500 Consumers Road
North York, Ontario
M2J 1P8
PO Box 650
Scarborough ON
M1K 5E3

Andrew Mandyam
Director, Regulatory Affairs
Telephone: (416) 495-5499
Fax: (416) 495-6072
Email: EGDRegulatoryProceedings@enbridge.com

October 1, 2014

VIA RESS, EMAIL and COURIER

Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street
Suite 2700
Toronto, ON M4P 1E4

Dear Ms. Walli:

Re: Enbridge Gas Distribution Inc. (the "Company" or "Enbridge")
Ontario Energy Board File: EB-2014-0277
Application for 2013 Demand Side Management ("DSM") Clearance of Variance Accounts and Request for Confidentiality

Enclosed are copies of the Application and supporting evidence of Enbridge for an Order approving the amounts recorded in the 2013 DSM deferral and variance accounts and for approval for disposition of these amounts at the next available QRAM application.

Please note that the supporting evidence includes the reports of two Custom Project Savings Verification ("CPSV**"**) contractors, MMM Group Ltd. and Genivar Inc. ("CPSV Reports"). For the reasons set out below, Enbridge seeks confidential treatment of the CPSV Reports to the extent of the redactions made on these reports.

This request for confidential treatment is made pursuant to the Board's Practice Direction on Confidential Filings ("Direction") and Rule 10 of the Board's *Rules of Practice and Procedure* ("Rules").

Information has been redacted where it might reveal the identity of program participants, the location of participating facilities, and their internal processes and operations. These are either matters of privacy or commercial sensitivity. Enbridge has committed to protect such information, and it is the expectation of custom program participants that this will occur. Enbridge's future efforts to attract program participants could be prejudicially impacted if such information is released publicly.

As there may be only two or three competitors within a certain industry, to the extent that a competitor is able to identify a program participant from one of the CPSV Reports and to make use of any operations or process data, such information could have a negative effect on the competitiveness of the program participant.

In accordance with the Direction and the Rules, the Company is providing two paper copies of the unredacted versions of the CPSV Reports, with shading identifying those sections for which confidential treatment is requested. These versions of the CPSV Reports are marked Confidential.

In addition, the Company has attached two paper copies of the redacted versions of the CPSV Reports which may be placed on the public record together with the balance of the Application.

The above information is being filed through the Board's Regulatory Electronic Submission System today. Enbridge will provide the redacted Application materials on the Company's website at www.enbridgegas.com/about/regulatory-affairs.

Please contact the undersigned if you have any questions.

Yours truly,

(Original Signed)

Andrew Mandyam
Director, Regulatory Affairs

Enclosures

cc Dennis O'Leary, Aird & Berlis LLP

EXHIBIT LIST

EXHIBIT A - ADMINISTRATION

EXHIBIT B – EVIDENCE

ONTARIO ENERGY BOARD

IN THE MATTER OF the *Ontario Energy Board Act, 1998,* S.O. 1998, c. 15, Schedule. B, as amended;

AND IN THE MATTER OF an application by Enbridge Gas Distribution Inc. for an order or orders approving the balances and the clearance of certain Demand Side Management Variance Accounts into rates, within the next available QRAM following the Board's approval.

APPLICATION

1. Enbridge Gas Distribution Inc. ("Enbridge" or the "Company") is an Ontario corporation with its head office in the City of Toronto. It carries on the business of selling, distributing, transmitting and storing natural gas within Ontario. The Company also undertakes Demand Side Management ("DSM") activities.

2. Enbridge hereby applies to the Ontario Energy Board (the "OEB" or the "Board"), pursuant to section 36 of the *Ontario Energy Board Act, 1998,* as amended (the "Act"), for an Order or Orders approving the final balances in the following 2013 DSM accounts and the disposition of these balances:

DSM Incentive Deferral Account ("DSMIDA")	$4,538,188
LRAM Variance Account (Reimbursable to Ratepayers)	($50,317)
DSMVA Amount (Reimbursable to Ratepayers)	($3,601,806)
Total Amount Recoverable	$886,065

3. Enbridge applies to the Board for such final and interim orders and/or accounting orders as may be necessary in relation to the clearance of the accounts which are the subject of this Application, within the next available QRAM following the Board's approval. The Company further applies to the Board pursuant to the provisions of the Act and the Board's *Rules of Practice and Procedure* for such final and interim Orders and directions as may be necessary in relation to this Application and the proper conduct of this proceeding.

4. The persons affected by this Application are the customers of Enbridge. It is impractical to set out the names and addresses of the customers because they are too numerous.

5. Enbridge requests that a copy of all documents filed with the Board by each party to this proceeding be served on the Applicant and the Applicant's counsel, as follows:

Mr. Andrew Mandyam
Director, Regulatory Affairs
Enbridge Gas Distribution Inc.

Address for personal service:	500 Consumers Road Willowdale, ON M2J 1P8
Mailing Address:	P.O. Box 650 Scarborough, ON M1K 5E3
Telephone:	416.495-5499
Facsimile:	416.495-6072
E-mail:	EGDRegulatoryProceedings@enbridge.com

Please quote the name or docket number of the proceeding in all communications.

The Applicant's counsel:

Mr. Dennis M. O'Leary
Aird & Berlis LLP

Address for personal service and
Mailing address: Brookfield Place, Box 754
Suite 1800, 181 Bay Street
Toronto, ON M5J 2T9

Telephone: 416-865-4711
Facsimile: 416-863-1515
E-mail: doleary@airdberlis.com

Dated: October 01, 2014, Toronto, Ontario.

ENBRIDGE GAS DISTRIBUTION INC.

Per: ______________________________

SUMMARY OF APPLICATION

1. Enbridge Gas Distribution Inc. ("Enbridge" or the "Company") is applying to the Ontario Energy Board ("OEB" or the "Board") pursuant to Section 36 of the *Ontario Energy Board Act, 1998,* as amended ("Act") for an Order or Orders approving the final balances in certain 2013 Demand Side Management ("DSM") Deferral and Variance Accounts. The Company is also seeking approval for the disposition of the balances in these accounts and the inclusion into rates, within the next available QRAM following the Board's approval. The accounts which are the subject of this Application and the balances recorded are as follows:

DSM Incentive Deferral Account ("DSMIDA")	$4,538,188
LRAM Variance Account (Reimbursable to Ratepayers)	($50,317)
DSMVA Amount (Reimbursable to Ratepayers)	($3,601,806)
Total Amount Recoverable	$886,065

2. The net impact of the three 2013 DSM accounts is $886,065, recoverable in rates. The Company seeks approval from the Board for clearance of this amount through to rates in the next available QRAM, pending Board approval.

DSM Framework

3. The deferral and variance accounts which are the subject of this proceeding relate to DSM activities in 2013. This was the second year of operation under the June 30, 2011 DSM Guidelines (EB-2008-0346) (Guidelines) and the Company's Multi-Year (2012-2014) DSM Plan approved by the Board in EB-2011-0295, which was updated for 2013 by the Board's Decision dated July 4, 2013, in EB-2012-0394 (together the Updated Multi-Year Plan). The methodologies used by the Company to determine the amounts recorded in each of the 2013 DSMVA, LRAM and DSMIDA were the subject of the Guidelines and the approved Updated Multi-Year Plan.

4. The Guidelines and Updated Multi-Year Plan also provided for certain stakeholder consultation, monitoring and evaluation steps in respect of a year's DSM activities. This included the election of an Enbridge Audit Committee ("AC") and the continuation of a joint Technical Evaluation Committee ("TEC") with Union Gas Limited. This Application summarizes the actions taken by the Company in compliance with same.

Summary of Facts and Events

5. The DSM Consultative originally elected an AC for 2013 consisting of representatives from Green Energy Coalition ("GEC"), Low Income Energy Network ("LIEN"), and School Energy Coalition ("SEC"). In March 2014, the SEC representative stepped down from the AC. The DSM Consultative selected a representative from the Federation of Rental-Housing Providers of Ontario ("FRPO") to fill the vacancy.

6. For the purposes of calculating and evaluating its 2013 DSM program results, the Company commenced work on its 2013 DSM Draft Evaluation Report and retained two engineering firms, MMM Group Ltd., and Genivar Inc. (currently WSP Canada Inc.) to undertake a Custom Project Savings Verification ("CPSV") review of the Company's custom projects ("CPSV Contractors"). Consistent with past practice, prior to retaining the CPSV Contractors, the Company first consulted the TEC about the terms of reference ("ToR") that would be applicable to these retainers. An agreement was ultimately reached between the Company and the TEC in respect of the ToR for the CPSV Contractors. MMM Group Ltd. was retained to review custom Commercial and Low-income projects. The second firm, Genivar Inc. was retained to undertake an independent review of Industrial custom projects.

7. The reports prepared by the CPSV contractors are attached at Exhibit B, Tab 5, Schedules 1 and 2, respectively. These reports have been redacted as necessary

to preserve the privacy and to protect the commercial sensitivity of the program participants.

8. Consistent with Section 15 of the Guidelines, the Company prepared an evaluation report for 2013 titled 2013 DSM Draft Evaluation Report ("Draft Evaluation Report") dated May 7, 2014, which summarized the savings achieved and the amounts spent. The results of the independent review of custom projects by the CPSV Contractors were included in the Draft Evaluation Report. The Draft Evaluation Report also included calculations for the 2013 DSMIDA and DSMVA.

9. In compliance with the Guidelines at Section 15.3, the Company was required to subject its DSM results to an independent audit. The Company consulted the AC on the ToR for the audit, the Audit Work Plan, and the selection of the independent Auditor. After consultation with the AC, it was agreed that Optimal Energy, Inc. ("Optimal") would be the 2013 DSM Auditor. Subsequent to Optimal being retained, with its assistance, the Company undertook additional consultations with the AC in respect of the Audit Work Plan.

10. Optimal was provided with the Draft Evaluation Report and received copies of all drafts of the CPSV Contractors' reports. The AC was provided with drafts of both the Industrial and Commercial CPSV reports prior to the reports being finalized. Both Optimal and the AC reviewed these drafts and the final versions of the CPSV Contractors' reports and discussed with the CPSV Contractors, items such as baseline and measure life appropriateness. Optimal provided extensive recommendations and, with input from the AC, the rigour of the review of custom projects was improved.

11. For prescriptive savings claims, Optimal performed a review of the Company's program-by-program measure level calculations. Optimal also undertook a sampling of individual measures to verify the results. In respect of Market Transformation ("MT") programs, Optimal undertook extensive interviews with the

Company's MT program staff and completed a careful review of the data which supports the MT results. Optimal's review process also included detailed walk-throughs of other Enbridge programs and offers, such as the Run-it-Right program.

12. The independent Auditor verified the calculations underlying the proposed DSMIDA, LRAM and DSMVA amounts and made various recommendations. The full details of the extent of Optimal's audit of the Company's 2013 program results are set out in Optimal's Final Report dated June 24, 2014 ("Audit Report"). The Audit Report is filed at Exhibit B, Tab 2, Schedule 1. The filing of this report was supported by the AC.

13. The AC subsequently made recommendations respecting the clearance of the DSM variance accounts which were ultimately accepted by the Company, consisting of one small adjustment to the LRAMVA, as noted further below.

14. A copy of the 2013 DSM Audit Summary Report dated September 24, 2014 is filed at Exhibit B, Tab 3, Schedule 1.

15. A copy of the 2013 Final DSM Annual Report dated September, 2014, which reflects the post audit results, is filed at Exhibit B, Tab 1, Schedule 1.

<u>2013 Demand Side Management Variance Account</u>

16. The final DSMVA is the amount of ($3,601,806) reimbursable to ratepayers. This is the difference between the 2013 budget and the actual amount expended in 2013. This is the amount which the Company calculated in its Draft Evaluation Report. This figure was verified by the independent Auditor and has been accepted by the AC.

<u>Lost Revenue Adjustment Mechanism Variance Account</u>

17. The final LRAM is the amount of ($50,317) reimbursable to ratepayers. In the interests of efficiency, the Company and members of earlier ACs concluded that

the LRAM calculation should be undertaken after the final audit of savings values becomes available. The Company followed the practice this year, and accordingly, the Draft Evaluation Report did not include a value for the LRAM.

18. The Optimal Audit Report calculated the LRAM at ($49,213) reimbursable to ratepayers. During the audit summary process, the AC noted that there was no LRAM adjustment proposed for Rate 135. Although there were no budgeted volumes for Rate 135 customers, there were actual volumetric savings from this rate class due to customer participation in 2013 DSM programs. These actual Rate 135 results were included in Rate 145. Enbridge revised the LRAM calculation to show both Rates 135 and 145 separately. This resulted in a LRAM value of ($50,317), which is reimbursable to ratepayers. The small difference in distribution margins for Rates 135 and 145 resulted in the slight increase to the LRAM.

<u>DSM Incentive Deferral Account</u>

19. The Guidelines and the Updated Multi-Year Plan provide the method of calculating the DSMIDA and a cap of approximately $10.7 million for 2013. The Draft Evaluation Report calculated the DSMIDA at $4,378,508. Following its review of the Company's program results, the independent Auditor made recommendations with regard to the following measures, which the Company and the AC accepted:

(i) Industrial Custom Project Savings

(ii) Commercial Custom Project Savings

(iii) Custom Project adjustment factor calculation

(iv) Low income (Part 3) Custom Project Savings

(v) Run it Right Project Savings.

This resulted in an auditor-recommended DSMIDA of $4,538,188. The specifics of the recommendations made by Optimal are set out in its Audit Report. This amount was accepted by both the Company and the AC.

Recommendations of the Audit Committee

20. Following its review of the Draft Evaluation Report, the Optimal Audit Report, and the CPSV Contractors' reports, the AC made the following recommendations:

(a) The AC accepted the DSMVA calculation of ($3,601,806), being reimbursable to ratepayers. The Company agrees.

(b) The AC recommended the LRAM of ($50,317), being reimbursable to ratepayers. The Company agrees.

(c) The AC accepted the DSMIDA calculation of $4,538,188, being recoverable from ratepayers. The Company agrees.

21. The following Table summarizes the claims in the Draft Evaluation Report, the Auditor's recommendations, and the post-audit amounts.

	Draft DSM Annual Report (May 2014)	Audit Report (June 2014)	Post Audit Results
CCM Savings	812,563,714m^3	826,908,305m^3	826,908,305m^3
DSMIDA (Amount Recoverable)	$4,378,508	$4,538,188	$4,538,188
LRAM (Reimbursable to Ratepayers)	N/A	($49,213)	($50,317)
DSMVA (Reimbursable to Ratepayers)	($3,601,806)	($3,601,806)	($3,601,806)

Proposal for Clearance

22. The net amount which the Company proposes for clearance through to rates is $886,065. The Company respectfully requests that this amount be included in rates within the next available QRAM following the Board's approval.

23. The allocation methodology applied by the Company was approved by the Guidelines. Specifically, the methodologies applied were:

- The actual DSMVA spending variance amount versus budget targeted to each customer class was allocated to that customer class for rate recovery purposes (Guidelines ss. 13.2).
- The LRAM amount is recovered in rates on the same basis as the lost revenues were experienced so that the LRAM ends up being a full true-up by rate class (Guidelines ss. 13.3).
- DSM shareholder incentive amounts (DSMIDA) already allocated to the rate classes in proportion to the amount actually spent on each respective rate class (Guidelines ss. 13.4).

A breakdown of these allocations is attached at Exhibit B, Tab 4, Schedule 1.

<u>Benefits to Ratepayers</u>

24. The Company's DSM activities in 2013 generated estimated natural gas savings of approximately 826.9 M CCM. The 2013 DSM activities are estimated to have a TRC value of $81,887,495, which is the approximate value of bill savings enjoyed by Enbridge's customers.

2013

DEMAND SIDE MANAGEMENT ANNUAL REPORT

September 24, 2014

ENBRIDGE

Table of Contents

List of Tables

1. Executive Summary

In 2013, the second year of the 2012-2014 multi-year Demand Side Management (DSM) Plan, the overall goals of Enbridge Gas Distribution's (Enbridge, EGD or the Company) DSM Plan (the Plan) were to continue efforts in helping customers achieve deep and lasting energy savings, to capture lost opportunities, and to maximize cost-effective natural gas savings. The Plan was designed to accomplish these goals through a combination of programs developed within the framework of the Ontario Energy Board's (OEB or the Board) Demand Side Management Guidelines for Natural Gas Utilities (EB-2008-0346), published June 30, 2011.

The Annual Report on DSM program performance is intended to provide a compilation of the results achieved over the past year; to inform stakeholders on the utility's year-over-year progress in the implementation of the multi-year plan; and summarize the savings achieved, budget spent and evaluation conducted. In addition, the report incorporates any necessary adjustments to savings outcomes and the calculated amounts of the shareholder incentive earned for DSM activity.

This report presents the results of the Company's DSM program activities for 2013 and offers an overview of activities undertaken over the course of the year. As Enbridge continues to cultivate its DSM program in an effort to optimize opportunities presented under the current framework, the Company is pleased to report that in 2013 the portfolio generated total annual natural gas savings of 47,736,581 cubic meters or 826,908,305 lifetime (cumulative) cubic meters (CCM). These results were realized with spending of $27.84 million. For context, the total annual throughput of natural gas to EGD customers in 2013 was approximately 11 billion cubic meters.[1]

Under the provisions outlined in applying an OEB approved weighted scoring approach, the Demand Side Management Incentive (DSMI) has been determined in correspondence with Enbridge's 2013 DSM

1 This calculation is based on the total throughput for rate classes which contain 2013 DSM program participants (Rates 1, 6, 110, 115, 135, 145 and 170).

performance results. Consequently, the DSM Incentive for 2013 has been calculated at $4,538,188 compared with a maximum shareholder incentive available of $10.66 million.

Table 1. 2013 DSM Summary

2013 DSM Results Summary	
Net CCM Savings	**826,908,305 m^3**
DSMIDA amount recoverable	**$4,538,188**
LRAMVA amount repayable to Ratepayers	**-$50,317**
DSMVA amount repayable to Ratepayers	**$3,601,806**

Table 2. 2013 DSM Overall Results

Program	Annual Net Gas Savings (m3)	Cumulative Net Gas Savings (m3)	Budget	Spending ($)	TRC Ratio
Resource Acquistion					
Residential	1,949,026	38,980,521	$1,800,000	$2,376,897	1.07
Commercial	29,753,147	505,133,591	$7,931,920	$6,453,504	2.64
Industrial	13,110,756	222,575,355	$4,151,000	$2,607,644	3.90
Overheads			$4,528,033	$5,091,220	
Total Resource Acquisition	**44,812,930**	**766,689,466**	**$18,410,953**	**$16,529,266**	**2.43**
Low Income					
Part 9 (Single Family)	1,375,598	32,904,684	$4,363,950	$4,639,037	1.12
Part 3 (Multi Family)	1,548,054	27,314,154	$2,274,375	$723,728	3.99
Overheads			$522,050	$586,981	
Total Low Income	**2,923,651**	**60,218,838**	**$7,160,375**	**$5,949,747**	**1.53**
Market Transformation					
Drain Water Heat Recovery	n/a	n/a	$1,415,000	$1,937,030	n/a
SBD Residential	n/a	n/a	$2,305,000	$1,029,535	n/a
SBD Commercial	n/a	n/a	$590,000	$590,592	n/a
Home Labelling	n/a	n/a	$775,000	$755,900	n/a
Overheads			$931,872	$1,047,776	
Total Market Transformation	**n/a**	**n/a**	**$6,016,872**	**$5,360,834**	**n/a**
Grand Total	**47,736,581**	**826,908,305**	**$31,588,200**	**$27,839,846**	

Enbridge's DSM portfolio is designed to offer all customer classes access to cost-effective energy efficiency offerings and to optimize program results. The 2012-2014 DSM Plan uses a scorecard approach for measurement.

In 2013, though some DSM customer offerings achieved solid results relative to targets, in other areas, year-end results were down from 2012 performance results, and/or underperformed relative to targets.

Resource Acquisition (RA) offers for both the Commercial and Industrial sectors did not achieve savings targets outlined for 2013; cumulative cubic meter (CCM) savings from Commercial offerings totalled 505 million CCM and savings attributable to Industrial offerings approached 223 million CCM. Residential Resource Acquisition performance however, well exceeded upper targets, achieving 39 million CCM in natural gas savings and counting 1,649 participants in relation to the Residential Deep Savings metric.

Overall the combined Resource Acquisition program delivered almost 767 million CCM or 79% of original forecasts with spending 10% under budget. Savings in the program overall were realized with a low average cost per CCM of $0.0153/CCM.

The **Low Income** program continued in 2013 with offerings delivered to both the Single Family (Part 9) and the Multi-Residential (Part 3) low income customer segments. Results were mixed in the Low Income program. Single Family results were well above savings targets; CCM savings from Single Family offerings totalled 32.9 million CCM. Multi-Residential results however, fell short of 2013 goals, with total cumulative gas savings reaching 27.3 million CCM. Total savings of 60.2 million CCM represented 72% of the target. Spending for the Low Income program was 17% below budget and results were achieved at an average cost of $0.0891/CCM.

Market Transformation (MT) offerings had strong results. The Market Transformation program was a solid performer in all areas with the four offerings meeting or exceeding their weighted scorecard targets. Enrollment of builders in both the Commercial and Residential Savings by Design (SBD) offerings met or exceeded upper targets. Five years of effective promotion in the market of the Drain Water Heat Recovery (DWHR) technology also contributed to the success for the program. Enbridge concluded the DWHR offering in 2013 as planned. Spending for the Market Transformation program was 11% below budget overall.

In retrospect, this second year of the current three-year framework has provided some constancy, a clearer understanding of the current Guidelines, and the opportunity to reflect upon and further develop DSM programs. Enbridge delivered solid DSM related natural gas savings results on many fronts in 2013, but more importantly the DSM team has continued to learn from experience and will work towards improving the offerings provided to customers.

2. Introduction and Report Overview

2.1 Introduction

"Natural gas demand side management ("DSM") is the modification of consumer demand for natural gas through various methods such as financial incentives, education and other programs. While the focus of DSM is natural gas savings and the reduction in greenhouse gases emissions, it may also result in the saving of a number of other resources such as electricity, water, propane, and heating fuel oil."[2]

Beginning in 1995 with a directive from the Ontario Energy Board, (EBO 169-III), Enbridge has delivered Demand Side Management programs to help its customers reduce their demand for natural gas. The continuing need for DSM efforts was recognized by the Board with the release of the Demand Side Management Guidelines for Natural Gas Utilities (the Guidelines) on June 30, 2011.

The current DSM Guidelines set three central objectives which are intended to guide the utilities' DSM portfolios – maximize cost-effective natural gas savings; prevent lost opportunities; and pursue deep savings. The framework also establishes budget limits and provides for utility performance incentives for DSM activities.

In 1999, Enbridge sought and was granted Board approval to receive a financial incentive for DSM activities in the form of the Shared Savings Mechanism (SSM). Effective in 2012 and subsequently, the Demand Side Management Incentive replaced the SSM.

The Guidelines also provide for a Lost Revenue Adjustment Mechanism (LRAM) and Demand Side Management Variance Account (DSMVA). The LRAM "is a mechanism to adjust for margins the utility loses if its DSM Program is more (or less) successful in the period after rates are set than

2 *"Demand Side Management Guidelines for Natural Gas Utilities"* (EB-2008-0346), OEB, June 30, 2011, page 1.

was planned in setting the rates."[3] The DSMVA allows the Company to exceed the DSM budget in a given year, provided that the Company meets the Board approved target. It also sanctions the return of any unspent budget amounts to ratepayers.

In addition, the Guidelines provide an overarching framework in the consideration of program design and call for a scorecard approach to measuring DSM programs, setting out metrics appropriate to different customer offerings. The primary measurement metric for evaluating programs is cubic meters (m^3) of cumulative natural gas savings – cumulative cubic meters (CCM) which is defined as the natural gas savings over the life of an installed DSM measure.[4] Performance assessment may however, include other metrics such as number of participants.

As suggested in the Guidelines, a cost-efficiency measure, such as the "$ spent per m^3 of cumulative natural gas saved" provides greater transparency to all interested participants and the Board. As such, $/CCM savings calculations are included in this report. Total Resource Cost (TRC) is also an important and recognized measure of cost effectiveness for DSM purposes and is discussed further in this report.

Enbridge's DSM programs are funded through distribution rates and seek to achieve a wide variety of measured and unmeasured societal benefits such as reduced consumer bills, economic stimulus, environmental benefits and benefits specific to low income consumers. Since first implementing DSM in 1995, Enbridge's programs have evolved considerably with offers ranging from consumer rebates for high efficiency HVAC equipment, to custom industrial process solutions, collaborative building design sessions with construction stakeholders, and holistic residential retrofit initiatives.

The Company's current 2012-2014 DSM Plan outlines a three year strategy and direction for the Company's DSM program and was designed to respond to customer needs and changing market conditions. The Plan was constructed with input from both staff and external participants and its

3 EBRO 495, Decision, Page 100.
4 *"Demand Side Management Guidelines for Natural Gas Utilities"* (EB-2008-0346), OEB, June 30, 2011, page 28.

development involved a highly collaborative stakeholder engagement process. Key features of the Plan encompassing Resource Acquisition, Low Income and Market Transformation programs reflect extensive consultation between Enbridge and its Intervenors.

The resulting 2012-2014 DSM Plan (EB-2011-0295) was approved by the Board on February 9th, 2012. Subsequently, following further extensive negotiations with the DSM Consultative in 2012, the parties reached a Settlement Agreement to establish budget allocations, metrics and targets for 2013 and 2014. An update to the 2012-2014 DSM Plan was filed on March 4th, 2013 (EB-2012-0394). On July 4th, 2013, the Board provided a Decision on the Update. "The Board approves the Settlement Agreement and its rate consequences on an interim basis. In approving the Settlement Agreement, the Board expects Enbridge to proceed with the corresponding DSM activities in 2013 and 2014. The intent of this Board decision is to provide the opportunity for the 2014 DSM budget to be further reviewed."[5] On March 13, 2014 the Board provided a further Decision on the Update: "The Board agrees with Enbridge that given the findings of the Board in the GTA proceeding, the Settlement Agreement containing the 2013 and 2014 DSM budgets is approved and no additional submissions are required."[6]

2.2 Annual Report Overview

This Annual Report offers a retrospective of the Company's energy efficiency programs and results in terms of scorecard, and related to budget and program spend.

The 2013 Annual Report on DSM program performance provides a compilation of the results achieved over the past program year and summarizes what has been learned during the year to evaluate programs for greater efficiency in delivery. The report allows for a comparison of actual to target results, an assessment of the effectiveness of delivery, and outlines any planned modifications to program design or delivery. As part of

5 EB-2012-0394, OEB - Decision and Order on Settlement Agreement, July 4, 2013, page 3.
6 EB-2012-0394, OEB - Decision and Order on Settlement Agreement, March 13, 2014, page 4.

a multi-year plan, this Annual Report is intended to inform stakeholders on the utility's year-over-year progress.

The report also details the data used to determine rate adjustments and to calculate the shareholder incentive for DSM activity, and the report provides information in support of the Company's 2013 Demand Side Management Incentive Deferral Account (DSMIDA), DSMVA and LRAM claims. Once drafted, the report is reviewed through an independent audit and the process culminates in the Company finalizing the report and filing recommendations with respect to the disposition of any balances in the DSMVA, LRAM Variance Account (LRAMVA) and DSMIDA claims with the Board.

2.3 Approach to Natural Gas Savings Calculations

The DSM portfolio encompasses offerings directed toward Residential, Commercial and Industrial customers through the Resource Acquisition, Low Income and Market Transformation programs. As stated earlier, metrics for all programs were developed in consultation and through negotiations with Intervenors.

The Resource Acquisition and Low Income programs encompass three major categories of offerings – prescriptive, quasi-prescriptive and custom.

Results for prescriptive and quasi-prescriptive offerings are calculated based on the number of units installed together with the deemed savings and related assumptions for specific DSM measures, as filed and submitted to the Board in the Company's 2012-2014 DSM Plan (EB-2011-0295).

On December 19, 2012, the New and Updated DSM Measures Joint Submission from Enbridge Gas Distribution and Union Gas Ltd. (EB-2012-0441) sought approval for deemed savings on new and updated DSM measures from the Board. On January 31, 2013 EGD and Union Gas were granted approval of their new and updated DSM measures as outlined in EB-2012-0441.

Following consultation with the Technical Evaluation Committee (TEC), the most recent joint submission to the Board by Enbridge and Union provided an update to the assumptions for a selected number of measures. The New and Updated DSM Measures filing (EB-2013-0430) was submitted to the Board on April 30, 2014. On July 3, 2014 EGD and Union Gas were granted approval of their new and updated DSM measures as outlined in EB-2013-0430.

Natural gas savings for custom projects are based on detailed measure/ technology related calculations for individual projects undertaken at sites where energy efficiency improvements have been made as a result of Enbridge involvement. While many custom projects, particularly industrial projects require Enbridge's professional engineers to develop specialized calculations and methodologies to determine savings; where applicable, Enbridge utilizes its proprietary E-Tools calculation software to establish savings estimates. E-Tools analysis software has been developed by Enbridge's technical engineering review team to not only assist with identifying and quantifying natural gas savings opportunities for customers, but also to determine savings claims through a standardized approach for more common custom projects. E-Tools includes ongoing updates of industry-wide accepted code and input assumptions in the application of a thorough analysis and calculation methodology and produces detailed supporting documentation for each project file.

Results for Community Energy Retrofit (CER), a Residential Resource Acquisition offering, as well as results for the Low Income Weatherization offering, are determined utilizing accredited software like Natural Resources Canada's (NRCan) HOT2000 and the US Department of Energy's REM/Rate as the foundation for annual gas savings calculations.

The Market Transformation program is assessed in terms of metrics specific to each offering.

2.4. TRC Screening

Cost effectiveness screening of DSM programs is valuable in helping to determine the economic merit of a DSM program. Screening also helps with the process of prioritization among offerings if budget constraint considerations need to be addressed.

Enbridge utilizes the Total Resource Cost (TRC) test to screen for cost-effectiveness. If the TRC ratio – which compares the present value of the (natural gas, electricity and water savings) benefits to the present value of the costs – exceeds 1.0, the program is considered cost-effective. In recognition that the Low Income program may include benefits that are not easily captured in the TRC test, the Low Income program is screened using a TRC threshold of 0.7.

The Market Transformation program cannot be screened by way of a systematic screening approach as with TRC and is instead assessed on its own merits based on the objectives of the offerings.

Appendix E summarizes the TRC Screening estimates for the 2013 Enbridge DSM portfolio for illustrative purposes.

Although the current framework is based on CCM, total TRC net savings remains an important indicator of the extremely large and positive impact that Enbridge has with respect to DSM.

3. Overall 2013 DSM Program Scorecard Summary

The overall 2013 DSM program scorecard results in relation to plan targets are presented in Table 3.

Table 3. 2013 DSM Program Scorecard Summary

	Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	2013 Actual Result
Resource Acquisition	Volumes	*Cumulative Savings (million m^3)*	***92%***	729.46	972.61	1215.76	**766.69**
Resource Acquisition	Residential Deep Savings	*Number of Houses 1*	***8%***	549	732	915	**1,649**
Low Income	Single Family (Part 9)	*Cumulative Savings (million m^3)*	***50%***	17.30	23.10	28.80	**32.90**
Low Income	Multi-residential (Part 3)	*Cumulative Savings (million m^3)*	***45%***	45.00	60.00	75.00	**27.31**
Low Income	Multi-residential (Part 3) LIBPM*	*Percent of Part 3 Participants Enrolled 2*	***5%***	30%	40%	50%	**85%**
Market Transformation	Drain Water Heat Recovery	*# of Units Installed*	***100%***	2,813	3,750	4,688	**6,465**
Market Transformation	Residential Savings by Design	*Completed Units*	***40%***	675	900	1,125	**967**
Market Transformation	Residential Savings by Design	*Top 80 Builders Enrolled 3*	***60%***	11	14	18	**18**
Market Transformation	Commercial Savings by Design	*New Developments Enrolled*	***100%***	6	8	15	**16**
Market Transformation	Home Labelling	*Number of Committed Realtors 4*	***70%***	N/A	5,000 5	10,000 5	**78,000**
Market Transformation	Home Labelling	*Ratings performed*	***30%***	250	500	750	**138**

* LIBPM - Low Income Building Performance Management is the Low Income offering complement to the Commercial Run It Right (RiR) offering.

1. Number of houses with at least two major measures and where average annual gas savings across all participants is at least 25% of combined baseline space heating and water hearting usage.

2. Low Income Building Performance Management (LIBPM) Percentage of Part 3 buildings enrolled in current year program = (x+y)/(x+y+z) where:
   x = # of new LIBPM buildings in the current year which have participated in another aspect of the Low Income program in a previous year of 2012-2014 plan; y = # of new LIBPM buildings participating in current year which have not previously participated in the Low Income program; z = # of buildings in the current year which have implemented custom projects other than LIBPM.

3. Top 80 Previous Non-Participating builders enrolled.

4. Commitments to make provision for data field to show home's energy rating for all homes listed by participating realtors (industry-wide commitment to include such a field on MLS or similar listing service and/or realtors' commitment to do so with all the homes they list on their own websites, handouts, and other consumer material).

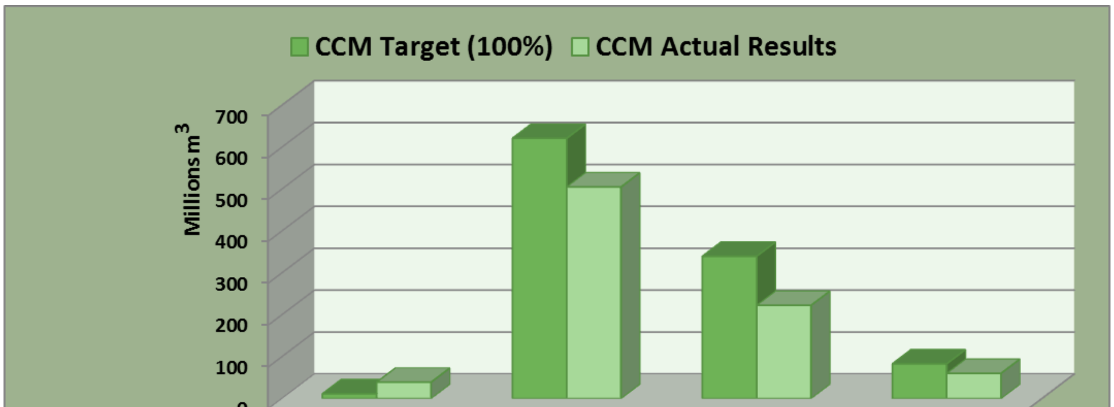
5. Commitment from realtors collectively responsible for more than 5,000 (middle target), 10,000 (upper target) listings/year.

As approved by the Board in the Update to the 2012 to 2014 Demand Side Management Plan in EB-2012-0394, program results are weighted (see Table 3). This weighted scorecard is used in the calculation of the Demand Side Management Incentive. The breakdown of the resulting DSMI for the 2013 program year is presented in Section 7 of this report.

Table 4. DSM CCM Savings Results – Target vs. Actual

Program/Sector	CCM Target (100%)	CCM Actual Results	% Target Achieved
Residential	*11,500,013*	*38,980,521*	339%
Commercial	*621,254,179*	*505,133,591*	81%
Industrial	*339,889,500*	*222,575,355*	65%
Resource Aquisition	**972,643,692**	**766,689,466**	**79%**
Low Income	**83,112,390**	**60,218,838**	**72%**
Total	**1,055,756,081**	**826,908,305**	

Table 5. CCM Savings by Sector – Target vs. Actual

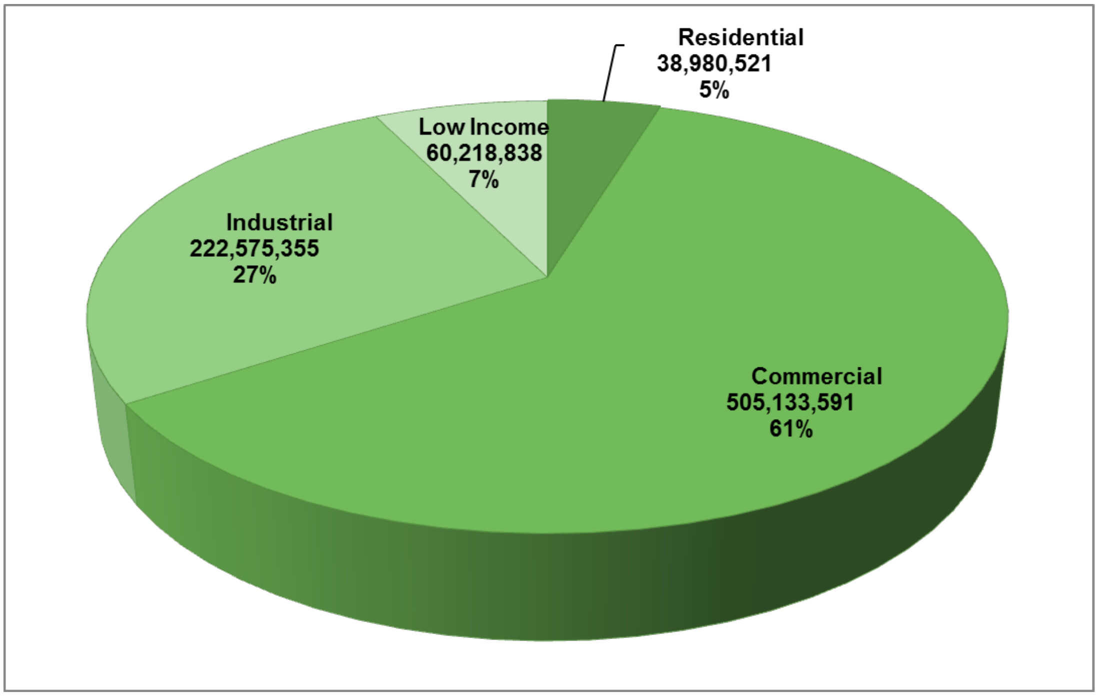


	Residential	Commercial	Industrial	Low Income
CCM Target (100%)	11,500,013	621,254,179	339,889,500	83,112,390
CCM Actual Results	38,980,521	505,133,591	222,575,355	60,218,838

Overall, in terms of CCM savings, as summarized in Table 4, the 2013 DSM portfolio fell short of the combined CCM savings target. Actual results totalled 826,908,305 CCM for all CCM generating offerings. Though results were below targets for the Commercial, Industrial and Low Income sectors

– with corresponding spending below budget for each sector respectively; results were well above the target set out for the Residential sector with the success of the Community Energy Retrofit offering – and actual spending for the Residential sector was above the original budgeted amount. A summary of 2013 DSM spending vs. budget is provided in Section 8 of this report.

Table 6. 2013 Distributed CCM Savings by Sector



As illustrated in Table 6, the Commercial sector was the largest overall contributor to CCM savings, accounting for 61% or 505 million CCM of the total results. In 2013, Industrial sector offerings accounted for 27% of the total CCM savings with the Low Income program and the Residential sector contributing 7% and 5% respectively.

All four of Enbridge's Market Transformation program offerings performed well in 2013 in relation to performance targets. As outlined previously in Table 3, on a weighted scorecard basis, all exceeded target, with three of the four offerings exceeding upper targets. Results for the Market Transformation program offerings are reviewed in Section 6.3 of this report.

4. 2013 DSM Natural Gas Savings

Table 7. Annual and Cumulative Natural Gas Savings

	Program	Gross Annual Gas Savings (m^3)	Net Annual Gas Savings (m^3)	Gross CCM (m^3)	Net CCM (m^3)
Resource Acquisition	**Residential**				
	Community Energy Retrofit	2,292,972	1,949,026	45,859,436	38,980,521
	Total Residential	**2,292,972**	**1,949,026**	**45,859,436**	**38,980,521**
	Commercial				
	Custom - New Construction	1,109,538	821,058	27,738,461	20,526,461
	Custom - Multi-Residential	9,607,971	7,686,377	209,954,005	167,963,204
	Custom - Other	14,734,575	12,991,295	233,096,858	205,746,949
	Total Commercial Custom	25,452,085	21,498,730	470,789,324	394,236,615
	Commercial Prescriptive	7,087,226	6,027,897	117,578,452	99,764,376
	Run It Right	2,226,520	2,226,520	11,132,600	11,132,600
	Total Commercial	**34,765,831**	**29,753,147**	**599,500,376**	**505,133,591**
	Industrial				
	Custom - Industrial (excl. Agriculture)	25,273,047	12,636,523	428,864,210	214,432,105
	Custom - Agricultural	724,438	434,663	12,253,076	7,351,845
	Total Industrial Custom	25,997,485	13,071,186	441,117,286	221,783,951
	Industrial Prescriptive	59,060	39,570	1,181,200	791,404
	Total Industrial	**26,056,545**	**13,110,756**	**442,298,486**	**222,575,355**
	Low Income				
	Single Family (Part 9)	1,389,513	1,375,598	33,044,263	32,904,684
	Multi-Residential (Part 3)	1,558,408	1,548,054	27,417,700	27,314,154
	Total Low Income	**2,947,922**	**2,923,651**	**60,461,963**	**60,218,838**
	Grand Total	**66,063,269**	**47,736,581**	**1,148,120,261**	**826,908,305**

Table 7 provides a summary of the annual gas savings and cumulative lifetime natural gas savings results (in cubic meters) attributable to program components where the assessment metric is CCM. Savings results are provided for both Gross and Net Savings (net of applicable adjustment factors).

Gross natural gas savings estimates are a function of inputs such as participation numbers, base-case assumptions, and assumed savings that result from implemented projects and measures.

Net savings calculations are the result of the inclusion of adjustment factors (e.g., attribution, persistence, free-ridership or spillover[7] effects, if any).

Cumulative lifetime savings are the product of annual savings and the assumed equipment life or measure life for the respective technology or custom project type.

7 For the 2013 program year, no adjustment for spillover was applied to determine net gas savings calculations.

5. 2013 and 2012 DSM Results Comparison

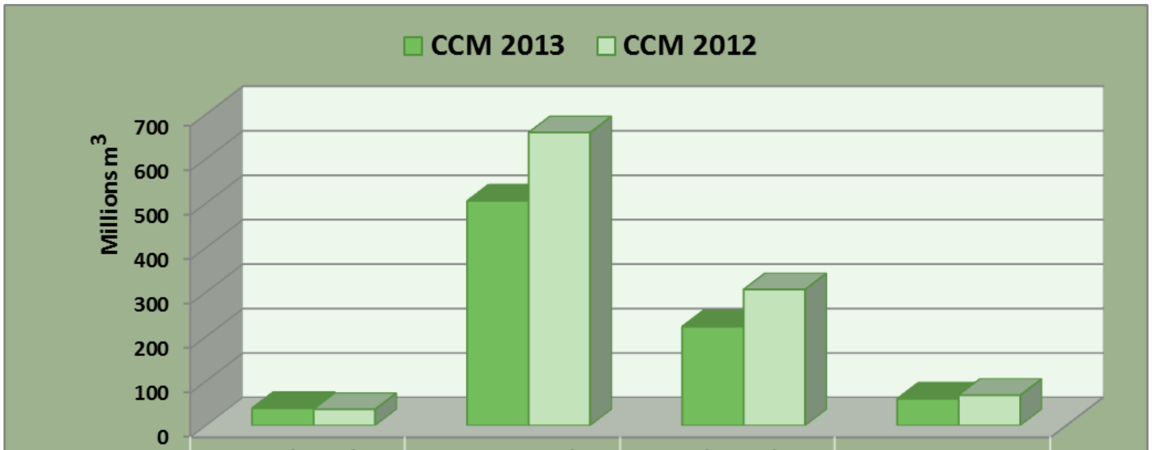
Table 8. 2013 vs. 2012 DSM Results

	Component	Metric	2013 Actual Result	2012 Actual Result	% Increase/ Decrease
Resource Acquisition	Volumes	*Cumulative Savings (million m^3)*	766.69	1,000.86	-23%
	Residential Deep Savings	*Number of Houses* [1]	1,649	209	689%
Low Income	Single Family (Part 9)	*Cumulative Savings (million m^3)*	32.9	24.7	33%
	Multi-residential (Part 3)	*Cumulative Savings (million m^3)*	27.3	43.4	-37%
	Multi-residential (Part 3) LIBPM	*Percent of Part 3 Participants Enrolled* [2]	85%	N/A	N/A
Market Transformation	Drain Water Heat Recovery	*# of Units Installed*	6,465	5,047	28%
	Residential Savings by Design	*Completed Units*	967	N/A	N/A
		Top 80 Builders Enrolled [3]	18	12	50%
	Commercial Savings by Design	*New Developments Enrolled*	16	9	78%
	Home Labelling	*Number of Committed Realtors* [4]	78,000	8,600	807%
		Ratings performed	138	N/A	N/A

1. Number of houses with at least two major measures and where average annual gas savings across all participants is at least 25% of combined baseline space heating and water hearting usage.
2. Low Income Building Performance Management (LIBPM) Percentage of Part 3 buildings enrolled in current year program = (x+y)/(x+y+z) where:
   x = # of new LIBPM buildings in the current year which have participated in another aspect of the Low Income program in a previous year of 2012-2014 plan; y = # of new LIBPM buildings participating in current year which have not previously participated in the Low Income program; z = # of buildings in the current year which have implemented custom projects other than LIBPM.
3. Top 80 Previous Non-Participating builders enrolled.
4. Commitments to make provision for data field to show home's energy rating for all homes listed by participating realtors (industry-wide commitment to include such a field on MLS or similar listing service and/or realtors' commitment to do so with all the homes they list on their own websites, handouts, and other consumer material).

As outlined in Table 8, in comparing overall CCM results year-over-year, total CCM savings achieved was down from 2012.

Table 9. CCM Savings by Sector – 2013 vs. 2012



	Residential	Commercial	Industrial	Low Income
CCM 2013	38,980,521	505,133,591	222,575,355	60,218,838
CCM 2012	36,108,689	658,836,828	305,915,406	68,116,009

In comparing each sector however, as illustrated in Table 9, the Residential sector achieved an increase in total CCM savings in 2013 vs. 2012 audited results. The Community Energy Retrofit offering generated excellent results in 2013 which drove Residential sector savings 8% higher compared with the year prior. The remaining sectors – Commercial, Industrial and Low Income saw reduced results in 2013 vs. results from 2012.

6. 2013 Program Review

As prescribed in the Guidelines, Enbridge's DSM offerings fall within three programs: **Resource Acquisition**, **Low Income**, and **Market Transformation**. This section provides an overview of Enbridge's 2013 DSM portfolio, including results across the three programs.

Resource Acquisition offerings focus on achieving direct, measureable savings customer by customer and generally consist of the installation of energy efficient equipment or operational improvements. The Resource Acquisition program is grouped into the following three sectors: Residential, Commercial and Industrial.

Low Income offerings also generally consist of the installation of energy efficient equipment or measures but are differentiated in recognition of the unique needs of their target customer base. It is acknowledged that though these offerings may result in a lower benefit/cost ratio – Total Resource Cost (TRC) than similar offers not tailored to Low Income, they include other unique societal benefits, and more suitably address the special needs of these consumers. The Low Income program encompasses two segments: Single Family (Part 9) Residential buildings, and Multi-Residential (Part 3) buildings.

Performance for both the Resource Acquisition and Low Income programs is measured primarily in terms of net CCM of natural gas savings and in some cases, based on number of participants or enrollment.

Market Transformation offerings are designed with the aim of influencing consumer behaviour in support of reducing their natural gas consumption and supporting fundamental changes on a path to increased market share of energy efficient products and services. The Market Transformation program encompasses two segments: Residential existing housing and, Residential and Commercial new construction. The Market Transformation program is assessed in terms of metrics specific to each offering.

In addition to summarizing natural gas savings results and scorecard achievement for the programs and the component offerings, this section of the report provides an overview of the offerings within each program and includes the following (as applicable):

- Objectives for the offering
- Target customer group
- Description of the customer offering
- Metrics
- Tracking methodology
- Highlights
- Results
- Cost-effectiveness
- Year-over-year performance
- Comments and lessons learned

6.1 Resource Acquisition Program

Table 10. Resource Acquisition Scorecard

	Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	2013 Actual Result
Resource Acquisition	Volumes	*Cumulative Savings (million m^3)*	***92%***	729.46	972.61	1,215.76	**766.69**
	Residential Deep Savings	*Number of Houses* *	***8%***	549	732	915	**1,649**

* Number of houses with at least two major measures and where average annual gas savings across all participants is at least 25% of combined baseline space heating and water heating usage.

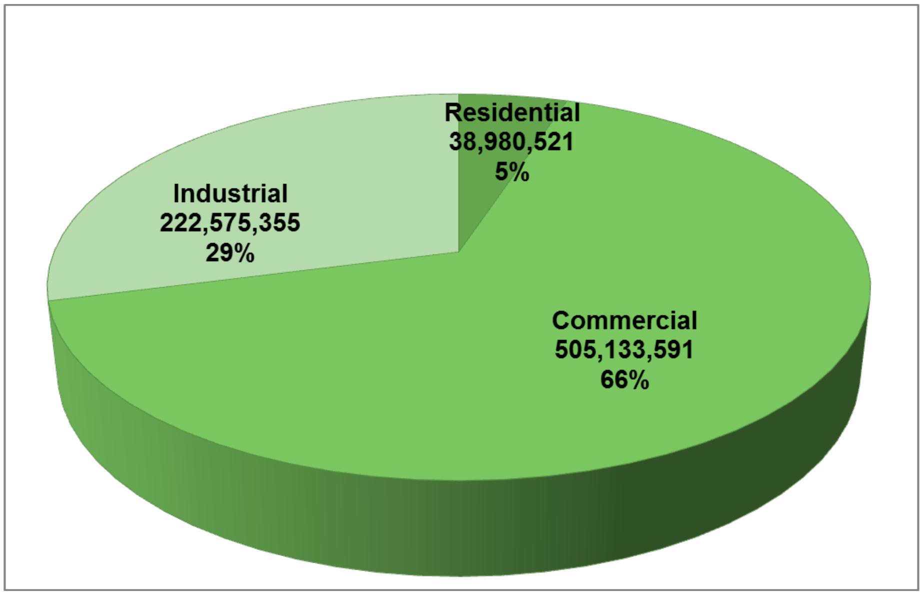
Overall results for Enbridge's Resource Acquisition (RA) program in 2013 were 766.69 million CCM, delivering 79% of the middle (100%) CCM target for the program. In addition to the CCM metric, there was also a deep savings metric for the RA program specific to the Residential sector. The number of houses that counted towards the deep savings metric was 1,649. This result was well above the upper scorecard target. Each sector of the RA program (Residential, Commercial and Industrial) included CCM savings target set out in the plan; results for each of these sectors are examined further in the pages that follow.

Table 11. Resource Acquisition – Program Results

Resource Aquisition Program Sector	CCM Target (100%)	Actual CCM	% Target Achieved	$/CCM	Participants/ Units Installed*
Residential	11,500,013	38,980,521	339%	$0.0680	1,649
Commercial	621,254,179	505,133,591	81%	$0.0128	17,796
Industrial	339,889,500	222,575,355	65%	$0.0117	142
Total/Average	**972,643,692**	**766,689,466**	**79%**	**$0.0153**	**19,587**

*Participants/Units installed includes the # of unique addresses for custom offerings, and the # of units for prescriptive offerings.

Table 12. Resource Acquisition – CCM Results by Sector



Within the Resource Acquisition program, CCM savings contributions from each sector are illustrated in Table 12. Commercial offerings were responsible for 66% of the total CCM savings from the RA program, with Industrial contributing 29% and Residential 5%.

6.1.1 Residential Resource Acquisition

There are almost 1.9 million Residential customers within the EGD franchise area. These customers are included in the Rate 1 rate class. Enbridge has been delivering energy efficiency initiatives to the Residential customer sector since 1995. Initiatives have included High Efficiency Furnace rebate and Domestic Hot Water Heater rebate offers as well as TAPS, the direct install water savings offering, for example.

The biggest challenge more recently in designing offerings for this sector is that some of the most successful initiatives in the past have reached maturity and the current DSM program needed to address new opportunities for Rate 1 customers. As a result, the Residential offering in place for 2013, as outlined in Enbridge's 2012-2014 Plan, was designed to meet the Board's DSM Guidelines, in particular stressing the requirement to pursue deep savings.

The focus for the Residential component of the Resource Acquisition scorecard is now aimed at the existing home sector through the Residential Community Energy Retrofit offering.

Residential Resource Acquisition natural gas savings results for 2013 were excellent and well surpassed targets. Further, the results relative to the deep savings metric also significantly exceeded the scorecard performance target.

Residential Community Energy Retrofit

The Community Energy Retrofit (CER) offering, is a home retrofit initiative that takes a focused and community and relationship based approach to marketing and engagement.

Objectives: The goal of the CER offer is to achieve deep energy savings in existing homes and to raise awareness of the benefits of energy efficiency. The initiative is designed to reduce energy use for space and water heating using a holistic approach, which encourages conservation through thermal envelope improvements to reduce the space heating load as well as the installation of high-efficiency equipment.

Target Customer: The CER offer targets Rate 1 residential customers. The 2013 CER offering continued to use a combination of 2012 quantitative criteria to define geographic areas for the offering but also extended to communities which leveraged relationships and community-based projects. Targeted neighbourhoods were identified by analyzing defined assessment criteria such as “above average” energy consumption; age of dwellings; and proportion of single-detached houses.

Initially, when the offer was launched in 2012, Enbridge chose the City of Markham as the first community to offer CER because of the older housing stock and also because of the city's strong commitment to sustainability through its Greenprint Community Sustainability Plan. The Forward Sorting Area (FSA) - L3P was selected for the launch – with a high proportion of homes being between 16 and 35 years old, this area was identified as ideal for the retrofit offering. The market was expanded to the entire City of Markham in October 2012 to further align with the City's Sustainability Plan.

In 2013 the community expansion of the offering continued based on the quantitative analysis of the geographic criteria to include York Region and its nine municipalities.

<u>Description</u>: It is estimated that the federal government funded ecoENERGY program that ran from April 2007 and ended in March 2012, reached approximately 10% of Canadian homeowners. Following the cancellation of the program, there has been a market need for initiatives that drive energy efficiency in the existing housing sector. The CER offer utilizes accredited software such as Natural Resources Canada's (NRCan) HOT2000 and the US Department of Energy REM/Rate as the foundation in calculating annual gas savings for each participant. The software provides an effective building energy simulation tool to model the savings. With a primary emphasis on deep savings, measures include home envelope improvements and mechanical system upgrades as these considerations offer the greatest opportunity for "deep", long-term energy conservation.

As part of the CER offer, Enbridge offers qualifying customers incentive dollars towards an initial energy audit of their home and the opportunity for additional incentives if the participant completes at least two of the eight qualifying measures. The offering aims to ensure that the installation of these measures contributes to the achievement of an average 25% gas savings over the participant portfolio, based on pre and post modeling results. The eight qualifying measures are as follows:

- Heating system replacement
- Water heating system replacement
- Attic insulation
- Wall insulation
- Foundation insulation
- Air sealing
- Window replacements
- Drain water heat recovery

Based on Enbridge's customer data, over 70% of the housing stock in the EGD franchise area is greater than 20 years old. These homes tend to consume more energy than those built more recently. The CER offer is designed to pursue deep energy efficiency savings opportunities in older housing stock through the delivery of a holistic, "whole home" approach which highlights not only natural gas savings opportunities but also electricity and water savings.

Metrics: The first metric is cumulative cubic meters (CCM) savings generated by participants. The second metric is total number of participants.

Tracking Methodology: Savings are claimed based on results calculated through the use of accredited modeling software used by certified Energy Auditors. Reports summarizing participant numbers and gas savings (m^3) are maintained and tracked monthly. The number of participants (houses) with at least two major measures and where average annual gas savings across all participants is at least 25% of combined baseline space heating and water hearting usage are tracked and counted toward the deep savings participant metric.

Highlights:

- In its second year, the CER offer has demonstrated great success. Key activities in 2013 included: incorporating learnings from 2012; training for contracted energy advisors; and expanding the offering to a broader community base.

- On average, CER participants installed more than two (2.5) eligible measures. The vast majority of participants installed heating system replacements; the next most commonly installed measures were air sealing and attic insulation.

- Lessons learned from 2012 triggered a change to the qualifiers for 2013. With the revision to the deep savings metric to a simplified 25% average annual gas savings approach, there was the ability to better determine and target the age and size of houses as well as the optimal combination of upgrades with the greatest potential of reaching the deep savings target.

- Improved engagement with energy auditors by way of training sessions assisted in solidifying procedures and processes required for tracking. Further group discussions on sales approaches and experiences assisted to ensure successful delivery of this offering.

- Improved engagement with contractors via EGD sales channel consultants assisted in communicating the offering and managing marketing approaches.

- With the deep savings metric more than quadrupling, in 2013 the offering was expanded to all of York Region. Enbridge also collaborated with three organizations in the GTA area to leverage focused community-based programs that aligned well with CER.

Results: As illustrated in Tables 13, 14 and 15, the CER offering overachieved against both scorecard metrics associated with the initiative. A total of 1,649 households participated and counted toward the CCM deep savings target, well exceeding the 100% target of 732 households. The 2013 CCM result was almost 39 million CCM or 339% of target.

Table 13. Residential Resource Acquisition Results

Residential Sector	Actual CCM	$/CCM	Participants
Community Energy Retrofit	38,980,521	$0.068	1,649

Table 14. Residential Sector CCM Performance

Residential Sector	Actual CCM	100% Target CCM	% Achieved
Community Energy Retrofit	38,980,521	11,500,013	339%

Table 15. Residential Sector Deep Savings Performance

Residential Sector	Participants	100% Target	% Target Achieved
Residential Deep Savings	1,649	732	225%

Cost-effectiveness: The CER offering is cost-effective as supported by the TRC screening (see Appendix E).

The CER offer exhibits a relatively high cost per cumulative cubic meter (CCM) of $0.068/CCM when compared with other Resource Acquisition offers. This cost is nonetheless substantially lower than in 2012, the first year in the market. The improvement can be attributed in part to the strategic focus in 2013 on targeting homes that achieve a minimum of 25% savings. Gains can also be attributed to the efficiencies realized through the refinement of the design and delivery of this initiative.

Year-over-Year Performance:

Table 16. CER 2013 vs. 2012 Results

Residential Sector	2013 Results	2012 Results	% Increase / Decrease
Community Energy Retrofit - CCM Savings	38,980,521	5,296,300	636%
Residential Deep Savings Participants	1,649	209	689%

As outlined in Table 16, in assessing the performance of the CER offering year-over-year, both in terms of CCM savings and deep savings participants, 2013 saw considerable growth over 2012 results.

Comments and Lessons Learned:

- To support the success of this offering in 2013, and in line with provisions set out in the Guidelines, funds were reallocated from within the Resource Acquisition program budget to support the opportunity for additional contributions to gas savings from CER. Budget considerations will again be monitored in 2014 to support expected higher than forecast participation and corresponding results for this offering. (The spending vs. budget comparison for the 2013 DSM Plan is outlined in Section 8 of this report).

- In 2014 Enbridge plans to continue expansion of the CER offer to additional selected communities. In particular, Enbridge is investigating inclusion of communities in the Ottawa and Niagara areas.

- For 2014, improvements to customer service training to better handle inquiries will be addressed to ensure effective response to customer calls.

- In addition Enbridge is assessing further expansion in City of Toronto communities in conjunction with the Home Energy Loan Program (HELP). In October 2012, the Ministry of Municipal Affairs and Housing made regulatory changes that enabled Ontario municipalities to use Local Improvement Charges (LICs) to finance energy retrofits on private property. In July 2013, Toronto City Council unanimously approved a $20 million pilot water and energy efficiency program for improvements to private residential properties. Since that time, Enbridge has worked with the City of Toronto on an LIC-based pilot project. HELP is a financing tool available to qualifying residents in specific neighbourhoods in Toronto to assist with improving their home's energy efficiency. The pilot program offers the loans in parts of Black Creek, Riverdale, the Beach, the Junction, High Park and south Scarborough - these eligible areas were defined by postal codes that overlap with Enbridge's CER offering. In addition to the Company's efforts with the City of Toronto and in response to the Province's Long-Term Energy Plan, Enbridge may explore the potential for utility on-bill financing as appropriate.

6.1.2 Commercial Resource Acquisition

Enbridge offers a suite of initiatives to Commercial sector customers. The offerings are designed to provide an array of energy efficiency options to meet the wide-ranging needs of the diverse commercial customer base. In addition to enabling activities, offerings encompass both custom project incentives, a variety of prescriptive and quasi-prescriptive incentives as well as operational improvements to support savings opportunities.
The initiatives offered to the Commercial sector are based on a combination of outreach, education, and incentives to encourage commercial customers to undertake energy efficiency investments. In 2013, Commercial DSM activities were focused on the following:

- Energy efficiency planning, support and education which provided assistance to customers with the identification of capital and operational improvements and developing an energy efficiency plan;
- Incentives provided to customers to help offset the cost of an energy audit which could assist in the identification of potential capital or operational energy efficiency improvements;
- Energy Compass, which provided an evaluation designed to benchmark the energy efficiency of a building portfolio, allowing Enbridge Energy Solution Consultants (ESCs) to educate building managers and assist in identifying buildings that have the highest savings potential and pinpoint key opportunities for capital and operational improvements;
- Run it Right (RiR) is designed to help commercial building customers analyze a building's energy performance, identify and implement no-cost/ low- cost operational improvements, educate building owners and operators on how to operate their building more efficiently, and provide continuous monitoring to increase and maintain efficiency, lower operating and maintenance costs, and improve the functionality of building systems; and,
- Assisting customers in reducing their natural gas consumption through the capture of cost-effective energy efficiency opportunities in commercial buildings, incentives for capital improvements and operational savings were offered for completing energy efficiency improvements including custom project funding and a suite of prescriptive and quasi-prescriptive incentives aimed at promoting specific measures.

Energy efficiency initiatives are promoted directly by ESCs through contact with customers, building owners/operators, as well as through representation at key industry tradeshows, speaker engagements and event sponsorships, and through e-marketing, print material and direct mail advertising to targeted sectors.

In addition to the promotion efforts of ESCs through direct customer relationship management and outreach, to increase awareness, Enbridge continues to expand its engagement with business partners and other service organizations throughout the commercial market – commercial HVAC contractors, engineering firms, energy service advisors, designers and others who often have an important role influencing customers to take action.

Table 17. Commercial Resource Acquisition Results

Commercial Sector	Actual CCM	$/CCM	Participants/ Units Installed*
Custom - New Construction	20,526,461	$0.0067	17
Custom - Multi-Residential	167,963,204	$0.0087	275
Custom - Other	205,746,949	$0.0118	374
Prescriptive	99,764,376	$0.0082	16,938
Run It Right	11,132,600	$0.1434	192
Total/Average	**505,133,591**	**$0.0128**	**17,796**

*Participants/Units installed includes the # of unique addresses for custom offerings, and the # of units for prescriptive offerings.

Overall, Commercial offerings did not reach CCM savings targets established for the sector. As detailed previously in Table 11, the Commercial sector contributed over 505 million CCM, or 81% of the middle (100%) Commercial savings target. Commercial sector savings amounted to 66% of the total Resource Acquisition CCM gas savings for the program year.

Offerings in the Commercial sector were cost-effective to deliver as supported by the TRC screening (see Appendix E). As outlined in Table 17, the Commercial offerings had an average cost of $0.0128/CCM.

The Commercial sector was trending toward 100% of target results however, it became apparent midway through the third quarter that results were not trending as initially forecast. The group began to launch campaigns in an effort to overcome the shortfall in CCM results. Results for the respective offerings are addressed in further detail in the pages that follow.

The shortfall in CCM results from the Commercial group translated to a surplus in budget. The comparison of 2013 DSM spending vs. budget is provided in Section 8 of this report.

Commercial – Custom

Objectives: The goal of the Commercial Custom offering is to reduce natural gas use through the capture of cost-effective energy efficiency opportunities in commercial sector buildings, including retrofits of building components and upgrades at time of replacement. The offering aims to promote the highest level of energy efficiency.

Target Customer: The Commercial Custom offering targets commercial customers in Rate 6, as well as commercial customers in Rates 135, 145, 110, 115 and 170 (over 99% of commercial customers are Rate 6). The offering is aimed at commercial customers/building owners in all segments of the Commercial sector. Segments within this sector include: Multi-Residential (not including social housing), Commercial Office Buildings, Schools/Universities, Hotels/Motels, Warehouses, Retail Business Customers, Food Services, Hospitals/Health-Care Facilities, and Government/Municipal customers.

Description: The Custom Commercial offering provides incentives for customers undertaking capital and operational improvements. Typical measures include boiler and HVAC retrofits, controls and building automation systems, heat recovery projects and building envelope improvements. In some cases, customers benefit from incentives for third-party energy audits.

The offering is primarily promoted and delivered by ESCs who are engaged in the marketplace. ESCs are trusted energy advisors; their technical and energy efficiency sales experience is fundamental to the successful execution of custom projects. ESCs provide advice on customized energy solutions to suit customers' energy efficiency goals in consideration of their budget and business needs.

ESCs work with national chain and large property management firms to introduce savings strategies and align DSM offerings with the customers' long term energy plans. ESC's use their technical expertise to work with smaller firms and managers of standalone buildings by educating them on savings concepts and providing recommendations and savings estimations for potential projects.

ESC work directly with large volume customers, for example, hospitals, colleges and universities by meeting with building operators and facility mangers to conduct site visits and make custom recommendations based on each building's unique systems.

Metrics: As part of the Resource Acquisition program, the primary metric for the Commercial Custom offering is lifetime natural gas savings - cumulative cubic meters (CCM) savings.

Tracking Methodology: Savings for each custom project are calculated on an individual basis, and then tracked monthly by the Tracking and Reporting team, utilizing EGD's sales tracking software.

Evaluation Activities*:* Savings for each project are determined individually for inclusion in the offering with project specific savings calculations. Where applicable, ESCs utilize standardized engineering calculators developed by Enbridge's technical engineering team. Selected projects are screened for an additional internal technical review to verify savings calculations.

An independent third-party engineering review – the Commercial Custom Project Savings Verification (CPSV) is conducted annually. The scope of work for this review is set out in a Terms of Reference established by the TEC. This verification study consists of a detailed review of the savings calculations for a statistically representative sample of Commercial sector custom projects claimed in 2013. The Commercial CPSV is summarized in Appendix A and the prescribed sampling methodology followed to establish the selected projects is referenced in Appendix I. Reported results include adjustments as recommended by the engineering review in conjunction with the application of determined realization rates as outlined in Appendix B.

Highlights:

- The Commercial Custom offering continues to be the largest contributor to the overall Resource Acquisition results in the Commercial sector. Custom type projects accounted for over 78% of all Commercial RA CCM results, and 51% of the total RA program CCM savings.

- In 2013, the sector saw a continuing trend of a growing number of projects being implemented in the multi-residential, office building, healthcare and retail sectors.

- Response to campaigns which promoted time limited opportunities was positive. The focus for campaigns is typically on technologies that are not well known in the marketplace. These campaigns are often best suited for less complex projects with relatively simple project execution.

- There was a concerted effort to increase sector penetration in 2013. Where appropriate, resources were focused on developing key account relationships within a particular commercial sector – of note efforts were particularly focused on the retail and universities sectors in 2013. Though this approach inherently requires more time and resources, this added investment in time is evolving as a successful strategy and Enbridge plans to continue to enhance this approach into 2014 and beyond.

- Enbridge supported a number of strategic sector initiatives in 2013 aimed at promoting awareness and enabling the marketplace. The Toronto Region Conservation Authority's Greening Healthcare Program and Greater Toronto Civic Action Alliance's Race to Reduce initiatives both incorporated third-party benchmarking and workshops focusing on sharing best practices in efforts to promote and recognize operational improvements.

Results: Commercial Custom projects were responsible for over 394 million CCM in natural gas savings. This result though sizeable, was lower than anticipated for 2013.

One of the largest impacts to 2013 Commercial sector performance was as a result of the removal of New Construction from the Resource Acquisition program.

As planned, the focus for the New Construction offering was redesigned in 2012 with the launch of the Commercial Savings by Design (SBD) Market Transformation initiative such that 2012 would be a transition year and moving forward Commercial new construction projects would be engaged through SBD.

There was a small carryover into 2013 of legacy projects from the predecessor Design Assistance Program and the New Building Construction Program which were included in the Commercial Custom results for 2013.

There were 70 New Construction projects which contributed 135 million CCM in 2012, over 20% of the total Commercial results. In 2013 however, there were 17 New Construction custom projects contributing just 20.5 million CCM. Despite efforts to ramp up the focus on the retrofit market across other commercial sectors, building a funnel to make up these results could not be achieved in twelve months.

An additional factor which impacted performance was due to Commercial group staffing changes which delayed planning timelines. As a result the 2013 offering and annual campaigns were rolled out later than anticipated.

In assessing the Commercial Custom results by sub-sector, as outlined in Table 55 in Appendix F, the multi-residential building market continues to lead with strong CCM results followed by the government, health-care and professional office building sub sectors.

Year-over-Year Performance: The total number of projects completed decreased by approximately 20% from the year prior to 666 Commercial

Custom type projects implemented in 2013. Total CCM savings of approximately 394 million CCM in 2013 were down by 31% from Commercial Custom related savings for 2012.

Cost-effectiveness: The Commercial Custom offering continues to be highly cost-effective as supported by the TRC screening (see Appendix E). Average costs per CCM saved can be summarized as follows: $0.0067/CCM for New Construction projects, $0.0087/CCM for Multi-Residential projects; and $0.0118/CCM in other Custom Commercial results.

Comments and Lessons Learned:

- The Commercial Custom offering continues to deliver significant cost-effective savings and remains a major contributor to the Resource Acquisition program.

- Feedback from customers has suggested that continuing low historical natural gas prices in 2013 impacted the decision for implementation of natural gas efficiency projects in comparison to electric efficiency improvement projects for some commercial customers.

- The strong relationships ESCs have developed with customers, business partners and the contractor communities have been an important factor in the delivery of the offering and will continue to provide a solid foundation for future efforts. These individuals and organizations place a great deal of value on the support they receive from Enbridge including savings calculations, equipment verification and energy data; and these customers recognize the value of the Enbridge brand.

- Over and above the access to incentive support, customers are displaying a growing interest in understanding their operations based on interpretation of their energy data. As the adoption of new platforms and available software which give customers access to real-time energy use information grows, leveraging on this trend will continue to provide a valuable tool for engaging customers in energy efficiency based dialogue and identifying capital improvement products.

Commercial – Prescriptive

Objectives: The Commercial prescriptive offering aims to capture energy savings in the Commercial sector through installation of prescriptive and quasi-prescriptive technologies. The offering employs broad scale marketing approaches in order to reach a wider customer base and achieve higher market penetration than would be possible with the direct customer contact approach used for the Commercial Custom offering.

Target Customer: Commercial Prescriptive offerings are targeted to commercial customers in Rate 6, 110, 115, 135, 145, and 170 (with most commercial customers falling in the Rate 6 category). Prescriptive offers are available to Commercial sector customers across the following market segments: Multi-Residential (not including social housing), Commercial Office Buildings, Schools/Universities, Hotels/Motels, Warehouses, Retail Business Customers, Food Services, Hospitals/Health-Care Facilities, and Government/Municipal customers.

Description: The Prescriptive Commercial offering for 2013 included fixed incentives for various prescriptive and quasi-prescriptive energy efficiency measures impacting space heating, water heating and food service requirements including: air doors, high efficiency boilers, condensing boilers (under 300 MBH), energy recovery ventilators (ERVs), heat recovery ventilators (HRVs), infrared heaters, ozone commercial clothes washers, showerheads, ENERGY STAR dishwashers, ENERGY STAR fryers, ENERGY STAR steam cookers, high efficiency under-fired broilers, and demand control kitchen ventilation systems.

Metrics: As part of the Resource Acquisition program, the primary metric for Commercial Prescriptive offers is lifetime natural gas savings - cumulative cubic meters (CCM) savings.

Tracking Methodology: Data is compiled for participants and tracked on a monthly basis by the Tracking and Reporting team, utilizing EGD's sales tracking software.

Highlights:

- The Prescriptive offering saw good traction in the marketplace in 2013. The marketing effort for the fixed incentive offering was supported through promotion at key industry tradeshows, speaker engagements, event sponsorships, the Company's website, e-marketing, print material and direct mail.

- Sector-based outreach and marketing in 2013 included a focus on the following sectors: Restaurants, Warehouses (air doors), Multi-Residential and Commercial laundries. Efforts continued in 2013 aimed at engaging the various distributor networks that service these market segments to promote awareness of the various technologies.

- The strategy of implementing targeted campaigns to promote specific technologies to applicable selected Commercial sectors continued in the second half of the year, promotions were directed to particular commercial customers groups and included: Demand Control Ventilation, Demand Control Kitchen Ventilation, Infrared, Destratification Fans and Showerheads. Highlighting technologies most applicable in particular commercial sectors aligned well with the sector based approach.

- A marketing brochure to support the Prescriptive offerings has been simplified into a single communications piece and application process which has enabled easier distribution, streamlined tracking, and more efficient processing.

Results: Commercial Prescriptive measures contributed 99.8 million CCM, equating to almost 20% of the overall Commercial RA results. High-efficiency boilers, ozone laundry, infrared heaters and ERVs were the technologies which had the largest contribution to the Commercial Prescriptive results in 2013.

Year-over-Year Performance: The relative contribution from Prescriptive offers in 2013 was almost 20% of all Commercial CCM savings. The 99.8 million CCM savings achieved is comparable with results from Prescriptive offerings in 2012.

Cost-effectiveness: The Commercial Prescriptive offering was highly cost-effective as supported by the TRC screening (see Appendix E). The cost per cumulative cubic meter for the Commercial Prescriptive offering was $0.0082/CCM.

Comments and Lessons Learned:

- This offering continues to deliver cost-effective savings to commercial customers with a straightforward transactional approach and defined fixed incentives.

- The marketing approach employed to promote the Prescriptive offering will continue to highlight sector focused efforts and targeted campaigns which leverage key account relationships, business partner channels and Supply Chain promotion.

- Looking forward, the Commercial team is investigating the introduction of a more diverse set of incentives to improve savings results, based on drivers such as targeted market penetration, resource requirements to support new products launches, technologies that deliver higher CCM, and multi-product installations.

Commercial – Run it Right (RiR) and Energy Compass

Run it Right is designed to help commercial building customers achieve continuous operational savings through no-cost/low-cost energy efficient solutions.

Energy Compass is a diagnostic service designed to help evaluate the operating efficiency of a portfolio of buildings to identify energy intensity levels as compared to other buildings and to identify energy efficiency improvement opportunities.

Objectives: The goal of Run it Right and Energy Compass is to encourage building owners to improve the energy performance of buildings in their portfolio through in-house benchmarking and continuous operational improvements. This includes support for energy monitoring services and related analysis, low cost/no cost re-commissioning measures, and energy savings opportunity assessments. Ultimately, these offerings aim to lead these commercial customers to data-driven decision making through a continuous improvement process.

Target Customer: These offers are targeted to commercial customers in Rate 6, 110, 115, 135, 145, and 170 (with most commercial customers falling in the Rate 6 category). More specifically, the offerings are designed for property managers of large commercial, multi-family and institutional buildings. The focus for the offering is primarily targeted on commercial buildings that have Metretek meters (with automated meter reading capabilities).

In 2012, the RiR initiative focused on larger volume customers consuming greater than 300,000 m^3.

The Energy Compass initiative was marketed to customers having a portfolio of buildings, most often in the Multi-Residential sector.

Description: The Run it Right offering, together with the Energy Compass initiative are designed to move higher consumption commercial customers towards performance-based conservation. The provision and analysis of detailed energy data aims to allow building operators and managers to make strategic data-driven decisions regarding energy savings and capital investments.

Through the Energy Compass and Run it Right initiatives, the Company assists large commercial customers and their energy managers to help them better manage the buildings in their portfolios, identify future cost-effective capital improvements, and implement operational improvements to achieve energy savings. Savings results from operational improvements implemented in any given year are recorded in the next year, following monitoring and verification. Therefore gas savings related to participants who implemented Run It Right improvements in 2012 were claimed in 2013.

Operational measures generally do not require the purchase and installation of new equipment, but rather costs are more often limited to labour and ongoing operational practices.

Metrics: As part of the Resource Acquisition program, the primary metric for Commercial Run it Right is lifetime natural gas savings - cumulative cubic meters (CCM) savings.

Tracking Methodology: For 2012 participants - the operational measures implemented in 2012, the average cost and resulting savings per participant were determined and reported in 2013. Consumption was monitored for one year following implementation of operational measures and compared to the previous year's consumption to calculate final results. The statistical methodology used to determine the results is based on actual metered data from which assumptions and inferences are built up.

Highlights:

- Analysis of the first year of RiR participant results has shown that average savings levels are significantly lower than the targets initially set which were based on anticipated savings of greater than 10%. Analysis of results from 2013 show that average savings were only 2.5% for participants enrolled in 2012.

- On average participants implemented three operational measures. Several of the participants consuming more gas during the monitoring year implemented fewer measures. While all the operational improvements save natural gas, savings were not equal. Savings potential depended on both the loads and existing condition of the system impacted by selected measures.

- An assessment of the 2012 offer identified a need to improve the offering to better assist customers in achieving savings through operational measures. It was determined that an increased emphasis was needed on ensuring customers adopt a process to support the offering; this involved, increasing knowledge and changing practices. To meet this requirement the offering was substantially re-designed in 2013.

- Considerable effort in 2013 focused on two fronts. First, a standardized methodology was established to assess buildings and determine savings protocols. Second, a uniform methodology using regression analysis was developed to determine savings results for participants.

- A minimum threshold of 5% estimated operational savings was added in order to be eligible for the implementation incentive to ensure a standard across all participants.

Results: A target of 56 million CCM was originally set for 2012 participants (2013 gas savings claims). This target was based on buildings consuming an average of 300,000 m^3 natural gas or greater annually and achieving 10% savings. There were 192 participants (including 174 multi-residential buildings) enrolled in 2012 for the RiR offering and were included in the 2013 energy savings results. These participants achieved combined natural gas savings of 11.13 million CCM, equating to 2.2% of the overall Commercial RA results. The average savings per participant was 2.5%. This calculation included 44 participants who consumed more gas during the monitoring year (recorded as negative savings). An assessment of the 131 participants that reduced gas consumption resulted in an average savings calculation of 5.1%. The remaining 17 participants did not have enough data to meet the minimum statistical requirements for the calculation and were removed from the analysis.

Year-over-Year Performance: 2013 is the first year savings have been claimed in relation to this offering.

Cost-effectiveness: The RiR offering was cost-effective supported by the TRC screening (see Appendix E). However, this offering was the most costly to deliver in comparison to other Commercial offerings. RiR savings claimed in 2013 were achieved at an average cost of $0.1434/CCM. Given the year over year delivery of the RiR offering, costs reflect a combination of expenditures for both 2012 and 2013 participants.

Comments and Lessons Learned:

- RiR savings results are exclusively generated through operational improvements. Many other utility re-commissioning/retro-commissioning programs, as well as local initiatives such as Greening Healthcare and Race to Reduce do not distinguish between capital and operational improvements and may include adding control measures or installing capital measures such as Variable Frequency Drives (VFDs) or Demand Control Ventilators (DCVs). These capital measures increase the potential savings that can be achieved. In addition, some of the results are based on total energy, not just natural gas savings. The 2.5% average savings result achieved through Enbridge's RiR suite of operational measures is considerably below the 10% average that was initially forecast during the preliminary program design phase, however savings in the 2% to 5% range are a reasonable achievement given the scope of operational measures being undertaken and the sole focus on gas savings.

- RiR includes control optimization and manual adjustment of existing equipment and controls. Experience gained thus far has indicated that many participants have not been previously exposed to the process of identifying and undertaking operational improvements and performance monitoring. Successful delivery requires longer term feedback, with a "building as a system" approach and inclusion of a large customer education component.

- The RiR offering evolved considerably through 2013 in an effort to increase Enbridge's knowledge of the potential impact of operational improvements and to maximize opportunities for gas savings results. Consequently the offering delivered to 2013 participants is structured into three phases:

    - Investigation Phase – includes analysis of building's current energy performance and an onsite walk-through building assessment to assist with identifying operational improvement opportunities.
    - Implementation Phase – provision of investigation report summarizing recommendations; completion customizable checklist to meet minimum 5% savings.
    - Monitoring Phase – utilization of an Energy Management Information System (EMIS), web-based building performance system that uses the building's real-time data to help businesses track performance, address over-consumption and maintain energy savings goals.

- It is anticipated that the addition of the EMIS will provide participants with greater insight into their consumption, provide a platform for training, awareness and knowledge, and provide the accessibility to daily data online so that participants will realize the value of the consumption load and saving reports. The EMIS system requires a Metretek meter (daily interval data meter) for full functionality (some buildings used monthly data for the previous base year).

- The cost to support the Run it Right offering is higher than typical "installed measure based" programs due to the emphasis on process, building knowledge capacity and changing behaviours. In 2013 Enbridge took a more hands-on approach by providing more resources and tools to provide greater assistance to customers in identifying and implementing the highest potential saving measures based on their building's consumption, These included: onsite investigations and improvement recommendations by contracted third-parties for each building; tools such as the interactive Customer Investigation Tool which estimates operational savings unique to each building; and, ongoing, daily monitoring and regular reporting using an Energy Management Information System.

- Education and training is also an important element to move the market towards performance based conservation. Workshops focused on operational improvements and the development of introductory training on energy management and monitoring data interpretation. Though it has sometimes been challenging to get a commitment from participants to attend workshops, feedback from participants who have attended these sessions was positive.

- With regard to 2013 enrollment, while 215 participants registered and completed the investigation phase, just 94 participants completed the implementation phase to participate in the 2013 monitoring term. Fewer participants will likely mean lower saving results for 2014. An additional 12 participants have been set up on the monitoring system that did not implement measures meeting an estimated 5% savings (the 2012 implementation requirement) to explore whether having access to an EMIS and energy performance management training alone can result in operational behavioural based savings.

- In line with the current framework, DSM activities are budgeted and assessed in one-year timeframes. The RiR offering however is currently structured with an extended timeframe. Participation (enrollment) and implementation take place in one year followed by a full twelve months of monitoring and follow-up reporting. Consideration of an assessment structure and metrics that would better support a multiple-year offering would be beneficial for this type of initiative – which focuses on changing behaviour and continuous improvement. Second, a uniform methodology using regression analysis was developed to determine savings results for participants.

- As EGD continues to learn extensively about delivering a building performance management offering, it is clear that participants have significantly varied levels of knowledge and understanding of energy management. Enbridge is exploring ways of how the offer might be tailored for different customers to better align with these varying levels of sophistication.

6.1.3 Industrial Resource Acquisition

In the Industrial sector, the Continuous Energy Improvement (CEI) approach encompasses the Industrial Custom Solutions offering and the introduction of prescriptive incentives. Together, these offerings along with a slate of enabling initiatives, present a complete package of DSM opportunities including support for industrial customers in identifying energy-saving opportunities through to project implementation assistance to capture savings.

Table 18. Industrial Resource Acquisition Results

Industrial Sector	Actual CCM	$/CCM	Participants/ Units Installed*
Custom - Industrial (non-Agricultural)	214,432,105	$0.0120	111
Custom - Agricultural	7,351,845	$0.0032	7
Prescriptive - Industrial	791,404	$0.0045	24
Total/Average	**222,575,355**	**$0.0117**	**142**

*Participants/Units installed includes the # of unique addresses for custom offerings, and the # of units for prescriptive offerings.

Although the Industrial group continues to be confident in its ability to influence industrial efficiency projects, given current market conditions, it was anticipated early in the year that it would be a struggle to achieve 2013 cumulative cubic meter targets. As per Table 18, the Industrial sector contributed 222.6 million CCM to the overall Resource Acquisition CCM result or approximately 29% of the Resource Acquisition results. As illustrated in Table 11, this outcome represented a 65% result relative to the middle (100%) target set in the plan. Further, the variance in actual spending for the sector was reflective of the CCM result, with spending in the Industrial sector 37% below initial budget. Additional commentary regarding results is provided in the sections that follow.

Industrial – Custom

Objectives: The Industrial Custom Solutions offering is designed to capture energy savings in the Industrial sector through the delivery of custom energy solutions aimed at supporting customers through a continuous improvement approach. To this end, ESCs focus on assisting customers overcome financial, knowledge and technical barriers to enable the adoption of energy efficiency technologies by these customers.

Target Customer: The offering targets industrial customers in Rates 6, 110, 115, 135, 145, and 170. Projects cover opportunities where savings are linked to unique building specifications, uses, technologies, and industrial processes. Most often, the primary target is industrial customers (both large and small) with significant process loads and annual consumption greater than 375,000 m^3.

Description: The Industrial Custom Solutions offer involves ESCs who work directly with customers to develop custom solutions in order to help production, energy efficiency and budgetary needs. Within the Industrial group, these ESCs are engineers.

Custom Solutions include both enabling support services and implementation incentives. Activities are designed to address technical barriers to energy efficiency adoption, as well as help with financial barriers that may hinder business justification and implementation.

Enabling support services allow ESCs to help customers identify potential opportunities, quantify benefits, and justify action. Enabling services include ESCs leveraging their skills and tools to identify efficiency opportunities; involvement of a third-party vendor to conduct a specific type of audit or assessment of the facility and/or ESCs assisting with the development of an implementation plan. This offering also provides customers with financial incentives to help offset the cost of energy saving initiatives including Audits and Assessments as well as savings driven incentives for energy efficiency implementation efforts.

Although solutions developed by ESCs are custom to the needs of each particular customer, in 2013 the offering focused on five core components:

- **Knowledge Development**: Technical publications, quarterly updates and themed workshops are offered to provide customers with the knowledge to make informed decisions through education and thereby increasing capacity.
- **Opportunity Identification:** ESCs provide support to assist customers in the identification of efficiency opportunities such as equipment testing and assessment, and thermal imaging.
- **Measurement**: ESCs assist customers in selecting appropriate means of measurement to quantify key energy inputs.
- **Engineering Analysis**: ESCs assist customers who do not have the resources needed to conduct financial, technical, and enterprise risk evaluations for potential projects.
- **Implementation Support**: ESCs work with customers on an implementation plan and connect them with business partners to complete the project.

Metrics: As part of the Resource Acquisition program, the primary metric for the Industrial Custom offering is lifetime natural gas savings - cumulative cubic meters (CCM) savings.

Tracking Methodology: Savings for each custom project are calculated on an individual basis, and then tracked monthly by the Tracking and Reporting team, utilizing EGD’s sales tracking software.

Evaluation Activities: Each project is assessed individually for inclusion in the offering. Subsequent to project specific savings calculations being completed by ESCs, an internal technical review of project applications and savings calculations is conducted. ESCs utilize standardized engineering calculators developed by EGD's technical engineering team, or where required, savings calculations are specialized based on project specific engineering analysis.

An independent third-party engineering review – the Industrial Custom Project Savings Verification (CPSV) is conducted annually. The scope of work for this review is set out in a Terms of Reference established by the Technical Evaluation Committee (TEC). This verification study consists of a detailed review of the savings calculations for a statistically representative sample of Industrial sector custom projects claimed in 2013. The Industrial CPSV is summarized in Appendix C and the prescribed sampling methodology followed to establish the selected projects is referenced in Appendix I. Reported results include adjustments as recommended by the engineering review in conjunction with the application of determined realization rates as outlined in Appendix D.

Highlights:

- Although the overall offering description and incentives did not change from 2012 to 2013, there was a much heavier emphasis in 2013 on knowledge development and opportunity identification to help generate additional awareness, interest and participation from the customer base, particularly among the small customer group.

- In an attempt to provide a comparable level of service to all customers regardless of size, while maintaining cost effectiveness, Enbridge increased efforts on a number of initiatives including:

  - Energy efficiency workshops and webinars
  - Quarterly newsletters
  - Audits and Assessments (including targeted assessment campaigns)
  - University led assessments
  - Dedicated ESCs with a small industrial customer focus.

- The University initiative, which began in 2012, focused on providing smaller industrial customers with project identification support, at no cost to the customer, by engaging University students guided by Enbridge ESCs to perform plant audits. This initiative gives young engineers real-life exposure to the energy efficiency world, in the hopes they may be interested in pursuing a career in the industry. Ten of these facility-wide audits were completed in 2013, and customers have provided positive feedback about the experience. Most importantly, 12 distinct projects were initiated as a result of this work.

- In 2013, budget spending on programs and activities for rate classes 110, 115, and 170 is limited. "In general, Enbridge will have the right, in the manner described in the Guidelines, to re-allocate budget between customer classes and groups to optimize the effectiveness of its DSM Plan. However, the Parties agree, for …2013 …that the total budget spent on programs and activities (including allocated overheads but excluding Low Income Allocations) for all customers in rate classes 110, 115, and 170 shall not exceed the following annual limits:"[8]

Table 19. Rate Class 110, 115 and 170 Spending vs. Limits

Rate Class	Spending Limit	Actual Spending
110	$1,636,000	$719,201
115	$1,261,000	$1,124,319
170	$2,164,000	$111,767

Actual spending (including allocated overheads but excluding Low Income Allocations) for each of these rate classes is also detailed in Table 19 and shows that spending is below the limits prescribed for all three rate classes.

To be mindful of budget spending limits, Enbridge set out implementation incentives of $0.07/m³ of natural gas saved in Rate classes 110, 115 and 170. In the balance of the rate classes served in the Industrial sector – Rate 6, 135, and 145, projects were eligible to receive an implementation incentive of $0.15/m³ of natural gas saved. The maximum incentive of $75,000 per project previously was increased to $100,000 in 2013.

8 "*Update to the 2012 to 2014 Demand Side Management ("DSM") Plan*" EB-2012-0394, Exhibit B, Tab 1, Schedule 3, page 5 of 20.

- Based on forecasted projects for 2013, targets within the Resource Acquisition program were adjusted with an accompanying reallocation of budget dollars to other sectors. Even so, spending in the Industrial sector was well below the budget outlined in the 2013 plan. The increased effort in 2013 on appealing to small industrial customers resulted in a substantial increase in the number of projects involving these customers. The actual average size of the projects however, was smaller than anticipated resulting in lower total incentive payouts than initially forecast. Also, the average size of the large industrial projects decreased in 2013, further reducing the incentive paid in support of these efforts than predicted. These factors contributed to the underspend when comparing actual spend vs. budget for the Industrial group.

Results: There were 111 Industrial and 7 Agricultural custom projects completed in 2013 contributing 221.8 million CCM. Custom projects contributed more than 99% of the overall Industrial sector CCM savings.

Cost-effectiveness: Despite some challenges in the market, Enbridge continues to see a high level of cost effectiveness for Industrial sector offerings as supported by the TRC screening (see Appendix E). Savings delivered from the Industrial sector were realized at an average cost of $0.0117/CCM.

Year-over-Year Performance: In comparison to 2013, there were 91 Industrial Custom projects completed in 2012 contributing 306 million CCM. Despite seeing an almost 30% increase in the number of projects completed in 2013 vs. 2012, in comparing CCM savings results, 2013 saw a decrease in overall savings of 27% from the year prior as a result of a significantly smaller per project average gas savings.

Comments and Lessons Learned:

- Project experience continues to provide evidence supporting the importance of the role Enbridge ESCs play in helping customers remove barriers to implementing efficiency projects. As each facility is unique, the most effective method to identify and quantify opportunities involves ESCs who leverage their technical knowledge and expertise to work directly with customers to: explore the various opportunities to save energy; assess the feasibility of these options with consideration of the customer's resources; identify optimal solutions; and, determine the benefits the customer can expect. In addition to providing financial incentives to help offset costs, this unbiased support through the investigation process provides significant value to customers. EGD's efforts must continue to highlight technical support, education, opportunity identification, engineering analysis and project validation as the key components in successfully delivering offerings.

- 2013 experience continues to support an identified trend – the majority of Industrial projects are not finalized until the last quarter of the year which coincides with the commonplace practice in the industrial sector of holiday shutdown.

- In 2014, EGD is modifying the Industrial Custom project incentive structure to a two-tiered approach so that all customers, regardless of rate class are entitled to the same incentive. The new tiered incentive approach is intended to encourage more projects by increasing financial support for customers.

- Enbridge will continue to look for ways to improve and/or build on the current offerings including a focus on supporting operational improvements through energy monitoring and targeting. The team is researching alternatives to launch a new initiative in this area. The intention is to provide customers with a more structured offering requiring a greater commitment from the customer. Ultimately, the initiative aims to encourage customers to incorporate operational efficiency as part of its culture to ensure improvements and investments are sustainable.

- The Industrial sector continues to face a variety of challenges and the sector is not back to pre-recession levels. With gas prices remaining near ten-year lows throughout 2013, a decreased customer focus on gas efficiency projects is evident given lengthened project paybacks which are often less attractive relative to other investments, and more specifically, to other energy efficiency alternatives focusing on electricity usage for example.

- The Industrial sector in Ontario is not a growth sector, and while it isn't expected that the challenges facing the industrial sector will diminish, a customer focused approach will continue to uncover energy efficiency solutions for customers. The majority of energy used in the industrial sector is for process as opposed to heating and ventilation purposes. As such, most energy efficiency opportunities exist in the improvement and optimization of these processes. Although customers understand the processes within their facilities, they often lack the technical knowledge of the energy efficient tools and technologies that can streamline these processes and reduce overall energy consumption. Enbridge's ESCs provide customers with that level of technical expertise by mapping out how their unique production processes work; identifying and quantifying custom solutions to maximize efficiencies within the customer's facilities. These process related custom projects are expected to remain the largest contributor to overall sector performance.

Industrial – Prescriptive

Objectives: The Industrial Prescriptive offering aims to capture energy savings in the Industrial sector through the installation of applicable prescriptive and quasi-prescriptive technologies, with particular focus on aiming to provide a supplementary offering to smaller customers to increase the adoption of energy efficiency technologies amongst that customer segment.

Target Customer: The offering is available to Industrial and Agricultural customers in Rate 6, 110, 115, 135, 145, and 170. The primary target market for the offer is small industrial customers with annual consumption of less than 375,000 m^3.

Description: The Industrial Prescriptive offer was derived by leveraging existing Commercial offers applicable to the industrial customer base.

2013 was the first year a Prescriptive/Fixed Incentive offer was made available to industrial customers. In order for the fixed incentives to apply in an industrial setting, a requirement was added to the initiative that any participating industrial facilities must be implementing the technology for space heating purposes only and not process purposes.

The Industrial "Fixed Incentive" offering for 2013 included incentives designed to help offset the cost of energy efficiency upgrades specifically relating to Air Doors, Heat Recovery Ventilators, Energy Recovery Ventilators and Infrared Heaters.

Metrics: As part of the Resource Acquisition program, the metric for Industrial Prescriptive offering is cumulative cubic meters (CCM).

Tracking Methodology: Data is compiled for participants and tracked on a monthly basis by the Tracking and Reporting team, utilizing EGD's sales tracking software.

Highlights:

- To support Industrial ESCs in raising awareness of the offering, a key means of promoting the offering was via business partners and service providers as this approach leveraged an already established distribution network.

- All fixed incentives implemented by customers in 2013 were related to the installation of Infrared Heaters, indicating that this form of technology was regarded as the most applicable to the industrial customer base.

Results: There were 24 prescriptive projects completed for industrial customers in 2013 with 791,404 CCM in natural gas savings.

Comments and Lessons Learned:

- While Custom Projects are extremely resource intensive and require extensive internal and external technical expertise and data analysis, fixed incentive projects are relatively simple to execute, making them ideal for smaller customers. Prescriptive initiatives however, will not contribute the significant CCM savings found in custom solution efforts.

- The offer provides a good complementary initiative accessible for small industrial customers however; leveraging Commercial channel managers and service providers to create awareness did not drive participation levels sought. It is clear, additional delivery channels will need to be introduced to support ESCs' efforts in promoting this offering to small industrial customers. Additional distribution networks will be explored in 2014.

- This offering will continue in 2014 with modest CCM forecasts. The following enhancements are being explored:

  - Introducing fixed incentives for additional technologies with industrial customer applications (e.g., condensing make-up air units).
  - Undertaking a telemarketing initiative to reach out to more small industrial customers and generate higher levels of awareness and participation.

6.2 Low Income Program

Enbridge has been delivering a program specifically designed for low income consumers since 2004. The Low Income program is intended to reduce the energy cost burden facing low income consumers and their housing providers through the installation of water saving and space heating measures and thermal envelope improvements. Two Low Income program streams target different segments of this market, Single Family Buildings (Part 9) and Multi-Residential Social Housing Buildings (Part 3).

Though low income dwellings are often less energy efficient than others, they are difficult to reach with traditional DSM initiatives. A program directed at this sector needs to be designed and delivered differently from traditional efforts to encourage customer awareness, access and participation.

A fundamental component to the Enbridge Low Income program delivery strategy is a focus on leveraging wherever available, tools and resources, community based organizations (CBOs), and local community channels, that have established relationships with trusted “grass-roots” organizations which support housing affordability and social service needs of low income consumers. Further, Enbridge continues to collaborate with business and community partners that represent the interests of low income consumers, and social and assisted housing support networks to help effectively inform and evolve program delivery.

Table 20. Low Income Scorecard

	Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	2013 Actual Result
Low Income	**Single Family (Part 9)**	*Cumulative Savings (million m^3)*	***50%***	17.3	23.1	28.8	**32.90**
	Multi-residential (Part 3)	*Cumulative Savings (million m^3)*	***45%***	45	60	75	**27.31**
	Multi-residential (Part 3) LIBPM	*Percent of Part 3 Participants Enrolled* *	***5%***	30%	40%	50%	**85%**

* Low Income Building Performance Management (LIBPM) Percentage of Part 3 buildings enrolled in current year program = (x+y)/(x+y+z) where:

x = # of new LIBPM buildings in the current year which have participated in another aspect of the Low Income program in a previous year of 2012-2014 plan; y = # of new LIBPM buildings participating in current year which have not previously participated in the Low Income program; z = # of buildings in the current year which have implemented custom projects other than LIBPM.

The Low Income program produced mixed results in 2013 relative to performance targets. As detailed in Table 21, cumulative natural gas savings totalled 60.2 million CCM. Results in the Single Family (Part 9) segment were strong, totaling 32.9 million CCM, well surpassing the upper target; results in the Multi-Residential (Part 3) segment however, were significantly below expectations with 27.3 million CCM, under the lower target. Overall the Low Income program achieved 72% of its CCM target, this result was reached with actual spending 17% below budget. Details regarding DSM spending vs. budget are provided in Section 8 of this report.

Table 21. Low Income Results

Low Income Component	CCM Target (100%)	Actual CCM	% Target Achieved	$/CCM	Participants/ Units Installed*
Single Family (Part 9)	23,107,630	32,904,684	142%	$0.1410	3,938
Multi-Residential (Part 3)	60,004,760	27,314,154	46%	$0.0265	1,396
Total/Average	**83,112,390**	**60,218,838**	**72%**	**$0.0891**	**5,334**

*Participants/Units installed includes the # of unique addresses for custom offerings, and the # of units for prescriptive offerings.

With the dominance of Toronto Community Housing (TCH) in the social housing sector, planned projects for 2013 anticipated significant savings contributions would come from this housing provider, by far the largest in the Enbridge franchise. However, changes within that organization in mid-2013 have had a major impact on Low Income program results, in both the single family and multi-residential segments. Specifically, key operational process and management changes at TCH have meant additional reviews prior to them taking action, finalizing decisions and moving forward on energy efficiency project implementation across their housing portfolio. The biggest impact to EGD came from the suspension of TCH multi-residential capital improvement projects, which were anticipated to be significant contributors in Part 3 results.

Similarly, organizational and operational changes with other delivery agents and business partners are also factors which negatively impacted results.

The introduction of a third metric for 2013 related to the enrollment of multi-residential buildings in an initiative focusing on building performance energy management. This effort is intended to provide an opportunity for Low Income buildings to access information, which provides them with consumption data analysis, benchmarking and energy savings opportunity identification.

There was good interest in the marketplace for this offering and Enbridge was able to reach a significant number of buildings. These participants contributed to an 85% result for this metric, exceeding the upper scorecard target as outlined in Table 20.

6.2.1 Single-Family (Part 9)

Weatherization and Water Conservation Measures

Objectives: The goal of the Single Family Low Income offering is to capture energy savings through the reduction of hot water use and space heating demand in low income single family homes through the installation of thermal envelope improvements and water saving measures.

Target Customer: Rate 1 and Rate 6 customers. Homeowners and tenants living in low-rise homes within the Enbridge franchise area who are in need of assistance with their energy costs – recipients of social benefits and/or tenants and homeowners meeting the eligibility criteria of 135% of Statistics Canada's Low Income Cut-off (LICO) measure; and, social housing providers where tenants are not paying their own utilities.

Description: The Low Income Weatherization offering is available to qualified, Part 9 building (three stories or less) private homeowners and residential tenants within the EGD franchise who meet established income eligibility criteria; as well as residents of social housing, and recipients of social assistance benefits.

Contracted delivery agents, utilizing certified energy auditors, perform energy audits to determine which cost-effective measures may be most appropriate for each home. Measures may include attic, wall and/or basement insulation, door and window caulking, and draft-proofing. Residents are also offered low-flow showerheads as well as kitchen and bathroom aerators and in some cases a programmable thermostat as part of the Weatherization screening process.

EnviroCentre, Green Communities, GLOBE (Green Light on a Better Environment) and GreenSaver, as in 2012, remained the four primary service providers contracted by Enbridge to market and deliver the offering. These delivery agents have extensive experience in energy efficiency audit and retrofit delivery activities and they are well established in their communities with recognized connections to Low Income constituents throughout the franchise area.

The strategy of delivering the offering in partnership with community based organizations with strong links to social service agencies continued in 2013 as it has been found to be an effective way of connecting with a hard-to-reach customer segment. Where possible, the delivery agent also refers participants to the local electric utility's conservation weatherization program.

Metrics: The primary metric is cumulative cubic meters (CCM) savings.

Tracking Methodology: In the case of Weatherization, reports are submitted from delivery agents summarizing installation site information (e.g., address, ownership, housing type) and natural gas savings (m^3) calculated based on the results of the energy audits conducted by energy auditors on a customized basis. Participation is also tracked by type of tenure, i.e., social housing or privately-owned dwellings.

Similarly, monthly reporting is provided by delivery agents summarizing savings per unit installed for water conservation measures and programmable thermostats, if any. Monthly reports are compiled by the Tracking and Reporting team utilizing EGD's sales tracking software.

Highlights:

- Despite challenges with key social housing providers, which involved executive management changes and a widespread re-evaluation of priorities that resulted in energy management initiatives being put on hold, significant savings were driven by the participation of other social housing providers, as well as through delivery efforts to the privately-owned low income housing customer base.

- As part of ongoing program improvement efforts, increased training and quality control improvements directed to delivery agents were a significant focus early in 2013. Enhanced data collection protocols, outlines and checklists to support work plan documentation and redefined reporting requirements were implemented to improve tracking and reporting efforts.

- Enbridge continues to see the trend of declining average savings in the offering, primarily due to the effect of smaller housing units participating through the social housing stream. The Low Income group is investigating additional measures and/or services that can be bundled with the offering to improve energy savings results and/or program delivery efficiencies.

Results: Single Family (Part 9) results were solid in 2013 – with actual cumulative savings of almost 33 million CCM as outlined in Table 22. This was an achievement of 142% of the middle target of 23.1 million CCM set out in the DSM Plan, as detailed in Table 21.

Table 22. Single-Family (Part 9) Low Income Results

Low Income Component	Actual CCM	$/CCM	Participants/ Units Installed*
Single Family (Part 9)	32,904,684	$0.1410	3,938

*Participants/Units installed includes the # of addresses for weatherization offerings, and # of units for showerhead water conservation offering.

The Enbridge Single Family offering included almost 4,000 participants in 2013. In particular, Weatherization projects were completed for 1,839 low income dwellings throughout the Enbridge franchise in 2013, collectively contributing 31.91 million CCM to the single family result.

The balance of the savings for the segment came from energy efficiency gains associated with low-flow showerhead installations in Ottawa Community Housing properties.

As summarized in Table 23, project analysis shows that average annual gas savings from social housing properties was 609 m^3; however, privately-owned homes had an average of 51% greater annual gas savings, or 915 m^3 on average in 2013. These results support a continued trend in comparing social vs. privately-owned savings observed the year prior.

Table 23. Weatherization – Average per Project Savings

Weatherization Average Annual Gas Savings	2013	2012
Average Annual Gas Savings/Home - Social Housing	609	877
Average Annual Gas Savings/Home - Privately-Owned	915	1,143
Average Annual Gas Savings/Home - All Projects	**694**	**948**

A breakdown of the Weatherization projects between social housing and privately-owned homes, in terms of both participant numbers and CCM savings contributions is outlined in Table 24.

