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December 6, 2013

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

Dear Ms Walli:

Re: Enbridge Gas Distribution Inc. ("Enbridge")
Ontario Energy Board File No. EB-2013-0352
<u>2012 Demand Side Management (DSM) Clearance of Variance Accounts - Enbridge Interrogatory Responses</u>

In accordance with the Ontario Energy Board's (the "Board") Procedural Order issued for the above noted proceeding, enclosed please find the interrogatory responses of Enbridge.

The Company notes that it has filed in response to the interrogatories received redacted copies of the 3 reports prepared by the Contractors retained to undertake a review of the Company's 2012 DSM custom projects. These reports were prepared by MMM Group Limited, Building Innovation Inc. and Byron J. Landry and Associates Inc. In reviewing these reports it was noted that they on occasion referred to specific customers and individuals or included information which might indicate the business or customer that was involved in the custom project. As a matter of customer and individual privacy and confidentiality, the Company has redacted only those portions of these reports which might disclose such matters. It is the view of the Company that the redactions do not detract from the ability of parties to understand the steps taken and the findings of the various Contractors and for this reason, it is believed that it is not necessary to file clean copies of the 3 reports in addition to the redacted versions and to formally request that the unredacted versions be received and dealt with in confidence. Enbridge believes that such a request would unnecessarily complicate the process but the Company does reserve the right to formally make such a request in the event this is required.

This submission was filed through the Board's RESS and will be available on the Company's website at www.enbridgegas.com/ratecase .

Please contact the undersigned if you have any questions.

Yours truly,

[original signed by]

Stephanie Allman
Regulatory Coordinator

cc: Dennis O'Leary, Aird & Berlis

BOMA INTERROGATORY #1

INTERROGATORY

Please describe the process by which custom commercial projects are initiated, managed, reviewed, audited and evaluated.

RESPONSE

Initiation

Commercial custom projects are initiated through Energy Solutions Consultants ("ESC"s) who maintain contact with customers and Enbridge trade allies - commercial HVAC contractors, engineering firms, designers and others who serve the Commercial sector. ESCs and trade allies provide advice on customized energy solutions to suit customer's business needs.

Management and Internal Review

Custom projects are managed and reviewed by internal Enbridge staff, from the Commercial and Industrial Marketing, Reporting and Analysis, and Market Development departments. The process to manage commercial custom projects is as follows:

- Once a new project has been initiated with a customer the ESC and/or trade ally work together with the customer to discuss specific energy efficiency options and approaches.
- An internal technical review is completed on projects as required, as a quality control measure.
- A file review of the Energy Efficiency Project ("EEP") application and associated documentation is completed for all projects.

External Review

As part of the annual evaluation and DSM audit process, Enbridge commissions third party firms to undertake engineering reviews of a random sample of custom projects in the Commercial and Industrial sectors. The elected members of the Audit Committee are involved in the selection process. The random sample for 2012 projects was selected utilizing a new sampling methodology that was developed by Navigant Consulting through the Technical Evaluation Committee. The development of a new sampling methodology for the 2012 to 2014 Multi-Year Plan was required to meet the new DSM Guidelines.

Witnesses: F. Oliver-Glasford
R. Sigurdson

Audit

In accordance with Ontario Energy Board (the Board) requirements, an independent audit was conducted of Enbridge's 2012 DSM program results, which included the random sample of custom projects within the CPSV. The external auditor is chosen by the Audit Committee (AC) which includes a representative of the utility and three intervenor representatives elected from the DSM Consultative. The Terms of Reference for the audit are determined jointly by the Union and Enbridge Audit Committees. The Audit Report for 2012 is included at EB-2013-0352, Exhibit B, Tab 2, Schedule 1.

Following publication of the Auditor's report the AC reviews and comments on the Auditor's recommendations. The result is the Audit Summary Report. The Audit Report and the Audit Summary Report are incorporated in the final version of the Company's Annual Report (Exhibit B, Tab 1, Schedule 1, page 1).

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #2

INTERROGATORY

Please explain the differences between establishing a base case for a custom commercial project and the establishment of free ridership rates for a DSM Program.

RESPONSE

The determination of the appropriate base case to be used for each custom commercial project is considered completely separately from the free ridership rates.

Custom projects cover opportunities where savings are linked to unique building specifications, uses and technologies. A base case is the assumed technology alternative that would have been installed if the customer had not been influenced to install the higher efficiency system, and is established based on various influencing factors such as “availability”, “code requirement”, and cost.

Offerings within Enbridge’s Resource Acquisition program apply factors for free ridership on a sector basis as approved in the Company’s 2012 to 2014 DSM Plan submission (EB-2011-0295, Exhibit B, Tab 2, Schedule 4, page 6 of 6). Low income offerings apply free ridership factors as approved in the 2012 Assumption update (EB-2012-0441, Exhibit B, Tab 1, Shcedule2). These previously approved free ridership rates are applied to all offerings, which include custom commercial projects.

