11,528	11,445	-82.8	-0.72%

*Includes all end uses

Source: Navigant team analysis.

Table 7-4 and Table 7-5 show the resulting gas and electric calibrated model outputs for the program homes and corresponding IECC 2012 baseline models. These results reflect the use of a Typical Meteorological Year 3 (TMY3) weather file for the Chicago O'Hare airport. The weighted average results reflect the contribution of each model bin to the total program savings. Table 7-6 and Table 7-7 show the calibrated model outputs without interactive effects.

Table 7-4. Average Gross Ex Post Gas Savings per Home by Model Bin

Model Bin	Baseline Model Gas Consumption (Therms)	Efficient Model Gas Consumption (Therms)	Gross Ex Post Gas Savings (Therms)	Gross Ex Post Percent Savings
Tier 1, One Story	1,262	967	295	23%
Tier 1, Two+ Story	1,309	1,041	268	20%
Tier 2, One Story	1,199	870	329	27%
Tier 2, Two+ Story	1,376	1,066	310	23%
Tier 3, One Story	1,253	898	355	28%
Tier 3, Two+ Story	1,639	1,190	449	27%
Weighted Average	1,363	1,052	312	23%

Source: Navigant team analysis.

Table 7-5. Average Gross Ex Post Electric Savings per Home by Model Bin

Model Bin	Baseline Model Electric Consumption (kWh)	Efficient Model Electric Consumption (kWh)	Gross Ex Post Electric Savings (kWh)	Gross Ex Post Percent Savings
Tier 1, One Story	8,121	7,644	478	6%
Tier 1, Two+ Story	8,929	8,307	622	7%
Tier 2, One Story	8,146	7,596	550	7%
Tier 2, Two+ Story	9,669	8,993	676	7%
Tier 3, One Story	8,214	7,209	1,005	12%
Tier 3, Two+ Story	11,891	10,847	1,044	9%
Weighted Average	9,487	8,800	686	7%

Source: Navigant team analysis.

Table 7-6. Average Gross Ex Post Gas Savings per Home by Model Bin (without interactive effects)

Model Bin	Baseline Model Gas Consumption (Therms)	Efficient Model Gas Consumption (Therms)	Gross Ex Post Gas Savings (Therms)	Gross Ex Post Percent Savings
Tier 1, One Story	1,263	967	296	23%
Tier 1, Two+ Story	1,311	1,041	270	21%
Tier 2, One Story	1,202	870	332	28%
Tier 2, Two+ Story	1,379	1,066	313	23%
Tier 3, One Story	1,260	898	362	29%
Tier 3, Two+ Story	1,643	1,190	453	28%
Weighted Average	1,366	1,052	314	23%

Source: Navigant team analysis.

Table 7-7. Average Gross Ex Post Electric Savings per Home by Model Bin (without interactive effects)

Model Bin	Baseline Model Electric Consumption (kWh)	Efficient Model Electric Consumption (kWh)	Gross Ex Post Electric Savings (kWh)	Gross Ex Post Percent Savings
Tier 1, One Story	8,120	7,644	476	6%
Tier 1, Two+ Story	8,925	8,307	618	7%
Tier 2, One Story	8,142	7,596	547	7%
Tier 2, Two+ Story	9,665	8,993	672	7%
Tier 3, One Story	8,204	7,209	996	12%
Tier 3, Two+ Story	11,884	10,847	1,038	9%
Weighted Average	9,483	8,800	682	7%

Source: Navigant team analysis.

To calculate the overall gross savings realization rate, Navigant adjusted the gross savings by HERS score and floor area in order to account for differences in efficiency at the individual home level. Table 7-6 shows the average HERS score and floor area for both the sample and the program overall; the average HERS score for the overall program was better than the sample average, yielding higher per home savings at the program level than for the sample.

