NAVIGANT

Nicor Gas Economic Redevelopment Program GPY2 Evaluation Report

Final

Energy Efficiency Plan: Gas Plan Year 2 (6/1/2012-5/31/2013)

Presented to Nicor Gas Company

January 27, 2014

Prepared by:

Tim Stanton
Navigant

Crystal Berry
Navigant

ENERGY CENTER OF WISCONSIN

CNTenergy

www.navigant.com

© 2013 Navigant Consulting, Inc.

Submitted to:

Nicor Gas Company
1844 Ferry Road
Naperville, IL 60563

Submitted by:

Navigant Consulting, Inc.
30 S. Wacker Drive, Suite 3100
Chicago, IL 60606
Phone 312.583.5700
Fax 312.583.5701

Contact:

Randy Gunn, Managing Director
312.938.4242
randy.gunn@navigant.com

Julianne Meurice, Director
312.583.5740
julianne.meurice@navigant.com

Disclaimer: This report was prepared by Navigant Consulting, Inc. ("Navigant") for Nicor Gas based upon information provided by Nicor Gas and from other sources. Use of this report by any other party for whatever purpose should not, and does not, absolve such party from using due diligence in verifying the report's contents. Neither Navigant nor any of its subsidiaries or affiliates assumes any liability or duty of care to such parties, and hereby disclaims any such liability.

NAVIGANT

Table of Contents

E. Executive Summary 1
- E.1. Program Savings 1
- E.2. Project Savings 2
- E.4. Participation Information 2
- E.5. Conclusions and Recommendations 3

1. Introduction 5
- 1.1 Program Description 5
- 1.2 Evaluation Objectives 5
  - 1.2.1 Impact Questions 5
  - 1.2.2 Process Questions 5

2. Evaluation Approach 6
- 2.1 Primary Data Collection 6
  - 2.1.1 Overview of Data Collection Activities 6
  - 2.1.2 Verified Gross Program Savings Analysis Approach 6
  - 2.1.3 Verified Net Program Savings Analysis Approach 7
  - 2.1.4 Process Evaluation Approach 7

3. Gross Impact Evaluation 9
- 3.1 Tracking System Review 9
- 3.2 Program Volumetric Findings 9
- 3.3 Development of the Verified Gross Realization Rate 10
- 3.4 Verified Gross Program Impact Results 10

4. Net Impact Evaluation 12

5. Process Evaluation 13

6. Conclusions and Recommendations 15

7. Appendix 17
- 7.1 ComEd, Nicor, Peoples Gas, and North Shore Gas EM&V Reporting Glossary. December 17, 2013 17
- 7.2 Detailed Impact Research Findings and Approaches 22
  - 7.2.1 ERP-01 Project Review 22
  - 7.2.2 ERP-02 Project Review 29
  - 7.2.3 ERP-03 Project Review 31
  - 7.2.4 ERP-04 Project Review 39
  - 7.2.5 ERP-05 Project Review 44
  - 7.2.6 ERP-06 Project Review 50
  - 7.2.7 ERP-07 Project Review 55
  - 7.2.8 ERP-08 Project Review 59
  - 7.2.9 ERP-09 Project Review 62
  - 7.2.10 ERP-10 Project Review 65
  - 7.2.11 ERP-11 Project Review 69
  - 7.2.12 ERP-12 Project Review 72

7.2.13 ERP-13 Project Review 76
7.2.14 ERP-14 Project Review 79
7.2.15 ERP-15 Project Review 82

List of Tables

Tables

Table E-1. GPY2 Total Program Natural Gas Savings 1
Table E-2. GPY2 Program Results, Project Level 2
Table 2-1. Core Data Collection Activities 6
Table 3-1. Savings and Participation Goals of GPY1 and GPY2 10
Table 3-2. Savings Summary by Project 11
Table 7-1: ERP-01 Savings Summary 22
Table 7-2: ERP-02 Savings Summary 29
Table 7-3: ERP-03 Savings Summary 31
Table 7-4: ERP-04 Savings Summary 39
Table 7-5: ERP-05 Savings Summary 44
Table 7-6: ERP-06 Savings Summary 50
Table 7-7: ERP-07 Savings Summary 55
Table 7-8: ERP-08 Savings Summary 59
Table 7-9: ERP-09 Savings Summary 62
Table 7-10: Ex-Ante Savings Summary of Measure 63
Table 7-11. eQuest Model Simulation Summary 64
Table 7-12: ERP-10 Savings Summary 65
Table 7-13. Ex-Ante Savings Summary of Measures 66
Table 7-14: eQuest Modeling Review Results 67
Table 7-15: eQuest Model Simulation Summary 67
Table 7-16: ERP-11 Savings Summary 69
Table 7-17: HVAC Equipment related to Roof Insulation 71
Table 7-18: ERP-12 Savings Summary 72
Table 7-19: ERP-13 Savings Summary 76
Table 7-20: ERP-14 Savings Summary 79
Table 7-21: ERP-15 Savings Summary 82

E. Executive Summary

This report presents a summary of the findings and results from the Impact and Process Evaluation of the GPY2[1] (Gas Program Year 2) of the Nicor Gas Economic Redevelopment Program (ERP). The ERP targets existing commercial, industrial, and commercial-sized multifamily facilities and properties undergoing major renovation in established "redevelopment areas" and encourages that they incorporate energy efficiency measures into the renovation process. The program provides technical assistance and enhanced incentives to render energy efficiency projects more affordable within these economically challenged communities.

The ERP experienced slow participation uptake rates in GPY1 but, due to a successful marketing and outreach campaign, significantly increased program participation from one project in GPY1 to 15 projects in GPY2. However, the ERP will be discontinued as a separate program after GPY3, and only the remaining projects in the pipeline will be completed; additional projects will be directed to another Nicor Gas program. Details behind and reasons for the ERP's discontinuation are outlined in the process evaluation section of this report.

E.1. Program Savings

Table E-1 summarizes the natural gas savings from the ERP.

Table E-1. GPY2 Total Program Natural Gas Savings

Savings Category †	Energy Savings (Therms)
Ex-Ante Gross Savings	132,207
Net to gross ratio (NTGR) ‡	0.70
Ex-Ante Net Savings	92,545
Verified Gross Savings	112,363
Verified Gross Realization Rate §	0.85
Verified Net Savings	78,654

Source: Utility tracking data and Navigant analysis.
† See the Glossary in the Appendix for definitions
‡ A deemed value.
§ Based on evaluation research findings.

[1] The GPY2 program year began June 1, 2012 and ended May 31, 2013.

E.2. *Project Savings*

The following table summarizes the savings results by project.

Table E-2. GPY2 Program Results, Project Level

Project Code	Verification Method			Ex-Ante Gross Savings (therms)	Verified Gross Savings (therms)	Realization Rate
	Engineering File Review	Onsite M&V	Billing Analysis			
ERP-01	X	X	X	8,650	6,780	0.78
ERP-02	X	X		779	779	1.00
ERP-03	X	X		21,870	19,720	0.90
ERP-04	X	X	X	18,131	7,522	0.41
ERP-05	X	X		24,600	21,560	0.88
ERP-06	X	X		5,855	4,902	0.84
ERP-07	X	X	X	4,036	3,501	0.87
ERP-08	X			940	931	0.99
ERP-09	X			10,267	9,619	0.94
ERP-10	X			18,877	18,375	0.97
ERP-11	X			1,175	1,105	0.94
ERP-12	X			7,487	7,375	0.99
ERP-13	X			4,027	4,402	1.09
ERP-14	X			4,267	4,970	1.16
ERP-15	X			1,246	822	0.66
Total				**132,207**	**112,363**	**0.85**

Source: Utility tracking data and Navigant analysis.

E.4. *Participation Information*

The program had 15 participants in GPY2. Seven of these participants were similar multifamily facilities owned by the same management company. The remaining eight participants were renovations of various existing community-based commercial facilities. The measures implemented by these customers included HVAC system, water heating, and building envelope improvements.

E.5. Conclusions and Recommendations

Overall, the ERP made significant progress in program participation and savings in GPY2. The implementation contractor's (IC's) savings calculation methodologies were generally reasonable, as reflected by the verified realization rate of 0.85. Midway through GPY2, Nicor Gas determined that the ERP was not cost-effective and discontinued the program, deciding to complete only the remaining projects in the pipeline and to redirect any additional incoming projects to another Nicor Gas program. The demise of the program was likely attributed to (1) lack of upfront capital to fund energy efficiency projects by the customers and (2) longer implementation time periods required by the customers to complete energy efficiency projects.

The following provides insight into key program findings and recommendations.

Program Savings Goals Attainment

Finding 1. The ERP did not achieve its original or revised GPY2 ex-ante gross savings goals.

Gross Realization Rates

Finding 2. Navigant's GPY2 ERP evaluation resulted in a realization rate of 0.85.

Finding 3. Three out of the five projects with the lowest realization rates were evaluated using billing data to directly compare the pre- and post-implementation periods (ERP-01, ERP-04, and ERP-07).

Finding 4. Navigant determined a low realization rate for ERP-15. This project's ex-ante savings were a high percentage of the facility's billed gas consumption. The ex-ante savings methodology utilized customized algorithms and inputs rather than guidelines specified in the Illinois Technical Reference Manual (TRM[2]).

Recommendation 4A. Prior to approving incentive payment for a project, Navigant recommends that Nicor Gas compare the claimed savings to the site's billed energy usage to assess the reasonableness of the claimed savings.

Recommendation 4B. Navigant recommends that the IC use the Illinois TRM to calculate savings where applicable.

Review Process

Finding 5. Despite thorough review of the project files and follow-up with the IC, the Navigant team could not identify baseline conditions upon which the ex-ante savings calculations are dependent for some projects (i.e. ERP-06, ERP-08, and ERP-11).

Recommendation 5A. Verification of claimed savings is greatly aided when thorough documentation of baseline conditions is provided, including:

- Pre-existing equipment and operation description,
- Energy savings assumptions and methodologies,
- Standard maintenance practices and history, and
- Inspection results.

[2] State of Illinois Energy Efficiency Technical Reference Manual. Final as of September 14, 2012, effective June 1, 2012. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Illinois_Statewide_TRM_Version_1.0.pdf.

While the IC is collecting this information, Navigant stresses the importance of sufficient project documentation to accurately portray the program's selection of baseline conditions for all projects.

Process Evaluation Findings

Finding 6[3]**.** The two main factors that likely led to the discontinuation of the ERP were:

1. Customers lacked the upfront capital to fund energy efficiency projects; and
2. Customers needed longer implementation periods to complete energy efficiency projects.

Recommendation 6A. Navigant recommends that future programs aimed at community-based organizations increase the incentive amounts and/or restructure the program so that customers receive incentives earlier in the project timeline.

Recommendation 6B. Navigant recommends that future programs aimed at community-based organizations allow for extended multi-year project timelines, granting these organizations more time to collect funding to install energy efficiency measures.

Finding 7. Lack of upfront capital was more of a barrier for community-based organizations, such as churches, YMCAs, homeless shelters, community assistance centers, and other community-based organizations, than for multifamily facilities located in Tax Increment Financing (TIF) districts or enterprise zones. This was because community-based organizations prioritized their funds for community service and day-to-day operations rather than management staff of multifamily facilities who prioritize budget for facility improvement projects in order to retain tenancy.

Recommendation 7A. Navigant recommends that Nicor Gas consider implementing a shared savings program for these types of customers, providing upfront financial assistance and allowing the customer to pay back the investment with the savings associated with the project.

Finding 8. The most successful outreach strategy to customers was likely through utilization of CNT Energy's personal relationships with non-profit organizations to directly contact the people most involved in the energy efficiency investment decisions of these projects.

Recommendation 8A. Navigant encourages Nicor Gas to continue this method of outreach to these customer types as future potential ERP projects are absorbed into other Nicor Gas programs.

Finding 9. Economic development agencies did not provide a significant number of leads to potential customers because they typically focused on assisting large commercial customers to relocate their business rather than on commercial entities planning to renovate their existing facilities.

[3] The numbering of the findings is not in order because this section only shows a summary of the main findings and recommendations. The full list of findings and recommendations is outlined in Section 6.

1. Introduction

1.1 Program Description

The Economic Redevelopment Program (ERP) targets existing commercial, industrial, and commercial-sized multifamily facilities and properties undergoing major renovation in established "redevelopment areas" and encourages that they incorporate energy efficiency measures into the renovation process. The program provides technical assistance and enhanced incentives to render energy efficiency projects more affordable within these economically challenged communities. The Energy Center of Wisconsin (ECW) is the implementation contractor (IC) for this program. CNT Energy (a non-profit organization founded by the Center for Neighborhood Technology), located in Chicago, conducts marketing and outreach for the program, including recruiting qualified potential participants. The target audiences for outreach include chambers of commerce, economic development departments, building owners, architecture firms and contractors.

The ERP experienced slow participation uptake rates in GPY1 but, due to a successful marketing and outreach campaign, significantly increased program participation from one project in GPY1 to 15 projects in GPY2. However, the ERP will be discontinued as a separate program after GPY3, and only the remaining projects in the pipeline will be completed; additional project will be directed to another Nicor Gas program. Details behind and reasons for the ERP's discontinuation are described in the process evaluation section.

1.2 Evaluation Objectives

The Evaluation Team identified the following key researchable questions for GPY2:

1.2.1 Impact Questions

1. What is the level of gross annual energy (therm) savings induced by the program?
2. What are the net impacts from the program?
3. Did the program meet its therm savings goal? If not, why not?
4. Are the assumptions and calculations in compliance with standard engineering best practices? If not, what changes are required?

1.2.2 Process Questions

1. Is this program's eligibility criterion clearly defined or does it need additional detail for customer understanding?
2. How does the program appeal to state and/or local agencies (e.g. economic development agencies, chambers of commerce, cities, towns, etc.)?
3. Is the program's current structure compelling participants to engage in Comprehensive projects if they would not otherwise do so?
4. What are the sources of program awareness for "hard to reach customers" and how can the program implement marketing and outreach activities to engage these target markets?
5. Are customers and program partners satisfied with the program?
6. How effective are program design and processes? What opportunities exist for program improvement?

2. Evaluation Approach

This evaluation of the Economic Redevelopment Program reflects the second full-scale year of program operation. During GPY2, 15 customers participated in the ERP. These customers either were located in Tax Increment Financing (TIF) districts or planned to implement projects that had the potential to create jobs and/or create other positive community impacts.

2.1 Primary Data Collection

2.1.1 Overview of Data Collection Activities

The core data collection activities included onsite measurement and verification (M&V), billing analysis validation, and program manager and implementer staff interviews. The full set of data collection activities is shown in the following table.

Table 2-1. Core Data Collection Activities

N	What	Who	Target Completes	Completes Achieved	When	Comments
Impact Assessment						
1	Onsite M&V Audit	Participants	7	7	June 2013	The facilities of all seven of these projects were owned by the same management company
2	Billing Analysis Validation	Participants	N/A	3	June – September 2013	Onsite participant interview to determine if utility billing analysis is a valid method of savings verification.
Process Assessment						
3	In Depth Interviews	Program Manager/Implementer Staff	2	2	May – September 2013	-

Source: Navigant analysis.

2.1.2 Verified Gross Program Savings Analysis Approach

Navigant performed engineering file reviews for all 15 projects, onsite verification for seven projects, and billing analysis for three projects. The evaluation approaches for these methods are outlined below.

Engineering File Review:

1. Navigant reviewed the project files, including: program applications and agreements, project correspondence, project plans and specifications, savings analysis files, energy reports, and pre- and post-inspection reports.

2. Navigant verified the reasonability of the savings calculation methodology and baseline justification. If determined to be unreasonable, Navigant adjusted the methodology using the Illinois Technical Reference Manual (TRM[4]) where applicable or using an alternative savings calculation methodology.
3. Navigant adjusted any inputs of the savings methodology based on information found in the project files.

Onsite Verification Activities:

1. Navigant reviewed the project files and calculation methodology and developed an M&V plan to verify savings onsite.
2. An engineer from Navigant performed onsite verification activities to verify and collect the information specified in the M&V plan.
3. Navigant adjusted the savings methodology and parameters based on the site visit.

Billing Analysis (for heating measures):

1. Navigant determined the validity of using billing analysis as a savings calculation method for heating measures using the following factors: sufficient pre- and post-implementation data was available, the measures represented a significant portion of the energy bill, no other savings measures were implemented separate from the project, no outside factors affected energy consumption, and the use and occupancy of the building did not significantly change from the pre- to the post-implementation periods.
2. Navigant subtracted out the average summer gas use (i.e. non-heating gas use) to disaggregate the heating and non-heating portions of the gas bills and then normalized the pre- and post-implementation data to actual weather data (heating degree-days (HDDs)).
3. Navigant then subtracted the post- from the pre-implementation heating gas use per HDD and multiplied by the HDDs in a typical meteorological year (TMY3), representing the gas savings in a typical year.