Free riders are customers who received an incentive through an efficiency program, yet would have installed the same efficiency measure on their own had the program not been offered. The free ridership rates were determined by a study commissioned jointly by Union Gas and Enbridge completed by Summit Blue Consulting, LLC, 2008 “Custom Project Attribution Study”.

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #3

INTERROGATORY

Has Enbridge complied with the Board's current DSM Guidelines which require using a Portfolio Average Approach for determining free ridership for a DSM Program?

RESPONSE

The current "Demand Side Management Guidelines for Natural Gas Utilities EB-2008-0346" do not indicate that the utilities are required to use a "Portfolio Average approach".

Enbridge's Resource Acquisition program applies factors for Free ridership on a sector basis as approved in the Company's 2012 to 2014 DSM Plan submission (EB-2011-0295, Exhibit B, Tab 2, Schedule 4, page 6). The Low income program applies free ridership factors as approved in the 2012 Assumption update (EB-2012-0441, Exhibit B, Tab 1, Schedule 2).

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #4

INTERROGATORY

What is the Portfolio Average used by Enbridge for commercial custom projects? How was this determined?

RESPONSE

Assuming that the “Portfolio Average” referred to in the question is in regards to free ridership, the current “Demand Side Management Guidelines for Natural Gas Utilities EB-2008-0346” do not indicate that the utilities are required to use a “Portfolio Average”.

Enbridge’s Resource Acquisition program applies factors for free ridership on a sector basis as approved in the Company’s 2012 to 2014 DSM Plan submission (EB-2011-0295, Exhibit B, Tab 2, Schedule 4, page 6 of 6). The Low income program applies free ridership factors as approved in the 2012 Assumption update (EB-2012-0441, Exhibit B, Tab 1, Schedule 2.

Free ridership rates were determined by a study commissioned jointly by Union Gas and Enbridge completed by Summit Blue Consulting, LLC, 2008 “Custom Project Attribution Study”.

Table 1 indicates the free ridership rates applied to custom projects for each sector.

Table 1
Enbridge Custom Projects

Sector	Free Rider (%)
Agriculture	40%
Industrial	50%
Commercial	12%
Multi-Residential	20%
New construction	26%
Low Income	0%

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #5

INTERROGATORY

No question was provided.

RESPONSE

No response required.

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #6

INTERROGATORY

Reference: Filed: 2013-10-24, EB-2013-0352, Exhibit A, Tab 1, Schedule 3, Page 3-4 of 6.

The DSM Consultative elected an Enbridge Audit Committee ("AC") for 2012 consisting of representatives from the Green Energy Coalition ("GEC"), Low Income Energy Network ("LIEN"), and the Canadian Manufacturers & Exporters ("CME").

Please provide the hours billed and the costs associated with all aspects of Audit Committee work by each DSM Consultative Member of the "AC" for the 2012 Audit.

RESPONSE

The Enbridge 2012 Audit Committee ("AC") was comprised of Vince DeRose representing Canadian Manufacturers and Exporters ("CME"), Chris Neme representing Green Energy Coalition ("GEC") and Judy Simon representing the Low Income Energy Network ("LIEN").

Invoices for Audit Committee intervenors' work on the 2012 Audit were gathered for the period September 2012 to October 2013, inclusive. Totals are shown in Table 1 below.

Table 1

Intervenor	Hours	Fees and Expenses
CME	62.50	$ 20,481.25
GEC	74.50	$ 20,961.93
LIEN *	64.56	$ 24,075.18
Total	201.56	$ 65,518.36

Witnesses: F. Oliver-Glasford
R. Sigurdson

Enbridge has made the best attempt to provide the information requested, however, intervenor invoicing is often billed on a monthly basis with billable hours encompassing various committees (2011 AC, 2012 AC, TEC) and regulatory initiatives.

* Total excludes two invoices (approx. 8 hours; $3000.00) yet to be invoiced by LIEN for work conducted in September and October 2013.

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #7

INTERROGATORY

Please provide the hours billed and the costs associated with each member of the Audit Committee with respect to the DSM Consultative in the development of the 2012 - 2014 DSM Plan not included in any formal Board Hearings for which costs were awarded.

RESPONSE

The Enbridge 2012 Audit Committee ("AC") was comprised of Vince DeRose representing Canadian Manufacturers and Exporters ("CME"), Chris Neme representing Green Energy Coalition ("GEC") and Judy Simon representing the Low Income Energy Network ("LIEN").

Invoices and billable hours were collected for work on the 2012 to 2014 DSM Plan conducted between January 2011 and December 2012 by Audit Committee members, and totals are shown below in Table 1.

Table 1

Intervenor	Hours	Fees
GEC	248.50	$ 62,839.53
CME	198.60	$ 54,197.91
LIEN *	106.75	$ 36,030,95
Total	553.85	$ 153,068.39

Enbridge has made the best attempt to provide the information requested, however, intervenor invoicing is often billed on a monthly basis with billable hours encompassing various committees (2011 AC, 2012 AC, TEC) and regulatory initiatives.

* The LIEN representation changed during the course of 2011. The hours indicated in Table 1 encompass both Marion Fraser and Judy Simon as intervenor representatives on behalf of LIEN during the time period in question.