Although 72% of projects, totaling 1,329 projects completed in 2013 were for social housing dwellings, only 63% of the CCM results were attributable to these social housing projects. Conversely, there were 510 privately-owned houses weatherized in 2013, or 28% of all projects however, these privately-owned homes accounted for 37% of Weatherization CCM savings.

A similar composition of results between social and privately-owned dwellings was also evident in 2012. Essentially, the social housing properties tend to be smaller dwellings such as townhomes or row houses and yield smaller energy savings.

Table 24. Weatherization – Social Housing and Privately-Owned Results

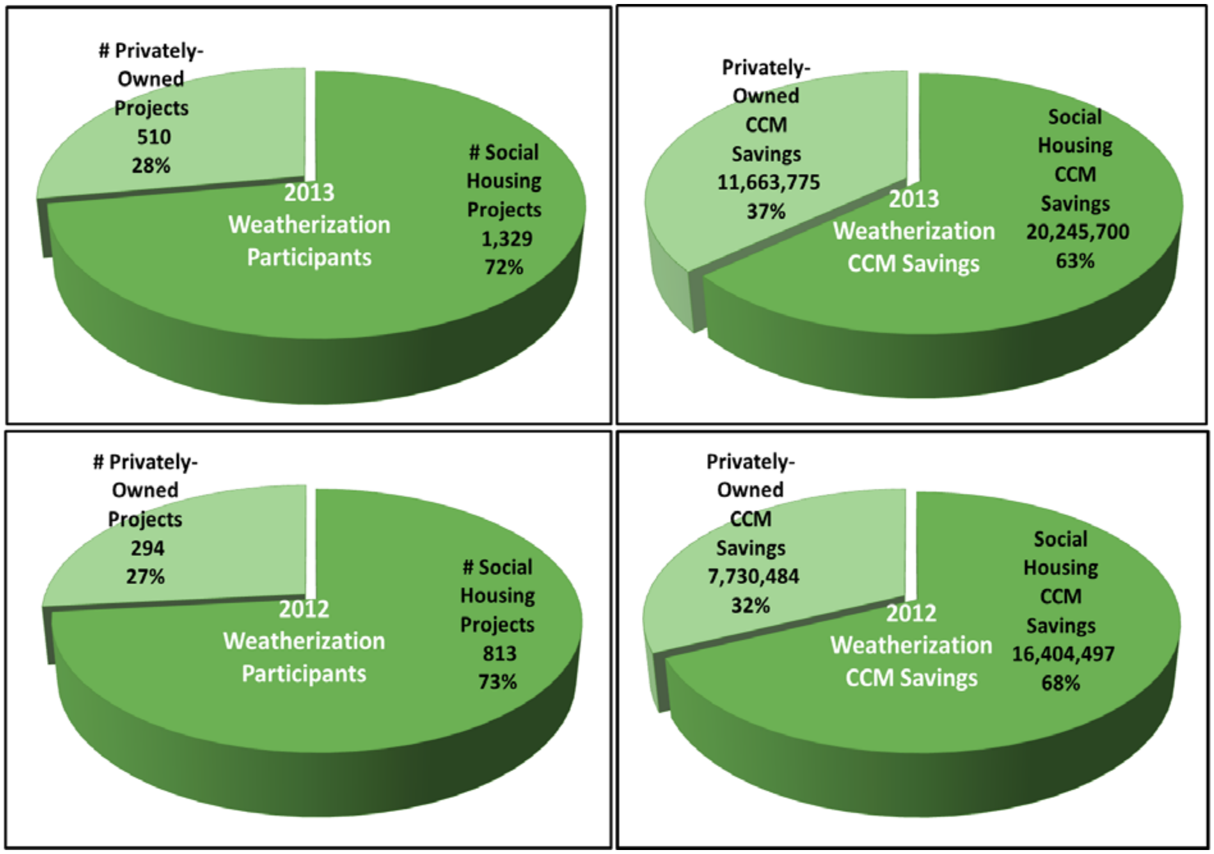


Table 25 below provides a measure by measure analysis for each of the components of the Weatherization offering for both social housing and privately owned homes.

Table 25. Weatherization – Measure by Measure Results

	Privately Owned Projects	Social Housing Projects	All Weatherization Projects
# projects which included Attic Insulation	346	309	655
Annual Gas Savings for Attic Insulation (m3)	71,320	71,630	142,950
# projects which included Wall Insulation	276	-	276
Annual Gas Savings for Wall Insulation (m3)	212,310	-	212,310
# projects which included Basement Insulation	150	1,313	1,463
Annual Gas Savings for Basement Insulation (m3)	43,091	541,309	584,400
# projects which included Draftproofing Measures	416	1,145	1,561
Annual Gas Savings for Draftproofing Measures (m3)	139,830	196,889	336,719
Total # projects	**510**	**1,329**	**1,839**
Annual Gas Savings for All Measures Combined (m3)	466,551	809,828	1,276,379
Measure Life	25	25	25
Total CCM	**11,663,775**	**20,245,700**	**31,909,475**

Cost-effectiveness: Although the Low Income program screening threshold is 0.70, the Low Income Single Family offering was cost-effective as supported by the TRC screening above 1.0 (see Appendix E). Gas savings from this sector were achieved at a cost of $0.141/CCM. Low Income programs are typically among the most expensive to deliver.

Year-over-Year Performance: As summarized in Table 26, total CCM savings from Single Family offerings increased by 33% year-over-year. In terms of projects completed, there were 1,839 low income homes weatherized in 2013 vs. 1,107 in 2012, an increase of 66%.

Table 26. Single-Family (Part 9) 2013 vs. 2012 Results

Low Income Component	Actual CCM 2013	Actual CCM 2012	Difference	% Increase/ Decrease
Single Family (Part 9)	32,904,684	24,708,220	8,196,464	33%

Comments and Lessons Learned:

- Partnering with delivery agents and social service agencies that have a strong community presence to promote low-income initiatives to customers will continue to be a crucial component in successfully reaching this market. The sector poses unique challenges in accessing energy efficiency initiatives through traditional activities. Obvious financial barriers, challenging housing conditions, competing priorities and core needs, as well as low customer awareness require customized outreach activities.

- Enbridge encourages delivery agents to cross promote the Weatherization offering while promoting the Ontario Power Authority's (OPA) funded saveONenergy Home Assistance Program (HAP) aimed at electricity focused energy efficiency. This approach has benefitted the customer by maximizing potential energy savings when participating in both offerings, and at the same time being more convenient for the customer as both audits can be done in one visit. Delivery agents have indicated this approach has increased uptake in the Weatherization offering.

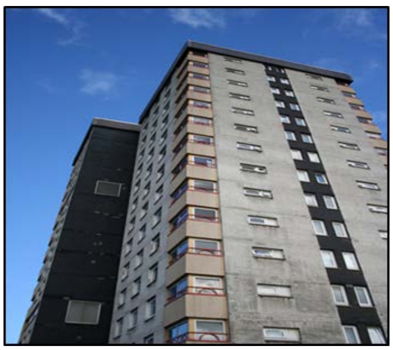
- Given the many recent staffing changes within both housing providers and delivery agencies, Enbridge will continue to focus on educating new stakeholders associated with the offering; capitalizing on the value they bring for the benefit of low income customers and their housing providers.

- The Weatherization offering expanded in 2012 to the social housing segment, which very often includes smaller townhouse or row house type dwellings. A trend identified last year, has continued in 2013 with the average gas savings per home decreasing.

- The increasing proportion of smaller homes has not necessarily equated to lower implementation and delivery costs. More aggressive marketing activities are needed to reach out to new potential customers and add to marketing and transactional costs. Enbridge will continue to explore opportunities for collaboration with electric utilities for efficiencies in delivering low income focused offerings.

- Enbridge recognizes that as targets increase and average savings per home are decreasing, more innovative and targeted marketing efforts will need to be pursued. The Low Income team will be looking to expand outreach and awareness efforts to food banks and walk-in clinics as well as introducing seasonal campaigns in 2014. In addition, the team is integrating its efforts more closely with LEAP (Low Income Energy Assistance Program) channels to provide outbound calls to LEAP applicants at the initiation of contact to effectively promote the offering.

6.2.2 Multi-Residential (Part 3)



Custom Projects and Water Conservation

Objectives: The goal of the Multi-Residential Low Income offering is to capture energy savings through the reduction of hot water use and space heating demand in low income multi-family social housing through the installation of water saving measures, space heating measures and thermal envelope improvements.

Target Customer: Rate 6 multi-residential social housing providers and managers.

Description: Low Income Multi-Residential (Part 3) efforts are directed at assisting social housing providers to improve the energy efficiency of aging buildings by offering direct installation of basic energy savings measures, as well as financial support for custom retrofit projects, major equipment replacement, thermal envelope improvements and controls. The Multi-Residential Custom Retrofit offering takes a "building as a system approach" to energy efficiency. It targets housing providers, building operators and tenants with a range of measures and includes enhanced financial incentives, technical information services, building assessments/audits, education, and project facilitation.

Financial barriers inherent to the low income sector related to limited capital availability are addressed by providing an increased financial incentive relative to the standard offer Multi-Residential custom offering incentive from $0.10/m^3 saved to $0.20/m^3 saved.

Technical issues are addressed by engaging sector experts to provide a suite of services including benchmarking, energy audits, technical assistance, and project facilitation.

In addition to their efforts with the Weatherization offering, GLOBE, a subsidiary of the Housing Services Corporation (HSC), is engaged to provide program management and delivery services for the social housing multi-residential low income offerings. The one exception is Toronto Community Housing. As the largest single social housing provider in the country, with an established relationship with Enbridge staff, TCH requires dedicated account management services from Enbridge so that it works directly with TCH on its multi-residential energy efficiency projects.

Enbridge also provides free installation of low-flow showerheads to eligible low income multi-residential social housing buildings. The measure is supplied at no cost to the social housing provider to accomplish water heating savings and water conservation.

Metrics: The primary metric is cumulative cubic meters (CCM) savings.

Tracking Methodology: As with Commercial Custom projects, the savings for each custom project are calculated on an individual basis. Additionally, savings per unit installed for low-flow showerheads are tracked and totalled. Results are recorded and summarized through a monthly tracking process utilizing EGD's sales tracking software.

Evaluation Activities: Following internal verification review of all Low Income multi-residential custom projects by the DSM technical group, a further verification of custom low income projects is undertaken as part of the Commercial Custom Project Savings Verification (CPSV) process.

An independent third-party engineering review – the Commercial Custom Project Savings Verification (CPSV) is conducted annually. The scope of work for this review is set out in a Terms of Reference established by the Technical Evaluation Committee. This verification study consists of a detailed review of the savings calculations for a statistically representative sample of Commercial sector custom projects (including Low Income multi-res) claimed in 2013. The Commercial CPSV is summarized in Appendix A and the prescribed sampling methodology followed to establish the selected projects is referenced in Appendix I. Reported results include adjustments as recommended by the engineering review in conjunction with the application of determined realization rates as outlined in Appendix B.

Highlights:

- Organizational changes at TCH and the resulting re-evaluation of initiatives and re-prioritization of multi-residential energy efficiency projects had a significant negative impact to Part 3 results.

- In ongoing efforts throughout the year to assist TCH in moving forward on energy efficiency project implementation in 2013, EGD endeavoured to engage multiple levels of EGD and TCH management – operational, middle management as well as senior strategic level management to help in addressing barriers and facilitate decisions.

- Financial incentives were significantly increased in the middle of the year aimed to accelerate project implementation in 2013. This action did not however result in projects being implemented. Resident engagement efforts undertaken in social housing buildings require an extended timeline to provide the time necessary to build tenant support for scheduled initiatives.

- A collaborative working group was established with Enbridge, Toronto Hydro, Toronto’s Social Housing Unit, and GLOBE early in the year. The engagement of key staff of the Toronto’s Social Housing Unit working very closely with GLOBE, and the data between both parties was invaluable in identifying housing providers and buildings that would benefit most in a utility energy efficiency program.

- To a smaller degree, a similar relationship was developed between the Region of Peel where the municipality consulted with their social housing arm, Peel Living, to identify ways to make projects financially viable. GLOBE manages the relationship with Peel Living while Enbridge jointly participates in discussions with the Region of Peel Energy Management staff.

Results: Results as reported include adjustments recommended in the CPSV verification findings.

Table 27. Multi-Residential (Part 3) Low Income Results

Low Income Component	Actual CCM	$/CCM	Participants/ Units Installed*
Multi-Residential (Part 3)	27,314,154	$0.0265	1,396

*Participants/Units installed is the # of unique addresses for custom type offerings, and # of units for prescriptive offerings.

The Multi-Residential offering faced significant challenges in 2013. CCM natural gas savings were well below target, achieving 27.3 million CCM versus a 100% target of 60 million CCM.

Cost-effectiveness: Although the Low Income program screening threshold is 0.70, the Low Income Multi-Residential offering was cost-effective as supported by the TRC screening above 1.0 (see Appendix E). Gas savings were achieved at a cost of $0.0265/CCM.

Year-over-Year Performance: CCM Savings from Part 3 sector offerings were down year-over-year by 37% in 2013.

Table 28. Multi-Residential (Part 3) Results 2013 vs. 2012

Low Income Component	Actual CCM 2013	Actual CCM 2012	Difference	% Increase/ Decrease
Multi-Residential (Part 3)	27,314,154	43,407,789	-16,093,635	-37%

Comments and Lessons Learned:

- Resident consultation and engagement as part of the project planning process is becoming a critical and influential factor in energy efficiency project implementation. Ottawa Community Housing, for instance, went through a user (resident) testing to identify the specific type of showerhead that will be used for their water conservation project. Toronto Community Housing, through their participatory budgeting process, seeks to get resident input on in-suite installation of heat reflector panels. These efforts tend to further extend project timelines.

- Massive capital replacements, i.e., mechanical equipment, have been completed in the past five years, under the Social Housing Energy Renovation and Retrofit Program (SHRRP). Technical and information services, e.g., new technologies, best practices in building maintenance and operations, benchmarking, etc., made available to social housing providers and their municipal service managers, in conjunction with GLOBE's expertise and role in [building] asset planning and renewal, are integral program support services that will inform energy efficiency projects' implementation.

- The sector in general is hyper-sensitive to program and funding cycles, specifically where project decisions rely heavily on availability of incentives. Capital replacements and resources are budgeted and allocated at least a year in advance of the program year. And where incentives are factored into the budget process, "limited time offer campaigns" are not as effective in increasing participation.

- Though the extensive management overhaul at TCH is undoubtedly an anomalous/infrequent occurrence, lessons learned from 2013 highlight the need for continued ongoing engagement at all levels of management between EGD and social housing providers to ensure EGD can effectively work with these agencies to address the various challenges that continue to pose barriers.

Low Income Multi-Res Private Market Rate Demonstration Initiative

As determined in the course of the negotiations for the Update to the 2012 to 2014 DSM Plan (EB-2012-0394), Enbridge committed to work with the Low Income Consultative sub-group in 2013 to develop protocols to include privately-owned Part 3 multi-residential buildings in the Low Income program.

This mandate has provided an opportunity for Enbridge to partner with a number of organizations to bring together energy and bill savings while engaging resident tenants and allowing them to participate and share the benefits of energy efficiency and conservation action. With direction from the Low Income consultative working group, Enbridge-led collaborative partnerships were established to deliver on an initiative in 2013. These partnerships included United Way Toronto (UWT), the Federation of Rental Housing Providers of Ontario, Toronto Hydro and the City of Toronto's Tower Renewal Office.

According to a United Way Toronto 2011 report entitled "Vertical Poverty: Poverty by Postal Code 2", there is an increasing concentration of poverty in Toronto's high-rise towers located in inner city neighbourhoods. The UWT research indicated that approximately 75% of rental stock is privately owned and most are high-rise buildings that are more than 40 years old.

For the Enbridge demonstration project, buildings were pre-identified using demographic and socio-economic characteristics and landlord participation. The aim of the project is to bring both energy AND non-energy benefits to Low Income residential building tenants and landlords.

The primary objective of this initiative is to gather data to inform establishment of protocols to define participant eligibility and building screening. Also, data collection related to building information and, participation and motivation is intended to assist with defining implementation considerations and inform program delivery.

With information gained and lessons learned in 2013 and continuing into 2014, Enbridge anticipates being able to move forward with a formalized income-qualified low income private multi-residential offering in 2014, similar in concept to the offering currently available for the social housing multi-residential segment.

Low Income Building Performance Management (LIBPM) [9]

Objectives: Building on the concept that the first step to effectively reducing energy costs is to collect and analyze building data, the initiative is designed to provide participants with detailed energy and water consumption information, and benchmarking reports at no cost, to raise their level of awareness on their energy usage. In addition, coaching for possible areas of improvement, energy efficiency tips and energy efficiency opportunities are communicated. By providing financial incentives for demonstrated reduction in natural gas consumption over a twelve- month monitoring period, participants are motivated to make operational and behavioural energy management improvements in their buildings.

Target Customer: Rate 6 multi-residential social housing providers and managers.

Description: As outlined in the 2013-2014 Update, EB-2012-0394, and recognizing the need for a Building Performance Management offering directed at the Low Income sector, the concept of the Commercial Run it Right activity has been modified to better reflect the needs of social housing providers and characteristics of social housing buildings. The Low Income

9 Low Income Building Performance Management is the Low Income offering complement to the Commercial Run it Right (RiR) offering.

Building Performance Management initiative (LIBPM) has been simplified and includes:

- benchmarking;
- analysis of historical consumption data;
- development of recommendations for reducing consumption; and,
- assessment of resulting changes in consumption 12 months later based on changes in actual gas usage.

In line with the Low Income delivery strategy of leveraging and/or enhancing existing sector and delivery agents' networks and their capacity, Enbridge entered into an agreement with GLOBE/HSC.

Initially developed as a one-year trial program, GLOBE secured funding from the OPA to pilot an electricity-focused benchmarking initiative. Enbridge engaged GLOBE to enhance and expand the building subscription of its Utility Management Program (UMP) to include gas benchmarking and consumption analysis.

Through this initiative, the energy consumption of the buildings is tracked over a twelve-month period. Quarterly reports are generated for each of the buildings forming part of the Enbridge UMP portfolio. Follow-up calls are made by GLOBE/HSC to "underperformers" based on the benchmarks established to provide coaching and identify pathways to energy savings – from improved operational practices to energy savings incentives.

Metrics: The metric for this offering is based on the percentage of Part 3 buildings enrolled in the current year. Building owners or managers who have "enrolled" in Low Income Building Performance Management, including UMP are counted towards the metric.

The formula for calculating this percentage metric of Part 3 buildings enrolled in the current year Low Income Building Performance Management offering is as follows:

$$\% \text{ LIBPM} = \frac{(x + y)}{(x + y + z)}$$

where:

x = Number of new LIBPM buildings in the current year which have participated in another aspect of the Low Income program in a previous year of 2012-2014 plan;
y = Number of new LIBPM buildings participating in current year which have not previously participated in the Low Income program; and,
z = Number of buildings in the current year which have implemented custom projects other than LIBPM.

Tracking Methodology: All participating buildings are required to complete an Enrollment and Participation Form. Copies of these forms are tracked along with copies of quarterly reports delivered by GLOBE and sent to participants as well as annual reports summarizing natural gas savings for each participant. The offering undergoes monthly tracking by the Tracking and Reporting team utilizing EGD's sales tracking software.

Highlights:

- The initiative was well received by housing providers and service managers. In particular, the municipal service manager for a large social housing portfolio has proactively requested a substantial allocation for their social housing providers. The organization views this initiative as a key information source in monitoring utility related expenditures of their providers.

- The partnership with Enbridge has allowed GLOBE to expand this initiative well beyond its initial, one-year phase, and make the necessary enhancements to make this tool more useful to housing providers.

Results: There were 164 properties that participated in the LIBPM offering in 2013. Based on the calculation outlined above this resulted in a score of 85% for this metric, well above the upper target for this initiative.

Comments:

- Enbridge will continue its support for UMP through the LIBPM initiative.

- TCH has its own Strategic Energy Management program that includes benchmarking, monitoring and targeting initiatives; however TCH lacks the capacity and resources to fully support these efforts. Enbridge will continue to provide the services TCH needs to scale up implementation across its portfolio.

6.3 Market Transformation Program

As described in the Board's DSM Guidelines, "market transformation programs are focused on facilitating fundamental changes that lend to greater market shares of energy-efficient products and services, and on influencing consumer behaviour and attitudes that support reduction in natural gas consumption. They are designed to make a permanent change in the marketplace over a long period of time."[10]

2013 has proved to be another successful year with respect to the performance of the Market Transformation (MT) program. Each of Enbridge's MT offerings has seen a substantial boost in recognition from the respective marketplaces they were designed to influence.

Market Transformation comprises offers for both new construction sectors (Commercial and Residential) as well as an offering directed to existing residential homes.

All four of Enbridge's MT program offerings performed well in 2013 in relation to performance targets. On a weighted scorecard basis, three of the four offerings exceeded their upper targets.

The Drain Water Heat Recovery (DWHR) offering is an initiative that has been made available by EGD to the new construction residential builder market for the last four years and was concluded towards the end of 2013 as planned, having demonstrated great success over the maturation of the offering.

The remaining two offers – Saving By Design Residential and Savings By Design Commercial, are geared to new construction and were newly introduced in 2012 in conjunction with the current multi-year plan. These offers were developed to play a role in influencing builders/developers to look at ways to build to standards above current building code requirements.

10 *"Demand Side Management Guidelines for Natural Gas Utilities"* (EB-2008-0346), OEB, June 30, 2011, page 10.

In the existing home arena, the Home Labelling (Rating) offering was developed to influence the home re-sale marketplace in understanding what a home rating represents and the value it brings to homebuyers and sellers.

The budget for the Market Transformation program compared with program spending in 2013 is outlined in Table 29.

Table 29. Market Transformation Budget vs. Spending

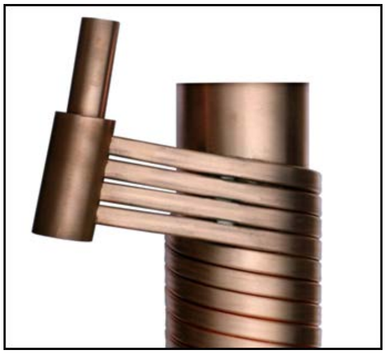
Program Offering	Actual Costs	Budget	Variance	Variance (%)
DWHR	$1,937,030	$1,415,000	$522,030	37%
SBD Residential	$1,029,535	$2,305,000	-$1,275,465	-55%
SBD Commercial	$590,592	$590,000	$592	0.1%
Home Labeling	$755,900	$775,000	-$19,100	-2%
Total	**$4,313,057**	**$5,085,000**	**-$771,943**	**-15%**

With the Drain Water Heating Recovery offer coming to a close in 2013, there was increased demand for the product, beyond expected forecasts and targets. Consequently additional funds were reallocated to support this final year demand.

There was a sizeable underspend of $1.275 million for SBD Residential in 2013 relative to the budget proposed. The offering provided for a three-year time horizon to builders to complete homes for performance incentives. The forecast for homes built and the associated incentive payable was not realized in the 2013 program year despite meeting the target. Nonetheless the offering continues to have an outstanding commitment to these participants over the multi-year provision of the offering.

Actual spending for the remaining two offers – Home Labelling and SBD Commercial, was very close to budget for both initiatives. The net result collectively was a $771,942 underspend in the Market Transformation program relative to what was budgeted in the plan.

6.3.1 New Construction



Drain Water Heat Recovery (DWHR)

Objectives: The primary goal of the Drain Water Heat Recovery offering is to transform the Residential New Construction market such that the installation of a DWHR unit becomes a standard element of new home construction throughout the Enbridge franchise area.

Target Customer: The DWHR offering targets builders of new – Rate 1, residential, low-rise (towns, semis, and detached) homes in the Enbridge franchise area. Enbridge targets its promotional activity directly to the builder market. The ultimate target market is residential Rate 1 customers, purchasers of new homes.

Description: DWHR saves water-heating energy by capturing the waste heat from drain water and using it to pre-heat inlet water. The DWHR initiative focuses on encouraging builders to install the unit during construction of a new home. New construction presents the best opportunity for efficient installation of this technology. Installation of this particular efficiency measure is more difficult and significantly more costly once a home is completed, particularly with older housing stock built to different building code standards. Enbridge works closely with builders, providing installation training and encouraging installation in model homes.

Metrics: The number of Drain Water Heating Recovery units installed.

Tracking Methodology: Results are tracked by recording the number of units installed as reported by the builder participants and confirmed by signed acknowledgment forms. Inventory shipped to builders is tracked and reconciled to installed verification claims.

Highlights:

- Due in part to the success of the offering, and ongoing efforts on behalf of Enbridge working closely with the manufacturers and builders, an update to Ontario Building Code (OBC) (Supplementary Bulletin 12; SB-12 -Energy Efficiency for housing) formally included Drain Water Heat Recovery Units in the prescriptive compliance path selections builder can choose to achieve code, in March of 2013. In anticipation of the Building code inclusion, EGD planned to end the offering. Accordingly, the DWHR initiative for the new construction residential market completed its final year in 2013.

- Over the life of the offering, Enbridge has built strong relationships with the DWHR manufacturers and builders alike, providing incentives to help increase the market penetration for power pipes. As outlined in the 2013-14 Plan Update, EB-2012-0394, Enbridge committed to ramping down financial incentives for the DWHR by the end of 2013, in anticipation of exiting the market altogether. Consequently, there was a decrease in the standard rebate provided from $400 in previous years to $300.

Results: This customer offering was extremely successful in 2013 with 6,465 units installed, exceeding the upper target.

Table 30. Drain Water Heat Recovery Scorecard

Component	Metric	Targets				2013 Actual Result
		Weight	Lower	Middle	Upper	
Drain Water Heat Recovery	*# of Units Installed*	***100%***	2,813	3,750	4,688	**6,465**

Year-Over-Year Performance:

The past year demonstrated the highest market penetration that the offering has experienced since inception. Installations were up 28% over the previous year's results. The adoption of the DWHR unit has been trending upward year-over-year since the offering was initiated in 2009.

Table 31. DWHR 2013 vs. 2012 Results

Component	Metric	2013 Actual Result	2012 Actual Result	% Increase/ Decrease
Drain Water Heat Recovery	*# of Units Installed*	**6,465**	**5,047**	**28%**

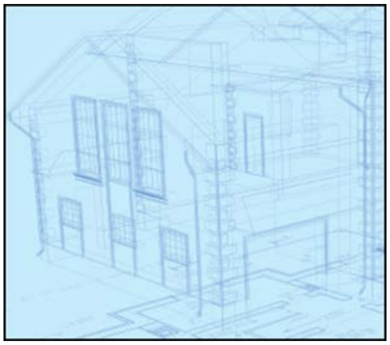
Results over the past five years show an impressive increase in builders taking advantage of the Enbridge incentive to use DWHR in new home builds, demonstrating an upward trend of adoption in the marketplace:

Year	DWHR Units
2009	455
2010	1,684
2011	4,052
2012	5,047
2013	6,465

***Comments and Lessons Learned*:**

- With Ontario becoming the first jurisdiction in North America to include the DWHR units as an option in the "paths to compliance" for the energy-savings component of the province's building code, this offering has ultimately achieved a positive outcome and has demonstrated an impact on market transformation. Given the uptake of the technology amongst builders in 2013, Enbridge will assess whether there remains an opportunity to further transform this market. Although DWHR has now been included in the OBC, it is not a requirement but rather an option and therefore could benefit from ongoing support of the technology.

- As would be expected for a successful market transformation effort, education has played a key role. EGD, directly and through partner engagement promoted the measure at a range of conferences and tradeshows and most importantly, the efforts of EGD's Channel Consultants in enlightening the builder market on the ease of installation of the technology, contributed to the overachievement and the concluding success of the offering.



Residential Savings by Design (SBD)

Objectives: The goal of the Residential Savings By Design offering is to use the Integrated Design Process (IDP) to demonstrate to builders the potential for achieving higher levels of energy and environmental performance through the application of alternative design approaches. Support this demonstration/ awareness with performance incentives that encourage builders to build new homes that are 25% better than existing building Ontario Building Code homes, ultimately leading to the adoption of higher energy efficiency levels in the OBC.

Target Customer: Builders and designers of new, Part 9 residential low-rise houses (towns, semis and detached homes) in the Enbridge franchise territory. The intent is to engage builders who construct multiple homes in any given year. The ultimate target market is purchasers of new homes, residential (Rate 1) customers.

Description: The Savings by Design Residential offering has been developed to address lost opportunities in the Residential new construction sector. The aim is to address market barriers by engaging building industry stakeholders and leveraging industry capabilities to encourage informed decisions and realize potential energy savings. The premise is that in influencing builders on how to build more energy efficiently – "design it right", will help facilitate a second step – "build it right".

SBD includes a variety of incentives and support activities for builders of new homes, including support for Integrated Design Process activities. The IDP involves participating design teams and other stakeholders as they consider alternative approaches to energy and environmental performance as part of the design activity.

The intent is to achieve higher energy performance through improved design to optimize features including – passive solar, day lighting, and natural ventilation; high-efficiency lighting and HVAC systems; the integration of lighting and HVAC controls to respond directly to occupant loads; reducing and/or optimizing internal loads; and improving the thermal characteristics of the building envelope.

Enbridge support is in part directed towards encouraging new design paradigms that can offer significant energy efficiency gains versus more conventional approaches. EGD expects that Residential SBD will help builders see the value of the IDP approach, encouraging adoption on an ongoing basis.

Having participated in the IDP process, the builder is required to construct at least one home to design specifications within three years of enrollment to access financial incentives. Once the home construction is complete, the builder receives incentives based on the number of homes that pass a performance audit.

Metrics: There were two metrics for SBD Residential in 2013. In addition to the metric previously in place for 2012 which scores the number of “top 80” previously non-participating builders that enroll and take part in the IDP, an additional metric was introduced in 2013 which counted number of homes built.

Tracking Methodology: This offering requires a commitment to construct within a three-year time frame following the completion of the IDP. In order to follow up on the builder commitment, the Channel Consultants maintain regular contact with builders to ensure proper submission procedures are followed for the builders to receive incentives, and to ensure builders follow through with their commitment of at least one home constructed to SBD standards within three years from the date of enrollment.

EnerQuality has been engaged to provide testing and verification services to ensure that buildings are constructed with 25% greater energy efficiency than required under the current OBC.

Highlights:

- 2013 has seen continued success in exposing new builders to the IDP initiative while also working with previous attendees to assist them in meeting established targets for building homes to the improved standards set out in the offering.

- In addition to the ongoing evolution of IDP activities, marketing efforts over the year included the construction of a website to engage participants, explain the offering, showcase participants and support sales efforts. Other efforts included the development of supporting marketing collateral and some sponsorship of key industry events to promote awareness.

- SBD Residential is a relationship-based effort. Success with the offering is dependent on the influence of EGD Channel Consultants to recruit senior management and key decision makers of building companies to reassess their energy efficiency considerations – in particular in their approach to building design, as a way of preventing lost opportunities and realizing deep energy savings.

- Enbridge ensured that participants were made aware of other energy efficiency programs available including the Ontario Power Authority (OPA) funded saveONenergy Residential New Construction program aimed at electricity focused energy efficiency in an effort to ensure the builder could take advantage of other potential energy savings.

Results: As illustrated in Table 32, in its second year of delivery, Residential SBD was successful in enrolling 18 new builders who completed the IDP process in 2013. The results are in line with the upper target for this metric.

In addition, there were 967 new homes built in relation to the completed units metric. In other words, for builders who had enrolled and completed the IDP process, there were 967 homes constructed through the initiative such that these homes had features consistent with the builder's IDP, and were thereby 25% more energy efficient than a new home built to the OBC. This result exceeded the middle target for completed units in 2013.

Table 32. Residential Savings by Design Scorecard

Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	2013 Actual Result
Residential Savings by Design	*Completed Units*	***40%***	675	900	1,125	**967**
	Top 80 Builders Enrolled *	***60%***	11	14	18	**18**

* Top 80 Previously Non-Participating builders enrolled

<u>Year-over-Year Performance</u>: Based on the assessment of the number of "top 80" builders enrolled in SBD Residential, performance increased 100% over 2012. The "number of units completed" scorecard metric was not in place in 2012, but was introduced in 2013.

Table 33. SBD Residential 2013 vs. 2012 Results

Component	Metric	2013 Actual Result	2012 Actual Result *	% Increase/ Decrease
Residential Savings by Design	*Completed Units*	**967**	**N/A**	**N/A**
	Top 80 Builders Enrolled	**18**	**12**	**50%**

* 2012 result includes both Top 80 and Top 20 builders

__Comments and Lessons Learned__:

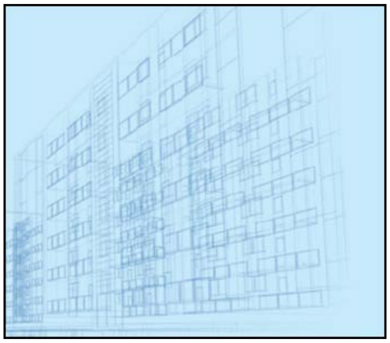
- SBD Residential has evolved into a successful model for getting builders to construct to a new standard of energy efficiency, and has provided a forum for enhanced relationship development between Enbridge, builders, municipalities and other industry stakeholders.

- The builders that have participated to-date in an IDP have realized the potential of alternative planning and design approaches as a means to achieving improved energy and environmental performance in their projects.

- Based on participation feedback, builders have found the IDP valuable and have indicated they would benefit in having an opportunity to go through the design process for subsequent projects given that each development is unique in terms of housing and environmental impacts. Enbridge is exploring the concept of multiple charrettes. Deepening awareness and education to optimize energy efficiency construction design in a strategic and sustainable way over the longer term may be more impactful through a repeated process.

- Enthusiasm among builders who have already taken part in the offering has been encouraging. To supplement current marketing efforts, additional focus will be put on developing point-of-sale materials that address how SBD can benefit the end homebuyer. These materials will support the builders in leveraging their participation in SBD as a “value-add” selling feature to potential buyers.

- The current DSM framework and planning process, including the budget timeframe is structured to address programs in one-year “windows”. The SBD Residential offering currently provides builders a three-year horizon in which to complete the homes that are eligible to be incented through the offering. Enbridge has identified some concerns from a forecasting perspective such that managing commitments made to participants over a multi-year period is proving challenging with annual (one-year) budgets. Enbridge intends to propose the use of a deferral account to address this challenge.



Commercial Savings by Design (SBD)

Objectives: The goal of the Commercial Savings By Design offer is to use the Integrated Design Process to demonstrate to builders the potential for achieving higher levels of energy and environmental performance through the application of alternative design approaches. The offering is intended to support this demonstration/ awareness with incentives that encourage builders to use the knowledge gained in the IDP to design and build buildings that are more energy efficient, ultimately leading to the adoption of higher energy efficiency levels in the OBC.

Target Customer: Builders and designers of new, Part 3 commercial buildings in the Enbridge franchise territory - Rate 6 customers. Enbridge targets its promotional activity to owners, builders and developers, design teams including architects, design engineers and energy modelers.

Description: The Commercial Savings by Design offering was designed and developed to encourage developers to build / construct Part 3 buildings to 25% above 2012 OBC. The Commercial initiative incorporates many of the same elements as Residential SBD.

Metrics: Builders and developers enroll in the program offering and complete the IDP process. Metrics are based on the number of projects to which a developer commits, i.e., the same developer with different clients or different kinds of projects may be counted multiple times. A minimum 100,000 square feet requirement applies to each project. A project is defined as either a single building or multiples of the same building by the same company that adds up to 100,000 square feet.[11]

---

11 EB-2012-0394, Exhibit B, Tab 2, Schedule 9, page 26 of 28.

Tracking Methodology: Enrollment is defined as a signed memorandum of understanding with a builder or developer containing a commitment to participate in the Commercial Savings by Design offering and participate in the IDP process.

The builder must commit to constructing building(s) to the IDP standard within five years in order to receive performance incentives. EGD Channel Consultants maintain regular contact with builders to track project status to project completion. Charrette reports for each IDP are maintained to provide a record of information on preliminary estimated savings for each project.

Highlights:

- As with the Residential offering, SBD Commercial has received an excellent response from builders looking to participate, and positive reviews from those taking part in the process.
- Following success in 2012 in engaging builders to participate in the design charrettes, 2013 saw increased enrollments.

Results: Enbridge was successful in enrolling 16 new developments in 2013 that met with eligibility requirements and completed the IDP process. This result surpassed the upper scorecard target of 15 new developments.

Table 34. Commercial Savings by Design Scorecard

Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	2013 Actual Result
Commercial Savings by Design	*New Developments Enrolled*	***100%***	6	8	15	**16**

Year-over-Year Performance: In terms of the number of new developments enrolled in SBD Commercial, performance increased 78% over the 2012 result.

Table 35. SBD Commercial 2013 vs. 2012 Results

Component	Metric	2013 Actual Result	2012 Actual Result	% Increase/ Decrease
Commercial Savings by Design	*New Developments Enrolled*	16	9	78%

***Comments and Lessons Learned*:**

- Despite changes that were made to the 2013 and 2014 offerings during the consultation process to update the 2012-2014 multi-year plan that allowed builders to participate, if a builder can show aggregate potential for construction of multiple, similar buildings to meet the square footage threshold, there continues to be lost opportunities resulting from projects that are disallowed to participate because they do not meet the minimum square footage requirement. Enbridge would like to expand the eligibility criteria in the future to capture these opportunities.

- Some participants continue to grapple with the perception that building green is an expense rather than an investment. The commercial builder is price sensitive and the additional cost for energy efficiency considerations is not always viewed as providing enough of a positive differentiator to offset a price increase to the end customer. Enbridge is considering how to include a cost estimation element to the IDP process to provide additional value in a cost/benefit analysis.

- Given the strength of the condo development market in Toronto in recent years, it is not surprising that many of the projects partaking in the process are condo projects. It is expected that the new condo construction market will slow in the next number of years, a consideration for future forecasting.

6.3.2 Existing Residential

Home Labelling (Rating)

Objectives: The primary objective of the Home Labelling offering is to achieve widespread adoption of a voluntary home labelling system in the residential home resale marketplace. This initiative is aimed at educating the Residential market (realtors and homeowners) to better understand the concept of home energy rating and the value it brings in the resale market.

The Home Labelling offering aims to raise awareness and understanding amongst Residential (Rate 1) realtors and their clients, while at the same time promoting the idea that the adoption and use of a recognized label (rating) will help customers make wiser energy choices when purchasing or renovating a home.

Ultimately the goal is to transform the re-sale market so that a home's energy performance rating becomes a standard condition of sale similar to home inspections. In other jurisdictions, for example, in the European Union, as a result of the government supported *Energy Performance of Buildings Directive*, many countries, for instance the UK, now have mandatory requirements for homes to obtain and disclose energy efficiency ratings before a house can be sold or leased.

Target Customer: The immediate target market to support the deployment of a home rating system is realtors and their various real estate brokerages. To achieve this, the offering is marketed to collaborate with brokerages willing to commit to promoting Home Labelling and educating real estate agents about the system, benefits and Enbridge's associated incentives. The ultimate market is residential (Rate 1) customers and real estate agents / brokerages who are listing homes for sale.

Description: The Home Labelling offering was developed in consultation with intervenors during the discussions undertaken in completing the current multi-year plan. This initiative was designed to influence the re-sale marketplace in understanding what a home rating represents and the value it can provide, and motivate realtors to include energy ratings in marketing material (e.g., Multiple Listing Service (MLS)).

Metrics: In addition to obtaining new commitments from realtors collectively responsible for more than 5,000 (middle target) or 10,000 (upper target) home listings per year, the 2013 scorecard introduced the second metric, which counts the number of ratings performed by buyers and/or sellers. The rating must be either included in a listing - or related marketing materials by the seller; or made a condition of sale by the buyer.

Tracking Methodology: Track Commitment letters from new realtors not counted towards a previous year's metric and home ratings included in Multiple Listing Service (MLS) listings or related marketing materials.

Highlights:

- In the first year, a key initiative of the offer in 2012 was to partner with an industry consultant to deliver an education package for real estate agents to provide continuing education credit. Enbridge learned that brokerages often prefer to choose their own education provider and/or course offering. Consequently, in 2013, efforts continued to focus on engaging individual brokerages through customized incentive support to better address the varied brokerage/realtor relationships and partnership models and to maximize the value derived from participation.

- Marketing support in 2013 included incentives for continuing education, e.g., National Association Of Green Agents and Brokers (NAGAB), intended to assist in understanding the value and benefits of energy ratings for agents and other continuing education credits related to Home Energy Ratings;

incentives such as home renovation retailer gift cards and energy savings kits were provided to participants who listed a home rating or label.

Results: In 2013, a substantial new commitment was secured from a large brokerage (with collective responsibility for 78,000 homes listed per year), and as a result NAGAB certification was offered to 150 agents. The number of home ratings marketed in 2013 did not reach the lower target, with only 138 ratings completed.

Table 36. Home Labelling Scorecard

Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	2013 Actual Result
Home Labelling	Number of Committed Realtors *	***70%***	N/A	5,000 **	10,000**	**78,000**
	Ratings performed	***30%***	250	500	750	**138**

* Commitments to make provision for data field to show home's energy rating for all homes listed by participating realtors (industry-wide commitment to include such a field on MLS or similar listing service and/or realtors' commitment to do so with all the homes they list on their own websites, handouts, and other consumer material).
** Commitment from realtors collectively responsible for more than 5,000 (middle target) and 10,000 (upper target) listings/year

Year-over-Year Performance:

Table 37. Home Labelling 2013 vs. 2012 Results

Component	Metric	2013 Actual Result	2012 Actual Result	% Increase/ Decrease
Home Labelling	Number of Committed Realtors *	**78,000**	**8,600**	**807%**
	Ratings performed	**138**	**N/A**	**N/A**

* Commitment to make provision for data field to show home's energy rating for all homes listed by participating realtor on MLS or similar listing service.

2012 was the first year that Home Labelling was marketed. The focus was on introducing the concept as well as securing commitments from brokerages. The scorecard had a single metric. The result for the commitment from realtors metric in year one was 8,600 compared with 78,000 in 2013, the second year of the initiative.

Comments and Lessons Learned:

- The introduction of a mandatory home rating system for all re-sale homes was outlined in a provision of the Green Energy Act but was subsequently removed after opposition from the real estate industry argued that mandated application for an energy rating would delay the change of ownership transaction. With continued anticipated opposition to a government enforced program from realtors, a voluntary system designed to gain acceptance in the marketplace by leveraging the existing infrastructure is the most appropriate approach. The aim is to achieve voluntary adoption of Home Labelling as standard practice in the resale home market – much the same way as offers to purchase are routinely made subject to a home inspection.

- Real estate agents do not appear interested in asking clients if they have an energy label or are interested in obtaining one. At this stage, identified challenges with the acceptance of the concept include:

  - an overall lack of knowledge and understanding from realtors;
  - a perception that energy labels are confusing and don't depict true operating costs;
  - cost implications for energy audits and upgrades;
  - real estate agents' focus on closing the sale of a home with minimal delays or barriers; and,
  - a belief that an energy rating will weaken the re-sale value and therefore, there is no benefit for agents to promote.

- In 2014, Enbridge plans to increase awareness and education efforts with a focus on the end customer – the home seller or buyer and in turn influence realtors.

- Broadened marketing initiatives are being explored to include energy auditors, financing institutions and mortgage brokers to promote the concept to customers on the purchasing-side by providing free energy auditors where offers of purchase include a request for an energy audit.

- EGD is developing onboarding for its internal sales team with the aim of promoting collaboration with brokerages in order to build awareness amongst their realtors about the incentives available and education incentives available for committed brokerages.

7. DSM Incentive Deferral Account (DSMIDA)

The DSMI provides an incentive to the Company for DSM activities. The DSM Guidelines explain that "the purpose of the DSMIDA is to record the shareholder incentive amount earned by a natural gas utility as a result of its DSM Programs."

It further stipulates that "the natural gas utilities should apply annually for disposition of the balance in their DSMIDA, together with carrying charges, after the completion of the annual third party audit," and that "incentive amounts paid to the natural gas utilities should be allocated to rate classes in proportion to the amount actually spent on DSM activities on each rate class."[12]

7.1 Scorecard Target and DSMI calculation

As stated in EB-2008-0346, the Guidelines call for targets for each of the three programs: Resource Acquisition, Low Income, and Market Transformation – to be included on their respective balanced scorecards. The Guidelines indicate that there should be three levels of achievement.[13]

Further the Guidelines state that "an incentive payment should be available to the natural gas utilities to encourage them to aggressively pursue DSM savings and recognize exemplary performance."[14]

The scorecards for each program offered in 2013 were developed in consultation with the intervenors and approved by the Board in the Update to the 2012 to 2014 Demand Side Management Plan (EB-2012-0394).

Table 38 illustrates how the maximum incentive available in 2013 is to be allocated across each program, further to approved values in the Update to the 2012 to 2014 Demand Side Management Plan (EB-2012-0394).

12 *"Demand Side Management Guidelines for Natural Gas Utilities"* (EB-2008-0346), OEB, June 30, 2011, page 35.
13 ibid, page 32.
14 Ibid, page 31.

Table 38. 2013 DSM Maximum Incentive Allocation

Program	Program Budget	Overheads	Total Budget	% of Total	Maximum Incentive Available
Resource Acquisition	$13,882,920	$4,528,033	$18,410,953	58%	$6,212,521
Low Income	$6,638,325	$522,050	$7,160,375	23%	$2,416,169
Market Transformation	$5,085,000	$931,872	$6,016,872	19%	$2,030,310
Total	**$25,606,245**	**$5,981,955**	**$31,588,200**	**100%**	**$10,659,000**

Scorecard results and the corresponding DSMI earned for the programs are detailed in the following tables:

Table 39. Resource Acquisition Scorecard & DSMI

Resource Acquisition						
Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	Actual Result
Volumes	*Cumulative Savings (million m^3)*	**92%**	729.46	972.61	1,215.76	**766.69**
Residential Deep Savings	*Number of Houses*	**8%**	549	732	915	**1,649**
					Max. DSMIDA	$6,212,521
					DSMIDA Achieved	**$1,545,045**

Table 40. Low Income Scorecard & DSMI

Low Income						
Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	Actual Result
Single Family (Part 9)	*Cumulative Savings (million m^3)*	**50%**	17.3	23.1	28.8	**32.90**
Multi-residential (Part 3)	*Cumulative Savings (million m^3)*	**45%**	45	60	75	**27.31**
Multi-residential (Part 3) LIBPM	*Percent of Part 3 Participants Enrolled*	**5%**	30%	40%	50%	**85%**
					Max. DSMIDA	$2,416,169
					DSMIDA Achieved	**$1,117,939**

Table 41. Market Transformation – DWHR Scorecard & DSMI

Market Transformation						
Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	Actual Result
Drain Water Heat Recovery	*# of Units Installed*	**100%**	2,813	3,750	4,688	**6,465**
					Max. DSMIDA	$564,973
					DSMIDA Achieved	**$564,973**

Table 42. Market Transformation – Residential SBD Scorecard & DSMI

Market Transformation						
Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	Actual Result
Residential Savings by Design	*Top 80 Builders Enrolled*	**60%**	11	14	18	**18**
	Completed Units	**40%**	675	900	1,125	**967**
					Max. DSMIDA	$920,327
					DSMIDA Achieved	**$765,221**

Table 43. Market Transformation – Commercial SBD Scorecard & DSMI

Market Transformation						
Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	Actual Result
Commercial Savings by Design	*New Developments Enrolled*	**100%**	6	8	15	**16**
					Max. DSMIDA	$235,572
					DSMIDA Achieved	**$235,572**

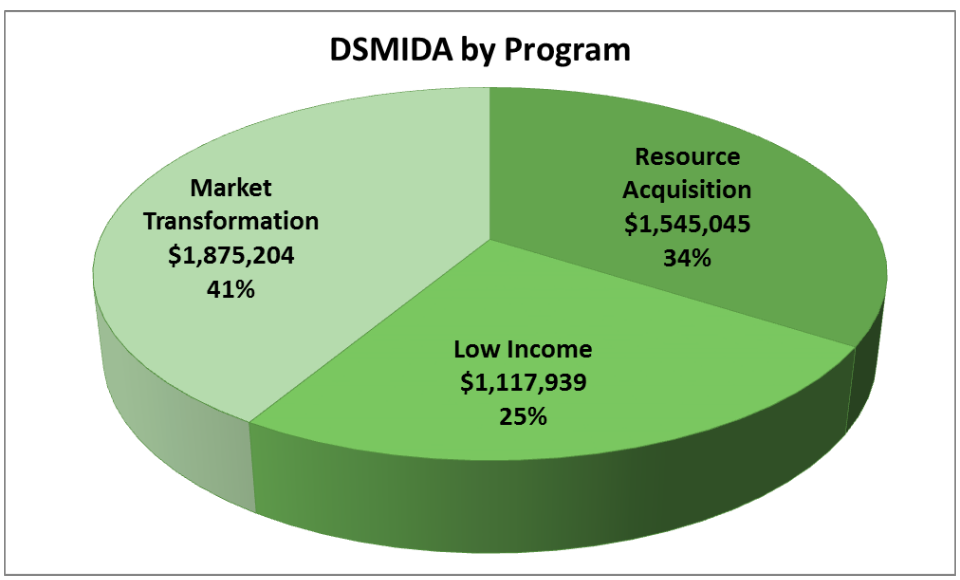
Table 44. Market Transformation – Home Labelling Scorecard & DSMI

Market Transformation						
Component	Metric	Weight	Targets Lower	Targets Middle	Targets Upper	Actual Result
Home Labelling	*Number of Committed Realtors*	**70%**	N/A	5,000	10,000	**78,000**
	Ratings performed	**30%**	250	500	750	**138**
				Max. DSMIDA		$309,438
				DSMIDA Achieved		**$309,438**

Table 45. 2013 DSMIDA Summary Statement

Program	DSMIDA $	DSMIDA %
Resource Acquisition	$1,545,045	34%
Low Income	$1,117,939	25%
Market Transformation	$1,875,204	41%
TOTAL	**$4,538,188**	**100%**

Table 46. 2013 Program Contribution to DSMIDA



8. 2013 Budget and Demand Side Management Variance Account (DSMVA)

8.1 Budget

"In 2012, following consultation with stakeholders, the Base Budget of $28.1 million was increased by 10% or $2.81 million (which was the allowable increase as indicated in the DSM Guidelines, Section 8.3, page 26), resulting in a total budget of $30.91 million and including a total Low Income budget of $7.025 million. Following consultation with stakeholders regarding the budget for 2013 and 2014, it was agreed that the 2013-2014 Update would propose to continue with the allowable increase to the Low Income Budget for 2013 and 2014 and a 2% annual increase based on the 2011 GDP-IPI."[15]

Based on the aggregate budget for 2012 of $30.91 million, for 2013, this base budget was escalated by the 2% GDP-IPI for 2011. The resulting budget for 2013 is $31.588 million.

Table 47 provides the 2013 budget proposed for the Resource Acquisition, Low Income, and Market Transformation program as approved in the Update to the 2012 to 2014 DSM Plan (EB-2012-0394).

Table 47. 2013 DSM Plan Budget

Program	Program Budget	Overheads	Total Budget	% of Total
Resources Acquisition	$13,882,920	$4,528,033	$18,410,953	58%
Low Income	$5,085,000	$931,872	$6,016,872	19%
Market Transformation	$6,638,325	$522,050	$7,160,375	23%
Total	**$25,606,245**	**$5,981,955**	**$31,588,200**	**100%**

Table 48 provides an overview of actual spending vs. budget for each program.

15 Update to the 2012 to 2014 Demand Side Management ("DSM") Plan EB-2012-0394, Exhibit B, Tab 1, Schedule 2, Page 1 of 13.

Table 48. 2013 OEB Approved Budget vs. Actual 2013 Spending

Program	OEB Approved Budget	Actual	Variance	%
Resource Acquisition	**$18,410,953**	**$16,529,266**	**-$1,881,687**	**-10%**
Residential	*$1,800,000*	*$2,376,897*	*$576,897*	
Commercial	*$7,931,920*	*$6,453,504*	*-$1,478,416*	
Industrial	*$4,151,000*	*$2,607,644*	*-$1,543,356*	
Overheads	*$4,528,033*	*$5,091,220*	*$563,187*	
Low Income	**$7,160,375**	**$5,949,747**	**-$1,210,628**	**-17%**
Part 9 Residential	*$4,363,950*	*$4,639,037*	*$275,087*	
Part 3 Multi residential	*$2,274,375*	*$723,728*	*-$1,550,647*	
Overheads	*$522,050*	*$586,981*	*$64,931*	
Market Transformation	**$6,016,872**	**$5,360,834**	**-$656,038**	**-11%**
DWHR	*$1,415,000*	*$1,937,030*	*$522,030*	
Residential SBD	*$2,305,000*	*$1,029,535*	*-$1,275,465*	
Commercial SBD	*$590,000*	*$590,592*	*$592*	
Home Labeling	*$775,000*	*$755,900*	*-$19,100*	
Overheads	*$931,872*	*$1,047,776*	*$115,904*	
Program Cost Sub Total	**$25,606,245**	**$21,113,868**	**-$4,492,377**	
Overhead Sub Total	**$5,981,955**	**$6,725,978**	**$744,023**	
Total (OEB Budget)	**$31,588,200**	**$27,839,846**	**-$3,748,354**	**-12%**
Total (Built into Rates)	**$31,441,652**	**$27,839,846**	**-$3,601,806**	**= 2013 DSMVA**

Total spending for EGD DSM activities in 2013 was $27.84 million, resulting in a variance (underspend) of $3.75 million or 12% under the OEB approved DSM budget for the year.

Of note, actual spending in the Resource Acquisition Commercial and Industrial sectors was lower than budget forecast, reflecting the below target performance in both these sectors. As noted, program dollars were re-allocated within the RA program towards the Residential CER offering to support energy savings opportunities that contributed to performance above targets in delivering this offering.

In the Low Income program, given the challenges in achieving targets in the Multi-Residential (Part 3) offering, actual spending for this segment was well below budget levels, with total spending at 17% below the original budget.

- Finally, the Market Transformation program ended the year with actual spending 11% lower overall than budget. This underspend was primarily due to the Residential SBD offer. With the offering providing a three-year time horizon to complete homes for eligible incentives, associated forecast incentives were not realized in the 2013 program year despite the outstanding commitment made to participants over the multi-year provision of the offering. As stated earlier, Enbridge intends to propose the use of a deferral account to address this challenge.

8.2 Demand Side Management Variance Account (DSMVA)

As stated in the Guidelines, the Demand Side Management Variance Account "should be used to track the variance between actual DSM spending by rate class versus the budgeted amount included in rates by rate class. A natural gas utility may record in the DSMVA in any one year, a variance amount of no more than 15% above its DSM budget for that year."[16]

The Guidelines further outline, "if spending is less than what was built into rates, ratepayers shall be reimbursed for the full amount. If more is spent than was built into rates, the natural gas utility may be reimbursed up to a maximum of 15% of its DSM budget for the year." [17]

Of the 2013 OEB approved budget of $31,588,200, an amount of $31,441,652 was built into rates. Total spending was $27,839,846 resulting in a variance of $3,601,806. This amount will be reimbursed to ratepayers. The 2013 DSMVA of $3,601,806 as aforementioned is shown in Table 48 above.

16 *"Demand Side Management Guidelines for Natural Gas Utilities"* (EB-2008-0346), OEB, June 30, 2011, page 34.

17 Ibid, page 34.

9. Lost Revenue Adjustment Mechanism Statement (LRAM)

The LRAM is a mechanism to adjust for margins the utility loses (gains) if its DSM program is more (less) successful in the period after rates are set than was planned in setting the rates. As outlined in the Guidelines, "the LRAM amount is a retrospective adjustment and may be an amount refundable to or receivable from the utility's customers, depending respectively on whether the actual natural gas savings resulting from the natural gas utility's DSM activities are less than or greater than what was included in the forecast for rate-setting purposes."[18]

Table 49. LRAM Statement

2013 Annual Report LRAM Calculation

Rate Class	Budget Net Partially Effective	Actual Net Partially Effective	Volume Variance	Distribution Margin	LRAM Allocation $	LRAM Allocation %
Rate 110	1,656,894	649,138	(1,007,756)	1.5147	($15,264)	20%
Rate 115	1,054,387	1,874,515	820,128	0.8590	$7,045	-16%
Rate 135	0	144,990	144,990	1.3326	$1,932	-3%
Rate 145	1,868,324	482,799	(1,385,525)	1.7744	($24,585)	27%
Rate 170	3,898,784	199,539	(3,699,245)	0.5256	($19,444)	72%
Totals	8,478,388	3,350,981	-5,127,408		$ (50,317)	100%
			Amount to be paid back to Ratepayers		$ (50,317)	

** Rate 1 and Rate 6 are not included in the LRAM amount for clearance above as these rate classes are covered under the Average Use True-Up Variance Account (AUTUVA)*

Note: Numbers may not add up due to rounding

18 *"Demand Side Management Guidelines for Natural Gas Utilities"* (EB-2008-0346), OEB, June 30, 2011, page 33.

10. DSM Rate Allocation and Impact

Table 50 illustrates the allocation to rate classes of the DSM Variance Accounts as prescribed in the Guidelines.[19]

Table 50. Rate Allocation

2013 Rate Allocation				
Rate Class	DSMIDA	LRAM	DSMVA	TOTAL
Rate 1	$2,094,687	N/A**	-$702,878	$1,391,809
Rate 6	$2,007,512	N/A**	-$2,373,653	-$366,141
Rate 9	$231	$0*	-$260	-$29
Rate 110	$122,874	-$15,264	-$479,323	-$371,714
Rate 115	$180,342	$7,045	$877,122	$1,064,508
Rate 125	$8,645	$0*	-$9,734	-$1,089
Rate 135	$42,874	$1,932	$175,933	$220,739
Rate 145	$54,402	-$24,585	-$441,826	-$412,010
Rate 170	$23,049	-$19,444	-$643,163	-$639,558
Rate 200	$2,997	$0*	-$3,374	-$377
Rate 300	$576	$0*	-$649	-$73
Total	$4,538,188	-$50,317	-$3,601,806	$886,065

** Rates 9, 125, 200, & 300 do not have any LRAM allocation since customers are not eligible for DSM programs*
*** Rate 1 and Rate 6 are not included in the LRAM amount for clearance above as these rate classes are covered under the Average Use True-Up Variance Account (AUTUVA)*
Note: Numbers may not add up due to rounding

Table 51 provides the estimated impact of the 2013 Clearance of DSM Variance Accounts on a typical customer's bill in each of the rate classes affected.

19 On page 26 of the Guidelines, Section 8.3 Budget for Low Income Programs states that: "The Board is of the view that the low-income DSM budget should be funded from all rate classes, to be consistent with the electricity conservation and demand management framework, as well as the LEAP Emergency Financial Assistance program." Allocation for the LEAP fund was outlined in EB-2008-0150 Report of the Board: Low Income Energy Assistance Program on page 11 Section 5.1.1 Funding LEAP.

Table 51. Estimated Impact of DSM Clearance on a Typical Customer

Rate Class	Annual Volume for Typical Customer (m^3)	Annual Bill for Typical Customer [1] ($)	DSM Amount for Recovery [2] ($)	Estimated % of Annual Bill
Rate 1 - Residential Heating & Water Heating	3,064	$1,050	$1	0.1%
Rate 6 - Commercial, Heating & Other Uses	22,606	$6,628	-$2	0.0%
Rate 9 - Container Service [3 5]			-$29	0.0%
Rate 110 - Industrial, small size, 50% Load Factor	598,568	$137,201	-$426	-0.3%
Rate 110 - Industrial, avg. size, 75% Load Factor	9,976,120	$2,125,526	-$7,100	-0.3%
Rate 115 - Industrial, small size, 80% Load Factor	4,471,609	$941,007	$8,370	0.9%
Rate 125 - Extra Large Firm Distribution [4 5]			-$218	
Rate 135 - Industrial, Seasonal firm	598,567	$121,725	$2,383	1.9%
Rate 145 - Commercial, avg. size	598,568	$131,438	-$1,481	-1.1%
Rate 170 - Industrial, avg. size, 75% Load Factor	9,976,120	$1,912,831	-$12,843	-0.7%
Rate 200 - Wholesale Service [3 5]			-$377	
Rate 300 - Firm or Interruptible Distribution [4 5]			-$36	

1. Annual bills based on October 1, 2014 rates.
2. DSM amounts for Recovery do not include interest amounts that will apply at the time of clearing.
3. Information is for the total amount of DSM recovery.
4. DSM amounts for recovery for Rate 125 and Rate 300 are for average customers in each rate class.
5. Rates 9, 125, 200, & 300 do not have any LRAM allocation since customers are not eligible for DSM programs.

11. Potential Study

In accordance with the DSM Guidelines, "the natural gas utilities should file their latest market potential studies, and any updates thereof, along with their DSM plan."[20]

Enbridge initiated a potential study in the third quarter of 2013, with completion planned for the fourth quarter of 2014. Enbridge has incorporated input on this study from external stakeholders at key milestones.

After a formal bidding process, Navigant Consulting was selected to undertake this study.

This study aligns with the requirements outlined in the Ministry of Energy Directive on March 31, 2014 to the OEB which outlined "that an achievable potential study for natural gas efficiency in Ontario should be conducted every three-years, with the first study completed by June 1, 2016, to inform natural gas efficiency planning and programs…"[21]

20 *"Demand Side Management Guidelines for Natural Gas Utilities"* (EB-2008-0346), OEB, June 30, 2011, page 45.
21 "Minister's Directive to the OEB", Ontario Ministry of Energy (MC-2014-875), March 31, 2014.

ENBRIDGE

12. Other Evaluation Research In Progress

Among a number of objectives outlined in the Joint Terms of Reference for Stakeholder Engagement on DSM Activities[22] is a provision for collaborative involvement between utilities and intervenors in the development and update of input assumptions and in determining evaluation research priorities and individual studies. The responsibility for this mandate rests primarily with the Technical Evaluation Committee (TEC).

In January 2013, the TEC identified the following evaluation priorities: continue evaluation activities identified in 2012; respond to recommendations made by the utilities' respective auditors and initiate two significant evaluation projects – a Custom Net to Gross (Free Ridership and Participant Spillover) Research Study and the establishment of a Technical Reference Manual (TRM).

Technical Reference Manual

In February 2013, the TEC selected ERS Inc. to be contracted by the utilities to develop a TRM that would be common to both Union Gas and Enbridge, documenting the most recent research underpinning efficiency measure savings assumptions (and/or formulae) necessary for cost-effectiveness screening and program metrics. The TRM is intended to provide an online reference for both utilities and the public, providing transparency and clarity regarding measure assumptions.

Net to Gross Study

In March 2013, a TEC-selected consultant provided information and options for determining net to gross values for natural gas DSM programs in Ontario. The resulting report summarized regulatory and methodological approaches applied in other jurisdictions, as well as net to gross values for programs with characteristics similar to Union Gas and Enbridge's custom commercial and industrial offerings. An assessment was provided of the risks associated with inaccurate Net to Gross values, along with an estimated cost to mitigate those risks.

22 *"Joint Terms of Reference on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution and Union Gas Limited"*, November 4, 2011.

Following the results of the Jurisdictional Review, the TEC resolved that a more fulsome study was warranted, based partly on the following observations:

- The magnitude of change in shareholder incentive based on potential changes to net to gross values;
- The benefits of having a higher level of precision for net to gross estimates;
- The likelihood that a study would result in an accurate net to gross estimate; and
- The benefits of employing different methodologies for estimating net to gross values.

In October 2013, the TEC finalized a request for proposal to complete a large-scale study of Free Ridership and Spillover. In February of 2014 DNV GL was selected by consensus by the TEC to develop and implement a survey of a sample group of Enbridge and Union Gas commercial and industrial customers in order to assist the TEC in developing net to gross factors to be applied to each utility's custom commercial and industrial offers.

13. Status Update – 2012 Auditor and Audit Committee Recommendations

The following is an overview of the recommendations made by the auditor in the 2012 DSM Audit as well as responses to each recommendation by Enbridge and the 2012 Audit Committee respectively. In addition, summarized below is the current status pertaining to each recommendation.

Resource Acquisition:

1. Recommendation:
Further refine the custom verification protocols to include more intensive investigation of projects, including post-retrofit equipment performance measurement over time (on-site metering). This year's terms of reference (TOR) for CPSV contractors did include language suggesting additional on-site data collection, but more stringent language and direction on M&V activities within the TOR is needed to further improve the CPSV process.
   a. Disallow Enbridge's E-Tools software as a CPSV tool. Do not permit the CPSV firms to use E-Tools as a primary evaluation method. The issue is not E-Tools itself, but the lack of alternate methodology when revised E-Tools runs are used to verify as-built savings. If a particular project presents a compelling reason for the CPSV firm to use E-Tools in their evaluation, then at a minimum, the results of the E-Tools run should be cross-checked by the CPSV firm with an alternate methodology.
   b. Request that the CPSV firms report their own savings values, even when they closely align with Enbridge's results. Though the impact to savings may be negligible, reporting the evaluator-generated savings figures lends transparency and credibility to the CPSV process.

   Enbridge Response:
   a. The CPSV firms will be instructed to come up with their own independent way of estimating savings. E-Tools should only be used as a last resort and then only if justification is provided and the CPSV firm states that it has assessed the reasonableness of the underlying formulae in E-Tools.
   b. Enbridge will bring forward the recommendation pertaining to the CPSV TOR to the Technical Evaluation Committee (TEC) for review and

discussion. Cost and timing are factors that must be considered in the level of post retrofit M&V required.

AC Response:
The AC endorses this response.

Status Update:
This recommendation was brought forward to the TEC at the November 2013 meeting. Recommended enhancements from the 2012 audit were incorporated into the 2013 CPSV Term of Reference (ToR). The CPSV (ToR) were redrafted with input and consensus from the 2013 Audit Committees representing both utilities in preparation for the 2013 CPSV Request for Proposal process.

2. Recommendation:
Consider a separate evaluation process for large commercial new construction projects. As identified in last years' audit, the commercial new construction project savings are based on energy models generated and reviewed by third parties. This methodology is appropriate for estimating savings during the review process. Historically, the evaluation effort has been limited to a cursory review of model inputs and a site visit to verify that the proposed equipment is installed as per the design. This evaluation methodology lacks rigor as it essentially verifies the model assumptions, but does not refine the analysis and savings to take actual performance into account. Alternate methodologies such as in-situ metering or post-install modeling reconciled to utility consumption data will provide more confidence in the evaluated and audited savings for this sector. An extended evaluation and audit cycle for these projects will need to be considered if these alternate methods are adopted, as they require the building be occupied for some period (a minimum of 6 months; ideally 18 months) so reasonable, accurate data can be collected. This may take the form of a verification independent of the normal cycle, with a one-year lag. The more intensive verification would increase the CPSV cost but should be considered in future program framework.

Enbridge Response:
With the exception of legacy projects, all 2013 Commercial New Construction projects will be claimed via the Savings By Design Market Transformation program. It is anticipated that 2013 CCM results for legacy projects (Resource Acquisition - RA) will be substantially lower than 2012.

AC Response:
The AC endorses this response.

Status Update:
As per Enbridge's response above, as anticipated, CCM results for legacy New Construction projects were substantially lower in 2013 than 2012.

3. Recommendation:
Consider research on Ontario commercial new construction standard practices for use in baseline energy use estimation**.** Multiple CPSV-verified projects claimed savings reductions in excess of 75% of the baseline with relatively conventional technologies. The CPSV firm verified and the Auditors affirmed that baseline assumptions generally reflected the Ontario Building Code requirements likely in effect at the time of the construction permit application. Even so, in ERS's judgment the standards represent a low standard. Comparing the new construction sample project application baseline EUIs with average existing new building EUI data from 2010 showed less than 15% improvement, reinforcing this perception. While using code as baseline is typical practice in jurisdictions throughout North America, the low code requirements compared to likely standard practice in Ontario suggests that either Enbridge should conduct research to determine if code is a reasonable baseline representing standard practice or the program should use a net-to-gross factor that specifically accounts for the likely high free ridership compared to a code baseline.

Enbridge Response:
See response to #2.

AC Response:
The AC endorses this response.

Status Update:
See status update provided for Recommendation #2.

4. Recommendation:
Establish a policy and analysis procedure for fuel-switching projects to account for the province-level impact on net fuel use and emissions reductions. Starting in 2012, Enbridge's performance metrics are based solely on gas savings. CCM does not inherently account for the electric penalty associated with a fuel switching measure; it just measures the gross measure gas savings.

Enbridge Response:
This Audit Recommendation will be directed to the TEC.

AC Response:
The AC endorses this response.

Status Update:
Following discussion with the TEC at the April 2014 meeting, it was agreed that a policy to address fuel-switching projects and the establishment of an associated analysis protocol should be addressed in the course of the upcoming DSM framework discussions.

5. Recommendation:
Provide additional clarification on the savings target increase mechanism linked to the Run it R*i*ght program as detailed in the Settlement Agreement. The document notes that savings targets will be revised upward if funds are "shifted" from the Run it Right program. There is no formal procedure through which funds are shifted; therefore, it is difficult to identify this trigger when some programs/portfolios are overspent and others are underspent.

Enbridge Response:
The following two requirements are necessary for funds to be considered "shifted" from the RiR budget to the RA budget and the target increase trigger to occur: 1) the RiR budget is underspent; and 2) the RA budget (less the RiR budget) is exceeded.

AC Response:
The AC endorses this response.

Status Update:
In 2013, the RA budget (less the RiR budget) was not exceeded.

6. Recommendation:
Establish a future Run it Right verification process. Once the Run it Right program begins to generate savings, it will need to be evaluated. As the program is based on pre- and post-install utility bill analysis, the typical CPSV process may not be appropriate. The Auditors recommend that the verification include a review of Enbridge's savings methodology and a desk review of a sample of projects to assess compliance with the methodology.

Enbridge Response:
Enbridge will direct the Auditor to conduct a desk review of a random sample of RiR projects to verify the reasonableness of the claimed savings and to ensure a yet to be agreed upon methodology (with the AC) has been followed.

AC Response:
The AC endorses this response.

Status Update:
This recommendation was discussed with the 2013 Audit Committee at a meeting on March 28, 2013. The 2013 AC agreed that Enbridge will propose the appropriate RiR savings calculation methodology and the 2013 Auditor was tasked with assessing the reasonableness of Enbridge's methodology and evaluating the application of the methodology by conducting a desk review of a sample of RiR projects.

7. Recommendation:
Review the administrative process associated with the Community Energy Retrofit program (CER). Enbridge indicated that they do not collect post-retrofit measure level information on the submitted projects, but the 2012 DSM plan states that this data is to be collected on a monthly basis.

Enbridge states that they are working with NRCan to provide the details required to capture individual measure savings post-retrofit.

Enbridge Response:
Enbridge and the AC agree to the following: "Enbridge will continue to work with NRCan and its energy advisors to obtain individual measure savings data post-retrofit solely for the purpose of informing program design for 2015 and beyond (not to affect 2014 results – see Recommendation #8)."

AC Response:
The AC endorses this response.

Status Update:
Enbridge engaged in consultation with NRCan in August 2013 to further investigate what information might be obtained by Enbridge to support program development. NRCan owns the HOT2000 energy modeling software, and the inputs and files supplied by the energy auditors. Though the project files include inputs for each installed/upgraded measure, the energy analysis outputs do not provide gas savings calculations specific to each measure since HOT2000 provides a holistic model of energy savings. Due to the onerous effort required to provide such information, NRCan is not in a position to comply with Enbridge's request.

8. Recommendation:
Review the measure lives associated with the CER program. As discussed in Section 2.2.1, there was some discrepancy in the nature of the program between Enbridge and the Audit Committee. It must be determined if the projects are to be treated holistically with a single blended or aggregated measure life, or if each measure is to be assessed on its own, each with a unique measure life. In either case the measure life or lives should be reviewed and documented within the DSM plan.

Enbridge Response:
The AC accepts that Enbridge will continue to utilize a 20-year holistic-measure life for the CER program in 2013, as it did in 2012. For the purpose of determining whether performance metrics have been achieved in 2014, Enbridge and the AC members agree that Enbridge will use a deemed 15-

year life for all home retrofits that include furnace replacements and a deemed 25-year life for all home retrofits that do not include a furnace replacement.

AC Response:
The AC endorses this response.

Status Update:
The recommendation is being implemented as outlined above for each of 2013 and 2014 respectively.

General:

1. Recommendation:
   Define what project milestone is used to determine a complete project and its completion date. Revise administrative procedures to support this new definition. Specifically, consider commissioning as it relates to project completion.

   Enbridge Response:
   Enbridge will consider a custom retrofit project complete when the equipment is purchased, installed, and turned-on by end-of-year and fully commissioned as intended within the next 60 days. If a project is identified as not fully commissioned during the audit process, the opportunity for resolution will be afforded until the audit is complete. Legacy new construction projects will be considered complete if Enbridge can demonstrate that efficiency measures were installed by the end of the year and the building is occupied and in use by April 30 of the following year. Legacy new construction projects not deemed completed in 2013 can be claimed in 2014 without penalty (provided they meet the definition of completion for that year).

   AC Response:
   The AC endorses this response.

Status Update:
This recommendation has been incorporated into the custom project review process.

2. Recommendation:
   Correct the post-verification weighting procedure to exclude the unverified "very small" stratum from the denominator of the realization rate calculation.

   Enbridge Response:
   Enbridge will use the post-verification weighting procedure excluding the unverified "very small" stratum from the denominator of the realization rate calculation.

   AC Response:
   The AC endorses this response.

   Status Update:
   The third-party consultant contracted to complete the Realization Rate analysis has been tasked to incorporate the recommended procedure into the sampling process.

3. Recommendation:
   Use the sample design contractor's sample- and energy-weighted average realization rate results in the Draft Evaluation Report and related calculations instead of the CPSV reports' energy-weighted average realization rates.

   Enbridge Response:
   Enbridge will use the sample design contractor's sample- and energy-weighted average realization rate results in the Draft Evaluation Report and related calculations instead of the CPSV reports' energy-weighted average realization rates. This may require that additional time be built into the CPSV process to allow for the transfer and recalculation of data.

   AC Response:
   The AC endorses this response.

Status Update:
The third-party consultant contracted to complete the Realization Rate analysis has been tasked to incorporate the recommended procedure into the sampling process.

4. Recommendation:
Require documented pre-approval for all large and/or custom incentives prior to project completion. In the course of reviewing completion dates and related paperwork of custom projects to affirm eligibility for savings, Auditors learned that some custom projects do not receive pre-approval before project completion when ESC's are working closely with established participants. This was found to be the case in one of the sampled custom commercial projects. In our experience such applicants are more likely to be free riders than those that apply for incentives before or at least closer to the time of decision-making. While this particular project may just be a case of lagging paperwork, requiring pre-approval of administrative burden but has proven to be a good mechanism to reduce this type of free ridership.

Enbridge Response:
Enbridge will provide the required documentation to substantiate the Company's involvement for each project prior to project completion.

AC Response:
The AC endorses this response.

Status Update:
This recommendation has been incorporated into the custom project sales tracking process.

5. Recommendation:
As discussed with Enbridge and the Audit Committee, it is ERS's opinion that a TEC subsection is not necessary in the Final Annual Report as the conversations and activities of the TEC will not impact the CCM or financial mechanisms reported on in this Audit Report.

Enbridge Response:
Enbridge will accept ERS's opinion that a TEC subsection is not necessary in the 2012 DSM Annual Report as the conversations and activities of the TEC will not impact the CCM or financial mechanisms reported on in this Audit Report.

AC Response:
The AC endorses this response.

Status Update:
This recommendation has been implemented.

Appendix A. Commercial Custom Project Savings Verification Study (CPSV)

As part of its annual evaluation and DSM audit process, EGD commissions third-party firms to undertake engineering reviews of a random sample of the custom projects in the Commercial and Industrial sectors. Following an RFP process, EGD retained MMM Group Limited (MMM) to conduct the engineering review of the savings for the 2013 Commercial Custom projects – the Commercial Custom Project Savings Verification Study (CPSV).

Purpose of the Study

The purpose of this CPSV evaluation is to provide an objective opinion of the reasonableness of the energy savings claimed by the Commercial sector custom projects in 2013, through a review of a statistically representative sample of the projects.

Methodology

Using a sampling methodology developed for EGD and Union Gas by Navigant Consulting, attached as Appendix I. Ipsos Loyalty was contracted as an additional independent third-party to randomly select a representative sample of Commercial sector com projects claimed in 2013 to be reviewed by MMM. In 2013, there were 641 Commercial Custom projects[23] completed of which 27 in total were selected for the CPSV.

The scope of work outlined for the CPSV study consists of a detailed review of the savings calculations and equipment costs for the project and is outlined to include on-site visits that would involve: an interview with the customer for the purposes of: validating installation of equipment and confirming operating conditions, verification of installations, utility savings results, project start-up and commissioning of measure, cost and purchase timing, any changes in the building that would change the impact of savings, any unforeseen disturbances, any savings measurements

23 The Commercial Custom project list includes Low Income Multi-Residential Custom projects completed in 2013.

undertaken by client, a review of savings calculations and methodology and, where a more appropriate calculation was identified, the results of such a calculation were provided.

Results of the Engineering Review are shown in the next table, with the claimed and revised savings for gas, electricity, and water as recommended by MMM.

2013 Commercial Custom Project Verification Results

2013 Commercial Engineering Review Results	Claimed	Recommended Revisions
Commercial Projects Sampled	27	25
CCM Savings	79,815,505	62,162,269

Appendix B. Commercial Custom Project Realization Rates

Ipsos was retained to select a statistically relevant set of sample projects for the 2013 Custom Project Savings Verification (CPSV), from a list of Enbridge's Commercial custom projects claimed during 2013. In selecting the random sample, Ipsos was required to follow a prescribed methodology, formulated by Navigant Consulting, Inc., the utilities (Enbridge & Union) and the Audit Committees.

For the 2013 Commercial CPSV, 27 projects were selected.

The CCM values recommended by MMM in their Final CPSV Report were reviewed by the auditor through the audit process and final auditor recommended values were then submitted to Ipsos for the purpose of final calculation of the Realization Rate and adjustment factor to be applied to all 2013 Commercial Custom and Low Income Multi-Residential Custom project results.

The final Realization Rate for the Commercial/Low income Multi-Residential Custom projects is 88.4%. Therefore original savings estimates for the total of all Commercial Custom projects and Low Income Multi-Residential Custom projects was reduced by 11.6%.

Appendix C. Industrial Custom Project Savings Verification Study (CPSV)

As part of its annual evaluation and DSM audit process, EGD commissions third-party firms to undertake engineering reviews of a random sample of the custom projects in the Commercial and Industrial sectors. Following an RFP process, EGD retained Genivar Inc.[24] (Genivar) to conduct the engineering review of the savings for the 2013 Industrial Custom projects – the Industrial Custom Project Savings Verification Study (CPSV).

Purpose of the Study

The purpose of this CPSV evaluation is to provide an objective opinion of the reasonableness of the energy savings claimed by the Industrial sector custom projects in 2013, through a review of a statistically representative sample of the projects.

Methodology

Using a sampling methodology developed for EGD and Union Gas by Navigant Consulting, attached as Appendix I. Ipsos Loyalty was contracted as an additional independent third-party to randomly select a representative sample of Industrial sector custom projects claimed in 2013 to be reviewed by Genivar. In 2013, there were 118 Industrial Custom projects[25] completed of which 17 in total were selected for the CPSV.

The scope of work outlined for the CPSV study consists of a detailed review of the savings calculations and equipment costs for the project and is outlined to include on-site visits that would involve: an interview with the customer for the purposes of: validating installation of equipment and confirm operating conditions, verification of installations, utility savings results, project start-up and commissioning of measure, cost and purchase

24 Genivar Inc. changed its name to WSP Canada Inc. effective January 1, 2014.

25 The Industrial Custom project list includes both Industrial and Agricultural Custom projects completed in 2013.

timing, any changes in the building that would change the impact of savings, any unforeseen disturbances, any savings measurements undertaken by client, a review of savings calculations and methodology and, where a more appropriate calculation was identified, the results of such a calculation were provided.

Results of the Engineering Review are shown in the next table, with the claimed and revised savings for gas, electricity, and water as recommended by Genivar.

2013 Industrial Custom Project Verification Results

2013 Industrial Engineering Review Results	Claimed	Recommended Revisions
Industrial Projects Sampled	17	4
CCM Savings	117,892,510	120,256,173

Appendix D. Industrial Custom Project Realization Rates

Ipsos was retained to select a statistically relevant set of sample projects for the 2013 Custom Project Savings Verification (CPSV), from a list of Enbridge's Industrial custom projects claimed during 2013. In selecting the random sample, Ipsos was required to follow a prescribed methodology, formulated by Navigant Consulting, Inc., the utilities (Enbridge & Union) and the Audit Committees.

For the 2013 Industrial CPSV, 17 projects were selected.

The CCM values recommended by Genivar in their Final CPSV Report were reviewed by the auditor through the audit process and final auditor recommended values were then submitted to Ipsos for the purpose of final calculation of the Realization Rate and adjustment factor to be applied to all 2013 Industrial Custom project results.

The final Realization Rate for the Industrial Custom projects is 106.9%. Therefore original savings estimates for the total of all Industrial Custom projects was increased by 6.9%.

Appendix E. TRC Screening Summary

Table 52. TRC Screening Summary

Sector/Program	NPV Total TRC Benefits	Total TRC Costs	TRC Net Benefit	TRC Ratio
Residential				
Community Energy Retrofit	5,760,075	5,360,352	399,722	1.07
All Residential Total	**5,760,075**	**5,360,352**	**399,722**	**1.07**
Commercial				
Commercial Custom	75,418,033	30,724,126	44,693,907	2.45
Commercial Prescriptive	19,716,920	4,469,445	15,247,474	4.41
Run It Right	1,733,797	1,466,887	266,910	1.18
All Commercial	**96,868,750**	**36,660,459**	**60,208,292**	**2.64**
Industrial				
Industrial Custom	31,382,118	8,050,681	23,331,437	3.90
Industrial Prescriptive	113,537	29,631	83,906	3.83
All Industrial	**31,495,655**	**8,080,312**	**23,415,342**	**3.90**
Overheads		5,091,220	-5,091,220	
Overall Resource Acquisition	**134,124,480**	**55,192,344**	**78,932,136**	**2.43**
Low Income				
Single Family (Part 9)	4,460,516	3,996,932	463,584	1.12
Multi-Residential (Part 3)	4,108,057	1,029,300	3,078,757	3.99
Overheads		586,981	-586,981	
Overall Low Income	**8,568,573**	**5,613,214**	**2,955,359**	**1.53**
Combined RA/Low Income *	**142,693,052**	**60,805,557**	**81,887,495**	**2.35**

***This summary does not include TRC calcuations for the Market Transformation Program.**

All values are provided for illustrative purposes only.

Appendix F. Summary Overview of Results

This appendix provides additional detail regarding the 2013 DSM results. Separate tables are presented for prescriptive and custom technologies.

Three tables summarize results as follows:

- by technology for prescriptive offers
- summarized by type of custom project
- custom projects by sub-sector.

These tables are presented for illustrative purposes only.

Table 53. Overview by Prescriptive Technology

Summary Overview by Prescriptive Technology						
	Net Annual Gas Savings (m3)	Cumulative Cubic Metres (CCM)	Total Incentive Amount $	Net Gas Saved per Incentive $ spent (m3)	Total Net Incremental Costs	Net Gas Saved per Incremental $ spent (m3)
Commercial						
Air Curtain	180,695	2,710,421	$22,000	8.21	$219,868	0.82
Boiler - Hydronic Condensing	129,849	3,246,221	$23,600	5.50	$217,711	0.60
Boiler - Hydronic High Efficiency	1,024,896	25,576,386	$127,550	8.04	$568,196	1.80
Commercial Multi-Residential Showerheads	827,890	8,278,902	$167,874	4.93	$177,491	4.66
Condensing Tank Water Heater	16,614	215,977	$7,200	2.31	$39,672	0.42
Demand Control Kitchen Ventilation (DCKV)	562,658	8,439,876	$97,500	5.77	$788,500	0.71
Energy Recovery Ventilators (ERV)	911,649	12,763,079	$113,273	8.05	$990,130	0.92
Energy Star Convection Ovens	1,355	20,328	$200	6.78	$1,400	0.97
Energy Star Dishwasher	194,328	2,994,770	$31,600	6.15	-$37,603	-5.17
Energy Star Fryer	129,094	1,549,123	$14,600	8.84	$122,538	1.05
Energy Star Steam Cooker	2,579	25,792	$100	25.79	$1,600	1.61
Energy Star Under Fired Broilers	2,683	32,198	$200	13.42	$2,032	1.32
Heat Recovery Ventilators (HRV)	71,057	994,800	$11,224	6.33	$136,599	0.52
Infrared Heaters	665,648	13,312,954	$53,700	12.40	$1,253,451	0.53
Ozone Laundry	1,306,903	19,603,549	$274,418	4.76	$544,990	2.40
Commercial Total	**6,027,897**	**99,764,377**	**$945,039**	**6.38**	**$5,026,574**	**1.20**
Industrial						
Infrared Heaters	39,570	791,404	$2,700	14.66	$29,631	1.34
Industrial Total	**39,570**	**791,404**	**$2,700**	**14.66**	**$29,631**	**1.34**
Low Income						
Boiler - Hydronic Condensing	16,396	409,900	$2,400	6.83	$12,749	1.29
Boiler - Hydronic High Efficiency	101,376	2,534,400	$19,800	5.12	$81,600	1.24
Low Income Showerheads	168,999	1,689,992	$0	0.00	$60,165	2.81
Low Income TAPS	4,048	43,504	$0	0.00	$1,643	2.46
Low Income Total	**290,819**	**4,677,796**	**$22,200**	**13.10**	**$156,157**	**1.86**

Table 54. Overview by Custom Technology

Summary Overview by Custom Technology	Net Annual Gas Savings (m3)	Cumulative Cubic Metres (CCM)	Total Incentive Amount $	Net Gas Saved per Incentive $ spent (m3)	Total Net Incremental Costs	Net Gas Saved per Incremental $ spent (m3)
Commercial						
Air Curtain	106,686	1,600,294	$13,714	7.78	$164,002	0.65
Air Handling Unit	5,919	88,778	$3,011	1.97	$20,000	0.30
Boiler - Hydronic Condensing	3,646,100	90,676,746	$849,348	4.29	$3,731,242	0.98
Boiler - Hydronic High Efficiency	5,803,792	144,205,506	$1,024,824	5.66	$8,004,743	0.73
Boiler - Steam	191,452	4,786,308	$25,446	7.52	$123,066	1.56
Building Envelope	519,295	9,301,993	$66,754	7.78	$466,725	1.11
Controls	5,398,515	80,977,723	$764,077	7.07	$10,927,663	0.49
Demand Control Ventilation (DCV)	678,203	10,173,047	$233,047	2.91	$836,724	0.81
Destratification	634,106	9,511,589	$127,135	4.99	$533,652	1.19
Drain Water Heat Recovery	65,763	1,644,076	$8,454	7.78	$66,000	1.00
Energy Recovery Ventilators (ERV)	22,703	317,839	$3,020	7.52	$34,431	0.66
Heat Recovery Ventilators (HRV)	896	12,546	$115	7.79	$2,192	0.41
Heat Recovery/Economizer	194,395	2,915,928	$19,454	9.99	$363,989	0.53
High Extraction Washer	112,693	1,690,402	$28,130	4.01	$51,072	2.21
Insulation/Caulking/Sealing	54,113	811,693	$6,956	7.78	$44,206	1.22
Make Up Air Unit	118,360	1,775,407	$17,369	6.81	$199,882	0.59
Metal Halide	53,855	807,819	$6,923	7.78	$297,876	0.18
Operational Improvements	1,592,427	7,363,817	$173,703	9.17	$839,719	1.90
Pool Heating	43,473	652,088	$5,589	7.78	$55,544	0.78
Reflective Panel	304,566	4,568,494	$52,541	5.80	$352,499	0.86
Steam Boiler Blowdown	89,631	1,344,467	$11,521	7.78	$132,880	0.67
Steam Pipe Insulation	32,299	484,489	$4,152	7.78	$38,434	0.84
Steam Trap	894,636	4,473,180	$72,647	12.31	$143,045	6.25
Tank Less/Instantaneous	9,876	177,762	$1,269	7.78	$74,800	0.13
Variable Frequency Drive (VFD)	912,820	13,692,296	$103,110	8.85	$2,213,729	0.41
Ventilation	12,155	182,325	$3,125	3.89	$12,320	0.99
Commercial Total	**21,498,730**	**394,236,615**	**$3,625,433**	**5.93**	**$29,730,435**	**0.72**
Industrial						
Air Cleaning/Filtration	13,396	200,943	$3,759	3.56	$7,860	1.70
Air Handling Unit	111,950	1,679,257	$31,417	3.56	$63,500	1.76
Boiler - Hydronic Condensing - Replacement	134,064	3,351,604	$28,588	4.69	$471,188	0.28
Boiler - Steam - Replacement	32,590	814,738	$9,146	3.56	$46,837	0.70
Building Envelope	161,650	4,041,248	$35,042	4.61	$132,286	1.22
Combustion Control	133,070	1,996,053	$10,724	12.41	$22,655	5.87
Condensing Economizer	13,167	197,511	$3,695	3.56	$17,726	0.74
Controls	1,725,521	25,882,815	$272,502	6.33	$804,950	2.14
Destratification	157,162	2,357,426	$45,109	3.48	$179,757	0.87
Direct Contact Water Heater	44,246	1,106,148	$5,795	7.64	$136,543	0.32
Dryer	284,147	4,262,207	$78,994	3.60	$83,197	3.42
Furnace	1,695,469	30,518,437	$316,240	5.36	$1,878,637	0.90
Greenhouse Curtains	43,842	438,416	$6,249	7.02	$17,119	2.56
Heat Recovery	148,528	2,227,927	$47,571	3.12	$57,185	2.60
Heat Recovery/Economizer	25,861	387,919	$3,387	7.64	$17,573	1.47
Industrial Equipment	5,928,718	118,574,357	$604,588	9.81	$2,882,794	2.06
Insulation	503,385	7,550,780	$139,908	3.60	$319,788	1.57
Linkageless Control	72,171	1,082,569	$12,429	5.81	$73,856	0.98
Pipe Insulation	164,776	2,471,637	$22,902	7.19	$142,533	1.16
Process Heating Improvements	875,845	8,258,733	$125,805	6.96	$81,295	10.77
Steam Trap	764,118	3,820,590	$76,797	9.95	$79,018	9.67
Variable Frequency Drive (VFD)	37,509	562,636	$10,526	3.56	$9,975	3.76
Industrial Total	**13,071,186**	**221,783,951**	**$1,891,172**	**6.91**	**$7,526,269**	**1.74**
Low Income						
Boiler - Hydronic Condensing	456,109	11,402,736	$125,142	3.64	$203,259	2.24
Boiler - Hydronic High Efficiency	132,121	3,303,022	$29,892	4.42	$133,480	0.99
Building Automation System (BAS)	33,617	504,251	$7,606	4.42	$16,052	2.09
Building Envelope	1,731	43,272	$0	0.00	$1,800	0.96
Controls	348,289	5,224,332	$91,638	3.80	$472,260	0.74
Make Up Air Unit	6,959	104,383	$1,578	4.41	$4,300	1.62
Reflective Panel	116,143	1,742,152	$112,179	1.04	$48,411	2.40
Low Income Total	**1,094,969**	**22,324,148**	**$368,034**	**2.98**	**$879,562**	**1.24**

Table 55. Custom Project Overview by Sub-Sector

Summary Overview by Sub-Sector for Custom Projects	Net Annual Gas Savings (m3)	Cumulative Cubic Metres (CCM)	Total Incentive Amount $	Net Gas Saved per Incentive $ spent (m3)	Total Net Incremental Costs	Net Gas Saved per Incremental $ spent (m3)
Commercial						
Accommodation	468,809	9,186,029	$146,366	3.20	$645,137	0.73
Food Services	12,155	182,325	$3,125	3.89	$12,320	0.99
Government	3,276,234	51,239,256	$426,297	7.69	$7,892,606	0.42
Health Care	3,583,075	48,993,113	$424,924	8.43	$4,439,097	0.81
Large New Construction	821,058	20,526,461	$121,493	6.76	$3,944,195	0.21
Logistics	935,415	15,803,686	$159,110	5.88	$1,160,768	0.81
Multi - Residential Private	7,437,691	161,746,064	$1,485,304	5.01	$4,027,737	1.85
Other Commercial	325,657	6,745,956	$54,371	5.99	$568,679	0.57
Professional	2,430,405	48,330,742	$437,509	5.56	$3,129,308	0.78
Recreational Non-Government	170,222	3,399,141	$28,851	5.90	$156,352	1.09
Retail	1,110,310	13,397,160	$163,906	6.77	$1,527,571	0.73
Schools	251,330	4,344,158	$37,383	6.72	$495,813	0.51
Universities	676,369	10,342,523	$136,794	4.94	$1,730,853	0.39
Commercial Total	**21,498,730**	**394,236,615**	**$3,625,433**	**5.93**	**$29,730,435**	**0.72**
Industrial						
Agriculture	434,663	7,351,845	$53,414	8.14	$596,186	0.73
Industrial Custom	12,636,523	214,432,105	$1,837,758	6.88	$6,930,083	1.82
Industrial Total	**13,071,186**	**221,783,951**	**$1,891,172**	**6.91**	**$7,526,269**	**1.74**
Low Income						
Multi Residential - Part 3	1,094,969	22,324,148	$368,034	2.98	$879,562	1.24
Low Income Total	**1,094,969**	**22,324,148**	**$368,034**	**2.98**	**$879,562**	**1.24**

Appendix G. Program Assumptions

On April 30, 2014, Enbridge Gas Distribution Inc. and Union Gas Ltd. submitted a joint application which sought approval for new and updated Demand Side Management measures from the Ontario Energy Board. The Board assigned this matter file number EB-2013-0430. On July 3, 2014 EGD and Union Gas were granted approval of their new and updated DSM measures as outlined in EB-2013-0430.

Here is the link to the Board's web page to access the list of assumptions:

http://www.rds.ontarioenergyboard.ca/webdrawer/webdrawer.dll/webdrawer/search/rec&sm_udf10=eb-2013-0430&sortd1=rs_dateregistered&rows=200

Appendix H. Avoided Costs

	2013 Gas Avoided Costs							
	Water Heating		Space Heating		Combined Space & Water Heating		Industrial	
	Baseload ($/m3)		Baseload ($/m3)		Baseload ($/m3)		Baseload ($/m3)	
	Rate	NPV	Rate	NPV	Rate	NPV	Rate	NPV
1	0.16810	$0.17	0.17452	$0.17	0.17391	$0.17	0.16786	$0.17
2	0.14875	$0.31	0.15623	$0.32	0.15507	$0.32	0.14922	$0.31
3	0.16355	$0.45	0.17324	$0.47	0.17166	$0.47	0.16431	$0.45
4	0.17566	$0.59	0.18442	$0.62	0.18281	$0.62	0.17674	$0.60
5	0.19522	$0.74	0.20490	$0.78	0.20311	$0.77	0.19657	$0.75
6	0.21475	$0.90	0.22592	$0.94	0.22374	$0.93	0.21604	$0.90
7	0.24218	$1.06	0.27799	$1.13	0.27307	$1.11	0.24430	$1.06
8	0.24683	$1.21	0.26316	$1.29	0.26030	$1.28	0.24859	$1.22
9	0.25285	$1.36	0.26957	$1.45	0.26664	$1.43	0.25465	$1.36
10	0.25475	$1.50	0.27160	$1.59	0.26865	$1.58	0.25657	$1.50
11	0.25984	$1.63	0.27703	$1.73	0.27402	$1.72	0.26170	$1.64
12	0.26504	$1.75	0.28257	$1.87	0.27950	$1.85	0.26693	$1.76
13	0.27034	$1.87	0.28822	$2.00	0.28509	$1.98	0.27227	$1.89
14	0.27575	$1.99	0.29399	$2.12	0.29079	$2.10	0.27772	$2.00
15	0.28126	$2.10	0.29987	$2.23	0.29661	$2.21	0.28327	$2.11
16	0.28689	$2.20	0.30586	$2.35	0.30254	$2.32	0.28894	$2.22
17	0.29263	$2.30	0.31198	$2.45	0.30859	$2.43	0.29471	$2.31
18	0.29848	$2.40	0.31822	$2.55	0.31476	$2.53	0.30061	$2.41
19	0.30445	$2.49	0.32459	$2.65	0.32106	$2.62	0.30662	$2.50
20	0.31054	$2.57	0.33108	$2.74	0.32748	$2.71	0.31275	$2.59
21	0.31675	$2.65	0.33770	$2.83	0.33403	$2.80	0.31901	$2.67
22	0.32308	$2.73	0.34445	$2.91	0.34071	$2.88	0.32539	$2.75
23	0.32954	$2.81	0.35134	$2.99	0.34752	$2.96	0.33190	$2.82
24	0.33613	$2.88	0.35837	$3.07	0.35447	$3.03	0.33853	$2.89
25	0.34286	$2.94	0.36554	$3.14	0.36156	$3.10	0.34530	$2.96
26	0.34971	$3.01	0.37285	$3.21	0.36879	$3.17	0.35221	$3.03
27	0.35671	$3.07	0.38030	$3.27	0.37617	$3.24	0.35925	$3.09
28	0.36384	$3.13	0.38791	$3.33	0.38369	$3.30	0.36644	$3.15
29	0.37112	$3.18	0.39567	$3.39	0.39137	$3.36	0.37377	$3.20
30	0.37854	$3.24	0.40358	$3.45	0.39919	$3.41	0.38124	$3.26

The Nominal Inflation Rate used in the table is 2.0%
The Discount factor used in the table is 7.0%

	2013 Water and Electricity Avoided Costs															
	Water Heating				Space Heating				Combined Space & Water Heating				Industrial			
	Water ($/m3)		Electricity ($/m3)		Water ($/m3)		Electricity ($/m3)		Water ($/m3)		Electricity ($/m3)		Water ($/m3)		Electricity ($/m3)	
	Rate	NPV	Rate	NPV	Rate	NPV	Rate	NPV	Rate	NPV	Rate	NPV	Rate	NPV	Rate	NPV
1	0.09520	$0.10	2.43080	$2.43	0.09520	$0.10	2.43080	$2.43	0.09520	$0.10	2.43080	$2.43	0.09520	$0.10	2.43080	$2.43
2	0.09730	$0.19	2.48438	$4.75	0.09730	$0.19	2.48438	$4.75	0.09730	$0.19	2.48438	$4.75	0.09730	$0.19	2.48438	$4.75
3	0.09936	$0.27	2.53713	$6.97	0.09936	$0.27	2.53713	$6.97	0.09936	$0.27	2.53713	$6.97	0.09936	$0.27	2.53713	$6.97
4	0.10136	$0.36	2.58816	$9.08	0.10136	$0.36	2.58816	$9.08	0.10136	$0.36	2.58816	$9.08	0.10136	$0.36	2.58816	$9.08
5	0.10340	$0.43	2.64009	$11.10	0.10340	$0.43	2.64009	$11.10	0.10340	$0.43	2.64009	$11.10	0.10340	$0.43	2.64009	$11.10
6	0.10549	$0.51	2.69348	$13.02	0.10549	$0.51	2.69348	$13.02	0.10549	$0.51	2.69348	$13.02	0.10549	$0.51	2.69348	$13.02
7	0.10765	$0.58	2.74865	$14.85	0.10765	$0.58	2.74865	$14.85	0.10765	$0.58	2.74865	$14.85	0.10765	$0.58	2.74865	$14.85
8	0.10986	$0.65	2.80504	$16.59	0.10986	$0.65	2.80504	$16.59	0.10986	$0.65	2.80504	$16.59	0.10986	$0.65	2.80504	$16.59
9	0.11204	$0.72	2.86086	$18.26	0.11204	$0.72	2.86086	$18.26	0.11204	$0.72	2.86086	$18.26	0.11204	$0.72	2.86086	$18.26
10	0.11422	$0.78	2.91646	$19.85	0.11422	$0.78	2.91646	$19.85	0.11422	$0.78	2.91646	$19.85	0.11422	$0.78	2.91646	$19.85
11	0.11650	$0.84	2.97471	$21.36	0.11650	$0.84	2.97471	$21.36	0.11650	$0.84	2.97471	$21.36	0.11650	$0.84	2.97471	$21.36
12	0.11881	$0.89	3.03374	$22.80	0.11881	$0.89	3.03374	$22.80	0.11881	$0.89	3.03374	$22.80	0.11881	$0.89	3.03374	$22.80
13	0.12118	$0.95	3.09426	$24.17	0.12118	$0.95	3.09426	$24.17	0.12118	$0.95	3.09426	$24.17	0.12118	$0.95	3.09426	$24.17
14	0.12360	$1.00	3.15601	$25.48	0.12360	$1.00	3.15601	$25.48	0.12360	$1.00	3.15601	$25.48	0.12360	$1.00	3.15601	$25.48
15	0.12606	$1.05	3.21868	$26.73	0.12606	$1.05	3.21868	$26.73	0.12606	$1.05	3.21868	$26.73	0.12606	$1.05	3.21868	$26.73
16	0.12857	$1.09	3.28273	$27.92	0.12857	$1.09	3.28273	$27.92	0.12857	$1.09	3.28273	$27.92	0.12857	$1.09	3.28273	$27.92
17	0.13114	$1.14	3.34841	$29.06	0.13114	$1.14	3.34841	$29.06	0.13114	$1.14	3.34841	$29.06	0.13114	$1.14	3.34841	$29.06
18	0.13376	$1.18	3.41528	$30.14	0.13376	$1.18	3.41528	$30.14	0.13376	$1.18	3.41528	$30.14	0.13376	$1.18	3.41528	$30.14
19	0.13643	$1.22	3.48367	$31.17	0.13643	$1.22	3.48367	$31.17	0.13643	$1.22	3.48367	$31.17	0.13643	$1.22	3.48367	$31.17
20	0.13915	$1.26	3.55297	$32.15	0.13915	$1.26	3.55297	$32.15	0.13915	$1.26	3.55297	$32.15	0.13915	$1.26	3.55297	$32.15
21	0.14192	$1.30	3.62364	$33.09	0.14192	$1.30	3.62364	$33.09	0.14192	$1.30	3.62364	$33.09	0.14192	$1.30	3.62364	$33.09
22	0.14474	$1.33	3.69570	$33.98	0.14474	$1.33	3.69570	$33.98	0.14474	$1.33	3.69570	$33.98	0.14474	$1.33	3.69570	$33.98
23	0.14763	$1.36	3.76958	$34.83	0.14763	$1.36	3.76958	$34.83	0.14763	$1.36	3.76958	$34.83	0.14763	$1.36	3.76958	$34.83
24	0.15058	$1.40	3.84497	$35.64	0.15058	$1.40	3.84497	$35.64	0.15058	$1.40	3.84497	$35.64	0.15058	$1.40	3.84497	$35.64
25	0.15360	$1.43	3.92187	$36.41	0.15360	$1.43	3.92187	$36.41	0.15360	$1.43	3.92187	$36.41	0.15360	$1.43	3.92187	$36.41
26	0.15667	$1.45	4.00031	$37.15	0.15667	$1.45	4.00031	$37.15	0.15667	$1.45	4.00031	$37.15	0.15667	$1.45	4.00031	$37.15
27	0.15980	$1.48	4.08031	$37.85	0.15980	$1.48	4.08031	$37.85	0.15980	$1.48	4.08031	$37.85	0.15980	$1.48	4.08031	$37.85
28	0.16300	$1.51	4.16192	$38.52	0.16300	$1.51	4.16192	$38.52	0.16300	$1.51	4.16192	$38.52	0.16300	$1.51	4.16192	$38.52
29	0.16626	$1.53	4.24516	$39.16	0.16626	$1.53	4.24516	$39.16	0.16626	$1.53	4.24516	$39.16	0.16626	$1.53	4.24516	$39.16
30	0.16958	$1.56	4.33006	$39.77	0.16958	$1.56	4.33006	$39.77	0.16958	$1.56	4.33006	$39.77	0.16958	$1.56	4.33006	$39.77

The Nominal Inflation Rate used in the table is 2.0%
The Discount factor used in the table is 7.0%

Appendix I. Sampling Methodology for Custom C&I Programs

NAVIGANT

A Sampling Methodology for Custom C&I Programs

Prepared for:
Sub-Committee of the
Technical Evaluation Committee

uniongas
A Spectra Energy Company

ENBRIDGE

November 12, 2012

Prepared by:
Dan Violette, Ph.D. & Brad Rogers, M.S., MBA

Navigant Consulting, Inc.
1375 Walnut Street, Suite 200
Boulder, CO 80302
303.728.2500
www.navigant.com

NAVIGANT

Acknowledgements

The authors wish to acknowledge Leslie Kulperger and Meredith Lamb of Union Gas Limited and Judith Ramsay and Rod Idenouye of Enbridge Gas Distribution for their guidance, assistance, and support of this work. The authors also wish to acknowledge Chris Neme and Bob Wirtshafter for their thoughtful criticism and direction on earlier drafts of this report. The authors appreciate the opportunity to work with such a knowledgeable and discerning team.