2.1.3 Verified Net Program Savings Analysis Approach

Navigant did not perform NTG analysis of the ERP in GPY2 because the NTGR was deemed at 0.70 per SAG[5].

2.1.4 Process Evaluation Approach

Navigant mainly utilized interviews with the program manager and implementation contractor to gather information on the key process evaluation questions. The evaluation team originally planned to interview participating and non-participating agencies (e.g., chambers of commerce, cities/towns, economic redevelopment agencies, etc.) to attempt to better understand how these agencies reached out to potential ERP customers, why customers who learned about the ERP did or did not participate,

---

[4] State of Illinois Energy Efficiency Technical Reference Manual. Final as of September 14, 2012, effective June 1, 2012. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Illinois_Statewide_TRM_Version_1.0.pdf.

[5] Document provided by Nicor Gas to the SAG summarizing the SAG-approved NTGR for Nicor Gas for GPY1-GPY3 as negotiated in March-August 2013. Distributed in the SAG Meeting on August 5-6, 2013. http://ilsagfiles.org/SAG_files/Meeting_Materials/2013/August 5-6, 2013 Meeting/Nicor_Gas_NTG_Results_and_Application_GPY1-3.pdf.

what external factors may or may not have affected customer participation, and other program process-related issues. However, due to Nicor Gas' decision to discontinue the ERP after GPY3, this effort was withdrawn for better utilization of evaluation resources within Nicor Gas' energy efficiency program portfolio.

3. Gross Impact Evaluation

Navigant evaluated 15 ERP projects completed in GPY2 between June 1, 2012 and May 31, 2013 as part of this impact evaluation. Navigant's review found a realization rate of 85%, which yielded research findings gross savings totaling 112,363 therms. Applying the deemed net-to-gross ratio (NTGR) of 0.70 resulted in net research findings savings of 78,654 therms. Navigant used engineering file reviews, onsite verification, and billing analysis to verify the savings of these projects.

3.1 Tracking System Review

Navigant reviewed the program tracking system and determined that the system properly tracked the data necessary for evaluation. The tracking system included:

- Project Name
- Program Year
- Project Address
- Process Step
- Project Track
- Acceptance Status
- Project Description
- Project Criteria
- Ex-Ante Annual Gas Savings
- Estimated Completion Date
- Primary Contact: Account Name
- Primary Contact: Name
- Primary Contact: Phone
- Primary Contact: Mailing Address

3.2 Program Volumetric Findings

The following table compares the savings and participation goals of GPY1 and GPY2. In general, the program performed a fairly successful ramp-up of participation and savings in GPY2.

Table 3-1. Savings and Participation Goals of GPY1 and GPY2

Metric[6]	GPY1	GPY2
Participation Goal (# of projects)	8	16
Participation Actual (# of projects)	1	15
Ex-Ante Savings Goal (gross therms)	150,000	300,000[7]
Ex-Ante Savings Actual (gross therms)	893	132,207
Verified Gross Savings (therms)	893	112,363
Verified Realization Rate	1.00	0.85

Source: Navigant EM&V analysis

3.3 Development of the Verified Gross Realization Rate

Navigant developed the gross realization rate by comparing the verified gross savings to the ex-ante gross savings as outlined in the algorithm below:

$$Realization\ Rate = \frac{Verified\ Gross\ Savings}{Ex\ Ante\ Gross\ Savings}$$

Navigant used engineering file reviews, onsite verification, and billing analysis to determine the verified gross savings. Navigant used the tracking system, cross-checked with information in the project files, to determine the ex-ante gross savings.

3.4 Verified Gross Program Impact Results

The resulting total program verified gross savings is 112,363 therms as shown in the following table.

[6] Goals are provided in the approved Nicor Gas Energy Efficiency Plan 2011-2014, Revised Plan Filed Pursuant to Order Docket No. 10-0562. Dated: May 24, 2011. Filed with the Illinois Commerce Commission on May 31, 2011. Available at http://www.icc.illinois.gov/docket/files.aspx?no=10-0562&docId=167582.

[7] According to Navigant's preliminary GPY2 evaluation planning call with ECW on 3/4/2013, the ex-ante gross savings goal was increased at the beginning of GPY2.

Table 3-2. Savings Summary by Project

Project Code	Verification Method			Ex-Ante Gross Savings (therms)	Verified Gross Savings (therms)	Realization Rate
	Engineering File Review	Onsite M&V	Billing Analysis			
ERP-01	X	X	X	8,650	6,780	0.78
ERP-02	X	X		779	779	1.00
ERP-03	X	X		21,870	19,720	0.90
ERP-04	X	X	X	18,131	7,522	0.41
ERP-05	X	X		24,600	21,560	0.88
ERP-06	X	X		5,855	4,902	0.84
ERP-07	X	X	X	4,036	3,501	0.87
ERP-08	X			940	931	0.99
ERP-09	X			10,267	9,619	0.94
ERP-10	X			18,877	18,375	0.97
ERP-11	X			1,175	1,105	0.94
ERP-12	X			7,487	7,375	0.99
ERP-13	X			4,027	4,402	1.09
ERP-14	X			4,267	4,970	1.16
ERP-15	X			1,246	822	0.66
Total				**132,207**	**112,363**	**0.85**

Source: Navigant EM&V analysis

ERP-04, ERP-15, ERP-01, and ERP-06 had the lowest realization rates at 0.41, 0.66, 0.78, and 0.84, respectively. For ERP-01 and ERP-04, Navigant used monthly gas billing data to compare the site's pre- and post-implementation weather-normalized gas usage. The evaluation team assessed the validity of this savings calculation method by interviewing the project representative to determine if any external factors (e.g., gas leaks, change in building use, building envelope upgrades, etc.) or occupancy differences affected the pre- and post-implementation site gas usage comparison.
For ERP-06 and ERP-15, Navigant modified the savings methodology to include the guidelines presented by the Illinois TRM. For ERP-15, Navigant found an input parameter to the savings algorithm that was significantly lower than the value assumed in the ex-ante savings calculation. The evaluation team also determined that ERP-15's ex-ante savings were a high percentage of the facility's billed gas consumption.

Details behind the adjustments for all 15 projects are in the appendix (Section 7.2).

4. Net Impact Evaluation

NTGR was deemed by SAG[8] at 0.70 to be used to calculate GPY2 verified net savings.

[8] Document provided by Nicor Gas to the SAG summarizing the SAG-approved NTGR for Nicor Gas for GPY1-GPY3 as negotiated in March-August 2013. Distributed in the SAG Meeting on August 5-6, 2013. http://ilsagfiles.org/SAG_files/Meeting_Materials/2013/August 5-6, 2013 Meeting/Nicor_Gas_NTG_Results_and_Application_GPY1-3.pdf.

5. Process Evaluation

Navigant's process evaluation focused on the reasons for Nicor Gas' discontinuation of the ERP and answering the key process questions outlined in Section 1.2.2. The evaluation team interviewed the program manager and the implementer to gather this insight.

Towards the end of GPY2, Nicor Gas determined that the ERP was not achieving a desirable amount of savings in return for the resources allocated to the program and discontinued the ERP, deciding to complete only the remaining projects in the pipeline and to redirect any additional incoming projects to another Nicor Gas program. The demise of the program was likely attributed to two main factors:

1. **Customers lacked the upfront capital to fund energy efficiency projects**. These customers, such as churches, YMCAs, homeless shelters, community assistance centers, and other community-based organizations, operate on tight budgets and often prioritize spending on community service rather than on renovating their facilities for energy efficiency. Since incentives were not paid until after the project was completed, customers could not benefit from the incentive program in the initial investment period. Lack of upfront capital was more of a barrier for community-based organizations than for multifamily facilities located in TIF districts or enterprise zones because management staff of multifamily facilities prioritize budget for facility improvement projects in order to retain tenancy.
2. **Customers needed longer implementation periods to complete energy efficiency projects**. Community-based participants often relied on rounds of fundraising or grants to fund energy efficiency projects. As a result, these customers were only able to implement a small portion of the suggested measures in GPY2 before needing additional funding.

Navigant's answers to the key process questions outlined in Section 1.2.2 are included below, with the key questions *in italics*:

1. *Is this program's eligibility criterion clearly defined or does it need additional detail for customer understanding?*

Eligibility criterion was clearly defined: customers located in TIF or enterprise zones, or who offer community benefits were eligible to participate in the ERP.

2. *How does the program appeal to state and/or local agencies (e.g. economic development agencies, chambers of commerce, cities, towns, etc.)?*

CNT Energy utilized a number of personal relationships with non-profits and community assistance agencies to attract projects. Direct contact with projects' decision-makers using these existing relationships appeared to be the most successful method of outreach for the ERP. Economic development agencies did not provide a significant number of customer leads because they were better suited to assist large commercial customers planning to relocate their business rather than commercial entities planning to renovate their existing facilities.

3. *Is the program's current structure compelling participants to engage in Comprehensive projects if they would not otherwise do so?*

In GPY2, the program exclusively offered Comprehensive track projects, discontinuing its offering of Systems track projects.

4. *What are the sources of program awareness for "hard to reach customers" and how can the program implement marketing and outreach activities to engage these target markets?*

The most successful way to reach customers was utilizing personal relationships with various non-profits and community assistance agencies. CNT Energy also contacted chambers of commerce and economic development agencies, but these entities focused on assisting large commercial customers planning to relocate their business, which was not a target audience for the ERP. Additional funding and promotions would have been needed to influence these agencies to assist outside of their area-of-expertise.

5. *Are customers and program partners satisfied with the program?*

Navigant did not conduct customer or program partner surveys to assess program satisfaction. However, ECW self-reported that customers expressed high satisfaction with the technical assistance. Customers who received technical assistance but did not implement energy efficiency measures still benefited from technical assistance reports because they can consider ECW's suggestions in future investment decisions.

6. *How effective are program design and processes? What opportunities exist for program improvement?*

The program design and processes proved to be effective for multifamily facilities located in TIF and enterprise zones and some commercial organizations. However, for many community-based organizations (e.g., churches, YMCAs, homeless shelters, etc.), the incentive amounts were either not enough or were not delivered early enough in the project timeline. Since upfront capital was likely the largest barrier to completing these projects, the incentives paid at the completion of the project was not sufficient influence on the initial decision-making process.

The program could have been improved with higher incentives or alternative financing approaches that delivered incentives to customers earlier in the project timeline. Because of the program's planned discontinuation, other opportunities for program improvement were not explored in detail.

6. Conclusions and Recommendations

This section summarizes the key impact and process findings and recommendations.

Overall, the ERP made significant progress in program participation and savings in GPY2. However, Nicor Gas determined that the ERP was not cost-effective and discontinued the program, deciding to complete only the remaining projects in the pipeline and to redirect any additional incoming projects to another Nicor Gas program.

Impact Findings:

Program Savings Goals Attainment

Finding 1. The ERP did not achieve its original or revised GPY2 ex-ante gross savings goals.

Gross Realization Rates

Finding 2. Navigant's GPY2 ERP evaluation resulted in a realization rate of 0.85.

Finding 3. Three out of the five projects with the lowest realization rates were evaluated using billing data to directly compare the pre- and post-implementation periods (ERP-01, ERP-04, and ERP-07).

Finding 4. Navigant determined a low realization rate for ERP-15. This project's ex-ante savings were a high percentage of the facility's billed gas consumption. The ex-ante savings methodology utilized customized algorithms and inputs rather than guidelines specified in the Illinois TRM.

Recommendation 4A. Prior to approving incentive payment for a project, Navigant recommends that Nicor Gas compare the claimed savings to the site's billed energy usage to assess the reasonableness of the claimed savings.

Recommendation 4B. Navigant recommends that the IC use the Illinois TRM to calculate savings where applicable.

Review Process

Finding 5. Despite thorough review of the project files and follow-up with the IC, the Navigant team could not identify baseline conditions upon which the ex-ante savings calculations are dependent for some projects (i.e. ERP-06, ERP-08, and ERP-11).

Recommendation 5A. Verification of claimed savings is greatly aided when thorough documentation of baseline conditions are provided, including:

- Pre-existing equipment and operation description,
- Energy savings assumptions and methodologies,
- Standard maintenance practices and history, and
- Inspection results.

While the IC is collecting this information, Navigant stresses the importance of sufficient project documentation to accurately portray the program's selection of baseline conditions for all projects.

Process Findings:

Process Evaluation Findings

Finding 6. The two main factors that likely led to the discontinuation of the ERP were:

1. Customers lacked the upfront capital to fund energy efficiency projects; and
2. Customers needed longer implementation periods to complete energy efficiency projects.

Recommendation 6A. Navigant recommends that future programs aimed at community-based organizations increase the incentive amounts and/or restructure the program so that customers receive incentives earlier in the project timeline.

Recommendation 6B. Navigant recommends that future programs aimed at community-based organizations allow for extended multi-year project timelines, granting these organizations more time to collect funding to install energy efficiency measures.

Finding 7. Lack of upfront capital was more of a barrier for community-based organizations, such as churches, YMCAs, homeless shelters, community assistance centers, and other community-based organizations, than for multifamily facilities located in Tax Increment Financing (TIF) districts or enterprise zones. This was because community-based organizations prioritized their funds for community service and day-to-day operations rather than management staff of multifamily facilities who prioritize budget for facility improvement projects in order to retain tenancy.

Recommendation 7A. Navigant recommends that Nicor Gas consider implementing a shared savings program for these types of customers, providing upfront financial assistance and allowing the customer to pay back the investment with the savings associated with the project.

Finding 8. The most successful outreach strategy to customers was likely through utilization of CNT Energy's personal relationships with non-profit organizations to directly contact the people most involved in the energy efficiency investment decisions of these projects.

Recommendation 8A. Navigant encourages Nicor Gas to continue this method of outreach to these customer types as future potential ERP projects are absorbed into other Nicor Gas programs.

Finding 9. Economic development agencies did not provide a significant number of leads to potential customers because they typically focused on assisting large commercial customers to relocate their business rather than on commercial entities planning to renovate their existing facilities.

7. Appendix

7.1 ComEd, Nicor, Peoples Gas, and North Shore Gas EM&V Reporting Glossary. December 17, 2013

High Level Concepts

Program Year

- EPY1, EPY2, etc. Electric Program Year where EPY1 is June 1, 2008 through May 31, 2009, EPY2 is June 1, 2009 through May 31, 2010, etc.
- GPY1, GPY2, etc. Gas Program Year where GPY1 is June 1, 2011 through May 31, 2012, GPY2 is June 1, 2012 through May 31, 2013.

There are two main tracks for reporting impact evaluation results, called Verified Savings and Impact Evaluation Research Findings.

Verified Savings composed of

- Verified Gross Energy Savings
- Verified Gross Demand Savings
- Verified Net Energy Savings
- Verified Net Demand Savings

These are savings using deemed savings parameters when available and after evaluation adjustments to those parameters that are subject to retrospective adjustment for the purposes of measuring savings that will be compared to the utility's goals. Parameters that are subject to retrospective adjustment will vary by program but typically will include the quantity of measures installed. In EPY5/GPY2 the Illinois TRM was in effect and was the source of most deemed parameters. Some of ComEd's deemed parameters were defined in its filing with the ICC but the TRM takes precedence when parameters were in both documents.

Application: When a program has deemed parameters then the Verified Savings are to be placed in the body of the report. When it does not (e.g., Business Custom, Retrocommissioning), the evaluated impact results will be the Impact Evaluation Research Findings.

Impact Evaluation Research Findings composed of

- Research Findings Gross Energy Savings
- Research Findings Gross Demand Savings
- Research Findings Net Energy Savings
- Research Findings Net Demand Savings

These are savings reflecting evaluation adjustments to any of the savings parameters (when supported by research) regardless of whether the parameter is deemed for the verified savings analysis. Parameters that are adjusted will vary by program and depend on the specifics of the research that was performed during the evaluation effort.

Application: When a program has deemed parameters then the Impact Evaluation Research Findings are to be placed in an appendix. That Appendix (or group of appendices) should be labeled Impact Evaluation Research Findings and designated as "ER" for short. When a program does not have deemed parameters (e.g., Business Custom, Retrocommissioning), the Research Findings are to be in the body of the report as the only impact findings. (However, impact findings may be summarized in the body of the report and more detailed findings put in an appendix to make the body of the report more concise.)