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Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #8

INTERROGATORY

The Company arranged for an independent evaluation of its custom projects. Prior to retaining the independent evaluators, the Company first consulted the TEC about the terms of reference for this evaluation. An agreement was subsequently reached between the Company and the TEC in respect of the terms of reference. The review was completed by two independent engineering firms.

Please provide the costs and expenses associated with the two independent engineering firms for their independent evaluation. Please provide the resumes of the principal representative of each firm.

RESPONSE

For the 2012 Custom Project Savings Verification (CPSV), three independent engineering firms were retained, MMM Group Ltd ("MMM") and Building Innovations Inc. ("BII") for Commercial projects, and Byron J Landry & Assoc. Inc. for Industrial projects.

The costs associated with each of the three firms for the CPSV reviews are shown in Table 1.

Table 1

Sector	CPSV Firm	Cost
Commercial	MMM Group Ltd.	$59,972.30
	Building Innovations Inc.	$17,500
Industrial	Byron J Landry & Assoc. Inc.	$41,343

Resumes for the principal representatives of each engineering firm are attached. For the MMM Group Ltd – Maurice Safatly; Building Innovations Inc. - Walter Stewart; Byron J. Landry & Assoc., Inc. - Byron Landry.

Witnesses: F. Oliver-Glasford
R. Sigurdson

BYRON J. LANDRY
& ASSOCIATES INC.

Byron J. Landry, P. Eng., CEM, CEA
1498 York Mills Drive
Ottawa, Ontario
K4A 2N4
(613) 769-5133

Byron Landry is an independent Energy Advisor with 35 years of experience in both energy production and utilization. His knowledge includes an understanding of energy efficiency strategies, central plants and thermal power generation systems, load assessments and economic evaluation.

Skills and Assets

Extensive professional experience in the energy sector. Twenty years as Chief Engineer of Energy with a consulting engineering firm have yielded a knowledge of energy consumption patterns, industrial plant operations, utility cost reduction measures, training and technology transfer, cash flow and life cycle economic analysis, investment risk assessments and formulation of funding options for international power generation projects. Experience with a power utility and major boiler manufacturer at beginning of career has provided a firm foundation in applied energy conversion systems at the operational level.

Proven Communications Skills

Career success has relied heavily on proven written and verbal communications skills. Past training assignments, speaking engagements, professional secondments and dialogue with senior management in industry and government required effective communications on a wide range of energy related issues.

Career Profile

Byron J. Landry & Associates Inc.
May 2001 – to date

Provide energy consulting support to a broad range of industrial/commercial/ institutional sector clients, aimed at reducing utility and operating costs. Client base includes Vale Canada Limited, Imerys Talc Canada, 3M Canada , National Research Council, Union Gas, Enbridge, Abbott Laboratories, BPB Canada, NRCan, CEA Technologies Inc., AECL, IKO Industries, RCMP, Canadian Coast Guard, Transport Canada, Flakeboard Company, Papier Masson, Ottawa Health Sciences Centre.

J. L. Richards & Associates Ltd.
Ottawa, Ontario
February 1981 to May 2001

Chief Engineer - Energy
Responsibilities:

- Develop all energy-related business on behalf of the firm, including marketing and proposal preparation.
- Manage all energy related assignments while maintaining a “hands on” involvement in projects.
- Conduct energy audits and cogeneration feasibility studies in industrial plants and commercial facilities.
- Analyze and direct the installation of industrial utility monitoring and targeting systems.
- Conduct independent third party reviews of energy performance contracting proposals for public and private sector clients.
- Prepare and present energy related training courses and workshops.

Selected Achievements

- Successfully fulfilled the role of catalyst for Inco Ltd. to accelerate the rate at which improvements in energy use are being made, resulting in annual energy budget reductions of $ 18 million over a four year period. Earned client trust by being assigned as a resource to Corporate Internal Audit team.
- Acquired a broad knowledge of plant processes and contacts from completion of 300+ industrial energy audits such as Labatt's, Kellogg's, Pepsi-Cola, Ault Foods, Nestle, Celanese Canada, Dupont, Essroc Cement, Inco, Canada Packers, Monarch, Loblaws, Abbott Laboratories, Nordion, Champlain Foods. Commercial sector facility audits include Bell Canada, Royal Bank Centre, Metropolitan Life Centre, St. Lawrence College (Cornwall Campus).
- Served on a three-year secondment to the Association of Consulting Engineers of Canada to disseminate information on energy efficient practices and transfer of existing or new technology to the private sector.
- Established working relationships with leading energy consultants from the U.K., who have key specialized experience in emerging European technologies and new developments.
- Developed a Community Energy Plan for The City of Greater Sudbury, in collaboration with Earthcare Sudbury's Technical Advisory Committee. Provided specialist advice on a broad portfolio of Renewable Energy Technologies.
- Co-authored a handbook "Energy Management Information Systems – Achieving Improved Energy Efficiency", published by NRCan.

Combustion Engineering Superheater Ltd.
Ottawa, Ontario

February 1980 to February 1981

Conducted performance testing of steam boiler systems and environmental emissions for the power generation and pulp and paper industry.