NAVIGANT

Table of Contents

NAVIGANT

1. Introduction

This report presents a sampling methodology intended for use in the evaluation of custom demand side management (DSM) programs delivered in commercial and industrial (C&I) sectors. The report provides a technical explanation of issues that have been raised in the evaluation processes. It also provides justification for the approaches recommended herein.

Past evaluation studies of Union Gas Limited (Union) and Enbridge Gas Distribution (Enbridge) custom programs have undergone third-party audits where the sample design and realization rate calculations are examined. The processes and judgments applied in these evaluation studies are audited to ensure that the analyses are transparent and accurate. The recommendations in this report along with the technical discussions are intended to better frame the issues for the third-party audit reviews and streamline the overall audit process.

The sample design methodology recommendations are presented in Section 5. The realization rate and achieved precision methodology recommendations are presented in Section 6. The report also contains three technical appendices discussing key issues and presenting the calculations required to develop statistical program estimates.

1.1 Background

Union and Enbridge have delivered DSM initiatives since 1997 and 1995, respectively. Union and Enbridge operate DSM programs, including programs that involve custom projects in the industrial, commercial, multi-residential, and new construction sectors. Custom projects cover opportunities where savings are linked to unique building and manufacturing specifications, end uses, and technologies. Each project is assessed individually for participation in the program. The DSM portfolio for both utilities includes several hundred custom projects annually.

Union and Enbridge DSM activities are regulated by the Ontario Energy Board (OEB) and adhere to the requirements as laid out in DSM Guidelines for Natural Gas Utilities.[1] For custom projects, the resource savings are determined through engineering calculations that are determined at the design stage of each project. There is a need to verify the resource savings through a third-party C&I engineering review.

A sampling methodology for custom projects was developed in 2008.[2,3] This methodology was intended to be used to evaluate future custom program impacts while the programs retained

[1] "Demand Side Management Guidelines for Natural Gas Utilities." EB-2008-0346. Ontario Energy Board. June 30, 2011.

[2] "Sampling Methodology for Engineering Review of Custom Projects." Enbridge Gas Distribution Inc. and Union Gas Limited. Prepared by Summit Blue Consulting. April 3, 2008.

roughly the same distribution of projects in terms of size and segment. There have been some changes to the custom programs and Union and Enbridge are now preparing for the engineering review of custom projects for 2012. As a result, there is a need to update the sampling methodology. Both utilities seek a harmonized approach to evaluating custom programs that involves on-site reviews of selected custom projects within a representative sample of the respective utility project populations.

In 2012, both utilities entered into a new regulatory framework in Ontario that established a new intervener process with the creation of a common Technical Evaluation Committee (TEC) for both utilities. The goal of the TEC is to establish DSM technical and evaluation standards for natural gas utilities in Ontario. The TEC will make recommendations to the OEB on annual Technical Reference Manual (TRM) updates, establish evaluation priorities, and reach consensus on the design and implementation of evaluation studies.

1.2 OEB Requirements for Evaluating Custom Projects

The OEB's DSM Guidelines for Natural Gas Utilities draws special attention to custom projects. The Guidelines define custom projects:[4]

> *Custom projects are those projects that involve customized design and engineering, and where a natural gas utility facilitates the implementation of specialized equipment or technology not identified in the Board approved list of input assumptions. Projects that simply include a combination of several measures provided in the list of input assumptions are not considered to be custom projects.* (p.5)

The Guidelines go on to prescribe an evaluation approach for custom projects:

> *For custom resource acquisition projects, which usually involve specialized equipment, savings estimates should be assessed on a case by case basis. It is expected that each custom project will incorporate a professional engineering assessment of the savings. This assessment would serve as the primary documentation for the savings claimed.*
>
> *A special assessment program should be implemented for custom projects. The assessment should be conducted on a random sample consisting of 10% of the large custom projects; and the projects should represent at least 10% of the total volume savings of all custom projects. The minimum number of projects to be assessed should be 5. Where less than 5 custom projects have been undertaken, all projects should be assessed. The assessment should focus on verifying the equipment installation, estimated savings and equipment costs.*

---

[3] "Update Memorandum: Proposed Sampling Method for Custom Projects." Summit Blue Consulting. October 31, 2008.

[4] "Demand Side Management Guidelines for Natural Gas Utilities." EB-2008-0346.Ontario Energy Board. June 30, 2011.

> *All program result evaluations should be conducted by the natural gas utilities' third-party evaluator(s). If possible, the natural gas utilities' third-party evaluator(s) should be selected from the [Ontario Power Authority's] OPA's third-party vendor of record list. The natural gas utilities' third-party evaluators should seek to follow the OPA's evaluation, measurement and verification protocols,[5] where applicable and relevant to the natural gas sector.* (p.39)

The recommended sample methodology contained in Sections 5 and 6 of this report conforms to the Guidelines for custom projects. Appendix B presents the detailed equations necessary to implement the recommended methodology.

1.3 Report Objective

The objective of this report is to develop a methodology for designing a sample and for calculating achieved realization rates and sample confidence and precision using the observed results from the sample. The recommended methodology must meet OEB requirements as well as address the technical and programmatic needs of Union and Enbridge custom programs. The steps taken to achieve this objective include the following:

- Understand the composition of Union and Enbridge custom programs (Sections 2 and 3)
- Review and analyze sample methodologies in selected jurisdictions (Section 4)
- Recommend a methodology for designing and selecting samples (Section 5)
- Recommend a methodology for calculating the achieved program realization rates and sample confidence and precision (Section 6)

The recommended statistical methodology can be described as two-stage stratified ratio estimation. A step-by-step approach to implementing the methodology for sample design is presented in Section 5.4.

The recommended sample methodology is intended to provide sufficient flexibility to allow Union and Enbridge to efficiently meet sample precision needs while the composition, participation, and impacts of their custom programs resemble the current 2011/2012 programs. If the nature of the custom programs changes, adjustments to the recommended methodology may be warranted.

[5] "EM&V Protocols and Requirements: 2011-2014." Ontario Power Authority. March 2011. (see page 129)

NAVIGANT

2. Overview of Union Custom Programs

Union's T1/R100 and commercial/industrial (C/I) custom programs are aligned under one brand platform, the *EnerSmart* program. This ensures a seamless, recognizable brand throughout Union's franchise. The program scorecards are divided based on rate class.[6] The T1/R100 program consists of T1 rate customers in Union's Southern delivery zone whose annual consumption is over 5M m^3 and R100 rate customers in Union's other delivery zones whose annual consumption is over 25.6M m^3. The C/I program consists of Union customers in all other rate classes. The methodology in this report pertains only to the custom measures in these programs. Additionally, Union is adding a new Low Income custom segment for the 2012 program year.[7]

Figure 1 outlines the rate class divisions of Union's custom projects. The number of projects in the C/I program is more than twice the number of the projects in the T1/R100 program but represents less than half of the savings of that program.

Figure 1. Union 2011 Custom Projects Overview

Union Custom Sector	# of Custom Projects	Gas Savings	% of Custom Portfolio
T1/R100	200	98,702,955	68.3%
Commercial/Industrial	459	45,472,108	31.5%
Low Income*	13	348,525	0.2%
Total	**672**	**144,523,588**	**100%**

*Low Income values are forecast for 2012 as this is a new segment for Union in 2012.
Source: Union Gas Limited

Custom projects are highly heterogeneous, with most projects tied directly to unique processes or technology requirements. Each project is validated on a stand-alone basis by a comprehensive professional engineering review and the overall programs are required to pass a Total Resource Cost (TRC) screening process. The EnerSmart program was designed to achieve savings in process-specific energy applications, as well as space heating, water heating, and the building envelope. Given the customized nature by which tracking database savings estimates are generated, Union conducts a third-party, on-site engineering study to verify the results of a representative project sample.

Account managers market the program directly to customers for T1/R100 and a combination of directly and indirectly through trade allies, channel partners, energy service companies, engineering firms, and equipment manufacturers to all other rate classes. Account managers work to cost-effectively promote energy efficiency within Union's C&I customer base.

[6] Historically, the Union custom C&I program was divided based on whether the customer purchased gas under a firm distribution contract or through a general service contract.
[7] Low income includes commercial and industrial general service customers.

3. Overview of Enbridge Custom Programs

Enbridge offers custom programs for the C&I sectors. A variety of incentive-based initiatives are offered to C&I sector customers. These initiatives include custom project incentives and a suite of prescriptive offerings aimed at promoting specific measures. Given the myriad of building types, end uses, ownership structures, and leasing arrangements, the C&I sector is a complex and variable segment in which to market and deliver energy efficiency.

Enbridge's Continuous Energy Improvement (CEI) initiative is focused on custom measures in the industrial segment. As part of ongoing modifications to this program, the industrial program will pursue greater targeting of small to mid-size operations and more flexibility in the incentives offered. As such, in 2012 Enbridge proposes to increase its custom incentive and expand its prescriptive offering to include more measures. Greater segment-focused marketing activities aimed at the mid-size facilities will augment the traditional marketing efforts for larger customers.

Figure 2 presents the commercial and industrial sector divisions of Enbridge custom projects in 2011. The number of projects in the commercial sector is more than six times the number of the projects in the industrial sector, but the average commercial sector project is only about one third the size of the average industrial sector project.

Figure 2. Enbridge 2011 Custom Projects Overview

Enbridge Custom Sector	# of Custom Projects	Gas Savings	% of Custom Portfolio
Commercial	780	37,470,116	68.2%
Industrial	127	17,482,847	31.8%
Total	**907**	**54,952,963**	**100%**

Source: Enbridge Gas Distribution Company

There are important differences in the Union and Enbridge custom programs. One difference is the average size of project. The average Enbridge commercial project is about 48K therms compared to about 99K therms for the Union C/I market projects. The average Enbridge industrial project is about 138K therms compared to the Union T1/R100 industrial projects, which average about 493K therms. In general terms, Enbridge's programs serve a market more dominated by commercial customers with smaller average project sizes, while Union's programs generally serve a market with more industrial customers, which results in larger projects in terms of savings. These factors need to be taken into account in an efficient sample design.

4. Analysis of Sampling Methodologies in Selected Jurisdictions

This section presents the findings from a review of sampling methodologies used in the evaluation of custom project programs in North America, including those described in annual evaluation reports of selected utilities as well as methodologies contained within evaluation protocols. The reviewed methodologies are all contained within publicly available documents. Because the reviewed documents contain varying degrees of detail and explanation, the Navigant Consulting, Inc. (Navigant) team applied its best interpretation of these documents to synthesize the available information in a consistent manner.

4.1 *Summary of Jurisdictions Reviewed*

The analysis of the reviewed methodologies accounts for factors such as fuel type, customer segment, and program design factors that might influence the design of samples for realization rate analyses.

Seventeen documents[8] were reviewed covering 12 unique jurisdictions in North America listed below:

- Illinois (Chicago) – Commonwealth Edison Company[9]
- Michigan (Detroit) – DTE Energy[10]
- Massachusetts – Massachusetts Energy Efficiency Advisory Council[11] covering NSTAR, National Grid, and Western Massachusetts Electric Company
- New Mexico – El Paso Electric Company,[12] New Mexico Gas Company,[13] and Public Service Company of New Mexico[14]
- Pennsylvania (Philadelphia) – PECO Energy Company[15,16]
- Ohio – AEP Ohio[17]

---

[8] Not counting the review of methodologies used by Union and Enbridge in prior evaluation cycles.
[9] "Evaluation Report: Smart Ideas for Your Business Custom Program." (Program Cycle 2010-2011.) Commonwealth Edison Company. Prepared by Navigant Consulting, Incorporated. May 16, 2012.
[10] "Reconciliation Report for DTE Energy's 2010 Energy Optimization Programs." DTE Energy Company. Prepared by Opinion Dynamics Corporation. April 15, 2011.
[11] "Impact Evaluation of 2008 and 2009 Custom CDA Installations." Massachusetts Energy Efficiency Advisory Council. Prepared by KEMA and SBW Consulting Incorporated. June 7, 2011.
[12] "Evaluation of 2011 DSM Portfolio." El Paso Electric Company. Prepared by ADM Associates Incorporated. May 2012.
[13] "Evaluation of 2011 DSM Portfolio." New Mexico Gas Company. Prepared by ADM Associates Incorporated. June 2012.
[14] "Evaluation of 2011 DSM & Demand Response Portfolio. "Public Service Company of New Mexico. Prepared by ADM Associates Incorporated. March 2012.
[15] "Annual Report to the Pennsylvania Public Utility Commission for the Period June 2010 through May 2011." PECO Energy Company. Prepared by Navigant Consulting. November 15, 2011.
[16] "Audit Plan and Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs. "Pennsylvania Public Utility Commission. Prepared by the PA Statewide Evaluation Team. November 4, 2011.
[17] "Program Year 2011 Evaluation Report: Business Custom Program." AEP Ohio. Prepared by Navigant Consulting, Incorporated. May 10, 2012.

NAVIGANT

- Maryland – EmPOWER Maryland[18] covering Baltimore Gas & Electric, Potomac Electric Power Company, Delmarva Power, Southern Maryland Electric Cooperative, and Potomac Edison
- California – California Public Utilities Commission,[19,20,21]covering Pacific Gas & Electric, Southern California Edison, Southern California Gas, and San Diego Gas & Electric
- Vermont – Vermont Department of Public Service[22] covering Efficiency Vermont and Burlington Electric Department
- PJM Interconnection – covering participating utilities in the Midwest and Eastern U.S.[23]
- U.S. Federally Owned Facilities – U.S. Department of Energy[24]
- International Performance Measurement and Verification Protocol (IPMVP) – Efficiency Evaluation Organization[25]

Figure 3 provides a high-level summary comparing the reviewed studies and Appendix C presents more detail on methods used in selected jurisdictions.

4.2 Key Findings – Review of Methods Used in Selected Jurisdictions

Commercial and industrial programs across North America range in type and size, and they frequently use inconsistent nomenclature. It is common to see custom C&I programs separated from prescriptive programs; however, some utilities do combine custom and prescriptive measures into a single program. Stratification approaches and confidence and precision targets are determined differently, depending on each utility's regulatory requirements and program organization.

Many publicly available evaluation reports tend not to describe sampling methodologies in much detail. These reports focus more on reporting evaluation results rather than describing methods used. Certain attributes of the sampling methodologies can be deduced from the reports, but explicit detail on the sampling approach ranges from little to none. The Navigant team applied its best interpretation in assessing utility evaluation reports.

[18]"EmPower Maryland 2011 Evaluation Report – Chapter 4: Commercial and Industrial Custom and Re-commissioning Programs." Baltimore Gas & Electric, Potomac Electric Power Company, Delmarva Power, Southern Maryland Electric Cooperative, and Potomac Edison. Prepared by Navigant Consulting, Incorporated.

[19]"Energy Efficiency Evaluation Report for the 2009 Bridge Funding Period." California Public Utilities Commission. January 2011.

[20]"The California Evaluation Framework." California Public Utilities Commission. Prepared by TecMarket Works. June 2004.

[21]"California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals." California Public Utilities Commission. Prepared by TecMarket Works. April 2006.

[22]"Verification of Efficiency Vermont's Energy Efficiency Portfolio for the ISO-NE Forward Capacity Market." Vermont Department of Public Service. Prepared by West Hill Energy and Computing Incorporated. July 29, 2010.

[23]"PJM Manual 18B: Energy Efficiency Measurement & Verification." PJM Forward Market Operations. March 1, 2010.

[24]"M&V Guidelines: Measurement and Verification for Federal Energy Projects Version 3." U.S. Department of Energy. Prepared by Nexant Incorporated. April 2008.

[25]"International Performance Measurement and Verification Protocol: Concepts for Determining Energy and Water Savings Volume 1." Efficiency Valuation Organization. January 2012.

NAVIGANT

Figure 3. Summary Comparison of Sample Methodologies in Selected Jurisdictions

N°	Service Territory or Jurisdiction	Organizations Reviewed	Year	Service Type	Timing	Precison Target	Stratify by Size	Stratify by Segment	Ratio Estimation
1	Illinois (Chicago)	Commonwealth Edison Company	2011	Electric	2-stage	90/08 (3yr utility program)	✓		✓
2	Michigan (Detroit)	DTE Energy	2010	Gas & Electric	1-stage	90/10 (utility program)		✓	✓
3	Massachusetts	Massachusetts Energy Efficiency Advisory Council (NSTAR, National Grid, Western Massachusetts Electric Company)	2009	Gas & Electric	1-stage	90/10 (statewide custom C&I)			✓
4	New Mexico	El Paso Electric Company, New Mexico Gas Company, Public Service Company of New Mexico	2011	Gas & Electric	1-stage	90/10 (utility total portfolio)	✓		✓
5	Pennsylvania (Philadelphia)	PECO Energy Company	2011	Gas & Electric	3-stage	85/15 (utility C&I total)	✓	✓	✓
6	Ohio	AEP Ohio	2011	Electric	2-stage	90/10 (utility program, RTO zone)	✓	✓	✓
7	Maryland	EmPower Maryland (Baltimore Gas & Electric, Potomac Electric Power Company, Delmarva Power, Southern Maryland Electric Cooperative, and Potomac Edison)	2011	Gas & Electric	1-stage	80/20 one-sided (utility program)	✓		✓
8	California	California Public Utilities Commission (Pacific Gas & Electric Company, San Diego Gas & Electric, Southern California Edison, Southern California Gas Company)	2009	Gas & Electric	flexible	90/10 (utility program)	✓	✓	✓
9	Vermont	Vermont Department of Public Service (Efficiency Vermont and Burlington Electric Department)	2010	Electric	2-stage	80/10 (utility portfolio)	✓	✓	✓
10	PJM Interconnection (Midwest & Eastern US)	PJM Interconnection	2010	Electric	flexible	90/10 one-sided (utility program, RTO zone)	✓	✓	✓
11	US Federal Facilities	US Department of Energy	2008	not applicable	flexible	not applicable		✓	
12	General International	Efficiency Valuation Organization (IPMVP)	2012	not applicable	flexible	not applicable		✓	

Source: Navigant review of previously cited documents in selected jurisdictions

Protocols for evaluating DSM projects in specific jurisdictions tend to provide a more detailed description of sampling methodologies used than the program evaluation reports. Protocols generally allow specific sampling options such as selecting between census, simple random sampling, and stratified sampling, as well as options for determining the appropriate basis for stratification. The reviewed protocols usually offer step-by-step processes for designing samples.

Meeting Precision Targets

Confidence and precision requirements vary widely across the reviewed methodologies. Both one-sided and two-sided confidence intervals are common. Confidence requirements range from 80% to 90%, and precision requirements ranged from 8% to 20%. These confidence and precision requirements frequently differ in the level at which they are applied, which could be for the program, the customer segment, the portfolio, or the transmission zone. One methodology[26] adheres to a relatively rigorous precision target of 90/08, but the target only applies to a 3-year term rather than annually.

On-site verification and evaluation is common industry practice for evaluating larger custom program impacts. There are cases where phone and engineering algorithm verifications have been used for custom programs in some years with more in-depth evaluation work performed in other years. Phone surveys are generally reserved for process evaluation and establishing free-ridership estimates. Phone surveys are less commonly used to estimate gross program impacts. The reviewed methodologies tend to contain a rather substantial description of the evaluation techniques used to estimate project savings, often describing in detail the engineering models applied and how parameters were measured and used. Several evaluation sample design methodologies apply more rigorous techniques or aim to achieve a census for large projects that represent a high concentration of savings in order to cost-effectively increase validity and accuracy of evaluation estimates at the project and program levels.[27,28]

Ratio estimation is used in nearly all of the reviewed methodologies and has now become a standard practice in the industry. Ratio estimation is a statistical technique whereby prior information from a tracking database—"tracked savings"—is employed to reduce the overall sample requirements. If stratification is used, the resulting precision is applied to the total based on applying the realization rate measured for each stratum.

An expected variance must be assumed to create an initial sample design. This assumption is made via an error ratio or coefficient of variation (CV). The CV is defined as the standard

[26] "Evaluation Report: Smart Ideas for Your Business Custom Program." (Program Cycle 2010-2011.) Commonwealth Edison Company. Prepared by Navigant Consulting, Incorporated. May 16, 2012.

[27] As a point of interest, the more rigorous evaluation approaches for selected large projects can, on occasion, produce a higher variance across the sample. This can produce the appearance of worsening sampling precision, but it is generally viewed as producing more appropriate levels of confidence and precision for the program.

[28] "EmPower Maryland 2011 Evaluation Report – Chapter 4: Commercial and Industrial Custom and Re-commissioning Programs." Prepared by Navigant Consulting, Inc.

deviation of the sample divided by the mean. In the case of ratio estimation, the CV should be based on the variance of project-specific realization rates rather than the variance of savings. Industry practice is to conservatively rely on historic evaluation results in selecting a CV for sample design. When historic data are not available, conservative assumptions are made, typically ranging from 0.5 to 1.0 depending on the expected homogeneity of the population.[29] Ratio estimation can sometimes reduce the CV to levels around 0.3; however, these levels represent "best outcomes" and should not be viewed as conservative when designing a sampling framework.

The reviewed methodologies more commonly apply Z-values[30,31] than T-values in determining sample precision. At larger sample sizes (i.e., greater than 30) the differences are insignificant. But for smaller samples, application of the Z-value fails to account for the limited degrees of freedom in the sample and can lead to overstating the confidence and precision achieved by the sample.

Use of the finite population correction (FPC) factor is not frequently discussed. However, the FPC has a valid statistical basis and should be used when evaluating smaller populations. Two of the reviewed methodologies[32,33] do not appear to use the FPC, and instead recommend a census if the calculated sample size approached or exceeded the population size. Any sample size calculation that exceeds the population is not taking into account the basic principles of sample design. This approach is not statistically valid and can lead to excessive evaluation costs. Although this topic is not frequently discussed, it is reasonable to assume that the FPC is applied whenever size-based sampling was used since application of the FPC is necessary to take advantage of the concentrations of savings in large projects.

Use of Stratification

The reviewed methodologies applied stratification in the sample design when population sizes were not sufficiently small to achieve a census. Stratification approaches vary across the reviewed methodologies and appear to be customized to fit each utility's program structure, number of projects, sizes of projects, regulatory requirements, and stakeholder concerns.

The review yielded two common approaches for stratifying based on size. The first approach defines the large stratum based on very large projects in the population. Sometimes a census is

---

[29] "PJM Manual 18B: Energy Efficiency Measurement & Verification." PJM Forward Market Operations. March 1, 2010. (See page 30)

[30] "Audit Plan and Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs." Pennsylvania Public Utility Commission. Prepared by the PA Statewide Evaluation Team. November 4, 2011.

[31] "The California Evaluation Framework." California Public Utilities Commission. Prepared by TecMarket Works. June 2004.

[32] "The California Evaluation Framework." California Public Utilities Commission. Prepared by TecMarket Works. June 2004. (See page 337)

[33] "Audit Plan and Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs." Pennsylvania Public Utility Commission .Prepared by the PA Statewide Evaluation Team. November 4, 2011. (see page 75)

sought when the very large stratum contains only a few projects. The second approach divides the population into strata of roughly equal contribution to total savings.[34] In some cases, this approach seemed to follow textbook examples rather than examining the program projects to see if alternate approaches to stratification could be designed to increase precision. Simply dividing the population into three roughly equal strata may overlook more appropriate stratification designs that could yield higher precision and confidence. This approach is more applicable when project size declines smoothly from large to small projects. Some of the reviewed methodologies apply more rigorous evaluation and measurement approaches to projects in the large stratum or for strata with highly heterogeneous populations in a cost-efficient effort to improve accuracy.

Many of the reviewed methodologies stratify by segment instead of or in addition to stratifying by size. Segments used for stratification included market sector (e.g., education, multi-family, manufacturing, and other customer-type segments), geography, and project types (space heating, water heating, or industrial process). Stratification by segment can be used to increase precision for a given sample size as well as make the sample more representative of the population.

Sample Staging

Schedule requirements for reporting often necessitate a rolling sample or staged approach to sampling in order to begin evaluation efforts early enough to complete the evaluation tasks in time to report results on schedule. About half of the reviewed methodologies implement staged sampling. Most of the methodologies do not require reporting intermediate results, but rather focus only on the final population results.[35]

A two-stage approach is most common[36,37,38] where a stage one sample is drawn based on either the first two or first three quarters of the year. Single-stage sampling and three-stage sampling also occur in the reviewed methodologies. Details on the rationale underlying the calendar periods for the different stages, and the allocation of sample to the different stages, were generally not explicitly stated. In general, approaches were based on "reasonable judgment" by the evaluators.

---

[34] "Program Year 2011 Evaluation Report: Business Custom Program." AEP Ohio. Prepared by Navigant Consulting, Incorporated. May 10, 2012. (See appendix J, page 33)

[35] Pennsylvania has a slight exception. Reporting quarterly results is required by Act 129. Although quarterly reporting has been interpreted as applying to unverified results, verified results are reported for the full year.

[36] "Evaluation Report: Smart Ideas for Your Business Custom Program." (Program Cycle 2010-2011.) Commonwealth Edison Company. Prepared by Navigant Consulting, Incorporated. May 16, 2012.

[37] "Program Year 2011 Evaluation Report: Business Custom Program." AEP Ohio. Prepared by Navigant Consulting, Incorporated. May 10, 2012. (See appendix J, page 33)

[38] "Verification of Efficiency Vermont's Energy Efficiency Portfolio for the ISO-NE Forward Capacity Market." Vermont Department of Public Service. Prepared by West Hill Energy and Computing Incorporated. July 29, 2010.

NAVIGANT

Gas & Electric Service

Major differences in evaluating savings between electric and gas utilities were not found. Differences in evaluation methods are more likely based on program size and number of years evaluating and reporting program savings. Most jurisdictions count both electric and gas savings for custom C&I measures regardless of whether the administrating utility supplies both fuel types.

Bias in Results

Industry best practices prescribe a demonstration of effort to control for common sources of bias. Once a population of projects exists, the goal of the sample design is to estimate the gross savings resulting from that population.[39] The principal concern about bias is that certain elements of the population may be over- or underrepresented in the sample. Stratification is a good approach for reducing this potential bias. Bias can also result from non-random sample selection. Finally, bias can be introduced into the analysis by anomalous observations in the sample that for some reason are unique and not representative of other members of the population. If anomalous observations are also "influential" observations, then corrective action may be necessary to provide accurate information from the realization rate calculation, and the accompanying calculations of precision and confidence. The California Evaluation Framework notes:[40,41]

> *[If] there is substantial bias, perhaps due to self-selection, non-response, deliberate substitution of sample projects, or measurement bias, then the methods presented here can be seriously misleading. For example it is misleading and counterproductive to report that the average savings has been estimated with a relative precision of 10% at the 90% level of confidence if there is a serious risk that the results might be in error by 25% due to bias.* (p. 327)

The reviewed methodologies contain little description of efforts made to minimize bias. Additionally, there is little discussion on the composition of the sample, treatment of outliers, sample replacements, missing data points, or other sample adjustments. These discussions could be addressed in project memos rather than expanding what is often a lengthy final evaluation report. However, this is an area where standard industry practice may not be on par with evaluation practices in other fields. It is not clear whether this deficiency is related only to reporting or if it reflects limitations on current evaluation practice.

---

[39] Issues such as self-selection bias in recruiting program participation are not an issue for sample designs whose purpose is to estimate the gross savings from those that did participate in the program. Once the frame of participant projects is determined, the biases of concern are typically based on ensuring random samples, ensuring representativeness, addressing extreme values, and using appropriate calculations consistent with the sample cases to produced unbiased estimates of the population parameters.

[40] "The California Evaluation Framework." California Public Utilities Commission. Prepared by TecMarket Works. June 2004.

[41] The California Evaluation Framework contains a substantive discussion on accuracy and bias in chapter 12.

NAVIGANT

5. Recommended Sample Design Methodology

This section describes the recommended sample design methodology for DSM programs for Union and Enbridge. Sections 5.1–5.3 describe the key attributes of the recommended methodology and offer support for their use in evaluating Union and Enbridge custom programs. Section 5.4 presents steps for appropriate sample designs and sample selection. Sections 5.5–5.6 present examples for Union and Enbridge illustrating how the sample methodology might be implemented using representative tracking data.

Ratio estimation has become standard practice for the evaluation of large C&I programs, as it leverages information available on the population of projects with the sample. The sample design approaches discussed in this section are constructed to make full use of the ability to leverage sample data in combination with information on the population from the project tracking database. This is important given the relatively high cost of rigorously evaluating custom C&I projects. Ratio estimation has become a common industry practice in evaluation since it leverages information on the population to better interpret information from the sample. Stratification has also become a common industry practice, although its application varies, and its application may not result in strata that enhance the efficiency of the sample design. The methods presented in this section are aligned with these basic concepts of leveraging information to get the most out of the analysis.

The level of specification for sampling protocols observed in jurisdictions across North America ranges widely. An overly specified methodology may lead to incompatibilities in future evaluation efforts as the composition, participation, and distribution of impacts evolve. However, an overly general methodology may lead to sample designs that do not meet Union and Enbridge's confidence and precision requirements with cost-efficient methods. The recommended sample design methodology is intended to strike a balance between flexibility and specification to allow Union and Enbridge to best meet their evaluation needs now and in future program years.

5.1 *Stratification*

Stratification is recommended in designing samples for evaluating custom C&I programs. Stratification is the practice of disaggregating the population into sub-groups based on some criteria. Strata should be defined such that the strata sample frames are mutually exclusive (i.e., no overlap) and exhaustive (i.e., strata sample frames combine to represent the appropriate population sample frame). There are three generally accepted reasons to use stratification:

1. Sample Efficiency: To reduce the required sample size needed to achieve confidence and precision targets on an estimate. There are two common stratification practices that can increase sample efficiency:

NAVIGANT

- Stratifying by project size may reduce the overall number of required samples by taking advantage of the concentrations of savings when relatively few projects contribute to a large fraction of total impacts. This is most commonly seen in C&I evaluations, and the majority of reviewed methodologies apply this approach.
- Stratifying based on qualitative segments (e.g., project type or customer segment) can reduce the effective variance compared to combining the segments in a single stratum when segments of a population produce different results. For example, if the project-level realization rate (RR) is expected to average 0.9 for lighting projects and 0.8 for heating, ventilating, and air conditioning (HVAC) projects, then the variance of these segments combined will usually be greater than their individual variances. Separating lighting from HVAC would then allow smaller sample sizes to meet the required precision criteria for total combined savings.

  Stratification design must reduce the effective sample variance in order to produce gains in precision. The simple rule is that projects within a sample should have a smaller variance within the strata than across strata. Lohr notes:[42,]

  > *Observations within many strata tend to be more homogeneous than observations in the population as a whole, and the reduction in variance in the individual strata often leads to a reduced variance for the population estimate.* (p. 77)

- Stratification cannot make the problem worse (i.e., decrease precision). As a result, it is strongly recommended.

2. <u>Segment Results Required</u>: To ensure sufficient sample sizes that can answer questions pertaining to certain segments of the total population**.** For example, if stakeholders or interveners require results specifically for HVAC-related projects in order to improve program implementation in subsequent years, then creating strata for HVAC projects and establishing a minimum precision requirement for those strata would help ensure that sufficient data are collected to understand HVAC projects.
3. <u>Reduced Potential for Bias by Improving the Representativeness of the Sample</u>: For many evaluators, this is the most important reason for stratification as part of sample design. Stratification helps ensure that the sample appropriately represents the population. Since simple random sampling allows for the possibility of under-sampling certain segments, stratification can help ensure that the sample drawn provides the appropriate sample size for each segment. For example, stratifying by project type can ensure that each major project category is appropriately represented in the sample by explicitly drawing samples for each project type. Other frequently used dimensions for stratification include customer segments and site geographies. Representativeness quotas are sometimes used instead of strata to ensure representativeness.

[42] Lohr, S. L., "Sampling: Design and Analysis," Second Edition, 2010.

The specific stratification approach will depend on evaluation of the population data. If the distribution of project savings for a program is relatively tight[43] and there is not an easily delineated group of large projects, then stratification by project size alone may not produce sampling efficiencies. However, if the distribution of project savings is wide or there is clear group of large projects, then stratifying by project size will likely produce sampling efficiencies.

It is important to note that when sample observations are collected based on a stratified sample design, the strata weights must be applied in the estimation of the population realization rate.

The general rule for stratification is to attempt to select strata that have smaller variance within the strata than between strata. Stratifying by segment may also be appropriate when realization rates are expected to vary by segment. Judgment should be applied to segment the population on the basis of mechanisms that lead to different realization rates, rather than simply using common predefined segments used in program administration. For example, if steam projects are expected to have a different realization rate than other project types—or even more widely varied realization rates across steam projects—then a potentially useful segmentation may be by steam projects vs. other non-steam projects. It is not necessary to segment by every major project category to achieve the desired sampling efficiency, only those where this effect is believed to be sizeable and where stratification may also help increase the representativeness of the final sample across important technology categories.

5.2 *Ratio Estimation*

The application of a ratio estimation approach is recommended. Ratio estimation is the statistical technique whereby the *accuracy* of "prior" tracked estimates is applied from the sample rather than directly applying the *absolute* estimates of the sample. For DSM evaluation efforts, the sample estimator is the realization rate for each stratum rather than the sampled savings for each stratum. Ratio estimation is often used to increase the precision of estimated means and totals. It is motivated by the desire to use information about a known auxiliary quantity (i.e., tracked savings) to obtain a more accurate estimator of the population total or mean (i.e., verified savings). When applying ratio estimation within a stratified population, the separate ratio estimator approach should be used where strata are defined and analyzed before combining strata.[44]

Ratio estimation would not be possible without initial savings estimates for the population. This technique relies on establishing the variance based on the errors between the savings predicted by the stratum average realization rates for each project and the actual savings measured for each project. Ratio estimation effectively develops verified savings estimates based on measuring the accuracy of the tracked savings. Therefore, it is necessary to ensure that the tracked savings in the tracking database represent the best possible estimate based on the available information.

[43] A "tight" project savings distribution is generally considered to be within a single order of magnitude. Size-based stratification should be considered when the distribution of savings spans multiple orders of magnitude.

[44] Lohr, S. L., "Sampling: Design and Analysis," Second Edition, 2010. (Section 4.5)

NAVIGANT

5.3 *Sample Staging*

A rolling sampling approach comprised of two sample draws (a two-stage sample approach) is recommended to ensure that spring reporting requirements can be met. Reporting schedules often do not provide sufficient time to design and evaluate a sample following the completion of the project year. This type of schedule constraint frequently occurred in the jurisdiction reviewed in Section 4. Sample staging can allow evaluation efforts to begin earlier on a preliminary sub-sample of projects completed early in the program year. Thus, staging can reduce the evaluation workload required between the end of the program year and the reporting deadline.

A two-stage sample is recommended, where the first stage takes a sample draw from projects completed in the first three quarters of the program year, and the second sample draw adds in projects completed in the fourth quarter.

The sample design for the first stage should estimate or extrapolate the numbers of projects in each stratum to the values expected at the end of the year.[45,46] Sample sizes should be determined for this preliminary sample frame as an indication of the final population. While judgment is needed to determine how much of the expected overall sample is drawn in the first stage, it is unlikely that the first stage sample would fully require three-quarters of the calculated sample sizes.[47] In general, practical considerations would support a lower split of the planned sample between the first and second stages. This would allow for a sample that adequately represents the year-end projects.

Union's and Enbridge's projects tend to come online more heavily in the fourth quarter, with roughly half to three-quarters (depending on which program) of projects completing in the last quarter. This would imply that a 50-50 split between sample stages would be reasonable, given constraints related to the calendar time needed to set up and conduct the verification studies. However, if the timing allows, Union and Enbridge might consider placing more of the sample into the fourth quarter when savings from projects completed in the fourth quarter are expected to contribute more than half of program savings. This recommendation is a compromise between the time and resources needed to perform the number of site verifications, and the need to meet program reporting deadlines. It simply is not possible for the utilities to wait until information on that year's full population of projects becomes available and then draw the sample and complete the site verifications while still meeting the program reporting deadlines.

---

[45] This step is important because it will reduce the effect of finite population correction that could otherwise lead to underestimating the required sample sizes.

[46] If the final quarter of the program year is known to have very large projects in disproportion to the first three quarters, the strata weighting may be adjusted to account for this information.

[47] The sample sizes may be further reduced slightly to allow for the possibility that the assumed CV is overly conservative. If upon evaluation of the first stage, the assumed CV was not overly conservative, then additional samples may be added in the second stage.

NAVIGANT

This rolling sample or two-stage approach is often used in program evaluation (see Section 4 above) to meet timely reporting deadlines.

The sample design for the second stage should consider the population of the program year in its entirety. Sample sizes should be determined for the entire population. The first stage sample is intended to fulfill about half of the overall sample. The second stage is intended to fulfill the remainder of the sample and should be selected from projects completed in the fourth quarter.[48] If analysis of the first stage sample observations indicates insufficient sample sizes, then the first stage may be reinforced in the second stage with additional projects selected at random from the full program year population. An analysis of sample data should investigate whether differences between sample stages are significant and adjustments are needed. Again, the goal is to produce good information for making decisions regarding the custom programs for both the utilities and stakeholders. Some judgment is needed in implementing this rolling two-stage sample selection approach.

5.4 Recommended Sample Design Process—Seven Steps

The sample study should be designed to estimate the impacts of the population of projects in each program year. At the time of this report, *cumulative* gas savings measured in cubic meters (m^3) is the primary impact to be studied and should serve as the basis of the sample design.[49] The recommended sample design methodology contains the following steps:

Step 1: Review project tracking database for accuracy and quality.
Prior to any stratification or sampling, large gains can be made in the resulting analysis and precision by reviewing the estimates in the tracking database and making sure that the best possible initial project-based engineering estimates are contained in the tracking database. It is also important to make sure that appropriate contact information is contained in the files to avoid having to replace drawn sample projects with supplemental projects held in reserve. One of the most cost-effective ways to enhance the precision and confidence in the evaluation results is to make the appropriate investment in the tracking database. A tracking database that is accurate will typically reduce the costs of the evaluation, yield project realization rates that are closer to one, and have a smaller variance across the project realization rates. Many utilities do a second check of the tracking database prior to the sample design and sample selection.

Identifying unique projects in the tracking database can help avoid outlier problems later in the analysis. Examples of unique projects may be those with the only instance of a certain efficient technology installed or even those with technologies whose impacts are difficult to predict.

---

[48] Although this approach is intended to achieve roughly equal proportions of projects for each quarter, disproportions by quarter should not be viewed as causing notable bias. Accordingly, if the first stage produces a small number of projects in excess of what is required in the second stage, these extra projects may be counted toward meeting the fourth quarter sample size requirements.

[49] This is a new basis for custom C&I evaluation studies beginning in program year 2012. The Technical Evaluation Committee may decide to change this basis in future years.

These unique projects may be treated separately from the primary population to produce more efficient samples for the vast majority of the population. Identification of unique projects can also help ensure the representativeness of the selected sample and help eliminate problems in the interpretation of the analysis such as bias in the realization rate.

Step 2: Evaluate the population and define strata.
Examine the population for ways to leverage the sample design to improve efficiencies in meeting target confidence and precision levels. This includes three activities:

- *Exclusion of extremely small projects* – Ratio estimation weights project realization rates according to project savings. Very small projects typically exert only negligible influence on estimates of the total realization rate, the total savings, and the total achieved precision. For many very small projects, a 100% difference in realized savings would produce a negligible impact on the total estimates. The cost of evaluating the impacts of these small projects exceeds the value of the information obtained from them. Additionally, including projects that contribute only small fractions of a percent to program savings in the sample frame might result in the random selection of projects that includes a disproportionate number of these very small projects, which could reduce the accuracy with which the overall realization rate is estimated for a given sample size and reduce the overall representativeness of the sample. It is therefore considered reasonable to exclude the very small projects (i.e., representing up to 5% of the total program savings as appropriate) from the sample frame. The savings of the population of very small projects may be adjusted by an appropriate realization rate[50] and added to the program savings total.
- *Identification of project size strata bounds* – Efficiencies can be gained by stratifying by project size when the distribution of project savings is wide or there is a clear group of large projects. Sorting the projects by savings size can allow easy identification of discontinuities in the project size distribution. If it is unclear whether natural project size groupings exist; visualization of the project savings in a histogram should provide a clearer indication. Typically, strata are set such that program savings within a stratum fall within an order of magnitude.[51] Set strata bounds first based on natural breaks in the distribution that result in easily delineated groupings. If natural groupings do not exist, other approaches may be used such as stratifying into strata of roughly equal total savings. The number of size-based strata typically ranges from two to four, with three most commonly applied for C&I program evaluations.

[50] If the remaining population is stratified by size, then the average small stratum realization rate should be applied. Otherwise the population total realization rate should be applied. However, the savings accounted for by these projects is so small that alternative assumptions should not affect the overall program savings estimates. Some applications simply use a realization rate of 1.0 for these very small projects.

[51] One rule of thumb is to keep the expected coefficient of variation of project savings to less than 1.0 within a stratum.

- *Identification of categorical characteristic strata bounds* – Efficiencies can be gained by defining strata along categorical qualities such that the coefficient of variation of project realization rates for each stratum is lower than the resulting CV of the aggregated group without the categorical strata. This basis for stratifying may be applicable when a certain segment of the project population is expected to have different or more variable realization rates than the rest of the population. Units that are generally more alike should be grouped together in a stratum. For commercial projects, strata could be defined by building type (e.g., schools, office building, and multi-family). Similar buildings could be expected to have a lower variance in the estimated realization rate across sites (i.e., within the stratum) than when combined with other building types. Although categorical strata bounds are frequently applied in many DSM studies, they are not mandatory and should be prudently applied.

The sample designer may be required to make trade-offs between stratification approaches. Defining the appropriate strata is often the most important part of sample design; however, it requires data analysis skills, subject matter expertise on the project types, and knowledge of program administration and participation issues.

Step 3: Estimate an appropriate variance for each stratum.
In ratio estimation, the variance considered is that of the residuals on the stratum average realization rate rather than the variance of the verified savings. Accordingly, a CV or error ratio should be based on the assumed distribution of individual realization rates for the population of projects in each stratum.

The CVs should be based on the un-weighted[52] realization rates historic sample data, when such data are available. Any changes in program composition, administration, or participation from the previous year will decrease the validity of applying prior year CVs, and the assumed CVs should be adjusted upward by 0.1-0.2 to prevent under-sampling. It is not recommended to apply a coefficient of variation less than 0.30, in order to ensure sample sizes sufficient for robust results and to allow for increasing variances that may result from evolving measurement approaches and program participation.

A two-staged sample provides an opportunity to adjust the assumed CVs in the second stage to incorporate the sample data already observed in the first stage. The observed CVs in the first stage should still be slightly adjusted upward to account for variance and size unknowns in the second stage sample.

A CV of 0.5 may be assumed when historic data are not available. This is a standard industry assumption and is generally conservative in ratio estimation if the population tracked savings in the tracking database are reasonably accurate. However, custom projects with poor tracking

[52] The realization rates are un-weighted rather than weighted because it is assumed that any correlation between the size of a project in a stratum and its realization rate is coincidental (especially in small sample sizes). So, applying the historic correlation could result in under-sampling or over-sampling in subsequent program evaluation efforts.

database estimates may produces CVs as large as 1.0. It is not uncommon to observe program CV's lowering over time as programs mature and tracking estimates improve. CVs can also increase if more rigorous and precise methods are used to evaluate project savings; however, this should not be viewed as a negative since rigorous methods create a more accurate understanding of project and program results.

Step 4: Allocate observations to each stratum.
The overall sample should be designed to achieve 10% precision at a 90% one-sided confidence level (i.e., 90/10 one-sided).[53, 54] This confidence and precision target is meant to be used for each custom program in each year. If changes are made to this target, these changes can be addressed in the sample size calculations and do not necessarily warrant changes in the recommended methodology. Appendix A and Figure 19 provide additional explanation and illustration for the 90/10 one-sided confidence interval and the other reporting confidence intervals.

Allocating the sample across strata to achieve target confidence and precision is not a simple exercise and can often require an iterative approach. Proportional sampling is one technique that is often applied, where the total sample size is calculated for the population and subsequently allocated to strata in proportion to some characteristic such as savings. Proportional sampling, however, fails to realize the efficiencies gained from stratifying and very frequently results in over-sampling. Lohr notes:[55]

> *If the variances are more or less equal across all the strata, proportional allocation is probably the best allocation for increasing precision. In cases where the variances vary greatly [across strata], optimal allocation can result in lower costs. In practice, when we are sampling units of different sizes, the larger units are likely to be pre variable than the smaller units [in absolute terms] and we would like to sample them with a higher fraction.*[56]

The California Evaluation Framework notes the skills required:

> *Stratified ratio estimation is somewhat more complex [than simple random sampling]…it probably still requires someone to have basic training and/or experience in statistics to ensure that it is understood and applied correctly.*[57]

---

[53] Based on October 25, 2012 Technical Evaluation Committee decision, the sample design should be based on a 90/10 one-sided confidence interval. Reporting of achieved confidence and precision should present the precision achieved for three confidence intervals: 90% one-sided on the lower bound, 90% one-sided on the upper bound, and 90% two-sided intervals. Appendix A provides additional explanation and illustrative examples for these reporting confidence intervals.

[54] This target may be inferentially interpreted as the intent to ensure that there is a 90% likelihood that the actual savings of the program population exceeds 90% of the sample estimate of program population savings.

[55] Lohr, S. L., "Sampling: Design and Analysis," Second Edition.2010. (Section 3.4.2 discusses optimal allocation)

[56] Lohr, S. L., "Sampling: Design and Analysis," Second Edition.2010. (Section 3.4.2 discusses optimal allocation in more detail – p. 87.)

[57] "The California Evaluation Framework." California Public Utilities Commission. Prepared by TecMarket Works. June 2004, p. 316.

Given the judgment needed to develop a sample design, it is important to test the robustness of the design by simulating different scenarios. Assessing several alternative allocations of the sample across strata can usually improve sample efficiency.

Step 5: Determine criteria for assessing sample representativeness. (optional)
There are often categorical characteristics of the population that are not used in defining strata but are still desired to ensure a reasonably representative sample.[58] For example, market segment may not have been used in defining strata; however, a random sample that fails to include certain major market segments would not be viewed as a representative sample. You could establish new strata for these factors; however, it is expected that a random draw will be representative across these factors and there is a benefit for a simple stratification design.

To address this, some criteria can be defined prior to randomly selecting a sample, which can be used to assess the representativeness of the sample. Criteria should be established only for the most important characteristics, and they should only be set for high-level characteristics that, if not met, would represent an extreme sample in terms of representing the population. Failure to meet the criteria will result in discarding the full original sample and selecting an alternate full sample. Criteria can be established only for the total population or specific strata as appropriate (See example in Section 5.5). Selection of a sample that does not meet representativeness criteria should be a rare occurrence. This approach is only meant to mitigate the possibility that a randomly selected sample might result in highly inaccurate statements about the entire population. The necessity to discard the original sample should not occur in most program years.

Step 6: Select a random sample.
The sample for each stratum should be selected at random from a uniform distribution. This provides an equal opportunity for each project within a stratum to be selected.[59] This can be accomplished in Microsoft Excel using the RAND() function[60] to assign a random number between 0 and 1 to each project in a stratum. The projects should be sorted within each stratum based on the random number assigned to it, and the projects with the highest random number should be selected for the sample until the target stratum sample size is reached.

The selected sample should be analyzed and documented. If criteria are set to assess the representativeness, the selected sample should be analyzed against these criteria at this point. If

[58] These criteria are not intended to be overly restrictive in selecting a sample. Rather, they are intended to prevent the unlikely but possible case where extreme over-representation or under-representation of certain project characteristics occurs in the sample.

[59] Sampling from a savings-weighted distribution can also be valid, but it is not recommended here since size-based strata are already employed.

[60] Note that the RAND() function will continue to generate a new set of random numbers each time a cell is updated. To prevent this, the values of the RAND() function can be copied and pasted (i.e., "paste values") into a separate column.

NAVIGANT

the sample does not meet the criteria for representativeness, then the full population sample should be discarded and a new sample should be selected.

Recruiting the full selected sample is often not achievable since some program participants may not respond or refuse to participate in the sample. Even when agreement to participate in evaluation activities is required to participate in the program, full recruitment of the selected sample can often not be achieved. Therefore, a set of potential replacement projects may be provided to recruiters to fill in for non-recruited participants.

Potential replacements should be selected from the same random number list of the population from which the original sample was selected. Replacements should be selected in priority of assigned random number until full recruitment is achieved. The full population of a stratum should not be provided to recruiters, whose incentives are not usually aligned to follow the random prioritization of the sample, unless the full sample size is not expected to be achieved.

Step 7: Recruit the sample.
Recruitment of each stratum sample can begin once the sample has been selected and assessed. Recruitment typically occurs over the phone, and may or may not involve scheduling of the on-site evaluation visit. Ensuring the accuracy and completeness of contact information in the tracking database can streamline the recruitment task.

The list of potential replacements may be initially withheld from recruiters to ensure that the originally selected sample projects are pursued fully before being replaced by alternate projects. This can help reduce the possibility for non-response bias in the sample. The California Evaluation Framework notes:[61]

> *It is very important to use the backup sample correctly. The most efficient way to recruit a sample of the desired size may appear to be to contact both the primary and backup sample at once and to schedule those sites that are first to respond and agree. But this is generally not sound practice since this approach ensures that the response will be no better than 50%, assuming that the backup sample size is equal to the primary sample size. Instead, the initial recruiting effort should be limited to the primary sample. A backup should be used only if a primary sample site is impossible to contact or refuses to participate.* (p. 350)

A full effort should be made to recruit the original sample before resorting to replacements, and the same effort should be made to recruit each replacement before moving on to the next.

[61] "The California Evaluation Framework." California Public Utilities Commission. Prepared by TecMarket Works. June 2004.

5.5 Example Implementation of Sample Design Methodology (Union)

This section demonstrates how the sample design methodology might be implemented for an example set of Union program data. The data used for this example has been randomized and does not indicate historic program achievements that have undergone regulatory review in prior years. The data for this example is intended to be representative of a typical program year and are used in this example for illustrative purposes only. This example is for reference and does not preclude the judgment needed to understand and address the idiosyncrasies of actual program data.

This example applies the seven steps of the sample design process presented in Section 5.4 above.

<u>Step 1</u> reviews the project tracking database for accuracy and quality. Of particular emphasis is a check on the processes used to produce the initial estimates for savings contained in the database and the contact information. This step is usually undertaken by the utility and is done to provide the third-party evaluator with the best information possible. As mentioned above, a more accurate tracking database will make it more likely that confidence and precision targets will be met. This example assumes that the tracking database has been reviewed.

<u>Step 2</u> evaluates the population and defines strata. Figure 4 and Figure 5 show representative project distributions of savings[62] for Union's T1/R100 and C/I programs, respectively. Analyzing the distribution of project sizes indicates that size-based stratification should produce sampling efficiencies. Other categorical bases for stratification are not chosen for this example, although Union may consider isolating new technologies into a unique stratum for future evaluation efforts.

[62] Net annual savings are used for illustration here. Beginning in 2012, the TEC will require cumulative savings to serve as the basis for evaluation studies.

NAVIGANT

Figure 4. Illustrative Distribution of Savings for Union'sT1/R100 Projects

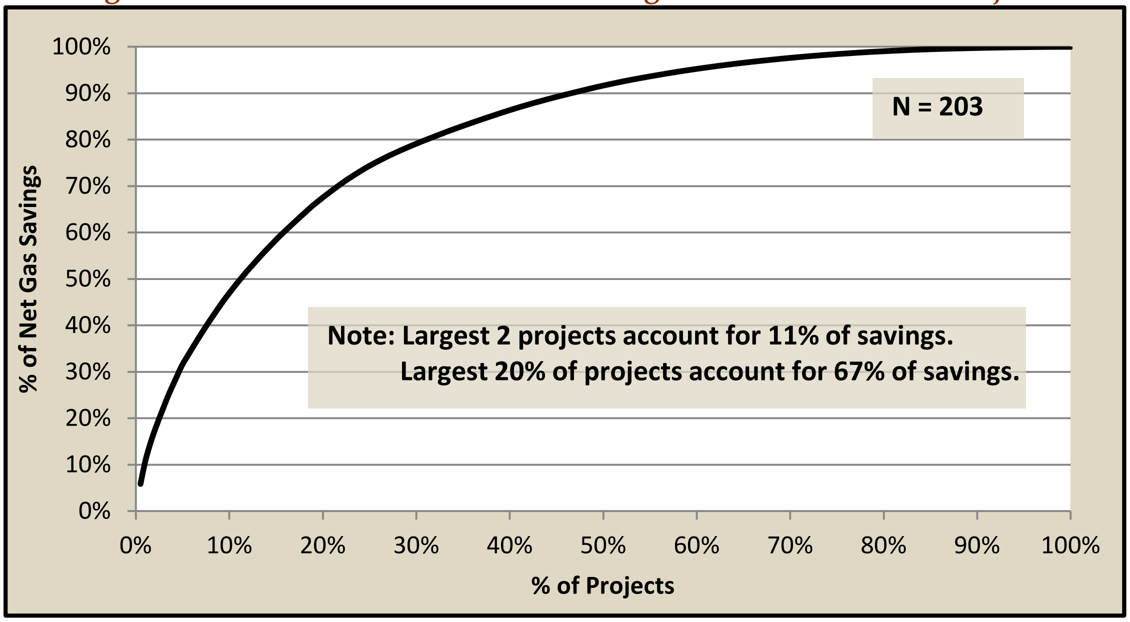
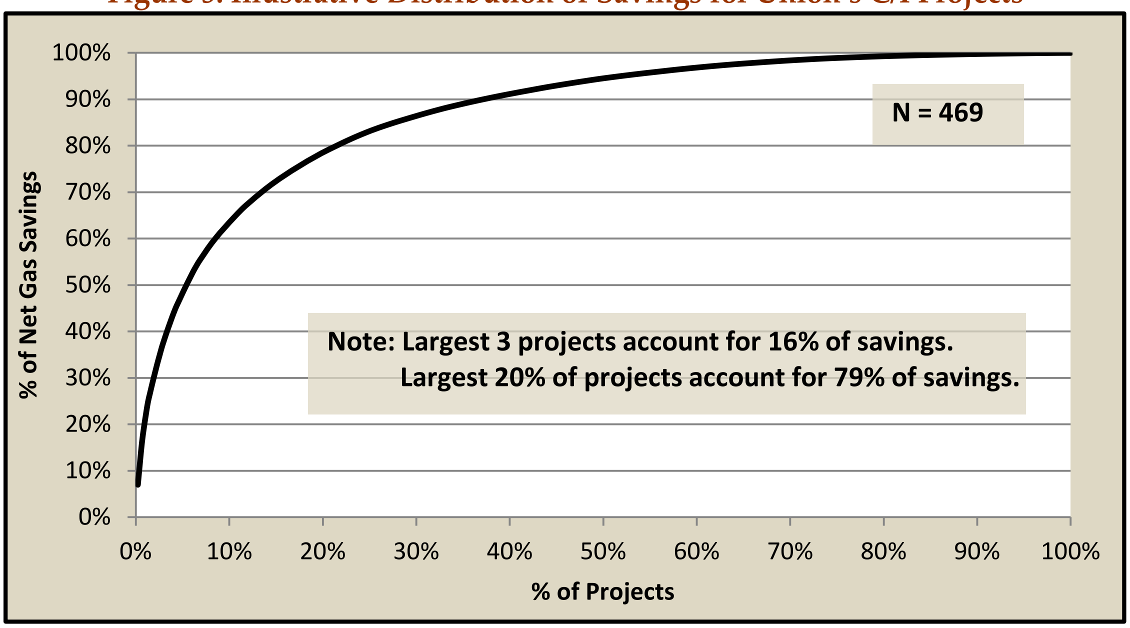


Figure 5. Illustrative Distribution of Savings for Union's C/I Projects



The sensitivity to sample sizes is investigated to determine appropriate savings thresholds for strata bounds. Figure 6 and Figure 7 show illustrative strata boundaries for Union's T1/R100 and C/I programs, respectively.

NAVIGANT

Figure 6. Illustrative Strata Boundaries for Union's T1/R100 Projects

Stratum Size	Lower Threshold of Net Gas Savings (m³)	Projects	Savings Represented (%)
Large	1,500,000	11	33.1%
Medium	800,000	24	29.5%
Small	100,000	97	33.9%
Very Small	0	71	3.4%

Figure 7. Illustrative Strata Boundaries for Union's C/I Projects

Stratum Size	Lower Threshold of Net Gas Savings (m³)	Projects	Savings Represented (%)
Large	800,000	9	30.1%
Medium	200,000	44	36.1%
Small	20,000	225	30.4%
Very Small	0	191	3.3%

The "Very Small" projects—representing the bottom 3.4% of T1/R100 program savings and the bottom 3.3% of C/I program savings—are removed from the sample frame. These projects are small enough that the value of the information gained by evaluating them is not likely to be worth the cost. These projects should be adjusted by the Small Project stratum realization rate when re-introduced in the final sample analysis.

Step 3 estimates an appropriate variance for each stratum. Historical evaluation results indicate that CVs on project realization rates have been as low as 0.20 or as high as 0.40. However, typical CVs have been near 0.25. CVs are set at 0.30 for all strata in this example.

Step 4 allocates observations to each stratum. Figure 8 and Figure 9 indicate the sample sizes[63] and the assumptions used to allocate the samples when applying the calculations presented in Appendix B.

Figure 8. Illustrative Sample Allocation for Union's T1/R100 Projects

Stratum Size	Population Size	Sample Size	CV	T - value	FPC	Mean Gas Savings	Total Gas Savings	Stratum Weight
Large	11	7	0.3	1.94	0.63	2,618,182	28,800,000	0.34
Medium	24	7	0.3	1.94	0.86	1,070,000	25,680,000	0.31
Small	97	6	0.3	2.02	0.97	303,608	29,450,000	0.35
	132	20		1.73				1.00

[63] In previous program cycles when Union's custom programs were differentiated based on service contract rather than rate class, the differences between program sample sizes were much greater. Sample sizes will likely be more similar for the Union programs now that the programs differentiated based on rate class.

NAVIGANT

Figure 9. Illustrative Sample Allocation for Union's C/I Projects

Stratum Size	Population Size	Sample Size	CV	T - value	FPC	Mean Gas Savings	Total Gas Savings	Stratum Weight
Large	9	6	0.3	2.02	0.61	1,532,222	13,790,000	0.31
Medium	44	7	0.3	1.94	0.93	375,909	16,540,000	0.37
Small	225	7	0.3	1.94	0.99	61,902	13,928,000	0.31
	278	20		1.73				1.00

The sample allocations are restricted to less than 75% of the total population for the two Large Project strata. This restriction allows for some backup projects to exist for the Large Project strata so that if recruitment of the original sample is unsuccessful, backup projects can be used and the sample will likely not require re-stratification or re-allocation.

Step 5 determines criteria for assessing sample representativeness. Note that this is listed as an optional step; however, it can be important for ensuring that the most appropriate information is provided from this analysis for making regulatory decisions such as payment of incentives and future program decisions. While the sample methodology applies techniques to minimize the required sample sizes, the smaller samples are at an increased risk that a random sample is not sufficiently representative. This is why ensuring representativeness is an import step.

This example establishes simple criteria to ensure representativeness of the sample across market segment in the R1/T100 and the C/I program sample.[64] Several market segments are specified in the tracking database, and their proportions are shown in Figure 10 and Figure 11.

Figure 10. Illustrative Representativeness Analysis of Project Market Segment for Union'sT1/R100 Program

Project Market Segment	Large Projects			Medium Projects			Small Projects		
	#	m^3	%	#	m^3	%	#	m^3	%
Agriculture	0	0	0%	0	0	0%	299	1,470,000	5%
Food Services	0	0	0%	0	0	0%	61	360,000	1%
Healthcare	0	0	0%	0	0	0%	370	910,000	3%
Manufacturing	66	28,800,000	100%	547	24,380,000	95%	6,344	24,400,000	83%
Resource	0	0	0%	0	0	0%	0	0	0%
Utility	0	0	0%	17	1,300,000	5%	1,074	2,310,000	8%
	66	28,800,000	100%	564	25,680,000	100%	8,148	29,450,000	100%

The main concern is that a randomly selected sample might under-represent the most important market segments, leading to a bias in program results. In these sample designs, less than ten sites may be drawn in a stratum; therefore, it is not impossible that this small sample size might be quite unrepresentative in some strata due to an unlucky sample draw. Increasing the sample sizes in each stratum could help resolve this issue, but the high cost of visiting each site and

[64] Union and its sampling advisor may determine that no criteria are needed or that other criteria are needed based on judgment and assessment of actual program data.

NAVIGANT

gathering the verification data makes this very expensive. As a result, this representativeness check should be considered.

In the T1/R100 program, manufacturing is clearly the dominant market segment and ensuring that a representative sample from this segment across size categories is all that may be needed; however, an evaluator may want to check to see if the random project selection (in the next step) provides some projects from non-manufacturing segments such as agriculture and utility market segments. The most significant risk is likely to occur in the small projects sample where manufacturing accounts for 77% of the projects and 83% of the savings. It could be possible to have an "extreme" sample occur in a random draw where non-manufacturing sites are "overly" represented.[65] The sample for this stratum is only six projects. If five of these projects are non-manufacturing when manufacturing accounts for 83% of the savings, this sample may not provide the information desired from this verification effort. A criteria that at least three of the projects in this stratum be manufacturing projects may represent the minimum needed to consider the sample representative overall.

Figure 11. Illustrative Representativeness Analysis of Project Market Segment for Union's C/I Program

Project Market Segment	Large Projects			Medium Projects			Small Projects		
	#	m^3	%	#	m^3	%	#	m^3	%
Agriculture	0	0	0%	519	4,090,000	25%	10,784	4,301,000	31%
Education	7	4,400,000	32%	40	250,000	2%	2,438	1,210,000	9%
Entertainment	0	0	0%	0	0	0%	349	112,000	1%
Healthcare	0	0	0%	0	0	0%	3,306	918,000	7%
Manufacturing	38	9,390,000	68%	827	12,200,000	74%	19,337	6,896,000	50%
Multi-Family	0	0	0%	0	0	0%	569	152,000	1%
Resource	0	0	0%	0	0	0%	65	160,000	1%
Retail	0	0	0%	0	0	0%	172	43,000	0%
Transport	0	0	0%	0	0	0%	93	110,000	1%
Utility	0	0	0%	0	0	0%	237	26,000	0%
	45	13,790,000	100%	1,386	16,540,000	100%	37,350	13,928,000	100%

In the C/I program, the most important market segment is clearly manufacturing, followed by agriculture and education. To ensure that this is a representative sample, it may be important to be sure that the projects selected in the next step (random selection) contain some projects from each of these market segments. Manufacturing represents 64% of the overall savings. The agriculture and education market segments account for 18% and 13%, respectively, or 31% of total savings when taken together. Given a sample size of 20 overall, and no more than 7 in each stratum, a sample might be drawn that could be extreme in terms of its accurate representation of the population. Again, the concern is the high cost of conducting the site visits, which argues against simply expanding the sample size or adding new strata. To ensure that manufacturing does not entirely dominate the sample, it might be good to set representativeness criteria, for example, that at least four sites be non-manufacturing sites.

[65] What constitutes "overly" represented simply has to be defined by judgment exercised by the evaluator.

Step 6 selects a random sample. The selection of the sample should be uniformly random within each stratum. This is accomplished by applying the RAND() function in Microsoft Excel and selecting the projects with the highest randomly assigned numbers to fulfill sample size requirements. The sample is reviewed to ensure that it meets any previously established criteria. Backup projects are also selected to replace any projects from the primary sample that are not successfully recruited.

Step 7 recruits the sample. Projects from the primary sample are only replaced after four recruitment attempts on four different dates. Projects that are not successfully recruited are documented before being replaced by backup projects.

These seven steps illustrate how the sample design methodology might be implemented using representative data. Following verification and evaluation of the sample, the sample data should be analyzed according to the realization rate methodology presented in Section 6 and according to the calculations presented in Appendix B.

5.6 *Example Implementation of Sample Design Methodology (Enbridge)*

This section demonstrates how the sample design methodology might be implemented for an example set of Enbridge program data. The data used for this example has been randomized and does not indicate historic program achievements that have undergone regulatory review in prior years. The data for this example is intended to be representative of a typical program year for illustrative purposes only. This example is for reference and does not preclude the judgment needed to understand and address the idiosyncrasies of actual program data.

This example applies the steps of the sample design process presented in Section 5.4.

Step 1 reviews the project tracking database for accuracy and quality. This example assumes that the tracking database has been reviewed.

Step 2 evaluates the population and defines strata. Figure 12 and Figure 13 show representative project distributions of savings[66] for Enbridge's commercial and industrial programs, respectively. Analyzing the distribution of project sizes indicates that size-based stratification should produce sampling efficiencies. Other categorical bases for stratification are not chosen for this example.

[66] Net annual savings are used for illustration here. Beginning in 2012, the TEC will require cumulative savings to serve as the basis for evaluation studies.

NAVIGANT

Figure 12. Illustrative Distribution of Savings for Enbridge Commercial Projects

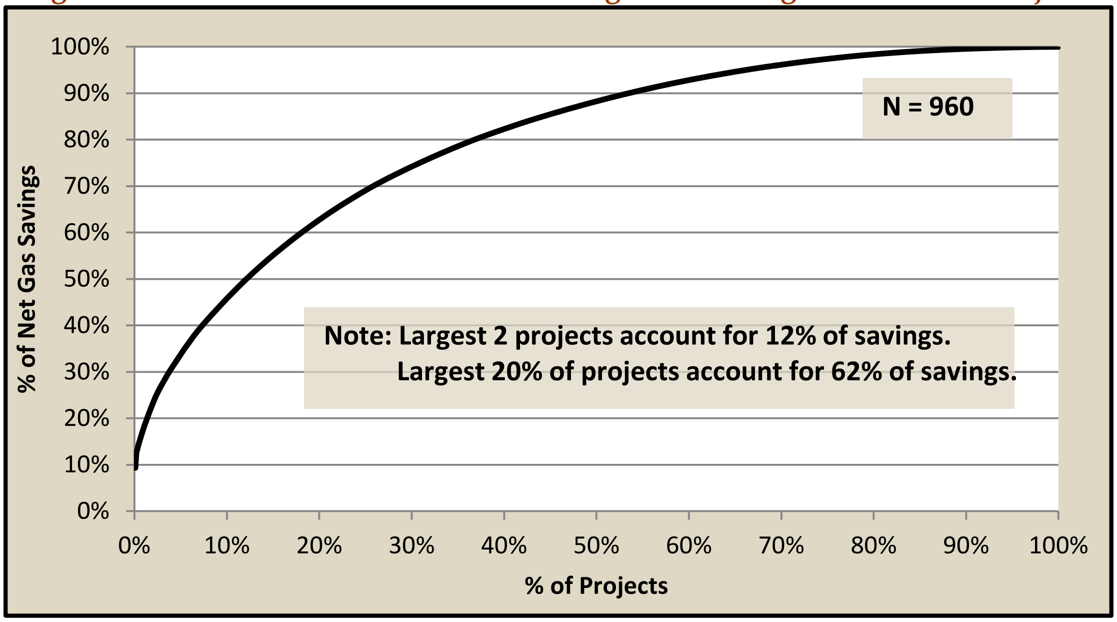
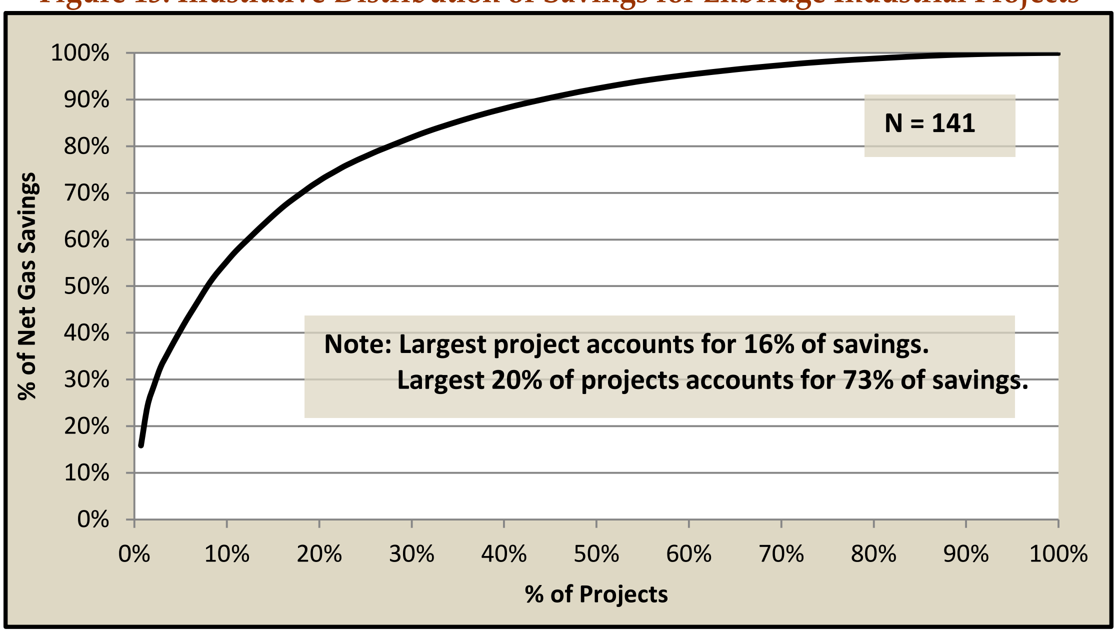


Figure 13. Illustrative Distribution of Savings for Enbridge Industrial Projects



The sensitivity to sample sizes is investigated to determine appropriate savings thresholds for strata bounds. Since the commercial program has a relatively large number of projects, it is necessary to balance the effects of strata weight with the effects of finite population correction when determining the threshold for the Large Project stratum. Figure 14 and Figure 15 show illustrative strata boundaries for Enbridge's commercial and industrial programs, respectively.

NAVIGANT

Figure 14. Illustrative Strata Boundaries for Enbridge Commercial Projects

Stratum Size	Lower Threshold of Net Gas Savings (m^3)	Projects	Savings Represented (%)
Large	250,000	9	17.5%
Medium	70,000	125	35.8%
Small	10,000	563	43.5%
Very Small	0	263	3.2%

Figure 15. Illustrative Strata Boundaries for Enbridge Industrial Projects

Stratum Size	Lower Threshold of Net Gas Savings (m^3)	Projects	Savings Represented (%)
Large	400,000	8	42.9%
Medium	100,000	32	37.7%
Small	20,000	62	17.2%
Very Small	0	39	2.2%

The "Very Small" projects—representing the bottom 3.2% of commercial program savings and the bottom 2.2% of industrial program savings—are removed from the sample frame. These projects are small enough that the value of the information gained by evaluating them is not likely to be worth the cost. These projects should be adjusted by the Small Project stratum realization rate when re-introduced in the final sample analysis.

Step 3 estimates an appropriate variance for each stratum. Historical evaluation results indicate that CVs on project realization rates have been very low, sometimes less than 0.10. However, applying CVs less than 0.30 is not recommended in order to ensure sample sizes sufficient for robust results and to allow for increasing variances that may result from evolving measurement approaches and program participation. CVs are set at 0.30 for all strata in this example.

Step 4 allocates observations to each stratum. Figure 16 and Figure 17 indicate the sample sizes and the assumptions used to allocate the samples when applying the calculations presented in Appendix B.

Figure 16. Illustrative Sample Allocation for Enbridge's Commercial Program

Stratum Size	Population Size	Sample Size	CV	T - value	FPC	Mean Gas Savings	Total Gas Savings	Stratum Weight
Large	9	5	0.3	2.13	0.71	751,111	6,760,000	0.18
Medium	98	8	0.3	1.89	0.97	110,384	13,798,000	0.37
Small	590	11	0.3	1.81	0.99	29,766	16,758,000	0.45
	697	24		1.71				1.00

NAVIGANT

Figure 17. Illustrative Sample Allocation for Enbridge's Industrial Program

Stratum Size	Population Size	Sample Size	CV	T - value	FPC	Mean Gas Savings	Total Gas Savings	Stratum Weight
Large	8	6	0.3	2.02	0.53	947,500	7,580,000	0.44
Medium	32	6	0.3	2.13	0.92	208,125	6,660,000	0.39
Small	62	5	0.3	2.35	0.97	48,903	3,032,000	0.18
	102	17		1.75				1.00

The key reason that the required sample size is smaller for the industrial program than the commercial program is that a larger fraction of the savings is concentrated in a smaller number of projects for the industrial program. The sample allocations are restricted to less than 75% of the total population for the two Large Project strata. This restriction allows for some backup projects to exist for the Large Project strata so that if recruitment of the original sample is unsuccessful, backup projects can be used and the sample will likely not require re-stratification or re-allocation.

Step 5 determines criteria for assessing sample representativeness. This can be important for ensuring that the most appropriate information is provided from this analysis for making regulatory decisions such as payment of incentives and future program decisions. While the sample methodology applies techniques to minimize the required sample sizes, the smaller samples are at an increased risk that a random sample is not sufficiently representative. This is why ensuring representativeness is an important step.

This example establishes a simple criterion to ensure representativeness of load type in the commercial program sample.[67] Three load types are specified in the tracking database, and their proportions are shown in Figure 18.

Figure 18. Illustrative Analysis of Project Load Types for Enbridge's Commercial Program

Project Load Type	Large Projects			Medium Projects			Small Projects		
	#	m^3	%	#	m^3	%	#	m^3	%
Space Heating	7	6,190,000	92%	111	11,853,000	86%	485	14,874,000	89%
Water Heating	1	320,000	5%	3	368,000	3%	65	1,386,000	8%
Combined	1	250,000	4%	11	1,577,000	11%	13	498,000	3%
	9	6,760,000	100%	125	13,798,000	100%	563	16,758,000	100%

The main concern is that a randomly selected sample might over-represent water heating to the detriment of properly representing space heating projects simply due to an unlucky draw of insufficiently representative projects. As example criteria, it might be reasonable to require that space heating projects must account for at least 70% of the savings in each stratum. A sample

[67] Enbridge and its sampling advisor may determine that no criteria are needed or that other criteria are needed based on judgment and assessment of actual program data.

that does not meet these criteria would be viewed as unrepresentative and would be discarded and re-selected.

Step 6 selects a random sample. The selection of the sample should be uniformly random within each stratum. This is accomplished by applying the RAND() function in Microsoft Excel and selecting the projects with the highest randomly assigned numbers to fulfill sample size requirements. The sample is reviewed to ensure that it meets any previously established criteria. Backup projects are also selected to replace any projects from the primary sample that are not successfully recruited.

Step 7 recruits the sample. Projects from the primary sample are only replaced after four recruitment attempts on four different dates. Projects that are not successfully recruited are documented before being replaced by backup projects.

These seven steps illustrate how the sample design methodology might be implemented using representative data. Following verification and evaluation of the sample, the sample data should be analyzed according to the realization rate methodology presented in Section 6 and according to the calculations presented in Appendix B.

5.7 Summary of Sample Design Methodology

The sample design methodology described in this section is meant to apply advanced industry practices to create a cost-efficient sample by leveraging preexisting project and program information to the greatest extent possible. The methodology can be described as employing a "stratified ratio-estimation" approach. The sample is administered in two stages to make the best use of early observations that can be collected prior to completion of the program year. The methodology provides a step-by-step description of sample design tasks, but leaves flexibility to accommodate program changes in future years and cycles.

6. Recommended Realization Rate Methodology

This section describes the recommended methodology for determining realization rates and achieved confidence and precision based on sample observations of custom DSM programs for Union and Enbridge. Section 6.1 describes the approach to determine verified realization rates. Section 6.2 describes the approach to determine the precision on the realization rate and total savings achieved by the sample. Section 6.3 discusses several potential adjustments that may be needed to ensure that the results appropriately characterize the population and provide the information needed by the utilities and stakeholders.

It is important ensure the quality of sample observation data prior to calculating achieved realization rates and savings. Data quality issues can sometimes be discovered when analyzing the sample, but it can be costly to correct the data at that point. Undetected data quality issues would result in inaccuracies of total savings and precision estimates.

6.1 Determining Verified Realization Rates

Realization rates should be calculated for each stratum sample and applied to each respective stratum population when estimating total savings. Applying realization rates to population strata is more complicated than assessing the results in a simple random sample without strata, but it is necessary when efficiencies are sought through stratification.[68]Again, efficiencies are important in this application due to the high cost of gathering the verification data at each sample site. Lohr notes:

> *The population total is the [sum across all strata of the estimated stratum population mean times the stratum population size]…This is a weighted average of the sample stratum averages; the weights are the relative sizes of the strata. To use stratified sampling, the sizes or relative sizes of the strata must be known.* [69]

Also, Wadsworth notes:

> *The estimator of the total of a stratified population can be expressed as the sum of strata of estimators of the individual stratum totals. This representation suggests the valid generalization that the estimator of the total in a stratum need not be limited to the expansion estimator, but could be any appropriate estimator of the population in the stratum, including a ratio estimator…then an estimate of the total in a stratified population may be constructed as a sum over strata.* [70]

[68] There are examples in the evaluation literature where strata weights have not been used in the calculation of the mean realization weight. This is clearly an oversight in these evaluations as it is a simple matter to weight the mean ratios of each stratum by the appropriate stratum weight (i.e., the proportion of the population in that stratum).

[69] Lohr, S. L., "Sampling: Design and Analysis," Second Edition. 2010, p. 69.

[70] Wadsworth, H.M., "Handbook of Statistical Methods for Engineers and Scientists," 1990, p. 9.25.

These are standard procedures for developing population estimates from a stratified sample. The methods for estimating the population parameters must take into account the strata weights when stratification is used. The calculations needed to develop a verified realization rate from stratified sample data are shown in Appendix B. This approach is based on widely recognized methods published by Lohr.[71]

This approach for determining realization rates is consistent with the recommended sample design methodology presented in Section 5.

6.2 Determining Achieved Confidence & Precision

A precision level cannot be calculated without first establishing the confidence level. The calculation for both confidence and precision comes from the same basic equation. Either confidence or precision is first established, then the other is solved for. For example, a precision of +/- 10% implies that the stated confidence level should span +/- 10% from the mean estimate. The confidence may turn out to be 90%, 82% or another value. The confidence level is more typically established and the precision is solved for. For example, the level of precision achieved at a 90% level of confidence can be calculated and may turn out to be 10%, 12%, 15% or some other number (as illustrated in Appendix A). Regardless, the calculating confidence and precision are part of the same equation and one cannot be estimated without establishing the other. Misunderstanding this basic concept frequently leads to problems in presenting and discussing evaluation results in the industry. Additional discussion on confidence and precision can be found in Appendix A.

Confidence and precision calculations also have to take into account the fact that a stratified random sample has been used. The equations for calculating confidence and precision from a stratified sample design are shown in Appendix B. This approach for determining confidence and precision is consistent with the recommended sampling methodology in Section 5, and it is consistent with the population realization rate and savings estimates described in Section 6.1.

Communications with the TEC indicated that they were interested in both the likelihood that savings exceeds a given value and the likelihood that it falls above a given value. As a result, the recommendation is to report achieved confidence and precision in three ways:[72]

1. Achieved precision corresponding to 90% one-sided confidence on the lower bound
2. Achieved precision corresponding to 90% one-sided confidence on the upper bound[73]
3. Achieved precision corresponding to a 90% two-sided confidence interval

---

[71] Lohr, S. L., "Sampling: Design and Analysis," Second Edition.2010. (Sections 4.1-4.5)

[72] The achieved precision is a result of analyzing the sample data, and will usually differ to some extent from the targeted precision applied in designing the sample.

[73] Achieved precision of the upper bound represents a simple inversion of the confidence interval for the lower bound. Reporting on the upper bound is intended to facilitate an understanding that sampling uncertainties can just as likely lead to underestimation of the realization rate and therefore underestimating overall program savings as they are to result in overestimates.

NAVIGANT

Appendix A provides additional explanation and illustrative examples for the reporting of confidence and precision in the estimated realization rate. The Figures in Appendix A are intended to clarify the interpretation of confidence and precision in making decisions based on the estimated realization rate.

6.3 *Sample Adjustments & Related Issues*

This section discusses several sampling adjustments that may be needed to accurately synthesize the total population realization rate and savings estimates. The following three types of adjustments are discussed:

1. Treatment of outliers and influential observations
2. Replacing sample projects
3. Post-stratification

Appropriately treating outliers and influential observations is important in accurately estimating the realized savings for DSM programs. Parties to a discussion of estimating program savings should understand appropriate treatment of outliers and influential observations when estimates are based on a sample of the population.

Treatment of Outliers & Influential Observations

This section first presents a conceptual discussion. Following this discussion, an example from a recent Union custom program evaluation is presented. Most statistical analyses should examine the data for outliers and test to determine whether these outliers may be "influential observations" that can skew the accuracy of a sample. Kennedy states the rationale for treating outliers:

> *The rationale for looking for outliers is that they may have a strong influence on the estimates…an influence that may not be desired.* [74]

In other words, the reason for looking for evaluating outliers is that there may be a sample case drawn that is well outside the expected bounds of the distribution and that this observation may exert undue influence on the estimates of the analysis (i.e., an influential observation). Osborne and Overbay further describe the effect of outliers:

> *The presence of outliers can lead to inflated error rates and substantial distortions of parameter and statistic estimates when using either parametric or nonparametric tests (e.g., Zimmerman, 1994, 1995, 1998). Casual observation of the literature suggests that researchers rarely report checking for outliers of any sort.* [75]

[74] Kennedy, P. "A Guide to Econometrics." Third Edition. MIT Press, 1992, p. 279.

[75] Osborne, J., Overbay, A. "The Power of Outliers and Why Researchers Should Always Check for Them."2004 Practical Assessment, Research & Evaluation, volume 9, section 6. Link: http://pareonline.net/getvn.asp?v=9&n=6

The issue is whether it is appropriate for a single observation to swing the overall results in a substantial manner.[76] If such an observation is found, then further study is needed to determine the most appropriate course of action. In general, a sample of 10 from a population of 100 projects implies that each sample point represents 10 projects. However, if a selected sample point is truly a unique case and does not represent other projects in the population, then an adjustment may be warranted. Osborne and Overbay go on to state:

> *[The appropriate treatment] depends in large part on why an outlier is in the data in the first place. Where outliers are illegitimately included in the data, it is only common sense that those data points should be removed… Few should disagree with that statement.*

The sample analysis should seek to determine whether or not outliers and influential observations can be viewed as representative members of the main population upon which population estimates may be inferred. Barnett and Lewis note:[77]

> *If they are not [suitable]…they may frustrate attempts to draw inferences about the original (main) population.*

One example can be taken from the analysis of the sample observation in Union's 2011 custom program. Two outliers were identified in the Distribution Contract (DC) custom program. One verified project observed a gas savings realization rate of 3.75 and a second project observed a realization rate of 0.18. A sensitivity analysis tested for the influence of these two observations by removing[78] them and noting the changes in results.[79]

The estimated overall realization rate for gas savings when including both observations was 1.25. This is a relatively high realization rate when compared to evaluation efforts across North America, but not an unheard of result. Excluding the high observation lowered the estimated overall estimate from 1.25 to 1.05. Excluding the low observation raised the overall estimate from 1.25 to 1.32. Excluding both outliers produced an overall realization rate on gas savings of 1.11.

Discussions were held with Union concerning the two outlier observations. It is important not to exclude an observation without examining the reasons that may contribute to the

[76] A simple intuitive example of the impacts an outlier can have on a statistical analysis can be found in a Wikipedia contribution (8/20/2012): *Naive interpretation of statistics derived from data sets that include outliers may be misleading. For example, if one is calculating the average temperature of 10 objects in a room, and nine of them are between 20 and 25 degrees Celsius, but an oven is at 175 °C, the median of the data could be between 20 and 25 °C but the mean temperature will be between 35.5 and 40 °C. In this case, the median better reflects the temperature of a randomly sampled object than the mean; however, naively interpreting the mean as "a typical sample", equivalent to the median, is incorrect. As illustrated in this case, outliers may be indicative of data points that belong to a different population than the rest of the sample set.*

[77] Barnett, V., Lewis, T., "Outliers in Statistical Data." Wiley Series in Probability & Statistics, 1998/1994.

[78] Removing or excluding an outlier entails isolating the sample point in a unique stratum such that the sample point still counts in the analysis, but it is not used for extrapolating results for the un-sampled population.

[79] Note that some observations may be identified as outliers but do not significantly influence the analysis results.

NAVIGANT

observation's extreme value. If the observation is representative of other projects in the population, it should be left in. If it can be shown to result from a one-time construct and is not likely to be replicated by other members of the population, then exclusion of this observation should be considered. The discussions with Union indicated that both observations were likely due to unique calculation issues and technologies involved.

The most conservative position in treating this outlier issue was taken—the high observation was removed and the low observation was retained in the sample data set. This produces the lowest overall program realization rate given the choices in addressing the identified outliers. However, removing outliers in strata with small sample sizes may also adversely affect the confidence and precision results and the sample may require augmentation to achieve confidence and precision targets.

Projects that implement new technologies—whose savings estimates have had less validation—or certain technology classes that are complex and difficult to estimate for the tracking database may be at an increased likelihood to result in outlier realization rates. Identifying such projects in the program tracking database could help isolate them and reduce their chance of skewing program estimates. These projects could be placed into a separate category with different confidence and precision targets for new technologies. Any projects that are truly unique should be identified and addressed during sample design. These steps would not eliminate these projects in terms of their contribution to overall program savings, but would allow for appropriate methods to more accurately estimate program savings. If sampled, these unique projects should not be considered representative of other projects in the main program. As a result, addressing this issue in advance could improve the sample analysis and the resulting program estimates.

Replacing Sample Projects

The final recruited sample should be analyzed and summarized, especially when replacement projects are substituted into the originally selected sample. Recruiters should document the reasons for unsuccessful recruitment of original sample members. Replacement samples should always be selected in priority based on the assigned random number, and full effort should be made to recruit selected replacements before substituting other replacements. If recruitment rates are very poor, this may introduce a significant non-response bias. Low recruitment rates should be investigated and documented, and recommendations may be made to improve recruitment in subsequent evaluation years.

Post-Stratification

If a sample did not achieve the desired confidence and precision and the stratification basis is thought to be sub-optimal, post-stratification may be used to retrospectively re-stratify a sample along more appropriate dimensions to demonstrate an improved precision achieved by the sample. Often, post-stratification will not improve achieved precision, especially at relatively small sample sizes; however, under certain circumstances this technique may be useful. The Ontario Power Authority notes that:

A technique known as post-stratification may be used to develop estimates about sub-populations after the study is complete and can be used if characteristics about the sub-populations are unknown at the time the study in conducted.

This advanced technique should be reserved for special situations and utilized only after careful consideration of other options and well documented in the experimental approach of the Draft Evaluation Plan. [80]

Post-stratification should not be used on a normal basis, and if necessary should inform subsequent program evaluation cycles to improve the sample frame and prevent the need for post-stratification in future years.

6.4 Summary of Realization Rate Methodology

This section presents the method for calculating verified ex-post realization rates as well as for appropriately calculating the confidence and precision levels for the estimated realization rate and overall program savings. It also discusses three issues that can lead to adjustments to the sample and recalculation of the realization rate along with confidence and precision levels. There are several important concepts presented in this section:

- The program realization rate is inferred from the sample observations based on the separate realization rates for each stratum.
- The realization rate calculations should apply the strata weights to accurately interpret sample observations. This adds a bit of complexity, but no alternate application of the observed data would be appropriate. This is considered standard practice in the application of a stratification approach in statistics.
- There are some important and legitimate considerations that should be examined when inferring estimates for a population from an observed sample. The following three factors are discussed in this section:
    1. Outliers and influential observations
    2. Replacement projects when data cannot be gathered from the originally sampled project
    3. Post-stratification to provide higher precision and greater confidence in the results

The equations needed to calculate the realization rates and achieve confidence and precision from the sample data are contained in Appendix B.

[80] "EM&V Protocols and Requirements: 2011-2014." Ontario Power Authority. March 2011, p. 130.

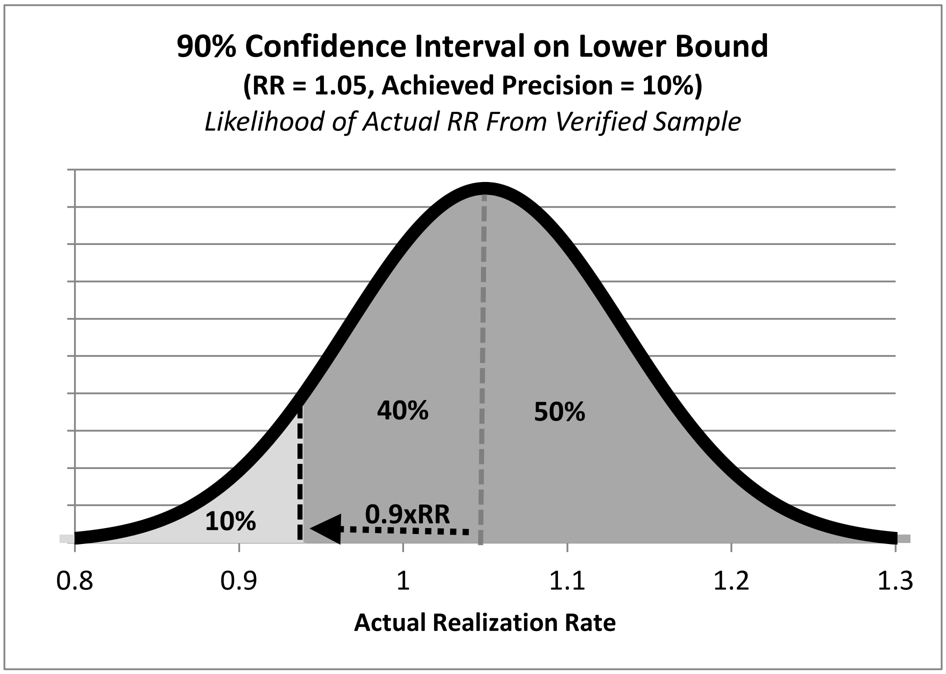
NAVIGANT

Appendix A. Explanatory Note on Confidence & Precision

The level of certainty associated with a statistical sample is most often stated in terms of a confidence interval. A confidence interval contains two components: confidence level and precision. Confidence level indicates the likelihood that an actual variable either exceeds a value (i.e., one-sided confidence) or falls within a range (i.e., two-sided confidence). Precision[81] indicates the bounding values of the corresponding confidence level. Confidence and precision are both necessary to sufficiently describe a confidence interval.[82]

At the time of this report, the target confidence interval for the design of the sample is established as 90/10 one-sided.[83] Figure 19 illustrates a 90% one-sided confidence interval with 10% precision for a sample whose realization rate (RR) is estimated to be 1.05.

Figure 19. Illustration of a 90% One-Sided Confidence Interval on the Lower Bound



---

81 Relative precision (e.g., 10% of the estimate) is most often used to set the precision as a percentage of the estimated value rather than in absolute terms.

82 Also, the shape (i.e., one-sided or two-sided) is often used to fully specify the confidence interval.

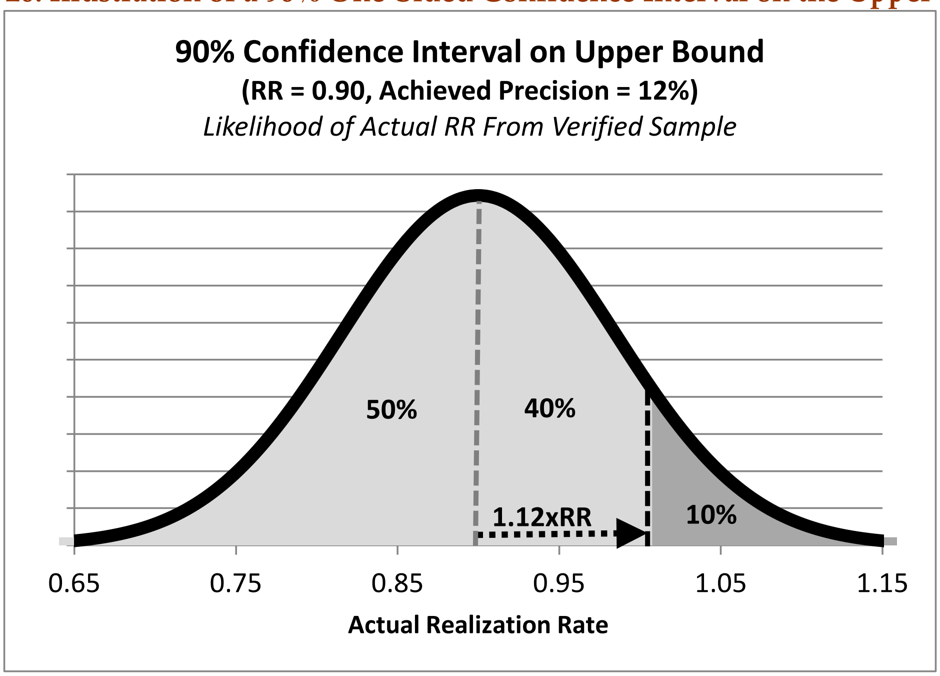
83 Based on October 25, 2012 Technical Evaluation Committee decision the sample design should be based on a 90/10 one-sided confidence interval. Reporting of achieved confidence and precision should present the precision achieved for both the 90% one-sided and 90% two-sided intervals.

Reading off of Figure 19, this confidence interval can be interpreted as showing that:[84]

- There is a 10% likelihood that the actual value is less than 10% below the mean sample estimate of 1.05.
- There is a 40% likelihood that the actual value falls between 10% below the sample estimate and the sample estimate of 1.05.
- There is a 50% likelihood that the actual value exceeds the sample estimate of 1.05.

The reporting recommendations in Section 6.2 of the main report also call for the reporting of a one-tailed test around an upper bound and a two-tailed test at a 90% confidence level. These are illustrated in Figure 20 and Figure 21. Figure 20 illustrates a 90% one-sided confidence interval on the upper bound. For this illustration a different realization rate estimate is use that was used in Figure 19. In this case, the estimated realization rate is 0.90 and the level of precision achieved at the 90% confidence level is observed from the sample to be 12%. This confidence interval illustrates that the actual value has a 10% likelihood of exceeding the estimated realization rate of 0.90 plus 12% (i.e., exceeding a realization rate 1.01). This likelihood is illustrated by the dark shaded portion of the distribution in the Figure.

Figure 20. Illustration of a 90% One-Sided Confidence Interval on the Upper Bound

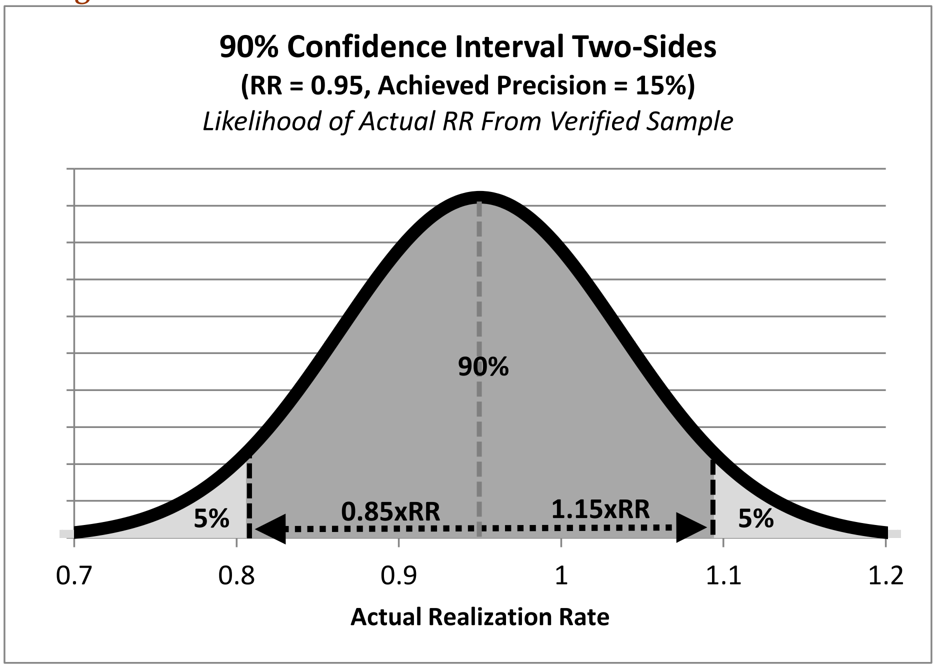


[84] This interpretation of the confidence interval is based on statistical inference, which assumes that the sample provides an adequate representation of the population.

NAVIGANT

Figure 21 illustrates a 90% two-sided confidence interval on a sample whose realization rate is observed to be 0.95 and whose achieved precision is 15%. The dark shaded area in the middle of the distribution represents the 90% confidence level that the actual value would fall between the bounds set dat plus or minus 15% of the observed sample estimate. There is only a 5% likelihood that the actual value would fall below the lower bound.

Figure 21. Illustration of a 90% Two-Sided Confidence Interval



Appendix B presents the detailed calculation methods for determining the confidence and precision achieved by a sample.

NAVIGANT

B.1 Calculating Target Sample Confidence & Precision from Assumed CV

(Note: The formulae in this appendix are based on application of Lohr[85] and Cochran,[86] and are adapted to the vocabulary of the stratified realization rate problem of efficiency program evaluation.)

The standard error of the total savings of stratum h based on tracked ex ante savings[87] is given by,

$$SE'_h = FPC_h \times \frac{CV_h}{\sqrt{n_h}} \times TS'_h$$

Where CV_h[88] is the estimated coefficient of variation in stratum h, defined as the expected stratum standard deviation divided by the expected stratum mean.[89] Where FPC_h is the finite population correction factor of stratum h, n_h is the sample size of stratum h, and TS'_h is the tracked ex ante total savings in stratum h.[90] FPC_h is given by,

$$FPC_h = \sqrt{\frac{N_h - n_h}{N_h - 1}}$$

Where N_h is the population size of stratum h. The relative precision at the stated confidence level of stratum h is given by,

$$RP'_h = t_h \times \frac{SE'_h}{TS'_h} \times 100\%$$

Where t_h is the t-value derived from the confidence requirement and the sample size of stratum h. The overall standard error can be calculated by aggregating the sample according to each stratum's weighting (i.e., expected percent contribution to total program savings). The overall standard error of the tracked ex ante total savings of the program is given by,

---

[85] Lohr, S. L., "Sampling: Design and Analysis," Second Edition, 2010.
[86] Cochran, W. G., "Sampling Techniques," Third Edition, 1977.
[87] The prime symbol (apostrophe) is used to indicate that these values are based on tracked ex ante values rather than verified ex post values.
[88] In cases of ratio estimation, the error ratio is substituted for the coefficient of variation.
[89] The coefficient of variation may be based on savings or realization rate, as in the case of ratio estimation.
[90] Total tracked ex ante is not necessarily required to compute relative precision since this term is also in the denominator of the relative precision calculation.

NAVIGANT

$$SE'_P = \sqrt{\sum_h SE_h^{\ 2}}$$

The overall relative precision at the stated confidence level is given by,

$$RP'_P = t_P \times \frac{SE'_P}{TS'_P} \times 100\%$$

Where t_P is the t-value derived from the confidence requirement and the overall sample size in the population, and TS'_P is the estimated total savings across all strata based on verified ex post savings.

B.2 *Calculating Achieved Realization Rates*

Defining $x_{i,h}$ as the tracked ex ante estimate and $y_{i,h}$ as the verified ex post estimate of a single sample point i in stratum h, the effective realization rate of a single sample point i in stratum h is given by,

$$RR_{i,h} = \frac{y_{i,h}}{x_{i,h}}$$

The stratum sample realization rate of stratum h is the sum of all verified ex post savings in the sample of stratum h divided by the sum of all tracked ex ante savings in the sample of stratum h, given by,

$$RR_h = \frac{\sum_{i \in h} y_{i,h}}{\sum_{i \in h} x_{i,h}}$$

In stratified ratio estimation, the stratum realization rate should be applied to the tracked ex ante estimates of each member j[91] of the full population of stratum h to produce the total savings estimate for stratum h. The verified total savings estimate for stratum h is the sum of all tracked ex ante estimates in stratum h multiplied by the stratum realization rate, given by,

$$TS_h = RR_h \times \sum_{j \in h} x_{j,h}$$

[91] Note that i members of the sample are a subset of j total members of the applicable population.

The verified total savings of the program can be calculated by aggregating strata results. The program verified total savings estimate is given by,

$$TS_P = \sum_h TS_h$$

The overall realization rate across all strata is the verified total savings of the program divided by the tracked ex ante total savings of the program, given by,

$$RR_P = \frac{TS_P}{TS'_P}$$

B.3 *Calculating Achieved Sample Confidence & Precision*

A predicted estimate can be made for each member of stratum h based on the stratum realization rate, where the predicted estimate is the tracked ex ante estimate of each member of the stratum multiplied by the stratum realization rate. A residual error can be calculated for each sample point in stratum h based on the difference between the verified ex post savings of the sample point and the predicted estimate. The residual of each sampled point is given by,

$$e_{i,h} = y_{i,h} - RR_h \times x_{i,h}$$

The sample variance[92] of the verified total savings in stratum h is derived from the stratum residuals, given by:

$$V_h = \frac{1}{n_h - 1} \sum_{i \in h} e_{i,h}^2$$

The standard error of the sample of stratum h can be calculated using the stratum sample variance and the finite population correction factor. The standard error of the verified total savings of stratum h is given by,

$$SE_h = FPC_h \times \frac{\sqrt{V_h}}{\sqrt{n_h}} \times N_h$$

[92] Sample variance is based on residuals of the verified measurement compared to the predicted estimate using the stratum realization rate when applying ratio estimation.

NAVIGANT

The relative precision for the stated confidence level of the verified estimate of stratum h is given by,

$$RP_h = t_h \times \frac{SE_h}{TS_h} \times 100\%$$

The resulting confidence interval can be stated in terms of the realization rate or the total estimate. The absolute two-sided confidence interval for the stratum realization rate and verified total savings of stratum h is given by,

$$RR_h \pm (RR_h \times RP_h) \qquad and \qquad TS_h \pm \; (TS_h \times RP_h)$$

The absolute one-sided confidence interval for the stratum realization rate and verified total savings of stratum h is given by,

$$> RR_h - (RR_h \times RP_h) \qquad and \qquad > TS_h - \; (TS_h \times RP_h)$$

The standard error of the verified total savings of the program is given by,

$$SE_P = \sqrt{\sum_h SE_h^2}$$

The overall relative precision at the stated confidence level is given by,

$$RP_P = t_P \times \frac{SE_P}{TS_P} \times 100\%$$

The absolute two-sided confidence interval for the overall program realization rate and verified total savings of the program is given by,

$$RR_P \pm (RR_P \times RP_P) \qquad and \qquad TS_P \pm \; (TS_P \times RP_P)$$

The absolute one-sided confidence interval for the overall program realization rate and verified total savings of the program is given by,

$$> RR_P - (RR_P \times RP_P) \qquad and \qquad > TS_P - \; (TS_P \times RP_P)$$

NAVIGANT

Appendix C. Summaries of Custom C&I Samples in Selected Jurisdictions

This appendix presents brief summaries of the sampling approaches used in custom commercial and industrial (C&I) programs in selected jurisdictions. The reviewed approaches are all contained within publicly available documents. Because the reviewed documents contain varying degrees of detail and explanation, the Navigant team applied its best interpretation of these documents to synthesize the available information in a consistent manner. Eight jurisdictions are discussed below. Published information on the sampling procedures allowed for a useful summary to be produced.