Table 7-8. Average HERS Scores and Floor Area by Model Bin, Sample and Program

Model Bin	Sample Average HERS Score	Program Average HERS Score	Sample Average Area (ft ²)	Program Average Area (ft ²)
Tier 1, One Story	56.5	56.7	3,739	3,611
Tier 1, Two+ Story	56.7	56.2	3,671	3,791
Tier 2, One Story	53.3	54.5	4,087	4,077
Tier 2, Two+ Story	54.5	53.9	4,043	4,339
Tier 3, One Story	52.9	51.3	3,854	4,522
Tier 3, Two+ Story	51.7	50.5	4,614	4,889
Total	55.1	54.6	3,942	4,113

Source: Navigant analysis of GPY5/EPY8 program tracking data.

Navigant found overall gross realization rates of 94 percent for natural gas and 101 percent for electric energy savings. Table 7-9 and Table 7-10 show these results as well as the calculated realization rates for each model bin. Table 7-11 and Table 7-12 show the results and realization rates without interactive effects.

Table 7-9: Ex Ante and Ex Post Gross Gas Savings by Model Bin

Model Bin	Ex Ante Gross Gas Savings per Home (Therm)	Ex Post Gross Gas Savings per Home (Therm)	Ex Ante Total Gross Gas Savings (Therm)	Gross Realization Rate	Ex Post Total Gross Gas Savings (Therm)
Tier 1, One Story	239	286	20,343	119%	24,271
Tier 1, Two+ Story	282	282	100,920	100%	101,047
Tier 2, One Story	323	320	14,868	99%	14,715
Tier 2, Two+ Story	388	338	107,421	87%	93,643
Tier 3, One Story	389	432	3,502	111%	3,888
Tier 3, Two+ Story	560	488	67,183	87%	58,548
Total	351	331	314,237	94%	296,111

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

Table 7-10. Ex Ante and Ex Post Gross Electric Savings by Model Bin

Model Bin	Ex Ante Gross Gas Savings per Home (kWh)	Ex Post Gross Gas Savings per Home (kWh)	Ex Ante Total Gross Gas Savings (kWh)	Gross Realization Rate	Ex Post Total Gross Gas Savings (kWh)
Tier 1, One Story	476	468	24,251	99%	23,890
Tier 1, Two+ Story	665	656	221,593	99%	218,446
Tier 2, One Story	606	538	10,910	89%	9,682
Tier 2, Two+ Story	740	726	179,842	98%	176,453
Tier 3, One Story	657	1,191	2,627	181%	4,763
Tier 3, Two+ Story	1,002	1,142	100,196	114%	114,217
Total	720	731	539,419	101%	547,451

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

Table 7-11: Ex Ante and Ex Post Gross Gas Savings by Model Bin

Model Bin	Ex Ante Gross Gas Savings per Home (Therm)	Ex Post Gross Gas Savings per Home (Therm)	Ex Ante Total Gross Gas Savings (Therm)	Gross Realization Rate	Ex Post Total Gross Gas Savings (Therm)
Tier 1, One Story	239	287	20,343	120%	24,368
Tier 1, Two+ Story	282	285	100,920	101%	101,926
Tier 2, One Story	323	323	14,868	100%	14,839
Tier 2, Two+ Story	388	341	107,421	88%	94,427
Tier 3, One Story	389	440	3,502	113%	3,958
Tier 3, Two+ Story	560	492	67,183	88%	59,091
Total	351	331	314,237	94%	298,609

Source: GPY5/EPY8 program tracking data and Navigant team analysis.

Table 7-12. Ex Ante and Ex Post Gross Electric Savings by Model Bin

Model Bin	Ex Ante Gross Gas Savings per Home (kWh)	Ex Post Gross Gas Savings per Home (kWh)	Ex Ante Total Gross Gas Savings (kWh)	Gross Realization Rate	Ex Post Total Gross Gas Savings (kWh)
Tier 1, One Story	476	467	24,251	98%	23,813
Tier 1, Two+ Story	665	652	221,593	98%	217,197
Tier 2, One Story	606	534	10,910	88%	9,619
Tier 2, Two+ Story	740	722	179,842	98%	175,361
Tier 3, One Story	657	1,180	2,627	180%	4,718
Tier 3, Two+ Story	1,002	1,135	100,196	113%	113,493
Total	720	727	539,419	101%	544,202

Source: GPY5/EPY8 program tracking data and Navigant team analysis.