Ontario Hydro
Toronto, Kingston and Port Dover, Ontario
May 1978 to February 1980

Assigned to Lakeview, Lennox and Nanticoke Generating Stations. Gained varied "hands on" experience in the maintenance and operation of boilers, turbines and auxiliary equipment in the station's production groups.

Education

B. Eng., Mechanical Engineering
Carleton University, 1978

Bilingual

Ability to communicate in English and French**.**

Memberships and Certifications

- Professional Engineers of Ontario
- Association of Energy Engineers, Senior Member: **Certified Energy Manager, Certified Energy Auditor**
- Cogeneration Institute
- ASHRAE (Past-President, Ottawa Valley Chapter)

MAURICE SAFATLY, P.Eng, LEED® AP, CMVP

Manager, Commissioning – Energy

PROFESSIONAL EXPERIENCE

Maurice Safatly joined MMM Group in 2008, bringing with him a wealth of expertise and experience in energy modelling and mechanical design. His concrete technical skills and project management experience make him a valuable member to his team. Maurice is the manager of MMM's energy group, is a registered professional engineer with the Province of Ontario, a LEED Accredited Professional, is a certified as an M&V Professional, and has played an integral role in the supervision and completion of multiple projects, including but not limited to: energy modeling using EE4, eQuest, RETScreen and other in-house developed software, for newly constructed buildings and mechanical and electrical systems for existing buildings; energy audits and feasibility studies for GWLRA – portfolio of 17 buildings; Halton District School Board – portfolio of 30 schools; various sites, TD Centre, Oxford Residential Buildings, and Fairmont Hotels; measurement and verification projects; and BOMA-program evaluator and BBP-program evaluator.

PROJECT EXPERIENCE

►► **LEED Modeling and Gap Analysis**

- ►► Screen architectural, mechanical, and electrical drawings and specifications for data gathering. For LEED projects in Canada: perform energy modelling using EE4 software to determine the energy performance of buildings based on hourly simulations using MNCEB performance compliance method.
- ►► For LEED Projects in USA: Perform energy modelling using Energy-Plus software to determine the energy performance of buildings based on hourly simulations using Energy Cost Budget performance compliance method. Prepare documentation, and follow up with reviewers to assure model compliance with EAp2 an EAc1.

►► **Energy Modeling using EE4 Software**

- ►► Screen architectural, mechanical, and electrical drawings and specifications for data gathering.
- ►► Perform energy models using EE4 software to determine the energy performance of buildings based on hourly simulations.
- ►► Prepare documentation, and follow up with reviewers to assure model compliance.

►► **Energy Audits and Feasibility Studies**

- ►► Performed energy efficiency feasibility studies for various energy measures to determine energy savings, payback, life cycle assessment, and environmental impact. Feasibility studies include lighting retrofit, mechanical equipment replacement, energy source comparison and renewable technologies.

PROFESSIONAL AFFILIATIONS:

Member – Professional Engineers of Ontario (PEO)

Certified – Leadership in Energy and Environmental Design (LEED®) Accredited Professional

Certified – Measurement and Verification Professional (CMVP) – Association of Energy Engineers (AEE)

Member – The Association of Professional Engineers of Nova Scotia (APENS)

Member – The Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA)

Member – The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)

Member – The Association of Energy Engineers (AEE)

Listed on the NRCan "Experienced Consultants" for modelling using EE4 software

EDUCATION:

2000
Bachelor of Mechanical Engineering, Dalhousie University, Halifax, Nova Scotia

1996
Diploma of Engineering, Saint Mary's University, Halifax, Nova Scotia

COMMUNITIES

TRANSPORTATION

BUILDINGS

INFRASTRUCTURE

- Collected data and background information from the client regarding facility operation and energy use; evaluated and assessed the condition existing electrical, and HVAC systems; assessed future demand and efficiency options; established rehabilitation / new facility alternatives of power and energy consumption systems.
- Inspected major energy-using equipment, such as: Lighting, HVAC systems, special systems, water consuming systems, and other energy using systems.
- Established base year consumption and reconciled with end use consumption estimates; analyzed savings and cost for each energy and water saving measure following the methodology of nationally-recognized authority; utilized assumptions, projects and baselines which best represent the true value of future energy and operating savings.
- Applied energy simulation programs to develop energy, lighting, heating, and cooling load building models to meet applicable codes and standards.
- Evaluated proposed options within the economical cost analysis; detail cost estimates for selected energy efficiency measures; conducted financial option review (LCA, payback) and projects risk analysis; assessed environmental and social impact.
- Prepared energy audit reports and follow-up with clients.