C.1 Summary from Illinois (ComEd)

The Commonwealth Edison Company (ComEd) Smart Ideas for Your Business program offers all eligible commercial and industrial customers financial incentives for upgrading their facilities with energy-efficient equipment. The program offers prescriptive incentives, available for qualified equipment commonly installed as part of retrofit and equipment replacement projects, or custom incentives, available for less common and more complex energy-saving measures. Examples of custom projects include heating, ventilating, and air conditioning (HVAC) measures (such as chiller upgrades and centralized thermostat control systems), large commercial refrigeration measures, air compressor system upgrades, high-rise building domestic water pumping systems, industrial process renovations, and non-prescriptive lighting measures. In 2011, the custom incentive levels were $0.03/kilowatt-hour (kWh) for equipment with less than a five-year life and $0.07/kWh for equipment with a five-year life or greater.[93] These incentive levels were applied for the first $100,000 in incentives and then reduced by half for the next $100,000, up to the project cost cap. In 2011, ComEd provided financial incentives to 887 projects. Of these, 32 projects were selected for evaluation to achieve confidence and precision targets of 90% and 8% over the three-year program.[94]

A two-stage sampling methodology was implemented, with the first projects being sampled in April of 2011 and the remaining projects sampled in July. The sampling approach stratified the population of projects by project size. All custom projects were sorted into three strata based on *ex ante* energy (kWh) savings, such that each stratum contained one-third of the total claimed energy savings.[95] The evaluation sample was drawn to represent the population distribution by stratum. Figure 22 shows the total number of projects and the evaluation sample by stratum. This sample represents 100% of the population's claimed energy savings in the first stratum,

[93] Any project involving Energy Management System programming is eligible for the $0.03/kWh incentive. To receive the $0.07/kWh custom incentive, equipment must have a minimum payback of one year and a maximum payback of seven years.

[94] A thirty-third project had been selected but after the site-visit it was moved into the following program year (PY4).

[95] Note that ComEd's custom program application does not require that applicants submit an estimate of savings, suggesting that the claimed savings may be underestimated. In addition, more projects may be assigned to stratum 3, resulting in a less precise estimation of *ex post* gross impacts.

NAVIGANT

59% in the second, and 5% in the third. In total, the 32 projects represent 45% of the program's custom projects' *ex ante* energy savings.

Figure 22. ComEd 2011 C&I Sample Summary

Sampling Stratum	Total Number of Projects	Evaluation Sample
1	2	2
2	27	15
3	858	15
Total	**887**	**32**

Source: Navigant Review of Evaluation Report[96]

C.2 *Summary from Michigan (DTE Energy)*

The DTE Energy C&I non-prescriptive program offers business customers financial incentives for the installation of "innovative and unique" energy efficiency equipment and controls. Examples of custom measures include energy management system controls, variable-speed air compressors, and ultrasonic HVAC humidification systems. Ineligible customer measures include on-site electricity generation, renewable energy, peak-shifting, fuel switching, or changes in operational/maintenance practices that do not involve capital costs. The custom incentive levels are $0.08/kWh, based on the first year of estimated energy savings, up to 50% of the project cost. Projects require a one-year minimum payback and an eight- year maximum payback.

In 2010, DTE Energy provided financial incentives for 515 energy efficiency measures associated with 381 unique projects. Of these projects, 56 were selected for evaluation to achieve confidence and precision targets of 90% and 10%, respectively, at the program level. This sample of 56 was based on a proportional sampling of measures from each of the three major technology groups: custom lighting, custom electric and custom gas.[97] Figure 23 shows the number of energy efficiency measures, unique projects, and evaluation sample size by group. The sample of custom lighting measures, custom electric measures, and custom gas measures represents 60%, 45%, and 90% of *ex ante* gross energy savings, respectively, for the population.

[96] "Evaluation Report: Smart Ideas for Your Business Custom Program." (Program Cycle 2010-2011.) Commonwealth Edison Company. Prepared by Navigant Consulting, Incorporated. May 16, 2012.

[97] Due to the small sample of "custom electric", several additional measure types were consolidated into this group to avoid a potential distortion in the realization rate. For example, custom HVAC, custom motors, and measures installed through a grocery RFP are included in the "custom electric" category.

NAVIGANT

Figure 23. DTE Energy 2010 Custom C&I Sample Summary

Sampling Stratum	Total Number of Measures	Total Number of Projects	Evaluation Sample
Custom Lighting	321	252	27
Custom Electric	150	93	9
Custom Gas	44	36	20
Total	**515**	**381**	**56**

Source: Navigant Review of Evaluation Report[98]

C.3 Summary from Massachusetts (National Grid, NSTAR, and Western Massachusetts Electric Company)

The C&I energy efficiency program run by the Massachusetts Program Administrators offers financial incentives to business customers for installing energy-efficient equipment. Custom projects are categorized as either a comprehensive design (CD) project or a comprehensive chiller (CC) project. CD projects typically involve the new construction of commercial, industrial, or municipal buildings that include at least four energy conservation measures (ECMs) that achieve a minimum of 20% energy savings relative to code.[99] CC projects typically involve the installation of a new chiller and multiple other ECMs in an existing building that achieve a minimum of 20% savings.

In 2008 and 2009, 25 custom projects were installed in National Grid, NSTAR, and Western Massachusetts Electric Company (WMECO) service territories.[100] Custom projects were stratified for National Grid, NSTAR, and WMECO separately, resulting in three strata for National Grid and one stratum for both NSTAR and WMECO. Although not specified in the evaluation report, it appears that stratification was based on project size. Figure 24 lists the number of projects and evaluation sample in each stratum by program administrator. Of these projects, five were selected for evaluation to achieve confidence and precision targets of 90% and 10%, respectively, three from National Grid and one each from NSTAR and WMECO.

[98] "Reconciliation Report for DTE Energy's 2010 Energy Optimization Programs." DTE Energy Company. Prepared by Opinion Dynamics Corporation. April 15, 2011.

[99] Examples of ECMs are building envelope upgrades, lighting fixtures and controls, cooling system upgrades, and Energy Management System controls.

[100] Twenty-two custom projects occurred in National Grid service territory, 2 in NSTAR, and 1 in WMECO.

NAVIGANT

Figure 24. Massachusetts 2008-2010 Custom C&I Sample Summary

Sampling Stratum	Total Number of Projects	Maximum Gross Savings (kWh)	Evaluation Sample
National Grid, 1	12	332,480	1
National Grid, 2	6	608,237	1
National Grid, 3	4	1,108,409	1
NSTAR, 1	2	3,352,840	1
WMECO, 1	1	496,579	1

Source: Navigant Review of Evaluation Report[101]

C.4 Summary from New Mexico (New Mexico Public Service Company and New Mexico Gas Company)

New Mexico Gas Company and the Public Service Company of New Mexico have programs that offer financial incentives to commercial and industrial customers for custom energy efficiency projects.[102] The custom C&I program offered by the New Mexico Gas Company is called "Commercial Solutions" and provides low-flow faucet aerators and pre-rinse spray valves at no cost, as well as a $0.75/therm incentive for custom measures (e.g., water heating, HVAC, building envelope, and industrial process improvements). The custom C&I program offered by the Public Service Company of New Mexico is called the "Commercial Comprehensive Program" and provides rebates for a range of prescriptive and custom measures. Projects are classified as either retrofit, new construction, or QuickSaver direct-install.

The sampling methodology to evaluate C&I programs utilizes stratified random sampling to achieve 90% confidence and 10% precision levels. Projects are stratified by project size. New Mexico Gas Company stratified into three strata. The Public Service Company of New Mexico implemented the sampling strategy for retrofit, new construction, and quick-saver projects separately. Due to the large population of projects for retrofit and QuickSaver, projects were stratified into five strata, while new construction projects were stratified into three strata. Figure 25 and Figure 26 show the number of projects and evaluation sample by stratum.

[101] "Impact Evaluation of 2008 and 2009 Custom CDA Installations." Massachusetts Energy Efficiency Advisory Council. Prepared by KEMA and SBW Consulting Incorporated. June 7, 2011.

[102] El Paso Electric Company also offers a custom C&I program. However, during 2010 and 2011 there were no participants and as a result an evaluation of the program was not conducted.

NAVIGANT

Figure 25. New Mexico Gas Company 2011 Custom C&I Sample Summary

Sampling Stratum	Total Number of Projects	Evaluation Sample
< 1,000 therms	16	3
1,000 – 5,000 therms	7	3
> 4,000 therms	5	5
Total	**28**	**11**

Source: Navigant Review of Evaluation Report[103]

Figure 26. Public Service Company of New Mexico 2011 Custom C&I Sample Summary

Retrofit		
Sampling Stratum	Total Number of Projects	Evaluation Sample
< 26.5 MWh	95	5
26.5-50 MWh	38	4
50-150 MWh	48	4
150-500MWh	29	5
>500 MWh	9	9
Total	**224**	**27**

QuickSaver		
Sampling Stratum	Total Number of Projects	Evaluation Sample
< 10 MWh	192	4
10-20 MWh	150	4
20-40 MWh	88	4
40-95 MWh	44	4
> 95 MWh	10	10
Total	**484**	**26**

New Construction		
Sampling Stratum	Total Number of Projects	Evaluation Sample
< 70 MWh	12	3
70-250 MWh	9	4
> 250 MWh	2	2
Total	**23**	**9**

Source: Navigant Review of Evaluation Report[104]

C.5 *Summary from Pennsylvania (PECO Energy)*

The PECO Energy Company Smart Equipment Incentives program offers financial incentives for installing energy-efficient equipment in commercial and industrial facilities and in master-metered multifamily residential buildings. The program offers incentives for both prescriptive and custom measures. Examples of custom projects include energy management systems,

[103] "Evaluation of 2011 DSM Portfolio." New Mexico Gas Company. Prepared by ADM Associates Incorporated. June 2012.

[104] "Evaluation of 2011 DSM & Demand Response Portfolio." Public Service Company of New Mexico. Prepared by ADM Associates Incorporated. March 2012.

compressed air systems, process equipment and chillers, industrial systems, whole building systems, and outdoor lighting. Custom incentive levels are $0.12/kWh for estimated on-peak energy savings and $0.08/kWh for estimated off-peak energy savings, up to 100% of project costs.[105]

In 2010, PECO provided financial incentives to 1,085 non-multi-tenant projects and 490 multi-tenant projects. Of these projects, 39 were selected for evaluation to achieve confidence and precision targets of 85% and 10%, respectively, at the program level.[106] The sample is stratified by project size, based on *ex ante* energy savings, and by project-type (lighting, non-lighting, custom). A three-stage sampling strategy was implemented, with the first stage occurring after the end of Q2, the second stage after Q3, and the third stage after Q4.[107,108] Within the sample, custom projects make up the majority of stratum 1, accounting for 49% of *ex ante* energy savings for the sample population.[109]

C.6 Summary from Ohio (AEP Ohio)

AEP Ohio offers commercial and industrial customers energy efficiency incentives through a number of programs. The custom program provides financial incentives for "less common or more complex energy-saving measures" that are installed as part of a qualified retrofit project or equipment replacement project. Examples of custom measures include lighting retrofits, HVAC measures such as VFDs, equipment controls, and process efficiency improvements. Custom incentive levels are based on both energy (kWh) and demand (kW) savings in the first year. Specifically, the incentive levels are $0.08/kWh, $100/kW, up to 50% of the project cost. In 2011, AEP Ohio provided financial incentives to 220 custom projects. Of these, 54 projects were selected for evaluation.

The sampling methodology stratified projects both by geography and by project size. At the time, AEP Ohio had gone through a merger of two regional operating companies so that participants in the custom program were distributed across two rate zone territories. The sample design was conducted separately for each rate zone, targeting confidence and precision levels of 90% and 10%, respectively, for each zone. A two-stage sampling methodology was implemented, with the first wave of projects sampled in November of 2011 and the second wave sampled in February of 2012. Projects were first separated by zone, then stratified based on *ex ante* energy (kWh) savings. Projects were assigned to one of three strata such that there

---

[105] On-peak hours include 12pm-8pm, June 1 – September 30 (excluding holiday weekdays). Off-peak hours include 8:01pm-11:59am, June 1-September 30, and all hours from October 1-May 31. https://peco.icfi.com/sites/peco/files/2011_PECO_CUSTOM_Incentive_Levels.pdf

[106] The evaluation plan targeted confidence and precision levels of 85% and 15%, respectively. However, the final sample design allowed for 85/10 confidence and precision targets.

[107] The first stage included projects implemented in both Q1 and Q2 due to low levels of participation in the program during Q1.

[108] Note that PECO reports unverified savings quarterly.

[109] Lighting and non-lighting measures account for 19% and 32%, respectively.

NAVIGANT

was a relatively even distribution of cumulative standard deviation in energy savings between strata. Figure 27 shows the number of total projects and the number of projects in the evaluation sample for each zone and stratum. In total, the evaluation sample represents 62% of *ex ante* gross energy savings for the population.

Figure 27. AEP Ohio 2011 Custom C&I Sample Summary

Sampling Stratum	Total Number of Projects	Evaluation Sample
Zone 1, Stratum 1	5	5
Zone 1, Stratum 2	19	7
Zone 1, Stratum 3	85	12
Zone 2, Stratum 1	8	5
Zone 2, Stratum 2	18	11
Zone 2, Stratum 3	85	14
Total	**220**	**54**

Source: Navigant Review of Evaluation Report[110]

C.7 Summary from Maryland (covers five Maryland utilities)

The five EmPOWER Maryland utilities (Baltimore Gas and Electric, Potomac Electric Power Company, Delmarva Power, Southern Maryland Electric Cooperative, and Potomac Edison) offer large commercial and industrial customers financial incentives for the installation of efficiency measures that are complex and/or unique, such as commercial HVAC and industrial process improvements. Baltimore Gas and Electric (BGE) and Southern Maryland Electric Cooperative (SMECO) offer rebates for up to 50% of retrofit projects and up to 75% of the incremental cost of new construction projects. Potomac Electric Power Company (PEPCO) and Delmarva Power (DPL) programs were implemented jointly and offer $0.16/kWh for energy savings in the first year.[111] Potomac Edison (PE) offers $0.05/kWh of *ex ante* energy savings. The target evaluation sample for each utility was 12 projects to achieve confidence and precision levels of 80% and 20%, respectively. At the time the evaluation samples were drawn, only BGE had enough participants to reach the targeted sample of 12. PEPCO/DPL had 10 custom projects completed, SMECO had 7, and PE had 11. For these utilities, the entire population was used as the evaluation sample.[112]

For BGE, the sampling strategy calculated the percentage of population energy (kWh) and demand (kW) savings for each project using equal weights. These percentages were used to sort the population of projects into three strata such that each stratum represented approximately one-third of population savings. Random numbers were then assigned to projects within each

[110] "Program Year 2011 Evaluation Report: Business Custom Program." AEP Ohio. Prepared by Navigant Consulting, Incorporated. May 10, 2012.

[111] As a result, participants in PEPCO and DPL's programs were combined into a single sample.

[112] The final evaluation sample for PEPCO/DPL was reduced to eight due to barriers in doing on-site verification for two custom projects.

stratum. Sample projects from each stratum were selected based on the random number designation. For BGE, the evaluation sample represents 58% of *ex ante* energy savings for the population.

C.8 Summary from Vermont (Efficiency Vermont)

Efficiency Vermont offers financial incentives for installing energy-efficient equipment in commercial and industrial facilities as well as multi-family buildings. The evaluation was conducted for two program years, 2007 and 2008. The sample size was chosen to achieve an 80% confidence level and 10% precision level for the entire portfolio of Efficiency Vermont programs.

Sampling occurred in two stages, with the first wave including projects completed by April 30, 2008, and the second wave including projects completed during the remainder of 2008. The sampling methodology categorizes projects by market type (retrofit or new construction/market opportunities) and end use (lighting, HVAC, and other).

The sample of retrofit projects includes projects of all end uses, whereas the evaluation sample of new construction/market opportunities projects only includes lighting projects. Projects were stratified into three strata based on *ex ante* peak demand savings. Because demand reductions are claimed separately for winter and summer, the population of projects/end uses was further stratified by season. In particular, if the estimated peak reduction was higher during winter, projects/end uses were assigned to "winter." If the estimated peak reduction was higher during summer or was roughly equivalent during winter and summer, projects/end uses were assigned to "summer/non-seasonal." Within each stratum, a random number was assigned to each project/end use and ordered. The evaluation sample was then selected from the top of each group. Figure 28 shows the total number of retrofit and NC/MOP projects, as well as the evaluation samples stratified by project size and seasonality.

Figure 28. Efficiency Vermont 2007-2008 Custom C&I Sample Summary

	Total Number of Projects		Evaluation Sample			
Sampling Stratum	**Retrofit**	**NC/MOP**	**Retrofit, Winter**	**Retrofit, Summer**	**NC/MOP, Winter**	**NC/MOP, Summer**
0.8-5 kW	263	652	8	8	15	15
5-35 kW	244	315	16	17	23	26
> 35 kW	64	35	49	49	21	23
Total	**571**	**1,002**	**73**	**74**	**59**	**64**

Source: Navigant Review of Evaluation Report[113]

113"Verification of Efficiency Vermont's Energy Efficiency Portfolio for the ISO-NE Forward Capacity Market." Vermont Department of Public Service. Prepared by West Hill Energy and Computing Incorporated. July 29, 2010.

500 Consumers Road
North York, Ontario M2J 1P8
PO Box 650
Scarborough ON M1K 5E3

Kevin Culbert
Manager, Regulatory Accounting
phone: 416-495-5778
fax: (416) 495-6072
Email: kevin.culbert@enbridge.com

June 27, 2014

VIA COURIER

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street, Suite 2700
Toronto, ON M4P 1E4

Dear Ms. Walli:

**Re: Natural Gas Reporting & Record Keeping Requirements –
Enbridge Gas Distribution 2013 DSM Audit Report**

The Ontario Energy Board's (the "Board") Reporting and Record Keeping Requirements for Gas Utilities requires under rule 2.1.12 that annually, by the last day of the sixth month after financial year end, the Utilities file an audited report of the actual results compared to the Board approved Demand Side Management ("DSM") plan with explanations of variances.

Under this rule, Enbridge Gas Distribution Inc. ("Enbridge") is required to file a fiscal 2013 DSM Plan Audit Report by June 30, 2014.

Enbridge has completed the 2013 DSM Plan Audit Report and attaches the results in accordance with the filing requirement as noted.

Should you have any questions related to this, please do not hesitate to call.

Sincerely,

(Original Signed)

Kevin Culbert
Manager, Regulatory Accounting

Attach.

Integrated Energy Resources

Independent Audit of Enbridge Gas Distribution 2013 DSM Program Results

FINAL REPORT

Prepared for the

Enbridge Gas Distribution Audit Committee

by

Optimal Energy, Inc.

June 24, 2014

Optimal Energy, Inc.
802-482-5600

www.optenergy.com

10600 Route 116, Suite 3
Hinesburg, VT 05461

CONTENTS

TABLES

EXECUTIVE SUMMARY

OBJECTIVES

The primary objective of the audit performed by Optimal Energy, Inc. (Optimal) was to provide an independent opinion to determine whether calculations of the Demand Side Management Incentive Deferral Account (DSMIDA), Demand Side Management Variance Account (DSMVA), and the Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), are reasonable and appropriate.

If the Enbridge Gas Distribution (Enbridge) values differed from what Optimal believed to be correct, Optimal calculated revised values.[1] The audit had the additional objective of recommending future evaluation research opportunities to enhance the assumptions used to calculate the DSMIDA and the LRAMVA along with recommendations to improve input assumptions, verification procedures, and the overall audit process.

METHODOLOGY

The audit tasks were broken down into three main areas:

- Custom Project Savings Verification (CPSV) process
- Verification of prescriptive savings claims
- Confirmation of the market transformation results

Custom commercial, industrial, and low-income multi-residential projects represented 79% of the total net Cumulative Cubic Meters (CCM) of saved gas consumption claimed by Enbridge.[2] Thus, the CPSV process was the main focus of the audit. The CPSV process consisted of the following steps:

1. An engineering review of a statistically significant sample of custom projects was completed by one of two independent CPSV Technical Evaluators (CPSV TE), one for commercial and low-income multi-residential projects and a second for industrial projects. Each CPSV TE reviewed Enbridge's saving calculation methodology and performed site visits to gather actual operational information.
2. The CPSV TEs issued detailed reports that provided final project-by-project savings recommendations. For each project, the CPSV TE either agreed with the savings value put forth by Enbridge or provided an alternative value.
3. The final CPSV TE results were used to calculate realization rates by comparing Enbridge's claimed savings value for the sampled project values to the CPSV TE values. The realization rates were calculated by an independent third-party statistics firm

[1] All of the Enbridge values cited in this audit are from the 2013 Demand Side Management Draft Evaluation Report issued by Enbridge on May 7, 2014.

[2] Enbridge's primary resource acquisition metric is net CCM. Net CCM is defined as the total savings to be achieved over the assumed lifetime of each energy saving measure. It is equal to the annual cubic meters saved after being adjusted for the Ontario Energy Board (OEB) approved free rider rate multiplied by the assumed measure life.

retained by Enbridge. The realization rates were then applied to all custom savings claimed by Enbridge to produce a final overall net CCM custom project value.

4. Optimal reviewed numerous early drafts of all CPSV TE reports. Optimal and the Enbridge Audit Committee (AC) both reviewed all drafts and the final versions. Optimal provided extensive recommendations that improved the overall rigor of the CPSV TE process. These recommendations consisted of four separate memos and numerous conference calls with the CPSV TEs and the Audit Committee. Optimal also reviewed CPSV spreadsheet savings calculations where applicable. Optimal and the AC also considered the discussions regarding baseline and measure life issues that were included in Enbridge's Year 2012 Clearance of Accounts process.[3]
5. Optimal conducted an extensive review of the final CPSV reports including gathering supplementary information from both the CPSV TEs and Enbridge staff. The results of this step were the final audit recommendations for the net CCM values for each of the custom projects.
6. Using the final CPSV audit values, Optimal recalculated final realization rates and the resulting overall custom project net CCM values. This process also included a full review of the realization rate calculations performed by the independent statistics firm engaged by Enbridge.

For the prescriptive savings claims, Optimal performed an overall review of Enbridge's program-by-program measure level calculations to confirm that the total net CCM values presented in Enbridge's evaluation report were consistent with these calculations. Optimal selected a sample of individual measures to verify that the deemed values (savings per measure, free rider rate, and measure life) were in compliance with the approved values filed by Enbridge with the Ontario Energy Board (OEB). Optimal also reviewed the deemed savings values filed with the OEB for the prescriptive measures that comprised the bulk (76%) of the commercial prescriptive savings claim. The purpose of this review was to ensure that these deemed values were generally in accordance with industry standards.

Verification of the Market Transformation metrics consisted of extensive interviews with Enbridge Market Transformation program staff, along with a careful review of the data put forth by Enbridge to support its Market Transformation results. Optimal confirmed that each of the Market Transformation results met all of the OEB approved requirements for each metric.

Optimal also reviewed Enbridge's monitoring and tracking administrative procedures and systems. This included an on-site demonstration of Enbridge's DSM tracking software, interviews with Enbridge's DSM tracking staff, and review of Enbridge's written operational and quality assurance procedures. The purpose of this review was to determine if the DSM program results were being properly recorded in Enbridge's DSM database. Optimal also reviewed the overall calculation workbooks that summarized Enbridge's DSM database and form the basis of the DSMIDA and LRAMVA values.

[3] OEB file number EB-2013-0352.

Throughout the entire audit process, Optimal audit staff continually considered forward looking recommendations that would improve the overall verification and audit process and enhance savings assumptions through future evaluation and verification studies.

FINDINGS

Tables 1, 2, and 3 summarize the overall results of Optimal's audit. Each table provides the pre-CPSV value; the post-CPSV value; the final audit value; a brief explanation of the audit adjustments made to the post-CPSV value, where appropriate; and a reference to the page(s) in this report where a complete description of the adjustment is located.[4]

For each of the custom savings categories (commercial, low-income multi-residential, and industrial), the "Post-CPSV Values" presented below are the adjustments made as a result of the CPSV process. The final report issued by the commercial/low income multi-residential CPSV TE adjusted the savings for 25 of the 27 sampled projects. These adjustments resulted in a 21.5% reduction in savings from Enbridge's pre-CPSV savings estimates for these 27 projects. This resulted in a commercial/low income multi-residential realization rate of 84.7%, meaning Enbridge's original savings estimate for the total of all commercial/low income multi-residential custom projects was reduced by 15.3%.[5]

The final report issued by the industrial CPSV TE adjusted the savings for 4 of the 17 sampled projects. These adjustments resulted in a 1.9% increase in savings versus Enbridge's initial savings calculations for these 17 projects. This resulted in an industrial realization rate of 104.7%, meaning Enbridge's original savings estimate for the total of all industrial custom projects was increased by 4.7%.

[4] Pre-CPSV Values are Enbridge's original savings estimates prior to the completion of the CPSV process. Post-CPSV values are the revised savings values after the CPSV process was completed. By its very nature, the CPSV process was designed to only adjust net CCM values for commercial, low-income multi-residential, and industrial custom projects. All other metrics were unchanged pre- and post CPSV. The audit process verified all post-CPSV values and made adjustments as warranted to the post-CPSV values.

[5] The 21.5% reduction represents the average reduction of the *sample,* whereas the 15.3% reduction represents the *weighted* average reduction to be applied to the entire population. The projects selected for inclusion in the sample represent different strata of the overall population of custom projects, but do not exactly represent the distribution of this population. The realization rate is calculated separately for each strata and the overall realization rate is a weighted average. This can be seen in the data presented in Table 8. As a result the average reduction for the sample does not match the overall weighted average reduction for the overall population. The industrial realization rate was calculated in the same fashion, with the similar result that the overall realization rate is not equal to the sample average adjustment.

Table 1. Summary of Adjustments: Resource Acquisition[6]

Metric	Pre-CPSV Value	Post-CPSV Value	Final Audit Value	Description of Audit Adjustment	Audit Report Reference Page
RESIDENTIAL COMMUNITY ENERGY RETROFIT					
Net CCM	38,992,509	38,992,509	38,980,521	Correction of minor data entry errors.	Page 18
Deep Savings Participants	1,649	1,649	1,649		
COMMERCIAL					
Custom					
Net CCM	471,290,902	403,057,642	419,558,496	Adjusted the net CCM on 5 of 27 sampled projects resulting in revised realization rate; correctly calculated realization rate based on gross CCM; corrected data entry errors made by independent statistics firm in the calculation of realization rates.	Pages 19 to 21
Prescriptive					
Net CCM	74,442,495	74,442,495	74,442,495		
Run It Right					
Net CCM	18,531,730	18,531,730	11,132,600	Projects that had increased gas consumption added back in. Correct process needs to look at both projects with high decreased consumption along with project where consumption increased; cannot just drop outliers at one end of the spectrum.	Pages 21 to 24
INDUSTRIAL					
Custom					
Net CCM	207,468,616	217,219,641	221,783,951	Adjusted the net CCM on 3 of 17 sampled projects resulting in revised realization rate; correctly calculated realization rate based on gross CCM; corrected data entry errors made by independent statistics firm in the calculation of realization rates.	Pages 24 to 27
Prescriptive					
Net CCM	828,600	828,600	791,404	Custom project realization rate was applied to industrial prescriptive projects. This was corrected.	Page 27
TOTAL RESOURCE ACQUISITION Net CCM	**811,554,852**	**753,072,617**	**766,689,466**		

[6] As indicated above the values for pre-CPSV and post-CPSV metrics only vary for custom commercial, industrial, and low income multi-residential.

Table 2. Summary of Adjustments: Low Income

Metric	Pre-CPSV Value	Post-CPSV Value	Final Audit Value	Description of Audit Adjustment	Audit Report Reference Page
SINGLE FAMILY (PART 9)					
Net CCM	32,904,684	32,904,684	32,904,684		
MULTI-RESIDENTIAL (PART 3)					
Custom Multi-Residential					
Net CCM	27,550,015	24,540,706	25,268,448	Adjusted the net CCM on 5 of 27 sampled projects resulting in revised realization rate; correctly calculated realization rate based on gross CCM; corrected data entry errors made by independent statistics firm in the calculation of realization rates.	Pages 19 to 21
Multi-Residential - Low Flow Showerheads					
Net CCM	738,287	738,287	738,287		
Multi-Residential - Run It Right					
Net CCM	1,307,420	1,307,420	1,307,420		
Low Income Building Performance Management					
% of Part 3 Building Installed	85%	85%	85%		
TOTAL Low Income Net CCM	**62,500,406**	**59,491,097**	**60,218,839**		

Table 3. Summary of Adjustments: Market Transformation

Metric	Post-CPSV Value	Final Audit Value	Description of Audit Adjustment	Audit Report Reference Page
Drain Water Heat Recovery				
Number of Units Installed	6,465	6,465		
Residential Savings by Design				
Completed Units	967	967		
Number of Top 80 Builders Enrolled	18	18		
Commercial Savings by Design				
Number of New Development Enrolled	16	16		
Existing Residential				
Number of Real Estate Home Sale Listings committed to list energy rating information	78,000	78,000		
Number of Home Ratings included in MLS of marketing materials	138	138		

Overall, Optimal's final audit adjustments that were made to the post-CPSV values:

- Increased the Resource Acquisition net CCM by 1.8%
- Increased the Low Income net CCM by 1.2%

Generally, the audit adjustments made to the post-CPSV values can be characterized as technical corrections to savings calculations; updated values based on post-CPSV information obtained; and data and process corrections. Overall, the results conformed to OEB approved assumptions and generally accepted industry practices. Optimal found Enbridge's efforts to be rigorous and reflective of a well-managed DSM program that undertakes a thoughtful and good faith effort to estimate actual savings.

As listed below in Table 4, the adjustments resulted in an increase of $159,681 or 3.6% to the DSMIDA, which is paid to Enbridge. Based on the final audited savings values, the final audit value for the LRAMVA is $49,213 to be refunded to ratepayers.[7] Optimal is not recommending any audit adjustment to the DSMVA value.

SAVINGS VERIFICATION STATEMENT

We have audited the Draft Evaluation Report, Net Cumulative Cubic Meters (CCM) savings, DSM Incentive Deferral Account (DSMIDA), Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), and Demand Side Management Variance Account (DSMVA) of

[7] The process agreed to with the AC calls for LRAMVA to be calculated only after the final audit savings values are available.

Enbridge Gas Distribution for the calendar year ending December 31, 2013. The Draft Evaluation Report and the calculations of net CCM, DSMIDA, LRAMVA, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts based on our audit. We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in its Decision with Reasons dated June 30, 2011, in EB-2008-0346. Details of the steps taken in this audit process are set forth in the Audit Report that follows, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that has been gathered and recorded using reasonable methods and is accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2013 DSM programs of Enbridge Gas Distribution:

- Net CCM savings of 826,908,305
- DSMIDA amount recoverable of $4,538,188 (due to Enbridge)
- LRAMVA amount payable of $49,213 (to be refunded to Enbridge ratepayers)
- DSMVA amount payable of $3,601,806 (to be refunded to Enbridge ratepayers)

Table 4 below provides a comparison of the final audit values and the post-CPSV values.

Table 4. Savings Verification Results

Positive Value Due to Enbridge/Negative Value Due to Ratepayers

Account	Post-CPSV Value	Final Audit Value	Increase/ (Decrease)
DSMIDA	$4,378,508	$4,538,188	$159,681
LRAMVA	n/a	($49,213)	n/a
DSMVA	($3,601,806)	($3,601,806)	$0

RECOMMENDATIONS

Optimal identified 19 different opportunities for Enbridge to enhance program operation and verification procedures going forward. Listed below are Optimal's highest priority recommendations. The complete list can be found in the final section of this report.

CPSV Process

- Select an independent third-party engineering firm to review the ETools software for consistency with acceptable engineering practice.
- Develop a standardized report template for use by the CPSV TEs.
- Request that the CPSV TEs estimate the remaining useful life of the existing equipment in cases where the EE measure is an "add-on" to existing equipment.
- Document the custom project realization rate calculation methodology.
- Undertake a baseline boiler study.

Run It Right

- Establish a free rider rate for the Run It Right program.
- Survey Run It Right participants.

Audit Process

- Produce a detailed audit guideline document for the auditor.
- Produce a written charter for the Audit Committee (AC).

Other Recommendations

- Provide enhanced quality control procedures for the data provided to the CPSV TE and the CPSV sampling and realization rate firm(s).

INTRODUCTION

Enbridge Gas Distribution (Enbridge) operates a series of demand side management (DSM) programs in accordance with its 2012-2014 Multi-Year Plan approved by the Ontario Energy Board (OEB).[8] Enbridge receives a combination of direct cost recovery and shareholder incentive payments associated with its program delivery. The OEB and Enbridge's Audit Committee (AC) require an independent third-party review of Enbridge's Draft Evaluation Report and supporting calculations to ensure that savings claims and shareholder incentive payments calculations are correct.

On behalf of its Audit Committee, Enbridge issued a Request for Qualifications in January 2014 and a Request for Proposals (RFP) to undertake the Year 2013 Audit on February 10, 2014. Optimal Energy, Inc. submitted its qualifications on January 14, 2014 and its full proposal on February 21, 2014. Optimal was awarded the contract on March 5, 2014.

OBJECTIVES

The primary objective of this audit was to review Enbridge's calculations for net Cumulative Cubic Meters (CCM) saved, the Demand Site Management Incentive Deferral Account (DSMIDA), the Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), and the Demand Side Management Variance Account (DSMVA) for the calendar year ended December 31, 2013, and to express an independent opinion on these amounts. Where the Enbridge-reported amounts differed from what Optimal believed to be correct, Optimal calculated alternative values. As a secondary objective, Optimal provided recommendations for forward-looking evaluation work and process improvements to be considered.

This audit was conducted under the direction of the AC and in accordance with the rules and principles set down by the OEB in its Decision with Reasons dated June 30, 2011, in EB-2008-0346; and RFP issued on February 21, 2014.

REPORT LAYOUT

The audit report is presented in four main sections:

- The "Methodology" section provides information on the steps Optimal performed to complete the audit.
- The "Audit of Claimed Savings and Other DSMIDA Metrics" section details the audit findings for each of Enbridge's net CCM savings claims, its Market Transformation results, and other DSMIDA metrics.
- The "Calculations Audit" section provides the final audited DSMIDA, LRAMVA, and DSMVA values.

[8] Settlement Agreement Enbridge Gas Distribution Inc. Demand Side Management Multi-Year Plan 2012-14, Exhibit B, Tab 2, Schedule 9 OEB Case EB-2011-0295; and Enbridge Gas Distribution Inc. Update to the 2012 to 2014 Demand Side Management ("DSM") Plan Ontario Energy Board ("Board") File No.: EB-2012-0394, dated February 28, 2013.

- The "Findings and Recommendations" section presents the main findings along with recommendations for forward looking savings verification and audit process improvements.

METHODOLOGY

OVERVIEW

Optimal staff began the audit by attending two full days of on-site meetings at Enbridge's offices. The overall purpose of the site visit was to gain a thorough understanding of each of Enbridge's DSM programs and to begin the initial process of gathering data, studies, and other documents needed to complete the audit. Following the site-visit, Optimal worked closely with Enbridge personnel, members of the AC, and the CPSV Technical Evaluators to solicit feedback, clarify questions, and resolve issues over the course of the audit process.

Optimal's approved audit work plan, which lists the step-by-step tasks performed, is included in this report as Attachment A. This section of the audit report provides additional details and information on supplementary audit activities over and above what was included in the work plan.

Shortly after the site visit, Optimal issued a formal written request to Enbridge to gather additional data and documents. The data request is included in this report as Attachment B. In addition to the information gathered via this formal request, Optimal staff gathered supplementary data, information, and documents as it proceeded with its audit tasks.

Numerous weekly conference calls were held between Optimal's audit staff, Enbridge staff, CPSV TE staff, and the AC throughout the entire audit time period. These conference calls included the following groups:

- Weekly AC and Optimal audit staff
- Weekly AC, commercial CPSV TE staff, Enbridge commercial staff, and Optimal audit staff
- Weekly AC, industrial CPSV TE staff, Enbridge industrial, and Optimal audit staff
- Weekly Optimal audit manager and Enbridge audit project manager

The AC and Optimal conference calls provided Optimal the opportunity to brief the AC on the progress of the audit process, resolve any issues as they arose, and obtain AC feedback throughout the entire audit timeframe.

The purpose of the AC, Optimal, and CPSV TE calls was to provide comments and feedback to the CPSV TEs as they were preparing their CPSV TE reports. Optimal, Enbridge, and the CPSV TEs participated in the call that took place prior to the issuance of the CPSV TE Reports. After the CPSV final reports were issued, Optimal used these calls to obtain supplemental information to complete its audit tasks. Optimal, Enbridge and the AC participated in these calls that took place after the CPSC TE final reports were issued.

Overall project management tasks and Optimal's data/document requests were discussed during the calls between Optimal's and Enbridge's audit project manager.

In total, Optimal staff attended over 35 separate conference calls with the AC, Enbridge staff, and CPSV TE staff.

CUSTOM PROJECTS

Overall Methodology

Enbridge's custom projects represented 79.4% of its total post-CPSV net CCM. As a result, a large share of the overall audit effort was devoted to reviewing these projects. The overall custom project review process was titled the "Custom Savings Verification Process" or "CPSV."

The CPSV involved several different steps completed by different firms. First, Enbridge's independent statistics firm developed a randomly selected and statistically significant sample from the total population of custom projects for inclusion in the savings review, using a sampling methodology developed by Navigant Consulting in 2012 and approved by the Technical Evaluation Committee for Enbridge and Union Gas.[9] Next, Enbridge, in consultation with the AC, hired two engineering firms (CPSV Technical Evaluators or CPSV TEs) to conduct an engineering assessment and evaluation of each of the sampled projects, one for commercial and low-income multi-residential projects and one for industrial projects. Each CPSV TE performed an on-site visit for each sampled project to verify equipment installations, model numbers, and overall equipment operations. They also verified the operating parameters that formed the basis of saving calculations assumptions. Each CPSV TE reviewed Enbridge's savings calculations and, where feasible, developed an independent savings calculation for each project. As agreed to with the AC, the CPSV TEs recommended revised savings values based on the following guidelines:

- The CPSV TE should always report the results of its independent savings calculations.
- If the CPSV TE savings number is within 5% of Enbridge's number AND the CPSV TE concludes that its methodology is less rigorous than Enbridge's approach, the CPSV TE can let the Enbridge number stand without adjustment.
- If the CPSV TE savings number differs by more than 5% or the CPSV TE concludes that its methodology is more rigorous, the CPSV TE should recommend adjusting Enbridge's savings claim and be fully prepared to defend its adjusted savings claim.
- If the CPSV TE uncovers a clear methodological or calculation mistake or other obvious error, then the Enbridge savings claim should always be adjusted regardless of the size of the variance.
- For all projects, the CPSV TE should provide clear reasoning for all recommended savings adjustments.

---

[9] *A Sampling Methodology for Custom C&I Programs*, prepared for Sub-Committee of the Technical Evaluation Committee for Enbridge Gas Distribution and Union Gas by Navigant Consulting, Inc., dated November 12, 2012.

At the conclusion of its work, each CPSV TE produced a detailed final report summarizing its methodology and project-by-project findings.[10]

Optimal's audit of Enbridge's custom projects involved reviewing CPSV activities and reports. Optimal staff attended weekly CPSV TE meetings via teleconference. Enbridge staff and the AC also attended. These meetings allowed Optimal to provide input and recommendations to the CPSV TEs prior to the completion of their evaluation work.

CPSV reports were completed by the TEs in "waves." Optimal was awarded its audit contract shortly after the CPSV TEs completed their Wave 1 draft reports. Optimal reviewed and provided feedback on the draft Wave 1 CPSV reports to ensure that the reports contained the quality and level of data needed to complete its audit tasks. In addition, Optimal provided feedback as to whether or not the CPSV TEs were meeting the requirements of the RFPs issued by Enbridge for this work. Optimal provided memos to the CPSV TEs and the AC with recommended revisions to be incorporated in the final CPSV reports on March 17, 2014. These recommendations also included extensive directives on the level of detail that should be included in the CPSV reports and the overall format of the reports to ensure that all relevant project information would be included.

Optimal also reviewed the Wave 2 draft reports and the full combined Wave 1 and Wave 2 draft reports. Informed by AC input, Optimal issued memos providing final comments and feedback on April 11, 2014. As a result of Optimal's far-reaching involvement in the overall CPSV process, the final CPSV reports were greatly improved.

Once the final CPSV reports were issued, Optimal took the following steps:

- **Reviewed the project-by-project evaluations contained in the CPSV final reports.** For this review we utilized a checklist allowing us to systematically ascertain that key project elements had been reported, were well documented, and were reasonable and appropriate. This checklist included reviews of baselines and measure lives.
- **Examined measure lives, advancement/replacement, and other baseline characterization assumptions.** Appropriate revisions were recommended if Optimal determined that OEB-approved or industry-accepted methodologies were not utilized in determining baselines or measure lives used for savings calculations.
- **Confirmed or revised CPSV TE final savings recommendations.** If Optimal disagreed with any of the final project CCM savings values put forth by the CPSV TEs, Optimal calculated revised savings claims.

Optimal was provided the following documents that were filed as part of Enbridge's Year 2102 Clearance of Accounts proceedings:[11]

---

[10] Because the CPSV reports contain customer specific data they are considered confidential and are not publically available documents. Optimal signed a non-disclosure agreement allowing it to have full access to all CPSV data.

[11] OEB file number EB-2013-0352.

- OEB Decision and Order, May 1, 2014
- Non-Confidential Redacted Final Argument on Behalf of the School Energy Coalition, March 19, 2014
- Enbridge Gas Distribution Inc. - Redacted Reply Submission Clearance of DSM Variance Accounts, April 2, 2014

As part if its review Optimal considered the comments and conclusions included in the above documents regarding baseline and measure life issues.

Optimal provided preliminary CPSV audit results to Enbridge and the AC on May 23, 2014. The AC and Enbridge staff provided written feedback on these preliminary results. One final set of meetings were held with Enbridge staff and the AC to review the feedback. Optimal finalized its CPSV results, taking into account all of the feedback and information received from Enbridge staff and the AC.

Boiler Replacements and ETools

The RFP for each of the CPSV TEs required them not to rely solely on Enbridge's in-house custom project savings calculation software, ETools.[12] Instead, they were requested to re-calculate project savings using alternative methodologies for purposes of independently verifying Enbridge's savings claims. For the bulk of the projects, the CPSV TEs adhered to this requirement.

For boiler replacement projects completed early in 2013, the commercial CPSV TE was able to develop independent savings calculations by performing a regression analysis using post-installation gas consumption data. Its analysis generally confirmed the accuracy of savings estimates developed by ETools.

However, for commercial boiler replacement projects that lacked sufficient consumption data, the commercial CPSV TE did not undertake an independent savings calculation. Instead, it verified key ETools savings assumptions. If the assumptions used by Enbridge were determined to be incorrect, the commercial CPSV TE had Enbridge re-run ETools based on the correct assumptions. The commercial CPSV TE used these updated ETools calculations as its final recommendation.

The key variable for boiler replacement projects is the boiler's seasonal efficiency.[13] The commercial CPSV TE did not develop an independent method to calculate seasonal efficiencies. ETools does provide a rigorous calculation of a boiler's seasonal efficiency. Optimal was given a demonstration of the ETools seasonal efficiency module and reviewed the ETools boiler documentation. Enbridge also noted that ASHRAE has yet to finalize guidelines for

[12] ETools consists of various modules. This discussion pertains specifically to the commercial sector module of ETools.

[13] Measurements of thermal efficiency are performed at full load with steady-state operation using specific conditions as per testing standards. Seasonal efficiency accounts for operation during various loads, including heat losses when the boiler is off.

determining a boiler's application seasonal efficiency.[14] Given these constraints, Optimal concluded that it was reasonable for the commercial CPSV TE to rely on ETools for this sub-set of projects.

PRESCRIPTIVE MEASURES

Enbridge provided Optimal with a spreadsheet that contained final Year 2013 measure level summary data for all prescriptive savings. The spreadsheet included the following information:

- Measure name
- Number of participants or units installed
- Annual gas savings per unit
- Free rider rate
- Agreed upon reduction rate for non-installs or removals
- Gross annual savings
- Net annual savings
- Measure life
- Gross CCM
- Net CCM

Optimal reviewed measures that represented the largest fraction of total savings and confirmed that the following deemed savings values were based on approved OEB values:

- Gas savings per unit
- Free rider rates
- Agreed upon reduction factors
- Measure lives

As part of its review, Optimal confirmed that the approved reduction rate/non-install factor was accurate and properly applied for all showerhead measures. Optimal also verified that the values from the measure summary spreadsheet were calculated correctly and consistent with the values put forth by Enbridge in its overall net CCM calculation.

Optimal also reviewed the deemed savings values for the high volume measures for purposes of any forward going recommendations regarding updating these values or possible studies. Optimal concluded that the savings values for these measures are reasonable and appropriate and therefore does not have any recommendations for revising these values either for purposes of this audit or going forward.

RESIDENTIAL COMMUNITY ENERGY RETROFIT

This program contained two separate DSMIDA metrics: net CCM and the number of "Deep Savings Participants." For the net CCM metric, Optimal reviewed the spreadsheet containing

[14] ASHRAE Standard 155P was created in 1994 to provide a test method to determine the seasonal efficiency of commercial space heating boiler systems. The latest feedback from the 155P committee is for this standard to be released for public review in the summer of 2014. The 155P Standard has been in various stages of development over the past 20 years.

participant-level data. Optimal verified that the correct free rider rate and agreed upon measure life were applied and that the total net CCM value for all participants was consistent with the values put forth by Enbridge in it overall net CCM calculation.[15]

The Deep Savings Participants metric required that each participant install a minimum of 2 major measures and that the average annual savings across all participants be a minimum of 25%. Optimal reviewed the spreadsheet that contained the participant-level savings to verify that the average savings across all participants met the 25% threshold. Optimal also reviewed the file for 10 participants out of a total of 1,649 to verify the installation of at least 2 major measures and the annual savings values.

RUN IT RIGHT

The AC agreed to the following verification procedure for Enbridge's retro-commissioning "Run It Right" program:

> "The 2013 AC agreed that Enbridge will propose the appropriate Run It Right savings calculation methodology and the 2013 Auditor was tasked with assessing the reasonableness of Enbridge's methodology and evaluating the application of the methodology by conducting a desk review of a sample of Run It Right projects."

Optimal reviewed Enbridge's "Run It Right 2012 Regression Analysis Methodology," dated April 1, 2014, to assess its ability to reasonably estimate savings.

Optimal received the complete list of 192 Run It Right projects and selected a random sample of 15 projects for review. The sample was evaluated under a binary pass-fail metric, for which a zero defects result would indicate with 90% confidence that the incidence of errors in the total group is 14% or less.

The projects in the sample group were evaluated individually and checked for compliance with Enbridge's savings calculation methodology. The primary criterion was the appropriate application of Enbridge's regression analysis methodology, specifically, that all projects for which savings were claimed had:

- R-Squared Value equal to or greater than 0.80
- F-Value equal to or greater than 120
- No fewer than 365 days of data[16]

Projects were also checked to verify that the baseline and reference periods were complete and covered the necessary time periods. Baseline and claimed savings figures from individual reports were verified to match those on the Run It Right program spreadsheet.

[15] As per Year 2012 Resource Acquisition Audit Recommendation 8, it was agreed that a 20-year holistic measure life would be used. See "2012 Demand Side Management Audit Summary Report" dated October 17, 2013.

[16] The R-Squared variable provides an indication of how well data points fit a statistical model. The F-Value tests the overall significance of the regression model.

Enbridge was also instructed by the AC to propose a free rider rate. Optimal reviewed retro-commissioning free rider rates in other jurisdictions to develop a recommended free rider rate for the Run It Right program.

MARKET TRANSFORMATION

Enbridge's Market Transformation effort consisted of four separate programs. Each program had its own unique DSMIDA metric(s). Optimal reviewed relevant tracking data and documentation (commitment forms, participant lists, completion forms, documented tracking protocols, etc.) specific to each Market Transformation metric. Verification also included two rounds of interviews with Enbridge Market Transformation staff.

DATA TRACKING SYSTEM

Optimal reviewed Enbridge's monitoring and tracking administrative procedures and systems. The purpose of this review was to determine if the DSM program results were being properly recorded in Enbridge's DSM database. This included an on-site demonstration of Enbridge's DSM tracking software, interviews of Enbridge's DSM tracking staff, and review of Enbridge's written operational and quality assurance procedures.

REVIEW OF DSMVA, LRAMVA, AND DSMIDA CALCULATIONS

The tasks outlined in the preceding sections provided a reasonable basis for Optimal to confidently make its determination on the validity of the DSMVA, LRAMVA, and DSMSIDA calculations. Optimal ensured that OEB-approved methodologies for all of these calculations were properly followed. Optimal also ensured that any recommended adjustments to the final net CCM results were properly incorporated into the LRAMVA and DSMIDA calculations.

Optimal's review of the DSMVA did not include auditing of Enbridge spending documentation. This is a financial auditor's responsibility. Optimal reviewed the calculation of the DSMVA to ensure consistency between actual expenditures included in the variance account calculations and the total DSM expenses reported in Enbridge's financial tracking system. Optimal also verified that the budget used for the DSMVA was the correct value that was built into Enbridge's Year 2013 rates.

For the LRAMVA, Optimal ascertained whether the methodologies and assumptions used to calculate actual sales volume net of installed efficiency measures were consistent with the methodologies and assumptions used to calculate the year's budgeted sales volume in advance. We also ensured that the net volumetric sales were appropriately allocated to each respective rate class.

For DSMIDA, Optimal reviewed the calculation spreadsheet to verify that it was consistent with the OEB-approved values and methodologies. We also ensured that the final audit calculation of DSMIDA contained the final audit values.

AUDIT OF CLAIMED SAVINGS AND OTHER DSMIDA METRICS

INTRODUCTION

This section presents Optimal's final audited value for each of the DSMIDA metrics and a discussion of any recommended adjustments.

RESOURCE ACQUISITION

Table 5. Final Resource Acquisition Audit Values

Metric	Pre-CPSV Value	Post-CPSV Value	Final Audit Value	Increase/ (Decrease)
RESIDENTIAL COMMUNITY ENERGY RETROFIT				
Net CCM	38,992,509	38,992,509	38,980,521	(11,988)
Deep Savings Participants	1,649	1,649	1,649	0
COMMERCIAL				
Custom				
Net CCM	471,290,902	403,057,642	419,558,496	16,500,854
Prescriptive				
Net CCM	74,442,495	74,442,495	74,442,495	0
Run It Right				
Net CCM	18,531,730	18,531,730	11,132,600	(7,399,130)
INDUSTRIAL				
Custom				
Net CCM	207,468,616	217,219,641	221,783,951	4,564,310
Prescriptive				
Net CCM	828,600	828,600	791,404	(37,196)
TOTAL RESOURCE ACQUISITION Net CCM	**811,554,852**	**753,072,617**	**766,689,466**	**13,616,849**

Residential Community Energy Retrofit

In reviewing Enbridge's participant savings spreadsheet, Optimal uncovered a minor data entry error. The final audited Community Energy Retrofit net CCM is 38,980,521, a 0.03% reduction. No adjustment was made to the number of Deep Savings Participants.

Commercial

Custom Projects

Commercial custom projects contributed 53.5% of Enbridge's Resource Acquisition post-CPSV Net CCM. In accordance with the Technical Evaluation Committee approved methodology, Enbridge's independent statistical firm selected 27 commercial and low-income multi-residential projects to be evaluated by the CPSV TE.[17] The final report issued by the CPSV TE adjusted the savings on 25 of these projects. These adjustments resulted in a 21.5% reduction in savings versus Enbridge's initial savings calculations. The difference between Enbridge's initial savings values and the CPSV TE adjusted values was used to calculate a realization rate that was subsequently applied to all of the commercial and low-income multi-residential custom project savings values. The adjusted commercial/low income multi-residential realization rate was 84.7%, resulting in a 15.3% savings reduction from Enbridge's original savings estimates for the total of all commercial and low income multi-residential custom projects.

Optimal adjusted the final savings values put forward by the CPSV TE on five projects. These adjustments resulted in a 4.9% increase in savings versus the CPSV TE values for the 27 sampled projects. The adjusted projects are listed in the table below. Following the table we provide our justification for these adjustments.

Table 6. Commercial & Low-Income Multi-Residential CPSV Project Summaries[18]

Enbridge Project Code	CPSV TE Gross CCM Value	Final Audit Gross CCM Value	Gross CCM Increase/ (Decrease)
RA.GOV.EX.021.13	465,315	1,305,733	840,418
RA.HC.EX.021.13	1,460,400	2,294,040	833,640
RA.MR.EX.017.13	0	304,125	304,125
RA.MR.EX.140.13	4,040,985	3,931,283	(109,702)
RA.UNIV.EX.006.13	6,750,885	8,468,167	1,717,282

RA.GOV.EX.021.13

This project involved a retrofit of a fume hood exhaust system. Over 140 individual fume hood exhaust motors were replaced with 6 large central motors. The fume hoods themselves were to be retrofitted to allow variable air volume. Even though they did not end up

[17] The custom program for low-income multi-residential buildings was essentially the same as non-low-income multi-residential buildings. The main difference was the incentive levels and the marketing techniques. These projects were subject to the same type of energy savings calculations (ETools) and same level of review by Enbridge's commercial technical engineering staff. As a result, these building were included in the overall commercial sampling process and technical review conducted by the CPSV TE.

[18] While all final DSMIDA savings value are net CCM, savings for the CPSV sampled projects are stated in gross CCM. The realization rates for custom projects are calculated using gross CCM prior to the application of the free rider rate. The realization rate is first applied to total custom project gross CCM, after which the free rider rate is applied to arrive at the net CCM value used for the DSMIDA.

implementing variable flow fume heads, 143 small single phase motors were replaced with 6 centralized triple phase motors with VFDs. Further, sensors were installed measuring the face velocity of the fume hoods. It was this change from single speed motors to centralized variable speed motors that allowed the rebalancing that yielded energy savings. We therefore believe that a 15 year measure life for motors/variable frequency drives is appropriate. Because the variable air volume control scheme was never implemented, the only actual gas savings are from the rebalancing that took place as a result of the new motors, VFDs, and sensors. The CPSV TE, therefore, properly reduced savings, since the fume hoods were not operating in variable volume. However, the CPSV TE updated savings were based on an outdated balancing report taken from the time of their site visit while the system was still being commissioned. Since the time of the site visit, the facility has further reduced the air flow in the exhaust system.[19] Also, the CPSV TE calculation did not include savings from energy associated with the steam injection humidification lost through the exhaust flow and used the delivery air temperature rather than the room air temperature for the change in temperature. The room air temperature is more properly used in this case, since all exhausted air is at room temperature. Therefore, the make-up air needs to be heated to room temperature from steam radiators in the building, even if the supply air from the ventilation system is somewhat cooler than the room set point. Optimal has updated the savings to reflect these factors. The verified savings are now 1,305,733 gross CCM.

RA.HC.EX.021.13

This project consisted of a heating system retrofit. The project scope went through numerous iterations; the final measures installed were not the same as the measures included in the original savings estimates. The CPSV TE correctly eliminated savings for measures that were not installed, but did not observe that a BAS/hot water pump upgrade had occurred, which the original savings estimates neglected to include. The measure was listed in the original application. It was verified as installed in April 2013 by both the facility operator and the energy service company but was overlooked in the initial savings estimates and not re-visited by the CPSV TE. Because this measure was installed in 2013, as part of the project for which the incentive was received, and was on the original application, the savings should be included in the final estimates. Optimal therefore added the savings for this measure to give verified savings of 2,294,040 gross CCM. As a check on these numbers, Enbridge ran a bill analysis, using data from March 2013 to March 2014 as the post-installation period. The results of billing regression analysis were within 4% of the adjusted audit savings.

RA.MR.EX.017.13

This project was a pump control upgrade, from continuous to intermittent, on a multi-family boiler project. The CPSV TE did not give any savings credit for this project because the control was switched to manual on the day of their visit. Furthermore, they performed a bill analysis using a post-retrofit period of April through November, which did not show any

[19] Optimal concluded that the CPSV TE site visits did not influence the outcomes for this project or any other CPSV projects except the one industrial project as noted below. In cases were operating conditions changed post CPSV it was apparent that each of these projects were still undergoing commissioning activities.

savings. However, the CPSV TE site visit happened on a very cold day and the warranty on the controls recommends switching to manual on days that are below 10°C. The project owners have since sent pictures of the controls in auto mode and have assured us that they manually switch the controls off when the weather is cold and switch them back on when it warms up. Optimal also examined the CPSV TE regression analysis and could not replicate their results, which showed an unrealistically high R^2. We also observed slopes for the pre and post-retrofit regression lines implying increased usage, even though the weather normalized consumption data showed savings. When Optimal attempted to recreate the regression analysis, we obtained results much closer to those of Enbridge, which did show savings starting from the install date in April 2013. Optimal's conclusion is that the CPSV TE regression analysis was flawed. Optimal does not recommend eliminating savings for an action that followed the warranty, especially as savings for the measure accrue during the shoulder seasons. This is especially true as the bill analysis seems to verify that savings have been achieved. We therefore adjusted the verified savings estimates from zero CCM to 304,125 gross CCM. This is still slightly lower than Enbridge's original savings due to changes in input values found during the CPSV TE site visit.

RA.MR.EX.140.13

For this project, two of three existing atmospheric boilers were replaced with new condensing units, with the remaining boiler used as the lag boiler in a lead-lag configuration. The replaced boilers were 11 years old, making this an advancement project. However, the CPSV TE did not use the standard methodology for calculating savings from advancement projects, but instead used an "average measure life" for the expected life of the lag boiler and the expected life of the new boilers. This is not the correct methodology to derive measure life; savings should be based on the existing boiler for the remainder of the existing boiler's life, at which time the baseline should shift to a standard efficiency boiler. Assuming a 25-year life for the new boiler, Optimal adjusted the calculation so that the first 14 years of savings reflect a baseline of the existing boiler and the remaining 11 years reflect savings from a new standard efficiency boiler. Updated savings are 3,391,283 gross CCM.

RA.UNIV.EX.006.13

This project involved installation of VFDs on supply and return fans, better controls and temperature sensors, and demand control ventilation. The CPSV TE originally reduced the savings because, during the site visit, they observed operation of fans at all hours of the day instead of a nighttime setback. However, since then, the facility implemented the originally planned setback. The facility provided trend data to confirm that the units were in fact controlled to operate fewer hours. As a result, Optimal adjusted the CPSV TE savings to reflect the fact that the night setback is now in effect, for final savings of 8,468,467 gross CCM.

Prescriptive

No audit adjustments were made to Enbridge's commercial prescriptive savings values.

Run It Right

The results of Optimal's desk review indicated that Enbridge properly implemented its savings calculation methodology on all 15 projects selected for the review.

Free Rider Rate

To date, a free rider rate has not been approved for this program. Enbridge was asked to recommend a free rider rate along with a justification for the proposed rate. Based on its own internal research, Enbridge proposed a free rider rate of 0%.

Optimal reviewed EM&V reports of other retro-commissioning gas programs. Results from eight different programs suggest that free ridership estimates were wide ranging (8-32%). Three of these calculations also included estimates of spillover, which ranged from 10 to 20%. When using either the average or median values of the free rider rate and the spillover rates, the net-to-gross calculation equals 0.96 or 96%. While it is likely that a pre/post billing analysis would inherently include short term participant spillover, Optimal still feels that spillover should be included in the overall review of Enbridge's free rider rate based on the following:

- It is possible that the program will lead to longer term participant spillover that is not currently captured in the billing analysis
- It is likely that continued program efforts will lead to non-participant spillover in the long run by building market expertise and creating more service providers and demand for retro-commissioning services

Because the average net-to-gross value is close to one, Optimal supports Enbridge's recommended free rider rate. However, Optimal recommends that additional efforts be made to better estimate free rider and spillover rates for this program.

Savings Calculation Methodology and Final Audit Value

Optimal reviewed the "Run It Right 2012 Regression Analysis Methodology" ("Analysis"), dated April 1, 2014, which Enbridge used to calculate the Run It Right savings estimates. The Analysis claimed a total of 18,531,730 net CCM from Run It Right projects implemented in Year 2012, equivalent to an average per project savings of 4.4%.[20] Optimal found that the Analysis methodology was well explained and professionally done.

However, Optimal believes some aspects of the methodology are problematic and introduced inappropriate bias into the Analysis. These criticisms are detailed below. Recommendations on improvements to future analyses are included in the Findings and Recommendation section of this report. The final audit value for this program has been adjusted to a net CCM of 11,132,600, an average per participant savings of 2.6%.

The regression analysis compared pre and post-treatment gas consumption, on a weather normalized basis, for all participants in the program. This was done through a series of steps. At a high level, the approach attempted to identify the typical outdoor temperature balance point that produced the best fit for each customer's data set to establish the relationship of usage to weather. The approach then regressed all customer site consumption against actual weather to estimate savings, which were then weather normalized. While this approach has merit, Optimal found a few aspects of the approach that were not appropriate.

---

[20] Savings from Run It Right projects implemented in 2012 are claimed in Year 2013. The savings are based on 12 months of post implementation usage.

The study initially did not survey customers or pre-screen them to determine whether available data were complete and sufficient. Nor did the study consider whether there were changes in the facilities that might render the data invalid. However, the Analysis found the following inconsistent results:

- 68.2% (131) of the projects consumed less natural gas during the reference period
- 22.9% (44) of the projects consumed ***more*** natural gas during the reference period
- 8.9% (17) of the projects failed the regression analysis parameters and therefore no results could be established

Based on these results, the Analysis found that those projects that saved energy (i.e., 131 buildings) averaged 5.1% savings (weather normalized). The 17 projects that failed the regression analysis were excluded from the total savings claimed because the data did not support a high level of confidence in its statistical validity. The approach of removing these projects is reasonable.

However, Optimal does not agree with the way the 44 projects that saw increased consumption were treated. These projects were surveyed after the initial Analysis and assigned to one of two categories:

- **Influence:** an exogenous influence unrelated to the Run It Right Program was identified that could potentially explain the increased usage (e.g., an addition was built, business expanded, etc.)
- **Unknown:** no clear identifiable exogenous influence was identified that could explain the increase in usage.

Four projects without savings fell into additional categories related to the subsequent removal of an operational measure or failure to implement the measure in a timely fashion. Optimal agrees that these projects should be removed and not considered to have any savings.

For the "Influence" category, 14 projects were identified. Because the exogenous influences identified could plausibly explain the usage increases, the Analysis assumed these projects actually achieved savings that, on average, were commensurate with the participants whose usage did decrease. For each of these 14 projects, Enbridge claimed savings of 5.1%. This resulted in a savings claim of 2,544,141 net CCM for these projects. Optimal believes this is inappropriate and does not reflect best practices. We believe this introduces a bias by treating these customers' data sets differently after the fact. Rather, Enbridge should have surveyed all customers prior to the Analysis and removed any projects that had major changes in building operation before conducting the Analysis – whether the changes would have likely led to either increased or decreased usage. Alternatively, Enbridge could have captured sufficient information to adjust for the outside influences prior to the Analysis. Only selecting those projects that saw increased usage and implicitly assuming all projects with lower usage did not change any operational factors is inconsistent and not supportable.

For the "unknown" category, Enbridge did not identify any reason to explain the increased usage. In these cases, it made the assumption that any Run It Right measure recommendations and subsequent implementation would not, by definition, increase usage. Therefore, Enbridge assumed data from these customers was not reliable and deemed them to be outliers. Enbridge then removed these data points from the analysis. In other words, neither savings nor increased usage was counted. Optimal believes this is inappropriate and does not reflect best practices. This introduces bias for a number of reasons. After reviewing the mix of measures installed in this program, it is entirely possible that, in some facilities, these recommendations may have resulted in increased gas usage, all else equal. To assume that all positive savings data are accurate, but all negative savings data are inaccurate, significantly biases the results. For example, it is possible that these increases were also attributable to recommendations that may have been ill-advised or that were implemented incorrectly or incompletely. Similarly, it is possible there are underlying trends leading to increased weather-normalized usage in general, and that this was simply masked for those participants that saved enough to overcome this natural load growth. Removing this data is not supportable. Optimal recommends that an appropriate analysis must consider the overall net impact, including those where "savings" appear to be negative.

Finally, Enbridge removed an additional 15 projects where usage increased, but they were unable to contact the customers and therefore had no information about whether they might fall into the "influence" or "unknown" category. This is similarly not supportable because there is no information to justify their removal. Effectively, Enbridge knows no more about these customers than they do about the participants that had positive savings and were never surveyed.

Optimal conducted a review of other gas utility retro-commissioning programs to assess whether any of these programs use savings calculation methodologies similar to those used by Enbridge. None of these programs used regression analysis on pre-project and post-project usage to calculate savings.

With the exception of the projects that did not implement the measures or removed the measures, Optimal subtracted the increased gas usage for the projects with increased consumption from the total net CCM claimed by Enbridge.

Industrial

Custom

Industrial custom projects contributed 28.8% of Enbridge's Resource Acquisition post-CPSV net CCM. In accordance with the Technical Evaluation Committee approved methodology, Enbridge's independent statistical firm selected 17 industrial projects to be evaluated by the CPSV TE. The final report issued by the CPSV TE adjusted the savings on four of these projects. These adjustments resulted in a 1.9% increase in savings versus Enbridge's initial savings calculations. The difference between Enbridge's initial savings values and the CPSV TE adjusted values was used to calculate a realization rate that was subsequently applied to all of the industrial custom project savings values. This resulted in an industrial realization rate of 104.7%, meaning Enbridge's original savings estimate for the total of all industrial custom projects was increased by 4.7%.

Optimal adjusted the final savings values put forward by the CPSV TE on three projects. These adjustments resulted in less than a 1% increase in savings versus the CPSV TE values for the 17 sampled projects. The adjusted projects are listed in the table below. Following the table we provide our justification for these adjustments.

Table 7. Industrial CPSV Project Summaries

Enbridge Project Code	CPSV TE Gross CCM Value	Final Audit Gross CCM Value	Gross CCM Increase/ (Decrease)
RA.IND.AGR.NRT.001.13	1,009,773	864,986	(144,788)
RA.IND.LG.NRT.001.13	819,750	623,808	(195,942)
RA.IND.LG.RT.022.13	16,637,580	16,994,560	356,980

RA.IND.AGR.NRT.001.13

This project involved installation of insulation on hot water process piping. The baseline condition was uninsulated piping from the boiler plant to the production area. The piping was located in both outside areas and indoor production spaces.

The savings values recommended by the CPSV TE reflect a reduction to the boiler efficiency and an increase to the total length of insulation installed (i.e., 1,200 feet versus the length of 1,000 feet originally used by Enbridge). While Optimal accepts the adjustment to the boiler efficiency, the adjustment to the total length of the installed insulation is supported only by facility personnel's knowledge of the lengths of the facilities and the vertical piping runs as relayed to the CPSV TE during the on-site visit; this adjustment is not based on any on-site measurements. Discussions with the CPSV TE suggest that the Enbridge project file did not contain an invoice indicating the length of insulation purchased and installed. Optimal recommends adopting the CPSV TE's calculations to accept the reduced boiler efficiency, but subsequent correspondence with Enbridge and the customer support assuming an insulated pipe length of 1,060 feet.

Further, Optimal recommends an adjustment to the ambient temperature assumed to calculate the heat loss for a portion of the piping. To develop the original savings estimate, for the purposes of estimating the annual heat loss, Enbridge had assumed that the entire length of piping was exposed to the average annual air temperature within the production facility. Of the total length of piping, a short section is located in an area outside of the production area maintained at a minimum of 5°C. Optimal assumes that all heat loss from this section of piping is waste heat except when the ambient outdoor air temperature is below 5°C. The final industrial CPSV TE report indicates that the boiler serving the hot water piping typically operates during the months of March through October. The ambient air temperature assumed to calculate the heat loss for this section of piping was adjusted to the average ambient outdoor air temperature for all hours in March through October where the temperature is above 5°C. Additionally, the annual operating hours of this section of piping were reduced to reflect only those hours in March through October where the temperature is above 5°C. Optimal agrees with the assumptions used to calculate savings for the remainder of the pipe length (i.e., the sections of piping located within production facility). With these adjustments, the recommended gross CCM is 864,986.

RA.IND.LG.NRT.001.13

This was a new construction project that consisted of a major expansion to an existing manufacturing facility. For the heating system, the design featured low temperature condensing hot water boilers. Consequently, the measure is to assess the incremental savings of a condensing hot water boiler versus a more typical high efficiency hot water boiler in this application. Building energy modeling software was utilized to estimate the claimed savings.

As stated in the final industrial CPSV TE report, it is the building owner's policy not to run hydronic pipes through certain supporting rooms (e.g. electrical rooms), but instead to always install electric resistance heat. However, the building energy simulation assumed that a conventional, standard efficiency boiler would have been installed in the base case to serve the entire space. This approach appears to be consistent with the ASHRAE Appendix G methodology; however, the assumption is inappropriate as it allows Enbridge to take credit for non-existent gas savings even though the program had no influence on the building owner's decision to install electric resistance heat in the electrical rooms. Per Enbridge's project file, the proposed model simulated 241,511 kWh of electric resistance heating for certain supporting rooms.[21] If we assume 100% efficiency for the electric heating system and an atmospheric boiler at 80% efficiency (ignoring seasonal efficiency), the annual consumption would be approximately 28,834 cubic meters of gas to satisfy the same heating load. From the "Sharing of Environmental Attributes Calculator" included in the project file, the total annual savings (i.e., the sum of Enbridge and Ontario Power Authority shares) were 139,088 cubic meters of natural gas and 4,734,409 kWh of electricity. Adjusting these savings values to reflect electric resistance heat in the baseline would yield total annual savings of 110,254 cubic meters of natural gas and 4,975,920 kWh of electricity. Finally, using these new savings values with the "Sharing of Environmental Attributes Calculator," Enbridge's share of the annual natural gas savings is calculated as 25,992 cubic meters.

Further, the final industrial CPSV TE report noted that, during inspection:

> "the hot water supply temperature was 140F [sic] for boiler #1 and 144F [sic] for boiler #2 which differs from the file which suggested 98 supply /64F [sic] return. The client confirmed this was as a result of some repair work done recently on one of the boilers - and the set point increased to compensate. The client remedied this to the operations by a phone call to reset the supply temperature."

Optimal recommends assuming a 24 year measure life as opposed to the OEB-approved life of 25 years to account for the fact that the boiler was not operating in condensing mode and

[21] Specifically, the email from the project's energy consultant to Aqeel Zaidi of Enbridge dated February 3, 2014.

would therefore have reduced efficiency for one year. We suggest only reducing savings for one year because this condition would likely have been temporary as the error probably would have been discovered through routine preventative maintenance.

Multiplying the reduced annual gas savings of 25,992 cubic meters by the reduced measure life of 24 years yields the recommended gross CCM of 623,808.

RA.IND.LG.RT.022.13

This project involves improvements to large process melting furnaces that resulted in lowered gas consumption.

There appears to be an error in the calculations performed by the CPSV TE and reported in the final industrial CPSV TE report. Savings should be calculated by first determining the cubic meters of gas consumption per pound of product produced for both the pre and post-retrofit periods. Next, the difference of these two factors should be multiplied by the post-retrofit annual production to determine annual savings. When multiplied by the measure life, this yields the recommended cumulative gross CCM savings of 16,994,560.

Prescriptive

In our review of the industrial prescriptive measures in Enbridge's master savings summary spreadsheet, we discovered that the industrial custom project realization rate was applied to industrial prescriptive measures. Optimal removed the realization rate adjustment. We also verified that the measures were implemented for space heating purposes only.

Realization Rate

Enbridge engaged an independent statistics firm to select the CPSV sample projects in accordance with the Technical Evaluation Committee approved methodology. The firm then calculated all of the realization rates based on the final results of CPSV Report.

Optimal made three sets of adjustments to these realization rates. First, we included adjusted CPSV audit values for the commercial and industrial projects that were corrected or revised. Second, we corrected the realization rate calculation methodology to be consistent with the process agreed to as part of the 2012 Audit. Enbridge's contractor incorrectly calculated the realization rates using net CCM savings, but the correct method is based on gross CCM values. Once the realization rates are calculated using gross CCM savings they are applied to Enbridge's total gross custom project savings. The free rider rate is then applied to this value to obtain net CCM. Third, we corrected various data entry errors made by Enbridge's contractor.

Table 8. Commercial and Low-Income Multi-Residential Realization Rates

Post CPSV Value		
Strata	**Net Realization Rate**	**Net CCM**
Large	73.9%	53,509,906
Medium	81.9%	135,611,845
Small	90.4%	195,377,295
Weighted Average	**84.7%**	**384,499,045**

Final Audit Value		
Strata	**Gross Realization Rate**	**Gross CCM**
Large	78.5%	65,426,438
Medium	86.6%	170,936,174
Small	92.9%	240,728,803
Weighted Average	**88.4%**	**477,091,415**

Table 9. Industrial Realization Rates

Post CPSV Value		
Strata	**Net Realization Rate**	**Net CCM**
Large	100.0%	124,333,383
Medium	113.1%	72,719,556
Small	108.5%	15,645,995
Weighted Average	**104.7%**	**212,698,934**

Final Audit Value		
Strata	**Gross Realization Rate**	**Gross CCM**
Large	100.1%	249,085,904
Medium	121.6%	154,028,020
Small	100.8%	28,734,541
Weighted Average	**106.9%**	**431,848,465**

LOW INCOME

Table 10. Final Low Income Audit Values

Metric	Pre-CPSV Values	Post-CPSV Values	Final Audit Value	Increase/ (Decrease)
SINGLE FAMILY (PART 9)				
Net CCM	32,904,684	32,904,684	32,904,684	0
MULTI-RESIDENTIAL (PART 3)				
Custom Multi-Residential				
Net CCM	27,550,015	24,540,706	25,268,448	727,741
Multi-Residential - Showerheads				
Net CCM	738,287	738,287	738,287	0
Multi-Residential - Run It Right				
Net CCM	1,307,420	1,307,420	1,307,420	0
Low Income Building Performance Management				
% of Part 3 Building Installed	85%	85%	85%	0%
TOTAL Low Income Net CCM	**62,500,406**	**59,491,097**	**60,218,839**	**727,742**

Part 9: Single-Family Weatherization

Based on its review of the Single-Family program data, Optimal is not recommending any adjustments to the net CCM claimed by Enbridge.

Part 3: Custom Multi-Residential Projects

The low-income custom multi-residential projects are included in the overall commercial CPSV process as stated above. The adjusted commercial realization rate was applied to the total savings for this program to obtain the final audited net CCM value.

Part 3: Multi-Residential Showerheads

Optimal reviewed a spreadsheet containing a list of the units installed and confirmed that Enbridge used the correct deemed savings values. Optimal also verified that the Year 2012 verification report non-install adjustment factor of 12.3%, as agreed to with the AC, was correctly applied to 2013 units.

Based on its review, Optimal is not recommending any adjustments to the net CCM claimed by Enbridge.

Part 3: Multi-Residential – Run It Right

This program consisted of retro-commissioning measures installed in nine low-income multi-residential buildings. Optimal reviewed the report prepared by the program's verification contractor.[22] Enbridge's claimed savings are based on the same pre and post-regression analysis that was used for the commercial Run It Right program. However, unlike that program, none of the low-income multi-residential buildings had increased gas consumption after project completion. The multi-residential Run It Right program saved an average of 6.5% per building. The total claimed savings for this program represent 2.2% of the total pre-CPSV low-income savings. Based on its review, Optimal is not recommending any adjustments.

Part 3: Multi-Residential – Low-Income Building Performance Management

Optimal reviewed the spreadsheet containing the metric calculation and confirmed that it conformed to the OEB approved formula. Based on its review, Optimal is not recommending any adjustments to this metric.

MARKET TRANSFORMATION

Table 11. Final Market Transformation Values

Metric	Post-CPSV Values	Final Audit Value	Increase/ (Decrease)
DRAIN WATER HEAT RECOVERY			
Number of Units Installed	6,465	6,465	0
RESIDENTIAL SAVINGS BY DESIGN			
Complete Units	967	967	0
Number of Top 80 Builders Enrolled	18	18	0
COMMERCIAL SAVINGS BY DESIGN			
Number of New Development Enrolled	16	16	0
EXISTING RESIDENTIAL			
Number of Real Estate Home Sale Listings committed to list energy rating information	78,000	78,000	0
Number of Home Ratings included in MLS or marketing materials	138	138	0

Drain Water Heat Recovery

The metric tracked for the Drain Water Heat Recovery offering is number of units installed. To verify this metric, Optimal reviewed a spreadsheet to confirm counts provided by builders. Optimal also reviewed one actual builder order and completion form and reviewed Enbridge's tracking protocol.

22 "BTU Savings Report" dated May 2014.

Based on these review activities, Optimal confirms the drain water heat recovery metric value as claimed by Enbridge.

Residential New Construction Savings by Design

The metrics tracked for the Residential New Construction Savings by Design program are the number of completed units and the number of builders enrolled in the program who are among the top 80 home builders (based on home completions). Optimal reviewed the spreadsheet to confirm that homes counted were built by builders enrolled in program. Optimal also reviewed the EnerQuality report for a randomly selected home. The EnerQuality report evaluates whether or not the home was built to achieve savings that are 25% over code.

Enbridge was unable to obtain a definitive list of the top 80 builders. Enbridge did demonstrate that it made a good faith effort to obtain this data. Typically, home builders are reluctant to reveal data about their businesses due to the highly competitive nature of this business. Enbridge did have each enrolled builder self-certify that it had built a minimum of 50 homes in 2012. This was a minimum requirement for builders to be eligible to participate in the program per the OEB filed definition for this metric. In addition, Enbridge reviewed various Ontario housing data. This review indicated that a builder who built 50 homes per year would be considered a top builder in Enbridge's service territory. Optimal concluded that this was a reasonable approach.

Additionally, Optimal reviewed a sample of the memoranda of understanding to confirm that they included a three-year commitment from the participant.

Based on these review activities, Optimal confirms the Residential Savings by Design metric values claimed by Enbridge.

Commercial New Construction Savings by Design

The metric tracked for the Commercial New Construction Savings by Design program is the number of new developments enrolled. To verify the value claimed for this metric, Optimal reviewed signed memoranda of understanding to confirm that they included a five-year commitment, commitment to building to IDP standard within five years, and that each development was greater than 100,000 square feet.

Based on these review activities, Optimal confirms the Commercial Savings by Design metric values claimed by Enbridge.

Existing Residential Home Rating

The two metrics tracked for the Existing Residential Home Rating program are the number of real estate home sale listings committed to list energy rating information and the number of home energy ratings included in actual home listings or related marketing materials. Optimal reviewed the commitment letter signed with the single brokerage participating in the program. This single, very large brokerage confirmed that it typically has over 78,000 listings each year.

Enbridge's value for the number of actual listings or related marketing materials that included an energy rating was 138, below the threshold needed to be reached to earn any DSMIDA for this metric.

CALCULATIONS AUDIT

Optimal reviewed the calculations of the DSMIDA, LRAMVA, and DSMVA in detail. Based on this review, Optimal determined that the calculations were properly applied in accordance with Enbridge's OEB Year 2013 plan filings. There was consistency between actual expenditures included in the variance account calculations and the total DSM expenses reported in Enbridge's financial tracking system and the Draft Evaluation Report. Additionally, for the LRAMVA calculation, the actual sales volume, net of installed efficiency measures, was consistent with the methodologies and assumptions used to calculate the year's budgeted sales volume in advance. Net volumetric sales were appropriately allocated to each respective rate class.

Optimal recalculated the DSMIDA based on the final audit adjustments described in the preceding sections. Enbridge calculated the LRAMVA using the final audited savings values. Optimal reviewed and verified the LRAMVA calculation.

The tables below summarize the final audit values and present the recalculated DSMIDA, and DSMVA amounts and the calculated LRAMVA amounts.

Table 12. Resource Acquisition Values

Program	Post-CPSV Value	Final Audit Value	Increase/ (Decrease)
Residential Community Energy Retrofit - Net CCM	38,992,509	38,980,521	(11,988)
Commercial - Net CCM	496,031,867	505,133,591	9,101,724
Industrial - Net CCM	218,048,241	222,575,355	4,527,114
TOTAL Net CCM	**753,072,617**	**766,689,466**	**13,616,849**
Residential Community Energy Retrofit - Deep Savings Participants	1,649	1,649	0

Table 13. Low Income Values

Program	Post-CPSV Value	Final Audit Value	Increase/ (Decrease)
Single Family(Part 9) - Net CCM	32,904,684	32,904,684	0
Multi-Residential (Part 3) - Net CCM	26,586,413	27,314,155	727,742
TOTAL Net CCM	**59,491,097**	**60,218,839**	**727,742**
Multi-Residential (Part 3) Low Income Bldg. Performance Mgmt. - % of Part 3 Building Installed	85%	85%	0%

Table 14. Market Transformation Values

Program	Metric	Post-CPSV Value	Final Audit Value	Increase/ (Decrease)
Drain Water Heat Recovery	Number of Units Installed	6,465	6,465	0
Residential Savings by Design	Complete Units	967	967	0
Residential Savings by Design	Number of Top 80 Builders Enrolled	18	18	0
Commercial Savings by Design	Number of New Developments Enrolled	16	16	0
Existing Residential	Number of Real Estate Home Sale Listings committed to list energy rating information	78,000	78,000	0
Existing Residential	Number of Home Ratings included in MLS of marketing materials	138	138	0

Table 15. DSMIDA Values

Program	Post-CPSV Value	Final Audit Value	Increase/ (Decrease)
Resource Acquisition	$1,417,015	$1,545,045	$128,031
Low Income	$1,086,289	$1,117,939	$31,650
Market Transformation	$1,875,204	$1,875,204	$0
TOTALS	**$4,378,508**	**$4,538,188**	**$159,681**

Table 16. DSMVA Values

	Post-CPSV Value	Final Audit Value	Increase/ (Decrease)
OEB Approved Budget Built Into Rates	$31,441,652	$31,441,652	$0
Actual Enbridge Year 2013 Spending	$27,839,846	$27,839,846	$0
DSMVA - Negative Due to Ratepayers/Positive Due to Shareholders	**($3,601,806)**	**($3,601,806)**	**$0**

Table 18. LRAMVA Values[23,24]

Rate Class	Net Partially Effective Annual Cubic Meters Built into Year 2013 Rates	Actual Year 2013 Net Partially Effective Annual Cubic Meters	Annual Cubic Meter Variance	Distribution Margin per Cubic Meter	Monetized Value of Annual Cubic Meter Variance
Rate 110	1,656,894	649,138	(1,007,756)	$0.01515	($15,264)
Rate 115	1,054,387	1,874,515	820,128	$0.00859	$7,045
Rate 145	1,868,324	653,899	(1,214,425)	$0.01774	($21,549)
Rate 170	3,898,784	199,539	(3,699,245)	$0.00526	($19,444)
TOTAL LRAMVA (Positive due to Enbridge/Negative Due to Ratepayers)					**($49,213)**

23 The agreed upon process with the AC called for Enbridge to only calculate LRAMVA once the final audit savings values were available.

24 Annual Cubic Meters is the unit for the purposes of LRAMVA because Enbridge's rates are based on sales of annual cubic meters not CCM. The cubic meter values are "Net Partial Effective." This is the process that accounts for the fact that measures are installed throughout the year. For example, a measure implemented in October would generate three months' worth of savings for the 2013 calendar year. The number included in the LRAMVA calculation for this measure is therefore the average monthly gas savings multiplied by three.

FINDINGS AND RECOMMENDATIONS

FINDINGS

We have audited the Draft Evaluation Report, Net Cumulative Cubic Meters (CCM) savings, DSM Incentive Deferral Account (DSMIDA), Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), and Demand Side Management Variance Account (DSMVA) of Enbridge Gas Distribution for the calendar year ending December 31, 2013. The Draft Evaluation Report and the calculations of CCM, DSMIDA, LRAMVA, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts based on our audit. We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in its Decision with Reasons dated June 30, 2011, in EB-2008-0346. Details of the steps taken in this audit process are set forth in this Audit Report, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that has been gathered and recorded using reasonable methods and is accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2013 DSM programs of Enbridge Gas Distribution:

- Net CCM savings of 826,908,305
- DSMIDA amount recoverable of $4,538,188 (due to Enbridge)
- LRAMVA amount payable of $49,213(to be refunded to Enbridge ratepayers)
- DSMVA amount payable of $3,601,806 (to be refunded to Enbridge ratepayers)

RECOMMENDATIONS

Throughout the performance of this audit we noted areas that would improve the overall verification and audit process and enhance savings assumptions through future evaluation and verification studies. These recommendations are listed below. They are sorted by category and ranked by relative importance.

CPSV Process

1. **Select an independent third-party engineering firm to review the ETools software for consistency with acceptable engineering practice.** The CPSV TEs are directed to perform independent analyses to confirm or revise the saving estimates calculated by Enbridge or engineering contractors. In many cases, these savings estimates are generated by Enbridge's proprietary ETools analysis software. Instead of performing independent savings estimates each year, Optimal recommends that a third-party engineering contractor--one with significant experience with Excel and the VBA-based tools used to develop ETools—be retained to perform a thorough audit of all of the ETools software modules. Once the validity of the methodologies embedded in the

ETools software is independently verified, the CPSV TE review of projects employing ETools can focus on determining:

- Whether the methodology used by ETools is appropriate for the specific project.
- Whether the inputs used in the ETools calculations are reasonable.

As ETools is typically updated on a semi-annual basis, an independent annual review of any modifications to the ETools software should be incorporated in the annual audit process.

2. **Develop a standardized report template for use by the CPSV TEs.** Providing a report template would assist the CPSV TEs in developing more consistent reports that provide all of the information required to validate their review. The template should stress the importance of including all relevant project assumptions, inputs, and calculation methodologies. The inclusion of all relevant project information in a consistent format and level of detail will allow the auditor to perform their task without having to request the full project file from Enbridge. Auditor review of Enbridge project files for clarification or to obtain missing data is a redundant and inefficient effort. The template will also allow the auditor to easily locate data and information within each CPSV TE project write-up leading to a more streamlined CPSV audit review process.
3. **Request that the CPSV TEs estimate the remaining useful life of the existing equipment in cases where the energy efficiency measure is an "add-on" to existing equipment for both the commercial and industrial sectors.** For example, if the measure is an efficiency control on an existing boiler, the CPSV TE should determine if the existing boiler will be in place for the entire measure life of the efficiency control. If not, then a baseline (or measure life) adjustment should be made to account for the existing boiler being replaced with a more efficient boiler prior to the end of the measure life. Alternatively, develop one or more deemed measure lives for these types of projects, which are not currently included in the OEB measure life tables.
4. **Document the custom project realization rate calculation methodology.** The 2012 Audit provided guidance on the correct process to calculate realization rates, but there is no formal stand-alone document that lists all the agreed upon steps. The method employed by Enbridge's realization rate contractor for 2013 contained process errors that Optimal needed to correct as part of its audit review.
5. **Undertake a baseline boiler study.** For replacement projects, the base case is a code compliant boiler with 80.5% thermal efficiency. In many other jurisdictions, higher efficiency boilers are often code or standard practice. Standard practice might also include additional boiler control efficiency measures. A boiler baseline study was completed three years ago. However, given the importance of this measure and the reality that these markets change quickly, it is important to update this work. An updated study will determine if the standard practice in Enbridge's service area is actually above code, which would indicate a need for a revised baseline.

6. **Provide clear instructions to the CPSV TEs to focus on evaluation of annual gas savings and measure lives, the inputs used to determine CCM.** The sole DSMIDA metric for custom projects is CCM. Given tight timelines and the need to use ratepayer funds efficiently, the CPSV TEs should not spend time reviewing non-gas savings values or measure cost data.

7. **For projects modeled using eQUEST, consider using IPMVP protocols for New Construction projects with adequate calibration of both the baseline and as-built models.** In addition, each project file should contain the final model used to support the project savings claim. If necessary, any secondary calculations to overcome shortcomings of the modeling tools should also be saved in the file.

8. **Proper IPMVP protocols should be followed to verify project savings.** While most projects employ sound measurement and verification methodologies, it was not always clear that CPSV contractors followed proper IPMVP protocols. Access and schedule issues as well as budget limitations may prevent CPSV contractors from performing the level of on-site measurement necessary to comply with IPMVP guidelines. Future CPSV contractors should endeavor to clearly identify which IPMVP option was employed and provide a thorough description of how that option was implemented. For example, if "Option A. Retrofit Isolation: Key Parameter Measurement" is determined to be the best option for a given project, the contractor should clearly establish which parameters are measured, which are estimated, and the methodology used to calculate savings. Presenting the verification results within the framework of IPMVP would lead to more justifiable savings estimates and facilitate review by future auditors.

9. **Enbridge should develop site-specific destratification factors based on the building site, ceiling height, fan diameter, and speed.** For custom industrial destratification fan projects, Enbridge assumes that the contractor/vendor will design and install the project to destratify the entire space. Enbridge then applies a blanket factor of 0.85 to derate the destratification savings to be conservative. Developing site-specific destratification would result in a more rigorous savings estimate.

Run It Right

10. **Establish a free rider rate for the Run It Right program**. Currently, there is no OEB approved free rider rate for this program. As part of this audit process, Enbridge proposed a free rider rate. Optimal conducted an informal review of free rider rates for gas retro-commissioning programs in other jurisdictions and recommended adoption of Enbridge's requested rate for purposes of this audit. Enbridge should formally establish a free rider rate that is subsequently filed and approved by the OEB.

11. **Survey Run It Right participants.** Ideally, Enbridge or its evaluator should survey participants prior to any billing regression analysis. This would ensure better data and avoid noted problems with ex-post adjustments to the sample that resulted from exogenous factors affecting gas usage. The importance of conducting a survey prior to the analysis is that all data is treated equally, and any obvious outliers or other problem data can be removed or adjusted without bias. In addition, this process will allow for

removal of any obviously bad or incomplete data. Surveys should accomplish the following:

- Determine whether the participant implemented the measures recommended in the timeframe indicated.
- Determine whether the participant made any significant changes to the facility, its operations, or equipment outside of the Run It Right Program. If changes were made, determine whether changes can be attributed to Run It Right spillover savings, are completely independent of the Program, or were already counted in another Enbridge program.
- Collect basic participant characteristics, including building type, occupancy load, usage, and size.

Based on this information, the analyst can remove or adjust all data in a consistent fashion. For example, if a major piece of equipment was replaced with a more efficient one, it may be appropriate to adjust the ex-post data to subtract the expected additional savings. Further, if building usage or operations have changed significantly, the data can be adjusted if the impacts of these changes can be estimated with relative certainty. In some cases, it may be more appropriate to simply remove a participant from the sample.

12. **Include a "comparison group" of similar customers that did not participate in the Run It Right program.** A comparison group of customers that are matched to the participant group (in terms of building type, major end-uses, size, and consumption) should be included in the analysis. Typically this would be done with a "dummy variable" that indicates whether the customer was a participant or not. The biggest benefit of including a comparison group is that it can more explicitly control for weather and other variations over time. Because all sites will have been exposed to the same weather, the analysis inherently controls for weather without the need to identify balance temperature points for each facility. It also avoids introducing uncertainty from determining a building specific relationship between weather and gas usage. This will significantly simplify the analysis and result in a more accurate isolation of weather effects. A comparison group also can adjust for unknown variables that may be important but are difficult to identify and control for. For example, there may be natural growth in existing buildings' gas usage that would mask some of the true program savings. Comparing participants with similarly situated non-participants would automatically control for any such effects.

13. **Consider sampling approaches that balance required resources with level of importance.** When performing the analysis and incorporating the two previous recommendations, we recognize that this approach may add additional program costs related to surveying participants and using comparison groups. We also understand that Enbridge intends for this program to expand and hopefully have more participants in the future. As a result, it may be appropriate to analyze a sample of participants rather than a full census of participants. This is appropriate, particularly if the number of participants grows significantly. We recommend that the sample of participants first be

stratified by size. The largest usage customers will tend to have a disproportionately high impact on overall savings. As a result, we recommend developing size strata and oversampling the largest stratum (depending on range of usage and number of participants, it may make sense to oversample more than one large stratum). Often, the very largest stratum might only have a few participants, who would all be included in the sample. This approach of devoting more resources to the largest projects will enhance the overall precision of the sample without the need to actually increase the numbers of participants sampled. Once the strata cut points are selected, the samples should be drawn in a randomized way (except for any strata where a full census is used). Similarly, the comparison group should align with the same strata and also be randomly selected.

Audit Process

14. **Produce an audit guidelines document for the auditor.** Currently, each auditor establishes its own detailed process to meet the overall requirements stated in the audit RFP. This can lead to inconsistencies over time. A clear, detailed set of guidelines would result in more consistent audit results from year-to-year.

15. **Clarify Audit Committee role.** The AC should have a written charter that spells out its decision-making process, purpose, duties, and powers. While the "Union Gas Limited – 2012-2014 Demand Side Management Plan Settlement Agreement on Terms of Reference for Stakeholder Engagement" provides high level guidance on the function and operation of the AC, it would be useful to have a more detailed, stand-alone charter that is provided to the auditor. This would add clarity to the AC role for the auditor and generally make for a more efficient audit process.

16. **Award the audit contract earlier in the process.** Optimal received its audit contract on March 5, 2014. OEB rules require that the final audit report be submitted by June 30 of each year. Optimal was able to quickly shift its other workloads to allow its audit staff to devote the necessary effort needed to produce rigorous audit results over this short timeframe. For example, in order to provide timely feedback on the CPSV draft Wave 1 reports, Optimal staff had to devote more than a full time effort at the outset of its contract period. Fortunately, Optimal was able to shift other work to accommodate this initial, quick turn-around. Because subsequent auditors may not be able to adjust so rapidly, issuing the audit contract earlier will better ensure a robust and thorough audit report within the necessary timeframe. This recommendation is not intended to suggest that Optimal did not have sufficient time to produce a high quality and rigorous audit. Optimal did indeed have ample time. Rather, it is meant to address potential challenges that may arise if future audit firms are unable to re-deploy staff resources as readily.

17. **Seek written comments and feedback from the Audit Committee as one unified document as opposed to individual documents from each AC member.** Currently, the auditor has to respond to and sort through multiple documents. Having a single document from the AC for each set of comments would simplify the auditor's work flow.

Other Recommendations

18. **Produce a single document that pulls in all of the current year final OEB approved metrics, DSMIDA amounts and calculation procedures with appropriate citations back to the OEB regulatory filings.** This document would be provided to the auditor at the start of their work plan. Currently, all of this data is buried in hundreds of pages of OEB regulatory filings and exhibits. For someone not familiar with these proceedings, it is time consuming and not efficient to dig through all of these documents. In addition, it is sometimes difficult to determine the final approved values given the various revisions and updates.

19. **Provide enhanced quality control procedures for the data provided to the CPSV TE and the CPSV sampling and realization rate firm(s).** In its audit review, Optimal identified minor data entry errors in data sets provided by Enbridge to its sampling and realization rate contractor and the CPSV TEs. Project level savings data were not always consistent between the realization rate contractor and the CPSV TEs. We suspect that as Enbridge records and updates the data in its DSM tracking system, it is not also ensuring that all the various firms performing audit and verification tasks receive updated data sets.

ATTACHMENT A: OPTIMAL'S APPROVED AUDIT WORK PLAN

Optimal ENERGY *Integrated Energy Resources*

Independent Audit of Enbridge Gas Distribution 2013 DSM Program Results:

Final Work Plan

Prepared for the

Enbridge Gas Distribution Audit Committee

by

Optimal Energy, Inc.

28 March 2014

Optimal Energy, Inc.
802-482-5600

www.optenergy.com

10600 Route 116, Suite 3
Hinesburg, VT 05461

CONTENTS

INTRODUCTION AND OBJECTIVES

Enbridge Gas Distribution (Enbridge) operates a series of demand side management (DSM) programs in accordance with its 2012-2014 Multi-Year Plan approved by the Ontario Energy Board (OEB).[1] Enbridge receives a combination of direct cost recovery and performance-based payments associated with its program delivery. The OEB and Enbridge's Audit Committee (AC) require an independent third-party review of Enbridge's annual report and supporting calculations to ensure that savings claims and performance-based payment calculations are correct.

Enbridge issued a Request for Proposals (RFP) on behalf of its Audit Committee to undertake the Year 2013 Audit on 10 February 2014. Optimal Energy Inc. submitted its proposal on 21 February 2014 and was awarded the contract on 5 March 2014.

The primary objective of this audit is to review Enbridge's calculations for Cumulative Cubic Meters (CCM) savings, the Demand Site Management Incentive Deferral Account (DSMIDA), the Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), and the Demand Side Management Variance Account (DSMVA) for the calendar year ended December 31, 2013, and to express an independent opinion on these amounts. If the Enbridge-reported amounts differ from what Optimal believes to be correct, Optimal will present alternative values. As required in the RFP, the auditor has a secondary role to recommend any forward-looking evaluation work for consideration.

This audit will be conducted under the direction of the AC and in accordance with:

- the rules and principles set down by the Ontario Energy Board in its Decision with Reasons dated June 30, 2011, in EB-2008-0346; and
- the RFP issued on 21 February 2014.

Optimal will perform this audit as further described below.

[1] Settlement Agreement Enbridge Gas Distribution Inc. Demand Side Management Multi-Year Plan 2012-14, Exhibit B, Tab 2, Schedule 9 OEB Case EB-2011-0295 dated; and Enbridge Gas Distribution Inc. Update to the 2012 to 2014 Demand Side Management ("DSM") Plan Ontario Energy Board ("Board") File No.: EB-2012-0394, dated 28 February 2013.

TASK 1: PLANNING, MEETINGS AND WORK PLAN

TASK 1.1 - KICK-OFF CONFERENCE CALL WITH ENBRIDGE DSM STAFF AND AUDIT COMMITTEE

Optimal staff will attend a kick-off conference call with Enbridge's DSM staff and the Audit Committee (AC). The purpose of this meeting will be:

- to introduce the Optimal team and the roles that each of its staff will undertake
- obtain feedback from the AC on Optimal's scope of work contained in its proposal
- obtain feedback from the AC as to any particular areas of focus for this year's audit

Deliverables

1. draft agenda submitted prior to the conference call

Schedule

The kick-off conference call was held on 11 March 2014.

TASK 1.2 - ON-SITE MEETINGS WITH ENBRIDGE DSM STAFF

Optimal staff will attend two days of on-site meetings at Enbridge's offices. The overall purpose of the site visit will be to gain a thorough understanding of each of Enbridge's DSM programs and to begin the initial process of gathering data, studies and other documents needed to complete the audit. This will be accomplished via a set of specific meetings set up by Enbridge that that will:

- provide an in-depth review of each Enbridge DSM program
- demonstrate Enbridge's monitoring and tracking systems
- demonstrate eTools, Enbridge's in-house savings estimation tool that standardizes inputs and calculations for complex measures

Enbridge staff have set up the following itinerary:

Optimal Energy Itinerary

Time Slot	Monday, March 17	Tuesday, March 18
9:00-10:00	DSM EM&V Introductions	Low Income
10:00-11:00	Monitoring & Tracking	Market Transformation
11:00-12:00	Business Technology	Run It Right
12:00-1:00	Lunch	Lunch
1:00-2:00	BT Presentation (Etools)	Commercial Dept.
2:00-3:00	Industrial Dept.	Residential Dept.
3:00-4:00	Industrial CPSV	Commercial CPSV
4:00-5:00	Open	Open

Optimal will also present its draft work plan for review and final approval.

Deliverables

None

Schedule

The site visit will take place on 17 and 18 March 2014.

TASK 1.3 - FINAL WORK PLAN

Optimal will submit a draft final work plan to Enbridge and the AC. The work plan will be based on the RFP requirements, Optimal's scope of work contained in its proposal and its discussions to date with Enbridge staff and the AC.

Deliverables

1. draft work plan
2. final work plan

Schedule

The draft work plan will be submitted on 14 March 2014. Optimal requests that Enbridge and the AC review and provide comments by 21 March 2014. Optimal will revise the work plan for final approval by 26 March 2014.

TASK 1.4 - DATA/DOCUMENT COLLECTION AND REVIEW

Optimal will prepare a detailed data request for any needed additional information not gathered during the site visits. This task will ensure that all data needed to complete the audit has been collected. This request will include the following:

- CCM documents, records, screening tools, and calculations
- DSMIDA, LRAMVA, DSMVA documents, records and calculations
- Year-end program evaluation and savings verification reports for all programs that are not included in the CPSV reports:
    - Residential Community Energy Retrofit
    - Residential TAPS/ESK
    - Commercial Prescriptive
    - Commercial Multi-Res
    - Energy Compass and run It Right
    - Continuous Energy Improvement: Industrial and Agricultural
    - Low-Income Single Family
    - Low-Income Multi-Res
    - Market Transformation
    - Savings by Design: Commercial and Residential
    - Existing Residential – Home Rating
- pertinent OEB orders
- approved technical reference manuals

- Enbridge DSM plans filed with the OEB

Task 1.4 is primarily a data collection exercise. Optimal will, however, undertake high level review of the orders and plans to develop an understanding of underlying program polices. An in-depth review of the 2013 program and research reports is part of Task 3.

Deliverables

1. Detailed data request

Schedule

Data request will be submitted by 4 April 2014.

TASK 1.5 - WEEKLY MEETINGS

Optimal staff will attend weekly AC and Custom Project Savings Verification (CPSV) Contractor meetings via teleconference.

The CPSV meetings will allow Optimal to provide input and recommendations to the CPSV contractors prior to the completion of their verification work.

The AC meetings will provide Optimal an opportunity to share preliminary audit findings. This will give the AC, Enbridge and its evaluation and verification contractors the opportunity to provide more data, clarify issues, or correct auditor perceptions, with the goal of producing the most accurate and useful audit results and recommendations. Optimal will recommend agenda items as they pertain to the audit and will issue meeting notes or action items following each meeting.

Deliverables

1. Weekly agenda items, as needed
2. Meeting notes and action items

Schedule

AC meetings will occur weekly on an as-needed basis.

There will be two CPSV Contractor meetings per week, one for the commercial contractor and one for the industrial contractor. The weekly meetings will continue until the CPSV contractors have issued their final reports. As needed, Optimal may have additional (outside of the scheduled weekly meeting) discussions with the CPSV firms. Optimal will inform the Enbridge Audit Committee if these additional discussions occur.

TASK 2: REVIEW & VALIDATE CPSV RESULTS AND REALIZATION RATES

TASK 2.1 – REVIEW DRAFT WAVE 1 CPSV REPORTS

Optimal will review the draft Wave 1 CPSV reports to provide feedback on the quality, reasonableness and accuracy of the project savings estimates. We will also ensure that the contractors are meeting the requirements of the RFPs issued by Enbridge for this work and that the Year 2012 Auditor Resource Acquisition Recommendation 1 was properly implemented by the CPSV contractors.[2] Optimal's recommendations will help ensure that the final Wave 1 reports and the subsequent Wave 2 reports are of high quality and meet the requirements of the AC.

Deliverables

1. Memo summarizing findings and recommendations regarding the Wave 1 draft reports

Schedule

Optimal will provide the memo on 17 March 2014.

TASK 2.2 – REVIEW FULL WAVE 1 AND WAVE 2 DRAFT CPSV REPORTS

Optimal will review the draft of the full Wave 1 and Wave 2 reports to ensure that the final CPSV reports will contain the level and quality of project information that will allow Optimal to provide its independent audit opinion as to the CPSV savings claims.

Deliverables

1. Memo providing recommended revisions to be incorporated in the final CPSV Reports.

Schedule

The following Table provides the revised 2013 CPSV timeline as discussed with the CPSV firms and Optimal.

[2] Year 2012 Auditor Recommendations along with Enbridge's and the AC responses are contained in the 2012 Demand Side Management Audit Summary Report dated October 17, 2013.

Date	Milestone
4 April 2014	Final Drafts of Wave 1 and Wave 2 Commercial and Industrial CPSV Report
11 April 2014	Optimal Response on Final Drafts of CPSV Reports
17 April 2014	Final CPSV Reports
24 April 2014	Ipsos Realization Rates

Optimal will issue its memo on 11 April 2014.

TASK 2.3 – FULL EXAMINATION OF FINAL CPSV REPORTS

Optimal will undertake the following sub-tasks steps in its examination of the final CPSV report results:

- **Review the project-by-project evaluations contained in the CPSV final reports.** - For this review we will utilize a checklist allowing us to systematically ascertain that key project elements have been reported, are well documented, and are reasonable and appropriate. If additional information is needed, Optimal may request the full Enbridge project file.
- **Examine advancement/replacement and other baseline characterization assumptions** - Appropriate revisions will be recommended if it is determined that OEB-approved or industry-accepted methodologies were not utilized in determining baselines used for savings calculations.
- **Confirm or revise project performance estimates** - Our experience with project review informs us that there will be times when a common understanding of project performance will not be met. When this occurs, we will include a recommendation for revised project assumptions or calculations, comparing this with what was originally reported, and fully defending the reasons for the recommended adjustments.

We will utilize both in-house data developed from our engagements with custom project reviews for other clients and published evaluation work to compare assumptions, methodologies, and savings results.

- All other pertinent studies relevant to industrial and commercial custom projects that have been completed in support of the Enbridge DSM Annual Report will be reviewed and utilized in making final recommendations.