Program-Level Savings Estimates Terms

N	Term Category	Term to Be Used in Reports‡	Application†	Definition	Otherwise Known As (terms formerly used for this concept)§
1	Gross Savings	Ex-ante gross savings	Verification and Research	Savings as recorded by the program tracking system, unadjusted by realization rates, free ridership, or spillover.	Tracking system gross
2	Gross Savings	Verified gross savings	Verification	Gross program savings after applying adjustments based on evaluation findings for only those items subject to verification review for the Verification Savings analysis	Ex post gross, Evaluation adjusted gross
3	Gross Savings	Verified gross realization rate	Verification	Verified gross / tracking system gross	Realization rate
4	Gross Savings	Research Findings gross savings	Research	Gross program savings after applying adjustments based on all evaluation findings	Evaluation-adjusted ex post gross savings
5	Gross Savings	Research Findings gross realization rate	Research	Research findings gross / ex-ante gross	Realization rate
6	Gross Savings	Evaluation-Adjusted gross savings	Non-Deemed	Gross program savings after applying adjustments based on all evaluation findings	Evaluation-adjusted ex post gross savings
7	Gross Savings	Gross realization rate	Non-Deemed	Evaluation-Adjusted gross / ex-ante gross	Realization rate
1	Net Savings	Net-to-Gross Ratio (NTGR)	Verification and Research	1 – Free Ridership + Spillover	NTG, Attribution
2	Net Savings	Verified net savings	Verification	Verified gross savings times NTGR	Ex post net
3	Net Savings	Research Findings net savings	Research	Research findings gross savings times research NTGR	Ex post net
4	Net Savings	Evaluation Net Savings	Non-Deemed	Evaluation-Adjusted gross savings times NTGR	Ex post net
5	Net Savings	Ex-ante net savings	Verification and Research	Savings as recorded by the program tracking system, after adjusting for realization rates, free ridership, or spillover and any other factors the program may choose to use.	Program-reported net savings

‡ "Energy" and "Demand" may be inserted in the phrase to differentiate between energy (kWh, Therms) and demand (kW) savings.

† **Verification** = Verified Savings; **Research** = Impact Evaluation Research Findings; **Non-Deemed** = impact findings for programs without deemed parameters. We anticipate that any one report will either have the first two terms or the third term, but never all three.

§ Terms in this column are not mutually exclusive and thus can cause confusion. As a result, they should not be used in the reports (unless they appear in the "Terms to be Used in Reports" column).

Individual Values and Subscript Nomenclature

The calculations that compose the larger categories defined above are typically composed of individual parameter values and savings calculation results. Definitions for use in those components, particularly within tables, are as follows:

Deemed Value – a value that has been assumed to be representative of the average condition of an input parameter and documented in the Illinois TRM or ComEd's approved deemed values. Values that are based upon a deemed measure shall use the superscript "D" (e.g., delta watts^{D}, HOU-Residential^{D}).

Non-Deemed Value – a value that has not been assumed to be representative of the average condition of an input parameter and has not been documented in the Illinois TRM or ComEd's approved deemed values. Values that are based upon a non-deemed, researched measure or value shall use the superscript "E" for "evaluated" (e.g., delta watts^{E}, HOU-Residential^{E}).

Default Value – when an input to a prescriptive saving algorithm may take on a range of values, an average value may be provided as well. This value is considered the default input to the algorithm, and should be used when the other alternatives listed for the measure are not applicable. This is designated with the superscript "DV" as in X^{DV} (meaning "Default Value").

Adjusted Value – when a deemed value is available and the utility uses some other value and the evaluation subsequently adjusts this value. This is designated with the superscript "AV" as in X^{AV}

Glossary Incorporated From the TRM

Below is the full Glossary section from the TRM Policy Document as of October 31, 2012[9].

Evaluation: Evaluation is an applied inquiry process for collecting and synthesizing evidence that culminates in conclusions about the state of affairs, accomplishments, value, merit, worth, significance, or quality of a program, product, person, policy, proposal, or plan. Impact evaluation in the energy efficiency arena is an investigation process to determine energy or demand impacts achieved through the program activities, encompassing, but not limited to: *savings verification*, *measure level research*, and *program level research*. Additionally, evaluation may occur outside of the bounds of this TRM structure to assess the design and implementation of the program.

Synonym: **Evaluation, Measurement and Verification (EM&V)**

> **Measure Level Research**: An evaluation process that takes a deeper look into measure level savings achieved through program activities driven by the goal of providing Illinois-specific research to facilitate updating measure specific TRM input values or algorithms. The focus of this process will primarily be driven by measures with high savings within Program Administrator portfolios, measures with high uncertainty in TRM input values or algorithms

[9] IL-TRM_Policy_Document_10-31-12_Final.docx

(typically informed by previous savings verification activities or program level research), or measures where the TRM is lacking Illinois-specific, current or relevant data.

Program Level Research: An evaluation process that takes an alternate look into achieved program level savings across multiple measures. This type of research may or may not be specific enough to inform future TRM updates because it is done at the program level rather than measure level. An example of such research would be a program billing analysis.

Savings Verification: An evaluation process that independently verifies program savings achieved through prescriptive measures. This process verifies that the TRM was applied correctly and consistently by the program being investigated, that the measure level inputs to the algorithm were correct, and that the quantity of measures claimed through the program are correct and in place and operating. The results of savings verification may be expressed as a program savings realization rate (verified ex post savings / ex ante savings). Savings verification may also result in recommendations for further evaluation research and/or field (metering) studies to increase the accuracy of the TRM savings estimate going forward.

Measure Type: Measures are categorized into two subcategories: custom and prescriptive.

Custom: Custom measures are not covered by the TRM and a Program Administrator's savings estimates are subject to retrospective evaluation risk (retroactive adjustments to savings based on evaluation findings). Custom measures refer to undefined measures that are site specific and not offered through energy efficiency programs in a prescriptive way with standardized rebates. Custom measures are often processed through a Program Administrator's business custom energy efficiency program. Because any efficiency technology can apply, savings calculations are generally dependent on site-specific conditions.

Prescriptive: The TRM is intended to define all prescriptive measures. Prescriptive measures refer to measures offered through a standard offering within programs. The TRM establishes energy savings algorithm and inputs that are defined within the TRM and may not be changed by the Program Administrator, except as indicated within the TRM. Two main subcategories of prescriptive measures included in the TRM:

Fully Deemed: Measures whose savings are expressed on a per unit basis in the TRM and are not subject to change or choice by the Program Administrator.

Partially Deemed: Measures whose energy savings algorithms are deemed in the TRM, with input values that may be selected to some degree by the Program Administrator, typically based on a customer-specific input.

In addition, a third category is allowed as a deviation from the prescriptive TRM in certain circumstances, as indicated in Section 3.2:

Customized basis: Measures where a prescriptive algorithm exists in the TRM but a Program Administrator chooses to use a customized basis in lieu of the partially or fully deemed inputs. These measures reflect more customized, site-specific

calculations (e.g., through a simulation model) to estimate savings, consistent with Section 3.2.

7.2 Detailed Impact Research Findings and Approaches

7.2.1 ERP-01 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-01
Verification Method: Onsite M&V, Engineering File Review, and Billing Analysis

Navigant's evaluation of this project consisted of an engineering file review, billing analysis, and onsite verification activities. Navigant's evaluation verified the annual energy savings to be 6,780 therms, resulting in a project realization rate of 0.78, summarized in Table 7-1.

The primary reason for the difference in the ex-ante and research findings gross savings is that the energy model used to calculate ex-ante savings overestimated the gas savings due to heating system measures.

Table 7-1: ERP-01 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Increase venting and balance steam heating system (same set-point across building)	1,907	1,449	0.76
Insulate all exposed DHW pipes (basement, garages, storage spaces) to R-4.5	1,993	1,653	0.83
Lower DHW temperature to lowest allowable by code	280	280	1.00
Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board	2,337	1,776	0.76
Insulate all exposed steam pipes (basement, garages, storage spaces) to R-6	2,134	1,622	0.76
Total	**8,650**	**6,780**	**0.78**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-01 Customer implemented energy efficiency measures at their multifamily housing facility with a project completion date of 12/1/2012. The project was completed as part of the ERP because the facility was located in a TIF district.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions
The following text outlines the baseline conditions identified by onsite verification and review of the project files:

- Building description: Multifamily facility built in the 1920s
- Walls: Brick with air gap; minimal air sealing
- Roof: Minimal insulation
- Windows: 10-15 years old; double-paned; vinyl frame
- Unbalanced steam distribution system
- No insulation on steam pipes
- No insulation on DHW pipes
- Minimal air sealing in basement
- DHW Temperature Setting: 130˚F

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: Increase venting and balance steam heating system
The IC used the following algorithm to calculate gas savings from this measure:

$$Therms\ Saved = (1 - \%\ Lacking\ Steam) * Heating\ days * Temp\ Increase * Avg\ Therms\ per\ HDD$$

Algorithm Parameter	Value	Unit	Source/Description
% Lacking Steam	50	%	Portion of the building not receiving adequate steam
Heating days	142.02	Days (equivalent)	212 heating days*67% to account for time the boiler is not in use during the heating season
Temp Increase	3	˚F	Assumed; temperature increase required to deal with imbalance of steam heating system
Avg Therms per HDD	8.95	therms/HDD	Linear regression of degree days to therms used
Therms Saved	1,907	therms	Calculated; excess therms required to heat the rest of the building

Source: Navigant's analysis of project files

Measure: Insulate all exposed DHW pipes to R-4.5

The technical assistance team used a pipe insulation calculator[10] to estimate the energy loss factor associated with poorly insulated pipes. The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Pipe\ Length * \frac{Loss\ Factor}{Avg\ Boiler\ Efficiency}$$

Algorithm Parameter	Value	Unit	Source/Description
Pipe Length	491	feet	Measured onsite
Loss Factor	2.76	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	68	%	Assumed
Therms Saved	1,993	therms	Calculated

Source: Navigant's analysis of project files

Measure: Lower DHW temperature to lowest allowable by code

The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Avg\ Summer\ Gas\ Use * 12\frac{months}{year} * \%\ DHW\ Savings * 0.8$$

Algorithm Parameter	Value	Unit	Source/Description
Avg Summer Gas Use	636	therms	Utility gas bills
% DHW Savings	4.6%	%	Modeled results from Nicor ERP and Energy Savers
0.8	0.8	-	Assumed ratio of DHW to avg summer gas use
Therms Saved	280	therms	Calculated

Source: Navigant's analysis of project files

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board

The IC estimated the gas savings from this measure based on Energy Savers audit reports. The following was included in the analysis file provided by the IC:

"Energy Savers basement air sealing measure is based on the R-value of insulation in rim joists and typical infiltration values for this type of basement. Their formula has been tuned from utility bill monitoring of dozens of similar buildings. As a further constraint, we benchmark total air sealing energy savings to be at most 30% of gas usage; a typical anecdotal limit to potential; with limited information on this building, a very conservative portion of this leakage (15%) has been attributed to the basement."

[10] http://www.wbdg.org/design/midg_design_echp.php

The ex-ante savings calculation estimated the annual gas savings due to this measure at 2,337 therms.

Measure: Insulate all exposed steam pipes (basement, garages, storage spaces) to R-6
The technical assistance team used a pipe insulation calculator[11] to estimate the energy loss factor associated with poorly insulated pipes. The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Pipe\ Length * \frac{Loss\ Factor}{Avg\ Boiler\ Efficiency}$$

Algorithm Parameter	Value	Unit	Source/Description
Pipe Length	309	feet	Measured onsite
Loss Factor	5.18	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	75	%	Assumed
Therms Saved	2,134	therms	Calculated

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed onsite verification activities at this site on June 27, 2013. The measure-level findings and analysis of the site visit are outlined below.

Billing Analysis: All space heating measures
Navigant interviewed the site representative to determine the validity of using billing analysis as a verification method. This interview revealed that no non-ERP energy efficiency measures were implemented at this site, no major changes were made to the building envelope or HVAC system besides the measures implemented as part of the ERP, and no gas leaks or other problems arose that would have affected the facility's gas usage. Navigant also acquired building tenancy data from the building's manager which showed a trivial change in average occupancy: 97.7% in the pre-implementation period and 97.5% in the post-implementation period. Thus Navigant executed a weather-normalized comparison of the pre- and post-implementation gas billing data to estimate gas savings due to the facility's heating system upgrades.

Navigant first calculated the 2011 and 2012 summer monthly gas use averages to determine the non-heating portion of the gas billing data. Separate averages for summer 2011 and summer 2012 were calculated to account for behavioral changes and the installation of non-heating system gas efficiency measures. Navigant performed a regression analysis of the heating portion of the gas billing data and monthly HDDs and found an R^2 of 0.99 and 0.75 for the pre- and post-implementation periods, respectively. The evaluation team calculated pre- and post-implementation weather-normalized gas consumption at 7.87 and 6.78 therms per HDD60, respectively. Thus, Navigant found a savings of 1.09 therms per HDD60 for the facility's heating system, resulting in 4,843 therms of savings for an average year using Chicago-O'Hare TMY3 weather data (4,449 HDD60s, excluding summer).

[11] http://www.wbdg.org/design/midg_design_echp.php

Compared to 6,378 therms of combined ex-ante savings (all heating system measures), Navigant verified that the realization rate for all heating system measures is 0.76.

Measure: Increase venting and balance steam heating system

This multifamily facility, since it was built in the 1920s, uses steam distributed through a pipe network to transfer heat from the steam boiler to individual apartment units. This system was not originally designed for efficiency and did not provide even distribution of heat. By installing steam vents, the rate of steam flow to individual apartment units' radiators can be adjusted to prevent overheating in apartment units near the steam boiler and under-heating in apartment units far from the steam boiler.

Navigant verified new steam venting devices and radiator air vents to balance the steam distribution system, shown below in Figure 7-1.

Figure 7-1: ERP-01 Steam Vents

Source: Navigant's onsite verification on July 27, 2013

Navigant performed a gas billing data analysis (summarized in the previous section) on all measures related to the heating system of this facility. Based on the billing analysis, Navigant verified that the annual savings for this measure are 1,449 therms.

Measure: Insulate all exposed DHW pipes to R-4.5

Navigant verified that approximately 491 feet of DHW pipes were insulated, with a segment of the insulated pipes shown below in Figure 7-2.

Figure 7-2: ERP-01 DHW Insulation

Source: Navigant's onsite verification on July 27, 2013

Navigant identified the DHW boiler as an A.O. Smith HW-420 932 with 82% nameplate efficiency. Replicating the algorithm used in the ex-ante savings calculation with the originally used pipe length and loss factor and a DHW boiler efficiency of 82%, the research findings annual savings for this measure are 1,653 therms.

Measure: Lower DHW temperature to lowest allowable by code

Navigant observed the DHW temperature setting to be 125˚F. The Illinois TRM specifies a baseline DHW temperature setting at 135˚F. According to documentation in the analysis file[12], there was a 10˚F turn-down. Therefore, Navigant made no adjustments, and the research findings annual savings for this measure are 280 therms.

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board

Navigant verified thorough ceiling air sealing, spray foam over window and wall leaks, and rigid foam board over rim joists in the basement of the facility.

Navigant performed a gas billing data analysis (summarized above) on all measures related to the heating system of this facility. Based on the billing analysis, Navigant verified that the annual savings for this measure are 1,776 therms.

Measure: Insulate all exposed steam pipes (basement, garages, storage spaces) to R-6

Navigant verified that approximately 309 feet of steam pipe insulation was installed as part of the project. Navigant identified the steam boiler as a Weil-McLain Model 88 Series 2 boiler (model 1288). The nameplate efficiency for this steam boiler is 85.6%[13].

---

[12] "Nicor Gas ERP Energy Calculations – 101 Harvey – Verification.xlsx" → "Other ECM Calcs" tab

[13] Weil-McLain Specifications of the 88 Series 2 Commercial Gas Oil Boiler (http://weil-mclain.com/en/weil-mclain/pd-88-series-2-commercial-gas-oil-boiler/)

Navigant performed a gas billing data analysis (summarized above) on all measures related to the heating system of this facility. Based on the billing analysis, Navigant verified that the annual savings for this measure are 1,622 therms.

RECOMMENDATIONS FOR FUTURE PROJECTS

Navigant does not have any recommendations based on evaluation of this project.

7.2.2 ERP-02 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-02
Verification Method: Onsite M&V and Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review and onsite verification activities performed by a Navigant engineer on June 27, 2013. Navigant's evaluation verified the annual energy savings to be 779 therms, resulting in a realization rate of 1.00, summarized in Table 7-2.

Table 7-2: ERP-02 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joints with rigid foam board	779	779	1.00
Total	**779**	**779**	**1.00**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-02 Customer implemented energy efficiency measures at their multifamily housing facility with a project completion date of 12/1/2012. The project was completed as part of the ERP because the facility was located in a TIF district.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions
The following text outlines the baseline conditions identified by onsite verification and/or review of the project files:

- Building description: Multifamily facility built in the 1920s
- Walls: Brick with air gap; minimal air sealing
- Minimal air sealing in the basement
- Roof: Minimal insulation
- Windows: 10-15 years old; double-paned; vinyl frame

Energy Efficient Conditions
The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joints with rigid foam board

The IC estimated gas savings from this measure based on an inverse energy model developed by Energy Savers of five similar vintage and construction type multifamily buildings. The model takes

building usage and envelope data, and backs out infiltration and air sealing savings. Using this model, a regression analysis on these five data points resulted in 41 therms saved per residential unit. Therefore, for this 19-unit building, the ex-ante savings were 779 therms.