PROFESSIONAL BACKGROUND

2008 – Present | MMM Group Limited

►► Manager, Commissioning – Energy (2013 – Present) ►► Project Manager (2008 – 2012)

2006 – 2008 | High Performance Energy Systems Inc., Halifax, Nova Scotia

►► Energy Engineer

2002 – 2006 | David C. Stewart & Associates Inc., Dartmouth, Nova Scotia

►► Energy Simulator

2001 – 2002 | Beaini & Associates Engineers Ltd., Halifax, Nova Scotia

►► Project Coordinator

BUILDING *innovation*

Walter Stewart, P.Eng., M.B.A., CPMP, CMVP

Contract Lead - Commissioning

CONTACT INFORMATION

Building Innovation Inc.,
750 Oakdale Road, Unit 54, Toronto, Ontario M3N 2Z4
Tel: (416) 748-6222
Fax: (416) 748-0344
Email: wstewart@buildinginnovation.com

CURRENT COMPANY POSITION AND DUTIES

Walter is a Principal of Building Innovation Inc., co-founding the company in 1996, and has 18 years experience assessing, planning, implementing, and commissioning retrofits and upgrades to existing building environmental systems. Walter is normally the prime contact for commissioning projects responsible for client liaison, development of commissioning strategies and plans, assessing owner project requirements, evaluating energy and life cycle issues, managing commissioning process, and tracking and communicating issues with project stakeholders.

PROFESSIONAL DESIGNATIONS AND CERTIFICATIONS

Walter is a Professional Engineer (P.Eng.), has a Building Code Identification Number (BCIN) under the Ontario Ministry of Municipal Affairs and Housing (MMAH), and has his Masters in Business Administration (M.B.A.). Walter also has his Certified Measurement & Verification Professional (CMVP) designation from AEE, as well as his Commissioning Process Management Professional (CPMP) certification from ASHRAE.

MEMBERSHIPS AND ACTIVITIES

Walter is a member of Professional Engineers Ontario (PEO), Ontario Society of Professional Engineers (OSPE), Construction Specifications Canada (CSC), and The Institute of Electrical and Electronics Engineers (IEEE).

EDUCATION

Walter graduated from the University of Waterloo in 1992 with a degree in Computer Engineering, and from Wilfrid Laurier University in 1993 with Master of Business Administration degree.

WORK HISTORY

- Building Innovation Inc. (1996 – Present) – Principal
- Dynacon Enterprises (1992 – 1996) – Systems Designer

PROJECT EXPERIENCE

Oakville Hydro Electricity Distribution Inc. - HPNC Project Evaluator, Oakville, Ontario (Jun 2012 - Date) - Developed auditing, reporting, and technical review process to perform role of project evaluator to support Oakville Hydro's administration of their High Performance New Construction project. Evaluations include technical evaluations of DOE 2.2 based simulations, site visits, and auditing of prescriptive based project applications.

City of Mississauga – Building Systems Re-commissioning – 4 Facilities, Mississauga, Ontario (Apr 2012 - Oct 2013) - Managed and executed re-commissioning project for 4 City facilities that was focussed on identifying operational and energy improvements. The project involved various phases including scoping, investigation, implementation, and hand-off. Various activities were completed including detailed field investigations, documentation reviews, functional tests on controls and HVAC systems, controls point to point testing, controls sequences investigations and testing, recommendations for changes and improvements to performance. Custom "Operating for Efficiency" manuals were developed as a template for future projects including specific roles and procedures for operating, maintenance, and energy champions to complete to promote and protect efficient building operation. Staff were trained on the new procedures and implemented modifications.

MHPM Project Managers Inc. / Infrastructure Ontario – Whitby Land Registry Office, Whitby, Ontario (Apr 2013 – Oct 2013) – Managed "consultant as commissioning agent" process for a heating plant replacement project for a government building. A commissioning plan and commissioning activities were developed to include pre-startup check lists, post-startup checklists, functional performance tests, documentation and site labelling reviews, as well as a detailed training requirements list. Functional performance tests included capacity tests, failover tests, and operating mode tests. Emphasis was placed on control sequence documentation including interface between manufacturer sequencers and building automation system.

CBRE Limited / Infrastructure Ontario – Elgin-Middlesex Detention Centre, London, Ontario (Nov 2011 – Jun 2012) - Managed and involved with commissioning project that focused on construction activities for client acceptance of a comprehensive mechanical and controls upgrade project to replace and renew the central cooling plant and reduce operating costs and energy use. Commissioning responsibilities included development of commissioning plan, specifications, installation and start-up checklists, functional performance tests, documentation and training review.

MHPM Project Managers / Infrastructure Ontario – Brampton Court House, Brampton, Ontario (Aug 2011 – Aug 2012) - Lead engineer for electrical and controls design of extensive controls upgrade at an Infrastructure Ontario courthouse facility. The project involved assessing the facility and discussions with stakeholders for requirements and options, as well as phase-in considerations and extending the existing base building control system. Design issues included review of risks and benefits of multiple vendor solutions over BACnet versus methods and procurement issues surrounding single sourcing of existing BAS vendor. The project included liason with a third party commissioning provider and measurement and verification.

City of Hamilton – Critical Facilities Generator Black-out Testing, Hamilton, Ontario (Jun 2011 – Dec 2012) – Performed quality control reviews for generator black-out testing across 40 critical facilities, including emergency response centres, emergency operations, and fire stations. The project involved development of test specifications, functional testing forms, and drawings in order to evaluate and test the generator systems and document emergency power distribution system. Reporting included assessments for code compliance and direction for tendering work to the trades. The project was tendered to electrical and generator service trades to complete black-out testing during after normal working hours. Included in this work was to test the generator, emergency power distribution systems, document electrical systems throughout the facilities, complete load tests, complete light level readings.