At the conclusion of our custom projects examination, if Optimal disagrees with any of the final project CCM savings claims put forth by the CPSV contractors we will provide revised savings claims for these projects. Ipsos, Enbridge's sampling and realization rate contractor, will then calculate new realization rates based on these adjustments. Optimal will employ these new realization rates in its audit report. We will also note findings, issue opinions, and make recommendations regarding Enbridge's custom program initiatives and future savings documentation practices; these activities will take place under Task 6.

Deliverables

1. Preliminary results providing details on recommended adjustments to individual projects' savings calculations and overall adjustments to realization rates.
2. Finalized savings calculations adjustments and adjusted realization rates that will be incorporated

Schedule

Preliminary CPSV recommendations will be provided by 2 May 2014. This date is contingent on the final CPSV reports being completed by the CPSV contractors no later than 17 April 2014.

Final CPSV recommendations will be provided by 16 May 2014. This date is contingent on AC review of preliminary recommendations being completed no later than 9 May 2014.

TASK 3: REVIEW ANNUAL REPORT STAKEHOLDER COMMENTS AND VERIFICATION STUDIES

TASK 3.1 - CONSIDER STAKEHOLDER COMMENTS TO ANNUAL REPORT

Optimal will review and respond to stakeholder and AC comments on Enbridge's draft Year 2013 Annual DSM Report.

Deliverables

1. Memo providing Optimal's response and feedback regarding comments provided by stakeholders and AC.

Schedule

Memo will be provided by 15 May 2014. This due date is contingent upon:

- 2013 DSM Annual Evaluation Report being issued on 1 May 2014; and
- Stakeholder and AC comments being provided no later than 8 May 2014.

TASK 3.2 – REVIEW VERIFICATION STUDIES

Enbridge has informed Optimal that no Year 2013 verification studies were conducted. Optimal will, however, ensure that any approved adjustment factors that resulted from any Year 2012 studies are properly incorporated into the CCM calculations presented in the 2013 DSM Annual Evaluation Report.

Deliverables

N/A

Schedule

N/A

TASK 4: REVIEW ENBRIDGE'S DSM TRACKING SYSTEMS

Optimal will review Enbridge's monitoring and tracking administrative procedures and systems as part of its on-site visit in Task 1.2 above. Tracking procedures will be reviewed to determine if Enbridge's DSM analysis, reporting, and tracking system (DARTS) results are being properly entered into the CCM and the DSMIDA calculation workbooks that form the basis of the results reported in Enbridge's DSM Annual Report. Optimal will review the flow of information through the system.

The aggregating system will be tested to determine whether the stored data is accurate. Our data system review will include the following activities on a sample of project records:

- Validation of data inputs
- Verification of storage and back-up protocols
- Review of quality assurance and quality control protocols
- Review of exception-handling mechanisms
- Review of user documentation

As a follow-up to Year 2012 Auditor General Recommendation 1 regarding updated project completion definitions and procedures Optimal will review the progress of implementing this recommendation.

Auditor General Recommendation 4 requires Enbridge to provide documentation to substantiate its involvement for each large and/or custom project prior to project completion. Optimal will review a sample of projects to ensure that this procedure has been put in place.

Deliverables

None – the results of this review will inform and will be incorporated into Task 5 and 7.

Schedule

The on-site review will be incorporated into Optimal's site visit on 17 and 18 March 2014. Any follow-up with Enbridge staff needed to complete the review will take place no later than 18 April 2014.

TASK 5: REVIEW AND VERIFY CCM, DSMIDA, LRAMVA AND DSMVA CALCULATIONS

The previous tasks lay the groundwork for proceeding with the primary objective of the audit:

> *to provide an independent opinion to DSM stakeholders that serves to determine if the DSMVA, LRAM and utility DSM Shareholder Incentive calculations are appropriate.*

To verify the relevant savings and account calculations, we must first determine whether reported savings values are based on reasonable and accurate measure inputs, assumptions, and calculations. This will proceed in a series of sub-tasks. Below, we describe how we will review all of the relevant calculations and arrive at our opinions. Note that our efforts to assess the CPSV are described in Task 2. The findings from those reviews will be incorporated into the reviews and verification conducted under this task.

TASK 5.1 - COMPARE ASSUMPTIONS TO RELEVANT SOURCES

Optimal's findings from Task 4 will determine if savings data is accurately recorded. For this task Optimal will begin by checking Enbridge's measure characterizations and savings calculations against Board and/or Technical Evaluation Committee (TEC) approved values. As noted in the RFP, such assumptions will be generally presumed to be correct. Thus, Optimal will only conduct a cursory review of them. However, in cases in which that cursory review raises any "red flags" regarding the reasonableness of the assumptions – particularly for measures that account for a significant portion of claimed prescriptive savings – Optimal will examine the assumptions more close and, as appropriate, recommend alternatives (as part of our work in Task 7 below).

TASK 5.2 - REVIEW CCM CALCULATIONS

All of the foregoing information and data will be brought together to verify the calculation of cumulative cubic meters (CCM) gas savings in order to support the further calculations of the cost recovery and incentive mechanisms. As noted above, this will also include incorporating the findings of the CPSV review (Task 2). While our review and validation will cover all aspects of the calculations across all programs and measures, we will focus our efforts on those aspects of the estimate that 1) carry the most uncertainty, 2) contribute the largest cumulative savings to the overall portfolio total, 3) represent areas where past audits have identified problems to be modified in the future, or 4) represent newer measures or measures in which there may be changes to assumptions and savings estimates as a result of changing market conditions.

As part of the CCM review process and in accordance with Year 2012 Auditor Resource Acquisition Recommendation 6 Optimal will conduct a desk review of a random sample of the Run It Right program to verify the reasonableness of the claimed savings for this program.

TASK 5.3 - REVIEW DSMVA, LRAMVA, AND DSMIDA CALCULATIONS

The tasks outlined in the preceding sections provide for a reasonable basis for Optimal to confidently make its determination of the validity of the DSMVA, LRAM, and DSMSIDA calculations. We will ensure that OEB approved methodologies for all of these calculations were properly followed. We will also ensure that any recommended adjustments to the final CCM results are properly incorporated into the LRAM and DSMIDA calculations.

Optimal's review of the DSMVA will not include auditing of Enbridge spending documentation. This is a financial auditor's responsibility. Optimal will review the calculation of the DSMVA to ensure consistency between actual expenditures included in the variance account calculations and the total DSM expenses reported in Enbridge's financial tracking system and the DSM Annual Report.

For the LRAMVA we will also ascertain whether the methodologies and assumptions used to calculate actual sales volume net of installed efficiency measures are consistent with the methodologies and assumptions used to calculate the year's budgeted sales volume in advance. We will also ensure that the net volumetric sales are appropriately allocated to each respective customer class. With regard to gas sales, we will be particularly interested in the Company's weather-normalization processes and algorithms, making sure that Enbridge consistently applied such processes to both its sales forecasts and its actual sales volume.

Task 5 Deliverables

1. Preliminary recommendations for any adjustments to the CCM, DSMIDA, LRAMVA and the DSMVA will be provide to the AC for their review and consideration. Final results will be incorporated into Task 7 below.

Task 5 Schedule

Preliminary recommendations will be provided no later than 23 May 2014.

TASK 6: IDENTIFY FUTURE ENHANCEMENTS

Throughout the performance of this audit we will note areas where future enhancements in either evaluation procedures, assumptions, or implementation practices might result in more accurate calculations, simpler verification procedures, or improved confidence in the results reported in the DSM Annual Report. These will be gathered together in one document and sorted by the type of recommendation (e.g., procedural change vs. quantitative assumptions) and ranked by relative importance. Optimal will also identify future evaluation research opportunities to enhance the assumptions used to calculate the DSMIDA and LRAM.

And finally Optimal will provide an update as to the status of the Year 2012 Auditor recommendations.

Deliverables

None - the suggested enhancements will be included in the draft and final audit report issued under Task 7.

Schedule

This task will be ongoing and will conclude prior to the preparation of draft audit report.

TASK 7: ISSUE AUDIT FINDINGS, RECOMMENDATIONS AND REPORT

Upon the successful completion of the above-noted tasks, we shall provide the AC an independent opinion relative to the Company's calculations leading up the proposed amounts in each of the relevant DSM accounts.

TASK 7.1 - RESOLVE ISSUES PRIOR TO AUDIT COMPLETION

Through the weekly meetings and regular updates, Optimal will work with AC members to resolve any relevant issues prior to preparation of the draft audit report.

TASK 7.2 – ISSUE DRAFT AUDIT REPORT

Incorporating the adjustments, results, and recommendations from Tasks 2, 5, and 6 Optimal will prepare a draft audit report for review and comment by Enbridge staff and the AC. The draft report will provide the required audit opinion as to whether the CCM, DSMIDA, LRAMVA, and DSMVA calculations and results are correct and reasonable as submitted in Enbridge's Annual DSM Report. If necessary, the report will provide independently developed alternative calculations for these accounts. The report will full explain our decision processes and how and where we used our judgment to develop our opinions. If Optimal provides independently developed alternative calculations the report will provide clear documentation and justification for these alternative values.

Optimal will make a full and formal presentation of the findings, recommendations and conclusions contained on the draft report via webinar to the AC.

Deliverables

1. Draft Audit Report
2. Formal presentation to the AC via webinar of draft findings

Schedule

The draft audit report will be provided no later than 30 May 2014.

The formal presentation will be scheduled during the week of 2 June 2014.

TASK 7.3 – ISSUE FINAL AUDIT REPORT

Once Optimal has received the draft audit report response from the AC a final audit report will be prepared and submitted. The final report will include the following statements:

> We have audited the Annual Report, Cumulative Cubic Meters (CCM) savings, DSM Incentive Deferral Account (DSMIDA), Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), and Demand Side Management Variance Account (DSMVA) of Enbridge Gas Distribution for the calendar year ended December 31, 2013. The Annual Report and the calculations of CCM, DSMIDA, LRAMVA, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts

based on our audit. We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in its Decision with Reasons dated June 30, 2011, in EB-2008-0346. Details of the steps taken in this audit process are set forth in the Audit Report that follows, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that has been gathered and recorded using reasonable methods and is accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2013 DSM programs of Enbridge Gas Distribution:

- CCM Savings - $xxx,xxx,xxx
- DSMIDA Amount Recoverable - $x,xxx,xxx
- LRAMVA Amount Recoverable - $x,xxx,xxx
- DSMVA Amount Recoverable - $xxx,xxx

The final report will contain the full and final list of forward-looking recommendations.

If necessary, we will make available an expert witness to defend or describe our findings, opinions, and recommendation at an OEB hearing at the hourly rates contained in our proposal. We expect that Mr. Mosenthal would serve as this witness, potentially supplemented with engineering experts.

Deliverable

1. Final Draft Year 2013 DSM Audit Report
2. Final Year 2013 DSM Audit Report

Schedule

The final draft annual report will be submitted no later than 12 June 2014. This due date is contingent upon receiving the AC's response to the initial draft no later than 6 June 2014.

The final audit report will be submitted no later than 19 June 2014. This due date is contingent upon receiving the AC's response to the final draft no later than 16 June 2014.

TASK SCHEDULE

	Week Ending															
	7-Mar	14-Mar	21-Mar	28-Mar	4-Apr	11-Apr	18-Apr	25-Apr	2-May	9-May	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun
1.1 - Kick-Off Conference Call		M														
1.2 - On-Site Meetings			M													
1.3 - Final Work Plan			D													
1.4 - Document Collection/Review					D											
1.5 - Weekly Mtgs - AC			M	M	M	M	M	M	M	M	M	M	M	M	M	M
1.5 - Weekly Mtgs - CPSV			M	M	M	M	M									
2.1 - Draft Wave 1 CPSV Reports			D													
2.2 - Draft Wave 1 & Wave 2 CPSV						D										
2.3 - Final CPSV Reports									D		D					
3.1 - Annual Report Comments											D					
3.2 - Review Verifications Studies: No 2013 Studies Issued - N/A																
4 - Review Tracking Systems																
5.1 - Compare Assumptions												D				
5.2 - Review CCM Calculations												D				
5.3 - DSMVA, LRAMVA, DSMIDA												D				
6 - Identify Future Enhancements																
7.1 - Resolve Issues																
7.2 - Draft Audit Report													D	P		
7.3 - Final Audit Report															D	D

D = Deliverable
M = Meeting
P = Presentation

ATTACHMENT B: OPTIMAL DATA/DOCUMENT REQUEST

Optimal ENERGY *Integrated Energy Resources*

MEMORANDUM

To: Rodney Idenouye, Enbridge Gas Distribution

From: David Bardaglio

Date: 4 April 2014

Subject: Year 2013 DSM Audit Data and Document Request

Listed below is Optimal Energy Inc.'s (OEI) initial request for data and documents needed to undertake the Year 2013 DSM Audit per its approved work plan. This list is based on OEI's on-site meetings, subsequent conference calls, and review of documentation received to date.

After OEI has reviewed the data/documentation submitted below, additional data/documents may be requested. In addition, after OEI has received Enbridge's Draft Evaluation Report and supporting documentation, OEI may determine additional information is required. In either case, OEI will prepare and submit supplemental data/document requests as needed.

1) Enbridge's Updated Year 2013 Measures List
2) For the Technical Reference Manual, please provide:
   a) Savings assumptions (deemed annual savings, measure life, spillover/free rider values, etc.) for all prescriptive measures.
   b) Percent of the total year 2013 unaudited savings that each measure represents.
   c) Approval status for each measure; explicitly:
      i) Technical Evaluation Committee (TEC)/Ontario Energy Board (OEB) approved;
      ii) New measure being evaluated by Energy & Resources Solutions;
      iii) TEC/OEB approval pending.
3) List of approved OEB measure lives.
4) Where available, process maps for each of Enbridge's market transformation and resource acquisition programs.
5) For the Enbridge's DSM monitoring and tracking systems, provide:
   a) Process Map
   b) User Operational Manuals

c) Written Quality Assurance/Quality Control (QA//QC) Procedures
d) Written QA/QC procedures implementation documentation and/or results
e) Documentation of any QA/QC corrective action taken

6) For the Part 3 and Part 9 Low-Income programs provide a sample contract used for the third-party program delivery contractors and a sample completed project completion package.

7) For each of the Market Transformation programs, provide samples of all participation documentation.

8) For the Community Energy Retrofit program, provide:

a) Sample participation agreement
b) One complete project file

9) For the Run It Right Program, provide:

a) Documentation of methodology used to calculate claimed savings
b) List of all Run It Right projects that resulted in Year 2013 claimed savings. For each project provide:
i) Project identifying number,
ii) Total CCMs,
iii) Project type (multi-res, commercial, etc.), and
iv) Short description of the project.
c) OEI will then select a sample of projects from this list and request the full project file for each of the selected projects.

10) For the most current version of E-Tools, please provide:

a) User's manual
b) Technical documentation detailing savings methodology and algorithms.

11) For each of the industrial and commercial custom projects included in the CPSV contractor reports, where applicable, provide the final E-Tools output report.

12) For the High Performance New Construction (HPNC) Program, please provide any guidelines or protocols to which applicants and model verification contactors are instructed to adhere. Specifically, please provide any guidelines or protocols regarding acceptable energy simulation models and practices.

OEI is not requesting any EM&V studies, because we were informed that no new EM&V studies where undertaken in Year 2013.

Optimal requests that the above items be provided no later than April 18, 2014.

Please feel to contact me if any of the above items need clarification.

Thank you for providing all of this data and these documents.

2013

DEMAND SIDE MANAGEMENT AUDIT SUMMARY REPORT

September 24, 2014

Table of Contents

Enbridge Gas Distribution
2013 DSM Audit Committee
Audit Summary Report

1.0 Introduction

In accordance with Ontario Energy Board (the Board) requirements, an independent audit was conducted on Enbridge Gas Distribution 2013 DSM program results as reported in the Company's 2013 DSM Draft Evaluation Report.

This Audit Summary Report provides a summary of:

- the process followed to audit the 2013 DSM Draft Evaluation Report of May 7, 2014;
- impact of Audit results on the 2013 DSM savings, associated Demand Side Management Variance Account (DSMVA), Demand Site Management Incentive Deferral Account (DSMIDA), and Lost Revenue Adjustment Mechanism (LRAM) claims;
- Enbridge's and the Audit Committee's (AC's) responses to the Auditor's recommendations.

The AC fully endorses the 2013 Audit and Enbridge's post-audit DSMIDA and DSMVA claims as presented in this report and accepts that the Auditor has reviewed the LRAM calculation. Therefore, the AC supports the clearance of the DSMIDA, LRAM, and DSMVA.

As outlined by the Ontario Energy Board in the DSM Guidelines for Natural Gas Utilities (EB-2008-0346):

"The third party Auditor, although hired by the natural gas utilities, should be independent and ultimately serve to protect the interests of ratepayers.

At a minimum the independent third party Auditor should be asked to:

- provide an audit opinion on the DSMVA, LRAM and incentive amounts proposed by the natural gas utilities and any amendment thereto;
- verify the financial results in the Draft Evaluation Report to the extent necessary to express an audit opinion;
- review the reasonableness of any input assumptions material to the provision of that audit opinion; and
- recommend any forward-looking evaluation work to be considered.

The independent third party Auditor is expected to take such actions by way of investigation, verification or otherwise as are necessary for the Auditor to form its opinion. Custom projects should be audited using the same principles as any other programs. The independent third party Auditor's work will culminate in its final audit report."

2.0 Audit Process

2.1 Selection of 2013 Audit Committee

The 2013 AC is comprised of three representatives elected from the DSM Consultative and one representative from the utility. The 2013 AC representatives are:

- Chris Neme – Green Energy Coalition (GEC)
- Judy Simon – Low-Income Energy Network (LIEN)
- Dwayne Quinn – Federation of Rental Providers of Ontario (FRPO)

  Note: Dwayne Quinn was elected by the DSM Consultative on April 2, 2014 and replaced Jay Shepard (SEC) who was originally elected on September 23, 2013.
- Ravi Sigurdson – Enbridge Gas Distribution Inc.

2.2 Terms of Reference and Selection of Auditor

Through a consensus process, Enbridge, the AC, and the TEC developed the 2013 Audit Terms of Reference, and Enbridge and the AC conducted the competitive bidding process. As outlined in the Joint Terms of Reference on Stakeholder Engagement for DSM Activities, the AC and Enbridge followed the auditor selection process in selecting Optimal Energy (Optimal) as the Auditor of the 2013 Draft Evaluation Report.

The 2013 Audit Terms of Reference described the overall objective of the audit as well as required tasks and deliverables.

A copy of the Terms of Reference can be found in Appendix A.

2.3 Project Start Up

Optimal was selected as the Auditor on March 4 and the first conference call between the AC and the Auditor commenced on March 5. Weekly conference calls with the AC and Auditor were scheduled thereafter. At least one non-utility member of the AC was required to participate in order for the meeting to proceed.

As part of the agreed to work plan, Enbridge arranged a two day site visit with the Auditor at the Enbridge offices on March 17 and 18, 2014 (See Table 1 for the

Optimal Itinerary). The overall purpose of the site visit was to gain a thorough understanding of each of Enbridge's DSM programs and to begin the initial process of gathering data, studies, and other documents needed to complete the audit. In addition, time was scheduled to accomplish the following:

- demonstrate Enbridge's monitoring and tracking systems
- demonstrate eTools, Enbridge's in-house savings estimation tool that standardizes inputs and calculations for complex measures

Meetings were also arranged with the contractors responsible for the independent third-party engineering review of custom projects. Appendix C contains a schedule of meetings throughout the Audit process.

Table 1.

Optimal Energy Itinerary		
Time Slot	**Monday, March 17**	**Tuesday, March 18**
9:00-10:00	DSM EM&V Introductions	Low Income
10:00-11:00	Monitoring & Tracking	Market Transformation
11:00-12:00	Business Technology	Run It Right
12:00-1:00	Lunch	Lunch
1:00-2:00	BT Presentation (Etools)	Commercial Dept.
2:00-3:00	Industrial Dept.	Residential Dept.
3:00-4:00	Industrial CPSV	Commercial CPSV
4:00-5:00	Open	Open

2.4 Information Exchange

At the outset of the audit and throughout the course of the audit process, Enbridge provided documents and information to the Auditor as requested which include those listed below:

- ❑ Custom Commercial and Industrial program reports
  - 2013 Commercial Custom Projects Savings Verification Reports
  - 2013 Industrial Custom Projects Savings Verification Reports
  - 2012 Sampling workbooks completed to select projects for the program review
  - 2012 Sampling methodology guidance documents
  - Run It Right Methodology

- ❑ Other Research Reports
  - o 2011 Multi-Residential Showerhead Verification
  - o 2012 Low-Income Multi-Residential Showerhead Verification
- ❑ Cumulative Cubic Meters (CCM) documents, records, screening tools, and calculations
  - o 2013 CCM Results Workbook
  - o 2013 DSMIDA calculations workbook
  - o 2013 LRAM calculations workbook
  - o 2013 DSMVA calculations workbook
  - o 2012 LRAM calculation workbook
  - o Enbridge's 2013 DSM Draft Evaluation Report
- ❑ OEB orders and approved technical reference manuals and Enbridge filed plans
  - o OEB 2008-0346: Demand Side Management Guidelines for Natural Gas Utilities
  - o OEB Decision Framework
  - o Enbridge DSM Plan
  - o Enbridge Updated DSM Measures Lists
  - o OEB 2013-0352 Decision and Order
- ❑ Prior audit reports and recommendations
  - o 2012 Audit Report
  - o 2012 Audit Summary
- ❑ Data tracking records and documents such as completed forms, back-up documentation, and spreadsheets
- ❑ Financial documents

2.5 2013 Audit Scope of Work and Approach to Audit

The primary objective of the 2013 audit was to review the Enbridge claims for DSMIDA, LRAM, and DSMVA for the calendar year ending December 31, 2013, and to express an independent opinion on these amounts. When the Enbridge reported amounts differed from what the Auditor believed to be correct, the Auditor calculated alternative values. The audit had the secondary objective of recommending methodological changes to the program administration, input assumptions, verification, and audit processes for the future.

Drafting of the Work Plan for the 2013 audit began immediately after the AC conference call on March 11 and the final version of the Work Plan was distributed to

Enbridge and the AC on March 28, 2014. The first key element of the Work Plan was a review of the Commercial and Industrial (C/I) Custom Project Savings Verification (CPSV) process.

The CPSV process involves independent third party engineering firms reviewing savings estimates for a random sample of commercial and industrial custom projects that were selected by an independent third party statistical firm through a prescribed sampling methodology. The sampling methodology used was previously endorsed by the Technical Evaluation Committee (TEC). The sampled projects were divided into two Waves. Wave 1 included projects that were completed between January and September 2013 and Wave 2 included projects that were completed throughout the entire 2013 program year.

The 2013 CPSV process commenced in Q4 of 2013. As agreed to with the AC, for the Commercial CPSV, the same engineering firm retained in 2012 was utilized. For the Industrial sector, a new firm was selected by Enbridge and the AC through an RFP process (this was as a result of an agreement with a past AC to limit the terms of CPSV firms). Also, as a learning through the 2012 Clearance of Accounts proceeding, (EB-2013-0352) additional emphasis was placed on reviewing the appropriateness of the baseline, measure life, and persistence.

The Auditor conducted a review of the Draft CPSV Report for both the Commercial and Industrial sectors, providing feedback and their opinion on the reasonableness of the adjustments recommended by the CPSV firms on Wave 1 projects and the CPSV firms' approaches to Wave 2 projects. Weekly scheduled conference calls between the Auditor, Enbridge, and the CPSV firms provided the opportunity to review the CPSV firm's progress and approach in real time. The Draft 2013 CPSV reports were also provided to all AC members for review and comment. The AC was subsequently invited to join the weekly conference calls with the CPSV firms (at least one AC member was able to attend these meetings). Arguments and decisions filed through EB-2013-0352 were shared with the Auditor and AC and considered throughout the 2013 Audit. As a result, the Auditor requested and was approved a budget increase of approximately 15%, due to the additional time required to ensure that the CPSV projects were properly reviewed, the results were reasonable, and that numerous required conference calls between the Auditor, CPSV firms, Enbridge and/or the AC could take place.

Beyond its involvement in the CPSV reviews, the Auditor's review process included detailed walk-throughs of other Enbridge programs and offers such as Market Transformation and Run it Right (RIR).

The Auditors' Final Work Plan is attached in this report in Appendix B.

2.6 2013 Audit Reports

A preliminary draft of Optimal's 2013 Draft Audit Report was circulated to the AC on May 23, 2014, with a first draft on June 6, 2014, and a second draft on June 13, 2014.

The Final Audit Report was circulated to the AC on June 20, 2014, and a revised version on June 24, 2014. The revisions made were to ensure additional clarity and accuracy. The Final Audit report was filed on June 27, 2014 with the Board pursuant to the Regulatory Reporting Requirements.

3.0 Results Audit

3.1 Results Summary: 2013 Recommended CCM, DSMIDA, LRAM and DSMVA

Table 2 is a summary of the amounts reported by Enbridge in the 2013 DSM Draft Evaluation Report, compared to the amounts recommended by the Auditor in the Final Audit Report.

The AC accepted the Auditor's recommended adjustments without any further modifications and supports the Final Audit Report figures in Table 2 below.

Table 2. CCM, DSMIDA, LRAM and DSMVA Recommendations

Account	Draft Evaluation Report	Final Audit Value	Audit Summary	Increase/ (Decrease)
CCM	812,563,714 m3	826,908,305 m3	826,908,305 m3	14,344,591 m3
DSMIDA	$4,378,508	$4,538,188	$4,538,188	$159,680
LRAMVA	n/a	$49,213 (to be paid to the ratepayers)	$50,317 (to be paid to the ratepayers)	n/a
DSMVA	$3,601,806 (to be paid to the ratepayers)	$3,601,806 (to be paid to the ratepayers)	$3,601,806 (to be paid to the ratepayers)	$0

3.2 CCM Results & DSMIDA Calculations

Table 3 summarizes the Auditor recommended revisions to gross m3 gas savings estimates for the resource acquisition and low income programs. Note that Enbridge's performance goals are expressed as net savings, not gross savings. However, because the auditor began its work first adjusting gross savings and then applying net-to-gross factors to the adjusted gross savings, both adjusted gross savings (Table 3) and adjusted net savings (Table 4) are presented in this report.

Table 3. Summary of Gross Savings Adjustments by Program Type in Final Audit Report

Metric	Post-CPSV Value	Final Audit Value	Difference (m3)	Difference %
RESIDENTIAL COMMUNITY ENERGY RETROFIT				
Gross CCM	45,873,540	45,859,436	(14,104)	0.0%
Deep Savings Participants	1,649	1,649	0	0.0%
COMMERCIAL				
Custom				
Gross CCM	480,565,699	500,270,682	19,704,983	4.1%
Prescriptive				
Gross CCM	88,097,094	88,097,094	0	0.0%
Run It Right				
Gross CCM	18,531,730	11,132,600	(7,399,130)	-39.9%
INDUSTRIAL				
Custom				
Gross CCM	432,039,100	441,117,286	9,078,185	2.1%
Prescriptive				
Gross CCM	1,236,716	1,181,200	(55,516)	-4.5%
TOTAL RESOURCE ACQUISITION Gross CCM	**1,066,343,880**	**1,087,658,299**	**21,314,418**	**2.0%**
SINGLE FAMILY (PART 9)				
Gross CCM	33,044,263	33,044,263	0	0.0%
MULTI-RESIDENTIAL (PART 3)				
Custom Multi-Residential				
Gross CCM	24,540,706	25,268,448	727,741	3.0%
Multi-Residential - Low Flow Showerheads				
Gross CCM	841,832	841,832	0	0.0%
Multi-Residential - Run It Right				
Gross CCM	1,307,420	1,307,420	0	0.0%
TOTAL Low Income Gross CCM	**59,734,221**	**60,461,963**	**727,741**	**1.2%**
TOTAL Gross CCM	**1,126,078,101**	**1,148,120,261**	**22,042,160**	**2.0%**

*Note: no Audit adjustments to Market Transformation Programs

*Note: Numbers may not add up due to rounding

AC Response:

The AC supports the foregoing CCM calculations.

Table 4 below presents a detailed comparison of the program associated CCM values reported in the Draft Evaluation Report with those provided in the Audit Report based on *net* m3 savings. As noted above, these net values are the values used to assess Enbridge's performance relative to its savings performance metrics.

Table 4. Detailed Summary of Net CCM Values from the Draft Evaluation Report and the Final Audit Report

CCM (m^3) by Program Area	2013 Draft Evaluation Report (net m3)	Final Audit Report (net m3)	Increase / (Decrease)
Residential Community Energy	38,992,509	38,980,521	(11,988)
Total Residential	38,992,509	38,980,521	(11,988)
Commercial Prescriptive	74,442,495	74,442,495	0
Commercial Custom	403,057,642	419,558,496	16,500,854
Run It Right	18,531,730	11,132,600	(7,399,130)
Industrial Prescriptive	828,600	791,404	(37,196)
Industrial Custom	217,219,641	221,783,951	4,564,310
Total Business Markets	714,080,108	727,708,946	13,628,837
Total Resource Acquisition Programs	753,072,617	766,689,466	13,616,849
Residential Part 9	32,904,684	32,904,684	0
Commercial Part 3	26,586,413	27,314,154	727,741
Total Low-Income	59,491,097	60,218,838	727,741
Total All Programs	**812,563,714**	**826,908,305**	**14,344,591**

***Note: Numbers may not add up due to rounding**

AC Response:

The AC supports the foregoing CCM calculations.

Table 5 below presents a detailed comparison of the scorecard associated DSMIDA values reported in the Draft Evaluation Report with those provided in the Audit Report.

Table 5. DSMIDA Adjustment from Draft Evaluation Report to Final Audit Report to Final AC Adjusted Values

Program	Draft Evaluation Report	Final Audit Value	Increase/ (Decrease)
Resource Acquisition	$1,417,015	$1,545,045	$128,030
Low Income	$1,086,289	$1,117,939	$31,650
Market Transformation	$1,875,204	$1,875,204	$0
Total	**$4,378,508**	**$4,538,188**	**$159,680**

AC Response:

The AC supports the foregoing DSMIDA calculations.

3.3 LRAM Results

In preparing rates for a given year, the forecast DSM volumes are taken into account. LRAM was established to account for the revenue impact of any variance between the forecast DSM volumes and post audit DSM volumes for the program year. LRAM only addresses the variance in DSM volumes.

In the 2013 Final Audit Report, the Auditor reviewed and approved Enbridge's LRAM calculation of ($49,213), as the amount to be returned to ratepayers. During the Audit Summary process, the AC noted that there was no LRAM adjustment proposed for Rate 135. Although there were no budgeted volumes for Rate 135 customers, there were actual volumetric savings from this rate class, due to customer participation in 2013 DSM programs. These actual Rate 135 results were included in Rate 145. Enbridge revised the LRAM calculation to show both Rates 135 and 145 separately (a small amount of savings volumes were shifted from Rate 145 to Rate 135), resulting in a LRAM value of ($50,317). Note: The difference in distribution margins for rates 135 and 145 resulted in the slight increase to the LRAM.

Table 6 illustrates the corrected LRAM by rate class. A negative variance is payable to the ratepayers. A positive variance is due from the ratepayers.

Table 6. LRAM Calculated in Final Audit Report

Rate Class	Net Partially Effective Annual Cubic Meters Built into Year 2013 Rates (m3)	Actual Year 2013 Net Partially Effective Annual Cubic Meters (m3)	Annual Cubic Meter Variance (m3)	Distribution Margin per Cubic Meter (cents)	Monetized Value of Annual Cubic Meter Variance
Rate 110	1,656,894	649,138	(1,007,756)	1.51469	($15,264)
Rate 115	1,054,387	1,874,515	820,128	0.85897	$7,045
Rate 135	0	144,990	144,990	1.33260	$1,932
Rate 145	1,868,324	482,799	(1,385,525)	1.77444	($24,585)
Rate 170	3,898,784	199,539	(3,699,245)	0.52562	($19,444)
TOTAL LRAMVA (Positive due to Enbridge/Negative due to Ratepayers)					**($50,317)**

*Note: Numbers may not add up due to rounding

Rate 1 and Rate 6 are not included in the LRAM amount for clearance above as these rate classes are covered under AUTUVA (Average Use True-Up Variance Account).

The agreed upon process with the AC called for Enbridge to only calculate LRAMVA once the audit savings values were available.

Annual Cubic Meters is the unit for the purposes of LRAMVA because Enbridge's rates are based on sales of annual cubic meters not CCM. The cubic meter values are "Net Partial Effective." This is the process that accounts for the fact that measures are installed throughout the year. For example, a measure implemented in October would generate three months' worth of savings for the 2013 calendar year. The number included in the LRAMVA calculation for this measure is therefore the average monthly gas savings multiplied by three.

AUTUVA

DSM is one of several factors contributing to declining average use in Rate 1 and Rate 6. The purpose of the 2013 AUTUVA is to record ("true-up") the revenue impact, exclusive of gas costs, of the difference between the forecast of average use per customer, for general service rate classes (Rate 1 and Rate 6), embedded in the volume forecast that underpins Rates 1 and 6 and the actual weather normalized average use experienced during the year. The calculation of the volume variance between forecast average use and actual normalized average use will exclude the volumetric impact of Demand Side Management programs in that year.

The Company's gas rates for Rate 1 and Rate 6 are based on budgeted average volumes per customer. At the end of each year the actual average volumes are calculated from the total metered usage which includes the impact of any DSM activities. During year-end if either the audited DSM volume information or an updated estimate is not available, the budget DSM volume information, which is the best available estimate of the actual DSM volume information, will be utilized in the AUTUVA calculation. If it turns out that the current year actual audited DSM volumes are different from the budget when this information is not available for current year AUTUVA calculation, the LRAM calculation is only required for other rate classes.

AC Response:

The AC accepts the foregoing LRAM calculations.

4.0 Findings & Recommendations

4.1 Auditor Recommendations with Enbridge and AC responses

CPSV Process

1. Recommendation:

Select an independent third-party engineering firm to review the E-Tools software for consistency with acceptable engineering practice. The CPSV TEs are directed to perform independent analyses to confirm or revise the saving estimates calculated by Enbridge or engineering contractors. In many cases, these savings estimates are generated by Enbridge's proprietary E-Tools analysis software. Instead of performing independent savings estimates each year, Optimal recommends that a third-party engineering contractor--one with significant experience with Excel and the VBA-based tools used to develop E-Tools—be retained to perform a thorough audit of all of the E-Tools software modules. Once the validity of the methodologies embedded in the E-Tools software is independently verified, the CPSV TE review of projects employing E-Tools can focus on determining:

- Whether the methodology used by E-Tools is appropriate for the specific project.
- Whether the inputs used in the E-Tools calculations are reasonable. As E-Tools is typically updated on a semi-annual basis, an independent annual review of any modifications to the ETools software should be incorporated in the annual audit process.

Enbridge Response:
Enbridge agrees with selecting an independent third-party firm to review the Commercial boiler seasonal efficiency module of the E-Tools software for consistency with acceptable engineering practice, as soon as feasible. Enbridge's agreement is contingent on the TEC's endorsement to update the CPSV TOR to reflect that the CPSV firms can utilize the utilities' software for project reviews. Enbridge's agreement is also based on the AC's support that, barring a change in the market, in industry understanding of savings estimation, in the OEB's DSM guidelines or other factors that might affect commercial boiler savings estimates, such a change in the CPSV TOR should remain in place until at least the mid-term review of the next multi-year plan.

AC Response:
The AC endorses this response.

2. Recommendation:

Develop a standardized report template for use by the CPSV TEs. Providing a report template would assist the CPSV TEs in developing more consistent reports that provide all of the information required to validate their review. The template should stress the importance of including all relevant project assumptions, inputs, and calculation methodologies. The inclusion of all relevant project information in a consistent format and level of detail will allow the Auditor to perform their task without having to request the full project file from Enbridge. Auditor review of Enbridge project files for clarification or to obtain missing data is a redundant and inefficient effort. The template will also allow the Auditor to easily locate data and information within each CPSV TE project write-up leading to a more streamlined CPSV audit review process.

Enbridge Response:

This Audit Recommendation will be directed to the TEC, as it potentially impacts the CPSV TOR. The 2013 CPSV reports, which underwent substantial revision in response to the Auditor's feedback, could be a starting point for discussion.

AC Response:

The AC endorses this response.

3. Recommendation:

Request that the CPSV TEs estimate the remaining useful life of the existing equipment in cases where the energy efficiency measure is an “add-on” to existing equipment for both the commercial and industrial sectors. For example, if the measure is an efficiency control on an existing boiler, the CPSV TE should determine if the existing boiler will be in place for the entire measure life of the efficiency control. If not, then a baseline (or measure life) adjustment should be made to account for the existing boiler being replaced with a more efficient boiler prior to the end of the measure life. Alternatively, develop one or more deemed measure lives for these types of projects, which are not currently included in the OEB measure life tables.

Enbridge Response:

This Audit Recommendation will be directed to the TEC, as it potentially impacts the CPSV TOR.

AC Response:

The AC endorses this response.

4. Recommendation:

Document the custom project realization rate calculation methodology. The 2012 Audit provided guidance on the correct process to calculate realization rates, but there is no formal stand-alone document that lists all the agreed upon steps. The method employed by Enbridge’s realization rate contractor for

2013 contained process errors that Optimal needed to correct as part of its audit review.

Enbridge Response:
This Audit Recommendation will be directed to the TEC as it potentially impacts the current, TEC endorsed, sampling methodology.

AC Response:
The AC endorses this response.

5. Recommendation:
Undertake a baseline boiler study. For replacement projects, the base case is a code compliant boiler with 80.5% thermal efficiency. In many other jurisdictions, higher efficiency boilers are often code or standard practice. Standard practice might also include additional boiler control efficiency measures. A boiler baseline study was completed three years ago. However, given the importance of this measure and the reality that these markets change quickly, it is important to update this work. An updated study will determine if the standard practice in Enbridge's service area is actually above code, which would indicate a need for a revised baseline.

Enbridge Response:
This Audit Recommendation will be directed to the TEC for completion in 2015. Further to the Auditor's report, this study will focus on the commercial sector.

AC Response:
The AC endorses this response.

6. Recommendation:
Provide clear instructions to the CPSV TEs to focus on evaluation of annual gas savings and measure lives, the inputs used to determine CCM. The sole DSMIDA metric for custom projects is CCM. Given tight timelines and the need to use ratepayer funds efficiently, the CPSV TEs should not spend time reviewing non-gas savings values or measure cost data.

Enbridge Response:
This Audit Recommendation will be directed to the TEC, as it potentially impacts the CPSV TOR.

AC Response:
The AC endorses this response.

7. Recommendation:

For projects modeled using eQUEST, consider using IPMVP protocols for New Construction projects with adequate calibration of both the baseline and as-built models. In addition, each project file should contain the final model used to support the project savings claim. If necessary, any secondary calculations to overcome shortcomings of the modeling tools should also be saved in the file.

Enbridge Response:
As was the case during discussions and agreement in the 2012 Audit process last year, it is anticipated that the 2014 CCM results for legacy projects (captured under Resource Acquisition) will be minimal, therefore this recommendation would not be an effective use of resources and budget dollars. For additional clarity, with the exception of legacy projects, all 2014 Commercial New Construction projects will be claimed via the Savings By Design Market Transformation offer, which is not based on CCM.

AC Response:
Requiring calibration of simulation models, as required by IMPVP is undoubtedly industry best practice. However, such calibration would require waiting perhaps 18 months after the building was completed before claiming savings (perhaps 6 months to allow for transition to full occupancy and another 12 months of consumption data across all seasons of the year). That is consistent with a recommendation by the 2012 Auditor. If Enbridge was to continue to claim savings from commercial new construction projects in the future, the AC would endorse such recommendations from both Auditors. However, given that (1) any new construction projects on which the Company began work since 2012 are being addressed only through its market transformation program (i.e. no resource acquisition savings claims), (2) there are no more than a few pre-2012 "legacy" projects for which the Company is expected to claim savings in 2014,and (3) savings goals for the 2012-2014 period were set without the expectation that the Company would have to wait 18 months after completion to claim savings from legacy new construction projects, the AC can accept not changing practices for 2014.

8. Recommendation:

Proper IPMVP protocols should be followed to verify project savings. While most projects employ sound measurement and verification methodologies, it was not always clear that CPSV contractors followed proper IPMVP protocols. Access and schedule issues as well as budget limitations may prevent CPSV contractors from performing the level of on-site measurement necessary to comply with IPMVP guidelines. Future CPSV contractors should endeavor to clearly identify which IPMVP option was employed and provide a thorough description of how that option was implemented. For example, if “Option A. Retrofit Isolation: Key Parameter Measurement” is determined to be the best option for a given project, the contractor should clearly establish which parameters are measured, which are estimated, and the methodology used to calculate savings. Presenting the verification results within the framework of IPMVP would lead to more justifiable savings estimates and facilitate review by future Auditors.

Enbridge Response:
This Audit Recommendation will be directed to the TEC, as it potentially impacts the CPSV TOR.

AC Response:
The AC endorses this response.

9. Recommendation:
Enbridge should develop site-specific destratification factors based on the building site, ceiling height, fan diameter, and speed. For custom industrial destratification fan projects, Enbridge assumes that the contractor/vendor will design and install the project to destratify the entire space. Enbridge then applies a blanket factor of 0.85 to de-rate the destratification savings to be conservative. Developing site-specific destratification would result in a more rigorous savings estimate.

Enbridge Response:
Enbridge will calculate the actual percentage of destratified coverage area for a specific project, based on best available information.

AC Response:
The AC endorses this response.

Run It Right

10. Recommendation:
Establish a free rider rate for the Run It Right program. Currently, there is no OEB approved free rider rate for this program. As part of this audit process, Enbridge proposed a free rider rate. Optimal conducted an informal review of free rider rates for gas retro-commissioning programs in other jurisdictions and recommended adoption of Enbridge's requested rate for purposes of this audit. Enbridge should formally establish a free rider rate that is subsequently filed and approved by the OEB.

Enbridge Response:
This Audit Recommendation will be directed to the TEC, as Union has indicated that they have a similar program. As such, there may be value in developing a free ridership rate for both utilities through the TEC. If it is determined that this is not the case, Enbridge will proceed with establishing its own free ridership rate for the RIR offer.

AC Response:
The AC endorses this response.

11. Recommendation:
Survey Run It Right participants. Ideally, Enbridge or its evaluator should survey participants prior to any billing regression analysis. This would ensure better data and avoid noted problems with ex-post adjustments to the sample that resulted from exogenous factors affecting gas usage. The importance of conducting a survey prior to the analysis is that all data is treated equally, and any obvious outliers or other problem data can be removed or adjusted without bias. In addition, this process will allow for removal of any obviously bad or incomplete data. Surveys should accomplish the following:

- Determine whether the participant implemented the measures recommended in the timeframe indicated.
- Determine whether the participant made any significant changes to the facility, its operations, or equipment outside of the Run It Right Program. If changes were made, determine whether changes can be attributed to Run It Right spillover savings, are completely independent of the Program, or were already counted in another Enbridge program.
- Collect basic participant characteristics, including building type, occupancy load, usage, and size.

Based on this information, the analyst can remove or adjust all data in a consistent fashion. For example, if a major piece of equipment was replaced with a more efficient one, it may be appropriate to adjust the ex-post data to subtract the expected additional savings. Further, if building usage or operations have changed significantly, the data can be adjusted if the impacts of these changes can be estimated with relative certainty. In some cases, it may be more appropriate to simply remove a participant from the sample.

Enbridge Response:
Enbridge agrees that completing a survey with a random sample of participants would be more appropriate in order to gain further insight into results. The random sample would be conducted in a manner similar to the CPSV process. A survey of all participants would be cost prohibitive (this is in line with recommendation #13).

AC Response:
The AC endorses this response.

12. Recommendation:
Include a “comparison group” of similar customers that did not participate in the Run It Right program. A comparison group of customers that are matched to the participant group (in terms of building type, major end-uses, size, and

consumption) should be included in the analysis. Typically this would be done with a "dummy variable" that indicates whether the customer was a participant or not. The biggest benefit of including a comparison group is that it can more explicitly control for weather and other variations over time. Because all sites will have been exposed to the same weather, the analysis inherently controls for weather without the need to identify balance temperature points for each facility. It also avoids introducing uncertainty from determining a building specific relationship between weather and gas usage. This will significantly simplify the analysis and result in a more accurate isolation of weather effects. A comparison group also can adjust for unknown variables that may be important but are difficult to identify and control for. For example, there may be natural growth in existing buildings' gas usage that would mask some of the true program savings. Comparing participants with similarly situated non-participants would automatically control for any such effects.

Enbridge Response:
Enbridge's proposal for recommendation #11 appropriately addresses the need for increased accuracy and information, without unduly increasing the cost and complexity of the offer.

AC Response:
The AC agrees that the revisions associated with Auditor recommendation #11 are a good next step in the evolution of the evaluation of this program, and that the addition of a control group is not necessary at this point in time. However, that decision should be revisited in the future as more experience with the program (and its evaluation) is gained, particularly if the program grows substantially in size.

13. Recommendation:

Consider sampling approaches that balance required resources with level of importance. When performing the analysis and incorporating the two previous recommendations, we recognize that this approach may add additional program costs related to surveying participants and using comparison groups. We also understand that Enbridge intends for this program to expand and hopefully have more participants in the future. As a result, it may be appropriate to analyze a sample of participants rather than a full census of participants. This is appropriate, particularly if the number of participants grows significantly. We recommend that the sample of participants first be stratified by size. The largest usage customers will tend to have a disproportionately high impact on overall savings. As a result, we recommend developing size strata and oversampling the largest stratum (depending on range of usage and number of participants, it may make sense to oversample more than one large stratum). Often, the very largest stratum might only have a few participants, who would all be included in the sample. This approach of devoting more resources to the largest projects will enhance the overall precision of the sample without the need to actually increase the numbers of participants sampled. Once the strata cut points are selected, the samples should be drawn in a randomized way (except for any strata where a full census is used). Similarly, the comparison group should align with the same strata and also be randomly selected.

Enbridge Response:
Please refer to the response to recommendation #11.

AC Response:
The AC endorses this response.

Audit Process

14. Recommendation:

Produce an audit guidelines document for the Auditor. Currently, each Auditor establishes its own detailed process to meet the overall requirements stated in the audit RFP. This can lead to inconsistencies over time. A clear, detailed set of guidelines would result in more consistent audit results from year-to-year.

Enbridge Response:
Although this recommendation may result in consistency, it may impact the level of independence that exists for each Audit year, therefore the Auditor should independently establish their own detailed process to meet the overall requirements. To aid in this activity, Enbridge will engage the 2014 AC to ensure that the Auditor is provided with a reasonable level of orientation to the process as a whole.

AC Response:
The AC endorses this response.

15. Recommendation:

Clarify Audit Committee role. The AC should have a written charter that spells out its decision-making process, purpose, duties, and powers. While the "Union Gas Limited – 2012-2014 Demand Side Management Plan Settlement Agreement on Terms of Reference for Stakeholder Engagement" provides high level guidance on the function and operation of the AC, it would be useful to have a more detailed, stand-alone charter that is provided to the Auditor. This would add clarity to the AC role for the Auditor and generally make for a more efficient audit process.

Enbridge Response:
Enbridge notes that the document the Auditor is referring to is the "Joint Terms of Reference on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution Inc. and Union Gas Limited". Enbridge will discuss this recommendation with the 2014 AC early in the Audit process.

AC Response:
The AC endorses this response.

16. Recommendation:

Award the audit contract earlier in the process. Optimal received its audit contract on March 5, 2014. OEB rules require that the final audit report be submitted by June 30 of each year. Optimal was able to quickly shift its other workloads to allow its audit staff to devote the necessary effort needed to produce rigorous audit results over this short timeframe. For example, in order to provide timely feedback on the CPSV draft Wave 1 reports, Optimal staff had to devote more than a full time effort at the outset of its contract period. Fortunately, Optimal was able to shift other work to accommodate this initial, quick turn-around. Because subsequent Auditors may not be able to adjust so rapidly, issuing the audit contract earlier will better ensure a robust and thorough audit report within the necessary timeframe. This recommendation is not intended to suggest that Optimal did not have sufficient time to produce a high quality and rigorous audit. Optimal did indeed have ample time. Rather, it is meant to address potential challenges that may arise if future audit firms are unable to re-deploy staff resources as readily.

Enbridge Response:
Enbridge agrees that it would be beneficial to have the Auditor's contract awarded earlier. This recommendation will be brought forward to the 2014 AC.

AC Response:
The AC endorses this response.

17. Recommendation:

Seek written comments and feedback from the Audit Committee as one unified document as opposed to individual documents from each AC member. Currently, the Auditor has to respond to and sort through multiple documents. Having a single document from the AC for each set of comments would simplify the Auditor's work flow.

Enbridge Response:
Enbridge will support the decision made by the 2013 AC on this issue.

AC Response:
The AC appreciates that compliance with the Auditor's recommendation would make life a little simpler for the Auditor. However, the most that we could say is that the AC should do this whenever possible, with the understanding that it often won't be. Given the very tight timelines for review of draft materials, there often just isn't enough time to get everyone together, explain and discuss each comment, debate conflicting comments, document a consolidated set of comments, send it to everyone

so that they agree the consolidated document represents everyone's perspective accurately and then send to the Auditor.

Other Recommendations

18. Recommendation:

Produce a single document that pulls in all of the current year final OEB approved metrics, DSMIDA amounts and calculation procedures with appropriate citations back to the OEB regulatory filings. This document would be provided to the Auditor at the start of their work plan. Currently, all of this data is buried in hundreds of pages of OEB regulatory filings and exhibits. For someone not familiar with these proceedings, it is time consuming and not efficient to dig through all of these documents. In addition, it is sometimes difficult to determine the final approved values given the various revisions and updates.

Enbridge Response:
Enbridge will work with the 2014 AC and Auditor to determine what is useful and appropriate.

AC Response:
The AC endorses this response.

19. Recommendation:

Provide enhanced quality control procedures for the data provided to the CPSV TE and the CPSV sampling and realization rate firm(s). In its audit review, Optimal identified minor data entry errors in data sets provided by Enbridge to its sampling and realization rate contractor and the CPSV TEs. Project level savings data were not always consistent between the realization rate contractor and the CPSV TEs. We suspect that as Enbridge records and updates the data in its DSM tracking system, it is not also ensuring that all the various firms performing audit and verification tasks receive updated data sets.

Enbridge Response:
Enbridge will review current processes to ensure accuracy of data not only internally, but with external contractors. Subsequent process changes will be shared with the 2014 AC.

AC Response:
The AC endorses this response.

Appendix "A"

Enbridge/Union Terms of Reference
(Request for Proposal):

Enbridge Gas Distribution

Request for Proposal

Independent Audit of 2013 DSM Program Results

BACKGROUND

Enbridge Gas Distribution has been delivering Demand Side Management (DSM) initiatives since 1995 to its broad customer base. DSM activities include planning, developing, implementing and evaluating energy efficiency initiatives for residential, commercial, industrial and low income markets. Enbridge Gas Distribution's DSM activities are regulated by the Ontario Energy Board (OEB/Board) and adhere to the requirements as laid out in the newly implemented EB-2008-0346 DSM Guidelines for Natural Gas Utilities.

The OEB DSM Guidelines include two financial mechanisms: the Demand Side Management Variance Account (DSMVA) and the Lost Revenue Adjustment Mechanism (LRAM), with a provision for a DSM Shareholder Incentive.

The Guidelines establish an annual cap for the 2012 DSM Shareholder Incentive at $9.45M to be escalated for inflation in subsequent years. This cap was later increased by the Board to $10.45M to reflect the increased budget for the utilities' Low Income programs. In the new Guidelines, the DSM Shareholder Incentive is no longer based on TRC, but on scorecards with a focus on lifetime cumulative cubic meters of natural gas savings.

Program results are presented in a detailed Evaluation Report which is then subject to a third party audit. The 2013 DSM Evaluation Report contains a review of DSM program results and will be provided to the auditor.

As part of the new framework, the utilities worked with intervenor (active participants before the OEB) stakeholder groups to develop a "Joint Terms of Reference on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution Inc and Union Gas Limited" (hereto referred to as ToR) for the 2012-2014 Plan period.[1]

In accordance with the ToR, each utility will have an Audit Committee (AC). Comprised of three intervenor representatives and a utility representative, the goal of the AC is to ensure that there is, each year, an effective and thorough audit of the utility's DSM results.

[1] www.ontarioenergyboard.ca

OBJECTIVE

The primary objective of the audit is to provide an independent opinion to DSM stakeholders (i.e. the OEB, Intervenor consultative members, and the utility), that serves to determine if the DSMVA, LRAM and utility DSM Shareholder Incentive calculations are appropriate.

The auditor should include in their final report or subsequent memo an independent professional opinion in the following form, with or without qualifications:

We have audited the Evaluation Report, DSM Shareholder Incentive, Lost Revenue Adjustment Mechanism (LRAM) and Demand Side Management Variance Account (DSMVA) of Enbridge Gas Distribution for the calendar year ended December 31, 2013. The Evaluation Report and the calculations of DSM Shareholder Incentive, LRAM, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts based on our audit.

We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in the DSM Guidelines for Natural Gas Utilities (EB-2008-0346). Details of the steps taken in this audit process are set forth in the Audit Report that follows, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that has been gathered and recorded using reasonable methods and accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2013 DSM programs of Enbridge Gas Distribution:

DSM Shareholder Incentive Amount Recoverable	-	*$x,xxx,xxx*
LRAM Amount Recoverable	-	*$x,xxx,xxx*
DSMVA Amount Recoverable	-	*$xxx,xxx*

REPORTING STRUCTURE

2013 Enbridge Gas Distribution AC members are: Chris Neme representing Green Energy Coalition, Jay Shepherd representing School Energy Coalition, Judy Simon representing Low Income Energy Network, and Ravi Sigurdson, Enbridge Gas Distribution.

The AC members, together with the utility representative, endeavor to reach consensus on both a bidders list for the auditor RFP and selection of the winning bid. In the event consensus is not possible, the utility has responsibility for final selection of the firms on the bidders list and the non-utility AC members make the final decision on the selection of the auditor from among those submitting bids. In practice, consensus on both has been the norm.

The following excerpts from the ToR outline the primary function of the AC with respect to the Audit itself:

- "The auditor will receive guidance and direction from the AC (e.g., on the scope of work, draft work plans, and draft work products). However, the Auditor's report and effort will be independent of utility or intervenor control or influence."[2]
- The AC will make recommendations based on the Audit Report regarding the utility's claims regarding DSM results and DSMVA, LRAM, and utility DSM Shareholder incentives through the AC Report submitted to the Board.

The AC will also help to ensure that the process enables the utility to file the Final Auditor's Report and recommended DSMVA, LRAM and DSM Shareholder Incentive claims by June 30th as required by the Board's Directive and in keeping with the Guidelines.

While the AC will provide guidance and direction throughout the audit process, "The utility will administer the audit contract and hold the auditor accountable to the terms of the contract."[3]

The initial start-up meeting with the Auditor will be held with all members of the AC to ensure a consistent understanding among all parties of the scope and expectations of the independent audit. Additional meetings between all Committee members and the Auditor will be arranged for group discussion and progress reporting. Meetings will be held at Company offices or through conference calls as appropriate.

[2] Joint ToR on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution Inc. and Union Gas Limited, November 4, 2012, page 15 of 21.
[3] Ibid, page 15 of 21.

SCOPE AND REQUIREMENTS

The Auditor shall, at a minimum:

- provide an audit opinion on the DSMVA, LRAM and DSM Shareholder Incentive amounts proposed by the natural gas utility and any amendment thereto;
- identify any input assumptions that either warrant further research or that should be updated with new best available information;
- audit the reasonableness of Custom Project Savings Verification (CPSV) reports produced by independent 3rd-party engineering firms and, if necessary and appropriate, proposing modifications to custom C&I project savings realization rates;
- audit the reasonableness of any other work (e.g. studies of installation rates and/or persistence of installation of measures) that has been undertaken to inform utility savings estimates; and
- recommend any forward-looking evaluation work to be considered.[4]

The Auditor selected for this task will be expected to exercise his/her expert judgment to determine the elements of the audit, and to set the approach and process that will be followed in the audit in order to meet the regulatory requirements as stated above.

The deliverable will be a written report outlining the principles of the audit, the methodology followed, and the findings and recommendations of the audit, including an opinion in the form set forth above.

The following list outlines activities that are expected to be carried out for the purpose of this audit. The Auditor is encouraged to propose other tasks that they believe would be helpful in reaching the study objective.

Audit Activities

1. Consider and respond to stakeholder comments on Enbridge Gas Distribution's Evaluation DSM Report for 2013, including those of the AC.
2. Review Enbridge Gas Distribution's 2013 procedures for tracking program participants and determine whether they lead to accurate counts, particularly for programs that do not provide customer rebates.

[4] Ibid, page 17 of 21.Modified to reflect recent updates in requirements that have evolved.

3. Determine whether Enbridge Gas Distribution's reported values for participation, measure lives and gas savings are appropriate for calculation of LRAM and DSM Shareholder Incentive. This shall include assessing: (1) whether values are adequately documented by program records, evaluation studies and other relevant data; (2) where applicable, whether assumptions regarding measure lives and gas savings are in line with assumptions filed to the Board for calculation of the DSM Shareholder Incentive; and (3) the reasonableness of measure lives and savings for the calculation of LRAM and DSM Shareholder Incentive. The Auditor will be provided with a set of prescriptive measure assumptions, some of which have been reviewed and approved by the TEC. TEC-approved assumptions will be rebuttably presumed to be correct unless the Auditor has compelling information to the contrary.
4. Review measures that are considered advancements (sometimes called "early retirement" measures) rather than purchases at times of natural equipment replacement to ensure measure lives and gas savings are treated appropriately.
5. Review and verify the accuracy of all calculations leading up to the proposed DSMVA, LRAM, and DSM Shareholder Incentive amounts and verify that the calculations are consistent with the Board-approved prescribed methodology.
6. In accordance with OEB direction, Enbridge Gas Distribution, in consultation with their AC have retained independent third party engineering consultants to undertake a detailed review of the savings estimates for Custom Project Savings Verification (CPSV) for custom projects. The AC has made provision for the Auditor to work with the selected firm to enable the review of both the draft and final reports and an opportunity to discuss individual projects, any findings and adjustment factors recommended throughout the firm's review The Auditor will be expected to provide its independent opinion on all claimed results, including those that come out of the CPSV process. This will include its opinion on the reliability and reasonableness of the error ratio (and/or realization rate) from the CPSV reports when applied to a larger population of custom projects. Any recommendations to change realization rates from those recommended by the CPSV will be explained and substantiated by relevant research/documentation.
7. Any recommendations to change realization rates from those recommended by the CPSV will be explained and substantiated by relevant research/documentation.
8. The auditor will also review all verification studies conducted in support of the DSM Evaluation Report and ensure the conclusions are sound and that the results have been appropriately incorporated into the calculation of the DSM Shareholder Incentive.
9. Identify any assumptions underlying Enbridge Gas Distribution's DSM program design that should be modified prospectively, based on the auditor's experience, the results of the audit, and knowledge of other studies or data.

10. Identify future evaluation research opportunities to enhance the assumptions used to calculate the DSM Shareholder Incentive and LRAM.
11. Work with the AC and Enbridge Gas Distribution to resolve any relevant issues prior to completion of the audit.
12. Identify any other matters considered by the Auditor to be relevant to an assessment of Enbridge Gas Distribution's DSMVA, LRAM and DSM Shareholder Incentive claims.

Audit Resources

To assist the Auditor in conducting the audit, all relevant Enbridge Gas Distribution documentation will be made available to the Auditor for review. Enbridge Gas Distribution is committed to providing the necessary data and tools the Auditor deems reasonably necessary in order to meet the ultimate goal of the audit.

SCHEDULE

Following the Board Directive of December 2004, the independent audit of DSM results is to be completed and a recommendation filed with the Board by the last day of the sixth month after the financial year end.

Due to the importance to meet these Board imposed deadlines, the Auditor will be contractually bound to meet the deadlines outlined in their proposal. If due to the Auditor's negligence, the Auditor has not provided the AC with the deliverables, 10% of the amount payable to the Auditor may be deducted for each week beyond the deliverable dates specified herein that the Auditor has not provided the AC with the deliverables.

2013 Audit Schedule	
Activity	**Due Date**
RFP Dissemination	10-Feb-14
Questions of Clarification	12-Feb-14
Proposals Due	February 21, 2014 – 4:00 PM E.S.T.
Contract Awarded	4-Mar-14
Auditor Work Plan	Week of March 7, 2014
Launch Meeting	Week of March 7, 2014
Wave 1CPSV Draft Reports	Week of January 27, 2014
Wave 2 CPSV Draft Reports	Week of March 24, 2014
CPSV Final Reports	Week of April 7, 2014
DSM Evaluation Report sent to Auditor	18-Apr-14
AC & Consultative Comments on Evaluation Report	25-Apr-14
Draft Audit Report	On or before May 29, 2014
Response from AC	On or before June 5, 2014
Final Draft Audit Report	On or before June 12, 2014
Final Audit Report	On or before June 19, 2014

SELECTION CRITERIA

Proposals will be evaluated on the following criteria listed in approximate order of importance:

Qualifications & Experience of Project Team

- Experience in Ontario and knowledge of the DSM regulatory framework for natural gas utilities
- Demonstrated ability to work with (and be viewed as credible and objective by) a variety of different types of stakeholders, including utilities, environmental groups, consumer groups and industry
- Experience to include both market transformation and resource acquisition programs for all market sectors (residential, commercial, industrial, and low-income)
- Qualification and experience of key project personnel in evaluation of natural gas utility DSM programs
- Relevant engineering experience (preference for a PEng), particularly in understanding Commercial and Industrial Custom Projects

Approach

- Quality, depth and clarity of writing in the proposal and work plan
- Logical presentation of a reasonable, clear, and comprehensive approach and method; and supporting rationale for approach including description of quantitative and qualitative assessments that will be conducted.

Cost and Administration

- Reasonableness of cost proposal including allocation of dollars per task and team member
- Ability to work in Eastern Standard Time (E.S.T.) regular business hours

MANDATORY PROPOSAL REQUIREMENTS

The proposal must include the following elements:

- A clear disclosure of any potential conflict of interest,
- A description of the methodology and approach to be used in the audit,
- A list of proposed tasks,
- Suitable information for the AC to determine the qualifications of individuals and their roles in the project:
    - Breadth of expertise in impact evaluations of gas DSM
    - Experience in developing deemed savings and/or review of year end savings calculations
    - Identify exact nature of historic experience with DSM in Ontario
    - Identify and describe technical expertise that the firm would bring to the role for the review of the CPSV
    - Focus on examples of experience in the past 5 years
- Confirmation that the proponent will be able to meet the Enbridge Gas Distribution contractor insurance and WSIB requirements as described in the attachment, and,
- Confirmation of ability to meet timelines or specific reasons why a deviation from the schedule is required.

The cost proposal must include:

- Breakout of costs by task and roles,
- Assumptions regarding the number of meetings at the Enbridge Gas Distribution offices and the associated costs, and
- Hourly rates for additional related work such as appearing as an expert witness at the OEB.

Proposals are due no later than 4:00pm EST February 21, 2014. Proposals must be submitted in electronic format via email.

Questions of clarification should be directed to the utility representatives at the coordinates indicated below. Responses to questions of clarification will be circulated to all respondents.

Proposals must be sent to the attention of all stakeholders listed in Appendix A.

APPENDIX A – AUDIT CONTACTS

Enbridge Gas Distribution **Representatives**

Rod Idenouye - rodney.idenouye@enbridge.com
Ravi Sigurdson - ravi.sigurdson@enbridge.com

Intervenor Representatives:

Chris Neme - cneme@energyfuturesgroup.com
Jay Shepherd - jay.shepherd@canadianenergylawyers.com
Judy Simon - judysimon@jsimon.net

Appendix "B"

Audit Final Work Plan
(submitted by Optimal Energy, Inc.)

Optimal ENERGY *Integrated Energy Resources*

Independent Audit of Enbridge Gas Distribution 2013 DSM Program Results:

Final Work Plan

Prepared for the

Enbridge Gas Distribution Audit Committee

by

Optimal Energy, Inc.

28 March 2014

Optimal Energy, Inc.
802-482-5600

www.optenergy.com

10600 Route 116, Suite 3
Hinesburg, VT 05461

CONTENTS

INTRODUCTION AND OBJECTIVES

Enbridge Gas Distribution (Enbridge) operates a series of demand side management (DSM) programs in accordance with its 2012-2014 Multi-Year Plan approved by the Ontario Energy Board (OEB).[1] Enbridge receives a combination of direct cost recovery and performance-based payments associated with its program delivery. The OEB and Enbridge's Audit Committee (AC) require an independent third-party review of Enbridge's annual report and supporting calculations to ensure that savings claims and performance-based payment calculations are correct.

Enbridge issued a Request for Proposals (RFP) on behalf of its Audit Committee to undertake the Year 2013 Audit on 10 February 2014. Optimal Energy Inc. submitted its proposal on 21 February 2014 and was awarded the contract on 5 March 2014.

The primary objective of this audit is to review Enbridge's calculations for Cumulative Cubic Meters (CCM) savings, the Demand Site Management Incentive Deferral Account (DSMIDA), the Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), and the Demand Side Management Variance Account (DSMVA) for the calendar year ended December 31, 2013, and to express an independent opinion on these amounts. If the Enbridge-reported amounts differ from what Optimal believes to be correct, Optimal will present alternative values. As required in the RFP, the auditor has a secondary role to recommend any forward-looking evaluation work for consideration.

This audit will be conducted under the direction of the AC and in accordance with:

- the rules and principles set down by the Ontario Energy Board in its Decision with Reasons dated June 30, 2011, in EB-2008-0346; and
- the RFP issued on 21 February 2014.

Optimal will perform this audit as further described below.

[1] Settlement Agreement Enbridge Gas Distribution Inc. Demand Side Management Multi-Year Plan 2012-14, Exhibit B, Tab 2, Schedule 9 OEB Case EB-2011-0295 dated; and Enbridge Gas Distribution Inc. Update to the 2012 to 2014 Demand Side Management ("DSM") Plan Ontario Energy Board ("Board") File No.: EB-2012-0394, dated 28 February 2013.

TASK 1: PLANNING, MEETINGS AND WORK PLAN

TASK 1.1 - KICK-OFF CONFERENCE CALL WITH ENBRIDGE DSM STAFF AND AUDIT COMMITTEE

Optimal staff will attend a kick-off conference call with Enbridge's DSM staff and the Audit Committee (AC). The purpose of this meeting will be:

- to introduce the Optimal team and the roles that each of its staff will undertake
- obtain feedback from the AC on Optimal's scope of work contained in its proposal
- obtain feedback from the AC as to any particular areas of focus for this year's audit

Deliverables

1. draft agenda submitted prior to the conference call

Schedule

The kick-off conference call was held on 11 March 2014.

TASK 1.2 - ON-SITE MEETINGS WITH ENBRIDGE DSM STAFF

Optimal staff will attend two days of on-site meetings at Enbridge's offices. The overall purpose of the site visit will be to gain a thorough understanding of each of Enbridge's DSM programs and to begin the initial process of gathering data, studies and other documents needed to complete the audit. This will be accomplished via a set of specific meetings set up by Enbridge that that will:

- provide an in-depth review of each Enbridge DSM program
- demonstrate Enbridge's monitoring and tracking systems
- demonstrate eTools, Enbridge's in-house savings estimation tool that standardizes inputs and calculations for complex measures

Enbridge staff have set up the following itinerary:

Optimal Energy Itinerary		
Time Slot	**Monday, March 17**	**Tuesday, March 18**
9:00-10:00	DSM EM&V Introductions	Low Income
10:00-11:00	Monitoring & Tracking	Market Transformation
11:00-12:00	Business Technology	Run It Right
12:00-1:00	Lunch	Lunch
1:00-2:00	BT Presentation (Etools)	Commercial Dept.
2:00-3:00	Industrial Dept.	Residential Dept.
3:00-4:00	Industrial CPSV	Commercial CPSV
4:00-5:00	Open	Open

Optimal will also present its draft work plan for review and final approval.

Deliverables

None

Schedule

The site visit will take place on 17 and 18 March 2014.

TASK 1.3 - FINAL WORK PLAN

Optimal will submit a draft final work plan to Enbridge and the AC. The work plan will be based on the RFP requirements, Optimal's scope of work contained in its proposal and its discussions to date with Enbridge staff and the AC.

Deliverables

1. draft work plan
2. final work plan

Schedule

The draft work plan will be submitted on 14 March 2014. Optimal requests that Enbridge and the AC review and provide comments by 21 March 2014. Optimal will revise the work plan for final approval by 26 March 2014.

TASK 1.4 - DATA/DOCUMENT COLLECTION AND REVIEW

Optimal will prepare a detailed data request for any needed additional information not gathered during the site visits. This task will ensure that all data needed to complete the audit has been collected. This request will include the following:

- CCM documents, records, screening tools, and calculations
- DSMIDA, LRAMVA, DSMVA documents, records and calculations
- Year-end program evaluation and savings verification reports for all programs that are not included in the CPSV reports:
    - Residential Community Energy Retrofit
    - Residential TAPS/ESK
    - Commercial Prescriptive
    - Commercial Multi-Res
    - Energy Compass and run It Right
    - Continuous Energy Improvement: Industrial and Agricultural
    - Low-Income Single Family
    - Low-Income Multi-Res
    - Market Transformation
    - Savings by Design: Commercial and Residential
    - Existing Residential – Home Rating
- pertinent OEB orders
- approved technical reference manuals

- Enbridge DSM plans filed with the OEB

Task 1.4 is primarily a data collection exercise. Optimal will, however, undertake high level review of the orders and plans to develop an understanding of underlying program polices. An in-depth review of the 2013 program and research reports is part of Task 3.

Deliverables

1. Detailed data request

Schedule

Data request will be submitted by 4 April 2014.

TASK 1.5 - WEEKLY MEETINGS

Optimal staff will attend weekly AC and Custom Project Savings Verification (CPSV) Contractor meetings via teleconference.

The CPSV meetings will allow Optimal to provide input and recommendations to the CPSV contractors prior to the completion of their verification work.

The AC meetings will provide Optimal an opportunity to share preliminary audit findings. This will give the AC, Enbridge and its evaluation and verification contractors the opportunity to provide more data, clarify issues, or correct auditor perceptions, with the goal of producing the most accurate and useful audit results and recommendations. Optimal will recommend agenda items as they pertain to the audit and will issue meeting notes or action items following each meeting.

Deliverables

1. Weekly agenda items, as needed
2. Meeting notes and action items

Schedule

AC meetings will occur weekly on an as-needed basis.

There will be two CPSV Contractor meetings per week, one for the commercial contractor and one for the industrial contractor. The weekly meetings will continue until the CPSV contractors have issued their final reports. As needed, Optimal may have additional (outside of the scheduled weekly meeting) discussions with the CPSV firms. Optimal will inform the Enbridge Audit Committee if these additional discussions occur.

TASK 2: REVIEW & VALIDATE CPSV RESULTS AND REALIZATION RATES

TASK 2.1 – REVIEW DRAFT WAVE 1 CPSV REPORTS

Optimal will review the draft Wave 1 CPSV reports to provide feedback on the quality, reasonableness and accuracy of the project savings estimates. We will also ensure that the contractors are meeting the requirements of the RFPs issued by Enbridge for this work and that the Year 2012 Auditor Resource Acquisition Recommendation 1 was properly implemented by the CPSV contractors.[2] Optimal's recommendations will help ensure that the final Wave 1 reports and the subsequent Wave 2 reports are of high quality and meet the requirements of the AC.

Deliverables

1. Memo summarizing findings and recommendations regarding the Wave 1 draft reports

Schedule

Optimal will provide the memo on 17 March 2014.

TASK 2.2 – REVIEW FULL WAVE 1 AND WAVE 2 DRAFT CPSV REPORTS

Optimal will review the draft of the full Wave 1 and Wave 2 reports to ensure that the final CPSV reports will contain the level and quality of project information that will allow Optimal to provide its independent audit opinion as to the CPSV savings claims.

Deliverables

1. Memo providing recommended revisions to be incorporated in the final CPSV Reports.

Schedule

The following Table provides the revised 2013 CPSV timeline as discussed with the CPSV firms and Optimal.

[2] Year 2012 Auditor Recommendations along with Enbridge's and the AC responses are contained in the 2012 Demand Side Management Audit Summary Report dated October 17, 2013.

Date	Milestone
4 April 2014	Final Drafts of Wave 1 and Wave 2 Commercial and Industrial CPSV Report
11 April 2014	Optimal Response on Final Drafts of CPSV Reports
17 April 2014	Final CPSV Reports
24 April 2014	Ipsos Realization Rates

Optimal will issue its memo on 11 April 2014.

TASK 2.3 – FULL EXAMINATION OF FINAL CPSV REPORTS

Optimal will undertake the following sub-tasks steps in its examination of the final CPSV report results:

- **Review the project-by-project evaluations contained in the CPSV final reports.** - For this review we will utilize a checklist allowing us to systematically ascertain that key project elements have been reported, are well documented, and are reasonable and appropriate. If additional information is needed, Optimal may request the full Enbridge project file.
- **Examine advancement/replacement and other baseline characterization assumptions** - Appropriate revisions will be recommended if it is determined that OEB-approved or industry-accepted methodologies were not utilized in determining baselines used for savings calculations.
- **Confirm or revise project performance estimates** - Our experience with project review informs us that there will be times when a common understanding of project performance will not be met. When this occurs, we will include a recommendation for revised project assumptions or calculations, comparing this with what was originally reported, and fully defending the reasons for the recommended adjustments.

We will utilize both in-house data developed from our engagements with custom project reviews for other clients and published evaluation work to compare assumptions, methodologies, and savings results.

- All other pertinent studies relevant to industrial and commercial custom projects that have been completed in support of the Enbridge DSM Annual Report will be reviewed and utilized in making final recommendations.

At the conclusion of our custom projects examination, if Optimal disagrees with any of the final project CCM savings claims put forth by the CPSV contractors we will provide revised savings claims for these projects. Ipsos, Enbridge's sampling and realization rate contractor, will then calculate new realization rates based on these adjustments. Optimal will employ these new realization rates in its audit report. We will also note findings, issue opinions, and make recommendations regarding Enbridge's custom program initiatives and future savings documentation practices; these activities will take place under Task 6.

Deliverables

1. Preliminary results providing details on recommended adjustments to individual projects' savings calculations and overall adjustments to realization rates.
2. Finalized savings calculations adjustments and adjusted realization rates that will be incorporated

Schedule

Preliminary CPSV recommendations will be provided by 2 May 2014. This date is contingent on the final CPSV reports being completed by the CPSV contractors no later than 17 April 2014.

Final CPSV recommendations will be provided by 16 May 2014. This date is contingent on AC review of preliminary recommendations being completed no later than 9 May 2014.

TASK 3: REVIEW ANNUAL REPORT STAKEHOLDER COMMENTS AND VERIFICATION STUDIES

TASK 3.1 - CONSIDER STAKEHOLDER COMMENTS TO ANNUAL REPORT

Optimal will review and respond to stakeholder and AC comments on Enbridge's draft Year 2013 Annual DSM Report.

Deliverables

1. Memo providing Optimal's response and feedback regarding comments provided by stakeholders and AC.

Schedule

Memo will be provided by 15 May 2014. This due date is contingent upon:

- 2013 DSM Annual Evaluation Report being issued on 1 May 2014; and
- Stakeholder and AC comments being provided no later than 8 May 2014.

TASK 3.2 – REVIEW VERIFICATION STUDIES

Enbridge has informed Optimal that no Year 2013 verification studies were conducted. Optimal will, however, ensure that any approved adjustment factors that resulted from any Year 2012 studies are properly incorporated into the CCM calculations presented in the 2013 DSM Annual Evaluation Report.

Deliverables

N/A

Schedule

N/A

TASK 4: REVIEW ENBRIDGE'S DSM TRACKING SYSTEMS

Optimal will review Enbridge's monitoring and tracking administrative procedures and systems as part of its on-site visit in Task 1.2 above. Tracking procedures will be reviewed to determine if Enbridge's DSM analysis, reporting, and tracking system (DARTS) results are being properly entered into the CCM and the DSMIDA calculation workbooks that form the basis of the results reported in Enbridge's DSM Annual Report. Optimal will review the flow of information through the system.

The aggregating system will be tested to determine whether the stored data is accurate. Our data system review will include the following activities on a sample of project records:

- Validation of data inputs
- Verification of storage and back-up protocols
- Review of quality assurance and quality control protocols
- Review of exception-handling mechanisms
- Review of user documentation

As a follow-up to Year 2012 Auditor General Recommendation 1 regarding updated project completion definitions and procedures Optimal will review the progress of implementing this recommendation.

Auditor General Recommendation 4 requires Enbridge to provide documentation to substantiate its involvement for each large and/or custom project prior to project completion. Optimal will review a sample of projects to ensure that this procedure has been put in place.

Deliverables

None – the results of this review will inform and will be incorporated into Task 5 and 7.

Schedule

The on-site review will be incorporated into Optimal's site visit on 17 and 18 March 2014. Any follow-up with Enbridge staff needed to complete the review will take place no later than 18 April 2014.

TASK 5: REVIEW AND VERIFY CCM, DSMIDA, LRAMVA AND DSMVA CALCULATIONS

The previous tasks lay the groundwork for proceeding with the primary objective of the audit:

> *to provide an independent opinion to DSM stakeholders that serves to determine if the DSMVA, LRAM and utility DSM Shareholder Incentive calculations are appropriate.*

To verify the relevant savings and account calculations, we must first determine whether reported savings values are based on reasonable and accurate measure inputs, assumptions, and calculations. This will proceed in a series of sub-tasks. Below, we describe how we will review all of the relevant calculations and arrive at our opinions. Note that our efforts to assess the CPSV are described in Task 2. The findings from those reviews will be incorporated into the reviews and verification conducted under this task.

TASK 5.1 - COMPARE ASSUMPTIONS TO RELEVANT SOURCES

Optimal's findings from Task 4 will determine if savings data is accurately recorded. For this task Optimal will begin by checking Enbridge's measure characterizations and savings calculations against Board and/or Technical Evaluation Committee (TEC) approved values. As noted in the RFP, such assumptions will be generally presumed to be correct. Thus, Optimal will only conduct a cursory review of them. However, in cases in which that cursory review raises any "red flags" regarding the reasonableness of the assumptions – particularly for measures that account for a significant portion of claimed prescriptive savings – Optimal will examine the assumptions more close and, as appropriate, recommend alternatives (as part of our work in Task 7 below).

TASK 5.2 - REVIEW CCM CALCULATIONS

All of the foregoing information and data will be brought together to verify the calculation of cumulative cubic meters (CCM) gas savings in order to support the further calculations of the cost recovery and incentive mechanisms. As noted above, this will also include incorporating the findings of the CPSV review (Task 2). While our review and validation will cover all aspects of the calculations across all programs and measures, we will focus our efforts on those aspects of the estimate that 1) carry the most uncertainty, 2) contribute the largest cumulative savings to the overall portfolio total, 3) represent areas where past audits have identified problems to be modified in the future, or 4) represent newer measures or measures in which there may be changes to assumptions and savings estimates as a result of changing market conditions.

As part of the CCM review process and in accordance with Year 2012 Auditor Resource Acquisition Recommendation 6 Optimal will conduct a desk review of a random sample of the Run It Right program to verify the reasonableness of the claimed savings for this program.

TASK 5.3 - REVIEW DSMVA, LRAMVA, AND DSMIDA CALCULATIONS

The tasks outlined in the preceding sections provide for a reasonable basis for Optimal to confidently make its determination of the validity of the DSMVA, LRAM, and DSMSIDA calculations. We will ensure that OEB approved methodologies for all of these calculations were properly followed. We will also ensure that any recommended adjustments to the final CCM results are properly incorporated into the LRAM and DSMIDA calculations.

Optimal's review of the DSMVA will not include auditing of Enbridge spending documentation. This is a financial auditor's responsibility. Optimal will review the calculation of the DSMVA to ensure consistency between actual expenditures included in the variance account calculations and the total DSM expenses reported in Enbridge's financial tracking system and the DSM Annual Report.

For the LRAMVA we will also ascertain whether the methodologies and assumptions used to calculate actual sales volume net of installed efficiency measures are consistent with the methodologies and assumptions used to calculate the year's budgeted sales volume in advance. We will also ensure that the net volumetric sales are appropriately allocated to each respective customer class. With regard to gas sales, we will be particularly interested in the Company's weather-normalization processes and algorithms, making sure that Enbridge consistently applied such processes to both its sales forecasts and its actual sales volume.

Task 5 Deliverables

1. Preliminary recommendations for any adjustments to the CCM, DSMIDA, LRAMVA and the DSMVA will be provide to the AC for their review and consideration. Final results will be incorporated into Task 7 below.

Task 5 Schedule

Preliminary recommendations will be provided no later than 23 May 2014.

TASK 6: IDENTIFY FUTURE ENHANCEMENTS

Throughout the performance of this audit we will note areas where future enhancements in either evaluation procedures, assumptions, or implementation practices might result in more accurate calculations, simpler verification procedures, or improved confidence in the results reported in the DSM Annual Report. These will be gathered together in one document and sorted by the type of recommendation (e.g., procedural change vs. quantitative assumptions) and ranked by relative importance. Optimal will also identify future evaluation research opportunities to enhance the assumptions used to calculate the DSMIDA and LRAM.

And finally Optimal will provide an update as to the status of the Year 2012 Auditor recommendations.

Deliverables

None - the suggested enhancements will be included in the draft and final audit report issued under Task 7.

Schedule

This task will be ongoing and will conclude prior to the preparation of draft audit report.

TASK 7: ISSUE AUDIT FINDINGS, RECOMMENDATIONS AND REPORT

Upon the successful completion of the above-noted tasks, we shall provide the AC an independent opinion relative to the Company's calculations leading up the proposed amounts in each of the relevant DSM accounts.

TASK 7.1 - RESOLVE ISSUES PRIOR TO AUDIT COMPLETION

Through the weekly meetings and regular updates, Optimal will work with AC members to resolve any relevant issues prior to preparation of the draft audit report

TASK 7.2 – ISSUE DRAFT AUDIT REPORT

Incorporating the adjustments, results, and recommendations from Tasks 2, 5, and 6 Optimal will prepare a draft audit report for review and comment by Enbridge staff and the AC. The draft report will provide the required audit opinion as to whether the CCM, DSMIDA, LRAMVA, and DSMVA calculations and results are correct and reasonable as submitted in Enbridge's Annual DSM Report. If necessary, the report will provide independently developed alternative calculations for these accounts. The report will full explain our decision processes and how and where we used our judgment to develop our opinions. If Optimal provides independently developed alternative calculations the report will provide clear documentation and justification for these alternative values.

Optimal will make a full and formal presentation of the findings, recommendations and conclusions contained on the draft report via webinar to the AC.

Deliverables

1. Draft Audit Report
2. Formal presentation to the AC via webinar of draft findings

Schedule

The draft audit report will be provided no later than 30 May 2014.

The formal presentation will be scheduled during the week of 2 June 2014.

TASK 7.3 – ISSUE FINAL AUDIT REPORT

Once Optimal has received the draft audit report response from the AC a final audit report will be prepared and submitted. The final report will include the following statements:

> We have audited the Annual Report, Cumulative Cubic Meters (CCM) savings, DSM Incentive Deferral Account (DSMIDA), Lost Revenue Adjustment Mechanism Variance Account (LRAMVA), and Demand Side Management Variance Account (DSMVA) of Enbridge Gas Distribution for the calendar year ended December 31, 2013. The Annual Report and the calculations of CCM, DSMIDA, LRAMVA, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts

based on our audit. We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in its Decision with Reasons dated June 30, 2011, in EB-2008-0346. Details of the steps taken in this audit process are set forth in the Audit Report that follows, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that has been gathered and recorded using reasonable methods and is accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2013 DSM programs of Enbridge Gas Distribution:

- CCM Savings - $xxx,xxx,xxx
- DSMIDA Amount Recoverable - $x,xxx,xxx
- LRAMVA Amount Recoverable - $x,xxx,xxx
- DSMVA Amount Recoverable - $xxx,xxx

The final report will contain the full and final list of forward-looking recommendations.

If necessary, we will make available an expert witness to defend or describe our findings, opinions, and recommendation at an OEB hearing at the hourly rates contained in our proposal. We expect that Mr. Mosenthal would serve as this witness, potentially supplemented with engineering experts.

Deliverable

1. Final Draft Year 2013 DSM Audit Report
2. Final Year 2013 DSM Audit Report

Schedule

The final draft annual report will be submitted no later than 12 June 2014. This due date is contingent upon receiving the AC's response to the initial draft no later than 6 June 2014.

The final audit report will be submitted no later than 19 June 2014. This due date is contingent upon receiving the AC's response to the final draft no later than 16 June 2014.

Optimal Energy Inc. Year 2013 DSM Audit Work Plan

TASK SCHEDULE

	Week Ending															
	7-Mar	14-Mar	21-Mar	28-Mar	4-Apr	11-Apr	18-Apr	25-Apr	2-May	9-May	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun
1.1 - Kick-Off Conference Call		M														
1.2 - On-Site Meetings			M													
1.3 - Final Work Plan			D													
1.4 - Document Collection/Review					D											
1.5 - Weekly Mtgs - AC			M	M	M	M	M	M	M	M	M	M	M	M	M	M
1.5 - Weekly Mtgs - CPSV			M	M	M	M	M									
2.1 - Draft Wave 1 CPSV Reports			D													
2.2 - Draft Wave 1 & Wave 2 CPSV						D										
2.3 - Final CPSV Reports									D		D					
3.1 - Annual Report Comments											D					
3.2 - Review Verifications Studies: No 2013 Studies Issued - N/A																
4 - Review Tracking Systems																
5.1 - Compare Assumptions												D				
5.2 - Review CCM Calculations												D				
5.3 - DSMVA, LRAMVA, DSMIDA												D				
6 - Identify Future Enhancements																
7.1 - Resolve Issues																
7.2 - Draft Audit Report													D	P		
7.3 - Final Audit Report															D	D

D = Deliverable
M = Meeting
P = Presentation

Appendix "C"

Audit Scheduled Meetings

2013 Audit - Audit Committee and Custom Project Savings Verification Scheduled Meetings

#	Date	Topic	Audit Committee			Custom Project Savings Verification (CPSV)	
			AC	EGD	Optimal	Comm.	Ind.
1	Tuesday, March 04, 2014	Auditor Selection					
2	Wednesday, March 05, 2014	AC Call					
3	Tuesday, March 11, 2014	AC Kick-off Call					
4	Monday, March 17, 2014	Optimal On-site Visit					
5	Tuesday, March 18, 2014						
6	Wednesday, March 19, 2014	AC Call					
7	Thursday, March 20, 2014	Comm. CPSV Call					
8	Thursday, March 20, 2014	Ind. CPSV Call					
9	Tuesday, March 25, 2014	Ind. CPSV Call					
10	Thursday, March 27, 2014	Comm. CPSV Call					
11	Thursday, March 27, 2014	Ind. CPSV Call					
12	Friday, March 28, 2014	AC Call					
13	Tuesday, April 1, 2014	Ind. CPSV Call					
14	Thursday, April 03, 2014	Comm. CPSV Call					
15	Thursday, April 03, 2014	Ind. CPSV Call					
16	Friday, April 04, 2014	AC Call					
17	Thursday, April 10, 2014	Comm. CPSV Call					
18	Thursday, April 10, 2014	Ind. CPSV Call					
19	Friday, April 11, 2014	AC Call					
20	Tuesday, April 15, 2014	Comm. CPSV Call					
21	Wednesday, April 16, 2014	AC Call					
22	Wednesday, April 23, 2014	AC Call					
23	Wednesday, April 30, 2014	AC Call					
24	Tuesday, May 06, 2014	Ind. CPSV / AC					
25	Wednesday, May 07, 2014	Comm. CPSV Call					
26	Friday, May 09, 2014	AC Call					
27	Friday, May 09, 2014	Ind. CPSV Call					
28	Wednesday, May 14, 2014	Comm. CPSV / AC					
29	Friday, May 16, 2014	Ind. CPSV / AC					
30	Friday, May 16, 2014	AC Call					
31	Wednesday, May 21, 2014	Comm. CPSV / AC					
32	Friday, May 23, 2014	AC Call					
33	Thursday, May 29, 2014	Ind. CPSV / AC					
34	Friday, May 30, 2014	AC Call					
35	Monday, June 02, 2014	Comm. CPSV / AC					
36	Friday, June 06, 2014	AC Call					
37	Thursday, June 12, 2014	AC Call					
38	Friday, June 13, 2014	AC Call					
39	Thursday, June 19, 2014	AC Call					
40	Friday, June 20, 2014	Audit Summary					
41	Tuesday, July 08, 2014	Audit Summary					
42	Tuesday, July 15, 2014	Audit Summary					
43	Friday, July 18, 2014	Audit Summary					
44	Monday, July 28, 2014	Audit Summary / LRAM					

Note: The schedule above does not include Audit meetings that occurred prior to the selection of the 2013 Enbridge Auditor.

ALLOCATION TO DSM VARIANCE ACCOUNTS

1. The chart below illustrates the allocation to rate classes of the DSM Variance Accounts.

2013 Rate Allocation				
Rate Class	**DSMIDA**	**LRAM**	**DSMVA**	**TOTAL**
Rate 1	$2,094,687	N/A**	-$702,878	$1,391,809
Rate 6	$2,007,512	N/A**	-$2,373,653	-$366,141
Rate 9	$231	$0*	-$260	-$29
Rate 110	$122,874	-$15,264	-$479,323	-$371,714
Rate 115	$180,342	$7,045	$877,122	$1,064,508
Rate 125	$8,645	$0*	-$9,734	-$1,089
Rate 135	$42,874	$1,932	$175,933	$220,739
Rate 145	$54,402	-$24,585	-$441,826	-$412,010
Rate 170	$23,049	-$19,444	-$643,163	-$639,558
Rate 200	$2,997	$0*	-$3,374	-$377
Rate 300	$576	$0*	-$649	-$73
Total	$4,538,188	-$50,317	-$3,601,806	$886,065

* Rates 9, 125, 200, & 300 do not have any LRAM allocation since customers are not eligible for DSM programs

** Rate 1 and Rate 6 are not included in the LRAM amount for clearance above as these rate classes are covered under the Average Use True-Up Variance Account (AUTUVA)

Note: Numbers may not add up due to rounding

2. The chart below provides the estimated impact of the Clearance of the DSM Variance Accounts on a typical customer's bill in each of the rate classes affected.

Rate Class	Annual Volume for Typical Customer (m^3)	Annual Bill for Typical Customer[1] ($)	DSM Amount for Recovery[2] ($)	Estimated % of Annual Bill
Rate 1 - Residential Heating & Water Heating	**3,064**	**$1,050**	**$1**	**0.1%**
Rate 6 - Commercial, Heating & Other Uses	**22,606**	**$6,628**	**-$2**	**0.0%**
Rate 9 - Container Service[3 5]			**-$29**	**0.0%**
Rate 110 - Industrial, small size, 50% Load Factor	**598,568**	**$137,201**	**-$426**	**-0.3%**
Rate 110 - Industrial, avg. size, 75% Load Factor	**9,976,120**	**$2,125,526**	**-$7,100**	**-0.3%**
Rate 115 - Industrial, small size, 80% Load Factor	**4,471,609**	**$941,007**	**$8,370**	**0.9%**
Rate 125 - Extra Large Firm Distribution[4 5]			**-$218**	
Rate 135 - Industrial, Seasonal firm	**598,567**	**$121,725**	**$2,383**	**1.9%**
Rate 145 - Commercial, avg. size	**598,568**	**$131,438**	**-$1,481**	**-1.1%**
Rate 170 - Industrial, avg. size, 75% Load Factor	**9,976,120**	**$1,912,831**	**-$12,843**	**-0.7%**
Rate 200 - Wholesale Service[3 5]			**-$377**	
Rate 300 - Firm or Interruptible Distribution[4 5]			**-$36**	

1. Annual bills based on October 1, 2014 rates.

2. DSM amounts for Recovery do not include interest amounts that will apply at the time of clearing.

3. Information is for the total amount of DSM recovery.

4. DSM amounts for recovery for Rate 125 and Rate 300 are for average customers in each rate class.

5. Rates 9, 125, 200, & 300 do not have any LRAM allocation since customers are not eligible for DSM programs.

MMM Group Limited

Engineering Review of Enbridge Gas Distribution 2013 Custom Projects

Prepared for:
Enbridge Gas Distribution Inc.

Prepared by :

MMM Group Limited
100 Commerce Valley Drive West
Thornhill, Ontario Canada L3T0A1
tel. 905.882.1100
fax. 905.882.7282
www.mmm.ca

MMM GROUP

COMMUNITIES
TRANSPORTATION
BUILDINGS
INFRASTRUCTURE

Submitted Revision #1: April 25, 2014

MMM GROUP

Contents

MMM GROUP

MMM GROUP

MMM GROUP

1.0 Executive Summary

MMM Group Limited (MMM) was retained by Enbridge Gas Distribution (EGD) to perform an engineering savings review for the 2013 Commercial Sector Custom Projects.

The purpose of this review is to provide an impartial opinion of the reasonableness of the energy savings claimed by the custom projects in 2013 through a review of statistically representative sample of projects. The sample projects were provides to MMM in two packages. Selected projects for both waves are tabulated below.

Report Section	DSM Code	Building Type	Claimed Measure Life (years)	Claimed Natural Gas Savings (m^3)	Claimed CCM Savings (m^3)	Claimed Electricity Savings (kWh)	Claimed Water Savings (m^3)
3.1	RA.MR.EX.004.13	Multi Residential	25	42,783	855,664	0	0
3.2	RA.MR.EX.017.13	Multi Residential	15	24,971	299,650	0	0
3.3	RA.MR.EX.018.13	Multi Residential	15	70,110	841,320	106,566	0
3.4	RA.MR.EX.020.13	Multi Residential	25	14,977	299,535	0	0
3.5	RA.MR.EX.023.13	Multi Residential	25	207,221	4,144,422	0	0
3.6	RA.MR.EX.041.13	Multi Residential	15	159,967	1,919,604	148,297	0
3.7	RA.MR.EX.046.13	Multi Residential	25	117,028	2,340,558	0	0
3.8	RA.MR.EX.053.13	Multi Residential	25	75,374	1,507,497	0	0
3.9	RA.MR.EX.108.13	Multi Residential	15	52,779	633,351	0	0
3.10	RA.REC.EX.003.13	Recreational Centre	15	53,700	708,840	0	0
3.11	RA.GOV.EX.007.13	Office	15	27,082	357,482	0	0
3.12	RA.HC.EX.016.13	Healthcare	*	527,704	11,257,488	50,000	0
3.13	LW.MR.PART3.044.14	Multi Residential	25	144,416	3,610,400	0	0
3.14	RA.ACC.EX.017.13	Hospitality	15	18,131	239,329	0	0
3.15	RA.GOV.EX.021.13	Healthcare	15	590,285	7,791,762	442,256	0
3.16	RA.GOV.EX.024.13	Sewage Processing	25	1,050,208	23,104,576	0	0
3.17	RA.HC.EX.021.13	Healthcare	25	93,114	2,048,508	50,252	0
3.18	RA.HC.EX.049.13	Healthcare	25	45,325	997,150	0	0
3.19	RA.MR.EX.054.13	Multi Residential	25	41,760	835,202	0	0
3.20	RA.MR.EX.105.13	Multi Residential	20	69,570	834,836	0	0
3.21	RA.MR.EX.140.13	Multi Residential	**	215,509	3,682,271	0	0
3.22	RA.MR.EX.169.13	Multi Residential	25	83,054	1,661,072	0	0
3.23	RA.MR.EX.211.13	Multi Residential	25	22,680	453,597	0	0
3.24	RA.PRO.EX.016.13	Office	25	72,778	1,601,119	0	0
3.25	RA.PRO.EX.027.13	Office	15	16,644	219,701	0	0
3.26	RA.RET.EX.070.13	Retail	25	24,939	548,659	0	0
3.27	RA.UNIV.EX.006.13	Academic	15	531,963	7,021,912	618,000	0
			Claimed Savings	4,394,072	79,815,505	1,415,371	0

Table 1 Selected 2013 Projects

MMM GROUP

2.0 METHODOLOGY

2.1 *Document Review*

MMM reviewed all applicable documentation that was provided by EGD. Additional documentation and clarification was requested from project stakeholders and EGD when necessary.

2.2 *Site Visit*

MMM completed site visits with project contacts or their representatives. The purpose of the site visits was to:

- Confirm installation details, including:
  - Equipment specifications
  - Equipment configurations
  - System operation parameter
    - Schedule
    - Set-points
    - etc.
- Confirm assumptions used in savings calculations,
- Confirm project scope and timing.

MMM took this opportunity to interview building personnel to discuss any seasonal operation differences that may exist, but could not be easily confirmed via visual inspection.

2.3 *Savings Calculation Review*

MMM evaluated the assumptions used in calculating the energy savings presented in each application. Unclear assumptions were reviewed with EGD and project contacts. The review included, but was not limited to the following:

- Climate data used was verified to local historical station data compiled hourly from Environment Canada trend data.
- Equipment specification assumptions were compared to industry standards when actual specifications were not available.
- Equipment and occupancy schedules were compared to typical schedules for the building type.
- All other assumptions were evaluated based on our professional opinion, industry standards, available benchmarks, and discussions with involved parties.

MMM also reviewed the methodology used to calculate the application savings. MMMs methodology has been provided in the event that it differs from the application methodology.

2.4 *Life Measure and Free Ridership*

The validity of the measure life assumptions for each measure was evaluated as part of this review. Commentary for each measure is provided within the body report.

EGD also incorporates a free ridership discount to the measure life to determine the life measure savings. MMM did not evaluate the validity of these values. The same free ridership values used in the original application were applied to the audited measure life in this report.

2.5 *Savings Variances Guideline*

MMM has used the variance guideline as indicated below for adjusting claimed saving for all custom projects:

- CPSV contractor should always reports the results of its independent savings calculations.
- If the CPSV savings number is within 5% of Enbridge's number AND the CPSV concludes that its methodology is less rigorous then Enbridge's approach the CPSV contractor can let the Enbridge number stand without adjustment.
- If the CPSV savings number differs by more than 5% or the CPSV concludes that its methodology is more rigorous the CPSV contractor should recommend adjusting Enbridge's savings claim and be fully prepared to defend its adjusted savings claim.
- If the CPSV uncovers a clear methodological error, math error or other obvious error then the Enbridge savings claim should always be adjusted regardless of the percent variance.
- For all projects the CPSV contractor should provide clear reasoning for all its recommended savings adjustments."

2.6 *Assumptions and Limiting Conditions*

This report is subject to the following assumptions and limiting conditions:

- MMM may have relied on verbal information or site documents without confirming its accuracy
- Code compliance review were not completed
- Review of building simulation models were completed only for project where they were provided

Due to the closed nature of the EGD E-Tools software, MMM was not able to fully review and qualify the embedded equations and calculations. In these circumstances MMM preformed the calculation using our professional opinion with the help of published resources and accepted methods.

The EGD T-Tools software was used to determine the seasonal efficiencies for boiler controls and boiler replacement and advancement projects. Since in many instances the base case condition could not be confirmed from site investigation, it was determined that the more appropriate approach to evaluate these types of measurers was to identify any discrepancy in the inputs used in E-Tools. In addition, since E-Tools was used to calculate the base case and energy efficient case, any potential errors in the determination of base case and proposed seasonal efficiencies would to some extend cancel each other out, and therefore be less significant.

2.7 *Boiler Savings Calculation Methodology*

For boiler upgrades, the boiler savings were calculated using two different methods depending on if the project was considered a replacement or advancement. A replacement project is one where the boilers being replaced are at the end of their life and must be replaced regardless of the incentive program. Advancement projects are where the boilers being replaced are not at the end of their life, and the motivation for the replacement is to increase the efficiency to achieve annual savings.

For replacements, the savings is calculated based on comparing the installed boilers with an assumed minimally code compliant "base case" boiler instead of the original boilers. To calculate this, MMM and EGD uses the weather adjusted annual natural gas consumption, the calculated seasonal efficiency of the old boilers and the calculated seasonal efficiency of the assumed base case boilers to estimate the annual building consumption with the base case boilers, as per equation (1). Then, the annual natural gas consumption is estimated for the proposed boilers using equation (2). The difference between (1) and (2) represents the estimated annual savings.

(1) $\textit{Annual Building Consumption} \times \frac{\textit{Exisitng Boiler Efficiency}}{\textit{Base Boiler Efficiency}}$

(2) $\textit{Annual Building Consumption} \times \frac{\textit{Exisitng Boiler Efficiency}}{\textit{Proposed Boiler Efficiency}}$

For advancements, the savings is calculated by comparing the estimated annual consumption with the proposed new boilers compared to the existing weather adjusted annual consumption with the existing boilers. This method uses only equation (2) above compared to the actual building's weather adjusted annual consumption.

The measure life savings for both scenarios is calculated by multiplying the estimated measure life and the annual natural gas savings. A free ridership is applied to some measures. As indicated above, MMM did not evaluate the validity of the free ridership value.

MMM GROUP

3.0 Results

The results from the selected projects are presented in the following two tables. Table 2 outlines the claimed and revised natural gas savings and Table 3 outlines the claimed and revised electricity and water savings. It should be noted that electricity and water savings were in general not evaluated as part of this project.

Report Section	DSM Code	Claimed Measure Life (years)	Claimed Natural Gas Savings (m³)	Claimed CCM Savings (m³)	Adjusted Gas Savings (m³)	Natural Gas Savings Adjustment (%)	Audited CCM Savings (m³)	CCM Savings Adjustment (%)
3.1	RA.MR.EX.004.13	25	42,783	855,664	42,783	0.00%	855,664	0.00%
3.2	RA.MR.EX.017.13	15	24,971	299,650	0	-100.00%	0	-100.00%
3.3	RA.MR.EX.018.13	15	70,110	841,320	64,673	-7.75%	776,076	-7.75%
3.4	RA.MR.EX.020.13	25	14,977	299,535	19,306	28.90%	386,120	28.91%
3.5	RA.MR.EX.023.13	25	207,221	4,144,422	195,878	-5.47%	3,917,560	-5.47%
3.6	RA.MR.EX.041.13	15	159,967	1,919,604	158,987	-0.61%	1,907,844	-0.61%
3.7	RA.MR.EX.046.13	25	117,028	2,340,558	120,500	2.97%	2,410,000	2.97%
3.8	RA.MR.EX.053.13	25	75,374	1,507,497	69,627	-7.62%	1,392,560	-7.62%
3.9	RA.MR.EX.108.13	15	52,779	633,351	37,328	-29.27%	447,938	-29.27%
3.10	RA.REC.EX.003.13	15	53,700	708,840	24,655	-54.09%	325,446	-54.09%
3.11	RA.GOV.EX.007.13	15	27,082	357,482	27,380	1.10%	361,416	1.10%
3.12	RA.HC.EX.016.13	*	527,704	11,257,488	313,351	-40.62%	6,893,722	-38.76%
3.13	LW.MR.PART3.044.14	25	144,416	3,610,400	31,249	-78.36%	781,255	-78.36%
3.14	RA.ACC.EX.017.13	15	18,131	239,329	18,329	1.09%	241,943	1.09%
3.15	RA.GOV.EX.021.13	15	590,285	7,791,762	31,021	-94.74%	409,477	-94.74%
3.16	RA.GOV.EX.024.13	25	1,050,208	23,104,576	1,050,208	0.00%	23,104,576	0.00%
3.17	RA.HC.EX.021.13	25	93,114	2,048,508	58,416	-37.26%	1,285,152	-37.26%
3.18	RA.HC.EX.049.13	25	45,325	997,150	72,667	60.32%	1,598,671	60.32%
3.19	RA.MR.EX.054.13	25	41,760	835,202	35,534	-14.91%	710,680	-14.91%
3.20	RA.MR.EX.105.13	20	69,570	834,836	35,890	-48.41%	430,678	-48.41%
3.21	RA.MR.EX.140.13	**	215,509	3,682,271	175,695	-18.47%	3,232,788	-12.21%
3.22	RA.MR.EX.169.13	25	83,054	1,661,072	76,876	-7.44%	1,537,520	-7.44%
3.23	RA.MR.EX.211.13	25	22,680	453,597	21,368	-5.78%	427,360	-5.78%
3.24	RA.PRO.EX.016.13	25	72,778	1,601,119	91,146	25.24%	2,005,212	25.24%
3.25	RA.PRO.EX.027.13	15	16,644	219,701	19,703	18.38%	260,080	18.38%
3.26	RA.RET.EX.070.13	25	24,939	548,659	23,716	-4.90%	521,752	-4.90%
3.27	RA.UNIV.EX.006.13	15	531,963	7,021,912	450,059	-15.40%	5,940,779	-15.40%
		Claimed Savings	4,394,072	79,815,505	3,266,345	-25.66%	62,162,269	-22.12%

Table 2 Natural Gas Review Results

MMM GROUP

Report Section	DSM Code	Claimed Measure Life (years)	Claimed Electricity Savings (kWh)	Claimed Water Savings (m^3)	Adjusted Electricity Savings (kWh)	Electricity Savings Adjustment (%)	Adjusted Water Savings (m^3)	Water Savings Adjustment (%)
3.1	RA.MR.EX.004.13	25	0	0	0	0.00%	0	0.00%
3.2	RA.MR.EX.017.13	15	0	0	0	0.00%	0	0.00%
3.3	RA.MR.EX.018.13	15	106,566	0	106,566	0.00%	0	0.00%
3.4	RA.MR.EX.020.13	25	0	0	0	0.00%	0	0.00%
3.5	RA.MR.EX.023.13	25	0	0	0	0.00%	0	0.00%
3.6	RA.MR.EX.041.13	15	148,297	0	148,297	0.00%	0	0.00%
3.7	RA.MR.EX.046.13	25	0	0	0	0.00%	0	0.00%
3.8	RA.MR.EX.053.13	25	0	0	0	0.00%	0	0.00%
3.9	RA.MR.EX.108.13	15	0	0	0	0.00%	0	0.00%
3.10	RA.REC.EX.003.13	15	0	0	0	0.00%	0	0.00%
3.11	RA.GOV.EX.007.13	15	0	0	0	0.00%	0	0.00%
3.12	RA.HC.EX.016.13	*	50,000	0	0	-100.00%	0	0.00%
3.13	LW.MR.PART3.044.14	25	0	0	0	0.00%	0	0.00%
3.14	RA.ACC.EX.017.13	15	0	0	0	0.00%	0	0.00%
3.15	RA.GOV.EX.021.13	15	442,256	0	442,256	0.00%	0	0.00%
3.16	RA.GOV.EX.024.13	25	0	0	0	0.00%	0	0.00%
3.17	RA.HC.EX.021.13	25	50,252	0	50,252	0.00%	0	0.00%
3.18	RA.HC.EX.049.13	25	0	0	0	0.00%	0	0.00%
3.19	RA.MR.EX.054.13	25	0	0	0	0.00%	0	0.00%
3.20	RA.MR.EX.105.13	20	0	0	0	0.00%	0	0.00%
3.21	RA.MR.EX.140.13	**	0	0	0	0.00%	0	0.00%
3.22	RA.MR.EX.169.13	25	0	0	0	0.00%	0	0.00%
3.23	RA.MR.EX.211.13	25	0	0	0	0.00%	0	0.00%
3.24	RA.PRO.EX.016.13	25	0	0	0	0.00%	0	0.00%
3.25	RA.PRO.EX.027.13	15	0	0	0	0.00%	0	0.00%
3.26	RA.RET.EX.070.13	25	0	0	0	0.00%	0	0.00%
3.27	RA.UNIV.EX.006.13	15	618,000	0	618,000	100.00%	0	0.00%
		Claimed Savings	1,415,371	0	1,365,371	-3.53%	0	0.00%

Table 3 Electricity and Water Review Results

3.1 *RA.MR.EX.004.13*

Project Information

ESM File #: 1-73415611-12-28-11

Building Type: Multi Residential

Project Description: Replacement of heating and DHW boiler.