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed onsite verification activities at this site on June 27, 2013. The measure-level findings and analysis of the site visit are outlined below.

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joints with rigid foam board

Navigant visually verified thorough ceiling air sealing, spray foam over window and wall leaks, and rigid foam board over rim joists in the basement of the facility. An example of the basement air sealing is shown in Figure 7-3.

Figure 7-3: ERP-02 Air Sealing

Source: Navigant's onsite verification on July 27, 2013

Navigant could not perform a billing analysis on this project due to lack of pre-implementation gas billing data.

Navigant considers the Energy Savers methodology of using modeled results from five similar buildings, normalized to the number of apartment units, to be reasonable. Therefore, the research findings annual savings for this measure are 779 therms.

RECOMMENDATIONS FOR FUTURE PROJECTS

Navigant does not have any recommendations based on evaluation of this project.

7.2.3 ERP-03 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-03
Verification Method: Onsite M&V and Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review and onsite verification activities performed by a Navigant engineer on June 27, 2013. Navigant's evaluation verified the annual energy savings to be 19,720 therms, resulting in a realization rate of 0.90, summarized in Table 7-3.

The primary reason for the difference in the ex-ante and research findings gross savings is that the ex-ante savings calculations for multiple measures do not apply accurate boiler efficiencies. The steam boilers' efficiencies were verified via combustion analysis testing, but the ex-ante savings calculation for other measures dependent on the steam boiler efficiency did not use verified efficiency parameters. In addition, while the IC accurately adjusted the DHW boiler efficiency retroactively in the "Verification Changes" line item for one measure, they did not adjust this value in the savings calculations for other measures dependent on the DHW boiler efficiency.

The secondary reason for the difference in the ex-ante and research findings gross savings is that the IC's energy model calculated energy savings using parametric runs without considering the interactive effect of multiple measures. Specifically, the IC's energy model calculated savings from basement air sealing using an inefficient boiler despite the boiler also being tuned-up as part of this project and the related savings separately captured.

Table 7-3: ERP-03 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Air sealing basement windows, rim joists, doors	1,786	1,415	0.79
Tune-up and control improvement to existing boiler	1,706	1,352	0.79
Install new DHW boiler (>95%+ eff.)	2,077	997	0.48
Replace boiler room vent with mechanical louver	255	0	0.00
Insulate all remaining uninsulated steam pipes	5,098	4,346	0.85
Insulate all remaining uninsulated DHW pipes	2,013	2,333	1.16
Repair/replace all failed steam traps	8,505	7,770	0.91
Air seal apartment units: baseboard, windows, doors	1,765	1,507	0.85
Verification changes (see below)	-1,335	N/A	N/A
Total	**21,870**	**19,720**	**0.90**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-03 Customer implemented energy efficiency measures at their 35-unit multifamily apartment building with a project completion date of 1/12/2013. The project was completed as part of the ERP because the facility was located in a TIF district.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions
The IC used an energy model calibrated to billing data to estimate existing baseline gas usage. This baseline model included the following inputs:

- Windows: Single pane, U-0.95, SHGC = 0.95
- Walls: Brick with air gap; minimal air sealing
- Roof: 75% R-38 blown-in cellulose
- Boiler: 67% efficiency
- No insulation on steam pipes
- No insulation on DHW pipes
- Minimal air sealing in basement

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: Air sealing basement windows, rim joists, doors
This measure consists of the use of two-part spray foam and rigid foam board (for larger gaps) to seal all leaks in the basement envelope (primarily window frames, rim joists, and doors). The IC used a TRACE 700 energy model to compare the energy use of the baseline case versus an efficient case with the air sealing measure. The energy model reduced the garage infiltration rate from 1.7 air changes per hour (ACH) in the baseline case to 0.8 ACH in the air sealing case. The energy model output was an estimated annual gas savings of 1,786 therms.

Measure: Tune-up and control improvement to existing boiler
This measure includes the installation of new boiler controls including a cutout control on two boilers located at this site. In addition, a professional contractor completed the following steps in tuning the boiler: (1) measure combustion efficiency, (2) optimize air flow, (3) optimize burner input, (4) clean and inspect burners/chamber/HX, (5) check venting, (6) visually inspect piping/insulation, (7) check safety control, (8) verify adequate combustion air.

The IC used a TRACE 700 energy model to compare the energy use of the baseline case versus including the boiler tune-ups. The energy model used a boiler efficiency of 67% and 70% in the baseline and boiler tune-up cases, respectively. The ex-ante savings calculation estimated the annual gas savings due to this measure at 1,706 therms.

Measure: Install new DHW boiler (>95%+ eff.)
The IC used a TRACE 700 energy model to compare the energy use in the baseline case and the energy use including the new DHW boiler. The energy model used a boiler efficiency of 70% and 95%

in the baseline and new DHW boiler cases, respectively. The ex-ante savings calculation estimated the annual gas savings due to this measure at 2,077 therms.

Measure: Replace boiler room vent with mechanical louver
The IC estimated the gas savings from this measure based on a TRACE 700 energy model. The ex-ante savings calculation estimated the annual gas savings due to this measure at 255 therms.

Measure: Insulate all remaining uninsulated steam pipes
This measure consists of insulating existing steam piping (R-6) where current insulation is failing, inadequate, or missing. The technical assistance team used a pipe insulation calculator[14] to estimate the energy loss factor associated with poorly insulated pipes. The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Pipe\ Length * \frac{Loss\ Factor}{Avg\ Boiler\ Efficiency}$$

Algorithm Parameter	Value	Unit	Source/Description
Pipe Length	811	feet	Measured onsite
Loss Factor	4.4	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	70%	%	Assumed efficiency of steam boiler
Therms Saved	5,098	therms	Calculated

Source: Navigant's analysis of project files

Measure: Insulate all remaining uninsulated DHW pipes
This measure consists of insulating existing DHW piping (R-4.5) where current insulation is failing, inadequate, or missing. The technical assistance team used a pipe insulation calculator[15] to estimate the energy loss factor associated with poorly insulated pipes. The gas savings for this measure were calculated via the following algorithm:

[14] http://www.wbdg.org/design/midg_design_echp.php
[15] http://www.wbdg.org/design/midg_design_echp.php

$$Therms\ Saved = Pipe\ Length * \frac{Loss\ Factor}{Avg\ Boiler\ Efficiency}$$

Algorithm Parameter	Value	Unit	Source
Pipe Length	693	feet	Measured onsite
Loss Factor	2.76	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	95%	%	Assumed efficiency of DHW boiler
Therms Saved	2,013	therms	Calculated

Source: Navigant's analysis of project files

Measure: Repair/replace all failed steam traps

This measure consists of repairing or replacing 52 failed steam traps. The ex-ante gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = \frac{\#\ Traps * Steam\ Loss * DRF * OpHrs * \frac{therms}{100\ lbs}}{Boiler\ eff} * (1 - Other)$$

Algorithm Parameter	Value	Unit	Source/Description
# Traps	52	traps	Number of steam traps
Steam Loss	15	lb/hr	From: http://uesystems.com/tech_support_charts_steam_loss.asp
DRF	0.5	-	Derating factor (TRM)
OpHrs	1880	hours	Based on 8 hours/day during heating season
Therms/100 lbs	0.01	Therms/lbs	Conversion factor
Boiler eff	75%	%	Steam boiler efficiency
Other	0.13	-	Fraction of heating savings captured in other measures
Therms Saved	8,505	therms	Calculated

Source: Navigant's analysis of project files

Measure: Air seal apartment units: baseboard, windows, doors

This measure consists of sealing the baseboards with foam and caulk, caulking around the storm windows, and weather-stripping the rear doors. The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = \#\ of\ Units * Savings\ per\ Unit * (1 - \%other)$$

Algorithm Parameter	Value	Unit	Source/Description
# of Units	35	Apartment units	Onsite
Savings per Unit	58	Therms	Energy Savers model
%other	13.1%	%	Modeled results; Usage saved by previous measures
Therms Saved	1,765	Therms	Calculated

Source: Navigant's analysis of project files

Verification changes

The IC adjusted the final savings results due to the verified DHW boiler efficiency of 82% (originally assumed at 95%). This adjustment resulted in a change in the reporting savings of the "Install new DHW" measure and was calculated via the following algorithm:

$$Verification\ Changes = Savings\ from\ new\ DHW * \frac{eff_{baseline} - eff_{EE\ verified}}{eff_{EE\ assumed} - eff_{baseline}}$$

Algorithm Parameter	Value	Unit	Source/Description
Savings from new DHW	2,077	Therms	Energy Model
$eff_{EE\ verified}$	82	%	Combustion analysis test results located in project files
$eff_{EE\ assumed}$	95	%	Assumed
$eff_{baseline}$	70	%	Assumed
Verification	-1,080	Therms	Calculated

Source: Navigant's analysis of project files

Additionally, the project did not replace the boiler room vent with a mechanical louver, resulting in a 255 therm reduction in savings.

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Due to the complexity of this project, Navigant explored the opportunity of using billing analysis to compare the pre- and post-implementation gas usage to determine annual gas savings. Based on an onsite interview with the property manager, Navigant learned that a condensate leak was found after the project was implemented which skewed the gas use for a portion of the post-implementation period. Thus, billing analysis is not a reasonable method for calculating gas savings.

Navigant performed onsite verification activities at this site on June 27, 2013. The findings of the site visit are outlined below.

Measure: Air sealing basement windows, rim joists, doors
Measure: Tune-up and control improvement to existing boiler
During onsite verification, Navigant verified thorough ceiling air sealing, spray foam over window and wall leaks, and rigid foam board over rim joists in the basement of the facility. Navigant was only provided access to one of the two tuned-up boilers which was identified as a Weil McLain Model LGB-16 Series 2 Boiler, matching the invoice in the project files.

Without blower door testing, Navigant was unable to verify the reduction in infiltration rate to the basement assumed by the energy model but considers these assumptions reasonable. The energy model assumed a steam boiler efficiency of 67%; however according to the combustion analysis results from the steam boiler tune-up verification documentation in the project files, the pre- and post-tune-up efficiencies were 79.05% (average of 79.9% and 78.2%) and 82.3% (average of 82.2% and 82.4%), respectively.

Since the savings calculations of the air sealing and boiler tune-up measures are dependent on each other, Navigant considers it best practice to apply both measures in a parametric energy model comparison. Navigant applied 79.05% boiler efficiency and 1.7 ACH infiltration rate in the baseline case and 79.05% boiler efficiency and 1.7 ACH infiltration rate in the energy efficient case, and resulting savings were 2,767 therms or a realization rate of 0.79 (ex-ante savings were 1,785 therms for air sealing and 1,706 for the boiler tune-ups). Navigant applied this realization rate to both measures in the Executive Summary to report the research findings savings per measure.

Measure: Install new DHW boiler (>95%+ eff.)
Navigant visually identified the new DHW boiler as a Lochinvar CWN270PM boiler. Navigant verified that the IC correctly applied the nameplate efficiency of this boiler (82%) in the reported "Verification Changes" (see above) for this measure, resulting in a research findings annual savings of 997 therms.

Measure: Replace boiler room vent with mechanical louver
Navigant determined that this measure was not implemented as part of this project. The ex-ante savings calculation properly negated the savings due to the lack of implementation of this measure in the "Verification Changes" line item (see above). Thus, the research findings annual savings of this measure is zero therms.

Measure: Insulate all remaining uninsulated steam pipes
Navigant visually verified insulation on all steam pipes, as shown in **Figure 7-4.**

Figure 7-4: ERP-03 Steam Pipe Insulation

Source: Navigant's onsite verification on July 27, 2013

The ex-ante savings calculation for this measure assumed 70% steam boiler efficiency. Navigant considers the steam boiler efficiency to be 82.1% based on the combustion analysis results in the project files. Replicating the ex-ante savings algorithm with the verified steam boiler efficiency of 82.1%, the research findings savings for this measure are 4,346 therms.

Measure: Insulate all remaining uninsulated DHW pipes

During onsite verification, Navigant visually verified new insulation on all DHW pipes and identified the new DHW boiler as a Lochinvar CWN270PM boiler with a nameplate efficiency of 82%. The IC originally assumed 95% efficiency and properly adjusted the gas savings of the "install new DHW boiler" measure within the "Verification Changes" line item. Navigant determined that the IC did not apply this efficiency adjustment to the "insulate all remaining uninsulated DHW pipes" measure. Replicating the ex-ante savings algorithm with the verified DHW boiler efficiency of 82%, the research findings savings for this measure are 2,333 therms.

Measure: Repair/replace all failed steam traps

Navigant verified numerous repaired or replaced steam traps (example in Figure 7-5) during onsite verification activities.

Figure 7-5: ERP-03 Steam Trap

Source: Navigant's onsite verification on July 27, 2013

Navigant also reviewed the steam trap invoices in the project files and verified that 52 steam traps were repaired or replaced. The ex-ante savings algorithm used 75% steam boiler efficiency; however, based on Navigant's review of the combustion analysis results of the steam boilers, a boiler efficiency of 82.1% should have been used instead. Replicating the ex-ante savings algorithm with the verified steam boiler efficiency of 82.1%, the research findings savings for this measure are 7,770 therms.

Measure: Air seal apartment units: baseboard, windows, doors
Navigant was not able to visually verify air sealing in apartment units because the units were occupied with tenants during the site visit. The IC estimated the gas savings per apartment unit using Energy Savers modeled results. The IC assumed steam boiler efficiencies of 70% and 75% for the ex-ante savings algorithms of other measures that also depend on the steam boiler efficiency.

Based on Navigant's review of the combustion analysis results of the steam boilers, the verified boiler efficiency is 82.1%. Navigant adjusted the savings attributed to this measure by multiplying the reporting savings by the ratio of the reported efficiency (assumed to be 70%) to the new steam boiler efficiency (82%). The research findings savings for this measure are 1,507 therms.

Recommendations for Future Projects

Finding: The IC did not use consistent boiler efficiencies in the savings algorithms for multiple measures dependent on the same boiler.

> **Recommendation**: Navigant recommends that the IC establish consistent boiler efficiency inputs for measures dependent on the same boiler.

Finding: The IC's energy model calculated energy savings using parametric runs without considering the interactive effect of multiple measures.

> **Recommendation**: Navigant recommends that the IC run their energy model comparing one pre-implementation to one post-implementation case (with all measures built in) when multiple measures are dependent on each other.

7.2.4 ERP-04 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-04
Verification Method: Onsite M&V, Engineering File Review, and Billing Analysis

Navigant's evaluation of this project consisted of an engineering file review, billing analysis, and onsite verification activities. Navigant's evaluation verified the annual energy savings to be 7,522 therms, resulting in a project realization rate of 0.41, summarized in Table 7-4.

The primary reason for the difference in the ex-ante and research findings gross savings is that the ex-ante energy model overestimated the gas savings due to heating system measures. Navigant calculated the research findings energy savings for these measures by conducting a utility gas billing analysis to compare the pre- and post-implementation time periods.

Table 7-4: ERP-04 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Replace roof (R-39), air seal	5,462	2,106	0.39
Tune-up and control improvement to existing boiler	3,875	1,494	0.39
Insulate DHW pipes (R-4.5)	1,090	1,090	1.00
Air sealing basement windows, rim joists, doors	2,664	1,027	0.39
Turn down DHW heater temperature to 120˚F	358	0	0.00
Air seal apartment units: baseboard, windows, doors	2,449	944	0.39
Increase main steam line air vents; balance heating	2,234	861	0.39
Total	**18,131**	**7,522**	**0.41**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-04 Customer implemented energy efficiency measures at their 56-unit multifamily apartment building with a project completion date of 12/1/2012. The project was completed as part of the ERP because the facility was located in a TIF district.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified by onsite verification and/or review of the project files:

- Building description: Multifamily facility built in the 1920s
- Walls: Brick with air gap; minimal air sealing
- Roof: Minimal insulation
- Windows: 10-15 years old; double-paned; vinyl frame
- Unbalanced steam distribution system
- No insulation on steam pipes
- No insulation on DHW pipes
- Minimal air sealing in basement
- 72% efficient steam boiler
- DHW temperature setting: 135˚F

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: Replace roof (R-39), air seal

This measure consists of air sealing all penetrations, and at all adjacent walls, with two-part spray foam and then insulating the cavity with blown-in cellulose to R-39. The IC used an eQuest model to calculate the energy savings due to this measure. The model assumed the facility's roof had a baseline R-value of R-2. The ex-ante savings calculation estimated the annual gas savings due to this measure at 5,462 therms.