City of Hamilton – Lister Block, Hamilton, Ontario (Aug 2011 – Feb 2012) – Involved with commissioning of mechanical, electrical, envelope, structural and other building environmental systems of the major renovation of Lister Block. The facility was completely renovated under a design-build arrangement, with professional designers such as engineers and architects as sub-consultants to the design-build team. The first year operations identified various deficiencies and operational issues. Building Innovation was retained to review the existing systems for completion, requirements, and performance issues. Additional details are confidential.

City of Hamilton – Hamilton City Hall, Hamilton, Ontario (Dec 2010 – May 2011) – Involved with commissioning of mechanical, electrical and other building environmental systems of the major renovation of Hamilton City Hall. The facility was completely renovated under a design-build arrangement, with professional designers such as engineers and architects as sub-consultants to the design-build team. The first year operations identified various deficiencies and operational issues. Building Innovation was retained to review the existing systems for completion, requirements, and performance issues. Additional details are confidential.

SNC-Lavalin ProFac / Public Works and Government Services Canada – Milton RCMP, Milton, Ontario (Oct 2010 – Feb 2011) - Managed and involved with electrical maintenance and repairs project throughout the facility. The project involved assessing systems, equipment and components on site, specification and tender development, and construction services for maintenance work by the trades. Maintenance investigations and tests required in terms of extent and frequency of maintenance were developed, including determination of disruptive and non-disruptive tests, scheduling coordination, and reporting requirements including mechanical testing of components, infra-red testing, coordination study, arc flash study, single line documentation verification and updating. This facility was secure.

City of Hamilton – Central Utilities Plant, Hamilton, Ontario (Jun 2010 – Feb 2011) - Managed and involved with electrical testing and maintenance project for the substations serving multiple buildings and facilities, including transformers and circuit breakers. The project involved assessing equipment and components on site, specification and tender development, and construction services for maintenance work by the trades. Investigation work focussed on determining the best approach to assess the existing systems in order to determine extraordinary issues that may impact equipment and component longevity. Testing and maintenance work required in terms of extent and frequency were developed, including determination of disruptive and non-disruptive tests, scheduling coordination, and reporting requirements including mechanical testing of components, infra-red testing, coordination study, single line documentation verification and updating. Based on the results of the work, additional reporting was completed on substation capacity and future expansion via replacement or addition of another transformer and circuit breaker set.

SNC-Lavalin ProFac / Ontario Realty Corporation – Robarts School for the Deaf, London, Ontario (Nov 2008 – Mar 2010) - Managed commissioning project and developed commissioning program for the controls systems portion of the recently implemented retrofit project at the facility. The project involved developing and implementing a commissioning program to verify operation, identification of deficiencies and repair recommendations, establishment of a baseline operation, and ongoing evaluations reporting over each season. Results were reviewed by and discussed with the client, the design engineer, the prime contractor, and the controls sub-contractor. Results included recommendations on additional energy efficiency and operational improvements.

City of Hamilton – District Cooling Loop – Phase 1 (Central Utilities Plant), Hamilton, Ontario (Oct 2008 – Jul 2009) - Managed aspects of and involved with electrical and controls design of 2400 ton district cooling plant replacement, including refrigerant safety systems, variable speed drives on chiller compressors as well as pumps and fans. Various advanced controls optimization strategies were implemented including advanced adaptive control algorithms, efficiency based equipment sequencing and speed control, condenser relief with multiple cooling tower cells, demand based variable flow and temperature reset, switching between chiller parallel and series operation which allows for wide temperature differences across condenser and chilled water loops. Managed commissioning process including writing commissioning plan and specification, performing witnessed testing, writing and coordinating functional performance testing, reviewing site and written documentation, overseeing training, and performing measurement and verification of results.

Ontario Power Authority – Chilled Water Plant Ongoing Commissioning (Oct 2008 – Oct 2009) – Managed and designed controls and commissioning program for the City of Hamilton's Central Utilities Plant (2400 ton plant for the district cooling loop) for the purposes of completing extensive commissioning activities, including monitoring and verification of results. The project involved developing and implementing controls solutions, a commissioning program to verify operation, establishment of a baseline operation, and ongoing reporting. Evaluations were completed on additional improvements. ASHRAE Guideline 11, Tier 3 testing was employed to evaluate and measure equipment performance curves to identify performance at varying loads. The results are reviewed by and discussed with Ontario Power Authority as well as a third party program auditor.

Enbridge Gas Distribution, Toronto, Ontario (Mar 2007 – Present) – Managed and involved with all aspects for performance audits of a utility company's Conservation Demand Management energy efficiency incentive program at numerous projects, including over 200 file reviews over 7 years of incentive applications. Projects included educational, health care, industrial, recreational, multi-unit residential, and worship. This project was completed to meet Ontario Energy Board auditing requirements. Project involved the verification and independent assessment of applied for savings under this program.