Project Details: Replace one existing heating boiler with new high-efficiency boiler and operate as lead boiler in a lead lag arrangement.

Replace one existing DHW boiler with new mid-efficiency boiler and operate as a lead boiler in a lead lag arrangement.

Project Type: Replacement

Implementation Date: January 2013

MMM GROUP

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		42,783	42,783	0
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		855,664	855,664	0

Heating Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		41,352	41,352	0%
Life Cycle (m^3)		827,040	827,040	0%

Domestic Hot Water Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		1,431	1,431	0%
Life Cycle (m^3)		28,620	28,620	0%

Base Case

The original building boilers were at the end of their life and in need of replacement. The energy savings for this application are based on the incremental savings of a high efficiency boiler compared to new 80.5% thermal efficiency boilers.

The building was equipped with three LAARS (MH 1466 KN01) boilers that were staged to sequence on and off with the building heating demand. Each boiler is rated at 1,466 MBH and is equipped with a 3-speed Grandfos circulating pump. The circulating pumps did not have any controls and operated 24/7 during the heating season.

The buildings domestic hot water (DHW) system was composed of two LAARS (N Kt-400 CN) DHW boilers with a total input capacity of 800 MBH. Each boiler was equipped with a 1/5 HP circulation pump. The circulating pumps did not have any controls and operated 24/7.

Proposed Energy Efficient Case

One of the heating boilers has been replaced with a new high efficiency Thermal Solution (EVS1500BN1-UAF) boiler with output capacity of 1,320 MBH at a manufacturer's published maximum thermal efficiency of 88%. The new boiler is operated as the lead boiler while the two old boilers support the lead boiler during high heat demand periods as lag boilers. Based on an interview with the building operator, the second lag boiler is never used. A boiler control system has been installed that controls the boiler circulating pumps. The pumps will only operate when there is a call for heat, and turn off after a set time delay when the boiler cycles off; therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

One of the old domestic hot water boilers has been replaced with new mid-efficiency efficiency Thermal Solution (S0L0500WNB) boiler with output capacity of 420 MBH at a manufacturer's published maximum thermal efficiency of 84%. The new boiler is operating as the lead boiler, while the old boiler is operating as the lag boiler.

Review Information

Site visit was and building operator interview were conducted on December 20th, 2013.

The site installation was in general conformance to the project application. The following information was gathered through observation and staff interview:

- The new high efficiency heating boiler was ON and the supply water temperature (SWT) and return water temperature (RWT) were 160°F and 149°F, respectively. The boiler was operating in accordance to outdoor reset schedule which was set to provide maximum SWT of 170°F. During the site visit the boiler set point was 160°F while the outdoor air temperature was 32°F.

- The lag boilers and their associated pumps were off. Therefore, it was confirmed that the heating boiler pump control upgrade is working as expected.

- The new mid-efficiency DHW boiler was cycling on/off during the site visit. The SWT and RWT were 141°F and131°F, respectively. The boiler set point was checked from boiler controller and confirmed to be 140°F.

- The pumps associated with DHW boilers were ON at all times during the site visit.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from January 2009 to December 2009 using E-tools and the weather-adjusted annual natural gas consumption was calculated based on 30 year weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 and 2 below for the heating boilers and domestic hot water boilers respectively. Since this application is a replacement with new lead-lag boiler operation, there are four seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new lead boiler seasonal efficiency is an estimation of the actual installed new lead boilers. The proposed new lag boiler seasonal efficiency is an estimation of the new seasonal efficiency of the remaining old boiler with new controls installed as part of the conversion to lead-lag. Bin table analysis is performed assuming that the building's design load matches the old boiler's capacity to determine the annual hours the lead boilers will be able to meet the building's load and the annual hours the lag boiler will be required. Then the annual seasonal efficiency of the lead-lag boilers as a packaged system will be calculated using the time weighted average of each boiler's seasonal efficiency.

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed Lead (New Boiler)	Proposed Lag (old boiler)
Thermal Efficiency	73%	80.5%	88%	73%
Boiler Pumping	Continuous	Continuous	Intermittent	Intermittent
Flue Dampening	None	None	Burner Fan	None
Maximum Design Supply Temperature	180°F	180°F	170°F	170°F
Maximum Design Return Temperature	160°F	160°F	150°F	150°F
I/O Controls with Reset	Traditional	Traditional	Characterized	Characterized
A/F Control	None	None	Modulating	None
Purge Cycle	None	None	Pre and Post	None
Calculated Seasonal Efficiency	**50.78%**	**58.28%**	**83.22%**	**63.01%**

Table 2: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed Lead (New Boiler)	Proposed Lag (old boiler)
Thermal Efficiency	73%	80.5%	84%	73%
Boiler Pumping	Continuous	Continuous	Continuous	Continuous
Flue Dampening	None	None	None	None
Maximum Design Supply Temperature	140°F	140°F	140°F	140°F
Maximum Design Return Temperature	120°F	120°F	120°F	120°F
Controls	Old	Old	New	New
A/F Control	None	None	Modulating	None
Purge Cycle	None	None	Pre or Post	None
DHW Tank Insulation	Good	Good	Good	Good
Calculated Seasonal Efficiency	**59.6%**	**67.10%**	**75.45%**	**60.3%**

MMM Group Savings Calculation Methodology

Regression analysis for baseline period was done using in-house software (the balance temperature which resulted in highest R^2 was selected) and the results were in good agreement with E-Tools calculated value.

Based on our observation during our site visit, the assumed inputs used in the applicant calculation were in accordance to actual conditions and no change to the proposed E-Tools inputs was required.

The gas consumption for March 2013 to Dec 2013 was normalized based on 30 year average weather data and a balance temperature of 18^{0}C. The post-retrofit normalized consumption (142,666 m^3) was compared to base load normalized consumption calculated by E-Tool (183,766 m^3) which resulted in an annual natural gas savings of 41,100 m^3. This saving is in good agreement with the estimated E-Tool calculation of 42,783 m^3.

Discussion

The resulting natural gas savings for this application are due to control upgrades and the replacement of older less efficient boilers with new high efficiency boilers. These changes resulted in an improvement in heating and DHW system seasonal efficiency by 17.44% and 4.85%, respectively.

The total project cost was $97,930 plus HST. The incremental cost was estimated to be $9,229. This incremental cost seems reasonable for the upgrade completed at this building. The simple payback period is 0.57 years.

Enbridge based the life measure savings estimate on retrofit life expectancy of 25 years, with a free ridership of 20%. This appears reasonable since the retrofit includes boiler replacement and upgrading the controls.

The estimated annual savings of 42,783 m^3 and life measure savings of 855,664 m^3 are reasonable for this retrofit. No changes to the estimated savings are recommended.

3.2 *RA.MR.EX.017.13*

Project Information

ESM File #: 1-75704751-04-10-12

Building Type: Multi Residential

Project Description: Heating boiler controls upgrade

Project Details: Upgraded heating boilers' pump operation from continuous to intermittent pumping.

Project Type: Controls upgrade

Implementation Date: March 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		24,971	0*	-100%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		299,650	0*	-100%

*Controls were not turned on. Savings of 20,275 m^3 per year are expected if the pumps are operated as designed.

Base Case

The building heating plant consists of three (3) Teledyne Laars Atmospheric boilers, each with a rated input of 1825 MBH, for a total heating plant input of 5475 MBH. Boiler circulation pumps run continuously. E-Tools was used to calculate the base case seasonal boiler plant efficiency of 48.6%.

Proposed Energy Efficient Case

The building heating plant's three atmospheric boilers were outfitted with intermittent pumping control, to cause the boiler circulation pumps to only operate when their associated boiler is firing. This was expected to produce savings on building heating and AHU use, since both are supplied by the heating boiler loop.

This retrofit was understood to have occurred in March 2013. It is assumed that the measure life will be 15 years, with a free ridership of 20%.

Review Information

Review of the submitted documentation found several discrepancies:

- There were savings claimed on the application due to the installation of a VFD on the air handling unit. The VFD retrofit was not meant to be part of this incentive application.
- Claimed savings amounts for the heating plant and AHU were higher than they should have been due to the "Oversizing Ratio" on the Seasonal Efficiency page being set to "1" for the new boiler plant, where it should have been 1.6 as in the existing case. This caused the calculated seasonal efficiency to be 61.8% when it should have been 58.2%

Enbridge was informed of these discrepancies and provided us with updated calculation sheets which did not contain VFD savings, and which corrected the "oversizing ratio" to 1.6.

The site inspection found that the boiler controls had in-fact been installed as claimed, however, the switch on each of the boilers' pump controller was set to 'manual'. This caused the boiler pumps which were supposed to run intermittently, to run continuously just as they had before the retrofit occurred.

Applicant Savings Calculation Methodology

E-Tools was used by Enbridge to divide the building's gas usage into its' various end uses, such as domestic hot water, building heating, make-up air, and air handling unit (AHU).

It was stated through E-Tools that the anticipated efficiency of the plant with continuous pumping was 48.6%, and once the intermittent pumps were installed, the efficiency was expected to rise to 61.8%.

The increase in system efficiency resulted in the proposed savings.

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Proposed New
Thermal Efficiency	73%	73%
Boiler Pumping	Continuous	Intermittent
Oversizing factor	1.6	1.0
Maximum Design Supply Temperature	180°F	180°F
Maximum Design Return Temperature	160°F	160°F
Calculated Seasonal Efficiency	**48.6%**	**61.8%**

MMM Group Savings Calculation Methodology

MMM group requested historical utility bill data and was provided with meter readings from January 2010 through to December 2013.

Two regression analyses were performed for the building, one analyzing the gas data for 2012, and one analyzing the gas usage data from April 2013 until November 2013 which is the period of time after the retrofit occurred.

The pre-retrofit analysis determined the baseline gas load (DHW) to be 3900 m^3 per month, which correlates very closely with the 3900-4000 m^3 per month baseline calculated by E-Tools for 2011. The post-retrofit analysis determined the baseline gas load to be 3955 m3 which correlates very closely as well.

It was stated through E-Tools that the anticipated efficiency of the plant with continuous pumping was 48.6%, and once the intermittent pumps were installed, the efficiency was expected to rise to 61.8%, however it was discovered that the oversizing ratio from the existing to new case was not kept constant at 1.6. Enbridge revised the input to show an oversizing ratio of 1.6 for both cases, and the new boiler seasonal efficiency dropped from 61.8% to 58.2%.

Table 2: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Proposed New
Thermal Efficiency	73%	73%
Boiler Pumping	Continuous	Intermittent
Oversizing factor	1.6	1.6
Maximum Design Supply Temperature	180°F	180°F
Maximum Design Return Temperature	160°F	160°F
Calculated Seasonal Efficiency	**48.6%**	**58.2%**

Discussion

After determining that the boiler plant pump controls were set to manual, it was hypothesized that there would be no savings on the building's gas usage.

The regression analyses determined that the number of m^3 of gas consumed per heating degree-day was 64 m^3 pre-retrofit and 70 m^3 post-retrofit. This shows an increase in gas use after the retrofit while the expectation was to see the same gas use before and after due to the retrofit not having been implemented properly.

The cause of this increase in gas use is unknown, and could be attributed to several factors, including equipment efficiency degradation over time, fluctuations in tenant DHW use, fluctuations in temperature set-points, or simply noise in the utility data.

Ideally, the regression analysis would show a decrease in building gas use, which we could then attribute to the improved boiler pump controls.

It should be noted that the re-calculated E-Tools annual savings of 20,275 m^3 of natural gas is reasonable for this type of retrofit. With the revised estimate for annual savings of 20,275 m^3, a life measure life cycle of 15 years and a free ridership of 20%, the new estimated life measure savings were recalculated to 243,300 m^3.

The retrofit is expected to be capable of achieving the above revised estimated savings; however, since the control was set to manual the auditor had to report that there are no savings.

The total project cost of $4,994 plus HST is reasonable for this type of controls upgrade.

Additional Post Audit Information

A response was received from Enbridge in regards to the original draft of this report, to address our observations that the improved pump controls were not being utilized. The response was in the form of a letter which was provided to Enbridge by the service provider. This letter states that the service provider's warranty recommended that the automatic pumping controls be switched to manual when the outside temperature is below -10°C. On the day of the site visit, the minimum temperature in Toronto was -1°C and was -3.7°C the day before (December 19th and 18th, 2013, respectively). There is no way to ascertain if the pump controls are being switched between auto and manual mode as recommended by the service provider. Furthermore, the analyses performed by Enbridge and by MMM to determine gas savings assumes that the pump controls are on intermittent control 100% of the time.

The additional information should be evaluated by the third party auditing firm, and discussed with the audit committee in order to finalize the audited savings. MMM recommends that the revised annual savings of savings of 20,275 m^3 and revised life measure savings of 243,300 m^3 are used in the event that the warranty letter is accepted.

3.3 *RA.MR.EX.018.13*

Project Information

ESM File #:	1-73955881-01-18-12
Building Type:	Multi Residential
Project Description:	Addition of VFD to make-up air unit
Project Details:	MUA air flow reduction via scheduled fan modulation using VFD.
Implementation Date:	February 22, 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		70,110	64,673	-7.75%
Electricity (kWh)		106,566	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		841,320	776,076	-7.75%

Base Case

The building comes equipped with one 38,000 CFM packaged roof-top make-up air unit. The unit supplies conditioned make-up air to the corridors of the building. The unit has a natural gas fired section for heating up make-up air during the heating season, and a direct expansion cooling section to cool the make-up air during the cooling season.

The unit was operated at 100% capacity all year long. The supply air temperature is manually adjusted from 68°F during the heating season to 75°F during the cooling season, using a Honeywell pre-programed controller.

Energy Efficient Case

A VFD for the make-up air units was installed to modulate the volume of fresh air delivered to the corridors based on a pre-set schedule. The supply air temperatures for both heating and cooling were to remain the same.

Natural gas savings from this retrofit are achieved by decreasing the volume of air that is being conditioned and supplied to the corridor.

Review Information

A site visit was conducted on December 19th, 2013.

The following information was gathered during the site visit:

- MUA specifications indicate that the unit can provide a maximum of 38,000 CFM
- Current MUA set-point
    - Heating season set-point at 72°F
    - Cooling season set-point at 75°F
- VFDs was installed was confirmed, and operating schedule was noted.
- The fan motor size was confirmed to be 30 HP with a rated efficiency of 92.4%.
- MUA balancing report was requested, but not received due to unavailability.

Applicant Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools software. Savings resulting from the VFD control of the MUA were derived using EGD Ventilation Load model. This model is based on assumptions/actual data on air temperatures, air handler air supply capacity.

The supply airflow was estimated to be 100 CFM per apartment as per the ASHRAE minimum requirements, which resulted in a total airflow of 26,800 CFM based on a total of 276 apartments. The heating and cooling set-points were assumed to be 68°F and 75°F respectively. The base case operating hours were 24 hours per day.

With the above inputs, the E-Tools software calculated the normalized natural gas consumption for the MUA of 210,120 m^3.

The following schedule was included in the application for the proposed retrofit:

Period From	Period To	Speed (%)	Frequency (Hz)
24:00	6:00	60	36
6:00	8:00	80	48
8:00	11:30	60	36
11:30	13:30	80	48
13:30	17:00	60	36
17:00	21:00	80	48
21:00	24:00	60	36

Using the revised schedule in, E-Tools determined that the new annual MUA natural gas consumption is 140,010 m^3.

MMM Group Savings Calculation Methodology

To validate the E-Tools calculation MMM Group performed a separate calculation for the base case using in house tools. Our base MUA unit consumption was calculated to be less than 0.3% different than the E-Tools output.

One main difference between the MMM Group calculation and the E-Tools calculation is that the MMM calculation used only the average of the past four years of historical weather data as compared to the standard 30 year average that is used in E-Tools. To compare our result to the E-Tools result, MMM proportionally adjusted the output to calculate the output that would have been had 30 years of historical weather data been used. As a result, the minor difference in likely due to that adjustment. In general we feel that the calculation process for determining MUA gas usage using E-Tools is interchangeable with MMMs approach, and both can be used to arrive at an accurate result provided that the inputs are correct.

To stay consistent with the 30 year average weather data, MMM Group requested a recalculation from Enbridge using E-Tools with new inputs as observed on site.

A temperature heating set-points of 72°F and an airflow of 38,000 CFM were applied to both the base case and existing case. In addition the new schedule was changed according to the schedule observed during the site visit. The observed schedule is outlined in the following table.

Period From	Period To	Speed (%)	Frequency (Hz)
24:00	7:00	70	42
7:00	9:30	90	54
9:30	11:30	70	42
11:30	13:30	90	54
13:30	16:30	70	42
16:30	20:30	90	54
20:30	24:00	70	42

The base case MUA usage using the updated inputs was calculated to be slightly more than the entire buildings normalized weather dependent usage. However, the building also has a heating boiler system which provides heating water to a heat pump loop.

Since the MUA unit balancing report was not available, and due to the uncertainty of the actual ventilation capacity of the unit, it was determined that the original assumption of 100 CFM minimum airflow per apartment was a reasonable estimate.

MMM revised the calculation with the observations collected on site and an estimated maximum MUA ventilation airflow of 27,600 CFM.

The revised calculation resulted in an estimated natural gas savings of 64,673 m^3.

Discussion

As discussed the base case natural gas consumption for the MUA was calculated using observed temperature settings on site and a manufacturers specified airflow of 38,000 CFM, which resulted in a higher normalized weather dependent gas usage for the MUA, then what the total actual normalized weather dependent natural gas usage was for the base case utility analysis.

Therefore, since the actual airflow of the unit could not be confirmed due to the unavailability of balancing report, it was determined that the original assumption of 27,600 CFM was appropriate. The 27,600 CFM figure was calculated with the assumption that each of the 276 apartments receives a minimum of 100 CFM as per ASHRAE minimum requirements.

The reduction in natural gas savings stems from the fact that the actual reduced ventilation schedule was set up to provide a higher volume of ventilation air to the building then was originally propose. An additional change to the original calculation included the air temperature set point change from 68°F to 72°F as observed on site. This change had a slightly positive effect on the overall gas consumption due to the higher potential for energy savings with a higher supply air temperature.

The estimated life cycle of the measure was determined to be 15 years with a 20% free ridership, which is reasonable for this type of installation. As a result of the decrease in annual natural gas savings to 64,673 m^3, we recommend a reduction in the life measure savings to 776,076 m^3.

The reported installation cost of $18,575.22 appears reasonable for this type of retrofit.

3.4 *RA.MR.EX.020.13*

Project Information

ESM File #: 1-81162759-12-04-12

Building Type: Multi Residential

Project Description: Domestic hot water plant retrofit

Project Details: Replace one existing non-condensing domestic hot water boiler with condensing boiler

Project Type: Replacement

Implementation Date: February 2013

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		14,977	19,306	28.90%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		299,535	386,120	28.90%

Base Case

Building domestic hot water (DHW) production was provided by two Raypak atmospheric boilers with a nameplate thermal efficiency of 73% and a calculated annual efficiency of 57.7%. Boiler circulation pumps ran continuously, and no flue damper control was provided. Inlet and outlet temperatures were stated to be 130°F and 150°F respectively.

Proposed Energy Efficient Case

One of the existing domestic hot water boilers was to be removed from the heating plant, and replaced with a new modulating condensing boiler (RBI Fusion-1500) with an input of 1500 MBH and a nameplate efficiency of 96.0%.

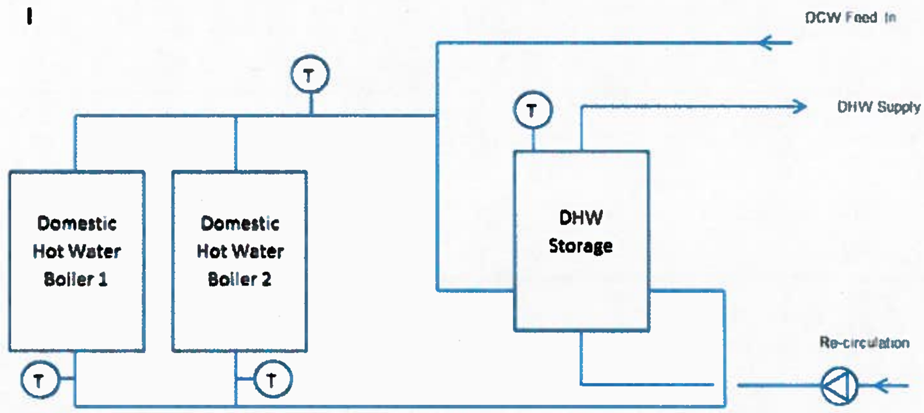
The energy savings stem from the following:

- The new boiler has a higher seasonal efficiency when compared to the existing heating system, due to an increased thermal efficiency and upgraded controls.

The new boiler comes complete with features such as force draft fans and automatic flue vent dampers which can help to improve the seasonal efficiency. The assumed measure life is 25 years.

Review Information

On-site inspection revealed that both of the original non-condensing boilers were replaced with high efficiency RBI Fusion-1500 modulating condensing boilers. The actual piping configuration was investigated and is depicted in the diagram below.



More specific details with respect to calculation inputs and site observations are included in the following two sections.

Applicant Savings Calculation Methodology

The provided savings were calculated using E-Tools. Gas utility data from February 2009 to January 2010 was used to create a weather normalized baseline, separated into non-weather relative and weather relative components. The non-weather relative component savings were calculated by multiplying the percentage improvement in domestic hot water heating system efficiency to the corresponding non-weather relative natural gas consumption.

Since only one boiler was replaced and set to run as the lead boiler with the existing boiler running as lag, the total efficiency of the boiler plant was calculated to be 81.2%, with the new boiler having a calculated seasonal efficiency of 86.98%, and the old boiler being 57.74%.

Table 1: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	96%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	2	2	11
Maximum Design Supply Temperature	150°F	150°F	130°F
Maximum Design Return Temperature	130°F	130°F	110°F
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	**57.74%**	**65.24%**	**87.38%**
Calculated System Efficiency (due to only 1 of two boilers being replaced)	**57.74%**	**65.24%**	**81.20%**

MMM Group Savings Calculation Methodology

After discovering that both boilers had been retrofit instead of the originally claimed single boiler, Enbridge was informed of the discrepancy. Based on our site visit observations, the inputs into E-Tools were updated and are summarized in Table 2 below. Enbridge then produced revised E-Tools calculation sheets showing the calculated savings from both boilers having been retrofit.

The revised annual gas savings were calculated to be 19,306 m^3 with both boilers replaced. The gas savings had originally been anticipated to be 14,997 m^3 with just the one boiler being retrofit.

MMM GROUP

Table 2: Summary of domestic hot water boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	96%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	2	2	11
Maximum Design Supply Temperature	150°F	150°F	130°F
Maximum Design Return Temperature	130°F	130°F	110°F
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated System Seasonal Efficiency	**57.74%**	**65.24%**	**87.38%**

Discussion

The replacement of both existing domestic hot water boiler instead of the proposed one boiler, resulted in an increased audited annual savings of 19,306 m^3.

In addition to the revised calculation, MMM group performed a pre and post retrofit regression analysis to validate the estimated savings.

Two regression analyses were performed for the building, one analyzing the gas data for 2011, and one analyzing the gas usage data from Feb 2013 until October 2013 which is the period of time after the retrofit occurred.

The regression analysis resulted in an annual savings of 18,796 m^3 of natural gas being saved on the domestic hot water production. This value correlates closely with the 19,306 m^3 of anticipated savings from the revised E-Tools calculation.

We feel that the close proximity of the savings that were calculated by regression analysis to the anticipated savings calculated by E-Tools validates this retrofit's savings and the incentives associated with it.

The total project cost of $59,560 plus HST, and the incremental cost of $16,172 should be revised based on the actual cost for the replacement of two boilers.

Enbridge based the life measure savings estimate on retrofit life expectancy of 25 years, with a free ridership of 20%. This appears reasonable since the retrofit includes boiler replacement and upgrading the controls. Based on the revised annual savings of 19,306 m^3, we recommend increasing the life measure savings to 386,120 m^3 of natural gas.

3.5 *RA.MR.EX.023.13*

Project Information

ESM File #: 1-78973701-09-07-12

Building Type: Multi Residential

Project Description: Boiler Replacement

Project Details: Three new 85% boilers where installed serving heating and DHW tanks. Supply water temperature reset scheduling was implemented based on outside temperature.

Project Type: Replacement

Implementation Date: March 2013

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		207,221	195,878	-5.47%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		4,144,420	3,917,560	-5.47%

Base Case

The original building boilers were at the end of their life and in need of replacement. This application is for a heating plant retrofit which serves two buildings. There is a single central heating plant located one of the buildings which provides building heating and domestic hot water for both buildings. The heating plant originally had two 5,000 MBH Power Master boilers serving the heating and domestic hot water demand. Each existing boiler had 2 stages.

Proposed Energy Efficient Case

One of the Powermaster boilers has been disconnected and three new 1,950 MBH Futera II series boilers have been installed to replace it. The second Powermaster boiler is still connected and operates with the new boilers in a lead-lag configuration. Each new boiler has 2 stages, for a total of 6 stages. The remaining old Powermast boiler has 2 stages.

The new boiler pumps have been upgraded to run intermittently, therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduce gas consumption.

The heating system is piped in a primary secondary loop configuration. The primary heating loop is programmed with a supply temperature reset schedule based on outdoor air temperature which varies the supply temperature between 150°F and 180°F. There are two secondary loops that serve each building. The secondary loops operate with three-way control valves to vary the loop temperature between 175°F at outside temperatures below 10°F and 115°F at outside temperatures higher than 55°F.

A new domestic hot water heat exchanger has been installed with a new insulated hot water tank. There is a constant volume pump that continuously circulates the water between the heat exchanger and the hot water tank. On the boiler side of the heat exchanger, there is a circulating pump with a VFD controller to modulate the heating water flow rate through the heat exchanger in order to maintain the domestic hot water set point of 125°F.

Review Information

We met on site with the project engineer for this project.

The two old Powermaster boilers were still installed on site and one was operating at the time of our site visit. The second one has been disconnected from the system and decommissioned. The building operator confirmed that one of the old Powermaster boilers has been operating most of the time during the winter.

Three new Futera II model #FB1950 boilers were installed. The boilers were controlled by a BAS system which can be accessed remotely by a web interface. The project engineer agreed to send us screenshots from the BAS system with the scheduling details and trends.

A new heat exchanger and hot water tank was installed for supplying DHW to the buildings. This system incorporates a secondary pump with VFD on the heating side of the heat exchanger and a continuously operated pump on the hot water side of the heat exchanger that circulates heating water between the hot water tank and the heat exchanger.

The service provider sent screenshots from the BAS showing that the outside temperature reset schedule is set to 170°F at an outside temperature of -5°F or lower and 160°F at an outside temperature of 60°F or higher. The screen shot also shows the set point temperature for the domestic hot water is 125°F.

During our site visit, it was discussed with the engineer [redacted] that in addition to installing the new boilers, they also installed VFD drives on the building MUA units. There are two MUA units, each supplying 6000 CFM of outside air into the common hallways with no heating or cooling. The new MUA unit VFD schedule is 75% from 6:00am to 12:00am and 45% from 12:00am to 6:00am. This will give electrical savings and natural gas savings; however, this retrofit was not part of the application and therefore outside of the scope for this application.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from January 2011 to December 2011 using E-Tools and the weather-adjusted annual natural gas consumption was determined. From the regression analysis, the non-seasonal load for domestic hot water and the clothes dryers and the seasonal load for the heating boilers were determined.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Table 1 below. The boilers serve both the building's heating and domestic hot water. Since this application is a replacement, there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the seasonal efficiency of the actual installed new boilers. The input assumptions are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project natural gas savings were calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case	Proposed New
Thermal Efficiency	73%	80.5%	85%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	4	4	6
Maximum Design Supply Temperature	180°F	180°F	160°F
Maximum Design Return Temperature	160°F	160°	140°F
I/O Controls with Reset	Traditional	Traditional	BAS
A/F Control	None	None	Staged
Purge Cycle	None	None	Pre or Post
Calculated Seasonal Efficiency	**54.51%**	**62.01%**	**80.29%**

MMM Group Savings Calculation Methodology

We reviewed the utility data analysis performed by E-Tools and determined that the calculation is acceptable, so we have used the weather adjusted building consumption from E-Tools in our verification calculations.

Based on our observations during our site visit, it was determined that only one of the old boilers had been taken off-line and replaced with three new boilers. The second existing boiler remains and was operating with the new boilers in a lead-lag control configuration. The E-Tools calculation was updated to a lead-lag operation for the new boiler installation and the revised inputs are summarized in Table 2 below. Since this application is now a replacement with new lead-lag boiler operation, there are four seasonal efficiencies used to calculate the final savings. In addition to the existing and base boiler efficiencies described in the applicant's calculation methodology, there is a new lead boiler and new lag boiler seasonal efficiency calculation. The proposed new lead boiler seasonal efficiency is an estimation of the actual installed new lead boilers. The proposed new lag boiler seasonal efficiency is an estimation of the new seasonal efficiency of the remaining old boiler with new controls installed as part of the conversion to lead-lag. The inputs summarized in Table 2 that are new or changed compared to the original application are shown in bold.

Table 2: Summary of boiler calculation input assumptions – Audited

Boiler Characteristic	**Existing**	**Base Case**	**Proposed New Lead**	**Proposed New Lag**
Thermal Efficiency	73%	80.5%	85%	**73%**
Boiler Pumping	Continuous	Continuous	Intermittent	**Intermittent**
Flue Dampening	None	None	Burner Fan	**None**
Total # of Heating Stages	4	4	6	**2**
Maximum Design Supply Temperature	180°F	180°F	**180°F**	**180°F**
Maximum Design Return Temperature	160°F	160°	**160°F**	**160°F**
I/O Controls with Reset	Traditional	Traditional	BAS	**BAS**
A/F Control	None	None	Staged	**None**
Purge Cycle	None	None	Pre or Post	**None**
Calculated Seasonal Efficiency	54.51%	62.01%	**79.58%**	**63.25%**

The changes made were to reflect the observed maximum supply/return temperature set points in the BAS controls and to reflect the lead-lag operation with the new and existing boilers. Bin table analysis was performed assuming the building's design load matches the old boiler's capacity to determine the annual hours the lead boilers will be able meet the building's load and the annual hours the lag boiler will be required. The result of the analysis was that on average the lead boilers will handle the building's load 98% of the year and the lag boiler will be required to operate along with the lead boilers for 2% of the year. The annual seasonal efficiency of the lead-lag boilers as a packaged system was calculated using the weighted average of each boiler's seasonal efficiency. This gave a weighted average seasonal efficiency of 79.25%.

Discussion

The revised E-Tools calculations resulted in an estimated annual savings of 195,878 m^3 of natural gas. This is a slight reduction from the original application, due to the applicant calculation incorrectly assuming the new boiler controls would operate with maximum supply/return temperatures of 160°F/140°F. The revision of the application to calculate the savings based on a lead-lag system was performed in order to most accurately reflect what was observed on site, however, this change had little overall effect on the application savings since the lag boiler will only operate 2% of the year.

The life cycle analysis for this project was estimated to be 25 years. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 20% free ridership. The one remaining boiler which is operating as the lag boiler is currently near the end of its expected life and will require replacement soon. However, the hours of operation have been significantly reduced, which should extend its useful life. The new boilers can be expected to last 25 years. Overall, the life cycle of 25 years with a free ridership of 20% is reasonable. The life cycle savings should be updated based on the revised annual gas savings to 3,917,560m^3 of natural gas.

The incremental project cost is $30,654, which seems reasonable for an upgrade that includes a full new BAS and domestic hot water system in addition to the new heating boilers.

3.6 *RA.MR.EX.041.13*

Project Information

ESM File #:	1-76546661-05-16-12
Building Type:	Multi Residential
Project Description:	▪ Heating water and domestic hot water system control upgrade ▪ Installing VFD on hot water MUA ▪ Installing VFD on gas-fired MUA
Project Details:	Upgrade the sequence of operation for the existing 5 heating boilers and 2 DHW boilers. Upgrade boiler pump operation from continuous to intermittent. Installation of VFD on two MUA units.
Project Type:	Controls Upgrade
Implementation Date:	March 2013

MMM GROUP

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		159,967	158,987	-0.61%
Electricity (kWh)		148,297	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		1,919,604	1,907,844	-0.61%

Heating Boiler Control Upgrade				
Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		31,061	47,105	51.65%
Life Cycle (m^3)		372,732	565,260	51.65%

Domestic Hot Water Boiler Control Upgrade				
Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		3,109	4,111	32.23%
Life Cycle (m^3)		37,308	49,332	32.23%

Ventilation Control Upgrade				
Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		125,797	107,771	-14.33%
Life Cycle (m^3)		1,509,564	1,293,252	-14.33%

Base Case

The building space heating is provided by five (5) heating boilers (Raypak H9-2002B). Each boiler is rated at 1,999 MBH input and is equipped with one 1.5 HP pump. The domestic hot water is provided by two (2) DHW heaters (Raypak WH9-2002B), with a total input capacity of 4,000 MBH. Each boiler is equipped with one 1.5HP pump.

Based on the interview with contractor and building operator, the heating boilers were wired for only 2 stages even though they were manufactured to operate as boiler with 4 stages. In addition the boiler pumps were operated continuously during the heating season. The domestic hot water boilers were operating in parallel with two stages each. The base case boiler operation could not be visually verified since the review occurred following the control proposed control changes.

The fresh air to the common spaces is provided via one gas-fired make-up air unit (model: AW-I-3-200/D, total capacity: 26,800CFM) located in the penthouse mechanical room and one MUA which is equipped with a hydronic heating coil that is connected to the heating plant loop via a secondary loop. The hydronic MUA (model: AW-a-1-36/chw, total capacity: 28,650CFM) is located in the lower level mechanical room. The hydronic MUA is referred to as an AHU in the

Enbridge application. Both MUA units were providing 100% outdoor air, based on our interview with the building operator and information provided by Enbridge in the application.

Proposed Energy Efficient Case

The existing boiler control is to be upgraded to allow for each boiler to operate with 4 stages instead of 2 as is in the base case. The new BMS modulates the heating boilers with all 4 stages to minimize the standby losses. The DHW boiler controls upgrade was also to be upgraded in the process to allow for modulation and a decrease in the maximum supply and return water temperature set points.

The heating boilers and DHW boiler pumps have been upgraded to run intermittently, therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

VFDs for the MUA and AHU were installed to modulate the fresh air delivered to the corridors based on a pre-set schedule.

Review Information

A site visit and building manger interview was conducted on January 6th, 2014. The site installation was in general conformance to the project application. The following observations were made during the site visit:

- DHW boiler 1 was running and the DHW boiler 2 was off
- The boiler pump for DHW boiler 2 was off.
- Both MUA and AHU were running at 90% speed (at 12:10PM)

In addition, a full two weeks of trend data was collected and analyzed. The trend data included information for outdoor air temperature, supply and return water temperature, boiler status for all of the boilers, status for all the boiler pumps, and the VFD speed and supply air temperature for both MUA units. Based on these trends, the following conclusions were reached:

- The five heating boilers are piped in series and each of them has 4 stages
- The heating boilers average supply water temperature and return water temperature are 180°F and 160°F, respectively
- The two DHW boilers are piped in series and each of them has 4 stages
- The DHW boilers average supply water temperature and return water temperature were 155°F and 145°F, respectively
- The natural gas fire MUA VFD set-back speed was originally set to at 55%; this however cased the gas furnace which is located on the discharge side of the fan to go into emergency heat mode due to overheating. As a result the, set-back speed was increased to 65% to avoid this.

- The hydronic MUA units is equipped with an additional control function which allows the fan to ramp down when the heating coil cannot provide sufficient heat to meet the supply air set point. However, in general the fan speed is controlled as a function of time.

Based on our site review and trend analysis the following parameters were different from the application:

- Heating boiler stages, SWT and RWT
- DHW boiler stages, SWT and RWT
- VFD schedule

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from January 2011 to December 2011 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on average 30 year weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers and make-up air units were estimated.

The seasonal efficiency of the base case boilers was estimated using E-tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 and 2 below for the heating boilers and domestic hot water boilers respectively. Since this application is a boiler controls upgrade, there are two seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the boilers with the base case control strategy. The proposed new boiler seasonal efficiency is an estimation of the seasonal efficiency with upgraded controls. The boiler operation controls summarized in Table 1 and 2 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the savings achieved in the proposed new boilers compared to the existing boilers.

MMM GROUP

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Proposed New
Thermal Efficiency	84%	84%
Boiler Pumping	Continuous	Intermittent
Flue Dampening	Burner Fan	Burner Fan
Maximum Design Supply Temperature	170°F	170°F
Maximum Design Return Temperature	150°F	150°F
I/O Controls with Reset	None	BAS
A/F Control	Staged	Staged
Purge Cycle	Pre and Post	Pre and Post
Calculated Seasonal Efficiency	**74.29%**	**79.46%**

Table 2: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Proposed New
Thermal Efficiency	84%	84%
Boiler Pumping	Continuous	Intermittent
Flue Dampening	Burner Fan	Burner Fan
Maximum Design Supply Temperature	140°F	130°F
Maximum Design Return Temperature	120°F	110°F
Controls	Old	New
A/F Control	Staged	Staged
Purge Cycle	Pre or Post	Pre or Post
DHW Tank Insulation	Good	Good
Calculated Seasonal Efficiency	**74.6%**	**76.78%**

Savings resulting from the VFD control of the gas-fired MUA unit was derived using EGD Ventilation Load model. This model is based on assumptions/actual data on air temperatures, equipment efficiency and air handler air supply capacity.

The supply airflow for the natural gas fired unit was estimated to be 26,800 CFM based on the manufacturer data. The heating set-point was assumed to be 68°F. The base case operating hours were 24 hours per day.

With the above inputs, the E-Tools software calculated the normalized natural gas consumption for the MUA of 204,030 m^3.

The following schedule was included in the application for the proposed retrofit which resulted in 61,310 m^3 gas saving.

Hour	Speed (%)
6:00 AM – 8:00 AM	90
8:00 AM – 11:00 AM	60
11:00 AM – 1:30 PM	90
1:30 PM – 5:00 PM	60
5:00 PM – 9:00 PM	90
9:00 PM – 6:00 AM	60

EGD Ventilation Load model was also used for calculating the saving resulting from the installing of a VFD for the hydronic MUA. This model is based on assumptions/actual data on air temperatures, air handler air supply capacity. It uses different equipment efficiencies for existing and new case based on the calculated boiler seasonal efficiency.

The supply airflow was estimated to be 28,000 CFM based on the manufacturer data. The heating set point was assumed to be 68°F. The base case operating hours were 24 hours per day. The equipment efficiency for the existing and proposed case is 74.3% and 79.5%, respectively which equals the calculated boiler seasonal efficiency.

With the above inputs, the E-Tools software calculated the normalized base case natural gas consumption for the hot water MUA of 229,549m^3.

The following schedule was included in the application for the proposed retrofit which in conjunction with the efficiency increase resulted in 79,443 m^3 gas saving.

Hour	Speed (%)
6:00 AM – 8:00 AM	90
8:00 AM – 11:00 AM	60
11:00 AM – 1:30 PM	90
1:30 PM – 5:00 PM	60
5:00 PM – 9:00 PM	90
9:00 PM – 6:00 AM	60

MMM GROUP

MMM Group Savings Calculation Methodology

We reviewed the utility data analysis performed by E-Tools and determined that the calculation is acceptable, so we have used the weather adjusted building consumption from E-Tools in our verification calculations.

Based on our observations during our site visit, the inputs into E-Tools were updated as summarized in Tables 3 and 4 below for the heating and domestic hot water boilers, respectively. Items that have been changed are shown in bold.

Table 3: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	**Existing**	**Proposed New**
Thermal Efficiency	84%	84%
Boiler Pumping	Continuous	Intermittent
Flue Dampening	Burner Fan	Burner Fan
Maximum Design Supply Temperature	**180°F**	**180°F**
Maximum Design Return Temperature	**160°F**	**160°F**
I/O Controls with Reset	None	BAS
A/F Control	Staged	Staged
Purge Cycle	Pre and Post	Pre and Post
Calculated Seasonal Efficiency	**70.46%**	**78.28%**

MMM GROUP

Table 4: Summary of domestic hot water boiler calculation input assumptions - Audited

Boiler Characteristic	**Existing**	**Proposed New**
Thermal Efficiency	84%	84%
Boiler Pumping	Continuous	Intermittent
Flue Dampening	Burner Fan	Burner Fan
Maximum Design Supply Temperature	**150°F**	**150°F**
Maximum Design Return Temperature	**140°F**	**140°F**
Controls	Old	New
A/F Control	Staged	Staged
Purge Cycle	Pre or Post	Pre or Post
DHW Tank Insulation	Good	Good
Calculated Seasonal Efficiency	**64.74%**	**79.22%**

To validate the E-Tools calculation for VFD installation on MUAs, MMM Group performed a separate calculation for the base case using in house tools. Our base consumption for gas-fired MUA unit and hot water MUA unit was calculated to be less than 0.3% different than the E-Tools output.

One main difference between the MMM Group calculation and the E-Tools calculation is that the MMM calculation used only the average of the past four years of historical weather data as compared to the standard 30 year average that is used in E-Tools. To compare our result to the E-Tools result, MMM proportionally adjusted the output to calculate the output that would have been had 30 years of historical weather data been used. As a result, the minor difference is likely due to that adjustment. In general we feel that the calculation process for determining MUA gas usage using E-Tools is interchangeable with MMMs approach, and both can be used to arrive at an accurate result provided that the inputs are correct.

Based on the trend data and site observations, the natural gas fired MUA and hydronic MUA supply fan speeds are operating with following daily schedule. As a result the inputs for E-Tools were revised and a new savings value was provided.

Gas-fired MUA		Hot water MUA (AHU)	
Hour	Speed (%)	Hour	Speed (%)
5:00 AM – 9:00 AM	90	5:00 AM – 9:00 AM	90
9:30 AM – 10:30 AM	65	9:30 AM – 10:30 AM	55
10:30 AM – 1:00 PM	90	10:30 AM – 1:00 PM	90
1:00 PM – 4:00 PM	65	1:00 PM – 4:00 PM	55
4:00 PM – 9:00 PM	90	4:00 PM – 9:00 PM	90
9:00 PM – 5:00 AM	65	9:00 PM – 5:00 AM	55

Discussion

Based on the information collected during the site visit and review of trend data, EGD recalculated the saving using E-Tools. The new calculation reflected the change in the heating boiler and DWH seasonal efficiency and the adjustment to the VFD schedules.

The VFD schedule for both MUA and AHU was modified to represent the actual schedule as was observed from a review of trends. As a result of the increase in the peak hours, the gas saving associated with ventilation control was decreased.

The change in maximum supply and return water temperature set-point was altered to both the base and energy efficient case. This resulted in a decrease in seasonal efficiency for both the base and energy efficient cases. However, due to improved controls in the retrofit, the decrease in seasonal efficiency for the energy efficient case was less than that of the base case. This in turn resulted in an increase in expected gas savings from the boiler control upgrade.

The total project cost was reported as $41,218, which seems reasonable for the scope of work completed. As this project is an advancement project the incremental cost equals to the total project cost.

Enbridge based the life measure savings estimate on a retrofit life expectancy of 15 years, with a free ridership of 20%. This appears reasonable since the retrofit is composed of a controls upgrade. Based on the revised annual savings of 158,987 m^3, we recommend decreasing the life measure savings to 1,907,844 m^3 of natural gas.

3.7 *RA.MR.EX.046.13*

Project Information

ESM File #:	1-81249181-12-07-12
Building Type:	Multi Residential
Project Description:	New near-condensing boilers
Project Details:	Two new near-condensing (85% efficient) serving both heating and DHW load were installed. Supply water temperature reset scheduling was implemented based on outside temperature.
Project Type:	Replacement
Implementation Date:	March, 2013

MMM GROUP

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		117,028	120,500	2.97%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		2,340,558	2,410,000	2.97%

Heating Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		104,515	107,442	2.80%
Life Cycle (m^3)		2,090,300	2,148,840	2.80%

Domestic Hot Water Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		12,513	13,058	4.36%
Life Cycle (m^3)		250,260	261,160	4.36%

Base Case

The original boiler plant consisted of one boiler supplying heating water and a separate RayPak boiler supplying domestic hot water. The original boilers were at the end of their life and in need of replacement. The energy savings for this application are based on the incremental savings of the near condensing boilers compared to new 80.5% efficient boilers.

Energy Efficient Case

The new system consists of two new DeDietrich model GT430A-14 boilers with a total output capacity of 5,774 MBH. The building is divided into North and South zones. Each zone has a mixing valve to accommodate different heating loads in each zone. The boilers are also connected to a new domestic hot water heat exchanger.

The new boiler pumps have been upgraded to run intermittently, therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

The new heating boilers operating temperatures are changed according to a supply temperature reset schedule that is based on outdoor air temperature. The schedule was set to a maximum supply temperature of 190°F at outdoor temperatures of 0°F or lower and a minimum supply temperature of 150°F at an outdoor temperature of 66°F or higher.

Heating for the domestic hot water is supplied through a secondary loop which is connected to the main heating system with a heat exchanger. A constant circulating pump circulates domestic hot water between the heat exchanger and the domestic hot water tank. The secondary loop circulating pump is equipped with a VFD that modulates to maintain the domestic hot water temperature at a set point of 130°F.

Review Information

We met on site with the installing contractor on December 17th, 2013.

The new boilers and domestic hot water system were installed and operating.

The operation of the boilers was confirmed on site by reviewing the boiler set points on the local boiler controller. The heating boilers operate of off a temperature re-set schedule based on outdoor air temperature. When the outdoor air temperature is 66°F, the supply temperature set point is 150°F and when the outside air temperature is 0°F, the heating supply temperature is 190°F.

The domestic hot water system runs off of a secondary loop with a heat exchanger. There is a constant pump circulating heating water through the hot side of the heat exchanger and a circulating pump with a VFD installed circulating the domestic hot water through the cold side of the heat exchanger and the domestic hot water tank. The VFD varies the domestic hot water circulating pump to maintain a hot water temperature of 130°F.

The boilers had modulating burners with a 4:1 turndown ratio. At the time of our site visit, both boilers were operating at around 35%.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from January 2011 to December 2011 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on 30 year weather data. From the regression analysis, the non-seasonal load for domestic hot water and the clothes dryers and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 and 2 below for the heating boilers and domestic hot water boilers respectively. Since this application is a replacement, there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the actual installed upgraded higher efficiency new boilers. Each of the inputs in Tables 1 & 2 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

MMM GROUP

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case	Proposed New
Thermal Efficiency	73%	80.5%	85.5%
Boiler Pumping	Continuous	Continuous	Continuous
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	1	1	4
Maximum Design Supply Temperature	180°F	180°F	170°F
Maximum Design Return Temperature	160°F	160°	150°F
I/O Controls with Reset	None	Traditional	Characterized
A/F Control	None	None	Staged
Purge Cycle	None	None	None
Calculated Seasonal Efficiency	**49.16%**	**58.66%**	**78.25%**

Table 2: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	**Existing**	**Base Case**
Thermal Efficiency	73%	80.5%
Boiler Pumping	Continuous	Continuous
Flue Dampening	None	None
Total # of Heating Stages	1	1
Maximum Design Supply Temperature	150°F	150°F
Maximum Design Return Temperature	130°F	130°F
Controls	None	Traditional
A/F Control	None	None
Purge Cycle	None	None
DHW Tank Insulation	Good	Good
Calculated Seasonal Efficiency	**55.67%**	**64.57%**

No data was available for the efficiency rating of the old boilers, so a thermal efficiency of 73% for both the heating boiler and the domestic hot water boiler was assumed. The old boilers had continuous pumping and no controls, contributing to the significant boiler losses.

For the base case boilers, it was assumed the new boilers will have thermal efficiencies of 80.5% with basic boiler controls.

The new boiler efficiency was input as 85.5% into E-Tools based on the manufacturer's published boiler efficiency rating and additional efficiency loss factors were added based on the new operating conditions of the boilers. The final estimated seasonal efficiency for the new boilers was determined to be 78.25%. The building's domestic hot water is heated from the heating boilers and therefore there are no new domestic hot water boiler inputs.

The annual natural gas consumption for heating and for domestic hot water determined form the regression analysis was used with the heating and domestic hot water boiler seasonal efficiencies to estimate the new building natural gas consumption for heating and domestic hot water. Since the new boiler system serves both the heating and domestic hot water, the two values were combined and the new boiler system seasonal efficiency was applied to estimate the new building natural gas consumption and natural gas savings.

MMM GROUP

MMM Group Savings Calculation Methodology

MMM reviewed the regression analysis performed in E-Tools in the applicant calculation and determined that it was performed correctly.

Based on our observations during our site visit, the inputs into E-Tools were updated as summarized in Tables 3 and 4 below for the heating and domestic hot water boilers, respectively. Items that have been changed are shown in bold.

Table 3: Summary of heating boiler calculation input assumptions – Audited

Boiler Characteristic	Existing	Base Case	Proposed New
Thermal Efficiency	73%	80.5%	85.5%
Boiler Pumping	Continuous	Continuous	**Intermittent**
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	1	1	4
Maximum Design Supply Temperature	180°F	180°F	**190°F**
Maximum Design Return Temperature	160°F	160°	**170°F**
I/O Controls with Reset	None	Traditional	Characterized
A/F Control	None	None	Staged
Purge Cycle	None	None	None
Calculated Seasonal Efficiency	**49.16%**	**58.66%**	**79.74%**

MMM GROUP

Table 2: Summary of domestic hot water boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case
Thermal Efficiency	73%	80.5%
Boiler Pumping	Continuous	Continuous
Flue Dampening	None	None
Total # of Heating Stages	1	1
Maximum Design Supply Temperature	150°F	150°F
Maximum Design Return Temperature	130°F	130°F
Controls	None	Old
A/F Control	None	None
Purge Cycle	None	None
DHW Tank Insulation	Good	Good
Calculated Seasonal Efficiency	**55.67%**	**64.57%**

The new boilers had intermittent pumping which had not been selected in the original application. In addition, the maximum supply/return temperatures were updated as per the reset schedule observed on site with maximum temperature set points of 190°F/170°F. This resulted in an overall slight increase in the seasonal efficiency compared to the applicant's calculation.

Discussion

The updated savings calculations resulted in a slight increase in the project savings to 120,500 m^3 of gas which better reflects the installed conditions observed on site.

The project cost was $218,929 based on the installing contractor's quote. The project was completed as a design-build, so this cost includes design. The incremental cost in the application is $8,902. We recommend that the incremental cost should be approximately $20,000 to reflect the upgrade to the DHW system and controls.

The life cycle analysis for this project was estimated to be 25 years. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 20% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 2,410,000 of natural gas.

MMM GROUP

3.8 *RA.MR.EX.053.13*

Project Information

ECM File #:	1-71228357-09-16-11
Building Type:	Multi Residential
Project Description:	Building heating and domestic hot water boiler replacement.
Project Details:	Replace three existing boilers with two condensing boilers (lead) and one high-efficiency boiler (lag) Replace two existing DHW boilers with two condensing boilers
Project Type	Replacement
Implementation Date:	January 2014

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		75,374	69,627	-7.62%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		1,507,497	1,392,560	-7.62%

Heating Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		53,560	50,139	-6.39%
Life Cycle (m^3)		1,071,200	1,002,780	-6.39%

Domestic Hot Water Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		21,814	19,489	-10.66%
Life Cycle (m^3)		436,280	389,780	-10.66%

Base Case

The original building boilers were at the end of their life and in need of replacement. The energy savings for this application are based on the incremental savings of the condensing boilers compared to new 80.5% thermal efficiency boilers.

The building space heating was provided by three (3) LAARS heating boilers. Each boiler was rated at 1,266 MBH input and equipped with 1.5 HP circulation pump. Domestic hot water was provided by two (2) LAARS DHW heaters, with a total input capacity of 2,400 MBH. Each boiler was equipped with one 1.5HP circulation pump.

The heating boiler and DHW boiler pumps were operated continuously.

Proposed Energy Efficient Case

The heating boilers were replaced with two (2) EnerPro (EPN1000) condensing boilers with a total output capacity of 1,916 MBH and a manufacturers published maximum thermal efficiency of 95.8% and one (1) De Dietrich (GT 430A-9) high efficiency boiler with a output capacity of 1,659 MBH and a manufacturers published maximum thermal efficiency of 85%. The two condensing boilers are operated as lead and the high efficiency boiler as lag boiler. To protect the high efficiency boiler against condensation, there is a control strategy which prevents it to operate unless the building return water temperature is above 57°C (135°F) and the two condensing boilers cannot maintain the building supply within 3°C (5°F) of set point while they are at 100% firing rate for 10 minutes or longer. The building supply water temperature automatically resets based on outdoor air temperature according to the adjustable limits as identified in the following table:

Outdoor Air Temp	Supply Water Reset
12°C (54°F)	50°C (122°F)
-14°C (7°F)	80°C (176°F)

The DHW water boilers were replaced with two (2) EnerPro (EPW1000) condensing boilers. The BAS enables and modulates the two condensing boilers in sequence to maintain the building supply water temperature at its set point.

The heating boilers and DHW boiler pumps have been upgraded to run intermittently, therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

Review Information

A site visit and building management interview was conducted on January 6th, 2014.

The site installation was in general conformance to the project application:

- At the time of the site visit two (2) condensing heating boilers were operating and the non-condensing boiler was off.
- DHW boiler 1 was running and the DHW boiler 2 was off.
- Both DHW boiler pumps were ON, it was confirmed that they changed the pump control to manual as a result of failure during the holiday. Trends show that pump control was set back to intermittent later.

In addition, the following information was gathered based on the trend reviews and interview with the contractor responsible for the retrofit:

- The two condensing boilers are enabled and modulated in sequence to maintain the building supply water temperature at its set point
- The heating boilers maximum supply water temperature and return water temperature are 180°F and 165°F, respectively
- Each heating boiler pump is only enabled when its respective boiler is enabled
- The two DHW boilers are modulated in sequence to maintain the DHW setpoint temperature.
- The DHW boilers average supply water temperature and return water temperature are 140°F and 120°F, respectively
- Each DHW boiler pump is only enabled when its respective boiler is enabled

Based on our site review and trend analysis the following parameters were different from the application:

- Heating boiler SWT and RWT
- DHW boiler SWT and RWT
- Condensing boiler thermal efficiency due to operating in non-condensing mode

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from January 2011 to December 2011 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on average 30 year weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 and Table 2 below for the heating boilers and domestic hot water boilers respectively.

For heating boilers the application is a replacement with new lead-lag boiler operation and there are four seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new lead boiler seasonal efficiency is an estimation of the actual installed new lead boilers. The proposed new lag boiler seasonal efficiency is an estimation of the new seasonal efficiency of the new high efficiency boiler with new controls installed as part of the conversion to lead-lag. Bin table analysis is performed assuming the building's design load matches the old boiler's capacity to determine the annual hours the lead boilers will be able to meet the building's load and the annual hours the lag boiler will be required. Then the annual seasonal efficiency of the lead-lag boilers as a packaged system will be calculated using the time weighted average of each boiler's seasonal efficiency.

For Domestic hot water boiler the application is a replacement and there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the seasonal efficiency of the actual installed new boilers.

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	**Existing**	**Base Case (for Replacements)**	**Proposed Lead (New Boiler)**	**Proposed Lag (New Boiler)**
Thermal Efficiency	73%	80.5%	95.8%	88%
Boiler Pumping	Continuous	Continuous	Intermittent	Intermittent
Flue Dampening	None	None	Burner Fan	None
Maximum Design Supply Temperature	180°F	180°F	180°F	180°F
Maximum Design Return Temperature	160°F	160°	110°F	160°F
I/O Controls with Reset	Traditional	Traditional	BAS	BAS
A/F Control	None	None	Modulating	Modulating
Purge Cycle	None	None	Pre and Post	Pre and Post
Calculated Seasonal Efficiency	**55.80%**	**63.30%**	**92.46%**	**83.56%**

Table 2: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	95.8%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Maximum Design Supply Temperature	140°F	140°F	140°F
Maximum Design Return Temperature	120°F	120°F	100°F
Controls	Old	Old	New
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre or Post
DHW Tank Insulation	Good	Good	Good
Calculated Seasonal Efficiency	**57.60%**	**65.10%**	**87.65%**

MMM Group Savings Calculation Methodology

The utility data used for the E-Tools calculation was from January 2011 to December 2011. It was noticed that a balance temperature of 20°C gives a better R^2 value; therefore a new regression analysis was performed using a 20°C building balance temperature. The higher balance temperature resulted in an increase of the normalized base load by 2.5%.

Based on our observations made during the site visit and an analysis of 2 weeks of trends, the inputs into E-Tools were updated as summarized in Table 3 and Table 4 below for the heating and domestic hot water boilers, respectively. Items that have been changed are shown in bold.

MMM GROUP

Table 3: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed Lead (New Boiler)	Proposed Lag (New Boiler)
Thermal Efficiency	73%	80.5%	92.6%	88%
Boiler Pumping	Continuous	Continuous	Intermittent	Intermittent
Flue Dampening	None	None	Burner Fan	None
Maximum Design Supply Temperature	180°F	180°F	180°F	180°F
Maximum Design Return Temperature	160°F	160°F	165°F	165°F
I/O Controls with Reset	Traditional	Traditional	BAS	BAS
A/F Control	None	None	Modulating	Modulating
Purge Cycle	None	None	Pre and Post	Pre and Post
Calculated Seasonal Efficiency	**55.80%**	**63.30%**	**88.16%**	**83.56%**

Based on the ASHRAE chart for condensing boiler thermal efficiency versus return water temperature (2000 ASHRAE Handbook- HVAC System and Equipment), a condensing boiler thermal efficiency will decreases as the boiler return water temperature increases. Using supply water temperature trends and an assumption that there is on average a 10°C (18°F) increase from the return water temperature through the boiler, we were able to determine the return water temperature profile. Using the return water temperature profile (i.e. return water temperature re-set schedule) in conjunction with ASHARE thermal efficiency chart and a bin table we were able to calculate the average thermal efficiency of the boiler for a normalized year of weather data. Using this method we determined the new average thermal efficiency of the boiler to be 92.6%.

MMM GROUP

Table 4: Summary of domestic hot water boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	95.8%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Maximum Design Supply Temperature	140°F	140°F	140°F
Maximum Design Return Temperature	120°F	120°F	120°F
Controls	Old	Old	New
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre or Post
DHW Tank Insulation	Good	Good	Good
Calculated Seasonal Efficiency	**57.60%**	**65.10%**	**84.53%**

Discussion

Based on the trends and site conditions observed during our review, we requested a re-run of the E-Tools calculations. The updated calculation included changes to the heating boiler supply and return temperatures at 180°F and 165°F, and the DHW boiler return temperatures at 120°F. The higher SWT and RWT increased the stand by losses and therefore decreased the seasonal efficiency.

Due to the higher return water temperature the lead heating boilers are not in the condensing mode for a significant portion of time. Therefore the thermal efficiency of the heating boiler was reduced to 92.6% and this number was used as an input for boiler thermal efficiency in E-Tools. These changes resulted in lower gas savings.

During the audit it was also noticed that a balance temperature of 20°C gives a better R^2 value; therefore a new regression analysis was requested from Enbridge with using a 20°C building balance temperature. The higher balance temperature resulted in an increased of the normalized base load by 2.5%.

The above modification to the E-Tool inputs resulted in a 7.6% decrease in the gas saving. It should be noted that the building re-commissioning is still in progress and it is expected that the return water temperature will decreases once the system is fully commissioned. Re-commissioning tasks to be complete include: ensuring that all apartment control valves are operational, all thermostats are operational and that all baseboards are cleaned and operating at specification. It is expected that the actual savings will increase if the associated re-commissioning task are performed. MMM has not received any additional information in regards to the progress of the commissioning work.

The total project cost reported as $168,475 and the incremental cost is $60,409. This incremental cost seems reasonable for the scope of work completed. The adjusted annual natural gas saving after this review has reduced to $1,080/year which increases the simple payback period to 4.61 years.

The life cycle analysis for this project was estimated to be 25 years, which seems reasonable for a boiler replacement. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 20% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 1,392,540 m^3.

3.9 *RA.MR.EX.108.13*

Project Information

ESM File #: 1-83882257-04-03-13

Building Type: Multi Residential

Project Description: Installation of Novitherm heat reflector panels

Project Details: The heat reflectors are installed on the wall behind hot water baseboard heaters to reflect radiant heat, thus resulting in reduced heating requirements.

Implementation Date: August 21, 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		52,779	37,328	-29.27%
Electricity (kWh)		0	0	0
Water (m^3)		0	0	0
Life Cycle (m^3)		633,351	447,938	-29.27%

Base Case

The building space heating is generated by natural gas fired heating boilers and distributed to the tenant space convective baseboard heaters by a hydronic water system. Corridor and common space ventilation is provided by an air handling unit (AHU) located on the roof-top. The AHU is also equipped with heating module (heating coil). The domestic hot water is provided by a separate gas fired domestic hot water heater.

Energy Efficient Case

Reflector panels are to be installed behind the hydronic heating equipment. The reflector panels act as an insulator and radiation barrier on the wall behind the hydronic heating equipment, thus reducing heat loss through the wall at this location and reflecting radiant heat back into the space.

Review Information

A site visit was conducted on January 10, 2014, during which our auditor randomly selected two apartment units to evaluate the completion of the proposed retrofit. Based on the site visit the reflectors installation conforms to the project application. The subject measure was implemented in August 2013.

The auditor also noted that there were several additional energy conservation projects that were implemented in late 2012 including parking CO ventilation control, MAU VFD control etc.

Through onsite investigation, it was noted that the fan inside the MAU has been retrofitted with a Variable Frequency Drive (VFD) to control the speed of its motor. Further investigation revealed that, the VFD speed setting was set at 70% at all times. The MUA operating flow rate is approximate 25,000 x 70% = 17,500 CFM.

There are number of unit heaters located in the semi-heated underground parking garage. The unit heaters are controlled by local installed thermostats that are set to various temperatures. It was observed on site that the unit heaters were operating in heating mode. The parking garage has six (6) exhaust fans that are controlled using CO sensor. Based on a previous incentive application (RA.MX.EX.237.12) the heating energy use by the unit heaters to maintain parking garage temperature was 26,172 m^3. Our site review determined that there is no significant difference within the parking garage that may impact the natural gas consumption by the unit heaters; as such this number of 26,172 m^3 is used.

Finally, literature reviews to research the energy saving potential by implementing reflect panels were conducted. Throughout the reviews of measurement and verification reports of previous radiator panel installation in residential sectors, it is determined the heating energy saving potential ranges from 8% to 20%. A 10% reduction was assumed reasonable as per the manufacturer's recommendation for multi-residential buildings. The factor of 10% was equal to the factor that E-Tools used.

Applicant Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools program. Gas usage data from January 2012 to December 2012 was used to create a weather normalized baseline, separated into seasonal and non-seasonal components. The seasonal load was further separated into MUA unit gas usage and perimeter radiator gas usage. The savings were estimated to be a 10% reduction in the perimeter radiator usage.

MMM Group Savings Calculation Methodology

In an effort to best isolate the energy saving from reflect panel installation, we conducted a separate regression analysis using utility bills from August 2012 to July 2013. During the 12 month period the total metered natural gas usage is 681,968 m^3. This number is lower than the previous year consumption of 787,803 m^3. Our regression analysis suggested that, building

MMM GROUP

balance temperature at 16 °C would yield the best statistics correlation between actual utility use and weather condition. Based on the suggested building balance temperature, the weather relative natural gas use is calculated to be 467,017 m^3 and non-weather relative natural gas use is 214,951 m^3.

Another regression analysis using bills from January 2013 to August 2013 was conducted and the result was compared with the above mentioned result. The difference is minor (weather relative natural gas use increased by 1%). In general a regression analysis with a higher number of sample data points is preferable, so the first regression result using utility bills from August 2012 to July 2013 was used for further calculation.

The comparison of these two regression analysis suggests that no significant energy conservation measures were implemented during this period. Which brings us to the assumption that the MUA VFD retrofit and the parking garage CO ventilation control projects had been completed prior or very close to August 2012.

Enbridge E-Tool uses 30-year average weather data to normalize weather dependent utility usage. To maintain consistency with this practice, the calculated 467,017 m^3 of weather relative natural gas use was normalized to 558,151 m^3.

The applicant calculation of the MUA natural gas usage which was based on 15,750 CFM was determined to be 142,830 m^3. With the observed flow rate of 17,500 CFM the calculated annual heating energy by MUA was recalculated to 142,830*17,500/15,700 = 158,700 m^3. As was mentioned in previous reviews, the ventilation load calculator within E-Tools has been confirmed to reasonably account ventilation energy usage.

As per application RA.MX.EX.237.12 and our site observations the heating energy use by the unit heaters to maintain parking garage temperature is approximately 26,172 m^3.

The natural gas usage by the perimeter heaters is calculated by subtracting the MUA use and parking use from the normalized building weather relative use, which resulted in an annual normalized consumption of 373,279 m^3.

Using an assumed savings of 10%, the audited savings were calculated to be 37,378 m^3.

Discussion

For this particular project, improved accuracy of energy saving calculation can be achieved by:

- Conducting independent checks for accuracy. While maximizing the use of information from applicant is important, it is also important to perform independent checks for accuracy of the information. In this particular project the natural gas used by parking garage unit heaters was not included in the calculation.

- Improve accuracy of the input parameter to conduct calculation. E-Tool used 15,750 CFM as the MUA operating flow rate to calculate the heating natural gas use. Based on our site visit the MUA is operated at a constant speed of 70%. With MUA design flow rate of 25,000 CFM at full speed, the operating air flow at 70% speed is calculated to be 17,500 CFM.

- Selecting appropriate utility billing data to set the pre-retrofit baseline. The utility billing data should isolate the subject energy conservation measure from impacts by other conservation measures.

Considering the anticipating prohibitive cost we don't recommend to approach Measurement and Verification. There are multiple conservation measures implemented or will be implemented in a short period, for example the building currently is replacing boilers with better efficiency. It will be very costly using Measurement and Verification approach to determine the actual energy saving from implementing the subject measure.

The reported cost of $62,045.26 appears reasonable for this type of installation.

The life cycle analysis for this project was estimated to be 15 years, which seems reasonable for this type of upgrade. The life cycle savings were calculated using a 15 year life cycle, which was de-rated using a 20% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 447,938 m^3.

3.10 *RA.REC.EX.003.13*

Project Information

ESM File #: 1-82028892-01-11-13

Building Type: Recreational Centre

Project Description: Installation of heat recovery systems to recover the heat from ice rinks for the purpose of swimming pool water heating and DHW heating

Project Details: Install an ice plant heat recovery system to recover heat from [redacted] ice plant to the pool boiler loop and the swimming pools at the facility.

Install an ice plant heat recovery system to recover heat from the [redacted] ice plant to the DHW system at the facility.

Implementation Date: [redacted] Heat Recovery System Installation: June, 2013

[redacted] Heat Recovery System Installation: December, 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		53,700	24,655	-54.09%
Electricity (kWh)		0	0	0
Water (m^3)		0	0	0
Life Cycle (m^3)		708,840	325,446	-54.09%

MMM GROUP

[redacted] Heat Recovery System				
Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		14,900	8,771	-41.13%
Life Cycle (m^3)		196,680	115,777	-41.13%

[redacted] Heat Recovery System				
Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		38,800	15,884	-59.06%
Life Cycle (m^3)		512,160	209,669	-59.06%

Base Case

The building is a recreational facility which houses two multi-purpose ice rinks named as the [redacted] and [redacted] and two swimming pools including a large size and a toddler pool.

The refrigeration systems used for the ice rinks in the facility are ammonia based systems. The [redacted] refrigeration system consists of three (3) compressors, brine chiller, under-ice pad heat exchanger, cooling tower, cold brine pump, warm brine pump, and cooling tower spray water pump. The [redacted] refrigeration system consists of two (2) compressors, brine chiller, under-ice pad heat exchanger, cooling tower, cold brine pump, warm brine pump, and cooling tower spray water pump. The refrigeration systems are controlled by a newly installed Kore RCS controller.

The space heating and pool water heating is provided by a natural gas fired boiler. Service water heating including domestic hot water and ice re-surfing water are provided by separate boilers.

Energy Efficient Case

There are two energy conservation measures. The first measure is to install an ice plant heat recovery system to recover heat from the [redacted] ice plant for the purpose of heating the pool make-up water. The second measure is to install an ice plant heat recovery system to recover heat from the blue rink ice plant to heat the DHW system.

Natural gas savings is achieved by reducing the heating load required to heat the swimming pool and DHW heating.

Review Information

As visit was conducted on January 9th, 2014 during which the building operator, management office [redacted] The following documents were provided during the visit: The original building mechanical drawings

- The occupancy profile data
- Information on the operation of the facility

MMM GROUP

Applicant Savings Calculation Methodology

[redacted] Heat Recovery System Savings Calculation

The following engineering calculation was used to determine the avoided natural gas consumption.

$$\text{Savings} = \frac{\text{Average Temperature increase} \times \text{Water Volume} \times \text{Density} \times \text{Specific Heat}}{\text{Boiler Efficiency}}$$

The engineering calculation assumed that 1,849,900 gallons of water are used for pool make up water annually. It was also assumed that the total volume of make-up water will be heated up by 30°F by the heat recovery system. Using an existing heating system efficiency of 87%, the avoided natural gas consumption was estimated to be 14,900m^3.

[redacted] Heat Recovery System Savings Calculation

The following engineering calculation was used to determine the avoided natural gas consumption.

$$\text{Savings} = \frac{\text{Average Temperature increase} \times \text{Water Volume} \times \text{Density} \times \text{Specific Heat}}{\text{Boiler Efficiency}}$$

The engineering calculation assumed that the total domestic hot water consumption for the facility is 4,430,675 gallons, which is assumed to be heated up from an assumed city water temperature of 50°F to 90°F. It was assumed that heat recovery to the domestic hot water is available 75% of the time. Using boiler efficiency 80%, the avoided natural gas consumption was estimated to be 38,800m^3.

MMM Group Savings Calculation Methodology

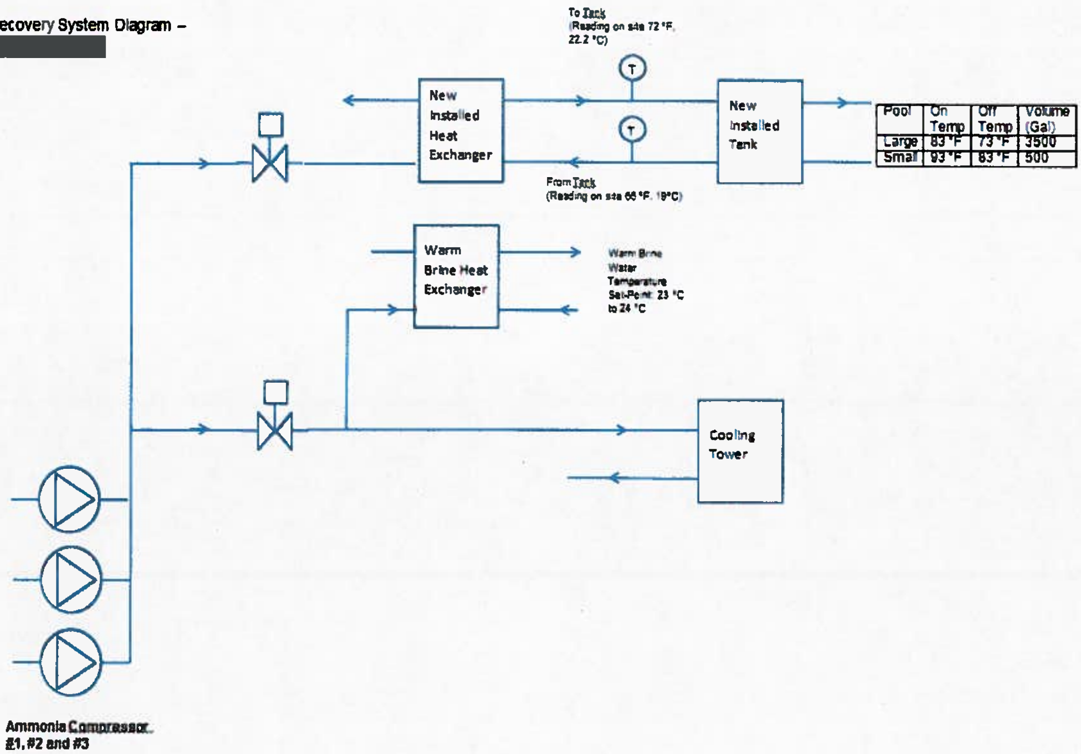
Calculation: [redacted] rink plant heat recovery system:

The design or as-built drawing were not available, as result in order to better understand and document the project evaluation the MMM auditor traced the system piping and recorded the temperature readings on site. The diagram below outlines the [redacted] system configuration.

MMM GROUP

The [redacted] has a similar piping configuration.

Heat Recovery System Diagram – [redacted]



The newly installed heat recovery system for the [redacted] consists of an ammonia heat exchanger, a storage tank, auxiliary piping and control valves. The new heat recovery is arranged in parallel with the existing condenser air cooling system (brine water heat recovery and cooling tower). The heat recovery system is controlled by a newly installed refrigeration control system [redacted] When high temperature hot gas is available, the solenoid valve is open to allow for hot gas to flow through the newly installed heat recovery heat exchanger. The gas to water heat exchanger takes available heat from the hot gas and transfers it to water. Water is stored in a newly installed storage tank which stored pool make-up water to replace any pool water loss.

There are two pools at the facility with different water temperature set-points. The big pool water is maintained at 28.3 °C (83 °F) while the smaller pool water is maintained at 33.8 °C (93°F). To accommodate the different temperature requirements the pool make-up water for the two pools are added at a different time of day.

The daily make-up water requirement for the big pool and small pool are 3500 Gal and 500 Gal respectively. The volumes of make-up water are metered by the [redacted] control system. The control system also monitors the storage tank temperature to ensure only that only warm water is introduced to the pools. For the big pool, the make-up water is enabled when the tank temperature reaches the pool water temperature set-point of 28.3 °C (83 °F), and is disabled when tank temperature is dropped by 5.56 °C (10°F) to 22.7 °C (73°F). For the small pool, the make-up water is enabled when the tank temperature reaches pool water temperature set-point of 33.8 °C (93 °F), and is disabled when tank temperature is dropped by 5.56 °C (10°F) to 28.3 °C (73°F).

According to the building staff interview, the city water temperature reaching the facility is at 55°F (12.8°C). When warm water is drawn from storage tank, cold city water is added into the storage tank, and therefore the tank temperature will decrease. Based on the control sequence, for the big pool we estimated the average water temperature drawn from the tank during one (1) feeding cycle is 25.6 °C (78°F). The heat recovered or avoided make-up water heating for the big pool is calculated using equation:

Heat = Average Temperature increase x Water Volume x Density x Specific heat

Where:

Average temperature increase = 25.6 °C – 12.8 °C = 12.8 °C

Water Volume = 3500 Gal = 13249 liter

Density = 1 kg/l

Specific heat = 4.2 kJ/(Kg.K)

The avoided make-up water heating for the big pool is equal to 712,264 kJ or 675 MBtu.

Based on the control sequence, for the small pool we estimated the average water temperature drawn from the tank during one (1) feeding cycle is 31.1 °C (88 °F). The heat recovered or avoided make-up water heating for the small pool is calculated using equation:

Using the same approach, the avoided make-up water heat for the small pool is calculated to be 147,881kJ or 140 MBtu with following parameters.

Average temperature increase = 31.1 °C – 12.8 °C = 18.6 °C

Water Volume = 500 Gal = 1893 liter

Density = 1 kg/l

Specific heat = 4.2 kJ/(Kg.K)

Total daily avoided make-up water heat to the pools is 860,145 kJ or 815 MBtu. The facility operates eleven months a year. Using boiler efficiency (87% based on applicant form), the annual natural gas saving is calculated as:

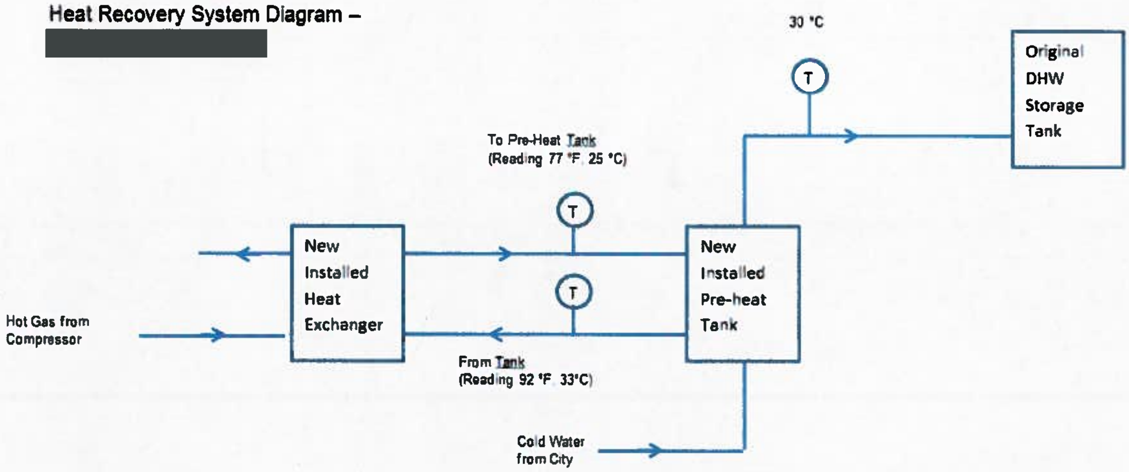
- 860,145 kJ x 11 month x 30.5 day/month / 87% = 331,700 MJ (314,390 MBtu)
- Conversion (Btu = 0.0000279 m^3)

The audited natural gas saving is determined to be 8,771 m^3, which is 41.4 % less than the proposed savings of 14,900 m^3.

Calculation: [redacted] rink plant heat recovery system:

The design or as-built drawing were not available, as result in order to better understand and document the project evaluation the MMM auditor traced the system piping and recorded the temperature readings on site. The [redacted] has a similar piping configuration as the [redacted] however, the control sequence is different.

Heat Recovery System Diagram – [redacted]



For the [redacted] the pre-heat tank water temperature is not controlled. From a heat balance point of view, the tank has a single heat flow which enters from the heat exchanger, and a single heat flow stream that exits to the DHW storage tank. Since the incoming and outgoing flows are not always equal due to the fact that refrigeration system loads and DHW demands do not always concur, the heat content, thus tank temperature varies throughout the day.

Additionally, the tank temperature impacts the magnitudes of heat in-flow and the heat-out flow. For example, the heat-in flow, i.e. heat transferred from the heat exchanger, ranges from near zero to a maximum load. Given a fixed hot gas temperature from the refrigeration cycle, log mean temperature differences will decreases when tank temperature increases. Once the tank temperature approaches the temperature of the hot gas, the heat transfer will stop as the driving force for heat transfer.

The maximum available heat at any time from the heat exchanger depends on the following factors:

- Size and configuration of the heat exchanger. This information is not available.
- Superheat availability was estimated at a best case condition with suction pressure 25 Psi, discharge 180 Psi, and with two compressors operating. In this best case scenario approximately 11.5% of the total system heat rejection is available in the superheat range, i.e. 47 kW. The maximum heat available is impacted by the system sizing factor and past energy retrofit aiming to reduce the refrigeration load after the facility was built. According to ASHRAE ICE Rink design "when two compressors are used, one compressor should be specified with ample capacity to maintain the ice sheet under normal load and operating conditions". In addition, many retrofits such as the installed desiccant dehumidification unit, can significantly reduce the compressor load. It is very

difficult to estimate how the above factors change the refrigeration load. In this study we discounted the recoverable heat load by 10 kW to 37 kW. We believe that the actual recoverable heat could be even lower.

- It is worthwhile to mentioned here that the superheat recovered is also used for heating the under ice-pad slab heating to prevent formation of frost in the soil under the flow. The average heating requirement for a standard size rink is about 7 kW. With this subfloor heat in place, the peak recoverable heat for DHW pre-heating is reduced by about 7kW to 30kW.

- Heat recoverable potential is impacted by the compressor discharge pressure. When compressor discharge pressure decreases, the recoverable heat decreases. The discharge pressure (hot gas saturate pressure) is a dependable of many other operational and environmental factors. The determining environmental factor is the dry bulb temperature. The condenser cooling system is equipped with a VFD driven fan and a spray water pump and works in stage to maintain hot gas pressure in a pre-defined range. When the outdoor dry-bulb temperature is low, the cooling system will be operated in "free- regime", which relies on natural convection of the cooling tower to satisfy the cooling demand. When the system is operated in this mode, the hot gas pressure ranges from 100 Psi to 130 Psi. Due to the cold weather, most of the time over a year the system is operating under this mode. The fan starts when hot gas pressure reaches 150 Psi (corresponding to a saturate temperature of 29°C), and stops when hot gas pressure drops below 130 Psi. If hot gas pressure continually increases to 175 Psi after the fan starts, the spray water pump will start. The cut-out pressure of the spray water pump is 155 Psi. When the system is operating under free-regime mode and the fan mode the recoverable heat is reduced by approximate 30% and 15%.

- For the mass flows and temperature of the cold water stream, the water pipe size has nominal diameter of one (1) inch. In general the maximum water flow of a one (1) inch pipe is 6.8 GPM or 0.43 l/s. The maximum temperature rise of water, i.e. the temperature difference between heat recovery water and incoming cold city water is 16.7 °C (30 °F increase). The maximum heat flow carried by the 6.8 GPM water flow is calculated as 30 kW.

The heat-out flow from the pre-heat tank, depends on tank temperature and water draws, and also varies depending on the hot water demand profile. To better assess the dynamic heat recovery process, MMM performed an energy simulation using TRNSYS® software. The output determined that the heat recovery potential for DHW is 0.7354 versus 0.75 as identified by the applicant.

Based on operator interviews it was noted that the building is open 18 hours/day. Using a recoverable energy value of 30 kW, for 18 hours/day, 30.5 days/year, 11 months/year, and a heat recovery potential of 0.7374 we arrive at an estimated annual savings of 133,586 kWh.

133,586 kWh at 80% efficiency can be converted to 569,327 MBtu, which equals to 15,884 m^3 of natural gas. The audited natural gas savings represent a decrease of 59.1% when compared to the proposed annual savings of 38,800 m^3.

MMM GROUP

Discussion

Discussion on [redacted] rink plant heat recovery system:

- The actual make-up water, based on site staff interview and which were further confirmed through a review of facility control, is 1,342,000 gallons which is approximately 27% lower than applicant assumption of 1,849,000 gallons of water per year. Over estimation of available make up water resulted over-estimated natural gas saving.
- According to the building staff interview, the city water temperature reaching the facility is at 55˚F (12.8˚C). This temperature is higher than the assumption of 50˚F (10˚C) that was used in the application. Assuming lower than actual city water temperature will result in a greater ΔT and consequently an increased heating load for heating make up water. The increase in city water temperature resulted in a reduction in natural gas saving.
- According to the building staff interview, the central heating system maintains the makeup water temperature of the bigger pool between 73˚F (22.8˚C) to 83˚F (28.3˚C) which is averaged at 78˚F (25.6˚C). The assumption made by applicant for the maximum maintenance temperature of makeup water was 90˚ F (32.2˚ C). The higher maximum maintenance temperature will result in bigger ΔT and consequently an over estimation of heating load.
- Since there is a time mismatch between the supply of recovered heat and demand a storage tank is used to maximize the recoverable heat. Due to the limit of the tank size, when heat is drawn the tank temperature will decrease. Applicant used load side mass flow and temperature rise to calculate the quantity of heat recovered, with an assumed constant tank temperature at high end. This assumption resulted in an over estimated heat recovered.

Discussion on [redacted] rink plant heat recovery system:

- Applicant did not evaluate the quantity of heat recoverable from refrigeration plant.
- Applicant declared that heat recovery to the service water heating will be available 75% of the time. It is not clear how the 75% is derived, this value was revised to 73.73%.
- Applicant appears to have over-estimated the amount of water being pre-heated. Calculation is based on heat recovered to be used for DHW and flooding water pre-heating. Based on site review, the recovery system is not used for pre-heating flooding water.

The reported project cost of $28,980 appears reasonable for the work completed.

The life cycle analysis for this project was estimated to be 15 years, which seems reasonable for a controls upgrade. The life cycle savings were calculated using a 15 year life cycle, which was de-rated using a 12% free ridership. We recommend increasing the life measure savings to 325,640 m^3 to correspond to the increase in estimated annual savings.

MMM GROUP

It should be noted that MMM Group did not evaluate the seasonal efficiencies of the two heating systems. As per the application, MMM Group used a thermal efficiency of 87% for the pool heating plant associated with the [redacted] heat recovery system, and a thermal efficiency of 80% for the domestic hot water heating system which is associated with the [redacted] heat recovery system.

Using the above methodology and calculated seasonal efficiencies for the two heating system could result in an alternate savings value.

<u>Measurement and Verification:</u>

For [redacted] IPMVP Option A – key parameter measurement method is the appropriate approach. The [redacted] control system is capable to monitoring and trend water temperatures and water mass flows. The trends can be used to calculate the amount of recoverable heat from the heat recovery system. Upon submission of the report, the requested trend logs have were not made available to MMM, and therefore could not be used to perform M&V.

For [redacted] IPMVP Option A is the appropriate approach. The other IPMVP options are not appropriate. Option A focuses on the performance of energy conservation measure such as items of equipment and installed retrofits that can be measured in isolation from the rest of the building. For the [redacted] the key parameters are the water mass flow and the water temperature from the pre-heat tank. Currently the [redacted] control system does not have a similar system as the [redacted] If M&V is determined necessary, BTU meter installation or using control the system to measure the above mentioned parameters is recommended.

Additional Post Audit Information

A response was received from EGD on Wednesday April 16, 2014 in regards audited savings to the original draft of this report. The response includes a revised calculation for both the [redacted] and [redacted] heat recovery systems.

In general the alternate approach that was provided by EGD is acceptable, however, there are several inputs that should be verified.

MMM Group responded to the EGD revised calculation and addressed several items in regards to the alternate approach in a follow up e-mail sent on April 17, 2014 to EGD and the third party evaluator.

It is recommended that several of the inputs in the revised EGD calculation are verified if the intent is to use the revised EGD savings calculation as the basis for the audited savings number. Details are included in the follow up e-mail and could not be included in this report due to the timing for final report submission.

MMM GROUP

3.11 *RA.GOV.EX.007.13*

Project Information

ESM File #: 1-76967500-06-06-12

Building Type: Office

Project Description: Schedule changes to ventilation

Project Details: Trim ventilation equipment schedule to decrease unnecessary natural gas consumption.

Implementation Date: March 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		27,082	27,380	1.10%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		357,482	361,416	1.10%

Base Case

The building comes equipped with several indoor and outdoor air handling units. These units supply conditioned ventilation air to several areas of the building. The units have a natural gas fired section for heating and a direct expansion cooling coil.

As per the application the schedule and temperature set-points for the affected equipment were as follows:

Table 1: Base Case Ventilation Schedule

Unit #	Model #	S/N	CFM	Average % of Fresh air	Heated CFM	Supply Air Temperature Occupied (°F)	Existing Scheduel (hrs/week)
AHU #1	781897	4399F58167	10000	30	3000	73	90.5
AHU #2	781897	4399F58166	10000	30	3000	73	87
AHU #3	781897	4399F58165	10000	30	3000	73	87.5
RTU #1	YSC120AWRHA15D101AOA00300	312100896L	4000	30	1200	72.3	94
RTU #2	YSC120AWRHA15D101AOA00300	312100967L	4000	30	1200	72.9	92.75
RTU #3	YSC120AWRHA15D101AOA00300 B	312100918L	2000	30	600	69.8	53.75
RTU #4	YCH15ODWHOAA	311100376D	4400	30	1320	72	74
RTU #5	YSC102AWRHA13D101AOA00300 D	312100871L	3400	30	1020	72.7	80.5
RTU #6	YSC072AWRHAOZ1AOA00300 C	312100825L	2400	30	720	73	56.5
RTU #7	YSC072AWRHA13D101AOA00300 C	312100822L	2400	30	720	71.6	76.25
RTU #8	YCH1808WHOGA	306100835D	5300	30	1590	72.5	69.5
MUA							
EF-1	JENN-AIR 161-1C3S		1000				55
EF-2	JENN-AIR 122-1C8S		400				55

MMM GROUP

Energy Efficient Case

As a result of re-commissioning it was recommended to optimize the operating schedule of the ventilation units to better coincide with the occupancy schedule of the various areas served by their respective units. Natural gas savings are resultant of a decrease in the ventilation schedule. There are also some inherent electricity savings stemming from a decrease in fan motor operation. Electricity savings were not evaluated as part of this application.

The following table outlined the changes to schedule as well as pre and post retrofit natural gas consumption that were to be implemented.

Table 2: Proposed Ventilation Schedule

Unit #	Supply Air Temperature Occupied (°F)	Existing Scheduel (hrs/week)	Existing Estimated Annual Natural Gas Consumpiton (m^3)	New Scehule (hrs/week)	Post-Retrofit Estimated Annual Natural Gas Consumpiton (m^3)	Savings (m^3)
AHU #1	73	90.5	14627	59	9525	5102
AHU #2	73	87	14060	62.25	10091	3969
AHU #3	73	87.5	14173	58.5	9524	4649
RTU #1	72.3	94	5934	47.5	3011	2923
RTU #2	72.9	92.75	6011	55	3570	2441
RTU #3	69.8	53.75	1566	37.5	1098	468
RTU #4	72	74	5113	43.75	3039	2074
RTU #5	72.7	80.5	4388	53	2900	1488
RTU #6	73	56.5	2204	40	1535	669
RTU #7	71.6	76.25	2830	65.75	1480	1350
RTU #8	72.5	69.5	5847	46.5	3898	1949
MUA						
EF-1		55		49		
EF-2		55		49		

Review Information

Natural gas usage for the facility as well as the re-commissioning report was requested from Enbridge on December 11, 2013 and received on January 15, 2014.

A site visit was conducted on January 7th, 2014, during which interviews with the operator were conducted.

The following information was gathered during the site visit:

- Hourly interval natural gas usage for the entire building from January 10, 2013 to January 7, 2014.
- Ventilation equipment nameplate information.
- Current Operating Schedule
    - Operation schedule log for AHU-1 and RTU-1

MMM GROUP

- It should be noted that the operator informed the auditor that the actual operating schedule for all units is revised throughout the year to meet operating requirements.
  - AHU-1 had actual average logged weekly operating hours of 66:07:58
  - RTU-1 had actual average logged weekly operating hours of 54:14:26
- The schedule log for these units was averaged out on a weekly basis to determine actual operating hours for each unit.
  - This resulted in average actual operating hours which were 87% of the schedule as was observed during the site visit.
- Logs for the other units were not available

- Supply air temperature set points

Table 3: Observed Ventilation Schedule

	Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Total Weekly
	From	To	From	To	From	To	From	To	From	To	From	To	From	To	Hours
AHU-1			5:00	19:00	5:00	21:00	5:00	21:00	5:00	19:00	5:00	18:00			73.00
AHU-2			6:00	19:00	6:00	21:00	6:00	21:00	6:00	19:00	6:00	18:00			68.00
AHU-3			7:00	19:00	7:00	22:00	7:00	21:00	7:00	19:00	7:00	18:00			64.00
RTU-1			6:30	19:00	6:30	21:00	6:30	21:00	6:30	19:00	6:30	18:00			65.50
RTU-2			6:45	19:00	6:45	21:00	6:45	21:00	6:45	19:00	6:45	18:00			64.25
RTU-3			7:30	16:30	7:30	16:30	7:30	16:30	7:30	16:30	7:30	16:30			45.00
RTU-4			7:30	17:00	7:30	17:00	7:30	17:00	7:30	17:00	7:30	16:30			47.00
RTU-5			7:30	16:30	7:30	20:00	7:30	20:00	7:30	20:00	7:30	16:30			55.50
RTU-6			7:30	16:30	7:30	17:00	7:30	17:00	7:30	17:00	7:30	17:00			47.00
RTU-7			7:00	19:00	7:00	21:00	7:00	21:00	7:00	21:00	7:00	18:00			65.00
RTU-8			9:00	17:00	8:00	21:30	9:00	21:30	8:00	21:30	9:00	16:00			54.50
MUA			8:00	15:30	8:00	15:30	8:00	15:30	8:00	15:30	8:00	15:30			37.50

In addition, we were informed by the operator that several other natural gas saving measures have been implement to the affected systems. The additional measures that were implemented are as follows:

- Demand control ventilation via CO_2 sensors on the return air
- Unoccupied temperature set-back
  - 18 C while in heating mode
  - 28 C while in cooling mode

It should be noted that the additional measures were not part of the original application, and therefore fall outside of the scope of this report.

Applicant Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools software. Savings resulting from the schedule changes to the ventilation equipment were derived using EGD Ventilation Load model. This model is based on assumptions/actual data on air temperatures, air handler nameplate information.

The inputs used within the E-Tools software calculation for pre and post retrofit cases are outlined in Table 1 and Table 2 above. The savings were based on an 18°C balance temperature and a thermal efficiency of 80% for all units.

MMM Group Savings Calculation Methodology

MMM Group performed an air flow calculation using the same inputs as Enbridge to validate the E-Tools Ventilation Load calculator. Our findings using these inputs resulted in a baseline natural gas usage which was 1% less than the value presented by Enbridge. This indicates to us that the Ventilation Load calculator within E-Tools provides a reasonably accurate estimate of ventilation load given that the inputs are correct.

To determine the normalized weather dependent pre-retrofit natural gas usage a regression analysis using billed natural gas data was performed. The regression analysis indicated that the balance temperature for the building which results in the best R^2 value is approximately 15.5°C. This weather dependent usage was then normalized using 15.5°C as a balance temperature to arrive at normalized annual weather dependent natural gas usage of 84,843 m^3. A ventilation load calculation was then performed for all affected units as well as one 2,800 CFM MUA using a balance temperature of 15.5°C. The efficiency of all units was then decreased from 80% to 74% to calibrate the calculated ventilation natural gas usage with the normalized weather dependent gas usage. It should be noted that there are no other weather dependent natural gas loads within the building.

The proposed ventilation schedule was then replaced with the observed ventilation schedule as indicated in Table 3 above, which was further de-rated by 87% to better represent the schedule changes that were occurring throughout the year. The revised schedule was then used to calculate the expected natural gas consumption. The difference between the calculated base case consumption and the gas consumption with the new schedule resulted in the audited savings of 27,380 m^3, which is an increase of 298 m^3 (1.1%).

Discussion

As per the above methodology we recommend increasing the annual natural gas saving to 27,380 m^3, which is an increase of 298 m^3 (1.1%).

A regression analysis was also performed using hourly natural gas consumption data for the post retrofit case. The weather dependent portion was normalized and compared to the base case normalized weather dependent gas usage. This resulted in a total annual savings of 35,506 m^3. As expected the actual natural gas usage is less than what was calculated, however, the additional 8,126m^3 in savings come as a result of savings measure which were not part of this application.

The project cost of $17,900 includes the cost associated with the re-commissioning of the units as well as all implementation costs. The costs appear reasonable for the consulting work and schedule changes that were required to complete this project.

The life cycle analysis for this project was estimated to be 15 years, which seems reasonable for a controls upgrade. The life cycle savings were calculated using a 15 year life cycle, which was de-rated using a 12% free ridership. We recommend increasing the life measure savings to 361,416 m^3 to correspond to the increase in estimated annual savings.

3.12 *RA.HC.EX.016.13*

Project Information

ESM File #: 1-25666319-11-04-10

Building Type: Healthcare

Project Description: Heating plant optimization through conversion from steam to high efficiency hot water boilers and ventilation optimization by new heat recovery systems.

Project Details: Replacing two existing steam boilers with three hot water heating boilers in central boiler plant.

Replacing steam heating with three hot water boilers in [redacted]

New condensing domestic hot water boilers for DHW.

Implementation Date: June 2011 to December 2011

Project Savings Summary

Measure Life (years)	*	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		527,704	313,351	-40.62%
Electricity (kWh)		50,000	0	-100%
Water (m^3)		0	N/A	0
Life Cycle (m^3)		11,257,488	6,893,722	-38.76%

*Multiple Measures with different Measure Life values. Please see individual measure tables below for details.

Heating Boiler - Hydronic High Efficiency - Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m3)		487,704	313,351	-35.75%
Life Cycle (m3)		10,729,488	6,893,722	-35.75%

MMM GROUP

Ventilation - Controls				
Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m3)		40,000	0	-100.00%
Life Cycle (m3)		528,000	0	-100.00%

Base Case

Four steam boilers located in the central boiler plant provide steam for space heating, DHW heating, sterilizations and kitchen equipment. Each boiler is rated at 6,280 MBH input at 150 psi and were manufactured in 1990 with dual fuel capability, natural gas and No.2 oil.

The steam from these boilers is distributed to hot water heat exchangers or directly to heating loads. The steam provides heating to AHU coils, perimeter heating, DHW heating, auto claves, dish washers and other kitchen equipment.

Energy Efficient Case

Within the central plant, two steam boilers were replaced with three hot water boilers - two hot water boilers (Buderus, Model GE615/14) with 4,113 MBH input capacity and one hot water boiler (De Dietrich, Model GTE 523) with 5,715 MBH. Nominal thermal efficiency for these boilers is 82%. These three boilers provide heating water for space heating in the building with a higher efficiency than the old steam boilers.

In the central boiler plant, one condensing boiler (Lochinvar, Model AWN701PM) in addition to a new hot water heat exchanger feeds DHW to two main storage tanks instead of the old steam system which delivered steam to hot water heat exchanger bundle in each storage tank. In room 1826, one condensing DHW heater (Lochinvar, Model SNA400-125) serves the emergency department. These two independent DHW systems are also heated through heat exchanger connected to the building heating water loop (main boilers) in series loop where the DHW heat exchangers are the last process in the series resulting temperature drop for the return water.

For the [redacted] the high pressure steam for space heating and DHW were retrofitted to have heating water provided from HW boilers in the central plant and one dedicated condensing DHW heater (Lochinvar, Model SNR200-100) replacing DHW storage tank with steam to hot water heat exchanger bundle.

Review Information

Site visit was conducted on January 10th, 2014. Building operator and facilities supervisor were interviewed during the visit and following documents were provided:

- Steam to hot water conversion drawings
- Energy report by consultant
- Natural gas consumptions in 2012 and 2013

The following information was gathered through observation and staff interview:

- None of the ventilation systems optimization measures, which include VFD's on exhaust fans for decontamination area and AHU replacement with heat recovery wheel in mechanical room #10 have been implemented.
- Two steam boilers are inter-locked to operate only one boiler at a time and de-rating from 150 Hp to 50 Hp has not been done.
- The demand for the steam is year-round for kitchen equipment and sterilization thus one steam boiler operates all year round with reduced steam distribution lines.
- In summer season, one of the heating boilers operates in order to provide heating water to reheat terminals in the zones such as operating rooms and emergency rooms etc.

The table below summarized heating equipment which were proposed in the measure and list of equipment which were implemented as a retrofit project, confirmed on site visit.

Location	Proposed	Implemented
Central boiler plant	• 2 new boilers (5,200 MBH) • 1 new boiler (4,700 MBH) • 1 new DHW boiler (620 MBH)	• 2 new boilers (4,113 MBH) • 1 new boiler (5,715 MBH) • 1 new DHW boiler (700 MBH)
[redacted]	• 1 new DHW boiler (184 MBH)	• 1 new DHW boiler (400 MBH)
[redacted] (Mech Rm #19)	• 3 new condensing boilers (640 MBH) • 1 new DHW boiler (200 MBH)	• None • 1 new DHW boiler (200 MBH)

Applicant Savings Calculation Methodology

The applicant used natural gas consumption from October 2007 to September 2008 as to determine the baseline consumption. From this total consumption for a year, natural gas savings from other measures, gas consumption that is not used by boiler plants such as direct fired make-up air units, and the load being taken off from the boilers such as dedicated DHW boilers were subtracted to get the boiler load.

Using the difference of existing and new boiler efficiency, the boiler efficiency gain was calculated. The boiler efficiency gain was multiplied by the boiler load to calculate natural gas savings. Equations as follow;

- Total billed consumption – (savings from other measures) – (gas not consumed by boiler plants) – (gas load being taken off from boilers plants) = Boiler Load
- New boiler efficiency – Current boiler efficiency = Boiler efficiency gain
- Total savings (m^3) = Boiler Load x Boiler efficiency gain

In the applicant's savings calculations, current steam boiler efficiency of 70%, new boiler efficiency of 85% for hot water boiler and 90% for condensing DHW boilers were used. In addition, the savings from steam to hot water conversion resulting from reduction in steam distribution – removal of failing steam traps have been considered.

MMM Group Savings Calculation Methodology

In general the approach that was used by the applicant to estimate the savings resulting from conversion from steam to hot water heating systems within the facility is reasonable. However, this approach will give the best result only when natural gas used by other equipment can be separated using sub-metered data. In this facility, steam was used for space heating, DHW heating, sterilization and kitchen equipment. Other than space heating, steam load is all year round and mostly constant every month. Therefore, the summer natural gas consumption is a good representative of these constant loads. Unless each load is measured with separate sub-meters, it is not easy to accurately estimate each load. In the applicant's sample savings calculations, it is not indicated how these loads were estimated and used in the savings calculations.