Measure: Tune-up and control improvement to existing boiler

This measure includes the installation of new boiler controls to include a cutout control and to improve short cycling. In addition, a professional contractor completed the following steps in tuning the boiler: (1) measure combustion efficiency, (2) optimize air flow, (3) optimize burner input, (4) clean and inspect burners/chamber/HX, (5) check venting, (6) visually inspect piping/insulation, (7) check safety control, (8) verify adequate combustion air.

The IC used an eQuest model to calculate the energy savings due to this measure. The model used a baseline boiler efficiency of 72% and a tuned-up efficiency of 80%. The ex-ante savings calculation estimated the annual gas savings due to this measure at 3,875 therms.

Measure: Insulate DHW Pipes to R-4.5 (1,090 therms)

The IC used an eQuest model to calculate the energy savings due to this measure. The model used a baseline DHW pipe insulation R-value of R-1 and post-implementation DHW pipe insulation R-value of R-4.5. The ex-ante savings calculation estimated the annual gas savings due to this measure at 1,090 therms.

Measure: Air sealing basement windows, rim joists, doors (2,664 therms)
The IC used an eQuest model to calculate the energy savings due to this measure. The model used a baseline basement infiltration rate of 0.10 cfm/ft^2 and a post-implementation basement infiltration rate of 0.078 cfm/ft^2. The ex-ante savings calculation estimated the annual gas savings due to this measure at 2,664 therms.

Measure: Turn down DHW heater temperature to 120˚F (358 therms)
The IC used an eQuest model to calculate the energy savings due to this measure. The model used a baseline DHW temperature setting of 135˚F and a post-implementation DHW temperature setting of 120˚F. The ex-ante savings calculation estimated the annual gas savings due to this measure at 358 therms.

Measure: Air seal apartment units: baseboard, windows, doors (2,449 therms)
This measure consists of sealing baseboards with foam and caulk, caulking around the storm windows, and weather-stripping the rear doors. The IC estimated energy savings using energy modeling results from an Energy Savers report[16]. The ex-ante savings calculation estimated the annual gas savings due to this measure at 2,449 therms.

Measure: Increase main steam line air vents; balance heating (2,234 therms)
The IC estimated the gas savings based on literature. The following was included in the analysis file provided by the IC:

"Reference: Cost Effective Boiler System Retrofits; Lobenstein, Hewett, and Katrakis; Consulting-Specifying Engineer February 2010.

This article was written based on empirical M&V of a steam retrofit measure performed by the Center for Energy and Environment in Minneapolis. They found between 5-10% savings for increasing the size of main line air vents in buildings where the heat delivery distribution was uneven. **We simply take the conservative 5%** end of the range to show SOME savings for an improvement in this building. This also fits within the average estimate for energy savings per housing unit for this type of property as provided by CNT's Energy Savers program."

The ex-ante savings calculation estimated the annual gas savings due to this measure at 2,234 therms.

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Billing Analysis: All space heating measures
Navigant interviewed the site representative to determine the validity of using billing analysis as a verification method. This interview revealed that no non-ERP energy efficiency measures were implemented at this site, no major changes were made to the building envelope or HVAC system besides the measures implemented as part of the ERP, no gas leaks or other problems arose that would have affected the facility's gas usage, and the number of tenants did not change between the

[16] "301 N Oak Park Report.pdf" in the project files

pre- and post-implementation periods. Navigant also acquired building tenancy data from the building's manager which showed a trivial change in average occupancy: 97.9% in the pre-implementation period and 97.2% in the post-implementation period. Thus Navigant executed a weather-normalized comparison of the pre- and post-implementation gas billing data to estimate gas savings due to the facility's heating system upgrades.

Navigant first calculated the 2011 and 2012 summer monthly gas use averages to determine the non-heating portion of the gas billing data. Separate averages for summer 2011 and summer 2012 were calculated to account for behavioral changes and the installation of non-heating system gas efficiency measures. Navigant performed a regression analysis of the heating portion of the gas billing data and monthly HDDs and found an R^2 of 0.99 and 0.88 for the pre- and post-implementation periods, respectively. Navigant subtracted the post- from the pre-implementation period heating gas consumption to actual HDD60 factors to find a savings of 1.44 therms per HDD60 for the facility's heating system. Multiplied by the annual HDD60s from TMY3 data (4,449 HDD60s for Chicago-O'Hare, not including summer), the resulting savings are 6,423 therms for an average year. Compared to 16,684 therms of combined ex-ante savings (all heating system measures), Navigant verified that the realization rate for all heating system measures is 0.39.

Measure: Replace roof (R-39), air seal
During onsite verification, Navigant did not have access to the roof area to visually verify the upgraded roof. The site representative confirmed that the roof was replaced with R-39 insulation and air sealing.

Navigant performed a gas billing data analysis (summarized in the section above) on all measures related to the heating system of this facility. The billing analysis revealed a realization rate of 0.39 for all heating measures. Navigant verified that the annual savings for this measure are 2,106 therms.

Measure: Tune-up and control improvement to existing boiler
Navigant confirmed with the site representative during the site visit that two Weil-McLain Model LGB-18 Series 2 boilers were tuned-up.

Navigant performed a gas billing data analysis (summarized above) on all measures related to the heating system of this facility. The billing analysis revealed a realization rate of 0.39 for all heating measures. Navigant verified that the annual savings for this measure are 1,494 therms.

Measure: Insulate DHW pipes (R-4.5)
Navigant verified that all DHW pipes were insulated during onsite verification. Navigant identified the DHW boiler as a Laars Luna 100T199E3N boiler. Navigant considers the assumed 80% average efficiency to be reasonable; therefore the research findings annual savings for this measure are 1,090 therms.

Measure: Air sealing basement windows, rim joists, doors
Navigant verified thorough ceiling air sealing, spray foam over window and wall leaks, and rigid foam board over rim joists in the basement of the facility.

Navigant performed a gas billing data analysis (summarized above) on all measures related to the heating system of this facility. The billing analysis revealed a realization rate of 0.39 for all heating measures. Navigant verified that the annual savings for this measure are 1,027 therms.

Measure: Turn down DHW heater temperature to 120˚F
Navigant observed the DHW temperature setting at 140˚F. The ex-ante savings calculation assumed a 135˚F baseline setting per the Illinois TRM and an assumed 120˚F turn-down setting. Therefore, the research findings annual savings for this measure are zero therms.

Measure: Air seal apartment units: baseboard, windows, doors
Navigant was not able to visually verify air sealing in apartment units because the units were occupied with tenants during the site visit.

Navigant performed a gas billing data analysis (summarized above) on all measures related to the heating system of this facility. The billing analysis revealed a realization rate of 0.39 for all heating measures, resulting in a research findings annual savings of 944 therms for this measure.

Measure: Increase main steam line air vents; balance heating
This multifamily facility, since it was built in the 1920s, uses steam distributed through a pipe network to transfer heat from the steam boiler to individual apartment units. This system was not originally designed for efficiency and did not provide even distribution of heat. By installing steam vents, the rate of steam flow to individual apartment units' radiators can be adjusted to prevent overheating in apartment units near the steam boiler and under-heating in apartment units far from the steam boiler.

During onsite verification, Navigant verified new steam venting devices and radiator air vents to balance the steam distribution system.

Navigant performed a gas billing data analysis (summarized above) on all measures related to the heating system of this facility. The billing analysis revealed a realization rate of 0.39 for all heating measures, resulting in a research findings annual savings of 861 therms for this measure.

RECOMMENDATIONS FOR FUTURE PROJECTS

Finding: Navigant's billing analysis revealed that the energy model used to calculate the ex-ante savings significantly overestimated savings from heating system measures.

> **Recommendation**: Navigant recommends that Nicor Gas review energy models' savings for projects with multiple heating system measures and, if possible, provide the IC with gas billing data to allow calibration of energy models to billing data.

7.2.5 ERP-05 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-05
Verification Method: Onsite M&V and Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review and onsite verification activities. Navigant's evaluation verified the annual energy savings to be 21,560 therms, resulting in a project realization rate of 0.88, summarized in Table 7-5.

The primary reason for the difference in the ex-ante and research findings gross savings is that the steam and DHW boiler efficiency values used in the ex-ante savings were lower than the nameplate values.

Table 7-5: ERP-05 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Air sealing of basement window, rim joints, doors	566	566	1.00
Lower DHW Temperature to 120˚F	83	0	0.00
Install a new power flame burner for steam boiler	4,385	3,586	0.82
Fully insulate all steam and DHW piping	3,654	3,466	0.95
Repair/replace all failed steam traps	15,912	13,942	0.88
Total	**24,600**	**21,560**	**0.88**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-05 Customer implemented energy efficiency measures at their 51-unit multifamily facility with a project completion date of 10/15/2012. The project was completed as part of the ERP because the facility was located in a TIF district.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified by onsite verification and/or review of the project files:

- Building description: Multifamily facility built in the 1920s
- Walls: Brick with air gap; minimal air sealing
- Roof: Minimal insulation

- Windows: 15-20 years old; double-paned; vinyl frame
- No insulation on steam pipes
- No insulation on DHW pipes
- Minimal air sealing in basement
- DHW Temperature Setting: 140˚F

Energy Efficient Conditions

Measure: Air sealing of basement window, rim joints, doors
The IC used an eQuest model and a TRACE 700 model to calculate the energy savings due to this measure. This energy model reduced the infiltration rate of the basement area from 0.140 cfm/ft² to 0.135 cfm/ft². The ex-ante savings calculation estimated the annual gas savings due to this measure at 566 therms.

Measure: Lower DHW Temperature to 120 degF
The IC used an eQuest model to calculate the energy savings due to this measure. The model reduced the DHW set-point temperature from 140˚F to 120˚F. The ex-ante savings calculation estimated the annual gas savings due to this measure at 83 therms.

Measure: Install a new power flame burner for steam boiler
The IC used the following algorithm to calculate gas savings from this measure:

$$Therms\ Saved = \frac{Boiler\ Cap * (parA * 6500 + parB) * \frac{0.025}{Boiler\ eff}}{100}$$

Algorithm Parameter	Value	Unit	Source/Description
Boiler Cap	4,763	MBH	Steam boiler capacity
Boiler eff	70%	%	Steam boiler efficiency
parA	0.416	-	Wisconsin Focus on Energy Evaluation Report
parB	-126.46	-	Wisconsin Focus on Energy Evaluation Report
Therms Saved	4,385	Therms	Calculated

Source: Navigant's analysis of project files

Measure: Fully insulate all steam and DHW piping

The technical assistance team used a pipe insulation calculator[17] to estimate the energy loss factor associated with poorly insulated DHW and steam pipes. The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Pipe\ Length * \frac{Loss\ Factor}{Avg\ Boiler\ Efficiency}$$

Algorithm Parameter	Value	Unit	Source/Description
Pipe Length	217	feet	Measured onsite
Loss Factor	3.77	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	75%	%	Assumed
Therms Saved	1,091	therms	Calculated

Source: Navigant's analysis of project files

Algorithm Parameter	Value	Unit	Source/Description
Pipe Length	413	feet	Measured onsite
Loss Factor	5.09	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	82%	%	Assumed
Therms Saved	2,564	therms	Calculated

Source: Navigant's analysis of project files

The ex-ante savings calculation estimated the annual gas savings due to this measure at a combined 3,654 therms.

Measure: Repair/replace all failed steam traps

This measure consists of repairing or replacing 92 failed steam traps. The ex-ante gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = \frac{\#\ Traps * Steam\ Loss * DRF * OpHrs * \frac{therms}{100\ lbs}}{Boiler\ eff} * (1 - Other)$$

[17] http://www.wbdg.org/design/midg_design_echp.php

Algorithm Parameter	Value	Unit	Source/Description
# Traps	92	traps	Number of steam traps. Count was reduced by 15% from original estimate to be conservative
Steam Loss	15	lb/hr	From: http://uesystems.com/tech_support_charts_steam_loss.asp
DRF	0.5	-	Derating factor (TRM)
OpHrs	1880	hours	Based on 8 hours/day during heating season
Therms/100 lbs	0.01	Therms/lbs	Conversion factor
Boiler eff	75%	%	Steam boiler efficiency
Other	0.08	-	Fraction of heating savings captured in other measures
Therms Saved	15,912	therms	Calculated

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed onsite verification activities at this site on June 27, 2013. Navigant could not perform a billing analysis on this project due to lack of site-level gas billing data. The measure-level findings and analysis of the site visit are outlined below.

Measure: Air sealing of basement window, rim joints, doors

Navigant verified during onsite verification thorough air sealing of the basement windows, rim joints, and doors. Navigant did not perform blower door testing to verify the infiltration rate adjustment; however, Navigant considers the original infiltration assumptions reasonable. Thus, the research findings annual savings for this measure are 566 therms.

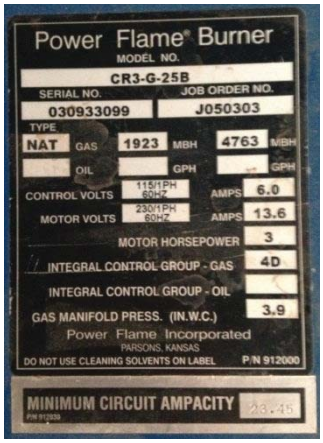
Measure: Lower DHW Temperature to 120 degF

Navigant observed the DHW temperature setting to be 135 ˚F. The ex-ante savings calculation assumed a baseline of 140˚F and a reduced temperature of 120˚F. The Illinois TRM specifies a baseline DHW temperature at 135˚F. Therefore, no temperature decrease from the baseline was observed, so the research findings annual savings for this measure are zero therms.

Measure: Install a new power flame burner for steam boiler

Navigant verified the power flame burner installation during the site visit, with the nameplate shown in Figure 7-6.

Figure 7-6: ERP-05 Power Flame Burner Nameplate



Source: Navigant's onsite verification on July 27, 2013

Navigant was unable to identify the source of the reported algorithm used to calculate for this measure. The IC assumed 70% steam boiler efficiency in the reported calculation. Navigant determined the actual steam boiler efficiency to be 85.6% based on identification of the boiler nameplate during onsite verification. Replicating the reported algorithm using the nameplate efficiency, the research findings savings for this measure are 3,586 therms.

Measure: Fully insulate all steam and DHW piping

Navigant visually verified insulation on all steam and DHW pipes during onsite verification, with an example shown in Figure 7-7. The onsite visit confirmed the reported lengths of 217 feet and 413 feet for the DHW and steam pipes, respectively.

Figure 7-7: ERP-05 Steam and DHW Pipe Insulation

Source: Navigant's onsite verification on July 27, 2013

Navigant identified the DHW boiler as a Laars PW0500IN09KACXX. The nameplate capacity of this boiler is 81%. Navigant identified the steam boiler as a Weil-McLain 1488 Natural Gas Boiler with a nameplate thermal efficiency of 85.6%.

Replicating the reported algorithms with the nameplate efficiencies, the research findings savings are 1,010 therms for the DHW pipes and 2,456 for the steam pipes, or a total of 3,466 therms.

Measure: Repair/replace all failed steam traps
Navigant identified numerous steam trap replacements during the site visit, with an example shown in Figure 7-8.

Figure 7-8: ERP-05 Steam Trap

Source: Navigant's onsite verification on July 27, 2013

Navigant identified more than 92 steam traps in an invoice located in the project files. The reported savings calculation assumed a steam boiler efficiency of 75%; however, Navigant identified the steam boiler as a Weil-McLain 1488 Natural Gas Boiler which has an efficiency of 85.6%. The evaluation team replicated the reported calculation using a boiler efficiency of 85.6%, and thus the research findings savings for this measure are 13,942 therms.

RECOMMENDATIONS FOR FUTURE PROJECTS

Finding: The IC did not use consistent boiler efficiencies in the savings algorithms for multiple measures dependent on the same boiler.

> **Recommendation**: Navigant recommends that the IC establish consistent boiler efficiency inputs for measures dependent on the same boiler.

7.2.6 ERP-06 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-06
Verification Method: Onsite M&V and Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review and onsite verification activities performed by a Navigant engineer on June 27, 2013. Navigant's evaluation verified the annual energy savings to be 4,902 therms, resulting in a realization rate of 0.84, summarized in Table 7-6.

The primary reason for the difference in the ex-ante and research findings gross savings is that Navigant used the Illinois TRM to calculate savings due to a boiler tune-up, rather than the IC's use of a Wisconsin Focus on Energy Evaluation Report. The secondary reason for the difference in savings is due to the steam and DHW boiler efficiency values used in the ex-ante savings being lower than the nameplate values.