BOMA INTERROGATORY #9

INTERROGATORY

Consistent with Section 15 of the Guidelines, the Company prepared an evaluation report for 2012 titled 2012 DSM Draft Evaluation Report ("Draft Evaluation Report") dated April 15, 2012, which summarized the savings achieved, the amounts spent and how the results were evaluated. The results of the independent review of custom projects were included in the Draft Evaluation Report which also included calculations for the 2012 DSMIDA and DSMVA.

Please describe the process by which Enbridge gathered the information and prepared the draft 2013 DSM Evaluation Report.

RESPONSE

Following the Board's DSM Guidelines, Enbridge is required to produce an annual report summarizing the year's program results to submit for review in the annual independent audit process. This is referred to as the DSM Draft Evaluation Report.

The process of developing the draft DSM evaluation report involved significant and comprehensive content gathering from Program Management, EM&V, and Reporting and Analysis staff, beginning in the third quarter of 2012. This content gathering and the results of the various verification studies informed the development of the master results spreadsheet.

The master results spreadsheet was produced and included all the inputs required to present the scorecard comparisons, tables, graphs and charts included in the Draft Evaluation Report. These values were also fundamental in the calculations of the DSMIDA, DSMVA and LRAM. (The final master results spreadsheet was subsequently made available for review by the Auditor and Audit Committee under confidentiality agreements during the course of the Audit process. The Enbridge Audit committee was selected via an election process by the DSM Consultative members to provide representation of the consultative during the audit process).

Throughout the development of the DSM Draft Evaluation Report, the document was circulated internally for reviewer comments and to ensure accuracy. The DSM Draft Evaluation Report, dated April 15th, 2013, was distributed to the Audit Committee and Auditor on April 15th, 2013 and to the DSM Consultative on April 17th, 2013.

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #10

INTERROGATORY

Please provide the costs associated with the Independent Audit of 2012 DSM Results.

RESPONSE

The costs associated with the Independent Audit of 2012 DSM Results include the third party auditor, CPSV auditors, and the DSM Audit Committee costs, these costs are summarized in Table 1 below.

The total invoice for Energy & Resource Solution ("ERS") was $84,769.70 USD ($88,524.99 CDN).

The total costs for the 2012 Audit Committee was $65,518.36. Please refer to the response to Boma Interrogatory #6, found at Exhibit I-1-6 for further detail.

The total cost for the CPSV was $118,850.30. Please refer to the response to Boma Interrogatory #8, found at Exhibit I-1-8 for further detail.

Table 1

Energy & Resource Solution (ERS)	$88,524.99
2012 Audit Committee	$65,518.36
CPSV	$118,815.30
Total*	$272,858.65

* This total does not include the estimated EGD staff full time equivalent (FTE) costs associated with the managing and coordinating of the audit process, nor does it include the costs that will be associated with the ongoing 2012 DSM Clearance of Accounts application (EB-2012-0352).

Witnesses: F. Oliver-Glasford
R. Sigurdson

BOMA INTERROGATORY #11

INTERROGATORY

Please provide the qualifications statement for ERS.

RESPONSE

Attached is a qualification statement from the Energy and Resource Solutions ("ERS") audit proposal.

Witnesses: F. Oliver-Glasford
R. Sigurdson

CORPORATE QUALIFICATIONS AND MANAGEMENT TEAM

ERS has a rich history in energy efficiency, evaluation, and auditing. This section first introduces the firm and our pertinent background then presents our proposed audit team and individual staff bios. Appendix A includes selected relevant corporate project briefs.

Note to readers: The content of this section is substantially the same as the similar section in the statement of qualifications submitted previously, albeit reorganized.

ERS Company Profile

ERS has provided energy efficiency program evaluation, implementation, consulting, and energy audit services to utility companies since 1995. The company has grown to become a leading energy efficiency consulting firm of more than sixty employees working with Enbridge Gas Distribution, Efficiency Nova Scotia, Efficiency New Brunswick, National Grid, NSTAR Electric, Public Service of New Hampshire, Northeast Utilities, NYSERDA, LIPA, and others in the northeastern United States along with the California Public Utilities Commission, the Northwest Energy Efficiency Alliance, and others in the western United States. We provide lighting, HVAC, and industrial process efficiency services directly to commercial, institutional, and industrial customers throughout the Northeast.

ERS employs over 60 professionals committed to the energy efficiency industry.

ERS has offices in Massachusetts, Maine, New York, Texas, California, and Oregon. More than half of our employees are degreed engineers. Support for this evaluation will come predominantly from our New York City and Massachusetts staff with back-up assistance provided by team members from our other office locations.

The single characteristic that most sets ERS apart from competing firms is our eagerness to embrace technical rigor to answer clients' questions and deliver defensible results they can trust. For example, ERS recently completed intensive measurement to assess the in situ performance of over twenty condensing boilers, and we performed hourly analysis of a group of ten combined heat and power systems. This real world field experience helps us review all customer engineering calculations and M&V methodologies with understanding regarding measurement options and necessary assumptions. Our evaluation studies have assessed water heaters, lighting retrofits, process enhancements, HVAC system controls improvements, and other measures that save natural gas. This evaluation work coupled with our development and implementation of DSM programs have prepared us to knowledgably assess the details of Enbridge's program delivery and to formulate an opinion regarding the reporting of program results.