Typically heating energy consumption is greatly affected by the weather. The linear regression analysis of natural gas consumption versus outside weather helps distinguishing weather related and non-weather related usage from the total gas consumptions. The non-weather related consumption in this case DHW heating, sterilization and kitchen equipment can be estimated using the linear equation acquired by regression analysis. The weather related consumption can be used to calculated net boiler load or heating load, multiplied by the seasonal boiler efficiency. The net heating load divided by new boiler efficiency will be new predicted gas consumption of new boilers. Therefore, the difference of current boiler consumption and predicted consumption is the savings by new boilers with higher efficiencies. The equations are shown as below:

Net heating load (output) = Current boiler consumption (input) x Current boiler seasonal efficiency

New boiler consumption (input) = Net heating load (output) / New boiler seasonal efficiency

Savings = Current boiler consumption (input) – New boiler consumption (input)

Seasonal efficiency of 68% for steam boilers, 78% for HW boilers and 90% for DHW heating boilers were used for savings calculations. The steam network loss through failed steam traps were accounted in seasonal efficiencies.

Discussion

The AHU-10 ventilation optimization has not been implemented in the facility therefore there is no natural gas or electric saving associated with this measure.

The retrofit to the Emergency Room section was completed in April 2008. The applicant used a base year from October 2007 to September 2008 and the retrofit was on going. Due to the construction, this base year is not a good representative as a base year. A new base year from October 2008 to September 2009 was selected for the regression analysis. From the regression analysis, the normalized weather dependent load was estimated to be 521,340 m^3 (44%) and non-weather dependent load to be 667,676 m^3 (56%). Since there were no changes to two steam boilers providing steam for sterilization and kitchen equipment, 20% is assumed for this load thus base load was revised to be 534,141 m^3. Using above equation for savings calculations, the saving is estimated be to 197,406 m^3.

Comparing base year consumption to a reference year of October 2012 to October 2013 (post retrofit) and normalizing to a representative design year weather data, the measured saving is estimated to be 291,882 m^3. This value was further corrected to take into account DHW boilers (located in [redacted] and [redacted] 6,041 m^3 and 3,122 m^3 respectively) which were transferred to a different gas account to adjust the savings. Additional gas consumption due to lighting retrofit, resulting in less heat output, was considered as well (30,631 m^3). Thus, revised saving is 313,351 m^3.

There is a significant amount of savings difference between the calculated and the actual savings achieved. The difference is assumed to be resultant from the improvement of inefficient heating distribution system – converting from steam to hot water distribution where heat loss through steam traps can be eliminated. A detailed steam trap audit would provide a better understanding of the amount of energy loss however steam trap audit information was not available for the analysis. With limited information given, it is difficult to quantify the amount of energy loss by steam trap failure or leaky steam piping distribution.

It should be highlighted that this project has a completion date of December 2011, however, this project was included in the savings for the 2013 year. As such we recommend that for situations like these, actual data instead of engineering calculations with assumptions is used to determine the savings. In general due to the complexity, size and signification number of unknowns it is recommended to perform an M&V process for the purposes of calculating actual savings for large and complex projects such as this.

Based on our calculation, it was determined that the estimated savings for this measure is approximately 197,406 m^3, however, due to the availability of actual date we propose that the savings are increased to match adjusted actual savings of 313,351 m^3. The actual audited savings represent a decrease of 40.6% from the proposed application savings.

The life cycle analysis for the heating plant upgrade was based on a 25 years and a free ridership of 12%, which is reasonable for this type of retrofit. The life cycle analysis for the AHU controls upgrade was based on 15 years and a freed ridership of 12%, which is reasonable for a controls upgrade. We recommend a revised life cycle saving of 6,893,722 m^3 based on a 25 year life cycle with 12% free ridership and the revised annual savings for the heating plant upgrade of 313,351 m^3.

The total reported project cost of $1,850,176 for the heating plant optimization seems reasonable and within industry standards for the work that was completed.

MMM GROUP

3.13 *LW.MR.PART3.044.14*

Project Information

ESM File #: 1-91451491-01-07-14

Building Type: Multi-unit Residential

Project Description: New near-condensing boilers

Project Details: Two new near-condensing (85% efficient) boilers where installed serving heating and two new near-condensing boilers and new tanks were installed serving DHW. Supply water temperature reset scheduling was implemented based on outside temperature for the heating water. A heating loop piping header was installed to allow for intermittent pumping through the boilers.

Project Type: Replacement

Implementation Date: October, 2013

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		144,416	31,249	-78.36%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		3,610,400	781,225	-78.36%

Heating Boiler Replacement

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		139,576	25,546	-81.70%
Life Cycle (m^3)		3,489,400	638,650	-81.70%

Domestic Hot Water Boiler Replacement

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		4,839	4,703	-2.81%
Life Cycle (m^3)		120,975	117,575	-2.81%

MMM GROUP

Base Case

The original building boilers were at the end of their life and in need of replacement. The energy savings for this application are based on the incremental savings of the near condensing boilers compared to new 80.5% thermal efficiency boilers. The base case heating boilers have continuous boiler pumping, two stages, traditional controls and a maximum supply temperature of 180°F. The base case domestic hot water boilers have continuous boiler pumping, two stages, traditional controls and a maximum supply temperature of 150°F.

Proposed Energy Efficient Case

The new heating system consists of two new Raypak model MVB H7-1104A boilers with a total output capacity of 1,848 MBH and a manufacturer's published maximum thermal efficiency of 84%. The boilers are vented using Class I induced draft venting. A new heating system header has been installed to allow for intermittent pumping through the boilers. The boilers are controlled with a new Tekmar model 274 boiler controller, which controls the boilers with a characterized temperature reset schedule based on outside temperature. The maximum boiler supply temperature set point is 180°F with a return temperature of 160°F. The boilers operate with a pre and post purge cycle at start-up/shutdown.

There is a new domestic hot water heater system, consisting of two new Raypak Hi Delta model WH3-HD401 boilers with total output of 678 MBH and a manufacturer's thermal efficiency rating of 85%. The new domestic hot water boilers have been installed to operate with intermittent pumping and use Class I induced draft venting. There are two new domestic hot water tanks and a new controller for controlling the domestic hot water boilers. The controller is set to maintain 130°F water temperature inside the hot water tanks. This will require the boilers to operate with a maximum supply temperature of between 140°F and 150°F depending on the building's hot water usage.

Review Information

A site visit and interview with the installation contractor was conducted on January 6th, 2014. The following information was reviewed and recorded:

- The information for the new boilers was recorded. For the heating system, there were two Raypak model MVB H7-1104A boilers and for the domestic hot water system, there were two Raypak model WH3-HD401 boilers.
- The heating boilers were being controlled by a Tekmar model 274 boiler controller panel. The controller resets the boiler supply temperature using a characterized curve using the outdoor air temperature. We observed the curve was set to supply a maximum water temperature of 180°F and we observed that the boilers were supply 180°F water at the time of our visit. The outside temperature at the time was approximately -20°C, therefore, the observed boiler supply temperature was as expected. The boilers were capable of modulating down to a minimum input of 60% of their maximum rated input. The boilers were vented using Class I, induced draft venting.
- There was a new heating loop header installed to allow for the boilers pumps to operate intermittently based on building demand.

- The domestic hot water boilers were two stage boilers installed with induced draft, Class I venting. There were two new domestic hot water tanks, each with 119 gallon capacity. There was a new controller installed to operate the boilers to maintain a water temperature of 130°F inside the domestic hot water tanks, which will require a maximum supply water temperature from the boilers to be between 140°F and 150°F depending on the building water usage. The boilers were being operated with intermittent pumping.

- We interviewed the building manager to confirm that there were no other changes made in the building that will affect the building natural gas consumption between the period of March 2013 and present.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from March 2012 to February 2013 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on 30 year weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 and Table 2 below for the heating boilers and domestic hot water boilers respectively. Since this application is a replacement, there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the actual installed upgraded higher efficiency new boilers. The boiler operation controls summarized in Table 1 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The projects natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

MMM GROUP

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	80%	80.5%	86.8%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	2	2	11
Maximum Design Supply Temperature	180°F	180°F	170°F
Maximum Design Return Temperature	160°F	160°	150°F
I/O Controls with Reset	Traditional	Traditional	Characterized
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	**61.71%**	**62.21%**	**82.05%**

Table 2: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	80%	80.5%	85%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	2	2	4
Maximum Design Supply Temperature	150°F	150°F	140°F
Maximum Design Return Temperature	130°F	130°F	120°F
Controls	Old	Old	New
A/F Control	None	None	Staged
Purge Cycle	None	None	Pre or Post
DHW Tank Insulation	Good	Good	Good
Calculated Seasonal Efficiency	**64.74%**	**65.24%**	**77.22%**

In the applications calculations, the new heating boiler model was selected as Raypak model WH3-H7-1253 within E-Tools and E-Tools automatically input the boiler thermal efficiency based on the manufacturer's published thermal efficiency rating, which is 87% for this model.

For the domestic hot water boilers, the new boiler model was selected as Raypak model WH3-402A within E-Tools and E-Tools automatically input the boilers thermal efficiency based on the manufacturer's published thermal efficiency rating, which is 85% for this model.

MMM Group Savings Calculation Methodology

The utility data used for the E-Tools calculation was from March 2012 to February 2013. However, the version of E-Tools used for the calculation was missing the weather heating degree day data for the months of September 2012 to February 2013. This resulted in E-Tools incorrectly calculating the normalized building consumption in the regression analysis. A new regression analysis was performed on the utility bills using an updated version of E-Tools and the correct normalized building consumption was revised to 133,646 m^3/year for the building heating boilers, and 31,425 m^3/year for the domestic hot water boilers.

Based on our observations during our site visit, the inputs into E-Tools were updated as summarized in Tables 3 and 4 below for the heating and domestic hot water boilers, respectively. Items that have been changed are shown in bold.

MMM GROUP

Table 3: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	**Existing**	**Base Case (for Replacements)**	**Proposed New**
Thermal Efficiency	80%	80.5%	84%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	2	2	4
Maximum Design Supply Temperature	180°F	180°F	180°F
Maximum Design Return Temperature	160°F	160°	160°F
I/O Controls with Reset	Traditional	Traditional	Characterized
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	**61.71%**	**62.21%**	**77.78%**

For the new heating boilers, the thermal efficiency was adjusted because we observed a different boiler model was actually installed on site compared to the proposed model in the original application. The installed boiler had a boiler manufacturer's thermal efficiency rating of 84%. The installed boiler had a modulating burner which was capable of modulating down to 60% and there are two boilers, so the number of heating stages was adjusted to 4 stages instead of 11. There was a Tekmar Boiler Controller model 274 installed on site to control the heating boiler system. It is a user friendly control system with pre-programmed characterized curves for resetting the boiler supply temperature based on outside temperature. The pre-set programs are selected based on the type of heating system in the building. In this case, the controller was set for radiator heating with a maximum boiler supply temperature of 180°F and minimum supply temperature of 140°F. Therefore, the E-Tools calculation was updated to a maximum supply temperature of 180°F and maximum return temperature of 160°F.

MMM GROUP

Table 4: Summary of domestic hot water boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	80%	80.5%	85%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Total # of Heating Stages	2	2	4
Maximum Design Supply Temperature	150°F	150°F	**150°F**
Maximum Design Return Temperature	130°F	130°F	**130°F**
Controls	Old	Old	New
A/F Control	None	None	Staged
Purge Cycle	None	None	Pre or Post
DHW Tank Insulation	Good	Good	Good
Calculated Seasonal Efficiency	**64.74%**	**65.24%**	**76.82%**

For the new domestic hot water boilers, the hot water tank temperature set point observed on site was 130°F. To maintain this tank temperature, the domestic hot water boiler controller will vary the boiler supply temperature depending on the building's hot water consumption. During peak usage times, the boiler will supply 150°F to meet the demand. Therefore, the E-Tools calculation was updated for a maximum supply temperature of 150° and maximum return temperature of 130°F.

Discussion

The revised E-Tools calculations resulted in an estimated savings from the heating boilers upgrade of 25,546 m^3 of gas and estimated savings from the domestic hot water boilers upgrade of 4,703 m^3.

This revised application savings represents a significant reduction from the original calculation, due in part from the error in the E-Tools regression analysis and in part because the boiler models installed on site were different from the models used in the original application calculation, and had slightly lower thermal efficiency rating.

The installing contractor's invoices are included in the application documentation and the total project cost was $119,000 plus HST. The incremental cost is $12,104. This incremental cost seems reasonable for the upgrade completed at this building. The adjusted annual natural gas saving after this review was reduced to $7,187/year which increases the simple payback period to 1.7 years.

The life cycle analysis for this project is based on 25 years. The total life gas savings should be adjusted to 781,225 m^3 of natural gas based on the adjusted annual gas savings.

3.14 *RA.ACC.EX.017.13*

Project Information

ESM File #: 1-83882251-04-03-13

Building Type: Hotel

Project Description: Installation of occupancy control in guest rooms.

Project Details: The occupancy control for the guest rooms controls the room temperature based on occupancy.

Implementation Date: December, 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		18,131	18,329	1.09%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		239,329	241,943	1.09%

Base Case

The building space heating is generated by steam purchased from [redacted] Purchased steam is used to heat up heating water which is pumped to the guest room fan coil units. The guest room thermostats were set to maintain the room temperature at 22°C during the heating season.

Energy Efficient Case

Occupancy sensors within the rooms detect occupancy and adjust the room set-point temperature accordingly. The lower heating set-point results in heating energy savings.

Occupancy control was installed in all rooms on the 7th and 8th floor of the hotel. This represents 227 of 1375 rooms (16.5%).

Review Information

A site visit was conducted on March 12, 2014, during which our auditor randomly selected two guest rooms to evaluate the completion of the proposed retrofit. Based on the site visit the occupancy control installation conforms to the project application.

The contractor was then interviewed to determine the control strategy associated with occupancy control. As per the interview the following is the sequence of operations for the HVAC control in the rooms;

- Room Not Rented and Unoccupied
  - Heating set-point is 17°C (63°F)
- Room Rented
  - Room set-point is automatically set to 22°C (72°F)
- Room Occupied
  - Guest can adjust set-point
    - For the purposes of this audit it will be assumed that the average user adjusted set-point remains set to 22°C (72°F)
- Room Rented and Unoccupied
  - Heating set-point is allowed to decrease by 2°C (4°F) from user set-point after the room is unoccupied for more than 10 min.
  - For the purposes of this audit, the auditor estimates that a rented room is occupied for approximately 10 hours per day, and unoccupied for the remaining 14 hours.

In addition to the above, the hotel occupancy rates were reviewed. As per 2013 occupancy rates, the hotel was on average 70% occupied.

Applicant Savings Calculation Methodology

The provided savings were calculated using an engineering calculation. The calculation determined the total seasonal load by performing a utility analysis. The estimated total seasonal load was then multiplied by the approximate percentage area of the building floor area that was affected to determine the estimate base case usage. A 15% decrease in heating energy was then assumed as the estimated savings.

MMM Group Calculation Methodology

The evaluator created a sample floor model of the 7th and 8th floor in RETScreen using the observations made on site as well as the approximate exterior dimensions and orientations of outer walls, and the quantity, orientation and size of windows.

A model was run with the assumption that 30% of the rooms are unoccupied at all times, and that 70% are occupied for 10 hours per day and un-occupied for the remaining 14 hours.

The total savings resulting from this model were determined to be approximately 18,329 m^3, using a heating system efficiency of 74% as per the Enbridge application.

Discussion

Although the calculation methodology that was provided with the application resulted in similar savings, it was determined to be an inaccurate methodology for determining the savings associated with the retrofit.

The facility in question is a very complex building with several different types of seasonal loads that cannot be easily separated by percent floor area. The building has over 20 different indoor and outdoor air handling systems that operate on different and sometimes irregular schedules.

Given the complexity of the system and available information, it was determined that the most reasonable approach to estimating the savings was to develop a model of a floor in the RETScreen modeling software. The model provided an estimated savings of 18,329 m^3, which is an increase of 1.1% when compared to the application savings.

Measurement and verification for this retrofit using a whole building energy usage approach is not possible since the estimated savings represent approximately only 1% of the total seasonal load.

The life cycle analysis for this project was estimated to be 15 years, which seems reasonable for a controls upgrade. The life cycle savings were calculated using a 15 year life cycle, which was de-rated using a 12% free ridership. We recommend increasing the life measure savings to 241,943 m^3 to correspond to the increase in estimated annual savings.

The proposed project cost of $108,862 appears reasonable for the scope of work completed.

3.15 *RA.GOV.EX.021.13*

Project Information

ESM File #:	1-85272031-05-23-13
Building Type:	Healthcare
Project Description:	Ventilation System Retrofit
Project Details:	Remove143 fume hood exhausts and replace with 6 larger capacity fans to add redundancy to exhaust system. In the process rebalance fume hoods and decrease overall supply and exhaust of lab air.
Implementation Date:	December, 2013

MMM GROUP

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		590,285	31,021	-94.74%
Electricity (kWh)		442,256	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		7,791,762	409,477	-94.74%

Base Case

The building house several laboratories that are outfitted with fume hood exhausts. The fume hoods are constant volume hoods with primarily dedicated exhaust fans. Some fume foods share a larger exhaust fan. The facility operates 24/7. Fresh air is delivered to the lab space via two make-up air units, and is exhausted exclusively through the fume hoods. The lab area is kept at a constant negative pressure.

Energy Efficient Case

The energy efficient case involves the removal of 143 individual fans, and tying the fume hood exhaust ducting of the affected fume hoods using a common header. The common header is to be connected to six larger fans, four of which would be operational, with the remaining two for redundancy. The retrofit also includes the rebalancing of all fume hoods, which is expected to result in an airflow reduction.

Review Information

A site visit was conducted on March 13, 2014, during which a building operator interview and BAS review was conducted. The following information was collected during this time:

- Name plate information for six new exhaust fans, including current operating parameters
  - Each fan is rated at 30,000 CFM maximum flow
  - 5 of 6 fans were operating at 77% VFD speed. This value was confirmed to be constant throughout the day.
  - 4 of the 5 operating fans had by-pass dampers fully close. The remaining operating fan had by-pass damper open 64.06%
  - The exhaust header for the system comes equipped with 6 static pressure sensor. The reading on these sensors ranged from -1.4" WC to -1.64" WC, with the average of all 6 at -1.55"
    - The by-pass damper on the exhaust fans is modulated to maintain a set-point exhaust damper static pressure of -1.5" WC.

- Fresh air supply for the lab area is provided by one hot deck MUA and one cold deck MUA. Supply air volume is for both fans are modulated with variable inlet vanes on the fan to maintain a set-point supply static pressure of 2.0" WC.
    - The hot deck MUA was supplying 13,840 L/s (29,325 CFM) outdoor air at a supply air temperature of 25.2°C (77.4°F)
    - The cold deck MUA was supplying 30,418 L/s (64,452 CFM) outdoor air at a supply air temperature of 12.45°C (54.4°F)
    - The blended supply air temperature was determined to be 16.4°C (61.5°F)
- Several of the fume hoods were inspected
    - All of the fume hoods in the facility are constant volume hoods, with by-pass when not in use.

In addition to the information that was collected during the site visit, MMM reviewed the following additional documents:

- Balancing report for fume hoods for pre and post retrofit
    - The balancing report for pre and post retrofit supply air volumes was tabulated
        - Pre-retrofit supply air was summed up to 103,811 CFM
        - Post-retrofit supply air was summed up to 98,854 CFM

Applicant Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools software. Savings resulting from the VFD control of the MUA were derived using EGD Ventilation Load model. This model is based on assumptions/actual data on air temperatures, air handler air supply capacity.

The supply airflow was estimated to be 600 CFM per fume hood, which resulted in a total airflow of 120,000 CFM based on a total of 200 fume hoods. The heating set-point was assumed to be 68°F, operating 24 hours per day.

With the above inputs, the E-Tools software calculated the base case normalized natural gas consumption for the MUA of 1,083,610 m^3.

The following schedule was included in the application for the proposed retrofit:

Period		Speed
From	To	(%)
24:00	6:00	33
6:00	8:00	66.57
8:00	16:00	66.57
16:00	18:00	66.57
18:00	24:00	33

The revised schedule including a 68°F supply air temperature and a system efficiency of 75% was input in E-Tools to determine the new annual MUA natural gas consumption of 493,325 m^3.

The difference in per and post natural gas usage resulted in an estimated savings of 590,285 m^3.

MMM Group Savings Calculation Methodology

To validate the E-Tools calculation MMM Group performed a separate calculation for the base case using in house tools. Our base MUA unit consumption was calculated to be less than 0.3% different than the E-Tools output.

One main difference between the MMM Group calculation and the E-Tools calculation is that the MMM calculation used only the average of the past four years of historical weather data as compared to the standard 30 year average that is used in E-Tools. To compare our result to the E-Tools result, MMM proportionally adjusted the output to calculate the output that would have been had 30 years of historical weather data been used. As a result, the minor difference in likely due to that adjustment. In general we feel that the calculation process for determining MUA gas usage using E-Tools is interchangeable with MMMs approach, and both can be used to arrive at an accurate result provided that the inputs are correct.

From the building operator interviews it was discovered that the supply and exhaust air to the lab is maintained at a relatively consistent volume, with only small automatic adjustment being performed by BAS to the supply and exhaust air to maintain static pressure set-point.

The fume hoods are also constant volume. The retrofit to the fume hoods included the removal of 143 individual motors, which were replaced with 6 larger motors. The fume hood ductwork was equipped with balancing vanes and extended to a common exhaust header. The provided balancing report for all fume hoods indicated that there was a decrease of approximately 4,957 CFM of airflow as a result of the retrofit.

MMM preformed a ventilation load calculation for the reduced airflow to determine the savings associated with the retrofit. Using inputs of 4,957 CFM, operating for 24 hours/day, with supply air temperature of 61.5°F and a system efficiency of 75%, the audited savings were estimated to be 31,021 m^3.

The system efficiency of 75% could not be confirmed, however, from interview with the operator and site review it was noted that the building heating is provide by a district heating plant. In general 75% efficiency is a reasonable assumption for system efficiency for a district heating plant.

Discussion

It is unclear how the proposed ventilation in the application was determined, as there was never any ventilation schedule changes performed at the facility as per our site review and building operator interview.

In addition, from our site observation it was discovered that the fume hoods in question are constant volume hoods, complete with by-pass. The retrofit of the fume hood exhaust system included the removal of 143 individual dedicated exhaust fans, the installation of balancing vanes in the exhaust ductwork, and the installation of 6 larger exhaust fans. The exhaust ductwork for the retrofitted fume hoods was connected to a common exhaust header from which air was exhausted using the newly installed exhaust fans.

The retrofit resulted in a reduction of exhaust air of 4,957 CFM, which was determined by comparing the pre and post construction exhaust balancing report. The calculated annual savings as a result of this were determined to be 31,021 m^3 annually.

The client was informed of this large discrepancy. As a result the client has decided to have the system exhaust setting verified and rebalanced if necessary. While it is possible that the rebalancing of the project will result in additional savings, it is not possible to predict the outcome. In addition, since the installed fume hoods are constant volume hoods, it is expected that the reduction if any will be minimal since the hoods have to operate at minimum face velocity to be effective. To achieve the claimed savings the customer could perform the following additional alterations to the system:

- Retrofit or Replace the existing fume hoods so that they are variable volume hoods.
  - This will allow for less ventilation requirement during periods when fume hoods are not in use.
- Re-balance the fume hoods so that the face velocity satisfies minimum requirements for fume hoods of 100 FPM.
  - This could result in a relatively constant reduction in fume hood air flow throughout the day.

Please note that the above listed possibilities are for information purposes only. Detailed design process should be followed before implementing either.

The driving force behind this project appears to be electricity savings as well as increase reliability and redundancy. It should be noted that the electricity savings were not evaluated in this review.

The reported project cost of $5,777,363 and incremental cost of $2,193,693 appears reasonable for the work completed.

The life cycle analysis for this project is based on 15 years and a free ridership of 12%, which is reasonable for this type of retrofit. The total life gas savings should be adjusted to 409,477 m^3 of natural gas based on the adjusted annual gas savings.

Additional Post Audit Information

EGD has started an investigation for this project as a result of the magnitude of the correction to the proposed savings. Some additional information that was collected was forwarded to MMM Group, however, this information was inconclusive and did not support the measure as was indicated in the original application.

There seems to be an indication in the gathered information that there has been a ventilation reduction in other areas of the building that are not related to the fume hoods. Insufficient

MMM GROUP

information was provided to evaluate the impact on the building natural gas savings, if any, as a result of these ventilation changes.

It should be noted that this application was for ventilation reductions to the fume hood system, and as such any ventilation changes for other portions of the building should not be considered part of this project.

3.16 *RA.GOV.EX.024.13*

Project Information

ESM File #: 505133-23-05-08

Building Type: Industrial

Project Description: Retrofit hot water boilers to run on digester gas

Project Details: Two existing natural gas hot water boilers were retrofitted to be able to run on digester gas which is byproduct from water treatment process that can be used as fuel source for hot water boilers.

Implementation Date: July 2013 to November 2013

Project Savings Summary

Measure Life (years) 25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	1,050,208	1,050,208	0
Electricity (kWh)	0	N/A	0
Water (m^3)	0	N/A	0
Life Cycle (m^3)	23,104,576	23,104,576	0

Base Case

The subject building is a sewage processing plant. Hot water for heating loads in the sewage plant including space heating and process loads were provided by seven hot water boilers, two Cleaver Brooks (Model NCB700-250) with 10,460 MBH input which are located in the [redacted] boiler room and five Unilux (Model ZF900W) with 9,000 MBH input located in the [redacted] boiler room. The plant has a digester gas collection system which can be used as a fuel source. Two Cleaver Brooks boilers in the [redacted] boiler room use digester gas as a fuel source and the remaining digester gas is burned off to the atmosphere using flares. Five Unilux boilers in the [redacted] boiler room operate only with natural gas.

The two boilers running on digester gas operate year round to provide heating for the process and load, while the five boilers with natural gas operate to meet the heating demand as required.

MMM GROUP

Energy Efficient Case

In order to utilize digester gas which was burned off using flares, it was decided to retrofit two of five Unilux boilers in the [redacted] boiler room to be able to run on digester gas and natural gas which required new burners, controls and digester gas pressure boosters.

Two converted boilers operate utilizing digester gas collected from the sewage plant as primary heating sources along with two existing Cleaver Brooks boilers which already operated on digester gas. There will be no natural gas consumption when the four boilers operating on digester gas can maintain return water temperature in the main heating water loop. Natural gas will be consumed only when any of three natural gas heating boilers need to operate to provide more heating due to cold weather or when boilers running on digester gas are down for maintenance.

It is estimated that daily digester gas produced can fuel a minimum four boilers out of total seven boilers.

Review Information

A site visit and a facility operations engineer interview were conducted on February 28th, 2014. The following information was gathered through observation and staff interview:

- A total of four boilers were observed to be retrofitted to use digester gas as a fuel source. Two of the boilers were the Cleaver Brooks and two where the Unilux model as reported in the application.
- All four boilers on digester gas were in operation and one of the three flares burned off excess amount of digester gas. In addition, one of the three natural gas Unilux boilers was in operation.
- The outdoor air temperature during the site visit was -15^{0}C.
- Boiler logs were reviewed and confirmed that four boilers operated on digester gas and one additional boiler on natural gas operated when the outdoor air temperature ranging -4^{0}C to -13^{0}C. The sixth boiler operation was not noticed in this temperature range.
- Boiler operation or heating load is affected by the weather and process load thus normalizing the consumption with weather is not relevant.

Applicant Savings Calculation Methodology

The provided savings were calculated based on hours of operations of five Unilux boilers which consumed natural gas. The boilers were assumed to run in relation to outdoor air temperature as follows;

- One boiler on when outdoor air temperature is less than 12^{0}C
- Second boiler on when it is less than 5^{0}C
- Third boiler on when it is less than 0^{0}C

- Fourth boiler on when it is less than -10⁰C

Hours of operation for each boiler were calculated using bin weather data [redacted] With operation hours, natural gas consumption was calculated using E-Tools program. A boiler seasonal efficiency of 76.5% was used and the total gas consumption by each boiler was calibrated with actual consumption data of 2011 and 2012. The non-boiler related consumption from flare pilots and one small rooftop unit was subtracted from the total to estimate boiler consumptions.

Natural gas consumption for the first two boilers was assumed to be replaced with digester gas produced on site which was claimed as the savings of natural gas. This is true since the converted boilers operate as primary boilers. In addition, downtime of the boilers running on digester gas for the regular maintenance was considered and adjusted and used to adjust the total operation hours of the boilers using digester gas. With the adjusted operation hours, the natural gas consumption was calculated again to estimate the savings.

MMM Group Savings Calculation Methodology

MMM agrees with the savings calculation approach performed by the applicant. As long as four boilers running on digester gas can maintain the heating load for the process and the space, there is no natural gas consumption. The new natural gas consumption will be the usage by the remaining three Unilux natural gas boilers which only operate in cold weather to provide additional heating to maintain return water temperature, and during maintenance of the digester burning gas burning boilers. Through interview with operations supervisor, it was determined that above 0⁰C four digester running boilers have enough capacity to maintain the load.

In order to verify the operations of the boilers, the boiler logs from December 2013 to February 2014 were reviewed. A total of thirteen (13) days of logs were available in this period with different outdoor temperatures. From the verification of the boiler operations, new natural gas consumption can be estimated based on the operation hours of those natural gas boilers.

Discussion

Before the retrofit, only two existing Cleaver Brooks boilers in [redacted] boiler room operated with digester gas and five Unilux boilers on natural gas operated as required by the demand. In the summer season, one or two Unilux boilers operated and up to three Unilux boilers operated to meet the heating demand in winter season.

After the retrofit, a total of four boilers are available to run on digester gas year round. In the summer season, all four boilers on digester gas are capable of handling process loads resulting in no natural gas consumption. In the winter season, in addition to running four boilers on digester gas, one or two boilers on natural gas operate depending on the process loads and weather.

The estimated boiler consumptions in relation to outdoor air temperature were calculated using E-Tools and the first and second boiler usages were assumed to be savings recognized by replacing with digester gas. Reviewing boiler operations through boiler logs and site visit, it is reasonable to assume that one additional natural gas fired boiler would be on when outdoor air temperature is below 0⁰C and a second additional boiler on below -10⁰C. It was noticed from the logs that one additional natural gas boiler was in some cases sufficient to satisfy the process and weather dependent loads even below -10°C, however at other times a second natural gas boiler was required. Overall the assumptions made by the applicant are reasonable.

The total project cost was $730,885 which seems reasonable for the upgrade completed at this facility including new burners, controls and gas boosters.

The life cycle analysis for this project is based on 25 years, and a free ridership of 12%, which is reasonable for this type of retrofit.

3.17 *RA.HC.EX.021.13*

Project Information

Project Code: 1-25666299-11-04-10

Building Type: Healthcare

Project Description: Heating plant optimization through heat recovery from the de-aerator, eliminating steam use in summer, and linkage-less burner controller

Project Details:

- Recover heat from the steam vent on de-aerator to preheat boiler feed water
- Isolation of two main steam valves in summer which provide steam for DHW heating and reheat coils, including conversion of two steam bundle DHW storage tanks with dedicated condensing boilers
- Installation of linkage-less burner controllers on steam boilers

Implementation Date: October 2010 to November 2012

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		93,114	58,416	-37.26%
Electricity (kWh)		50,252	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		2,048,508	1,285,152	-37.26%

*This measure was considered as one measure within the original application with the same measure life value. In reality the measure was composed of three separate retrofits, which have different measure life. Details for each measure are summarized below.

Linkage-Less burner controller				
Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m3)		19,616	0	-100.00%
Life Cycle (m3)		431,552	0	-100.00%

De-Aerator Heat Recovery				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m3)		10,498	10,498	0
Life Cycle (m3)		230,956	230,956	0

Zone Isolation Valves & Condensing DHW Boiler				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m3)		63,000	47,918	-31.47%
Life Cycle (m3)		1,386,000	1,054,196	-31.47%

Base Case

Five Cleaver Brooks (Model M5LV-6000) steam boilers located in the main boiler house provided steam for space heating, DHW heating, sterilizations, humidification and kitchen equipment. In shoulder and winter seasons, three to four boilers operate to meet the required demand. In summer season, typically one or two boilers are required to serve DHW heating, reheat coils, sterilizations and kitchen equipment.

Energy Efficient Case

There are two measures completed as boiler plant optimization on this site. A shell and tube type heat exchanger was installed on the de-aerator vent to recover heat from the de-aerator steam purges. The recovered heat is used to preheat incoming boiler feed water before entering the boilers to be further heated.

The steam network serves space heating, DHW heating and other process loads year round. Due to low seasonal loads in the summer, isolation valves on two main distribution steam lines were installed to eliminate steam distribution in summer season only. These steam lines served steam to a hot water heat exchanger for reheat coils and two DHW storage tanks. These two DHW storage tanks were retrofitted with dedicated condensing boiler (Lochinvar, Model AWN400PM) for each of the tanks. Each boiler has 400 MBH input capacity and operates year round to serve domestic hot water in the zones.

There are three steam to hot water heat exchangers in the remote penthouses which provide heating to reheat coils. Due to the elimination of steam during the summer to these heat exchangers, new hot water piping was installed to provide heating water directly to the heating water loop for re-heat coils. The heating water is converted from the heat exchanger located in the main boiler room and distributed in the loop using one of the existing pumps for radiators.

MMM GROUP

During winter operation the new piping is blocked using shut off valves, and the steam piping heat exchangers are used as per original design.

Review Information

A site visit was conducted on March 13th, 2014. At this time the building maintenance engineer and facilities supervisor were interviewed. The following information was gathered through observation and interview:

- One shell and tube heat exchanger was installed on the de-aerator vent to preheat boiler feed water.
- Two isolation valves installed on two main steam branches to eliminate steam distribution in summer.
- The DHW storage tanks with steam bundle in mechanical room #17 and #20 were retrofitted to have dedicated heating boilers year round.
- The heating water for the reheat coils in the summer was intended to be provided from heat recovery chiller. The heat recovery chiller was installed and tested in 2012, however, the heat recovery chiller did not operate since then due to operational issues. Thus, the heating water is provided from the steam to heating water heat exchanger located in the main boiler room.

The linkage-less burner controller was not installed on the steam boilers.

Applicant Savings Calculation Methodology

The linkage-less burner controller measure was assumed to generate typically 2 to 5% savings and savings calculations, 1% saving was assumed.

The heat recovery from de-aerator vent was calculated based on the recovery rate available from heat energy of steam using following equation;

$$\text{Natural gas saved} = \frac{\text{steam (lbs/hr) x enthalpy (Bu/lb) x op hours x recoverable rate (\%)}}{\text{Btu/m}^3\text{ conversion factor x boiler efficiency (\%)}}$$

35 lbs/hr of steam, 8,750 hrs of operation, 80% recovery rate and 75% boiler efficiency were assumed for savings calculations.

The savings by eliminating steam with isolation valves in summer is calculated assuming that 50% of summer use (consumption in July and August) can be avoided. Savings arise from reduced pressure with network and no losses in closed off sections.

MMM Group Savings Calculation Methodology

The typical range of savings by linkage-less burner controller would be 2-5% depending on operating conditions. 1% of saving is an achievable savings by the new control. However, this retrofit was not implemented and therefore there are no savings.

For heat recovery calculations in general, MMM agrees with the approach done by the applicant. 35lbs/hr of steam was estimated and used for sizing the condensing heat exchanger. According to DOE AMO (Advanced Manufacturing Office) steam tip sheet #10, the potential recoverable heat from boiler blow down is up to 90% utilizing latent heat of steam. The heat recovery rate of 80% was used for the calculation, which seems reasonable for the condensing heat exchanger. The estimated savings by heat recovery is 10,500 m^3.

The savings for summer steam elimination should consider less loss in steam network and DHW conversion from steam to dedicated condensing boilers which occurs throughout the year. The calculation estimated 50% of natural gas consumption in July and August in 2008, a base year for utility analysis in the study by the applicant.

The following approach was used for isolation valves saving calculations by MMM Group using utility bills before and after the retrofit.

- Average daily usage in July and August 2008 & 2009 (pre retrofit)
- Average daily usage in July and August 2013 (post retrofit)
- Savings = (pre retrofit usage – post retrofit usage) x 90 days, assuming summer isolation of 3 months period

The daily usage in base year was 1,989 m^3/day and in 2013 it was 1,669 m^3/day. Therefore, the savings resulting from the isolation of summer steam to two zones is for 90 days is 28,880 m^3.

In addition, part of the DHW heating system was converted from steam to two dedicated condensing boilers. The above savings account for savings resulting from the 3 summer month only. Additional saving of 2,124 m^3/month were calculated as a result of the seasonal efficiency improvement of condensing boilers over the steam heating plant. The additional savings were estimated at 19,118 m3 for the remaining 9 months. The total saving by summer steam elimination is 47,918 m^3.

Discussion

The claimed savings for natural gas are sum of three different measures as follows;

- Linkage-less burner controller – 19,616 m^3 (not completed)
- Heat recovery from de-aerator vent – 10,498 m^3
- Zone isolation valves – 63,000 m^3

The linkage-less burner controller was not installed on steam boilers thus, the saving for this measure is not achieved.

The summer steam elimination savings by zone isolation valves were revised to 47,918m^3 which includes the DHW heating boilers retrofit. Total savings are revised to be 58,418m^3.

The life cycle analysis for this project is based on 25 years with a free ridership of 12%, which is reasonable the measures implemented. The total life gas savings should be adjusted to 1,285,196 m^3 of natural gas based on the adjusted annual gas savings.

MMM GROUP

Additional Post Audit Information

A response was received from EGD on Thursday April 17, 2014 in regards to the original draft of this report. The response includes additional information in regards to the savings calculation.

MMM Group responded to the comments with a follow up e-mail sent on April 17, 2014 to EGD and the third party evaluator.

The EGD and follow up MMM Group e-mails should be taken into account by the third party evaluator when deciding on final audited savings.

3.18 *RA.HC.EX.049.13*

Project Information

Project Code: 1-84808141-05-08-13

Building Type: Healthcare

Project Description: Heating plant optimization through conversion from steam to hot water heating which includes two new steam boilers and one mid-efficiency hot water boiler.

Project Details:

- Replacing two existing steam boilers with new steam boilers
- Replacing one existing hot water boiler with new high efficiency boiler
- Convert from steam to hot water heating for DHW.

Project Type: Replacement

Implementation Date: July 2013 to November 2013

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		45,325	72,667	60.32%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		997,150	1,598,671	60.32%

MMM GROUP

Steam Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m3)		28,845	40,722	41.18%
Life Cycle (m3)		634,590	895,884	41.18%

Heating Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m3)		16,480	31,945	93.84%
Life Cycle (m3)		362,560	702,790	93.84%

Base Case

The space heating loads and process loads were provided by two steam boilers and two hot water boilers located in the boiler room.

The two steam boilers manufactured in 1968 and 1988 respectively, with a total output of 3,273MBH with non-modulating burners provided steam for DHW heating, sterilizations, humidification and kitchen equipment.

The two hot water boilers provided heating water for perimeter heating, AHU heating coils and reheat coils. One of the boilers was manufactured in 1968, 2,343 MBH output and the other boiler was manufactured in 1994, 2,400 MBH output.

Energy Efficient Case

The existing steam boilers were replaces with new steam boilers (Hurst, Model 4VT-GP2-25-150) each with an input capacity of 1,050 MBH. The nominal thermal efficiency for these boilers is 80%. The new boilers provide steam for humidification in the winter and sterilization including autoclaves and equipment washing throughout the year. The DHW heating was converted from the steam to the hot water system with two plate heat exchangers which were connected to the main heating water loop. Therefore, the new steam boiler sizes were reduced accordingly.

From the two existing hot water boilers, one old boiler which was manufactured in 1968 was replaced with a new boiler (Buderus, Model GE 615/11) with an 3,031 MBH input capacity. The nominal thermal efficiency for this boiler is 83.5%. The new boiler always operates as a lead boiler and the old boiler operates as a lag boiler, providing supplemental heating in the loop only when required. The hot water loop serves perimeter heating, DHW heating, AHU coils and reheat coils.

The steam boilers and hot water boilers operate year round since both steam and hot water are required throughout a year. Hot water supply temperature is reset in relation to the outside air temperature.

MMM GROUP

Review Information

Site visit was conducted on February 27th, 2014. Building operator and facilities supervisor were interviewed during the visit and the following information was gathered through observation and staff interview:

- Two new steam boilers provide steam for humidification and sterilization.
- A new hot water boiler operates always as a lead boiler with supply water temperature reset in relation to outdoor air temperature.
- The existing lag boiler was confirmed to operate a few days in January and February 2014 via BAS trends.
- The boilers require operation in dual fuels, natural gas and oil, but retrofits are not completed yet.

The table below summarized the loads served by existing and new heating system.

Location	Existing	Retrofit
Steam boilers	• DHW heating • Sterilization • Humidification	• Sterilization • Humidification
Hot water boilers	• AHU coils • Reheat coils • Perimeter radiators	• AHU coils • Reheat coils • Perimeter radiators • DHW heating

Applicant Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools program. Natural gas consumption from February 2012 to January 2013 was used as a baseline year.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 and 2 below for the heating boilers and steam boilers respectively. Since this application is a replacement, there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the actual installed upgraded higher efficiency new boilers. The boiler operation controls summarized in Table 1 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

MMM GROUP

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	**Existing**	**Base Case (for Replacements)**	**Proposed New**
Thermal Efficiency	73%	80.5%	78.2%
Boiler Pumping	Continuous	Continuous	Continuous
Flue Dampening	Burner Fan	None	Burner Fan
Total # of Heating Stages	2	2	11
Maximum Design Supply Temperature	170°F	170°F	150°F
Maximum Design Return Temperature	150°F	150°	130°F
I/O Controls with Reset	None	None	BAS
A/F Control	None	None	None
Purge Cycle	Pre or Post	None	Pre or Post
Calculated Seasonal Efficiency	**60.17%**	**64.39%**	**71.24%**

The thermal efficiency for proposed case is calculated with one new HW boiler (84.1% efficiency) and one old HW boiler (73% efficiency) blended to be 78.2% based on outputs.

MMM GROUP

Table 2: Summary of steam boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	80%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	Burner Fan	None	Burner Fan
Total # of Heating Stages	1	1	1
Maximum Design Supply Temperature	170°F	170°F	170°F
Maximum Design Return Temperature	150°F	150°F	150°F
Controls	Old	Old	New
A/F Control	None	None	None
Purge Cycle	Pre or Post	None	Pre or Post
DHW Tank Insulation	Good	Good	Good
Calculated Seasonal Efficiency	**57.54%**	**59.72%**	**68.71%**

MMM Group Savings Calculation Methodology

The steam boilers and hot water boilers both provide seasonal and non-seasonal loads. For instance, sterilization is non-seasonal but humidification would be a seasonal load served by the steam boilers. In addition, DHW water heating and reheat coils are part of non-seasonal but AHU coils and perimeter heating are seasonal loads.

New regression analysis was performed from December 2011 to November 2012 to calculate seasonal and non-seasonal loads. There were cooking usage and two air handling units (AHUs) connected with natural gas directly for heating. These consumptions were subtracted from normalized consumptions, non-seasonal and seasonal. Revised seasonal load is 166,393 m^3 and non-seasonal load is 197,320 m^3.

Based on our observations during our site visit, the inputs into E-Tools were updated as summarized in Tables 3 and 4 below for the heating and domestic hot water boilers, respectively.

Table 3: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	83.5%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	Burner Fan	None	Burner Fan
Total # of Heating Stages	2	2	11
Maximum Design Supply Temperature	170°F	170°F	190°F
Maximum Design Return Temperature	150°F	150°	170°F
I/O Controls with Reset	None	None	BAS
A/F Control	None	None	None
Purge Cycle	Pre or Post	None	Pre or Post
Calculated Seasonal Efficiency	**60.17%**	**64.39%**	**80.12%**

Table 4: Summary of steam boiler calculation input assumptions – Audited

Boiler Characteristic	Existing	Proposed New
Thermal Efficiency	70.4%	80.6%
Fluid Type	Steam	Steam
Steam pressure	100 psi	100 psi
Blowdown rate	4%	4%
Feed water temperature	230°F	230°F
Make-up water temperature	50°F	50°F
Calculated Seasonal Efficiency	**59.6%**	**70.2%**

The savings are resulted from seasonal efficiency improvement of the new boilers. To accurately reflect the retrofits, the loads have to be divided into seasonal and non-seasonal and where the efficiency improvement is from, either steam or hot water boilers as described in the following table.

MMM GROUP

Conversion	Seasonal Loads (%)	Non-seasonal Loads (%)	Loads (m^3)
Old steam New steam boiler	Humidification (*20%*)	Process (*35%*)	102,341 m^3
Old steam New HW boiler		DHW heating (*50%*)	98,660 m^3
Old HW New HW boiler	Space heating (AHU & radiators) (*80%*)	Reheat coils (*15%*)	162,712 m^3

The seasonal and non-seasonal loads from the regression analysis were divided into different types of loads and added to provide new loads for saving calculation of each conversion categories. The equation for savings calculations as follows;

- Saving (m^3) = current consumption (m^3) x [1 – (old efficiency / new efficiency)]

Discussion

Both steam and HW boilers provide seasonal and non-seasonal loads in the facility. Therefore, it is required to separate the loads accordingly with the boiler improvements – steam boilers or HW boilers since efficiency change is different.

It was confirmed that the E-Tools program for commercial sector is not capable of steam boiler seasonal efficiency calculation. Therefore, the industrial E-Tools version was used to calculate seasonal efficiency for the steam boiler upgrade. MMM reviewed the inputs within the industrial E-Tools run and used the output seasonal efficiency for the revised savings.

The improved efficiencies with adjusted seasonal and non-seasonal loads resulted in a total estimated savings of 72,667 m^3 of natural gas. The life cycle analysis for this project is based on 25 years with a free ridership of 12%, which is reasonable the measures implemented. The total life gas savings should be adjusted to 1,598,674 m^3 of natural gas based on the adjusted annual gas savings.

The reported incremental cost of $58,644 seems reasonable for the upgrade completed at this facility.

MMM GROUP

3.19 *RA.MR.EX.054.13*

Project Information

ECM File #: 1-71228362-09-16-11

Building Type: Multi Residential

Project Description: Building heating and domestic hot water boiler replacement.

Project Details: Replace three existing boilers with two condensing boilers (lead) and one high-efficiency boiler (lag)

Replace two existing DHW boilers with two condensing boilers

Project Type: Replacement

Implementation Date: January 2014

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		41,760	35,534	-14.91%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		835,202	710,680	-14.91%

Heating Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		28,813	23,967	-16.82%
Life Cycle (m^3)		576,260	479,340	-16.82%

Domestic Hot Water Boiler Replacement				
Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		12,947	11,567	-10.66%
Life Cycle (m^3)		258,940	231,340	-10.66%

Base Case

The original building boilers were at the end of their life and in need of replacement. The energy savings for this application are based on the incremental savings of the condensing boilers compared to new 80.5% thermal efficiency boilers.

The building space heating was provided by three (3) LAARS heating boilers. Each boiler was rated at 925 MBH input. Domestic hot water was provided by two (2) LAARS DHW heaters, with a total input capacity of 1950 MBH.

The heating boiler and DHW boiler pumps were operated continuously.

Proposed Energy Efficient Case

The heating boilers were replaced with two (2) EnerPro (EPN1000) condensing boilers with a total output capacity of 1,916 MBH and a manufacturers published maximum thermal efficiency of 95.8% and one (1) De Dietrich (GT 337A) high efficiency boiler with a output capacity of 872 MBH and a manufacturers published maximum thermal efficiency of 85%. The two condensing boilers are operated as lead and the high efficiency boiler as lag boiler. To protect the high efficiency boiler against condensation, there is control strategy which prevents it to operate unless the building return water temperature is above 57°C (135°F) and the two condensing boilers cannot maintain the building supply temperature within 3°C (5°F) of set point while they are at 100% firing rate for 10 minutes or longer. The building supply water temperature automatically resets based on outdoor air temperature according to the adjustable limits as identified in the following table:

Outdoor Air Temp	Supply Water Reset
12°C (54°F)	50°C (122°F)
-14°C (7°F)	80°C (176°F)

The DHW water boilers were replaced with two (2) EnerPro (EPW1000) condensing boilers. The BAS enables and modulates the two condensing boilers in sequence to maintain the supply water temperature at its set point.

The heating boilers and DHW boiler pumps have been upgraded to run intermittently, therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

Review Information

A site visit and building management interview was conducted on February 25th, 2014.

The site installation was in general conformance to the project application:

- At the time of the site visit two (2) condensing heating boilers were operating and the non-condensing boiler was off.
- DHW boiler 1 was running, while DHW boiler 2 and its circulating pump were off.

In addition, the following information was gathered based on the trend reviews and interview with the contractor responsible for the retrofit:

- The two condensing boilers are enabled and modulated in sequence to maintain the building supply water temperature at its set point

MMM GROUP

- The heating boilers maximum supply water temperature and return water temperature are 180°F and 170°F, respectively
- Each heating boiler pump is only enabled when its respective boiler is enabled
- The two DHW boilers are modulated in sequence to maintain the DHW setpoint temperature.
- The DHW boilers average supply water temperature and return water temperature are 140°F and 120°F, respectively.
- Each DHW boiler pump is only enabled when its respective boiler is enabled

Based on our site review and trend analysis the following parameters were different from the application:

- Heating boiler SWT and RWT
- DHW boiler SWT and RWT
- Condensing boiler thermal efficiency due to operating in non-condensing mode.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from January 2010 to December 2010 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on average 30 year weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 and Table 2 below for the heating boilers and domestic hot water boilers respectively.

For heating boilers the application is a replacement with new lead-lag boiler operation and there are four seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new lead boiler seasonal efficiency is an estimation of the actual installed new lead boilers. The proposed new lag boiler seasonal efficiency is an estimation of the new seasonal efficiency of the new high efficiency boiler with new controls installed as part of the conversion to lead-lag. Bin table analysis is performed assuming the building design load matches the old heating plant capacity to determine the annual hours the lead boilers will be able to meet the building load and the annual hours the lag boiler will be required. Then the annual seasonal efficiency of the lead-lag boilers as a packaged system will be calculated using the time weighted average of each boiler's seasonal efficiency.

For domestic hot water boiler the application is a replacement and there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the seasonal efficiency of the actual installed new boilers.

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	**Existing**	**Base Case (for Replacements)**	**Proposed Lead (New Boiler)**	**Proposed Lag (New Boiler)**
Thermal Efficiency	73%	80.5%	95.8%	88%
Boiler Pumping	Continuous	Continuous	Intermittent	Intermittent
Flue Dampening	None	None	Burner Fan	Burner Fan
Maximum Design Supply Temperature	180°F	180°F	180°F	180°F
Maximum Design Return Temperature	160°F	160°	110°F	160°F
I/O Controls with Reset	Traditional	Traditional	BAS	BAS
A/F Control	None	None	Modulating	Modulating
Purge Cycle	None	None	Pre and Post	Pre and Post
Calculated Seasonal Efficiency	**55.80%**	**63.30%**	**92.46%**	**83.56%**

MMM GROUP

Table 2: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	95.8%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Maximum Design Supply Temperature	140°F	140°F	140°F
Maximum Design Return Temperature	120°F	120°F	100°F
Controls	Old	Old	New
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre or Post
DHW Tank Insulation	Good	Good	Good
Calculated Seasonal Efficiency	**57.60%**	**65.10%**	**87.65%**

MMM Group Savings Calculation Methodology

We reviewed the utility data analysis performed by E-Tools and determined the calculation is acceptable, so we have used the weather adjusted building consumption from E-Tools in our verification calculations.

Based on our observations made during the site visit and an analysis of 2 weeks of trends, the inputs into E-Tools were updated as summarized in Table 3 and Table 4 below for the heating and domestic hot water boilers, respectively. Items that have been changed are shown in bold.

Table 3: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed Lead (New Boiler)	Proposed Lag (New Boiler)
Thermal Efficiency	73%	80.5%	90.2%	88%
Boiler Pumping	Continuous	Continuous	Intermittent	Intermittent
Flue Dampening	None	None	Burner Fan	Burner Fan
Maximum Design Supply Temperature	180°F	180°F	180°F	180°F
Maximum Design Return Temperature	160°F	160°	170°F	170°F
I/O Controls with Reset	Traditional	Traditional	BAS	BAS
A/F Control	None	None	Modulating	Modulating
Purge Cycle	None	None	Pre and Post	Pre and Post
Calculated Seasonal Efficiency	**55.80%**	**63.30%**	**85.81%**	**83.56%**

Based on the ASHRAE chart for condensing boiler thermal efficiency versus return water temperature (2000 ASHRAE Handbook- HVAC System and Equipment), a condensing boiler thermal efficiency will decreases as the boiler return water temperature increases. Using supply water temperature trends and an assumption that there is on average a 10°C increase from the return water temperature through the boiler, we were able to determine the return water temperature profile. Using the return water temperature profile (i.e. return water temperature re-set schedule) in conjunction with ASHARE thermal efficiency chart and a bin table we were able to calculate the average thermal efficiency of the boiler for a normalized year of weather data.

MMM GROUP

Table 4: Summary of domestic hot water boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	95.8%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Maximum Design Supply Temperature	140°F	140°F	140°F
Maximum Design Return Temperature	120°F	120°F	120°F
Controls	Old	Old	New
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre or Post
DHW Tank Insulation	Good	Good	Good
Calculated Seasonal Efficiency	**57.60%**	**65.10%**	**84.53%**

Discussion

Based on the trends and site conditions observed during our review, we requested a re-run of the E-Tools calculations. The updated calculation included changes to the heating boiler supply and return temperatures at 180°F and 170°F, and the DHW boiler return temperatures at 120°F. The higher SWT and RWT increased the stand by losses and therefore decreased the seasonal efficiency.

Due to the higher return water temperature the lead heating boilers are not in the condensing mode for a significant portion of time. Therefore the thermal efficiency of the heating boiler was reduced to 90.2% and this number was used as an input for boiler thermal efficiency in E-Tools. These changes resulted in lower gas savings.

The above modification to the E-Tool inputs resulted in a 15% decrease in the gas saving. It should be noted that the building re-commissioning is still in progress and it is expected that the return water temperature will decreases once the system is fully commissioned. Re-commissioning tasks to be complete include: ensuring that all apartment control valves are operational, all thermostats are operational and that all baseboards are cleaned and operating at specification. It is expected that the actual savings will increase if the associated re-commissioning task are performed.

The total project cost reported as $168,475 and the incremental cost is $69,488. This incremental cost seems reasonable for the scope of work completed.

MMM GROUP

The life cycle analysis for this project was estimated to be 25 years, which seems reasonable for a boiler upgrade. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 20% free ridership. We recommend increasing the life measure savings to 710,680 m^3 to correspond to the increase in estimated annual savings.

3.20 *RA.MR.EX.105.13*

Project Information

Project Code: 1-83882251-04-03-13

Building Type: Multi Residential

Project Description: Installation of Novitherm heat reflector panels

Project Details: The heat reflectors are installed on the wall behind hot water baseboard heaters to reflect radiant heat, thus resulting in reduced heating requirements.

Implementation Date: February, 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		69,570	35,890	-48.41%
Electricity (kWh)		0	0	0
Water (m^3)		0	0	0
Life Cycle (m^3)		834,836	430,678	-48.41%

Base Case

The building space heating is generated by natural gas fired heating boilers and distributed to the tenant space convective baseboard heaters by a hydronic water system. Corridor and common space ventilation is provided roof-top air handling units (AHUs). AHU heating water is provided by the same heating system via a glycol heat exchanger. The domestic hot water is provided by the same heating system via a heat exchanger.

Energy Efficient Case

Reflector panels are to be installed behind the hydronic heating equipment. The reflector panels act as an insulator and radiation barrier on the wall behind the hydronic heating equipment, thus reducing heat loss through the wall at this location and reflecting radiant heat back into the space.

Review Information

A site visit was conducted on March 11, 2014, during which our auditor randomly selected four apartment units to evaluate the completion of the proposed retrofit. Based on the site visit the reflectors installation conforms to the project application. The subject measure was implemented in February 2013.

The auditor also noticed that a heating system retrofit occurred in the later part of 2012.

Finally, literature reviews to research the energy saving potential by implementing reflect panels were conducted. Throughout the reviews of measurement and verification reports of previous radiator panel installation in residential sectors, it is determined the heating energy saving potential ranges from 8% to 20%. A 10% reduction was assumed reasonable as per the manufacturer's recommendation for multi-residential buildings. The factor of 10% was equal to the factor that E-Tools used.

Applicant Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools program. Gas usage data from January 2012 to December 2012 was used to create a weather normalized baseline, separated into seasonal and non-seasonal components. The seasonal load was further divided into the baseboard heater and AHU heating loads. The savings were estimated to be a 10% reduction in the perimeter radiator usage.

MMM Group Savings Calculation Methodology

As a result of this boiler upgrade, the calculation that had been provided by Enbridge had inconsistent inputs.

In an effort to stay consistent and to better isolate the energy saving resulting from the reflective panel installation, we conducted a separate regression analysis using utility bills from January 2011 to December 2011. During the 12 month period the total metered natural gas usage was approximately 801,152 m^3. Based on the regression analysis it was determined that the weather relative natural gas use is approximately 461,332 m^3 at a balance temperature of 18°C and non-weather relative natural gas use is 254,257 m^3.

It is standard practice by Enbridge to use 30-year average weather data to normalize weather dependent utility usage. To keep consistency the calculated 461,332 m^3 of weather relative natural gas use was normalized to 619,358 m^3.

Based on a previous Enbridge application which was submitted for the boiler upgrade project, the old heating system seasonal efficiency had been estimate to be 62.82%, and the new system seasonal efficiency was estimated at 81.6%.

The baseline normalized weather dependent gas usage had to be further separated into convective baseboard heater usage and AHU usage. Using the AHU airflow of 15,800 CFM operating 24 hours per day with a supply air temperature of 68°F and a system efficiency of 62.82%, it was determined that the base case AHU usage was approximately 153,163 m^3, prior to the boiler retrofit project. This resulted in a base case convective baseboard heater usage of 466,195 m^3.

Applying the system seasonal efficiency improvements resulting from the heating plant efficiency increase from 62.8% to 81.6% resulted in a new convective baseboard heater usage of 358,901 m^3.

MMM GROUP

Using an assumed savings of 10%, the audited savings were calculated to be 35,890 m^3.

Discussion

MMM Group also requested utility bills for the post retrofit period. To validate the savings MMM group compared the expected seasonal load of 440,924 m^3 which was calculated using the MMM Group savings calculation process to the weather normalized consumption of 437,813 m^3 which was determined from a utility regression analysis. The small difference in actual versus calculated seasonal heating load values validates the general approach that was used to calculate the audited savings of 35,890 m^3.

For this particular project, improved accuracy of energy saving calculation can be achieved by:

- Conducting independent checks for accuracy. While maximizing the use of information from applicant is important, it is also important to perform independent checks for accuracy of the information. In this particular project the new boiler seasonal efficiency of 81.6% had been used to determine the MUA usage, while the utility data that was used represented gas usage for a heating plant seasonal efficiency that was only 62.8%. This resulted in a much higher calculated base case radiator gas usage, and as such increased the potential for savings significantly.
- Selecting appropriate utility billing data to set the pre-retrofit baseline. The utility billing data should isolate the subject energy conservation measure from impacts by other conservation measures.

Considering the anticipating prohibitive cost we don't recommend to approach Measurement and Verification. It will be very costly using Measurement and Verification approach to determine the actual energy saving from implementing the subject measure.

The reported cost of $62,588.62 appears reasonable for this type of installation.

The life cycle analysis for this project was estimated to be 15 years, which seems reasonable for this type of upgrade. The life cycle savings were calculated using a 15 year life cycle, which was de-rated using a 20% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 430,578 m^3.

MMM GROUP

3.21 *RA.MR.EX.140.13*

Project Information

ESM File #: 1-77269226-06-20-12

Building Type: Multi-unit Residential

Project Description: New near-condensing boilers

Project Details: Two out of the three existing atmospheric heating boilers were replaced with two new near-condensing (88% efficient) boilers, operating in lead-lag operation with the third atmospheric boiler which remains.

Project Type: Advancement

Implementation Date: October, 2013

Project Savings Summary

Measure Life (years)	*	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		215,509	175,695	-18.47%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		3,682,271	3,232,788	-12.21%

* Measure life is 22 years, based on the average of a life expectancy of 25 years for the new lead boilers and 19 years for the old boiler. Old boiler is 11 years old, however, since it is operated as lag, it is expected to last an additional 5 years more than the typical 25 years.

Base Case

The building was completed in 2003 and the existing boilers were approximately 10 years old. The boilers were not at the end of their life, so the motivation for completing the upgrade was based on the energy savings and the project type has been designated as advancement. The existing system consisted of three atmospheric Raypak Raytherm boilers, rated for 2,100,000 Btu/hr input and 82% thermal efficiency supplying the building heating water and two similar Raypak Raytherm boilers were serving the building domestic hot water.

Proposed Energy Efficient Case

The new heating system consists of two new Camus Dayna Flame model DFNH-2501 boilers with total input capacity of 2,500,000 Btu/hr and a manufacturer's published thermal efficiency of up-to 88%, with forced draft venting. The new boilers have been installed to operate with one remaining Raytherm atmospheric boiler with lead-lag controls.

The new boiler pumps have been upgraded to run intermittently, therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

No changes have been made to the boilers serving the building domestic hot water.

Review Information

We met on site with the building manager on March 6, 2014.

The information for the existing and new boilers was recorded. There were two new Camus Dyna Flame model DFNH-2501 boilers and the remaining existing boiler was a Raypak Raytherm model E-2100-WTD.

We observed on site that the supply water temperature at the boilers was 160°F with a return temperature of 140°F. Since the heating system supplies heating water to fan coil units in the condo suites, the fan coils will be sized for one supply and return water temperature. Therefore, we expect that the observed temperature on site will remain constant.

We interviewed the building's manager to confirm that there were no other changes made in the building that will affect the building's natural gas consumption between the period of January 2011 and present.

- We contacted the manufacturer for the existing boilers that were installed approximately 10 years ago to determine their current efficiency. The manufacturer confirmed that the existing boilers were rated for 82% thermal efficiency. If the boilers have been properly maintained, the boiler thermal efficiency will remain within 2% of the rated thermal efficiency.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from January to December 2011 using E-Tools and the weather-adjusted annual natural gas consumption was determined. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were determined.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for the heating boiler efficiencies and controls are summarized in Table 1 below. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. Since the new installation is lead-lag, there are two seasonal efficiency calculations for the proposed new boilers. The proposed new lead boiler seasonal efficiency is an estimation of the seasonal efficiency of the new boilers operating as the lead boilers. The proposed new lag boiler is the adjusted seasonal efficiency of the remaining old boiler which is now operating as the lag boiler with upgraded controls. Bin table analysis is performed assuming that the building design load matches the old heating plant capacity to determine the annual hours the lead boilers will be able to meet the building load and the annual hours the lag boiler will be required. Then, the annual seasonal efficiency of the lead-lag boilers as a packaged system is calculated using the time weighted average of each boiler's seasonal efficiency.

MMM GROUP

The input assumptions are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Proposed New Lead	Proposed New Lag
Thermal Efficiency	73%	87.2%	73%
Boiler Pumping	Continuous	Intermittent	Intermittent
Flue Dampening	None	Burner Fan	None
Total # of Heating Stages	4	11	1
Maximum Design Supply Temperature	140°F	140°F	140°F
Maximum Design Return Temperature	120°F	120°F	120°F
I/O Controls with Reset	BAS	BAS	BAS
A/F Control	None	Modulating	None
Purge Cycle	None	Pre and Post	None
Calculated Seasonal Efficiency	**65.57%**	**84.85%**	**67.05%**

MMM Group Savings Calculation Methodology

We reviewed the utility data analysis performed by E-Tools and determined the calculation is acceptable, so we have used the weather adjusted building consumption from E-Tools in our verification calculations.

Based on our observations collected during our site visit, the inputs into E-Tools were updated as summarized in Table 2 below. Items that have been changed are shown in bold.

Table 2: Summary of boiler calculation input assumptions – Audited

Boiler Characteristic	**Existing**	**Proposed New Lead**	**Proposed New Lag**
Thermal Efficiency	**80%**	87.2%	**80%**
Boiler Pumping	Continuous	Intermittent	Intermittent
Flue Dampening	None	Burner Fan	None
Total # of Heating Stages	4	11	1
Maximum Design Supply Temperature	**160°F**	**160°F**	**160°F**
Maximum Design Return Temperature	**140°F**	**140°F**	**140°F**
I/O Controls with Reset	BAS	BAS	BAS
A/F Control	None	Modulating	None
Purge Cycle	None	Pre and Post	None
Calculated Seasonal Efficiency	**69.55%**	**83.86%**	**72.09%**

Based on our review with the boiler manufacturer, the rated thermal efficiency for the existing Raytherm boilers is 82% and the manufacturer confirmed that the boilers will maintain their rated thermal efficiency within 2% as long as they are properly maintained. Since the boilers were approximately 10 years old, we assumed worst case and revised the existing boiler thermal efficiency to 80%. The maximum supply and return temperatures were updated to 160°F and 140°F as per our observations on site. These changes increased the seasonal efficiency of the existing system to 69.55% and decreased the seasonal efficiency of the new lead-lag boilers to 83.86%. The seasonal efficiency of the existing boiler operating as a lag boiler is slightly higher than the existing due to upgrading the boiler pump control to allow for intermittent pumping through the boiler.

Discussion

After revising the E-Tools calculations, the estimated natural gas savings has been reduced from the original application to 175,695 m^3 of natural gas, which represents an 18.5% reduction in the savings. The main reason for the reduction in savings is due to the original application assumption that the old boilers were operating with a thermal efficiency of 73%, when the boiler manufacturer's data had a much higher efficiency of 82%.

The total project invoices were provided indicating a total project cost of $107,000. At a gas rate of $0.26/m^3 and an annual gas savings estimate of 175,695m3, the annual gas savings is estimated to be $45,680.70 annually. This gives a simple payback period of 2.3 years.

The life cycle analysis for this project is based on a blended life expectancy for the new and old boilers of 21.358 years. The new boilers installed can be expected to last for 25 years and the single existing boiler which remains as the lag boiler can be expected to have a remaining life of approximately another 14 more years. The majority of the building heating load will be supplied by the new lead boilers, which could extend the life of the existing boiler beyond the normal expected life. Therefore by increasing the existing boiler life by approximately 5 more years, we believe a 23 year blended life cycle for this installation is more reasonable. Based on the revised savings and a life cycle of 23 years with a free ridership de-rating of 20%, the life cycle savings should be 3,232,788 m^3 of natural gas.

3.22 *RA.MR.EX.169.13*

Project Information

Project Code:	1-90095661-11-18-13
Building Type:	Multi-residential
Project Description:	Heating boiler replacement
Project Details:	Replace two of the old heating boilers with high-efficiency boilers and operate them as lead boilers
Project Type:	Replacement
Implementation Date:	Dec 2013

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		83,054	76,876	-7.44%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		1,661,072	1,537,520	-7.44%

Base Case

The building had three LAARS (HH 3500 IN 11 K) boilers that were staged to sequence on and off with the building heating demand. Each boiler is rated at 3,500 MBH and is equipped with a 1 HP circulating pump that operated continuously.

There are two natural gas fired make up air units that serve the common areas that operate 24 hours per day at 100% airflow.

Proposed Energy Efficient Case

Two of the old heating boilers have been replaced with new near-condensing Camus (DFNH-3501) boilers with a total output capacity of 6,108 MBH at a manufacturer's published maximum thermal efficiency of 88%. The new boilers are operated as lead boilers to satisfy the building demand, and the remaining old boiler is used as a lag boiler during high heating load periods.

A boiler control system has been installed that controls the boiler circulating pumps on when there is call for heat and automatically turns the circulating pumps off after a set time delay when the boiler cycles off; therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

Review Information

A site visit and building operator interview was conducted on February 27th, 2014.

The proposed installation was in general conformance to the project application. The following information was gathered through observation and staff interview:

- Boiler 1 was operating at 30% and had a SWT and RWT of 160°F and 142°F, respectively. The boiler supply water temperature target was set to 175°F.
- The wall sensor for the main SWT temperature was set to 147°F and the SWT and RWT were recorded at 148°F and 135°F, respectively.
- Boiler 2 and associated circulating pump were off.
- The lag boiler was completely shut down due to leakage. As per the operator the lag boiler will not be repaired and is scheduled for decommission.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from Jan 2012 to December 2012 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on average 30 year weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 below for the heating boilers. Since this application is a replacement with new lead-lag boiler operation, there are four seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new lead boiler seasonal efficiency is an estimation of the actual installed new lead boilers. The proposed new lag boiler seasonal efficiency is an estimation of the new seasonal efficiency of the remaining old boiler with new controls installed as part of the conversion to lead-lag. Bin table analysis is performed assuming the building

MMM GROUP

design load matches the old boiler's capacity to determine the annual hours the lead boilers will be able to meet the building load and the annual hours the lag boiler will be required. Then the annual seasonal efficiency of the lead-lag boilers as a packaged system will be calculated using the time weighted average of each boiler's seasonal efficiency.

The boiler operation controls summarized in Table 1 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

Table 1: Summary of heating boiler calculation input assumptions – Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed Lead (New Boiler)	Proposed Lag (old boiler)
Thermal Efficiency	73%	80.5%	85%	73%
Boiler Pumping	Continuous	Continuous	Intermittent	Intermittent
Maximum Design Supply Temperature	180°F	180°F	180°F	140°F
Maximum Design Return Temperature	160°F	160°	160°F	120°F
I/O Controls with Reset	None	None	Characterized	None
A/F Control	Staged	Staged	Modulating	None
Purge Cycle	None	None	Pre and Post	None
Calculated Seasonal Efficiency	**50.84%**	**59.14%**	**81.78%**	**67.05%**

MMM Group Savings Calculation Methodology

During the audit it was also noticed that balance temperature of 15°C gives us better R^2 value; therefore the regression analysis was performed again with a 15°C balance temperature. Please note that the regression done by E-Tools resulted in higher normalized seasonal load which contradicts what happens in reality. Therefore MMM used in-house tools to perform a regression analysis and normalized it with 30 year average HDD provided by Enbridge. The new boiler base load was calculated at 295,695 m^3 which is 15.2% less than E-Tool calculated number at 18°C.

Based on observations collected during our site visit, the inputs into E-Tools were updated as summarized in Table 2 below for the heating boilers. Items that have been changed are shown in bold.

MMM GROUP

Table 2: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	88%
Boiler Pumping	Continuous	Continuous	Intermittent
Maximum Design Supply Temperature	180°F	180°F	180°F
Maximum Design Return Temperature	160°F	160°F	160°F
I/O Controls with Reset	None	None	Characterized
A/F Control	Staged	Staged	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	**50.84%**	**59.14%**	**84.78%**

For the new heating boilers, the thermal efficiency was adjusted because we observed that a different boiler model was actually installed on site compared to the proposed model in the original application. The installed boiler had a boiler manufacturer's thermal efficiency rating of 88%.

Also it was confirmed with the operator that the lag boiler was not in use and that they were in the process of removing it. As such, the lag boiler was excluded from the calculations.

Discussion

Based on the site conditions observed during our review, we had the E-Tools calculations updated to change the heating boiler thermal tot 88% and to remove the lag boiler from the calculation. The new seasonal efficiency was calculated to be 84.78%.

The above modification to the E-Tool inputs and the revised regression analysis resulted in 7.4% decrease in the audited gas saving.

The total reported project cost and incremental costs were $83,054 and $37,984, respectively. Both the total and incremental costs seem reasonable for the upgrade completed at this building.

The life cycle analysis for this project was estimated to be 25 years, which seems reasonable for new boilers. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 20% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 1,537,520 m^3 of natural gas based on the adjusted annual gas savings.

3.23 *RA.MR.EX.211.13*

Project Information

Project Code:	1-90088061-11-15-13
Building Type:	Multi-unit Residential
Project Description:	DHW boiler replacement
Project Details:	Replace one of the old DHW boilers with a new high-efficiency boiler and run it as a lead boiler
Project Type:	Replacement
Implementation Date:	November 2013

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		22,680	21,368	-5.78%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		453,597	427,360	-5.78%

Base Case

There were two RBI (1260E-NG) domestic hot water boilers with total input capacity of 2,520 MBH and one Raypak domestic hot water boiler with input capacity of 1,060 MBH. Each of the boilers was equipped with one circulation pump that operated continuously.

Proposed Energy Efficient Case

One of the old domestic hot water boilers has been replaced with a new high-efficiency Camus (DFNW-2001) boiler with an output capacity of 1,760 MBH and a manufacturer's published maximum thermal efficiency of 88%. The new boiler is operated as a lead while the remaining old boilers are operated as lag.

The boiler circulation pump for the new Camus boiler has also been replaced with a 3/4HP new pump. A boiler control system has been installed that controls the lead boiler circulating pump on when there is call for heat and automatically turns it off after a set time delay when the boiler cycles off; therefore the pumps will not circulate hot water into the boilers when the boilers are not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

Review Information

A site visit and building operator interview was conducted on February 26th, 2014.

The site installation was in general conformance to the project application. The following information was gathered through observations and staff interview:

- The new near-condensing DHW boiler was cycling on/off during the site visit. The boiler set point was checked from the boiler controller and confirmed to be 145°F. The average RWT was 130°F and the SWT was ranging from 130°F to 175°F depending on the boiler status.
- The two old DHW heaters were OFF during the site visit.
- The pumps associated with old DHW boilers were ON all the time during the site visit.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from Jan 2011 to December 2011 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on 30 year average weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 below for the heating boilers. Since this application is a replacement with new lead-lag boiler operation, there are four seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new lead boiler seasonal efficiency is an estimation of the actual installed new lead boilers. The proposed new lag boiler seasonal efficiency is an estimation of the new seasonal efficiency of the remaining old boiler with new controls installed as part of the conversion to lead-lag. Bin table analysis is performed assuming the building design load matches the old boiler capacity to determine the annual hours the lead boilers will be able to meet the building load and the annual hours the lag boiler will be required. Then the annual seasonal efficiency of the lead-lag boilers as a packaged system will be calculated using the time weighted average of each boiler's seasonal efficiency.

The boiler operation controls summarized in Table 1 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

MMM GROUP

Table 1: Summary of domestic hot water boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed Lead (New Boiler)	Proposed Lag (Old Boiler)
Thermal Efficiency	73%	80.5%	88%	73%
Boiler Pumping	Continuous	Continuous	Intermittent	Intermittent
Flue Dampening	None	None	None	None
Maximum Design Supply Temperature	140°F	140°F	140°F	140°F
Maximum Design Return Temperature	120°F	120°F	120°F	120°F
Controls	Old	Old	New	New
A/F Control	None	None	Modulating	None
Purge Cycle	None	None	Pre or Post	None
DHW Tank Insulation	Good	Good	Good	Good
Calculated Seasonal Efficiency	**60.2%**	**67.52%**	**81.65%**	**63.3%**

MMM Group Savings Calculation Methodology

We reviewed the utility data analysis performed by E-Tools and determined the calculation is acceptable, so we have used the weather adjusted building consumption from E-Tools in our verification calculations.

Based on our observations during our site visit, the inputs into E-Tools were updated as summarized in Tables 2 below for the heating boilers. Items that have been changed are shown in bold.

MMM GROUP

Table 2: Summary of domestic hot water boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed Lead (New Boiler)	Proposed Lag (old boiler)
Thermal Efficiency	73%	80.5%	88%	73%
Boiler Pumping	Continuous	Continuous	Intermittent	**Continuous**
Flue Dampening	None	None	None	None
Maximum Design Supply Temperature	140°F	140°F	140°F	130°F
Maximum Design Return Temperature	120°F	120°F	120°F	120°F
Controls	Old	Old	New	New
A/F Control	None	None	Modulating	None
Purge Cycle	None	None	Pre or Post	None
DHW Tank Insulation	Good	Good	Good	Good
Calculated Seasonal Efficiency	**60.2%**	**67.52%**	**81.65%**	**60.80%**

Based on the site conditions observed during our review, we had the E-Tools calculations updated to change the lag boiler pumping from intermittent to continuous. The continuous pumping increased the lag boilers stand by losses and therefore decreased the seasonal efficiency.

Discussion

The above modification to the E-Tools input resulted in a 6% decrease in the gas saving. The decrease in gas savings are as a result of the DHW heater pump control upgrade not being applied to the lab boilers as was indicated in the application. The revised annual savings were determined to be 21,368 m^3.

The total reported project cost and incremental costs were $66,500 and $3,499, respectively. Both the total and incremental costs seem reasonable for the upgrade completed at this building.

The life cycle analysis for this project was estimated to be 25 years, which seems reasonable for new boilers. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 20% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 427,720 m^3 of natural gas based on the adjusted annual gas savings.

MMM GROUP

3.24 *RA.PRO.EX.016.13*

Project Information

Project Code: RA.PRO.EX.016.13

Building Type: Office

Project Description: Heating boiler replacement

Project Details: Replace two old heating boilers with high-efficiency boilers

Project Type: Replacement

Implementation Date: Oct 2013

Project Savings Summary

Measure Life (years) 25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	72,778	91,146	25.24%
Electricity (kWh)	0	N/A	0
Water (m^3)	0	N/A	0
Life Cycle (m^3)	1,601,119	2,005,212	25.24%

Base Case

The original building's boilers were at the end of their life and in need of replacement. The energy savings for this application are based on the incremental savings of the high efficiency boilers compared to new 80.5% thermal efficiency boilers.

The building had two LAARS (HL 3333 KN11) boilers that are staged to sequence on and off with the building heating demand. Each boiler is rated at 3,333 MBH. Hot water is distributed to the west and east air handling units, perimeter radiators and basement heaters via four hot water pumps.

Proposed Energy Efficient Case

Two heating boilers have been replaced with new near-condensing Camus (DFNH-2501) boiler with a total output capacity of 4,400 MBH and a manufacturer's published maximum thermal efficiency of 88%. The new boilers are modulating based on the building demand. The piping configuration has been changed to primary-secondary with individual pumps for each boiler.

A boiler control system controls the boiler circulating pumps on when there is call for heat and automatically turns them off after a set time delay when the boiler cycles off; therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive

MMM GROUP

heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

Review Information

A site visit and building operator interview was conducted on February 26th, 2014.

The site installation was in general conformance to the project application. The following information was gathered through observation and staff interview:

- Boiler 1 was operating at 50.9% firing rate. The SWT and RWT were 191°F and 166°F, respectively.
- Boiler 2 was operating at 20% firing rate. The SWT and RWT were 191°F and 177°F, respectively.
- The hot water supply temperature to the building (secondary loop) is modulating based on the OAT (see table below). It was 75.1C at the time of the visit.

Weekday		Weekend	
OAT	SWT	OAT	SWT
-10°C (14°F)	70°C (158°F)	-10°C (14°F)	60°C (140°F)
10°C (50°F)	75°C (167°F)	10°C (14°F)	55°C (131°F)

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from October 2010 to November 2011 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on 30 year average weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 below for the heating boilers. Since this application is a replacement, there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the actual installed upgraded higher efficiency new boilers. The boiler operation controls summarized in Table 1 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

MMM GROUP

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	85%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Maximum Design Supply Temperature	180°F	180°F	170°F
Maximum Design Return Temperature	160°F	160°	150°F
I/O Controls with Reset	Traditional	Traditional	BAS
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	**57.92%**	**64.22%**	**80.56%**

MMM Group Savings Calculation Methodology

Regression analysis for baseline period was done using in-house software. The balance temperature which resulted in highest R^2 was selected and the results were in good agreement with E-Tools calculated value.

Based on our observations during our site visit, the inputs into E-Tools were updated as summarized in Tables 2 below for the heating boilers. Items that have been changed are shown in bold.

MMM GROUP

Table 2: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	79%	80.5%	88%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Burner Fan
Maximum Design Supply Temperature	190°F	190°F	190°F
Maximum Design Return Temperature	170°F	170°F	170°F
I/O Controls with Reset	Traditional	Traditional	BAS
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	55.51%	61.81%	82.97%

For the new heating boilers, the thermal efficiency was adjusted because we observed that a different boiler model was actually installed on site compared to the proposed model in the original application. The installed boiler had a boiler manufacturer's thermal efficiency rating of 88%.

Based on temperature reading on site and BAS schedule the boiler maximum supply temperature was changed to 190°F. There was no recorded information from the pre-retrofit boiler set point temperature. The interviews with the contractor revealed that there was no change in the boiler supply temperature, and therefore it was assumed that the old heating plant had the same temperature set-points as the new heating plant.

Discussion

Based on the site conditions observed during our review, we had the E-Tools calculation updated to change the heating boiler thermal efficiency to 88% and increase the boiler SWT and RWT to 190°F and 170°F, respectively. The new seasonal efficiency was calculated at 82.97% for the new boiler and 55.51% for the old boiler.

Increasing the new boiler thermal efficiency will increase the boiler seasonal efficiency. On the other hand increasing the SWT and RWT will have negative affect on the boiler seasonal efficiency. The above changes resulted in a 25.2% increase in audited natural gas savings.

The total reported project cost and incremental costs were $103,490 and $10,872, respectively. Both the total and incremental costs seem reasonable for the upgrade completed at this building.

The life cycle analysis for this project was estimated to be 25 years, which seems reasonable for new boilers. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 12% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 2,005,212 m^3 of natural gas based on the adjusted annual gas savings.

3.25 *RA.PRO.EX.027.13*

Project Information

Project Code: 1-87004783-07-29-13

Building Type: Office

Project Description: Demand Control Ventilation (DCV)

Project Details: Upgrade existing controls system to allow for DCV of roof top air handling equipment.

Project Type: Controls Upgrade, Including Sensor Installation

Implementation Date: January 2014

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		16,644	19,703	18.38%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		219,701	260,080	18.38%

Base Case

The building comes equipped with eight roof-top packaged units (RTUs). The nominal airflow of the RTUs varies from 2,400 to 5,000 CFM. All of the units have outside air dampers which were in a fixed position.

Proposed Energy Efficient Case

The retrofit included the installation of CO2 sensors along with the implementation of a demand-controlled ventilation (DCV) control strategy for the RTUs. In addition, a remote access monitoring and controls system was installed. With the new DCV system, the ventilation of the eight RTUs is modulated based on CO2 senor readings and set-point temperature of occupied spaces. Each one of the RTUs is installed with a CO2 sensor located on its return air duct.

MMM GROUP

Review Information

The subject building is currently being used as an office building. Due to the nature of operations within the building and the security restrictions associated with it, there were limitations with regards to visiting the building. In light of the schedule restrictions of this project, security clearance could not be attained in time to allow for a site visit. Similarly due to security restrictions, building drawings and retrofit drawings were not available.

Information available for the review of the application included the following:

- Roof-top unit schedule which included the maximum airflow
  - Total airflow of all units was determined to be 24,000 CFM
  - Base case fresh air supply determined from pre-set fresh air dampers was calculated to be 5,350 CFM
- Remote access to energy monitoring system, which provided trending data for three days. Trending data included the following:
  - CO2 level in the return air stream
  - Space temperature set-point and actual space temperature
  - Supply and return air temperature
  - Firing time of heating terminals for each of the units

During our review of the trending data we discovered that only 4 of the 8 units had reliable data. Thermostats #3, #5, #6, and #7 where either providing inconclusive information, or none at all since the Wi-Fi portal was not communicating properly with the monitoring system sue to technical issues.

In addition it should be noted that the building was originally a vacant warehouse, which was repurposed as office space. The HVAC system configuration and layout were modified to suit the office space with a 24/7 operation schedule.

Applicant Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools software. Savings resulting from the DCV control were derived using EGD Ventilation Load model. This model is based on assumptions/actual data on air temperatures, air handler air supply capacity.

The base case fresh supply airflow was estimated to be 5,350 CFM as per the provided RTU schedule. The supply air temperature was assumed to be 68°F, and the daily hours of operation were assumed to be 18 hours/day.

With the above inputs, the E-Tools software calculated the baseline normalized natural gas consumption for the RTUs of 30,547 m^3.

For the energy efficient case the applicant assumed that the new maximum ventilation requirements will be as per the minimum ASHRAE 62.1 requirements. The calculation included with the application determined that the minimum required ventilation for the space is 2,435 CFM. This resulted in a savings of 2,915 CFM.

This value of 2,915 CFM was input into E-Tools along with a supply air temperature of 68°F and an operating schedule of 18 hours/day to determine the estimated savings at 16,664 m^3 annually.

MMM Group Savings Calculation Methodology

Our saving calculation methodology was based on the reduction of fresh air supply resulting from the installation of demand control ventilation using CO2 sensors. The savings are determined by comparing the base case ventilation with fixed air dampers to post retrofit DCV with modulating outside air dampers, which is expected to result in a decrease of fresh air supply. The gas savings are resultant of a decrease of conditioned make-up air.

The base case was calculated using an outside air supply of 5,350 CFM, 68°F supply air temperature, and a revised schedule for 24 hours/day versus 18 hour/day. The estimate for base case was determined to be 40,729 m^3.

Taking into consideration the existing limitations described in the review information section of this report, our saving assessment was based on the trending data that was acquired from the remote monitoring system only. Three days of trending data was gathered for one weekday and two weekdays (March 23rd to March 25th) to verify the RTUs operation post retrofit. Due to the fact that receivable information was only available for 4 of 8 units, it was assumed that the remaining 4 four units will operate proportionally under the same conditions as the average of the other 4.

Using the available trending data MMM was able to determine the hourly outside air profile as well as the supply air temperature corresponding to each of the 24 hours. Using this information MMM calculated the normalized post retrofit RTU natural gas consumption. This value determined to be 21,026 m^3 annually. The savings were calculated as the difference of the base and exiting case, which resulted in 19,703 m^3.

Discussion

The main differences in the applicant calculation and the one provided by MMM are as follows:

- The original application used an operating schedule of 18 hours/day, when in reality the building operates 24 hours/day.
- The original application assumed energy efficient ventilation was as per ASHRAE 62.1 minimum requirements, whereas the MMM calculation used actual data to determine the volume of fresh air supplied to the facility.

As a result of these changes there was 18.5% increase in the audited savings.

The reported project cost is $16,633, which seems reasonable for this type of retrofit.

The life cycle analysis for this project was estimated to be 15 years, which seems reasonable for a controls upgrade. The life cycle savings were calculated using a 15 year life cycle, which was de-rated using a 12% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 260,080 m^3 of natural gas based on the adjusted annual gas savings.

3.26 *RA.RET.EX.070.13*

Project Information

Project Code:	1-77918703-07-17-12
Building Type:	Commercial
Project Description:	Heating Boiler Replacement
Project Details:	Replacing existing boilers with two new Viessmann Vitocrossal 200 model CM2-311 high efficiency condensing boilers.
Project Type:	Replacement
Implementation Date:	January 2014

Project Savings Summary

Measure Life (years)	25	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		24,939	23,716	-4.90%
Electricity (kWh)		0	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		548,659	521,752	-4.90%

Base Case

The original heating boilers were at the end of their life and in need of replacement. The original heating plant consisted of two fire tube Cleaver Brooks (P723-60) with a rated thermal efficiency of 73%. The boilers which were used for space heating only were equipped with continuous circulation pumps. The energy savings for this application are based on the incremental savings of the high efficiency boilers compared to new 80.5% thermal efficiency boilers.

Proposed Energy Efficient Case

The new heating system consists of two Viessmann Vitocrossal (200 model CM2-311) high efficiency condensing boilers with maximum output of 1,078 MBH and a manufacturer's published maximum thermal efficiency of 97%. The boilers operate with a pre and post purge cycle at start-up/shutdown.

A boiler control system controls the boiler circulating pumps on when there is call for heat and automatically turns them off after a set time delay when the boiler cycles off; therefore they will not circulate hot water into the boilers when the boiler is not firing. As a result, once the pump is off the heat exchanger develops a "thermal lock" with only a minuscule amount of conductive heat transfer occurring. This will reduce standby losses and therefore reduces gas consumption.

Review Information

A site visit and building operator interview was conducted on March 6th, 2014. The site installation was in general conformance to the project application, however there were some differences. The following information was gathered through observation and staff interview:

- Boiler 1 was operating and the SWT and RTW temperatures were 176°F and 165°F, respectively, while the outside air temperature was 32°C (0°C)

- Boiler 2 was not firing, and at that time the circulation pump was not circulating.

Although it was confirmed that, the new boilers have been set up to be controlled by the building automation system (BAS) and are capable to operate under a heating water temperature reset schedule, during the site visit it was observed that the controls were overridden. The site visit revealed that the heating water temperature was manually controlled at a fixed temperature and that the temperature reset control was not in use. The operator did acknowledge the discrepancy, and noted that the system was temperature re-set was overridden to stay at this level due to extreme weather. It was their intent to reinstate the schedule during milder weather.

Applicant Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills from December 2010 to November 2011 using E-Tools and the weather-adjusted annual natural gas consumption was calculated based on 30 year average weather data. From the regression analysis, the non-seasonal load for domestic hot water and the seasonal load for the heating boilers were estimated.

The seasonal efficiency of the base case boilers was estimated using E-Tools. The assumptions for boiler efficiencies and controls are summarized in Tables 1 below for the heating boilers. Since this application is a replacement, there are three seasonal efficiencies used to calculate the final savings. The existing boiler seasonal efficiency is the seasonal efficiency of the old boilers that have been replaced. The base case boiler seasonal efficiency is an estimation based on the assumption that the old boilers were just replaced with a new basic standard efficiency boiler without spending any extra money to achieve additional savings. The proposed new boiler seasonal efficiency is an estimation of the actual installed upgraded higher efficiency new boilers. The boiler operation controls summarized in Table 1 are input into E-Tools and E-Tools assigns efficiency reductions for each item to estimate the additional system losses from the boiler operation characteristics. The project's natural gas savings is calculated based on the additional savings achieved in the proposed new boilers compared to the base case boilers.

Table 1: Summary of heating boiler calculation input assumptions - Applicant

Boiler Characteristic	Existing	Base Case (for Replacements)	Proposed New
Thermal Efficiency	73%	80.5%	97%
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Mechanical
Total # of Heating Stages	2	2	11
Maximum Design Supply Temperature	170°F	170°F	150°F
Maximum Design Return Temperature	150°F	150°	120°F
I/O Controls with Reset	Traditional	Traditional	Characterized
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	54%	62.21%	93.09%

MMM Group Savings Calculation Methodology

MMM reviewed the regression analysis performed in E-Tools in the applicant calculation and determined that it was performed correctly.

Based on our observations during our site visit, the inputs into E-tools for thermal Efficiency and maximum design Supply temperature were incorrect. The applicant's calculation was based on 97% thermal efficiency, 150°F for maximum design supply temperature and 120°F for maximum design return temperature. We noted that the supply water temperature was 176°F at an outdoor air temperature of 32°F.

To better quantify the boiler efficiency versus ambient air temperature, the capability of the new system with heating water temperature reset control curve with the following parameters was confirmed:

- Supply Water Temperature (SWT) of 180°F at 0°F Outdoor Air Temperature (OAT)
- Supply Water Temperature (SWT) of 100°F at 55°F Outdoor Air Temperature (OAT)

Considering the heating plant distribution system is constant volume, the determining factor in heating load calculation is the ΔT between supply and return water temperature. For a condensing boiler to operate in its condensing mode the ΔT between the supply water temperatures must be kept low. For the purpose of our calculation, 30°F ΔT was assumed. This was used to determine the new boilers return water temperature based on building load variation as per outside air temperature. Also, from the temperature reset control curve provided by the applicant, it is possible to determine supply water temperature of the boilers. Knowing the return water temperature allows to determine the boiler efficiency at each outside air temperature. By using weighted average efficiency of the boilers in different outside air temperature, 91% average thermal efficiency was determined based on "ASHRAE handbook 2008 HVAC Systems and Equipment, Chapter 31, Figure 6" for boiler thermal efficiency at different return water temperatures (shown below) and used for the purpose of potential natural gas saving of the new system.

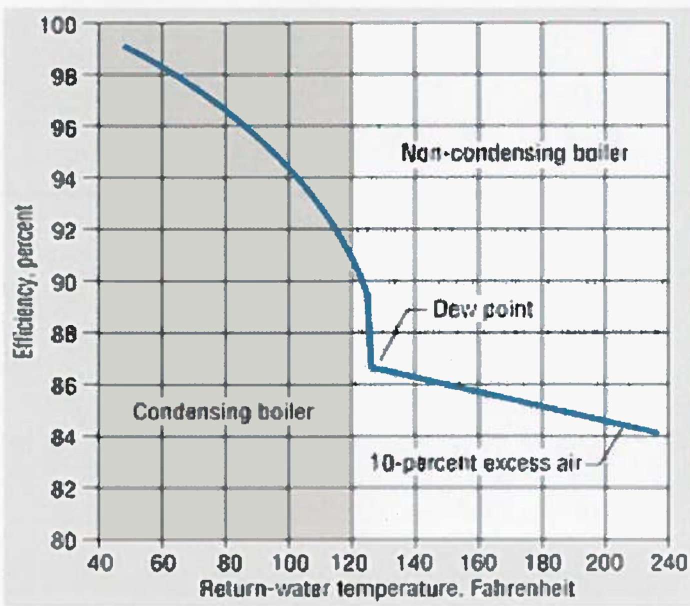


Figure 1: ASHRAE handbook 2008 HVAC Systems and Equipment, Chapter 31, Figure 6

The summary of the modified inputs into E-Tools are included in the following table.

Table 2: Summary of heating boiler calculation input assumptions - Audited

Boiler Characteristic	**Existing**	**Base Case (for Replacements)**	**Proposed New**
Thermal Efficiency	73.0%	80.5%	**91%**
Boiler Pumping	Continuous	Continuous	Intermittent
Flue Dampening	None	None	Mechanical
Total # of Heating Stages	2	2	11
Maximum Design Supply Temperature	180°F	180°F	180°F
Maximum Design Return Temperature	150°F	150°F	150°F
I/O Controls with Reset	Traditional	Traditional	Characterized
A/F Control	None	None	Modulating
Purge Cycle	None	None	Pre and Post
Calculated Seasonal Efficiency	**50.78%**	**58.28%**	**86.28%**

Discussion

Due to the higher return water temperature the lead heating boilers are not in the condensing mode for a significant portion of time. Therefore the thermal efficiency of the heating boiler was reduced to 91% and this number was used as an input for boiler thermal efficiency in E-Tools, along with the revise maximum supply and return water temperatures. The revised calculation resulted in a reduction of annual savings to 23,716 m^3.

The life cycle analysis for this project was estimated to be 25 years, which seems reasonable for a boiler upgrade. The life cycle savings were calculated using a 25 year life cycle, which was de-rated using a 12% free ridership. The life cycle savings should be updated based on the revised annual gas savings to 521,752 m^3 of natural gas based on the adjusted annual gas savings.

The total project cost reported as $181,288 and the incremental cost is $80,582. This incremental cost seems reasonable for the scope of work completed.

MMM GROUP

3.27 *RA.UNIV.EX.006.13*

Project Information

ESM File #: 1-86577387-07-10-13

Building Type: Institutional

Project Description: Retrofit of building BAS and controls to adjust ventilation based on actual occupancy using people counters, CO2 sensors, VFDs and air dampers.

Project Details:

- Installing new VFD supply and return fans, new CO2 sensors in mechanical room return ducts, new temperature sensors in AHUs and new people counting sensors
- Modifications on BAS including AHUs sequence of operations

Project Type: Demand-based ventilation retrofit

Implementation Date: November 2013

Project Savings Summary

Measure Life (years)	15	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)		531,963	450,059	-15.40%
Electricity (kWh)		618,000	N/A	0
Water (m^3)		0	N/A	0
Life Cycle (m^3)		7,021,912	5,940,779	-15.40%

Base Case

The subject building is a twelve storey multi-use building heated by three 5 MMBH Camus boilers rated at 88% efficiency. The same boilers also heat the domestic hot water in the building through a heat exchanger. The air handling units (AHUs) are original to the building and are composed of a combination of AHUs with heating and without heating. The AHUs with heating serve the North Auditorium, South Auditorium, South Interior Zone, Ground Interior, Library perimeter, Concourse Interior and the basement. The AHUs without heating serve the 2nd, 3rd, 4th, 6th to 12th floors.

The AHUs serving the interior zones are generally constant air volume (CAV) and the fans serving the perimeter zones are variable air volume (VAV). It should be noted that although the VAV system was originally equipped with variable inlet vanes on the fans, the vanes had been removed prior to the new owner taking over the building. And as such, the system was

MMM GROUP

operating at 100% prior to the retrofit. The VAV boxes are equipped with re-heat coils to further heat the air if required.

In the original building design, the AHUs fans were constant speed setting with no VFD in place. The outside air damper position was fixed and the AHUs mixed air temperature was set at 65°F (18°C). The air was then further heated at the VAV boxes to maintain the desire space set-point temperature.

Energy Efficient Case

In this project, the building was retrofitted with people counting sensors, data loggers, VFDs on AHUs, upgrades of outside air dampers and the building automation system (BAS). The purpose of the project was to reduce the ventilation air by adjusting the ventilation based on actual occupancy. With the new retrofit, the people counters at all entrances and exits to each floor detect the number of people present in the different areas of the building and this information is then used by the BAS to control the damper position to provide the required amount of fresh air accordingly. In addition, in the energy efficient case, CO2 sensors have been installed as a backup system which can override the people counting sensors if required. The CO2 sensors have been installed in the return duct of AHUs. As part of the new retrofit, the control system was to be set up to turn off all AHUs during overnight hours.

Review Information

A site visit was conducted on March 07, 2014 to confirm the installation. The building operator and facilities supervisor were interviewed during the visit. The following information was gathered through onsite observation and staff interview:

- The mechanical drawings of the retrofitted items
- Partial BAS trending and screenshots
- Weekly Normalized Occupancy Reports for several weeks
- Electricity consumption reports
- Energy report by consultant
- Natural gas consumptions in 2012 and 2013
- Load Profile Report October 31, 2013
- No CO2 level data was provided as it was confirmed by that CO2 levels are not trended in the building.
- During our investigation, we noted that comparing the utility bills of 2009 and 2012, significant differences of both weather relative and constant load were observed, while the consumptions were fairly close. It was verified by Enbridge that, some adjustments have possibly occurred prior to the controls upgrades. Starting in 2011 when the retrofit was in initial stages, modifications were made to the operation such as increasing the supply air temperature and reducing the minimum outside air damper settings.

MMM GROUP

Applicant Savings Calculation Methodology

The applicant used E-tools to perform a natural gas utility bills analysis for 2009 and 2010 consumption data to separate the heating loads for space heating, ventilation, reheat and DHW. The base load included both DHW and reheat (from VAV boxes). The DHW load was estimated at 58 MJ/m^2/yr based on the 2009 Marbek study. The re-heat load was determined by subtracting the estimated yearly DHW load from the base load.

For the base case, the applicant used a ventilation rate of 95,800 CFM as calculated by the customer. The applicant compared this value with a model created based on ASHRAE 90.1 minimum ventilation requirement and the result was within acceptable range. For the post-retrofit case, the applicant estimated the ventilation rate based on demand controlled ventilation (DCV) consisting of occupancy sensors and CO2 sensors resulting in 50,370 CFM. The applicant also made the assumption that, all AHUs turn off during overnight hours.

The total natural gas saving was estimated using E-Tools as result of reduced ventilation rate based on DCV installation and the nighttime setback.

MMM Group Savings Calculation Methodology

Based on our onsite observations and the review of BAS, it was determined that to best describe the potential savings is to separate the savings achieved from the AHUs with heating and without heating pre and post retrofit due to their different operational conditions.

In addition, the estimated natural gas consumption for AHUs serving the interior zones were separated from AHUs serving the perimeter zones pre and post retrofit, as the perimeter zones are served by variable air volume system (VAV) while interior zones are served with constant air volume system.

For the purpose of our calculations, the following assumptions were made:

- The mixed air temperature for both AHUs with and without heating for full and partial occupancy is set to be 18°C.
- The space temperature set-point is set at 22°C.
- The minimum damper position pre-retrofit was 30%. The minimum damper position post-retrofit was reduced to 15%.
- Based on our observation, the building night setback for shutting of all AHUs during night hours was not in place. Therefore 24 hours per day operation was used in our calculations.
- Also, our calculation for the post retrofit case accounted for the reduction of fan speed for both perimeter and interior zones due to the installation of VFDs. In the post retrofit case, the fans serving the perimeter zones were assumed to be running at 60% and the interior fans to be running at 75%.

The assumptions made above were all verified by the customer or are based from on site visit observations or interview of the building staff. MMM calculated the natural gas consumption for all AHUs with heating and without heating separately, with the above assumption in place and based on the calculated occupied and unoccupied hours for pre and post retrofit cases. For estimating natural gas usage in each case, the percentage of outdoor air flow was determined at different outdoor air temperatures to maintain 18°C supply air temperature. From the percentage of outdoor air, the amount of outdoor air flow and the energy required to heat up the air was calculated. Using bin hours table, the amount of natural gas required for this heating process in each scenario was then determined. The total natural gas saving was calculated as result of supply air volumes and the increased operating hours.

It must be noted that, the applicant used the weather normalized data for the last 30 years, while our calculation was based on the past four year average. The heating degree days (HDD) pattern in [redacted] for the past 30 years has dropped significantly. In order to maintain consistency with the applicant calculation result, an adjustment was made to ensure potential natural gas savings are within reasonable comparison with the applicants.

The table below shows the summary of above explanation:

Pre-retrofit	AHU with heating coil	AHU with no heating coil
Occupied Hours	176,593	340,452
Un-Occupied Hours	29,047	55,999
Total	205,639	396,451
Post-retrofit	AHU with heating coil	AHU with no heating coil
Occupied Hours	51,495	147,747
Un-Occupied Hours	4,005	11,744
Total	55,500	159,491
Avioded NG Use		
Occupied Hours	125,098	192,705
Un-Occupied Hours	25,042	44,254
Total	150,140	236,960

The above calculated total of 387,100 m^3 was then normalized to 30 year average weather data to arrive at a 30 year weather normalized savings of 450,059 m^3.

Discussion

Based on our calculations, the estimated savings post retrofit is 450,059 m^3 of natural gas. Which is approximately 15.4% lower than the applicants estimated savings amount of 531,963 m^3. The life measure analysis for this project is based on 15 years with a 12% free ridership, which is reasonable for a controls and VFD upgrade. The revised annual savings resulted in a revised life cycle savings of 5,940,779 m^3.

The revised application savings are different in part due to a different methodology used to calculate the savings, but primarily due to the fact the building currently actually operates 24 hours/day and not 17hours/day as reported in the application. It should be noted that using the applicant approach with only this alteration to the calculation would have resulted in an audited savings of approximately 372,728 m^3.

The reported project cost of $1,250,000 appears reasonable and within industry standards for the scope of work completed.

Additional Post Audit Information

EGD contacted the client following their review of draft version of this report. The communications between EGD and the client resulted in the following additional information:

- Since the audit date the client has implemented a schedule to shut down the ventilation equipment during night time. The revised schedule resulted in a 8 hour ventilation shut down during the week and a 10 hour shut-down during nighttime.
    - The revised schedule claim was supported with trend screenshots.
- Although the equipment is in shut-down mode during the un-occupied hours, there is still some operation of the perimeter units to maintain a set-back space temperature of approximately 15°C.

This change came as a result of final fine tuning as part of commissioning of the system.

MMM Group performed a second calculation that takes into account the above mentioned operational changes to the system. The revised savings with the above input changes resulted in an estimated annual savings of 560,963 m^3, and a life measure savings of 7,451,987 m^3. This revision represents an increase of 5.33% when compared to the application savings.

It is up to the audit committee and the third party audit firm to decide whether to use the original audited savings or the revised audit savings which incorporate the additional post audit information.

4.0 FUTURE CONSIDERATION

4.1 *E-Tools VFD Scheduling*

At the present time E-Tools is capable of accurately estimating the electricity and natural gas savings from VFD applications. One improvement that would benefit the software and increase its versatility would be to expand its schedule functionality. This can be achieved by allowing the user to adjust the frequency on an hourly basis versus the "breakfast, lunch, dinner" schedule that is currently used.

4.2 *Add Steam Boiler Seasonal Efficiency Commercial E-Tools*

The current version of the commercial E-Tools version does not have the capability to accurately calculate steam boiler seasonal efficiency. It is recommended to update the current version with this capability.

4.3 *E-Tools Weather Data Availability Check*

For one the project E-Tools incorrectly predicted the normalized weather dependent utility usage due to the unavailability of actual data. The E-Tools software is periodically updated with the latest weather data. It is recommended to program a warning message to alert E-Tools users of possible error in utility analysis due to unavailable weather data.

4.4 *Measurement & Verification*

We recommend that Enbridge implements a Measurement and Verification protocols as part of their evaluation process for project were the estimated savings percentage are sufficiently high to warrant verification through CUSUM analysis. This recommendation should be carefully evaluated by the audit committee to evaluate the feasibility of such an undertaking taking into consideration the current program timelines.