Table 7-6: ERP-06 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Insulate all exposed steam pipes (basement, garages, storage) to R-6	1,993	1,845	0.93
Tune-up existing boiler	1,517	937	0.62
Insulate all exposed DHW pipes (basement, garages, storage spaces) to R-4.5	796	688	0.86
Lower DHW temperature to lowest allowable by code	197	79	0.40
Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board	1,353	1,353	1.00
Total	**5,855**	**4,902**	**0.84**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-06 Customer implemented energy efficiency measures at their 33-unit multifamily housing facility with a project completion date of 12/1/2012. The project was completed as part of the ERP because the facility was located in a TIF district.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified by onsite verification and/or review of the project files:

- Building description: Multifamily facility built in the 1920s
- Walls: Brick with air gap; minimal air sealing
- Roof: Minimal insulation
- No insulation on steam pipes
- No insulation on DHW pipes
- Minimal air sealing in basement

Energy Efficient Conditions

Measure: Insulate all exposed steam pipes (basement, garages, storage) to R-6

The technical assistance team used a pipe insulation calculator[18] to estimate the energy loss factor associated with poorly insulated steam pipes. The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Pipe\ Length * \frac{Loss\ Factor}{Avg\ Boiler\ Efficiency}$$

Algorithm Parameter	Value	Unit	Source/Description
Pipe Length	212	Feet	Measured onsite
Loss Factor	7.05	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	75	%	Assumed
Therms Saved	1,993	Therms	Calculated

Source: Navigant's analysis of project files

Measure: Tune-up existing boiler

Navigant identified that the savings methodology for this measure used a Wisconsin Focus on Energy Evaluation Report. The ex-ante savings calculation estimated the annual gas savings due to this measure at 1,517 therms.

Measure: Insulate all exposed DHW pipes (basement, garages, storage spaces) to R-4.5

The technical assistance team used a pipe insulation calculator to estimate the energy loss factor associated with poorly insulated DHW pipes. The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Pipe\ Length * \frac{Loss\ Factor}{Avg\ Boiler\ Efficiency}$$

[18] http://www.wbdg.org/design/midg_design_echp.php

Algorithm Parameter	Value	Unit	Source/Description
Pipe Length	202	feet	Measured onsite
Loss Factor	2.76	therms/ft lost	Pipe insulation calculator
Avg Boiler Efficiency	70	%	Assumed
Therms Saved	796	therms	Calculated

Source: Navigant's analysis of project files

Measure: Lower DHW temperature to lowest allowable by code

The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Avg\ Summer\ Gas\ Use * 12\frac{months}{year} * \%\ DHW\ Savings * 0.8$$

Algorithm Parameter	Value	Unit	Source/Description
Avg Summer Gas Use	447	therms	Utility gas bills
% DHW Savings	4.6%	%	Modeled results from Nicor ERP and Energy Savers
0.8	0.8	-	Assumed ratio of DHW to avg summer gas use
Therms Saved	197	therms	Calculated

Source: Navigant's analysis of project files

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board

The IC estimated gas savings from this measure based on an inverse energy model developed by Energy Savers of five similar vintage and construction type multifamily buildings. The model takes building usage and envelope data, and backs out infiltration and air sealing savings. Using this model, a regression analysis on these five data points resulted in 41 therms saved per residential unit. Therefore, for this 33-unit building, the ex-ante savings were 1,353 therms.

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Due to the complexity of this project, Navigant explored the opportunity of using billing analysis to compare the pre- and post-implementation gas usage to determine annual gas savings. Based on an onsite interview with the property manager, Navigant learned that an underground gas leak was found after the project was implemented which skewed the gas use for a portion of the post-implementation period. Thus, billing analysis is not a reasonable method for calculating gas savings.

Navigant performed onsite verification activities at this site on June 27, 2013. The findings of the site visit are outlined below.

Measure: Insulate all exposed steam pipes (basement, garages, storage) to R-6

Navigant verified that approximately 212 feet of steam pipe insulation was installed as part of the project. Navigant identified the steam boiler as a Weil-McLain Model LGB-20 Series 2 boiler with 81% efficiency.

Therefore, replicating the algorithm used in the ex-ante savings calculation with the originally used pipe length and loss factor and a steam boiler efficiency of 81%, the research findings annual savings for this measure are 1,845 therms.

Measure: Tune-up existing boiler (1,517 therms)

Navigant identified the steam boiler as a Weil-McLain Model LGB-20 Series 2 boiler. During the site visit, the Navigant engineer interviewed the site representative who confirmed that a boiler tune-up was performed as part of the project. Navigant used the Illinois TRM algorithm for boiler tune-up to calculate savings due to this measure:

$$Therms\ Saved = \frac{N_{gi} * SF * EFLH}{eff_{pre} * 100}$$

Algorithm Parameter	Value	Unit	Source/Description
N_{gi}	2,000	kBTU/hr	Onsite and project files
SF	1.6%	%	Savings factor; reduction in gas consumption as a result of the tune-up; TRM
$EFLH$	2,050	Hours/year	Equivalent full load hours; TRM (Lodging in Zone 2 Chicago)
eff_{pre}	70%	%	Pre-implementation efficiency; project files
$Therms\ Saved$	937	therms	Calculated

Using the algorithm specified by the TRM, the research findings annual savings for this measure are 937 therms.

Measure: Insulate all exposed DHW pipes (basement, garages, storage spaces) to R-4.5 (796 therms)

Navigant verified that approximately 202 feet of steam pipe insulation was installed as part of the project. Navigant identified the steam boiler as a Laars 0400C Natural Gas Boiler with 81% thermal efficiency.

Therefore, replicating the algorithm used in the ex-ante savings calculation with the originally used pipe length and loss factor and a steam boiler efficiency of 81%, the research findings annual savings for this measure are 688 therms.

Measure: Lower DHW temperature to lowest allowable by code (197 therms)

Navigant observed the DHW temperature setting to be 129 ˚F. The Illinois TRM specifies a baseline temperature of 135˚F. The lowest temperature allowable by code is 120˚F. Navigant used a temperature ratio to adjust the savings; therefore the research findings annual savings for this measure are 79 therms.

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board (1,353 therms)

During onsite verification, Navigant verified thorough ceiling air sealing, spray foam over window and wall leaks, and rigid foam board over rim joists in the basement of the facility. Navigant considers the use of the Energy Savers model of five similar buildings to calculate savings due to this measure as reasonable. Thus, the research findings annual savings for this measure are 1,353 therms.

Recommendations for Future Projects

Finding: This project appeared to be accepted into the program without any documentation of the savings algorithms for multiple measures. Navigant acquired this documentation through follow-up contact with the IC.

> **Recommendation**: Navigant recommends that Nicor Gas require proper documentation of savings algorithms prior to accepting a project into the program.

7.2.7 ERP-07 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-07
Verification Type: Onsite M&V, Engineering File Review, and Billing Analysis

Navigant's evaluation of this project consisted of an engineering file review, billing analysis, and onsite verification activities. Navigant's evaluation verified the annual energy savings to be 3,501 therms, resulting in a project realization rate of 0.87, summarized in Table 7-7.

The primary reason for the difference in the ex-ante and research findings gross savings is that the ex-ante energy model slightly overestimated the gas savings due to heating system measures. Navigant calculated the research findings energy savings for these measures by conducting a utility gas billing analysis to compare the pre- and post-implementation time periods.

Table 7-7: ERP-07 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Increase main steam line air vents; balance heating	2,000	1,720	0.86
Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board	1,820	1,565	0.86
Lower DHW temperature to lowest allowable by code	216	216	1.00
Total	**4,036**	**3,501**	**0.87**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-07 Customer implemented energy efficiency measures at their multifamily housing facility with a project completion date of 12/1/2012. The project was completed as part of the ERP because the facility was located in a TIF district.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified by onsite verification and/or review of the project files:

- Building description: Multifamily facility built in the 1920s
- Walls: Brick with air gap; minimal air sealing
- Roof: Minimal insulation

- Unbalanced steam distribution system
- Minimal air sealing in basement

Energy Efficient Conditions

Measure: Increase main steam line air vents; balance heating

This multifamily facility, since it was built in the 1920s, uses steam distributed through a pipe network to transfer heat from the steam boiler to individual apartment units. This system was not originally designed for efficiency and did not provide even distribution of heat. By installing steam vents, the rate of steam flow to individual apartment units' radiators can be adjusted to prevent overheating in apartment units near the steam boiler and under-heating in apartment units far from the steam boiler.

The IC used an Energy Savers model to calculate the gas savings due to this measure. The ex-ante gas savings due to this measure was 2,000 therms.

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board

The IC used an Energy Savers model to calculate the gas savings due to this measure. The ex-ante gas savings due to this measure was 1,820 therms.

Measure: Lower DHW temperature to lowest allowable by code

The gas savings for this measure were calculated via the following algorithm:

$$Therms\ Saved = Avg\ Summer\ Gas\ Use * 12\frac{months}{year} * \%\ DHW\ Savings * 0.8$$

Algorithm Parameter	Value	Unit	Source/Description
Avg Summer Gas Use	492	therms	Utility gas bills
% DHW Savings	4.6%	%	Modeled results from Nicor ERP and Energy Savers
0.8	0.8	-	Assumed ratio of DHW to avg summer gas use
Therms Saved	216	therms	Calculated

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis

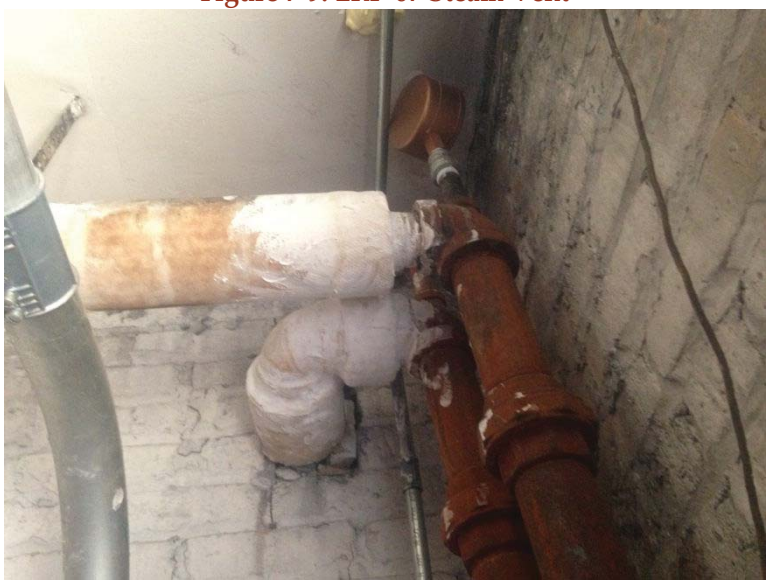
Navigant performed onsite verification activities at this site on June 27, 2013. The measure-level findings and analysis of the site visit are outlined below.

Measure: Increase main steam line air vents; balance heating

Measure: Air seal basement ceiling, and major window/wall leaks with spray foam; insulate rim joists with rigid foam board

During the site visit, Navigant verified numerous steam vents connected to the steam distribution pipe network, with an example shown in Figure 7-9. Navigant also verified thorough ceiling air sealing, spray foam over window and wall leaks, and rigid foam board over rim joists in the basement of the facility.

Figure 7-9: ERP-07 Steam Vent



Source: Navigant's onsite verification on July 27, 2013

Navigant interviewed the site representative to determine the validity of using billing analysis as a verification method. This interview revealed that no non-ERP energy efficiency measures were implemented at this site, no major changes were made to the building envelope or HVAC system besides the measures implemented as part of the ERP, and no gas leaks or other problems arose that would have affected the facility's gas usage. Navigant also acquired building tenancy data from the building's manager which showed a trivial change in average occupancy: 96.4% in the pre-implementation period and 94.2% in the post-implementation period. Thus, Navigant executed a weather-normalized comparison of the pre- and post-implementation gas billing data to estimate gas savings due to the facility's heating system upgrades.

Navigant first calculated the 2011 and 2012 summer monthly gas use averages to determine the non-heating portion of the gas billing data. Separate averages for summer 2011 and summer 2012 were calculated to account for change in tenants and the installation of the non-heating system gas efficiency measure (DHW temperature turn-down). Navigant determined the pre- and post-implementation weather-normalized gas savings to be 4.89 and 4.15 therms per HDD60 using actual weather data. Therefore, Navigant found a savings of 0.74 therms per HDD60 for the facility's heating system. The evaluation team multiplied this factor by 4,449 HDD60 (Chicago-O'Hare TMY3 data; excluding summer) resulting in 3,285 therms of savings for an average. Compared to 3,820 therms of combined ex-ante savings (all heating system measures), Navigant verified that the realization rate for all heating system measures is 0.86.

Measure: Lower DHW temperature to lowest allowable by code

During the site visit, Navigant verified the DHW temperature setting at 120˚F. The research findings savings for this measure are 216 therms.

RECOMMENDATIONS FOR FUTURE PROJECTS

Navigant does not have any recommendations for future projects based on this review.

7.2.8 ERP-08 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-08
Verification Method: Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review. Navigant's evaluation verified the annual energy savings to be 931 therms, resulting in a project realization rate of 0.99, summarized in Table 7-8.

The primary reason for the difference in the ex-ante and research findings gross savings is that Navigant used a different dataset of TMY3 weather data than what was used in the ex-ante savings calculation.

Table 7-8: ERP-08 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Direct Fired Make-Up Air Units (x2 10,000 cfm, 92% eff)	940	931	0.99
Total	**940**	**931**	**0.99**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-08 Customer implemented energy efficiency measures at their industrial facility with a project completion date of 8/12/2012. The project consisted of the installation of two direct fire make-up air units to replace the existing infrared heaters. The project was completed as part of the ERP because the project had the potential to create jobs.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified by onsite verification and/or review of the project files:

- Light industry facility
- Heating System Efficiency: 80%

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: Direct Fired Make-Up Air Units (x2 10,000 cfm, 92% eff)
The IC used the following algorithm to calculate gas savings from this measure:

$$Therms\ Saved = \frac{\sum Heat\ Load}{Baseline\ Efficiency} - \frac{\sum Heat\ Load}{EE\ Efficiency}$$

Algorithm Parameter	Value	Unit	Source/Description
Baseline Efficiency	80%	%	Baseline heating system efficiency
EE Efficiency	92%	%	Efficiency of energy efficient make-up air units
Σ Heat Load	5,765	therms	See below
Therms Saved	940	therms	Calculated

Source: Navigant's analysis of project files

The IC ran an 8,760 hour annual analysis in Excel to calculate the annual heat load. At each hourly time-step where the outdoor temperature was below the supply temperature of 70˚F, the model calculated the hourly heat load using the following algorithm:

$$Heat\ Load_i = 1.08 * Flow\ Rate_{max} * Air\ Flow\ \%_i * (Supply\ Temperature - Outdoor\ Temperature_i)$$

Algorithm Parameter	Value	Unit	Source/Description
1.08	1.08	Btu/cfm/˚F	Constant
Flow $Rate_{max}$	10,000	Cfm/unit	Maximum outside air flow rate through the make-up air units
Air Flow $\%_i$	Varies per hour i	%	Ventilation requirements based on custom occupancy schedule
Supply Temperature	70	˚F	Assumed
Outdoor $Temperature_i$	Varies per hour i	˚F	Weather data
Heat $Load_i$	Varies per hour i	Btu	BTUs required to properly heat the facility

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed an engineering file review of this project. The measure-level findings are outlined below.

Measure: Direct Fired Make-Up Air Units (x2 10,000 cfm, 92% eff)
Navigant reviewed the project files to verify the various assumptions used in the ex-ante savings calculation. Based on review of the make-up air unit invoice, Navigant identified a 92% efficiency rating and a 10,000 cfm supply flow rate per make-up air unit. Navigant also identified that the IC assumed a code-minimum baseline heating system efficiency of 80%. Navigant adjusted the ex-ante

savings calculation to include TMY3 weather data from Chicago - O'Hare Airport, the closest geographical weather site to this facility.

Replicating the calculation using TMY3 weather data, Navigant verified the annual savings as 931 therms.

Recommendations for Future Projects

Finding: Navigant could not identify the baseline heating system equipment after following up with the IC.

> **Recommendation**: Navigant recommends that the IC properly document all baseline conditions.

7.2.9 ERP-09 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-09
Verification Method: Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review. Navigant's evaluation verified the annual energy savings to be 9,619 therms, resulting in a project realization rate of 0.94, as summarized in Table 7-9.

The primary reason for the difference in the ex-ante and research findings gross savings is that the ex-ante energy model overestimated the gas savings due to heating system measures.

Table 7-9: ERP-09 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Replacement of locker room AHUs with more efficient RTU that has an energy recovery wheel	10,267	9,619	0.94
Total	**10,267**	**9,619**	**0.94**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

Project ERP-09 implemented energy efficiency measures at their recreational facility with a project completion date of 01/01/2013. The project was completed as part of the ERP because this project is a non-profit or community-based entity and provides strong positive community impact.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified through review of the project files:

- Building description: Recreational facility built in the 1980s
- Floor area: 11,000 ft^2
- Air-handler unit (AHU) Manufacturer and Model: RECOLD-AH 200C (supply air of 9,360 CFM)

Energy Efficient Conditions

This recreational facility is currently undergoing a series of major renovations of their entire HVAC system, as well as some plumbing, structural, and architectural improvements. However, this project specifically pertains only to a replacement of the facility's locker room air-handler unit (AHU) with a more efficient roof-top unit (RTU) that includes an energy recovery wheel. The energy recovery wheel saves energy by maximizing usage of outside air (OA) and utilizing return air (RA) to meet the supply air (SA) requirement of 5,865 CFM to the space area.

Measure: Replace locker room AHUs with more efficient RTU with energy recovery wheel (10,267 therms)

The IC used eQuest building simulation to determine annual energy consumption from this measure by running 2 separate models, a baseline case with the old AHU and an efficient case with a new RTU with an energy recovery wheel feature in Table 7-10.

Table 7-10: Ex-Ante Savings Summary of Measure

Run #	Scenario	Annual Natural Gas Consumption (therms)	Relevant Measure Description
1	Baseline	130,190	N/A
2	New Locker Room RTU; energy recovery wheel	119,923	Replacement of locker room AHUs with more efficient RTU that has an energy recovery wheel

Source: Navigant's analysis of project files

The IC used TMY2 weather data, which may correspond to an earlier historical weather time-frame.

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed an engineering desk review of this project by analyzing the reasonableness of eQuest modeling inputs and assumptions and comparing modeled results to historical billing data.

Modeling Review: Replacement of AHU with more efficient RTU with energy recovery wheel

To gauge the reasonableness of the ex-ante annual energy savings, Navigant analyzed the eQuest models in the project files pertaining to each modeling sequence as described in Table 7-10. Navigant reviewed modeling inputs and determined that key measure parameters (i.e., RTU packaged gas furnace input and output capacity, SA CFM requirements) were being modeled in eQuest in agreement with project documentation (i.e., mechanical sheet, building drawings). The evaluation found that the new RTU manufacturer and model was Modine MPR20. Navigant noted that the minimum OA hourly schedule for the main packaged multi-zone systems serving the non-locker room space areas had set the fraction/design ratio to -999. The ex-post savings evaluation utilized the OA value in accordance with the mechanical sheets.

Billing Consideration: Replacement of AHU with more efficient RTU with energy recovery wheel

To gauge the reasonableness of the simulated annual energy savings, Navigant considered the historical energy consumption of this facility that pertained to the pre-installation time-frame.

However, energy consumption patterns at the site may have changed from pre- and post-installation due to other parameters (e.g., facility hours of operation changes) not explicitly listed in the project documentation.

The results of the re-run parametric models using TMY3 weather data for Chicago O'Hare International Airport, which was the closest geographical weather site to this facility, are summarized in the following table.

Table 7-11. eQuest Model Simulation Summary

Month	Simulated Consumption (therms) - Sequence 1	Simulated Consumption (therms) - Sequence 2
1	17,607	16,236
2	14,857	13,736
3	12,980	12,057
4	9,426	8,726
5	6,638	6,111
6	3,677	3,144
7	2,496	1,924
8	3,149	2,651
9	4,620	4,173
10	8,553	7,893
11	11,724	10,801
12	16,887	15,543
Total Annual Consumption	**112,614**	**102,995**
Total Annual Savings	**-**	**9,619**

Source: Navigant's analysis of project files

Therefore, the research findings annual savings for this measure are 9,619 therms.

RECOMMENDATIONS FOR FUTURE PROJECTS

Navigant does not have any recommendations for future projects based on this review.

7.2.10 ERP-10 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-10
Verification Type: Engineering File Review

Table 7-12 summarizes the results of Navigant's engineering file review of this project. Navigant's evaluation verified the annual energy savings to be 18,375 therms, resulting in a project realization rate of 0.97.

The primary reason for the difference in the ex-ante and research findings gross savings is that the energy model used TMY2 instead of TMY3 weather data to calculate ex-ante savings.

Table 7-12: ERP-10 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Upgrade existing torn-off roof section with R-22	13,098	12,720	0.97
Upgrade rest of existing roof to R-22 with overlay	5,779	5,655	0.98
Total	**18,877**	**18,375**	**0.97**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

Project ERP-10 implemented energy efficiency measures at their warehouse facility with a project completion date of 03/01/2013. The project was accepted to the ERP because it will help create jobs.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions determined through review of the project files:

- Building description: Industrial warehouse facility with approximately 10% office space built in 1970
- Roof: Minimal insulation (assumed R-8 in modeling results), 116,138 ft² (area)

Energy Efficient Conditions

This warehouse facility underwent a major renovation that included new HVAC systems and upgrades to the lighting and envelope to comply with IECC 2009. However, this project specifically pertains only to the roof insulation as part of the envelope upgrade.

Measure 1: Upgraded existing torn-off section (71,200 ft2) of roof insulation to R-20 using 4" extruded polystyrene (13,098 therms)

Measure 2: Upgraded rest of existing roof (50,600 ft2) to R-20 with overlay (5,779 therms)
The IC used eQuest building simulation to determine annual heating-end use energy consumption from these measures by running parametric runs in sequence of the measures listed above as shown in Table 7-13.

Table 7-13. Ex-Ante Savings Summary of Measures

Seq. #	Scenario	Annual Natural Gas Consumption (therms)	U-factor (Btu/h-ft2-^{0}F)	Relevant Measure Description
1	Baseline	112,456	0.120	N/A
2	Partial improved roof insulation	99,736	0.048	Upgrade existing torn-off roof section with R-20
3	Complete improved roof insulation	94,081	0.048	Upgrade rest of existing roof to R-20 with overlay

Source: Navigant's analysis of project files

Annual energy savings for each respective measure is a result of subtracting the annual energy consumption of the previous eQuest modeling sequence (i.e., savings for Measure 1 was determined by subtracting the modeled annual consumption from Sequence 2 from that of Sequence 1). The IC used TMY2 weather data, which may correspond to an earlier historical weather time-frame.

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed an engineering desk review of this project by analyzing the reasonableness of eQuest modeling inputs and assumptions.

Modeling Review: Roof insulation upgrade measures
To gauge the reasonableness of the ex-ante annual energy savings, Navigant analyzed the eQuest models in the project files pertaining to each modeling sequence as described in Table 7-13. Navigant reviewed modeling inputs and determined that key measure parameters (i.e., U-factor and square footage of roof area) were being modeled in eQuest in agreement with project documentation provided (i.e., inspection reports, building drawings, and technical specification sheets).

Navigant re-ran the parametric eQuest model runs using TMY3 weather data for Chicago O'Hare International Airport, which was the closest geographical weather site to this facility, to determine the re-simulated annual energy simulation, summarized in Table 7-14.

Table 7-14: eQuest Modeling Review Results

Scenario #	Scenario Description	Simulation Results - Annual Natural Gas Consumption (therms)	U-factor (Btu/h-ft2-^{0}F)	Square Footage of roof area with new insulation
1	Baseline	114,691	0.120	0
2	Partial improved roof insulation	101,971	0.048	71,200
3	Complete improved roof insulation	96,316	0.048	50,600

Source: Navigant's analysis of project files

Billing Consideration: Roof insulation upgrade measures

To gauge the reasonableness of the simulated annual energy savings, Navigant considered the historical energy consumption of this facility that pertained to the pre-installation time-frame. However, due to the significant renovations that would likely change the occupancy patterns for a new tenant, the evaluation team did not further consider the usage of billing data for savings analysis.

The results of the re-run parametric models using TMY3 weather data are summarized in Table 7-15.

Table 7-15: eQuest Model Simulation Summary

Month	Simulated consumption (therms) - Sequence 1	Simulated Consumption (therms) - Sequence 2	Simulated Consumption (therms) - Sequence 3
1	22,829	20,597	19,479
2	18,758	16,961	16,061
3	15,085	13461	12774
4	8,914	7,904	7,511
5	2,943	2543	2392
6	321	320	277
7	23	23	19
8	62	62	41
9	1,025	900	785
10	7,285	5,816	5,385
11	13,650	11829	11129
12	21,560	19,320	18,228
Total Annual Consumption	**112,456**	**99,736**	**94,081**
Total Annual Savings	**-**	**12,720**	**5,655**

Source: Navigant's analysis of project files

The research findings annual savings for measures 1 and 2 are 12,720 therms and 5,655 therms, respectively. The slightly lower realization rate of 97% for this project is predominantly a result of usage of the ex-ante modeled savings being based off of TMY2 instead of TMY3 weather data.

Recommendations for Future Projects

Finding: The energy model used to estimate ex-ante savings was based on the same operating parameters pre- and post-installation of the roof insulation.

> **Recommendation**: While not always possible depending on the project completion date, Navigant recommends, for future projects with major building operational changes that rely upon building simulation, that the IC obtain post-installation operating parameters and consider billing usage to inform the savings calculation.

7.2.11 ERP-11 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-11
Verification Type: Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review. Navigant's evaluation verified the annual energy savings to be 1,105 therms, resulting in a project realization rate of 0.94, summarized in Table 7-16.

The primary reason for the difference in the ex-ante and research findings gross savings is that the ex-ante savings estimation used an indoor heating temperature set point that was slightly higher than Navigant's interpretation of that value from the project files, resulting in a slight overestimation of savings.

Table 7-16: ERP-11 Savings Summary

Measure Description	Reported Savings (therms)	Verified Savings (therms)	Realization Rate
Upgrade roof insulation to R-20 using 2.5-3 inch poly-ISO insulation	1,175	1,105	0.94
Total	**1,175**	**1,105**	**0.94**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

Project ERP-11 implemented energy efficiency measures at their office/warehouse facility with a project completion date of 12/01/2012. The project was accepted to the ERP because the facility is located in a TIF district, and the project serves a nonprofit entity and will create jobs.

REPORTED SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines some baseline conditions identified through review of the project files:

- Total area of building's roof: 48,000 ft^2 (only 4,800 ft^2 was part of project scope)
- Heating System Efficiency: 75%
- Existing U-Factor: 0.15
- Heating temperature set-point: 70 ^{0}F

Energy Efficient Conditions

Measure: **Upgrade roof insulation to R-20 (1,175 therms)**

The IC used the following algorithm to calculate gas savings from this measure:

$$IF\ T_{db} < T_{balance}, THEN$$

$$Therms\ Saved = \frac{\sum_{h=1}^{8760}\left(U_{existing} \times Area \times \left[T_{heat} - T_{db,h}\right]\right) - \sum_{n=1}^{8760}\left(U_{proposed} \times Area \times \left[T_{heat} - T_{db,h}\right]\right)}{Heating\ System\ Efficiency\ \times 100{,}000}$$

Algorithm Parameter	Value	Unit	Description
Roof Area (Area)	4,800	Ft^2	Area of roof that received roof insulation upgrade
Average zone balance point temperature ($T_{balance}$)	60	^0F	Assumed; Between 50 (for commercial) and 65 (multifamily)
Dry-bulb Temperature ($T_{db,h}$)	Varies	^0F	Varies hourly for an entire calendar year
Proposed U-Factor ($U_{proposed}$)	0.05	Btu/hr-ft^2-^oF	Corresponding to roof insulation of R-20
Existing U-Factor ($U_{existing}$)	0.15	Btu/hr-ft^2-^oF	Estimated value
Heating Temp (T_{heat})	70	^0F	Presumed indoor heating temperature setpoint
Heating System Efficiency	75	%	Estimated value
Therms Saved	1,175	therms	Calculated; excess therms required to heat the rest of the building

Source: Navigant's analysis of project files

Natural gas savings result from reduced heat transfer due to an increased R-value (decreased U-Factor) when the heating system is presumed to be operational (i.e., when dry-bulb temperature is less than the balance point temperature).

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed an engineering file review of the files provided for this project. Based on this review, the evaluation team was able to verify assumptions and inputs in the reported savings calculation and gathered additional information used to calculate verified savings for the roof insulation measure.

According to the IC's site verification report dated 10/12/2012, this project originally called for tearing off portions of existing roof deck and installing 3" poly-ISO insulation, resulting in an overall R-25 value. However, the verification report revealed 2.5"-3" poly-ISO insulation was installed in a single layer resulting in an overall R-20 value. In addition, though the entire warehouse facility's roof area is 48,000 ft^2 only 10% of the overall facility roof (4,800 ft^2) spanning the facility's lower office roof and new warehouse areas received the roof insulation upgrade. Navigant agrees with the values used for the baseline roof R-value estimation and the upgraded insulation R-value.

The evaluation team also discovered an energy audit report performed for this facility in February 2012 by an engineering firm identifying various energy efficiency opportunities. The audit report indicated that the facility's winter operating schedule is 5:30 AM – 4:00 PM, Monday – Friday and the temperature is set at 68°F during operating hours and setback to 62°F during non-operating hours. Further, this report reveals that the primary HVAC equipment found on-site are roof-top units (RTU) with gas furnaces. Table 7-17 represents the RTUs in the audit report that pertain to the space areas that had roof insulation upgrades.

Table 7-17: HVAC Equipment related to Roof Insulation

#	Manufacturer	Model #	Fan Capacity	Area served
RTU-9	Lennox	GCS16-120-270-1Y	6,400	New warehouse
RTU-10	Lennox	GCS16-120-270-1Y	6,400	New warehouse
RTU-11	Lennox	GCS16-120-270-1Y	6,400	New warehouse
RTU-12	Lennox	GCS16-120-270-1Y	6,400	New warehouse
RTU-13	Trane	YCD0603H0BE	2,000	Office Space
RTU-14	Trane	YCD0603H0BE	2,000	Office Space

Source: Navigant's analysis of project files

The evaluation team understands that these roof-top units include packaged natural gas furnaces and agrees with the original assumption of system efficiency of 75%.

Navigant agrees with the algorithm used to determine energy savings for this particular measure, but the project files do not support using an indoor heating temperature of 70°F. Since the energy audit report shows that the heating temperature during the winter season is 68°F, the evaluation team used this value and verified that the annual savings for this measure are 1,105 therms.

Recommendations for Future Projects

Finding: Navigant could not identify some of the baseline heating system characteristics after following up with the IC.

> **Recommendation**: Because this particular project's savings is based on reduced heating consumption, the evaluation team recommends better documentation on key components of the heating equipment (e.g., capacity, efficiency) related to the roof insulation upgrades.

7.2.12 ERP-12 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-12
Verification Method: Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review. Navigant's evaluation verified the annual energy savings to be 7,375 therms, resulting in a project realization rate of 0.99, summarized in Table 7-18.

The primary reason for the difference in the ex-ante and research findings gross savings is that the ex-ante calculation used a DHW heater of 96% while Navigant's evaluation determined an efficiency of 95%.

Table 7-18: ERP-12 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
CO_2 control in cardio, aerobic, spinning, and basketball rooms	5,693	5,693	1.00
(2) 95% Efficient, 400 MBH DHW heaters	1,794	1,682	0.94
Total	**7,487**	**7,375**	**0.99**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-12 Customer implemented energy efficiency measures at their fitness center facility with a project completion date of 10/1/2012. The project was completed as part of the ERP because it would put a building in use that was either vacant or underutilized.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified by review of the project files:

- Building description: Fitness center

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: CO_2 control in cardio, aerobic, spinning, and basketball rooms
The IC used the following algorithms to calculate gas savings from this measure:

$$Therms\ Saved = \frac{\sum DCV\ Heating}{Heating\ Efficiency/100{,}000}$$

$$DCV\ Heating = (Ventilation\ Heating) \times (1 - \%Occupancy)$$

$$Ventilation\ Heating = 1.08 \times Outdoor\ Air\ Flow\ Rate \times Indoor\ Heating\ Setpoint \times T_{db}$$

$$Outdoor\ Air\ Flow\ Rate = 1400 \times 4 + 800 + 1400 = 7800\ \text{cfm}$$

Algorithm Parameter	Value	Unit	Source/Description
Heating Efficiency	75	%	Assumed; efficiency of the heating system
%Occupancy	Varies	%	Occupancy rate as a percent. From ASHRAE 90.1-2010 User's Manual page G46
Indoor Heating Set point	70	°F	Assumed; temperature setpoint of heating system
T_{db}	Varies	°F	Dry bulb temperature at a given time on a given day of the year. From Chicago weather data.
Therms Saved	5,693	therms	Calculated

Source: Navigant's analysis of project files

Measure: (2) 95% Efficient, 400 MBH DHW heaters

The technical assistance team used the following algorithm to calculate gas savings from this measure:

$$Therms\ Saved = \frac{Cap \times CF \times (\frac{Hours}{year}) \times 0.01 \times Eff_{base} \times (Eff_{new} - Eff_{base})}{OF}$$

Algorithm Parameter	Value	Unit	Source/Description
Cap	800	MBtu/hr	Heating capacity of units; verified by IC onsite
CF	0.25	-	Capacity factor; from ASHRAE 90.1-2010 User's Manual page G44
Hours/year	8760	Hours	Assumed
Eff_{base}	80	%	Efficiency of base unit; Assumed
Eff_{new}	96	%	Efficiency of new unit; Verified by IC onsite
OF	1.25	-	Oversize factor; Assumed
Therms Saved	1,794	therms	Calculated

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed an engineering file review of this project. The measure-level findings and analysis of the file review are outlined below.