4.5 *Assistance for Identification of Additional Measures*

During one of our site visit, the property management asked about any services that could be offered to assess their building to determine potential future upgrades which could save additional natural gas. They also expressed interest in getting help in finding and obtaining an engineering consultant to help with designing the new upgrades. We believe that this could be a good recommendation for future improvements to the Enbridge incentive program. Enbridge could offer an incentive to off-set the cost of hiring a consultant to complete a building energy audit, which may encourage more program participation. Encouraging participants, and possibly incentivizing them to use qualified engineering consultants to assist with the design and implementation of the energy retrofits may also improve the program for both the participants and Enbridge to ensure that the systems that are designed and installed achieve the desired savings.

5.0 CONCLUSION

Based on our review of the twenty-seven (27) projects and available information, MMM recommends the following adjustment to the overall savings.

Utility	Adjustment	% Adjustment
Natural Gas (m^3)	-1,127,727	-25.66%
Electricity (kWh)	-50,000	-3.53%
Water (m^3)	0	0
Life Cycle (m^3)	-17,653,236	-22.12%

The above adjustment is based on available information gathered and site conditions observed during the site visits carried out by MMM Group. MMM Group has since then received responses in regards to the audited savings from EGD for the following five (5) projects after the draft report submission:

- 3.02 – RA.MR.EX.017.13
- 3.10 – RA.REC.EX.003.13
- 3.15 – RA.GOV.EX.007.13
- 3.17 – RA.HC.EX.021.13
- 3.27 – RA.UNIV.EX.006.13

MMM Group has provided alternate savings for projects 3.2 and 3.27 which can be used as the audited savings. We leave it up to the third party evaluator to make a decision whether to use the original or revised savings, given the timing of the receipt of the additional information and alteration to operating parameter.

EGD has provided an alternative calculation methodology for project 3.10. The approach used is reasonable and appropriate for the measure, however, there are several inputs that were used in the calculation that should be verified before the calculation is deemed complete. If the inputs in the application can be confirmed, then the output can be used as the audited savings. Otherwise it is recommended to use the savings value provided by MMM Group.

Addition information was provided for project 3.15, however, the additional information does not warrant a revision to the savings calculation, as this additional information does not apply to the original proposed measure.

For project 3.17, additional information was provided on April 17, 2014 and was followed up with an e-mail response by MMM Group on the same day. Due to the coinciding timing of the EGD response and the submission of this report, it was not possible to fully address all items in this final report. A follow up e-mail sent on the same day by MMM Group should be taken into account along with the EGD e-mail by the third party audit firm when deciding on the final audited savings value for this project.

GENIVAR

[redacted]

Senior Analyst – DSM Evaluation, Monitoring and Verification
[redacted]
2255 Sheppard Avenue East, Suite 410, Atria 1
North York, ON, M2J 4Y1

Re: [redacted]

Dear Deborah,

Attached is our report for the above project. For this assignment, we reviewed sample Enbridge Gas Distribution Files for 17 Industrial Custom Projects representing 12,905,060 m^3/year (combined) for the 2013 DSM Program.

Generally we found the quality of the reviewed files to be consistent with good engineering practice. Our site investigations identified that the measures were installed and operated as claimed and that Enbridge staff had been helpful in identifying the measure and supporting its implementation.

GENIVAR is appreciative to have been involved on this assignment with EGD and for the opportunity to have Optimal Energy Inc. auditing and providing their comments to support the report.

Yours truly,

GENIVAR Inc.

Kevin Gray, P.Eng.
Senior Project Manager

/klg

1300 Yonge Street, 8th Floor, Toronto, Ontario M4T 1X3
Telephone: 416.484.4200 · Fax: 416.484.8260 · www.genivar.com

Table of Contents

List of Tables

Appendices

1. Introduction and Understanding

1.1 Background

Enbridge Gas Distribution (EGD) operates Demand Side Management (DSM) programs including programs that involve custom projects in the commercial, multi-residential, industrial, agriculture, and new construction sectors.

The industrial DSM programs include:

- Boiler Plant Audits,
- Steam Trap Surveys,
- Industrial HVAC audits,
- Greenhouse Audits,
- Special Process Studies,
- Implementation of Measures, and
- Monitoring and Targeting.

Custom projects cover opportunities where savings are linked to unique building specifications, uses and technologies. Each project is assessed individually for participation in the program. The programs are designed to meet three main objectives:

1. Influence customer behaviour,
2. Accelerate technology development, and
3. Transform the market.

The Ontario Energy Board (OEB) has regulatory oversight and approves the rate impacts associated with the DSM programs. Projects are generally of two types: prescriptive and custom applications. In the Industrial market, most of the projects are custom.

1.2 Objectives of the Independent Review

As part of the annual evaluation and DSM audit process, Enbridge commissions third party firms to undertake an engineering review of a sample of the custom projects in the Commercial and Industrial sectors. The purpose of this evaluation is to provide;

- An objective third party engineering review of a statistically representative sample (determined by others) of Custom Projects in the Industrial Sector as per Ontario Energy Board Guidelines, and
- An independent objective opinion of the reasonableness of the energy savings and equipment costs claimed by custom projects.

1.3 Scope of Work

The project tasks are described in the 2013 Industrial Custom Project Savings Verification RFP (received November 25) and responses from Enbridge to GENIVAR clarifications (received November 27). For this assignment, the tasks performed by GENIVAR generally included the following:

Kick off Meeting at EGD	December 12, 2013
Wave 1 - Q1 to Q3 Site Visits and File Review	December 16 to January 24, 2014

GENIVAR reviewed the project files in advance of the site visits. Where necessary to add clarity to our understanding, GENIVAR contacted equipment vendors.

To commence our efforts with the industrial client stakeholders, GENIVAR drafted an email outlining;

- GENIVAR's role,
- The background of the Audit request (i.e. an inspection of the implemented measure at the client's facility, discussion of its performance relative to the calculation, whether any measurements or monitoring have been made, and any significant production variations at the facility which may differ from the original calculation),
- A proposed timeslot to facilitate the on-site meeting.

Upon concurrence by the client, GENIVAR performed an independent site inspection and interview to review the following:

- Review and verification of physical installation and its operation protocol,
- Discuss the reasonableness of the utility savings results,
- Whether the system has achieved its expected performance. Description of approach (if any) used by the client to measure and / or verify the savings. Request copies of monitoring software output or client collected data for review.
- On site instantaneous measurement where such measurements are anticipated to appreciably improve the accuracy of the savings verification and does not burden the client.
- Whether plant production / scheduling has changed in a substantial manner that would impact the savings,
- Whether the measure has introduced any unforeseen disturbances to other systems or resulted in any product quality concerns.
- Summary of feedback of performance or any process or configuration modifications subsequent to installation,

With the file review and site investigation completed, this report outlines our assessment of the file relative to utility savings in accordance with good engineering practice. If necessary, comment on the difference between the projected savings and the evaluated savings, and the reasons for this.

- Where an alternative calculation methodology may be warranted, this is provided together with a commentary of the rationale behind it. This will represent GENIVAR's own calculations, methodology and assumptions.
- Where the original file methodology is agreed to be appropriate, GENIVAR assessed the analysis.
- Where the methodology is agreed upon, but the findings of the site demonstrate a process variation or modification to set point, the analysis is modified.

Submission of Draft Q1 to Q3 Report	January 25, 2014
Wave 2 – Launch Meeting	February 11, 2014
Wave 2 Draft Report	April 4, 2014
Final Report	April 17, 2014

2. Sampling

Sampling was performed under separate contract by a separate 3rd party consultant retained by EGD. GENIVAR had no role in this process. The samples were made available to GENIVAR in two Waves as follows,

- Wave 1 (Q1-Q3) 6 files received in December, 2013.
- Wave 2 (Q1-Q4) 11 files received in February, 2014.

Table 2.1 summarizes the total number of Industrial projects assessed within the 2013 DSM Program and their claimed savings of natural gas and induced savings of electrical energy and water consumption.

Table 2.1 2013 Enbridge Industrial Projects - Wave 1 and Wave 2

Number of Projects	Gross Volume Savings Natural Gas m^3/yr	Gross Electrical Savings kWh/yr	Gross Water Savings m^3/yr
6	2,319,807	2,264,363	0
11	10,585,253	0	0

3. Review of the Industrial Projects

In this section of the report, each Industrial EGD File assessed in Wave 1 and Wave 2 is described in detail relative to our site inspection and file review.

3.1 Site Inspections

GENIVAR initiated contact with the clients via email with an introduction, an indication of the meeting expectations as well as a proposed meeting date and duration as follows;

> ***Background***
>
> *Enbridge Gas is currently undertaking an independent evaluation audit of its 2013 Industrial Custom Projects to meet the requirements of the Ontario Energy Board. As a participant with an implemented energy efficiency measure(s), your organization was randomly selected by an independent third party for a technical evaluation audit by GENIVAR to assess Enbridge's energy reduction measures for project(s) which they supported.*
>
> *This audit will involve a site visit to verify the type and installation of the equipment and operating parameters, as specified in the Enbridge Energy Efficiency Program agreement. To this end, GENIVAR has reviewed your project file. Your participation is requested to;*
>
> - *Provide a brief tour of the implemented measure(s) in your facility.*
> - *Discuss your thoughts on the success of the measure(s) relative to the predicted results. Has the measure operated as predicted or have any corrective modifications had to be performed.*
> - *Is your facility still operating at the same production as previously anticipated and the measure quantified?*
> - *Review whether you have performed any measurements or monitoring of the measure to confirm its predicted performance.*
>
> ***Site Visit***
>
> *It is anticipated that most of these site visits may be performed in less than 2 hours. Your participation is requested for your facility on **month / day @ time**. Please confirm by replying to this email if this is a convenient time. If not, please advise a few alternate timeslots.*
>
> *Your participation is appreciated in advance.*

Generally, clients were courteous and cooperative and made themselves available for, and to respond to questions during, the interview and site investigation, which is supplemental to the EGD file, and

- Enables visual 3rd party assurance that the system was implemented and generally operates as described.
- Provides an opportunity for client to share whether any product or process quality implications resulting from the measure were encountered and if any operational modifications were required.

3.2 General Comments

3.2.1 Safety

During site inspections, GENIVAR observe that on many occasions a brief safety discussion and / or sign off is required to ensure that personal protective equipment will be worn and safe conduct observed at all times. GENIVAR are full time escorted and are instructed not to touch production / process equipment.

3.2.2 Process Confidentiality

Industrial clients are generally guarded of the specific aspects of their facilities and processes and seek assurance that sensitive information observed is not to be released to third parties.

3.2.3 Measured Conditions

It is also noted that while production (whether batch or continuous) may have variations during a day, the feedback of the clients generally depict an annual representative average of process conditions. Hence during a brief visit, it is somewhat unlikely that a brief measurement (in whatever form) will be deemed to be credible enough to warrant an adjustment.

Furthermore, other concerns limit the merit of short term testing apparatus including;

- Calibration and proper use of measurement equipment,
- Seeking permission from client for installation and tampering by client staff who may not be aware of the measure and its data logging,
- Vandalism,
- Concerns of disruptions to process,
- Safety aspects for access and physical application upon (or within) heated and / or inaccessible process equipment.

GENIVAR are often able to observe local instrumentation (i.e. temperature, pressure, flow, etc.,) upon equipment or view the process on the client's SCADA. Recognizing the confidentiality of the client in this report, it is difficult to request detailed trending information of the process when this report may thereafter be available in the market to competition. Generally the EGD applications are comprised of client input of annual conditions and numerous interactions of EGD representatives to properly defend the analysis (sometimes including medium term data measurement). Unless specifically noted otherwise in the project analyses which follow, GENIVAR did not undertake further site testing.

On the assurance that the information is not contained in the report or released, GENIVAR are often allowed to photograph specific aspects of the implemented measure for the analysis.

3.2.4 Effect of Measure on Product Implications

GENIVAR ask the client to comment on the post measure implementation relative to the file analysis and also whether any implications of the measure have led to it being abandoned (owing to product non conformities or reject rates) or process / production modifications.

3.2.5 Condition of Measure Equipment

Owing to the unique nature of the process specific equipment, and the many types of processes which are encountered during the diverse site visits, it is often not possible to identify the condition of the directly, and in-directly, affected equipment upon which the measure is implemented – other than a visual, and a general appreciation of the facility upkeep.

The short duration of the inspection and the inability to open operational equipment, without a shutdown of the facility is not possible, or requested /feasible. It is generally relied that the client has evaluated the condition of the equipment, and its predicted remaining life, before a commitment is made to justify the investment of the measure together with the associated process downtime for its implementation and commissioning / testing.

Relative to the extrapolation of annual savings to the savings for the life of the measure additional aspects apply;

- Gradual decline of efficiency owing to service life deterioration or accumulated fouling of heat transfer;
- Repair or replacement of related components to the measure which result in an efficiency increase or hence reduced savings of the measure assessed in this report. Generally, industrial clients would replace end of life components on a "like for like" basis. Technologies which result in greater efficiencies generally cost a premium and hence this may be a future EGD candidate measure for this client at a future date.
- Of greater magnitude than the measure life, is the market of the client and their performance. Production variances of the initial year of the measure may change dramatically throughout the measure's life in service.

Industrial equipment is often built to custom and superior standards of robustness and performance. Our comments pertaining to measure life in the balance of the report is relative to the following reference;

Filed: 2011-11-04
EB-2011-0295
Exhibit B
Tab 2
Schedule 6
Page 2 of 2

Custom Resource Acquisition Technologies

Table 1 - Measure Life Assumptions

	Commercial	Industrial	Multi-residential
Boiler Related			
Boilers – DHW	25[1]	n/a	25[1]
Boilers - Industrial Process	n/a	20	n/a
Boilers – Space Heating	25[1]	25[1]	25[1]
Combustion Tune-up	5	5	n/a
Controls	15	15	15
Steam pipe/tank insulation	n/a	15	n/a
Steam trap	5[4]	5[4]	n/a
Building Related			
Building envelope	25	25	25
Windows	25	25	25
Greenhouse curtains	n/a	10	n/a
Double Poly greenhouse	n/a	5	n/a
HVAC Related			
Dessicant cooling	15	n/a	n/a
Heat Recovery	15	15	n/a
Infra-red heaters	10	10	n/a
Make-up Air	15	15	15
Novitherm panels	15	n/a	15
Furnaces (gas-fired)	18[2]	n/a	18[2]
Re-Commissioning	5[3]	n/a	5[3]
Process Related			
Furnaces (gas-fired)	n/a	18[4]	n/a

[1] Source: ASHRAE
[2] Source: ASHRAE updated in EB-2006-0021
[3] Source: Measure Life For Retro Commissioning And Continuous Commissioning Projects, Fine Projects.
[4] Source: Enbridge Gas Distribution Independent Audit of 2010 DSM Program Results, June 30, 2011, Pg. 54

3.2.6 Free Ridership

The assessment of the Free Ridership is not in the scope of GENIVAR to offer comment upon. Our analysis includes the Free Ridership contained in the EGD file in our calculations of cumulative cubic meters of gas savings (CCM).

[redacted]

3.3 Wave 1

RA.IND.LG.NRT.002.13

Industry Type:	[redacted]
Project Description:	**General** This [redacted] client has a number of fabrication hangars and facilities for the manufacture [redacted]. **Base Case** A large manufacturing hangar with a high ceiling (55') which is heated by forced air heaters at the 48' elevation. The heating source for the radiant heaters is from a remote steam plant. To maintain a comfortable workspace for the workers at ground level requires a considerable amount of heat to be added to overcome the substantial temperature stratification from the heaters. **Implemented Measure** For this hangar, the client has installed a total of 5 large diameter, slow speed de-stratification fans. This results in a mixing of the air at the different elevations for a more uniform temperature profile and a higher degree of air movement. By avoiding the extreme temperature below the ceiling, the resultant heating is reduced.
Summary of EGD File :	This file includes; • An EGD Developed computer program (E-tools) output to demonstrate the predicted energy savings of the implemented de-stratification fans. • An invoice of the supply and installation of the fans. Invoice dated Oct 2012 with an implementation cost of approximately [redacted] (not including taxes).
Site Inspection Date and Findings:	**January 7, 2014 at 9:30AM** During the site visit, GENIVAR verified the installation and operation of 5 de-stratification fans together with their associated controls. The client confirmed the success of the project in terms of worker satisfaction and general perception of reduced energy in the hangar. The client has confirmed that the peak output of steam plant has decreased [redacted] but this is noted as being dependent on the weather variation year by year. This steam flow is at the boiler plant exit and is comprised of the entire campus of buildings - there is no sub-metering of steam flows to each building to enable this hangar's performance to be isolated. **Verified Conditions** • Client confirmed that pre and post measure temperature control of this hangar is maintained at 68F. Post measure, this temperature was visually verified by GENIVAR at the local thermostat. The temperatures at the underside of the ceiling in winter conditions has decreased from a pre-measure range of 95 to 100F (per client) to 71 to 74F (per client and confirmed by exposure at upper mezzanine). This is closer to the thermostat control temperature and confirms the success of the measure. • GENIVAR generally reviewed the building envelope for its composition but recognize that this parameter is consistent both pre and post measure and hence detailed efforts to breakout varying compositions and windows / doors, etc., offers negligible benefit to the analysis. GENIVAR accept the coefficients in the EGD analysis as being reasonable for a facility of this era and for its applicability to this analysis. • GENIVAR visually concur that the building size information appears correct and the dimensions were agreed by the client. • GENIVAR viewed the boilers and agree that operational and seasonal efficiency of 80/65% are generally appropriate to the equipment installed.

[redacted]

	• GENIVAR noted that the VFD was set at 23 Hz. Hence this closely verifies the 33% motor loading parameter in the analysis. • Client indicated that boiler operation is between 7 and 8 months per year – which generally is in line with the 5702 hours per year in EGD E-tool. GENIVAR analysis is based on 8 months per year (5840 hours per year) which is appropriate to the heating profile of the client location. • From manufacturer's website, GENIVAR verified physical and mechanical / electrical performance information on the ceiling fans. • De-stratification factor of 85% represents for building irregularities and the sizing of the fan to the building dimensions (generally 4 to 5 fan diameters). As the building is served by 5 fans along its length and the fan is 20 foot diameter, and the building dimension is 542 x 131 feet, the 0.85 factor is appropriate.
EGD File Analysis:	The E-tools output does not readily convey the calculation algorithms but includes appropriate verified input conditions from the site inspection. On this basis, GENIVAR requested, and received, a copy of the EGD E-tools Reference Documentation (DE stratification Savings Calculator V1.07) for review. This document clearly describes the merits of this measure in candidate settings as well as the necessary information to enable the modelling of its anticipated performance. It also depicts the embedded calculations and the required parameters /units with industry recognized ASHRAE references. Being Version 1.07, it demonstrates a committed approach to continued refinement of this E Tool. De-stratification fan technology is a fairly new in industrial settings. Most of the applications and technical papers are based on warehouse type applications where there is limited heat gain from workers and internal processes. Hence, there is limited benchmarking data readily available. GENIVAR contacted the equipment vendor for their opinion of the typical savings of de-stratification fans in similar installations to benchmark against EGD E-tool output. Vendor analysis predicted a greater value of anticipated savings (148,806 m^3/year) than the EGD file. GENIVAR recognize that this analysis is focused on generation of interest in their product. Furthermore, the proprietary software is not available to assess the calculation algorithms and of other adjustments which are the contained within it. Hence GENIVAR disregard these findings. **Independent Analysis** See GENIVAR Independent analysis included in Appendix A. **Natural Gas** Using simplified ASHRAE calculation methodology (ASHRAE Fundamentals 2005, Chapter 30 and also "Saving Heating Costs in Warehouses" (Aynsley, ASHRAE Journal December 2005)); GENIVAR was able to produce a savings of 48,147 m^3/year which favourably compares (about 13%) with the EGD file of 55,152 m^3/year. Based on the evolving nature of the EGD E-tool (incorporating refinement and verification of numerous commercial and industrial installations), GENIVAR accept the results of the EGD file (versus GENIVAR value) as the E-tool will have better site specific Toronto ambient bin data than the simplified GENIVAR analysis based on limited pre and post measure values. **Electrical** GENIVAR was able to confirm the additional electrical load by using motor data from the manufacturer's website. Partially offsetting this, EGD claim a credit of 6,023 kWhr/year as "Auxiliary Electrical Savings". By review of the E-tools manual, this is claimed as "savings of reduced use of local unit heaters" and is sourced from ASHRAE 2008 S9, equation 13-9.15. Using this equation, GENIVAR calculate a value of 4,069 kWhr/year (variation is largely attributable to the difference in thermal load savings). Collectively GENIVAR calculate a net *additional* electrical load of 13,902 kWhr/year (versus 11,524 kWhr/year of the EGD file).

	As above, GENIVAR accept the results of the EGD file based on site specific Toronto ambient BIN data versus the simplified GENIVAR analysis based on limited pre and post measure values. **Condition Assessment and Measure Life** This measure is not interconnected with any aspects of the client's process - other than electrical supply and structural members (upon which it is secured). GENIVAR note the facility and processes therein, appear to be well maintained and the measure should reach the **full measure life of 15 years** as per the EGD file with prescriptive maintenance. The 15 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

RA.IND.LG.NRT.004.13

Industry Type:	Construction Product
Project Description:	**General** This is a company which produces materials for road construction and resurfacing. **Base Case** The product is heated in external insulated, jacketed tanks but the heating oil is conveyed through exterior uninsulated pipes. **Implemented Measure** For this measure, the bare exterior pipes were covered with 1.5" thick insulation and aluminum jacket.
Summary of EGD File :	This file includes; • A spreadsheet which captures the heat loss scenario pre and post measure. • An excerpt of an ASHRAE chart to justify the heating and wind design criteria for this application • A copy of the invoice from the insulation contractor to justify the capital cost expended, and also the specific breakout of various lengths of the different diameter hot oil piping. Invoice dated March 2012 at a cost of [redacted] (not clear if inclusive of tax). • A summary of the average ambient temperature from mid-April to mid-December from 2010 to 2012.
Site Inspection Date and Findings:	**December 18, 2013 at 9:30AM** During the site visit, GENIVAR verified the installation of insulation and cladding of exterior piping in this process and the general operation of the facility as it neared end of production for the year. **Verified Conditions** • The client confirmed the product is heated 8 month / year (mid-April to mid-December), 7 day / week, 24 hour / day with hot oil boiler. GENIVAR accept this number but recognize that this plant is dependant of weather and other contractual / production issues of its associated industry. • The client confirmed that prior to the measure, the hot oil supply and return was not insulated resulting in a significant heat loss. Post measure, the gas flow to the heater has reduced but there is no sub-metering of gas to the heater. • Client confirmed the supply temperature averages 325F and returns at 300F on an annual basis. The operator indicates that these numbers fluctuate up or down by 10 to 15 degrees depending on ambient and production conditions. On the day of the inspection (a very cold windy day in December), the supply temperature was 340F and the return was 315F so the dT is generally maintained on a floating basis. This was verified on local instrumentation and the client indicated there is no available trending of this data. • Also historically, the client indicated that the finished product undergoes evolution with new process and raw material variations. • The file is based on 77% heating efficiency. It is noted that the Heatec HC 200 (2.5 million btu/hour) heater is perhaps 20 years of age (original nameplate is missing and a replacement lamacoid nameplate does not state date of manufacture). By review of website, manufacturer identifies output is 2 million btu/hour (hence 80%). Based on its continuous operation of heating the product, and perhaps a slight de-rating of performance, EGD identifies a conservative 77% operational efficiency. This is accepted as reasonable by GENIVAR.

	• The piping network is complex and features horizontal, vertical and angled piping of various diameters. By review of the insulation invoice, there is clear indication of the installed lengths of insulation on a suitable breakout in accordance with pipe diameter. This is accepted by GENIVAR as being a reasonable verification of the length of the piping and was generally concurred during the inspection. • GENIVAR confirmed the measure consisted of 1.5" of mineral fibre with aluminum jacket
EGD File Analysis:	**Independent Analysis** See GENIVAR Independent analysis included in Appendix A. The EGD Spreadsheet provides adequate clarity to support the methodology of the reduction calculation. • The use of heat loss coefficients from 3E Plus software is appropriate as this is an industry wide recognized analysis tool. Upon request, EGD furnished a NAIMA 3E Plus4.0 output of the 4" diameter pipe heating supply condition to exactly match the pre/ post measure temperatures and heat loss of the pipe with exact match to the entries places in the EGD spreadsheet to adjust for actual lengths. • For this analysis, the appropriate process supply and return temperatures and ambient conditions were utilized to match the verified data. o The exterior temperature in the file was 58.46F – provided as an average monthly temperature from mid-April to mid-December for the past 3 years. This number is agreed by GENIVAR as being appropriate and its accuracy is representative of the calculation. GENIVAR reviewed historical monthly data on Weather Network website. o The exterior wind speed of 9 mph is based on ASHRAE data and accepted by GENIVAR. • File review confirmed the length of piping is cumulative of heat loss as both supply and return. Upon detailed checking, the spreadsheet analysis confirmed (Note 5) that the pipe lengths are 50% supply and 50% return and this is appropriate and the savings for each are applied to the delta heat loss (pre/post insulation). • GENIVAR provided an assessment for the 4" diameter pipe insulation system in process supply conditions. With the insulation performance coefficients of the insulation software, GENIVAR was able to achieve near exact correlation with the EGD analysis. On this basis, the repetition of the analysis for the other systems was accepted. GENIVAR thereafter calculated the natural gas savings from this reduced heat loss and achieved near identical correlation with the EGD analysis. Further to this software, GENIVAR also verified the performance of the insulation heat loss coefficients with an online tool from National Mechanical Insulation Committee (NMIC) Energy Calculator. http://www.wbdg.org/design/midg_design_echp.php There are no induced electrical or water savings associated with this measure. **GENIVAR accept the results of the EGD file.** **Condition Assessment and Measure Life** GENIVAR note the facility and piping insulation are in an exterior setting but suggest that the measure should reach the **full measure life of 15 years** as per the EGD file. The 15 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

RA.IND.LG.RT.007.13

Industry Type:	Pulp and Paper
Project Description:	**General** Company which manufactures paper product. **Base Case** Currently, the paper machine dryer releases hot air to the outside. Installed in 1976, the dryer previously had a heat recovery system which had been abandoned in the early 2000's. **Implemented Measure** Client removed the non-functional heat recovery system and retrofitted a replacement into the dryer. Recovered heat from the exhaust is now used to preheat make up [redacted] water to the process. In so doing, this reduces the requirement for steam to heat the process water. With an ultimate recovery capacity of [redacted] btu/hour, the plant is continuing to explore additional uses for the full utilization of the recovered heat. Currently about [redacted] million btu/hour is utilized - and is the basis of this file assessment.
Summary of EGD File :	The file includes; • Ventilation design data from the contractor together with the warranty assessment of the performance. • A data sheet of the new heat exchangers • A drawing of the hood modifications for the dryer exhaust to interconnect to the heat exchange system • A narrative of the current base case operation together with the efficiency measure as installed. This contains a heat balance and schematics of the base case steam requirement and of the energy measure as implemented. • Traces are included from the data logging performed on the recovered heat • A series of invoices from the equipment vendor ([redacted]) and the contractor ([redacted]) for the installation. A March 14, 2013 summary of invoices (circa June to December 2012) is included depicting a total cost of [redacted]. • Pictures of the previous heat recovery unit together with pictures of the new installation
Site Inspection Date and Findings:	January 8, 2014 at 9:30AM During the site inspection, GENIVAR verified the installation and operation of the heat recovery unit in the exhaust of the dryer together with the associated ducting upgrades and piping modifications for the recovered heat and process tank. Owing to the size of the hood and the moist, warm air variability across its transverse, the analysis is properly focussed on the use of the recovered heat in the process water stream. **Verified Conditions** • GENIVAR verified the heat recovery equipment installed in accordance with the documentation in the file • GENIVAR viewed the boilers, and lacking specific combustion analysis, agree the stable process load suggests an average efficiency of 75% is appropriate to the analysis. The robustness of industrial boilers of this type has service lives which may be in the 30 to 50 year range depending on operator maintenance and water quality. • Traces included from the data logging (flow devices were logging for 6 days and the temperature devices were logging for 16 days) to verify; o the process flow rate (average of [redacted] usgpm) with a very steady

[redacted]

	profile, o heat recovery loop water supply [redacted] / return temperature [redacted] and flow rate [redacted]. GENIVAR understand these are from external data loggers which were temporarily installed to verify the installation. • Traces of [redacted] water inlet depicting an average temperature of 70.6F were contained in the file from trended client annual readings. • GENIVAR verified the process water stream [redacted] via local instrumentation. • Other streams into the process water tank [redacted] are constants verified by the client from their process and are consistent both for base case and post measure. GENIVAR accept this data.
EGD File Analysis:	Client has confirmed that the heat recovery system has been very successful. GENIVAR prepared independent mass and energy balances (see GENIVAR Spreadsheet, Appendix A) to confirm that the heat recovered from the dryer matches the mass and heat balance in the submission and it is being utilized in the revised process. GENIVAR's assessment closely aligns with the EGD file. A couple of comments of the analysis in the file; • Indication of [redacted] water temperature of 70.6F on an annual average basis was confirmed by the client with a year of trended data. GENIVAR had searched for a credible reference source for this data. If this value was reduced, the natural savings could be increased during the winter season. • Further to the process data logging traces, confidence is demonstrated to accept the heat recovery flow rate and dT. This is the most important data to enable the recovered heat to be coordinated with its full utilization in the process. • The EEP analysis is properly calculated in the file. The [redacted] water make up is modified to be now split for injection both pre and post process water tank (see diagram EEP case, M2 and M4 flow rates). This enables the recovered heat to achieve a mix temperature (in the process water tank) [redacted] which exceeds the process requirement [redacted] and the (now) split [redacted] water flow actually cools the mix condition back down to the required process condition of [redacted]. **GENIVAR accept the results of the EGD file as our independent analysis resulted in a near identical value.** **Condition Assessment and Measure Life** GENIVAR note the measure should reach the **full measure life of 20 years** as per the EGD file and this is confirmed by the previous 1976 installation lasting until the early 2000's timeframe. The 20 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings exceeds the 15 year recommendation of EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. GENIVAR note that heat exchangers used in industrial applications are typically designed to more robust criteria than commercial or residential installations and often are seen to exceed 30 to 40 years of service (as per its predecessor). However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

RA.IND.LG.NRT.001.13

Industry Type:	Furniture
Project Description:	During the manufacture of steel furniture, the steel is cut, welded and formed into various shapes for the end product. The shaped product requires a cleaning to remove dirt and to enhance the bonding of the paint finish upon it. **Base Case** Until recently, the chemical added in the wash tank necessitated a 125F operating temperature to enable its appropriate performance. **Implemented Measure** The client has substituted a new cleaning chemical to the wash tank which operates at ambient temperature and hence does not require a heated condition in the tank.
Summary of EGD File :	The file includes, • A spreadsheet defining the physical size of the cleaning tank as well as the rating of the burner • A spreadsheet assessing the heat requirement of the cleaning tank on an annual basis • An email describing the cost of procurement of new chemicals, together with disposal of old chemical and cleaning in the amount of [redacted]
Site Inspection Date and Findings:	**January 9, 2014 at 9:30AM** During the site visit, GENIVAR confirmed that the client had switched to the new wash chemical. Client is extremely pleased with the energy measure. In addition to the natural gas savings, it has resulted in a more comfortable work environment (as the process tank is located in the vicinity of the open dryer) and the reduction in added heat in this region of the plant for worker exposure. The client has opted to not remove the burners and leave them in place as a contingency. Furthermore, these non-operational burners do not require planned or unplanned service and its resultant downtime on the process. Client confirmed that the burner for heat input to the tank has not been operated since the new chemical was introduced. File is for Paint Line #1 but client indicates that the measure has also been introduced for Paint Line #2 with similar savings. **Verified Conditions** • New chemical is actually a two part mix – initially it took some fine tuning by client to determine to proper mix ratio. The mix ratio was quickly found and has been maintained ever since. • Client confirmed that the effect on the finished product quality / reject rate has not been compromised as a result of this new wash chemical and the resultant temperature of the tank. • While on site, inspection of the plant controls confirmed that the burner was in the off position during production and via local instrumentation that the internal tank temperature was operating at 78.2 F. The client has found that the chemical performance at room temperature (68F) is adequate. • Client confirmed the previous chemical required a tank temperature of 125F. • The regulated temperature of the factory (not air conditioned but maintained at 70F during winter) enables the parts to be at room temperature prior to their washing and the heat rejected from the nearby dryer area enables the wash tank to rise every day as the dryers get to temperature and the production commences.

[redacted]

	• The tank is closed to minimize heat and evaporation losses. • Exterior dimensions of the tank were confirmed. Solution depth was generally confirmed by viewing of the tank without being able to measure in the closed operational tank. • Production was confirmed as 17.5 hour/day x 5 day / week x 50 week / year. • There is no dedicated local gas meter of the burner but as mentioned the burner is off. • The quantity of nozzles and flow rate was not able to be field verified. Data within the EGD file was discussed and was agreed by client as representative.
File Review Comments:	GENIVAR have prepared an independent assessment of the calculation and methodology (see GENIVAR spreadsheet of Appendix A) and have confirmed that the analysis and methodology is appropriate. For the baseline calculation gas consumption, GENIVAR offered a different methodology to calculate the start-up heat requirements. GENIVAR assessment is based on the heat loss during the non-production time, on the basis that the downtime is less than the time it would take for the tank contents to stabilize to the factory indoor set point temperature. GENIVAR used a manufacturer's Engineering Guide (Eclipse Combustion page 47) as a basis for heat loss from an uninsulated tank with a fluid temperature of 120F. This is a credible burner manufacturer of this application and the documentation is specifically pertaining to a spray washer application. In this Guide (page 47), the manufacturer suggests using a burner efficiency of 70% (versus 85%) in EGD file. GENIVAR accept the 85% efficiency as a more conservative approach. For the operational heat required for nozzle flow, GENIVAR (as mentioned) was unable to field verify the previous operational nozzle heat loss when the burner was used in the process. Using the same engineering guide for consistency of methodology, (page 48) suggested dT is presented for water temperatures. For 120F, a conservative 1F is used in the file and GENIVAR accept this conservative approach is appropriate for high flow, low dT condition which is the dominant component of the natural gas savings analysis. **GENIVAR analysis is very close to the EGD file (<1%) see Table 4.1 for our result. We suggest the EGD file result is appropriate.** **Condition Assessment and Measure Life** GENIVAR note the chemical is not a piece of equipment. The chemical will have a make up to replenish wash loss and spillage. The **full measure life of 20 years** is per the EGD file. The 20 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

RA.IND.I.G.RT.006.13

Industry Type:	[redacted]
Project Description:	**General** This [redacted] manufacturer utilizes 2 adjacent plants [redacted] **Base Case** Collectively for both plants, there are 30 air handling units [redacted]. On average, these draw 35% fresh air and are connected to the client's building automation system with a set point of 21C (production) / 18C (non-production). **Implemented Measure** Client installed VFDs for each air handling unit and adjusted the airflow to achieve a total (return + fresh air) flow reduction of 10%. As a result of this measure, the fresh air heating requirement reduces accordingly.

Summary of EGD File :	The file includes;
	• Air Flow Reduction Project – summary of natural gas and electrical savings for implemented measure.
	• Collection of invoices for the installation of the VFDs upon each air handling unit from February / March 2013 with a summary of invoices depicting a total cost [redacted]
	• Summary of the air handling units [redacted] together with indication of air flow and outside airflow %.
	• Spreadsheet of HVAC Bin Data and client production operational data together with explanation of basis of calculations depicting the gas and induced electrical savings as follows.
	  o Evaluation of **baseline scenario** with Production Time CFM (cumulative average of 35% fresh air) and Non Production Time (25% of total flow on and no fresh air)
	  o Evaluation of **energy measure** with Production Time and Non Production Time (as above) with 10% total flow reduction)
	• Spreadsheet depicting Fan Power Consumption (baseline versus energy measure implementation)

Site Inspection Date and Findings:	**January 10, 2014 at 11:00 AM** During the site inspection, the client confirmed that the 10% reduction measure was of the Total airflow (I.e. recirculated + Fresh air) not fresh airflow. Flow reduction was enabled via new VFDs. Client confirmed the success of the project in terms of continued operator satisfaction and of production quality. **Verified Conditions** • Client confirmed production is on average 6 days per week, 18 hours per day for 48 weeks per year = 5184 hours / year. • Manufacturing season is generally 48 weeks / year (8064 hour / year). • From the file, there is a schedule of 30 air handling units combined for [redacted] with a total of [redacted] outside air (cumulative total of 35% fresh air). GENIVAR spot checked 3 of these units for their flow relative to the schedule as it was not practical to visit all 30 of the units throughout both plants. • Client demonstrated via of the Building Automation System (BAS), the following items for GENIVAR verification; o 10% flow setback protocols as per the measure during production and non-production time.

[redacted]

	o During non-production, fresh air is eliminated (dampers closed) and flow is reduced to 25% of total ([redacted]) and the set point is 18C. o During production time, flow is [redacted] (fresh) and 814,320 (recirculated) with a set point of 21C. • There was no local metering to verify heating performance pre/post measure. GENIVAR accept that the performance of the measure is dependent on the EGD calculation. It is assumed that the manufacturing process (heat gain from manufacture and from workers) would be consistent pre / post measure to nullify its effects on the analysis.
EGD File Analysis:	GENIVAR have prepared independent confirmation of the analysis contained in the file (See Appendix A). • The EGD calculation is appropriately presented in a BIN analysis with grouping of 5F. Furthermore, it is broken out on a time of day basis (01-08, 9-16, 17-24) to enable the 18 hour shifts and 6 day / week production to be reasonably configured into the analysis. • Flow rates (production and non-production) contained in the analysis is as verified in the BAS. • Set point temperatures (21C for production and 18C for non-production) contained in the analysis is as verified in the BAS. It is pointed out that the production time analysis is based on a bin analysis with a 21C heating criteria for production and 18C heating criteria for non-production. • GENIVAR spot checked select row entries to assure due diligence of the modelling and the calculation. The level of analysis is appropriate in GENIVAR's opinion to validate the measure which is entirely weather dependant. • The BIN analysis is performed using Toronto weather data and a BIN multiplier [redacted] is implemented as a correction factor to account for the actual location. • GENIVAR's accept the 70% heating efficiency of the equipment being representative of a seasonal efficiency of this equipment. • GENIVAR's independent analysis confirms that the conversion of btu/hour, adjustment for efficiency and conversion to m^3/year is properly accounted for and our findings are within 1% of the EGD file results. • GENIVAR's independent analysis of the induced electrical savings agrees with numbers as presented in the file. The following points are noted; o Client mentioned that the electrical analysis has been audited by the electrical utility and its team and that the numbers in the file are as presented. o The refrigeration savings are based on a conversion from TR / year to kWhr / year of [redacted] kW/TR (which is a reasonable "rule of thumb" conversion for equipment of this vintage). o The fan power savings are based on a conversion from cfm to hp as follows; hp = (cfm x "w.c.) / (6356 x efficiency). This equation is from Eclipse Combustion Engineering Guide (p20) as well as others including Engineering Cookbook by Loren Cook Company) (p83). These numbers were spot checked by GENIVAR. The resultant savings are in accordance with the Fan Law (0.9^2). **GENIVAR accept the results of the EGD file.** **Condition Assessment and Measure Life** GENIVAR note the measure should reach the **full measure life of 15 years** as per the EGD file. The 15 year measure life used in the Cumulative Cubic Meters

[redacted]

	(CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

RA.IND.LG.NRT.001.13

Industry Type:	[redacted]
Project Description:	**General** This file is a plant expansion of [redacted] facility. **Base Case** A plant expansion built to Ontario Building Code 2006 and ASHRAE standards. **Implemented Measure** For this expansion, the building services (chilling and heating) were designed using an Integrated Building Design Approach with EGD (NBC) and OPA (HPNC) program assistance. For the heating system, the design featured low temperature condensing hot water boilers (in lieu of a more conventional hot water system at approximately 80- 82%). Consequently, the measure is to assess the incremental savings of a condensing hot water boiler versus a more typical high efficiency hot water boiler in this application. **Notes** 1. This file contains a Sharing of Attributes Calculator where by 76.43% of electrical and natural gas savings are accepted by OPA and 23.57% are accepted by Enbridge. GENIVAR does not have an opinion on this breakout or how it may be defended. 2. The chilling plant design uses technology which is discrete from (i.e. not induced by) a natural gas measure, nor does it influence the natural gas file. Consequently GENIVAR do not offer an opinion on the predicted electrical utility savings. Furthermore, as described below, there are already reports of opinions and modeling measures of these systems included in the file. Hence, GENIVAR suggest reliance on the assessments of others in this file. 3. This file differs from most in that a measure(s) was not introduced/ retrofit into an existing facility but rather into a facility which had not yet been built. Hence neither the client, nor the reviewer, has an existing thermal profile for comparison to be drawn on its effectiveness relative to baseline.
Summary of EGD File :	This file includes; [redacted] Enbridge sharing of environmental attributes calculator. [redacted] • HPNC Project Completion Report (Dec 27, 2012) prepared by [redacted] • HPNC New Construction Program Application (May 5, 2010) • HPNC Simulation Summary Report prepared by [redacted] (October 2010, Revised March 2012) with Appendices (*Note that these appendices feature several incomplete partial drawings in 8-1/2 x 11 of anticipated full size engineering drawings. These drawings in many cases are of poor quality. Full size, complete drawings were requested but GENIVAR were advised that they are not available*). • HPNC Project Completion Notification (December 20, 2011) prepared by Client including Appendices with vendor equipment data sheets.
Site Inspection Date and Findings:	**January 14, 2014 at 9:30AM** During the site inspection, the client claimed they were satisfied with the operation of the condensing hot water boiler and commented that in fact, on a frequent basis, there is adequate internal heat within the plant, and the boiler is only "topping up" the heating profile.

[redacted]

	Verified Conditions • GENIVAR verified that the installed boilers are as per the EGD File, namely Bryan Triple-Flex Ultra High Efficiency Condensing Hot Water Boilers. At the plant 98F design condition, the stated efficiency is 97.5%. • Review of the boiler operation on the day of the inspection identified that the hot water supply temperature was 140F for boiler #1 and 144F for boiler #2 which differs from the file which suggested 98 supply /64F return. The client confirmed this was as a result of some repair work done recently on one of the boilers - and the set point increased to compensate. The client remedied this to the operations by a phone call to reset the supply temperature. • Initial concern was that the 98F supply /64F return condition appeared to be inappropriate to a coil to maintain the desired facility set point. Client confirmed the suitability of the design condition and provided a cut sheet for the coil selection to verify these design conditions (Coil Master Dual Heating HWD08F10-49.5x132L with fluid supply 98F / fluid return 66.3F). As the coils are shared for the cooling and heating (Switchover), there is an 8 row design to optimize the heat transfer. **Unverified Conditions** • As mentioned, being a new facility, it was not possible to establish a baseline scenario to discuss the merits of the implemented measure with the client. • A considerable amount of heat is contained by process and manufacturing equipment within the facility, as well as workers – all of which contributed to internal heat gain. This would reduce the amount of heat which would be required to temper to workspace. It would be beyond the magnitude of the project and available time by GENIVAR to attempt to recreate this heat load and the client would certainly not support the amount of time to collect this data and its admission into a potentially public document. • Compounding this, the production layout at this facility is subject to variations on an annual basis as the plant's role changes to suit its contracts and annual commitments. • Hence there is a reliance on the substantial modelling (by the consultant of record) and the verification (by the file verification firm) to enable GENIVAR to offer its due diligence to offer an opinion on the realized savings of the measures.
EGD File Analysis:	Review of the file documents demonstrated that there is minimum information of the hot water system operation and modelling with condensing boilers. The majority of the correspondence addresses the merits of the electrical measure savings not associated with heating equipment. **From the Client HPNC Project Completion Notice (Dec 2011), Appendix A**, there is a monthly depiction of the Energy End Use Summary for all Fuel Meters for both the Proposed Design and the Baseline Model. Column 4 of these sheets depicts Space Heating. Hence, these monthly space heating loads are accepted for Proposed Design and Baseline models as the basis to calculate the anticipated natural gas savings for this measure (see GENIVAR Spreadsheet, Appendix A). For this approach, our comments follow; • The monthly space heating loads for both scenarios do not appear to be appropriate as the proposed design depicts much higher loads in the winter months (not expected) and much lower loads during the shoulder and summer months (expected). • However, on annual basis, the cumulative numbers appear to be appropriate. On this basis, the proposed design would yield a 12% natural as savings. However this savings is lower (54,194 m^3/yr.) than the claim of the file (139,088 m^3/yr.). **GENIVAR suggest that this reference did not provide an adequate correlation**

[redacted]

to EGD file.

From the Simulation Summary Report (October 2010, March 2012) the following data in the Summary (Page 3) was provided;

- Heating Boilers –
  - Proposed 11,962,546,764 btu/year, and
  - Baseline 15,224,901,119 btu/year.

In addition to recognizing that these numbers do not have adequate calculation support in the report, they would only represent a natural gas savings of 91,322 m^3/yr. – which does not correlate to the file (139,088 m^3/year).

GENIVAR suggest that this reference did not provide an adequate correlation to EGD file.

On this basis, GENIVAR sought reconciliation support through [redacted] (who prepared the HPNC Project Completion Report and comprehensively audited the HPNC Simulation Summary Report – which was prepared by [redacted]). Several clarifications were provided to aid in the assessment of the file;

From EPL Email Correspondence of January 31 / February 3 2014,

Space Heating	*Reference Gas Consumption MMBtu/yr*	*Proposed Gas Consumption MMBtu/yr*
Original by [redacted]	*15,225*	*11,963*
Revised by [redacted]	*7,505*	*2,522*

Verified by Screenshot of EPL Revision 4

These reference and proposed project natural gas consumptions were verified via comprehensive computer modelling by [redacted] as described below. Our verification was based on discussion and computer screenshots which were made available. Discussion follows;

- *The Reference Case was prepared using eQUEST simulation tool for the expansion portion only. During EPL's initial review, several deficiencies were identified,*
  - *the model was not built according to the ASHRAE 90.1 Chapter 11 or Appendix G methodologies,*
  - *schedules between the proposed and baseline models did not match*
  - *minor inputs that were inconsistent between the two models.*
- *The Proposed Case was designed using eQUEST and simulates the entire plant - this is required as the proposed chiller and hot water systems serve the entire facility. (In the reference model, the chiller and hot water systems were simulated to just provide as required for the proposed expansion). With the proposed simulation, careful work was required to separate the loads attributed to the existing facility and the expansion. Only the energy usages attributed to the expansion was accounted for in this application.*

To summarize, the natural gas consumption savings result from the following;

- Increased building envelope performance resulted in a decrease of 20% compared to the reference building envelope.
- High efficiency boilers (model used a conservative 93% efficiency) compared to a conventional atmospheric boiler (model used 80% efficiency which is reasonable).
- Use of electrical space heat to comply with client's policy not to use hot water heating in certain portions of the building (electrical room for example). In this analysis, this induces an additional 241,511 kWh of

	electrical energy (approximately equivalent to 824 MMbtu/hour) which is properly accounted for [redacted] analysis. **Based on these revised consumptions, and discussions with parties who had considerable and prolonged exposure to the project, GENIVAR was able to perform its due diligence to learn of the evolution of the design / modelling and accept the natural gas savings of this measure from the EGD file.** **Condition Assessment and Measure Life** GENIVAR note the facility and piping insulation are in an exterior setting but suggest that the measure should reach the **full measure life of 25 years** as per the EGD file. The 25 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility. **Sharing of Attributes** For this measure, EGD claimed 23.57% of electrical and gas savings with OPA receiving the balance.

3.4 Wave 2

RA.IND.SM.NRT.029.13

Industry Type:	Food
Project Description:	**General** Food manufacturer which uses [redacted] steam retorts [redacted]. **Base Case** A sophisticated PLC controls the steam injection to the retort for heating [redacted] and cooling water for cool down of the process with compressed air for pressurization. When the equipment was sized and configured approximately 10 years ago, the larger steam valve was the basis of steam into the retort. **Implemented Measure** Client retained a controls specialist to assess the dynamics of the process to Improve the stability of the process and reduce energy. Control loops were assessed and the process dynamics were optimized.
Summary of EGD File :	The file includes; • A project narrative by the controls specialist describing the project relative to the product [redacted] requirements together with the procedure to assess the existing and modified process control dynamics. • Spreadsheet which outlines 52 weeks of metered steam flow to the process with production output together with 22 weeks of data during the refinement and testing period and 21 weeks of data post measure implementation. • Regression analysis of the data • Summary of invoices [redacted] together with some support process control specialist invoices dated February 28, 2013.
Site Inspection Date and Findings:	**February 26, 2014 at 9:30 AM** During the site inspection, client confirmed the success of the controls in improving process stability and its energy performance. **Verified Conditions** • Steam to the [redacted] retorts originates from a separate boiler in an adjacent plant [redacted]. At the entry to the plant, a steam meter tracks steam consumption to the retorts. The client tracks the steam consumption twice daily and monitors the performance within tolerances. Should the performance trend outside of the tolerance, the energy manager addresses the situation with operators for reconciliation. The steam originates from a [redacted] steam boiler with efficiency of approximately 80 to 82 % per client. GENIVAR concur with this efficiency as being representative of this equipment [redacted] • Heating of the facility is by rooftop equipment not connected to the steam, so this is independent of the measure and its performance. • By view of the spreadsheet, the client verified that the data in the EGD file is as provided by them based on actual tracked steam flow and production yield. • Client demonstrated via computer spreadsheet analysis that the process is very stable and efficient and monitored. • Client confirmed that the primary success of the steam controls was to [redacted] better control the admission of steam to the retort [redacted]

[redacted]

	As a result of the improved control of steam to the retort, there is a reduction in the overpressure condition [redacted]
EGD File Analysis:	**Independent Analysis** See GENIVAR independent analysis included in Appendix A. • The base is from client 2012 data for one year of production (week 201 to 252). • During the extensive 22 week testing and refinement phase of the project in 2013 (week 301 to 322), the product safety and quality was rigorously verified with local resources as well as clients US process specialists who were assessing the measure for deployment at other plants. Heat pens and internal probes were used extensively upon the racks in the retort. Performance of this production duration was tracked but not included in our analysis of the measure. • GENIVAR's analysis is based on the collected data after the completion of the measure (week 323 to 344). Comparing 2012 base case ([redacted] tonne product / lb. steam) versus measure ([redacted] tonne product / lb. steam) demonstrates the success of the measure. Furthermore, by review on a weekly basis, the performance is very stable and consistent. Prorating the 2013 measure performance to the production level of the 2012 base case yields a saving of 10,655,020 lb. / year of steam. With a boiler efficiency of 82%, the measure results in a natural gas savings of 342,032 m^3/year which compares within less than 1% of the 343,250 m^3/year calculated in the EGD file. It is noted the EGD analysis is based on a regression analysis whereas GENIVAR used prorated data of the measure duration adjusted to be equivalent to the production of the base case 52 week data. The measure resulted in a reduction of [redacted] steam [redacted]. This would result in water savings as this [redacted] steam would not be returned to the condensate tank. At the conclusion of the [redacted] cycle, cooling water is admitted to the retort to cool down the product for its removal. The mixed steam condensate and cooling water is then drained [redacted]. At this mixed temperature condition, the heat loss on the return is minimal. Client does not measure or meter the condensate return to the steam plant and hence there is limited basis to attempt to quantify this water savings. **Based on the correlation of our simplified analysis, with the EGD calculation, GENIVAR accept the results of EGD file.** **Condition Assessment and Measure Life** GENIVAR note the facility and processes therein, appear to be well maintained and the measure should reach the **full measure life of 10 years** as per the EGD file. The 10 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is conservative to the 15 year measure life of controls per the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. This conservative approach recognizes the controls were optimized and the client, and the industry, is conservative to product safety. The operators will not modify these controls. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

RA.IND.LG.NRT.025.13

Industry Type:	Automotive
Project Description:	**General** Steam Trap audit and repair program at an automotive manufacturer. **Base Case** Do nothing. **Implemented Measure** Retain a steam trap specialist [redacted] to assess and repair/ replace identified steam traps throughout the facility.
Summary of EGD File :	The file includes; • Executive summary of steam trap company assessment of 1057 steam traps with an indication of summary of findings with an indication of steam losses and operational cost • Indication of cost to replace traps [redacted] and confirmation of completion (dated November 5, 2013). • Enbridge E-tools analysis to calculate annual gas savings.
Site Inspection Date and Findings:	**Not performed.** GENIVAR elected not to perform a site inspection owing to the statistical nature of steam traps in duty. Based on the number of traps in service at this facility (approximately 1000), any evaluated sample (of appropriate size) will identify variability in their condition and performance. This was discussed with EGD.
EGD File Analysis:	GENIVAR reviewed the file. The E-tools analysis has evolved over substantial field experience on the operational lifecycle of steam traps in service in industrial settings. Clients who maintain a regular protocol of on-going evaluation and repair / replacement of steam traps will regain and maintain performance and efficiency benefits. EGD identify the following; • client's annual gas baseline [redacted] • boiler efficiency of 75% [redacted] identify the following; • 1057 traps assessed • 29 traps leaking • 6 traps failed closed • 630 traps not in service • 15 traps disconnected • Steam losses of 1699 tons / year By analysis, this amounts to 3.4 million pounds / year (387 lb/hour based on 365 days / year and 24 hour / day. From Spirax "Design of Fluid Systems – Hook Ups" (12th Edition, Second Printing), page 57, the mean life of a steam trap is identified as 7 years (EGD measure life analysis is more conservative at 5 years). From this reference, Spirax identify that 15% (i.e.1/7) will fail during any given year with an annual loss of 5.62% (75% of 7.5% (failure of more than half of the year for clients with an annual steam trap program). [redacted], with a (rule of thumb) 25 lb. steam / m^3 natural gas coefficient, this would represent about [redacted] million lb. steam per year. Losses of 3.4 million out of [redacted] million is about [redacted] Correcting for 630 (out of service) /1057 (total) traps (i.e. 427 traps in service) would yield [redacted]. This

	number is well below the reference of 5.62% and represents a conservative approach. For a facility of this size, with the indicated population of traps and a strong commitment to operations and maintenance of their facility, this number appears reasonable. **GENIVAR accept the results of the EGD file.** **Condition Assessment and Measure Life** GENIVAR note the measure should reach the **full measure life of 5 years** as per the EGD file. The 5 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

RA.IND.AGR.NRT.001.13

Industry Type:	Agricultural
Project Description:	**General** Greenhouse producing various crops [redacted]. **Base Case** Uninsulated hot water piping from the boiler plant to the greenhouses. **Implemented Measure** Installation of 30mm insulation and aluminum jacketing to 1000 linear feet of 3" diameter header.
Summary of EGD File :	The file includes; • Output of NAIMA 3EPlus Version 4.1 software of insulation performance. • Enbridge E-tools analysis of insulation efficiency to calculate annual gas savings. • Email dated January 9, 2013 with indication of cost to procure and install the insulation upon the header [redacted] together with a photocopy of the insulation selection.
Site Inspection Date and Findings:	**March 5, 2014 at 1:30 PM** During the site visit, GENIVAR verified the previously uninsulated hot water header was uninsulated and had been insulated and jacketed. Previously, the uninsulated header resulted in heat losses on the portion of the piping between the boiler room and the greenhouses and along the perimeter of the greenhouse envelope which was not benefitting the intended climate of the growing operation. Consequently, there was non-uniformity of the plants at the perimeter of the greenhouse versus the interior. Post measure, the plants are more uniform with better yield. **Verified Conditions** • Hot water supply temperature of 185F was generally verified by local instrumentation. • Exhaust temperature of boiler of 370F was verified by local instrumentation. • GENIVAR verified the mineral fibre pipe insulation and aluminum cladding as per the file. Client indicated that the 1000 feet of insulation and cladding indicated in the file should be modified to be 1200 feet based on his knowledge of pipe horizontal runs (known length of greenhouses) plus vertical runs. • Greenhouse temperature of 68F was verified by local instrumentation. In an interior setting, there is no wind speed across the piping. • In the region between the greenhouse and the boiler plant, the client maintains this space to be slightly above freezing. • Client also confirmed the greenhouse operation of 5000 hours per year as being reasonable of the boiler operation as during spring and summer, the heated pipe controls the relative humidity and during fall and winter to maintain growing conditions. Depending on crop selection, and other factors, months of November through February are limited. • While the client has a very new boiler on site, they use a vintage boiler which had been re-tubed last year and runs at approximately 40% of full load per client (Greenhouse requires CO_2 from the exhaust of the boiler and is operated at a lower part load and efficiency setting). Rather than a boiler efficiency of 80% as stated in the file, it is suggested that the analysis be adjusted to file be based on a part load, seasonal efficiency of 60%.

[redacted]

EGD File Analysis:	Upon review of the file, GENIVAR acknowledge that the EGD Spreadsheet provides adequate clarity to support the methodology of the reduction calculation. The use of heat loss coefficients from 3E Plus software is appropriate as this is an industry wide recognized analysis tool. Further to this software, GENIVAR also verified the performance of the insulation heat loss coefficients with an online tool from National Mechanical Insulation Committee (NMIC) Energy Calculator. http://www.wbdg.org/design/midg_design_echp.php The conversion of btu/year to m^3/year is verified and confirmed as well as the adjustment for the heater efficiency. There are no induced electrical or water savings associated with this measure. GENIVAR's independent analysis verifies the EGD value within 1%. Based on site finding of modified length of insulated header and reduced boiler efficiency, GENIVAR performed an additional iteration of the calculation and suggest an adjusted savings of 67,138 m^3/year (versus EGD 41,736 m^3/year). The intermediate area (between the greenhouse and the boiler plant) was maintained just warm enough to keep liquids and workers (in jackets) from freezing. Hence even though it is not outdoors (in a region where heat loss is undesirable), if the pipe remained uninsulated, the parasitic heat loss along it (to achieve the necessary condition in the greenhouse) would be excessive compared to how much heat is to be conveyed in the pipe. With the insulation, the client is able to properly maintain the production area independently of the process conditions of the greenhouse. Furthermore, the heat loss of the former uninsulated pipe would be in the upper level of the greenhouse where its benefit to the minimal heating criteria of the production zone is very inefficient. During the shoulder season when heat is not needed in this intermediate region, the heat is still needed in the greenhouse. It would then be GENIVAR's opinion that the heat savings is appropriate as calculated. **GENIVAR accept the methodology of the EGD file and the performance of the NAIMA 3E Plus software, but recommend an adjusted value (based on site visit findings) to an annual savings of 67,318 m^3/year.** **Condition Assessment and Measure Life** GENIVAR note the piping insulation is in an interior setting but suggest that the measure should reach the **full measure life of 15 years** as per the EGD file. The 15 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the agricultural economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

RA.IND.LG.NRT.023.13

Industry Type:	Automotive
Project Description:	**General** Automobile [redacted] component manufacturer. **Base Case** Continue to use existing vintage, inefficient Melt Furnaces [redacted]. This technology lacks regenerative burners. **Measure** Implement new state of the art, efficient furnace technology known as a Tower Furnace including metal delivery system and holding equipment.
Summary of EGD File :	The file includes; • A description of the measure including a description of the facility background / together with the production changes at the facility over its history. • Discussion of the previous efficiency testing by EGD at this facility in 2010 on the Melt Furnaces. This includes measured parameters to establish the calculated combustion efficiency [redacted] • Discussion of the technology features of the new Tower Furnace technology together with its associated components of the entire process upgrade including metal delivery, holding, dosing, de-gassing / argon. • Methodology to establish the base case and implemented measure calculation using a specific fuel consumption of btu (gas) / lb. (product) and a 2014 Forecast model. • An email of December 16, 2013 depicting the incremental cost to upgrade to Tower Furnace technology versus melting [redacted]
Site Inspection Date and Findings:	**February 21, 2014 at 1:30 PM** During the site visit, GENIVAR verified that TF9 (this measure) and TF10 are both installed and operational. Client is very satisfied with the natural gas savings with this equipment. **Verified Conditions** • Information in the EGD package includes specific performance of the existing TF8 [redacted] which is identical to the new TF9 and TF10. Client tracks all [redacted] ingots to the Tower Furnaces (lb. of product) and each furnace features a dedicated natural gas meter (m^3 of natural gas). Each meter is tracked on the client's SCADA system. Hence monitoring and verification pre / post measure was provided by the client for inclusion in the EGD file. Client verified that the data in the file was provided by them. GENIVAR hence verify the performance of the measure is as submitted. • Further to this, the client was able to provide updated performance model from 11/1/2013 to 1/31/2014 for TF9 based on actual data [redacted] • Client confirmed that the quality of the parts is improved over previous technology with dramatically reduced rework of product re-admitted to the furnaces. • Previous melt furnaces had [redacted] excess O_2, with a stack temperature of [redacted] and calculated efficiency of [redacted] from previous investigation by EGD in 2010. [redacted] This information was verified by client from trended data but not witnessed by GENIVAR as the equipment is no longer in operation. Further this dated and unique equipment has no benchmarking performance data which is readily available.

	[redacted] 2014 production forecast for TF9 was verified by the [redacted] • Client indicated that facility is operational 50 weeks, 24 hours and 7 days per week.
EGD File Analysis:	**Independent Analysis** See GENIVAR independent analysis in Appendix A. • GENIVAR viewed the Tower Furnace information and performance on the manufacturer's website. Generally specific performance was limited but a project case file identified a specific performance of 1100 btu/lb. This is indicative of a substantial improvement relative to the previous melting furnace performance. Discussion with the client acknowledged this benchmark but re-affirmed that their operation is continuous 24/7 and with potentially different operation temperatures and product composition. • As the pre and post conditions are both metered and trended, the analysis by GENIVAR and EGD are based off same performance and 2014 production targets and arrive at the same predicted natural gas savings. • As mentioned, GENIVAR received from the client updated performance model from 11/1/2013 to 1/31/2014 for TF9 based on actual data at 909 btu gas / lb. product. In lieu of the basis of performance being the identical TF8, GENIVAR recommend this data be the basis of analysis as this for the actual TF9 of the measure. • For this process, the performance of the Tower Furnace is not dependant on exterior ambient conditions, so GENIVAR does not require any seasonality adjustments to be applied to this data. **With same analysis, but actual TF9 performance, GENIVAR determined an adjusted savings of 1,070,629 m^3/year should be representative of the measure's performance.** **Condition Assessment and Measure Life** GENIVAR suggest that the measure should reach the **full measure life of 18 years** as per the EGD file. The 18 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

RA.IND.I.G.NRT.021.13

Industry Type:	Automotive
Project Description:	**General** Automobile [redacted] component manufacturer. **Base Case** Failed and obsolete Honeywell Excel 5000 Building Automation System. Faulty controllers did not allow adjustments beyond the original design [redacted] **Implemented Measure** Installation of new Honeywell EBI Building Management System with ability to revise set point temperatures in an evolving manner to allow lowest possible process compliant and worker satisfaction condition.
Summary of EGD File :	The file includes; • A summary description of the base case with the implemented measure. • A schedule of the various make up air / air handling units together with airflow rates and base and measure temperature set points. • E-tools analysis for the calculation of natural gas savings based on the reduced temperature set points using appropriate BIN methodology. • A summary of incurred cost (dated 12/11/13) for the measure (BAS upgrade) [redacted]
Site Inspection Date and Findings:	**February 19, 2014 at 1:30 PM** During the site visit, GENIVAR verified the installation of a new BAS system operating as per the set point modifications of the measure. [redacted] GENIVAR learned that the client has reduced the set point temperatures without any implications on production or worker conditions. **Verified Conditions** • Client indicated that facility is operational 50 weeks, 24 hours and 7 days per week. [redacted] Client indicated that the previous BAS had been abandoned [redacted] • Client demonstrated the status and set points on the BAS. Further to the temperatures at the time of the measure, the client has continued to reduce the set points. Client provided the updated set points of the heating units. GENIVAR accept these as the measure conditions. • Client verified that no flow rate adjustments were changed for the measure relative to base case to maintain the necessary pressurization. In both base and measure conditions, the fresh air is 100% of the total flow [redacted]. • Direct gas fired make up air heaters are used to heat the facility. GENIVAR accept the efficiency of 92% as used in the EGD file. • GENIVAR accept the BIN data as being representative of the heating profile [redacted] without any adjustment for client location. **Unverified Conditions** • Owing to the extreme winter / wind weather during the site visit, GENIVAR did not access the roof to physically inspect the 20 make up air / air handling units. Client confirmed the unit flow rates were as provided by them and is accurate to what is in the file.
EGD File Analysis:	**Independent Analysis**

[redacted]

See GENIVAR independent analysis in Appendix A.

The following summarizes the methodology;

- GENIVAR accepted the operational hours of the BIN as depicted in the EGD file as the 2 weeks the plant is not operational is within the summer when the heating system would not be operational
- BIN analysis includes heating assessments for BINs below 60F - at that point, the units have the heating shut off as the internal heat within the facility (ovens, machinery, workers, solar heat gain, etc.) tempers the air.
- It is noted that the units each operate with different flowrates and temperature set points but all feature direct fired heating at the agreed 92% efficiency.
- On this basis, for the base and measure analysis GENIVAR calculated a flow weighted average temperature to enable BIN analysis to be performed. GENIVAR calculation of the average temperature base was 79.12F (EGD was 77.8F) and of the measure was 73.41F (EGD was 72.65F).
- GENIVAR used a spreadsheet BIN analysis of the base and measure conditions with the 8400 hour / year to establish the cumulative heating load.
- For the base case and the EGD measure, GENIVAR BIN analysis resulted in near identical values of the heat load and hence near identical savings of the measure (352,455 m^3/year GENIVAR / 352,606 m^3/year EGD file). Thus GENIVAR accept the results of the EGD file and its E-tools BIN analysis.
- As mentioned, GENIVAR received updated information from the client that they have continued to reduce the set points. Client provided the updated set points of the heating units. Using this data, GENIVAR calculated a flow weighted temperature of 69.63F as per previous methodology. EGD file did not have this updated information. Using this temperature, GENIVAR performed the spreadsheet BIN analysis and calculated a natural gas savings of 586,546 m^3/year.

We suggest that this adjustment be the basis of the natural gas savings for this file based on the updated set points provided by the client during the site inspection.

Condition Assessment and Measure Life

GENIVAR suggest that the measure should reach the **full measure life of 15 years** as per the EGD file. The 15 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions.

However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

RA.IND.LG.RT.022.13

Industry Type:	Manufacturer
Project Description:	**General** [redacted] **Base Case** Do nothing – continue operation with furnaces in declining condition. **Implemented Measure** Rebuild of Furnaces 1, 3, 4 and 5 with new refractory, rebuilt arches, furnace expansion, and replaced bag houses (except for Furnace 3).
Summary of EGD File :	The file includes; [redacted] Indication of capital budget for the project Status (dated August 2013) [redacted] • Spreadsheet of metered flow of natural gas to each furnace and measured product yield pre and post measure • Narrative of the manufacturer's process together with base case and energy efficiency case of implemented measure
Site Inspection Date and Findings:	**February 19, 2014 at 1:30 PM** [redacted] GENIVAR verified that the furnaces had been upgraded by visual assessment of the new refractory as visible through furnace loading doors and openings. GENIVAR also verified the upgrades to the bag houses as indicated in the file. **Verified Conditions** [redacted] • Client confirmed that the facility is operated 24/7. • The refractory had been damaged and deteriorated over the years and hence was lacking the ability to efficiently maintain heat within the furnace. • This client accurately tracks all [redacted] ingots to the furnace (lb. of product) and each furnace features a dedicated natural gas meter (m^3 of natural gas). Each meter is tracked on the client's SCADA system. Hence monitoring and verification pre / post measure was witnessed by GENIVAR on site and was provided by the client for inclusion into the EGD file. Client verified data in file was provided by them. GENIVAR hence verify the performance of the measure is defendable by analysis of data in file. • Furnaces each have [redacted] a total of [redacted] btu / hour. GENIVAR did not assess the efficiency of the burners as each furnace has a meter (Invensys) so it is already addressed in the data available. • Furthermore, the escaped heat within the non-air conditioned facility was detrimental to the working environment for the workers. Also noteworthy is that the furnaces were longitudinally expanded (with additional burners) during the rebuild to enable increased throughput per furnace at the enhanced efficiency (m^3 of gas / lb. of product). Client identified that Furnace #2 was recently upgraded (as per the measures of the other furnaces in this file) and was about to be reinstated back to service, and that a new Furnace has just been installed.
File Review Comments:	**Independent Analysis** See GENIVAR Independent analysis included in Appendix A. GENIVAR identified that for each furnace, the performance yield (m^3 of gas per

[redacted]

	pound of product) of this measure improved by a range from 3.55% [redacted] to 24.52% [redacted]. Client indicated that owing to budget restraints, the upgrade of [redacted] was deferred but has also recently been completed. By implementing this measure (and the associated furnace extensions), the client has dramatically improved their throughput on an annual basis. The furnace extension would not have happened without the complete furnace refractory lining repair as this would have resulted in differential zone heating performance in the furnace. Post measure, the plant annual output increased by [redacted] with only an additional [redacted] of natural gas. With the efficiency measure in place, and correcting for the additional production, the client would have realized a gas savings of 924,859 m^3 / year. This compares closely with the EGD claim of 924,309 m^3/year. **GENIVAR accept the results of the EGD file.** **Condition Assessment and Measure Life** GENIVAR suggest that the measure should reach the **full measure life of 18 years** as per the EGD file. The 18 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

RA.IND.SM.NRT.026.13

Industry Type:	Food
Project Description:	**General** A facility which converts bulk product to market ready packaging. Considerable warehousing is also present. **Base Case** For this facility, gaps have opened in the building envelope mainly by shifting of pre-cast panels and sealant failure. **Implemented Measure** Retain an insulation contract to remedy sealant replacement to close all gaps and openings.
Summary of EGD File :	The file includes; • Email correspondence of Insulation Contractor who had performed an assessment of the building envelope to establish magnitude of failed caulking seams and openings. Mitigation measure includes backer rod and new polyurethane caulking. • Email correspondence of September 24, 2013 establishing the cost of the project [redacted] • Calculations of ASHRAE methodology of crack infiltration and E-tools BIN analysis to depict the natural gas savings of the measure.
Site Inspection Date and Findings:	**February 19, 2014 at 9:30 AM** During the site inspection, client confirmed they were happy with the comprehensive repairs and improved quality of the building envelope. Client noted that the measure has resulted in a facility with an improved and consistent environment without cold spots and drafts. **Verified Conditions** • GENIVAR verified the general workmanship and integrity of the seams at vertical interfaces of each precast panel and horizontal interfaces at the top of foundation and roof. Geometry of the facility footprint is an irregular polygon shape. • GENIVAR verified the 101,000 ft^2 facility was built in 1987 (26 years old) and understand that this is a typical life of sealant before failure. • Remediation with backer rod and polyurethane sealant is understood to be a professional and proper approach. • Wind speed value of the file was generally verified by review of Environment Canada Website for 2012 (last full year of wind data). EGD E-tool uses WYEC2 data – GENIVAR does not have access to this data. • Building is heated by rooftop units, GENIVAR accept the 75% efficiency. Set point is 70F. • Building is not air conditioned (except offices) **Unverified Conditions** • Owing to the nature of the measure, it is not possible to identify the previous (base) condition of the building envelope. GENIVAR have reliance on the email of the contractor assessing the magnitude of the opening as the equivalent of 5500 linear feet at an average gap of 1/16" and the client's confirmation. See GENIVAR calculations for an opinion on the contractor's 5500 linear feet of crack.
EGD File Analysis:	**Independent Analysis** See GENIVAR independent analysis in Appendix A. • The EGD analysis uses E-tools to calculate equivalent crack area and infiltration. Thereafter, the infiltration is used in BIN analysis to calculate

heat load.

- Based on the equivalent crack in the correspondence from the contractor, GENIVAR attempted to establish an indication of the total (approximate) length of vertical seams (between precast panels) and horizontal seam at both the foundation and roof interface. GENIVAR accept for a building of this vintage, that 5500 of the (GENIVAR rough calculated) 6674 linear feet of joints seems reasonable and that the 1/16" average seems conservative. From this GENIVAR accept the equivalent area of infiltration.
- GENIVAR used an ASHRAE equation (ASHRAE 2005, F27.10, equation 29) to calculate infiltration. GENIVAR note that the E-tools are also based on this equation and agree this is the appropriate basis of calculation and that ASHRAE is an industry standard basis to accept. GENIVAR was able to calculate an identical infiltration flow rate of 4955 cfm with the parameters shown in our calculation.
- With the crack area and infiltration, GENIVAR spot check the EGD BIN analysis for the 36 to 40F BIN and concur that the calculation matches the heating load depicted in the BIN.
- With the total heating load of all BINs, GENIVAR calculated the efficiency of the makeup air unit and conversion to the value in the EGD analysis.

GENIVAR accept the results of the EGD file.

Condition Assessment and Measure Life

GENIVAR note the sealant is an exterior setting but suggest that the measure should reach the **full measure life of 25 years** as per the EGD file. The 25 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions.

However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

RA.IND.LG.RT.018.13

Industry Type:	Pulp and Paper
Project Description:	**General** [redacted] paper manufacturer. **Base Case** Continue existing operation with heat from the dryer not being recovered and utilized. **Implemented Measure** Install a dryer exhaust to water heat exchanger in the dryer exhaust to preheat process shower water and offset steam usage.
Summary of EGD File :	The file includes; • Description of the client's operation and particularly the heat recovery opportunity of the [redacted] machine. • EGD calculation based on recovered heat to determine natural gas savings. • 2013 Client metered data for production, gas, [redacted] and steam on a monthly basis. • Flow diagram of the implementation of the heat exchanger into the client's process to utilize the recovered heat and displace steam • Vendor's proposal (August 9 2011) describing the scope of supply of the heat exchanger together with the heat recovery opportunity and the commissioning [redacted] • Collected data of January 10 to 17, 2014 meter installation on the water loop.
Site Inspection Date and Findings:	**February 27, 2014 at 1:30 PM** During the site inspection, GENIVAR verified the installation of a paper machine exhaust / water heat exchanger and its piping interconnection to recover heat to preheat the process shower water and displace steam. **Verified Conditions** • Client verified that the performance of the measure (supply and return water temperatures and flow rates) was metered from January 10 to January 17 2014 and this data is the performance data in the EGD file. Hence GENIVAR verify that the M&V data in the file is recent and accurate. • During the site inspection, client utilized a Fluke handheld infrared laser thermometer (model 62 Max) to generally verify the water supply / return temperature of the dryer heat exchanger within the parameters of the measured data. • Client indicated that the paper machine and its measure commissioning refinement have been reasonably stable since November 2013. • GENIVAR verified the steam is from a Volcano Boiler (Arctic Combustion) with Faber Burner (129 million btu/hour input) and economizer. Year of manufacture and output were not included on the nameplate. Client suggested that the understood boiler efficiency is about 84%. • Client verified the 2013 data provided in the EGD file is monthly metered data for natural gas, biogas and steam plant output. Hence GENIVAR use this data as verified performance of the steam plant. • Client verified that typical plant operation is 24 hour/day x 7 day/week x 50 week / year = 8400 hour / year • Client also uses [redacted] from the process but this quantity is significantly less than the natural gas consumption. [redacted]

[redacted]

	any savings in process efficiency would be to displace natural gas purchase. • Client indicated that the paper machine and its measure commissioning refinement have been reasonably stable since November 2013.
EGD File Analysis:	**Independent Analysis** **See GENIVAR independent analysis included in Appendix A.** GENIVAR utilized the January 10 to 17, 2014 collected data as the basis of the recovered heat. Our analysis follows; • By graphing the trended data of the measure (January 2014), GENIVAR is able to verify that the flow rate and supply / return temperatures are reasonably stable. • With this data, the average flows / temperatures are used to calculate the recovered heat. Further to this, the recovered heat is also calculated for each data collection entry in the spreadsheet and the average of this values correlates to the calculation on average values. • GENIVAR utilized the 2013 monthly steam output [redacted] to develop [redacted] steam / m^3 gas coefficient. • EGD file is based on a 2011 coefficient [redacted] of steam / m^3 gas. • With this coefficient, GENIVAR is able to convert the recovered heat into displaced natural gas. • For this process, the dryer heat opportunity of the Paper Machine is essentially consistent on an annual basis and the recovered heat is preheating process shower water, so GENIVAR does not require any seasonality adjustments to be applied to this data. **GENIVAR calculated value of 901,089 m^3 gas per year compares favourably with the EGD value of 919,287 m^3 gas per year.** **Condition Assessment and Measure Life** The 20 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings exceeds the 15 year recommendation of EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. GENIVAR note that heat exchangers used in industrial applications are typically designed to more robust criteria than commercial or residential installations and often are seen to exceed 30 to 40 years of service (which is indicative of paper machine in service duty). However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

RA.IND.LG.RT.013.13

Industry Type:	Pulp and Paper
Project Description:	**General** Company which manufactures paper product. **Base Case** Previously the client added a [redacted] Dryer [redacted] to remove the majority of the moisture [redacted] Exhaust [redacted] was released to the atmosphere without any heat recovery. The ends of the [redacted] Dryer are uninsulated. **Implemented Measure** Recover heat from the [redacted] exhaust with air to water, and air to glycol heat exchangers and a direct contact mist eliminator. Recovered heat from the exhaust is now used for process heat and heating ventilation units [redacted]. Insulate the ends of the [redacted] Dryer.
Summary of EGD File :	The file includes; • A narrative of the client's process with the current base case operation together with the efficiency measure as installed. This contains a heat balance and schematics of the base case steam requirement and of the energy measure as implemented. • A proposal from the vendor for the rebuild [redacted] dated November 29, 2011. This includes several tasks and components inclusive of heat recovery equipment and insulation end caps for the [redacted] Dryer. • A E-tools output of the performance of the insulation on the ends of the [redacted] Dryer together with an email of April 24, 2013 describing the insulation system installed. • Traces (from December 19, 2013 to January 15, 2014) are included from the SCADA for the data logging performed on the recovered heat in the glycol and [redacted] water process loops. • Screenshots from the SCADA for the [redacted] heat recovery system together with performance indications (2013.11.25 and 2014.01.24).
Site Inspection Date and Findings:	**March 7, 2014 at 1:30 PM** During the site inspection, client confirmed the success of the measure relative to the base case and that the system has been operating in accordance of the project expectations. **Verified Conditions** • GENIVAR verified the installation and operation of the heat recovery unit together with the associated ducting upgrades and piping modifications for the recovered heat in accordance with the documentation in the file. • Client confirmed the plant generally operates 50 week / year, 24 hour / day, and 7 days / week for 8400 hour / year. • GENIVAR viewed the [redacted] boilers, and lacking specific combustion analysis, agree the stable process load suggests an average efficiency of 75% is appropriate to the analysis. The robustness of industrial boilers of this type has service lives which may be in the 30 to 50 year range depending on operator maintenance and water quality. • Client verified the traces and screenshots in the EGD file were from their SCADA and generally representative of the measures operation. • By viewing local digital [redacted] flow meters, GENIVAR was able to verify flows at time of visit were within the ranges of the annual traces. Similarly by viewing local thermometers, GENIVAR was able to verify the

[redacted]

	temperature conditions. **Unverified Conditions** • [redacted] water flow rate through mist eliminator is not metered so design flow rate is used. Client agreed this is the appropriate criteria.
File Review Comments:	**Independent Analysis** See GENIVAR independent analysis included in Appendix A. **Heat Recovery** [redacted] GENIVAR prepared independent mass and energy balances (see GENIVAR Spreadsheet, Appendix A) to confirm that the heat recovered [redacted] matches the mass and heat balance in the submission and it is being utilized in the revised process. GENIVAR used verified annual trends and screenshots to establish the following recovered heat utilized by the process for 8400 hour/year; • Heat utilization for the [redacted] water (6,049,779 btu/hour) from the flow conditions for the hot water heat exchangers. • Heat utilization for the [redacted] water (2,798,880 btu/hour) from the flow conditions for the hot water heat exchangers. GENIVAR also used annual trends and screenshots to establish the recovered glycol heat utilized for [redacted] the heating and ventilating units. For these opportunities, the recovered heat utilization is evaluated in a BIN analysis [redacted] • Where the process heat requirement exceeds the recovered heat, the recovered heat was the basis of the analysis. • Where the recovered heat exceeds exceeds the process heat requirement, the process heat requirement was the basis of the analysis. **GENIVAR accept the methodology of the EGD file for the heat recovery and suggest that the GENIVAR value and our independent analysis resulted in a near identical value.** **Insulation of** [redacted] **Dryer** For the [redacted] Dryer insulation measure, EGD used E-tools. GENIVAR verified the performance of the insulation heat loss coefficients with an online tool from National Mechanical Insulation Committee (NMIC) Energy Calculator. http://www.wbdg.org/design/midg_design_ece.php Our analysis of 63,582 m^3/year (based on mineral wool as per insulation email of April 24, 2013 in file) compares well with the EGD analysis of 69,768 m^3/year (which was based on mineral fibre). The nominal difference is assumed to be based on the different insulation systems in the calculations. While it may be noted that the heat loss of the ends of the [redacted] Dryer may be considered to have otherwise heated the ambient of the workspace and removed this load from the HV units. GENIVAR note that the aforementioned traces of performance were instrumental in establishing the maximum recovered heat utilization of the opportunity. These traces were made with the insulation in place and the GENIVAR analysis carefully limits the recovered heat by these criteria so there is no double credit taken for this complementary measure. **GENIVAR recommends an adjustment for the insulation measure.** **Condition Assessment and Measure Life** The 20 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings exceeds the 15 year recommendation of EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. GENIVAR note that heat exchangers used in industrial applications are typically designed to more robust criteria than commercial or residential installations and often are seen to exceed 30 to 40 years of service (which is indicative of paper machine in service

[redacted]

	duty). However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

[redacted]

Industry Type:	Pulp and Paper
Project Description:	**General** Client has expanded their paper facility with a new [redacted] building. **Base Case** Using conventional and conservative approach, adopt a 100% fresh air approach to recognize the inherent amount of [redacted] very fine dust loading [redacted] to the conventional size of the end user. This would be the conservative approach to ensure that dust loadings are removed from the facility to the requirements of OSHA and for equipment/ facility operation and maintenance. **Measure** Installation of new Heating and Ventilation equipment of a design to enable the existing process heat load to be contained in the workspace and recirculated after appropriate filtration to achieve the stated 1 mg/m^3 particulate loading criteria.
Summary of EGD File :	The file includes; [redacted] A report [redacted] dated 12 July 2012 [redacted] of the HVAC System for the New [redacted] Building. This includes the process heat gain, and building heat loss together with the sequencing of equipment to deliver the design basis. Also includes the HVAC P&ID [redacted] • Invoice dated 10/26/2012 in the amount of [redacted] for the supply of the HVAC equipment. • A report describing the process of making tissue, describing the Base Case versus implemented measure for the HV equipment describing the reduction of fresh air of 155,000 cfm by utilizing premium filtration on the dust collector and within the makeup air units. • E-tools BIN analysis for the base case operation and measure as implemented in terms of annual gas consumption.
Site Inspection Date and Findings:	**March 7, 2014 at 1:30 PM** During the site inspection, GENIVAR verified that the new production expansion for the [redacted] Building was operational in accordance with the described measure. Client was satisfied that the dust loading in the facility and the air quality for the workers was in accordance with the expectations. **Verified Conditions** • GENIVAR viewed the dust collection room and its process of extracting tissue paper dust via a filter and cyclone and verified that the exhaust of the process (55,000 cfm) is re-admitted to the facility via HV 20. • By review of the dust collection P&ID displayed in the dust collection room, GENIVAR was able to appreciate the sophisticated nature of the measure relative to the facilities process. • By review of Building Automation System, GENIVAR was able to verify the operation of HV 18 (50,000 cfm) and HV 19 (50,000 cfm) were operating in re-circulating mode. Client confirmed this is the basis of operation during the winter. • GENIVAR verify that 75% efficiency is appropriate for these units. • GENIVAR verify the facility is maintained at 68 to 70F by discussion with client. • The [redacted] P&ID reinforces the sequence of operations as per the measure. As a result of this, client confirmed that the fresh air loading is reduced by 155,000 cfm (HV 18, 19 and 20), from 410,000 cfm (base) to 255,000 cfm (winter) to achieve the natural gas savings of the measure. • [redacted] the BIN data [redacted] in the

[redacted]

	file is appropriate without requirement for correction factors. **Unverified Conditions** • Owing to the extreme winter / wind weather during the site visit, GENIVAR did not access the roof to view the HV 18, 19. As mentioned, GENIVAR was able to verify their recirculation operation from the BAS and their performance from the Issued for Construction P&ID and by client confirmation.
EGD File Analysis:	**Independent Analysis** See GENIVAR independent analysis included in Appendix A. GENIVAR reviewed "Recirculating Air from Dust Collectors" (Lee Morgan, Camfil Farr, "Plant Engineering, September, 2001) to understand the criteria by which dust collector exhaust streams could be re-admitted to an industrial facility. *"While OSHA guidelines must be met, plants should follow the guidelines published by the American Conference of Governmental Industrial Hygienists (ACGIH). The guidelines in this manual are often just a little tighter than those OSHA has adopted, and by meeting these guidelines, the plant engineer can ensure regulatory compliance (see Table 1)."* GENIVAR note the filter criteria of 1mg/m^3 appears to satisfy the majority of dust types in the referenced Table, but is reliant that the engineer of record [redacted] has made the appropriate assessment and filtration selection for this process. By review of the sequence of operations and the air balance it is agreed that the fresh air flow reduces from 410,000 cfm to 255,000 cfm. GENIVAR agree the BIN analysis is the appropriate calculation methodology to base the gas savings upon. GENIVAR selected a BIN to spot check to ensure the output matches our analysis basis on the equation Q = 1.08 x cfm x (dT) x hours / BIN. For this BIN, GENIVAR's calculation was performed for the base and for the measure with near exact results. Hence GENIVAR accept the calculation of the cumulative BIN analysis. This cumulative BIN analysis is performed for all BINs below 60F – which is appropriate as the HV heating would not be required above that owing to the internal heat gain of the equipment and workers tempers the air. The difference between these values represents the savings. The annual savings is hence the sum of the BINs which would then be corrected by the heating efficiency at 75%. With the sum of the BINs, the applied heating efficiency and the conversion to m^3/year, GENIVAR achieve a nearly exact value as EGD include in their file. **GENIVAR accept the results of the EGD file.** **Condition Assessment and Measure Life** GENIVAR note the equipment installed and the building expansion is new and suggests the measure should reach the **full measure life of 15 years** as per the EGD file. The 15 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

RA.IND.LG.RT.032.13

Industry Type:	Automotive
Project Description:	**General** Manufacturer of automobile components requiring a substantial amount of high purity, hot water in the [redacted] process. **Base Case** Do nothing, continue to operate boiler in out of tune fashion with older pneumatic controls. **Implemented Measure** For boiler #2, measure included combustion tune-up with new burner / feedwater electronic 2 element controls, drum level and steam flow transmitters. This enabled the O_2 in exhaust to be reduced from 17 to 8%.
Summary of EGD File :	The file includes; • Exhaust combustion analysis pre- measure by [redacted] (November 2010), • Exhaust combustion analysis post measure by EGD (November 2013) • E-tools (Version e4-10, 20 August 2013) analysis to depict the anticipated savings • Quotations of new controls and of contractor to implement the measure totalling $21,448 (not including taxes) dated June 2013. Measure implemented during July 2013 shutdown.
Site Inspection Date and Findings:	**March 14, 2014 at 9:00 AM** During the site visit, the client indicated the success of the measure and general disappointment that their equipment had been operating so inefficiently. **Verified Conditions** • The plant features 2 identical [redacted] steam boilers with nameplate 50 million btu/hour input (nameplate 80% efficiency). These boilers are 1967 vintage - neither of which feature an economizer (this is typical of installations in that era) or O_2 trim. • By local instrumentation, steam pressure was verified [redacted]. Feed water 232F. • Typical steam flow ranges from 4,600 lb. /hour [redacted] to 10,000 lb. /hour [redacted]. This is information provided by client and confirmed by boiler operator during inspection. Recently an appropriately sized boiler feedwater pump was implemented to better suit the [redacted] part load operation. This is a result of client using an inefficient direct contact water heater / storage tank (which also led to excessive moisture plumes to its surroundings) for part of the process. We are advised that this is going to be removed from service shortly and this thermal load will be reinstated to the boilers to achieve an improved efficient operating loading. • During the site investigation, GENIVAR noted that the measure was implemented for boiler #2 only as per the Enbridge file. Boiler #1 was tuned up only. • This facility operates 24/7 (except for a 2 week period [redacted] for planned maintenance) and frequently the Sunday operation is somewhat reduced. • On the EGD file, it is noted that the boiler is operated 4200 hours/year as this enables each of boiler 1 and boiler 2 to be alternated for operation. This was verified by the client. • The combustion analysis is a defendable analysis of the measure in its

[redacted]

	base and post measure performance. GENIVAR accept these values. o 2010 combustion analysis (base) depicted 52.44% (low fire) and 58.76% (high fire). Correcting radiation losses (7.86% low fire, 3.6% high fire) to be in conformance with ASTM PTC protocol, this is 60.3% (low fire) / 62.4% (high fire) for an average of 61.35%. o 2013 combustion analysis (measure) depicted 80.2% (low fire) and 79.4% (high fire) for an average of 79.8%. • The differential of the effect of seasonal efficiency is a variable which is present both pre and post and hence cancels out in the analysis. • A subsequent combustion analysis was not warranted owing to the recent (3 months) analysis in the file.
File Review Comments:	**Independent Analysis** See GENIVAR Independent analysis included in Appendix A. As mentioned, during the site visit, the client verified that the process steam condition is about [redacted] lb. /hr. GENIVAR used a simplified analysis with the documented base and measure efficiency and calculated a savings of 203,405 m^3/year - versus the 201,679 m^3/year of the EGD file. On this analysis, GENIVAR accept the methodology of the E-tools analysis in the EGD file. The client provided information that the base process steam flow of [redacted] lb. /hour is supplemented by additional steam flow for facility heating on cold days (<0C) during winter months. With this information, GENIVAR calculated an average steam flow (representative of process and building heating[redacted] **GENIVAR suggest that the EGD file analysis, and the calculated natural gas savings, should be adjusted in conformance with this annual steam rate (versus process steam rate). On this basis, the natural gas savings would be 258,382 m^3/ year.** GENIVAR learned that the client is pursuant of further savings opportunities associated with the boiler plant. For boiler 2, the client is considering a condensing economizer with a new FRP stack, and transitioning this boiler to be the lead boiler sometime in 2014 /2015. Boiler 1 will be exercised and operated only every second or third Sunday. Independent of efficiency gains of the economizer, this transition of operational protocol would achieve improved results on an annual basis as it will be utilized more hours per year as follows; = (50 weeks/year x 24 hour/day x 7 day/week) – (50 Sundays/ year x 24 hour /day x 0.5) = 7800 hours /year (versus 4200 in EGD file). GENIVAR do not suggest an adjustment at this point (by a 7800/4200 utilization factor) but wish to point out that a conservative approach is indicative of the file (despite the previous adjustment for steam flow). **Condition Assessment and Measure Life** The client indicated that boiler #2 is regularly inspected for physical condition (tubes, etc.) for insurance and reliability reasons and was deemed to be in good operating condition to justify the implemented measure. GENIVAR note the measure should reach the **full measure life of 15 years** as per the EGD file. The 15 year measure life used in the Cumulative Cubic Meters (CCM) of gas savings is in conformance with the EGD Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions. However, relating to the nature of the industrial economy, GENIVAR is unable to provide commentary of the client's long range business plans in this facility.

4. Discussion

As a result of review of the EGD files and the site inspections, GENIVAR was able to assess the predicted savings, based on discussions with the clients and assessment of post measure data collection via SCADA, local instrumentation or implemented data collection. GENIVAR performed independent analysis to offer its professional opinion of the measure's performance (*please refer to the spreadsheets within Appendix A of this report and to the preceding section of this report for detailed analysis per file*).

Table 4.1 shows a summary of GENIVAR's analysis together with the EGD analysis and any suggested adjustments. Generally, the files included analysis in conformance with good engineering practice to demonstrate the anticipated performance. It appears that a high degree of consistency and care have been taken in the file assembly and QA/QC in the file review by EGD.

4.1 Considerations of Adjustment

GENIVAR was provided with the following guidance from the AC regarding the adjustment of Enbridge's claimed savings for custom projects -

1. If the CPSV savings number is within 5% of Enbridge's number AND the CPSV concludes that its methodology is less rigorous then Enbridge's approach the CPSV contractor can let the Enbridge number stand without adjustment.
2. If the CPSV savings number differs by more than 5% or the CPSV concludes that its methodology is more rigorous the CPSV contractor should recommend adjusting Enbridge's savings claim and be fully prepared to defend its adjusted savings claim.
3. If the CPSV uncovers a clear methodological error, math error or other obvious error then the Enbridge savings claim should always be adjusted regardless of the percent variance.
4. Some of the adjustments recommended by GENIVAR are based on feedback from clients which would not have been available at the time of file submission by Enbridge.

For all projects the CPSV contractor should provide clear reasoning for all its recommended savings adjustments.

4.2 Measure Life

For the 17 Wave 1 and Wave 2 Files, EGD endorsed the Custom Resource Acquisition Technologies - Table 1 – Measure Life Assumptions on each occasion except on 4 instances;

- For 3 files (RA.IND.LG.RT.007.13, RA.IND.LG.RT.018.13 and RA.IND.LG.RT.013.13) which addressed heat recovery, GENIVAR agreed that the robust industrial designs of this equipment is intended to match the process equipment to which it is recovering the heat. GENIVAR agree that it is common that this equipment can often exceed 30 to 40 years in service, and hence, EGD adjustment of measured life from 15 to 20 years is in fact conservative.

[redacted]

- For file RA.IND.SM.NRT.029.13, EGD choose to select a more conservative measure life (10 years versus 15 for controls) to reflect the conservative nature of the food industry to the process tuning adjustments made.

On this basis, the GENIVAR analysis of cumulative cubic meters of natural gas (CCM) saved aligned with the calculations of EGD.

4.3 Natural Gas Savings

Of the 17 Wave 1 and Wave 2 Files, GENIVAR's cumulative gas savings was 2.5% greater than the EGD analysis (13,225,154 vs.12,905,060 m^3/year).

- Of the 17 separate files, GENIVAR's independent analysis was well within 5% of the EGD file on 12 occasions (Criteria 1, above). For these files, GENIVAR recommend that the gas savings of the EGD file be accepted.
- For the 4 files for which GENIVAR suggested an adjustment,
  - 3 of them were based on receiving information from the clients during the site visit (Criteria 4, above) indicating that the EGD files were appropriately calculated, but adjusted based on site investigation findings;
    - RA.IND.AGR.NRT.029.13 was adjusted to account for a greater length of insulation applied that anticipated.
    - RA.IND.LG.NRT.012.13 was adjusted to account for the client's continued efforts to leverage the benefits of the temperature setback measure to adapt to their process (69.63F versus 73.41F at the time of the measure implementation).
    - RA.IND.LG.RT.032.13 was adjusted to include the steam of the boiler for facility heating (versus process only heat load) during extremely cold portions of the year when the heat of the process needs to be supplemented for process and worker conditions.
  - For the 1 file where GENIVAR suggested an adjustment to the EGD file, this measure was a supporting measure to the main measure and represented 1.3% of the cumulative measure for the file. Our adjustment was based on an alternate insulation selection.
- On the remaining file, RA.IND.LG.NRT.002.13, GENIVAR's analysis was based on a simplified calculation to replicate the more involved E-tool analysis (which featured detailed Toronto BIN analysis). While our number differed by -12.7%, GENIVAR recommend the more involved analysis of the E-tool and EGD's commitment to refine this model (Version 1.07). Furthermore, it is noted that the EGD model is very conservative as GENIVAR had initially sought a vendor's software and found their value was 169% higher that the EGD analysis.

Independent of the 3 adjustments (based on site collected data not available to EGD at the time of the files), GENIVAR have a high correlation with the EGD data, and inclusive of these adjustments, is still within 2.5% of the EGD cumulative Wave 1 and Wave 2 analysis.

4.4 Electrical Savings

Only 3 of the 17 files included any electrical savings which result from the implementation of the measures. Only 1 file resulted in a result by GENIVAR which differed from the EGD file. Of the 17 Wave 1 and Wave 2 files, GENIVAR's cumulative electricity savings was 0.1% less than EGD's (2,261,985 vs. 2,264,363 kWhr/year).

4.5 Water Savings

For the files reviewed in Wave 1 and Wave 2, there were no identified induced water savings measures.

4.6 Capital Cost

As a result of the site investigation, all projects were confirmed as being implemented by the client with general conformance to the description in the files. Each file included supporting documentation in the form of either manufacturer's quotations or billings, which justify the incurred cost of the project.

It is noted that the competitiveness of the market and the fact that the projects may not have been competitively bid exposes the clients to a degree of variability in the contract cost. Generally all project costs are in a reasonable order of magnitude of Opinion of Probable Cost.

[redacted]

Table 4.1 Independent Analysis of 2013 Wave 1 and Wave 2 Industrial Custom Projects

Natural Gas Savings of Implemented Measure

Wave	File	Measure	Natural Gas Annual Savings: EGD Claim m³/yr	GENIVAR m³/yr	Difference %	Recommendation m³/yr	Additional Criteria: Ownership %	Free Ridership Adj. %	Gross Claim: EGD m³/yr	GENIVAR	Recommendation	Measure Life: EGD Claim Years	GENIVAR Years	Recommendation Years	Cumulative Natural Gas Savings: EGD Claim m³	GENIVAR m³	Recommendation m³
1	RA.IND.LG.NRT.002.13	Destratification Fans	55,152	48,147	-12.7%	55,152	100%	50%	27,576	24,074	27,576	15	15	15	413,640	361,104	413,640
1	RA.IND.LG.NRT.004.13	Insulation	98,781	98,844	0.1%	98,781	100%	50%	49,391	49,422	49,391	15	15	15	740,859	741,331	740,859
1	RA.IND.LG.RT.007.13	Heat Recovery	1,615,739	1,615,550	0.0%	1,615,739	100%	50%	807,870	807,775	807,870	20	20	20	16,157,390	16,155,504	16,157,390
1	RA.IND.LG.RT.001.13	Low Temperature Cleaning Agent	109,103	108,270	-0.8%	109,103	100%	50%	54,552	54,135	54,552	20	20	20	1,091,030	1,082,697	1,091,030
1	RA.IND.LG.RT.005.13	HVAC Fresh Air Reduction	301,944	298,488	-1.1%	301,944	100%	50%	150,972	149,244	150,972	25	15	15	2,264,580	2,238,658	2,264,580
1	RA.IND.LG.NRT.001.13	Condensing Hot Water Boilers	139,088	139,488	0.3%	139,088	23.57%	50%	16,392	16,439	16,392	25	25	25	409,788	410,965	409,788
	Wave 1		2,319,807	2,308,787	-0.5%	2,319,807			1,106,751	1,101,088	1,106,751				21,077,286	20,990,280	21,077,286
2	RA.IND.SM.NRT.029.13	Controls	343,250	342,032	-0.4%	343,250	100%	50%	171,625	171,016	171,625	10	10	10	1,716,250	1,710,158	1,716,250
2	RA.IND.LG.NRT.025.13	Steam Trap	96,922	96,922	0.0%	96,922	100%	50%	48,461	48,461	48,461	5	5	5	242,305	242,305	242,305
2	RA.IND.AGR.NRT.001.13	Insulation	41,736	67,318	61.3%	67,318	100%	60%	25,042	40,391	40,391	15	15	15	375,624	605,864	605,864
2	RA.IND.LG.NRT.023.13	New Melting Equipment	1,031,423	1,070,629	3.8%	1,031,423	100%	50%	515,712	535,314	515,712	18	18	18	9,282,807	9,635,660	9,282,807
2	RA.IND.LG.NRT.021.13	Building Energy Management	352,606	586,546	66.3%	586,546	100%	50%	176,303	293,273	293,273	15	15	15	2,644,545	4,399,095	4,399,095
2	RA.IND.LG.RT.022.13	Furnace Relining	924,309	924,859	0.1%	924,309	100%	50%	462,155	462,430	462,155	18	18	18	8,318,781	8,323,732	8,318,781
2	RA.IND.SM.NRT.026.13	Building Envelope	41,077	40,622	-1.1%	41,077	100%	50%	20,539	20,311	20,539	25	25	25	513,483	507,769	513,483
2	RA.IND.LG.RT.018.13	Heat Recovery	919,287	901,089	-2.0%	919,287	100%	50%	459,644	450,544	459,644	20	20	20	9,192,870	9,010,875	9,192,870
2	RA.IND.LG.RT.019.13	Heat Recovery	5,307,503	5,307,759	0.0%	5,307,503	100%	50%	2,653,752	2,653,877	2,653,752	20	20	20	53,075,030	53,077,533	53,075,030
		Insulation	69,768	63,582	-8.9%	63,582	100%	50%	34,884	31,791	31,791	15	15	15	523,260	476,865	476,865
2	RA.IND.LG.RT.035.13	Dust Collector Filtration / HVAC	1,255,693	1,256,434	0.1%	1,255,693	100%	50%	627,847	628,217	627,847	15	15	15	9,417,698	9,424,757	9,417,698
2	RA.IND.LG.RT.032.13	Boiler Controls	201,679	258,382	28.1%	258,382	100%	50%	100,840	129,191	129,191	15	15	15	1,512,593	1,937,862	1,937,862
	Wave 2		10,585,253	10,916,367	3.1%	10,895,292			5,296,800	5,464,915	5,454,378				96,815,225	99,352,484	99,178,888
	GRAND		12,905,060	13,225,154	2.5%	13,215,099			6,403,551	6,566,003	6,561,129				117,892,510	120,342,743	120,256,173

Electricity and Water Savings of Implemented Measure

Wave	File	Measure	Electrical: EGD Claim kWhr/yr	GENIVAR kWhr/yr	Difference %	Recommendation kWhr/yr	Water: EGD File m³/yr	GENIVAR m³/yr	Difference %	Recommendation m³/yr
1	RA.IND.LG.NRT.002.13	Destratification Fans	(11,524)	(13,902)	20.6%	(11,524)	-	-	-	-
1	RA.IND.LG.NRT.004.13	Insulation	-	-	-	-	-	-	-	-
1	RA.IND.LG.RT.007.13	Heat Recovery	-	-	-	-	-	-	-	-
1	RA.IND.LG.RT.001.13	Low Temperature Cleaning Agent	-	-	-	-	-	-	-	-
1	RA.IND.LG.RT.005.13	HVAC Fresh Air Reduction	1,159,757	1,159,757	0.0%	1,159,757	-	-	-	-
1	RA.IND.LG.NRT.001.13	Condensing Hot Water Boilers	1,116,130	1,116,130	0.0%	1,116,130	-	-	-	-
	Wave 1		2,264,363	2,261,985	-0.1%	2,264,363	-	-	-	-
2	RA.IND.SM.NRT.029.13	Controls	-	-	-	-	-	-	-	-
2	RA.IND.LG.NRT.025.13	Steam Trap	-	-	-	-	-	-	-	-
2	RA.IND.AGR.NRT.001.13	Insulation	-	-	-	-	-	-	-	-
2	RA.IND.LG.NRT.023.13	New Melting Equipment	-	-	-	-	-	-	-	-
2	RA.IND.LG.NRT.021.13	Building Energy Management	-	-	-	-	-	-	-	-
2	RA.IND.LG.RT.022.13	Furnace Relining	-	-	-	-	-	-	-	-
2	RA.IND.SM.NRT.026.13	Building Envelope	-	-	-	-	-	-	-	-
2	RA.IND.LG.RT.018.13	Heat Recovery	-	-	-	-	-	-	-	-
2	RA.IND.LG.RT.019.13	Heat Recovery	-	-	-	-	-	-	-	-
		Insulation	-	-	-	-	-	-	-	-
2	RA.IND.LG.RT.035.13	Dust Collector Filtration / HVAC	-	-	-	-	-	-	-	-
2	RA.IND.LG.RT.032.13	Boiler Controls	-	-	-	-	-	-	-	-
	Wave 2		-	-	-		-	-	-	-
	GRAND		2,264,363	2,261,985		2,264,363				

5. Closure

In our opinion, Enbridge continues to be proactive in its support to its industrial clients in understanding their processes and identifying measures to increase their efficiency and improve their market competitiveness.

It is clear that EGD have implemented consistent reporting of savings using good engineering practice analysis (and in some cases E-tools) together with appropriate quality assurance techniques to support the findings of the ESCs.

Appendix A GENIVAR Independent File Review Analysis