Measure: CO_2 control in cardio, aerobic, spinning, and basketball rooms
Navigant's engineering file review determined that the customer installed four CO_2 sensors for control in the following areas of the fitness facility: cardio, aerobic, and spinning rooms, as well as the basketball court. The evaluation team determined that the methodology and algorithm inputs were reasonable.

Navigant performed an engineering file review of this measure and verified that the annual savings for this measure are 5,693 therms.

Measure: (2) 95% Efficient, 400 MBH DHW heaters
Navigant's engineering file review determined that the customer installed two A.O. Smith BTH 400 commercial water heaters. The capacity of these water heaters is 400 MBtu/hr each, with nameplate thermal efficiency of 95% (see Figure 7-10 below). This was less than the 96% thermal efficiency used by the IC to calculate the therm savings for the measure. Using this efficiency with the original algorithm used, Navigant calculated the gas savings for this measure to be 1,682 therms.

Figure 7-10: ERP-12 Water Heater Nameplate

Source: LA Fitness – Nicor Gas ERP Verification Report.pdf

RECOMMENDATIONS FOR FUTURE PROJECTS

Navigant does not have any recommendations for future projects based on this review.

7.2.13 ERP-13 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-13
Verification Method: Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review. Navigant's evaluation verified the annual energy savings to be 4,402 therms, resulting in a project realization rate of 1.09, summarized in Table 7-19.

The primary reason for the difference in the ex-ante and research findings gross savings is that Navigant replicated the ex-ante savings using the eQUEST model created by the IC with TMY3 weather data. Navigant used the same parameters and determined the following research findings savings values.

Table 7-19: ERP-13 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
(2) Boiler Tune-ups	2,129	2,321	1.09
Install Lochinvar-Armor hot water boiler 94% efficient	638	695	1.09
Replace boiler room vent with automatic louvered make-up air dampers, interlocked with burner controls	1,271	1,386	1.09
Total	**4,027**	**4,402**	**1.09**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-13 Customer implemented energy efficiency measures at their 49-unit multifamily housing facility with a project completion date of 1/1/2013. The project was completed as part of the ERP because the facility was a non-profit or community-based entity, provided housing solutions, and provided strong positive community impact.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following text outlines the baseline conditions identified by onsite verification and/or review of the project files:

- Building description: 49 unit Multifamily facility
- Building size: 65,000 square feet
- Heated by a steam boiler with radiators in each unit

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: (2) Boiler Tune-ups

The IC used an eQUEST building simulation with the following inputs to calculate savings for each measure.

Algorithm Parameter	Value	Unit	Source/Description
Baseline efficiency	0.72	-	Efficiency of existing steam boilers; Assumed
Post tune-up efficiency	0.76	-	Efficiency of steam boilers after tune-ups; Assumed
Therms Saved	2,129	therms	Calculated

Source: Navigant's analysis of project files

Measure: Install Lochinvar-Armor hot water boiler 94% efficient

The IC used an eQUEST building simulation with the following inputs to calculate savings for each measure.

Algorithm Parameter	Value	Unit	Source/Description
Baseline efficiency	0.72	-	Efficiency of existing water heater; Assumed
New unit efficiency	0.94	-	Efficiency of new water heater; See invoices and spec sheets
Therms Saved	638	therms	Calculated

Source: Navigant's analysis of project files

Measure: Replace boiler room vent with automatic louvered make-up air dampers, interlocked with burner controls

The IC used an eQUEST building simulation with the following inputs to calculate savings for each measure.

Algorithm Parameter	Value	Unit	Source/Description
Damper infiltration - existing	0.15	cfm	Damper infiltration of existing system; Assumed
Damper infiltration - new	0.00	cfm	Damper infiltration of new system; Assumed
Therms Saved	1,271	therms	Calculated

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis
Navigant performed an engineering file review of the project. Navigant verified the energy savings by developing an energy model based on assumptions from the ex-ante model and/or the project files, and an updated weather file representing TMY3 data. The measure-level findings and analysis of the engineering file review are outlined below.

Measure: (2) Boiler Tune-ups
This multifamily facility uses steam distributed through a pipe network to transfer heat from the steam boiler to individual apartment units. The customer had both of their steam boilers tuned-up from an assumed efficiency of 72% to an assumed efficiency of 76%.

Navigant verified the IC's inputs in the eQUEST model and reran the simulation with TMY3 data. Navigant verified that the annual savings for this measure are 2,321 therms.

Measure: Install Lochinvar-Armor hot water boiler 94% efficient
Navigant analyzed the building simulation performed by the IC and verified the water heater efficiency assumptions of 72% for the existing unit and 94% for the new unit.

The water heating unit installed was a Lochinvar-Armor 94% efficient unit. Navigant verified the IC's inputs in the eQUEST model, reran the simulation with TMY3 data, and verified the annual gas savings for this measure are 695 therms.

Measure: Replace boiler room vent with automatic louvered make-up air dampers, interlocked with burner controls

Navigant analyzed the building simulation performed by the IC and verified the damper infiltration assumption of 0.15 cfm for the existing system and zero cfm for the new automatic louvered system. Navigant verified the IC's inputs in the eQUEST model, reran the simulation with TMY3 data, and verified the annual gas savings for this measure are 1,386 therms.

RECOMMENDATIONS FOR FUTURE PROJECTS

Finding: Navigant determined that the IC did not use a TMY3 weather file in their building simulation model used to calculate savings.

> **Recommendation**: Navigant recommends that the IC use TMY3 data when performing building simulations.

7.2.14 ERP-14 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-14
Verification Method: Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review. Navigant's evaluation verified the annual energy savings to be 4,970 therms, resulting in a project realization rate of 1.16, summarized in Table 7-20.

The primary reason for the difference in the ex-ante and research findings gross savings is that Navigant replicated the ex-ante eQUEST model using TMY3 data. Navigant used the same parameters and determined the following research findings savings value to be 4,970 therms.

Table 7-20: ERP-14 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
(2) Boiler Tune-ups	1,545	1,800	1.16
Replace boiler room vent with automatic louvered make-up air dampers, interlocked with burner controls	2,722	3,170	1.16
Total	**4,267**	**4,970**	**1.16**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-14 Customer implemented energy efficiency measures at their 54-unit multifamily housing facility with a project completion date of 1/1/2013. The project was completed as part of the ERP because the facility was a non-profit or community-based entity, provided housing solutions, and provided strong positive community impact.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following outline the baseline conditions identified by onsite verification and/or review of the project files:

- Building description: 54-unit Multifamily facility
- Building size: 65,000 square feet
- Heated by a steam boiler with radiators in each unit

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: (2) Boiler Tune-ups
The IC used an eQuest building simulation with the following inputs to calculate savings for this measure.

Algorithm Parameter	Value	Unit	Source/Description
Baseline efficiency	0.72	-	Efficiency of existing steam boilers; Assumed
Post tune-up efficiency	0.76	-	Efficiency of steam boilers after tune-ups; Assumed
Therms Saved	1,545	therms	Calculated

Source: Navigant's analysis of project files

Measure: Replace boiler room vent with automatic louvered make-up air dampers, interlocked with burner controls
The IC used an eQUEST building simulation with the following inputs to calculate savings for this measure.

Algorithm Parameter	Value	Unit	Source/Description
Damper infiltration South - existing	0.37	cfm	Damper infiltration of existing system; Assumed
Damper infiltration Humphrey - existing	0.51	cfm	Damper infiltration of existing system; Assumed
Damper infiltration - new	0.00	cfm	Damper infiltration of new system; Assumed
Therms Saved	2,722	therms	Calculated

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed an engineering file review of the project. The measure-level findings and analysis of the engineering file review are outlined below.

Measure: (2) Boiler Tune-ups
This multifamily facility uses steam distributed through a pipe network to transfer heat from the steam boiler to individual apartment units. The customer had both of their steam boilers tuned-up from an assumed efficiency of 72% to an assumed efficiency of 76%.

Navigant verified the IC's inputs in the eQUEST model and reran the simulation. Based on the analysis, Navigant verified that the annual savings for this measure are 1,800 therms.

Measure: Replace boiler room vent with automatic louvered make-up air dampers, interlocked with burner controls

Navigant analyzed the building simulation performed by the IC and verified the damper infiltration assumption of 0.37 cfm for the existing system at the South location, 0.51 cfm for the existing system at the Humphrey location, and zero cfm for the new automatic louvered system.

Navigant verified the IC's inputs in the eQUEST model and reran the simulation. Using the building simulation parameters from the IC, Navigant verified the annual gas savings for this measure are 3,170 therms.

Recommendations for Future Projects

Finding: Navigant determined that the IC did not use a TMY3 weather file in their building simulation model used to calculate savings.

> **Recommendation**: Navigant recommends that the IC use TMY3 data when performing building simulations.

7.2.15 ERP-15 Project Review

EXECUTIVE SUMMARY

Project Code: ERP-15
Verification Method: Engineering File Review

Navigant's evaluation of this project consisted of an engineering file review. Navigant's evaluation verified the annual energy savings to be 822 therms, resulting in a project realization rate of 0.66, summarized in Table 7-21.

The primary reason for the difference in the ex-ante and research findings gross savings is that Navigant used the Illinois TRM rather than the IC's methodology to calculate savings due to the installation of a high-efficiency furnace, with a significantly adjusted input capacity based on a post-inspection report. The secondary reason for the difference in the ex-ante and research findings gross savings is that the IC considered heat loss through both the windows and the walls when modeling the energy savings due to increased insulation in the walls. Navigant adjusted the inputs to the energy model to only consider the insulation in the walls.

Table 7-21: ERP-15 Savings Summary

Measure Description	Ex-Ante Savings (therms)	Research Findings Savings (therms)	Realization Rate
Install 92.5% efficient condensing furnace	476	115	0.24
Add insulation to walls (R-13, from R-0)	461	367	0.80
Add insulation to ceiling (R-21, from R-0)	309	340	1.10
Total	**1,246**	**822**	**0.66**

Source: Project files and Navigant's analysis

PROJECT SUMMARY

The ERP-15 Customer implemented energy efficiency measures at their industrial facility on a project completion date of 5/31/2013. The project was completed as part of the ERP because the project had the potential to create jobs and provide and strong positive community impact, and was located in a TIF District or Enterprise Zone.

EX-ANTE SAVINGS CALCULATION METHODOLOGY

Baseline Conditions

The following outline the baseline conditions identified by onsite verification and/or review of the project files:

- Heating System Efficiency: 75%

Energy Efficient Conditions

The IC used the following methodology to calculate the ex-ante savings from which the incentive was paid to the customer.

Measure: Install 92.5% efficient condensing furnace
The IC used the following algorithm to calculate gas savings from this measure:

$$Therms\ Saved = InputCap * \frac{\left(\frac{Annual\ Heat\ Load}{eff_{proposed} * 100} - \frac{Annual\ Heat\ Load}{eff_{baseline} * 100}\right) * eff_{proposed}}{AvgPeakHeat * 1000}$$

Algorithm Parameter	Value	Unit	Source/Description
$Therms\ Saved$	476	therms	Calculated
$InputCap$	199	MBtu/hr	Assumed
$Annual\ Heat\ Load$	38.3	kBtu/ft2	Calculated from CBECS assumptions and an assumed heating system efficiency of 75%
$AvgPeakHeat$	25	Btu/hr/ft2	CBECS 2003, Table E2A
$eff_{proposed}$	92.5%	%	Nameplate
$eff_{baseline}$	80%	%	Code minimum

Source: Navigant's analysis of project files

Measure: Add insulation to walls (R-13, from R-0)
The IC used the following algorithm to calculate gas savings from this measure:

$$Therms\ Saved = \frac{\left(HeatLoss_{baseline} - HeatLoss_{proposed}\right)}{Heating\ System\ Eff}$$

Algorithm Parameter	Value	Unit	Source/Description
$Therms\ Saved$	461	therms	Calculated
$Heating\ System\ Eff$	75%	%	Assumed
$HeatLoss_{baseline}$	1352	therms	8,760-hour energy model using TMY3 weather data
$HeatLoss_{proposed}$	1006	therms	8,760-hour energy model using TMY3 weather data

Source: Navigant's analysis of project files

Measure: Add insulation to ceiling (R-21, from R-0)
The IC used the following algorithm to calculate gas savings from this measure:

$$Therms\ Saved = \frac{(HeatLoss_{baseline} - HeatLoss_{proposed})}{Heating\ System\ Eff}$$

Algorithm Parameter	Value	Unit	Source/Description
$Therms\ Saved$	309	therms	Calculated
$Heating\ System\ Eff$	75%	%	Assumed
$HeatLoss_{baseline}$	30.43	MMBtu	8,760-hour energy model using TMY3 weather data
$HeatLoss_{proposed}$	7.24	MMBtu	8,760-hour energy model using TMY3 weather data

Source: Navigant's analysis of project files

ANALYSIS & RESULTS

Data Collection Findings and Analysis

Navigant performed an engineering file review of this project. Because the usage of the facility did not appear to change significantly from the pre- to the post-implementation periods, Navigant determined that the site-level ex-ante annual gas *savings* of 1,246 therms are unreasonably high compared to the site-level average annual billed gas *consumption* of 2,109 therms for the measures claimed as part of this project. Navigant adjusted the savings methodology for each measure, with the measure-level findings outlined below.

Measure: Install 92.5% efficient condensing furnace

Navigant reviewed the project files to verify the various assumptions used in the ex-ante savings calculation. The IC did not use the Illinois TRM to calculate savings for this measure; rather, the IC used various per-area assumptions from the Commercial Buildings Energy Consumption Survey (CBECS). Navigant does not agree with the ex-ante savings methodology of using per-area factors without incorporating the facility's square footage as a parameter in the savings algorithm. Navigant considers it best practice to use the Illinois TRM to calculate energy savings for this measure. The TRM specifies the use of the following algorithm to calculate savings for a commercial natural gas high efficiency furnace:

$$Therms\ Saved = EFLH * Capacity * \left(\frac{1}{AFUE_{baseline}} - \frac{1}{AFUE_{EE}}\right) * \frac{therm}{100{,}000\ BTU}$$

The site is located in Zone 3 (Hancock County) of the Illinois TRM climate zones. Navigant considers the best fit building type to be "Unknown," which has a higher EFLH than "Manufacturing Facility" and a lower EFLH than "Retail – Strip Mall." Navigant reviewed a post-inspection report by CNT Energy that indicated that a 60MBH Rheem furnace with a 92.5% rated AFUE was installed as part of the project. Therefore, Navigant calculated the gas savings using the above algorithm:

$$\mathbf{115\ therms} = 1{,}130\ hours * 60{,}000 \frac{Btu}{hour} * \left(\frac{1}{0.80} - \frac{1}{0.925}\right) * \frac{therm}{100{,}000\ BTU}$$

Thus the verified gas savings for this measure are 115 therms.

Measure: Add insulation to walls
Navigant reviewed the project files to verify the energy savings associated with the added wall insulation. The ex-ante savings model assumed an effective R-value improvement from R-3.4 in the baseline case to R-10.3 in the energy-efficient case. Because the energy-efficient R-value was hard-coded in the analysis file provided by the IC, Navigant reverse-engineered the savings calculation to solve for this R-value based on the final savings result. Navigant also determined that the IC included heat loss through the windows as part of the wall insulation savings calculation.

Navigant adjusted the parameters of the savings calculation to only consider the wall insulation being upgraded from R-3.4 as assumed in the baseline ex-ante calculation to R-13 as found in CNT Energy's post-inspection report. Replicating the ex-ante algorithm with these new parameters, Navigant determined the verified savings for this measure to be 367 therms.

Measure: Add insulation to ceiling
Navigant reviewed the project files to verify the energy savings associated with additional ceiling insulation. Navigant reviewed a post-inspection report by CNT Energy that indicated the roof cavity contains R-38 insulation. Navigant adjusted the average perimeter zone balance point temperature from 65˚F to 60˚F, a more realistic base temperature for a small commercial facility. Navigant also adjusted the proposed roof U-factor to incorporate the findings of CNT Energy's post-inspection report that indicated the roof insulation was blown to R-38. Replicating the ex-ante algorithm with the adjusted parameters, Navigant determined the verified savings of the measure to be 340 therms.

Recommendations for Future Projects

Finding: The claimed savings for ERP-15 were quite high compared to the facility's billed gas consumption.

> **Recommendation**: Navigant recommends that Nicor Gas conduct a preliminary comparison of these two values to ensure reasonability of the ex-ante savings calculation.

Finding: The IC used applied an algorithm alternative to the TRM to calculate gas savings due to the high-efficiency furnace replacement.

> **Recommendation**: Navigant recommends that the IC use the Illinois TRM where applicable.

4.11 Emerging Technology