Relevant Evaluation and Audit Experience

ERS's founding origins are in large C&I sector energy efficiency. We started as an energy studies firm serving this segment of the market. Our services quickly expanded to program implementation and evaluation. ERS is now one of the few firms that still provides clients with both program implementation and evaluation services. In fact every proposed individual audit team engineer currently is supporting both implementation and evaluation projects. We believe this combination of capabilities adds greatly to the quality of our evaluations and audit reports for two reasons: (1) we know where to look to assess factors of higher uncertainty and (2) our recommendations are rooted in the practical realm of program operation.

Due to our background in the large C&I sector, we initially evaluated predominantly custom projects. Our teaming partners tend to bring our engineers into the fold when they need technical experts to evaluate large complex projects with involved control systems. This large C&I background proved invaluable in our auditing role in 2012, as custom projects contributed over 85% of Enbridge's savings.

Over the past ten years, we have broadened our evaluation skills and now provide the full range of evaluation services including assessment of market transformation programs and all market sectors. In 2009, for example, ERS led a team that evaluated all of NYSERDA's natural gas efficiency programs, which ranged from new homes to large industrial facilities. ERS was responsible for both single-family and multi-residential analysis. We are currently evaluating a large multi-family residential program with substantial market transformative characteristics, and we are about to start an evaluation of a research and development-oriented combined heat and power program. We also just completed our second year of evaluation of a traditional resource acquisition natural gas program in Massachusetts.

ERS may, in fact, have more experience as a comprehensive natural gas program evaluator than any other firm in North America. We have evaluated or audited dozens of programs that were solely natural gas or included natural gas incentives. ERS's Jon Maxwell has authored peer-reviewed papers on gas program evaluation design,[1] and our engineers have conducted field research on the performance of condensing boilers.

The RFQ specifically inquired about such experience in a performance-based environment. ERS currently provides audits and/or evaluation services in California, New York, Massachusetts, Vermont, and other states operating in a performance-based environment. We provided audits for this environment in Ontario in 2012.

Ontario Evaluation and Audit Experience

ERS is familiar with the Ontario DSM regulatory framework for natural gas utilities, which includes a large number of interested parties. We worked within this framework in 2012. We understand the key entities associated with the audit process, and we have reported to the Enbridge Evaluation and Audit Committee (now the Audit Committee, AC). We have also worked with independent evaluators and compared program reported results with the protocols specified in OEB order 2008-0346: Demand Side Management Guidelines for Natural Gas Distributors, the OEB Decision Framework, and the OEB order 2006-0021: DSM Handbook. We have also worked with other key documents such as Enbridge's annual energy plan filing EB-2010-0175 and the OEB Decision with Reasons, EB-2006-0021.

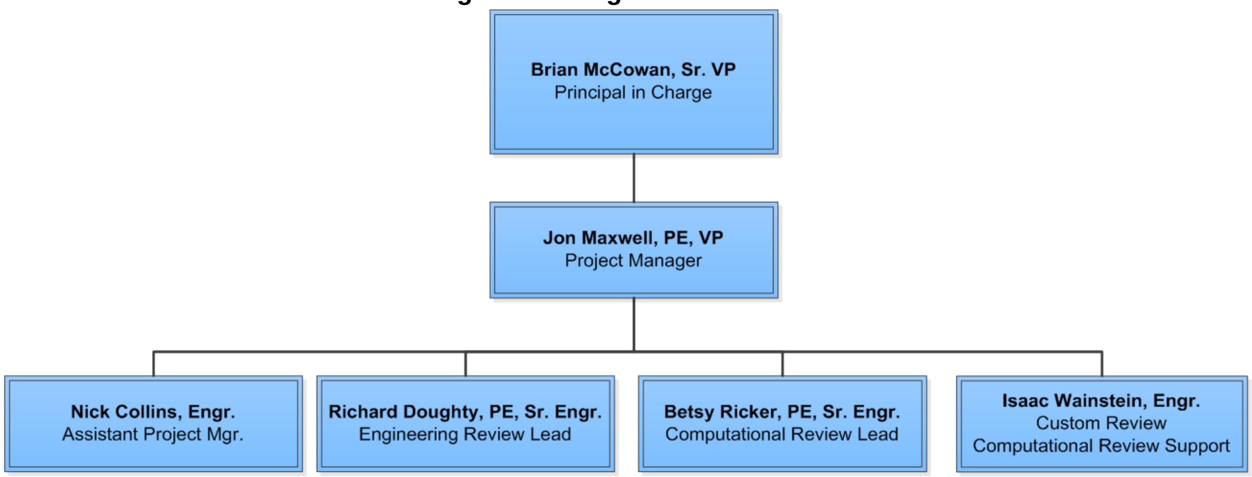
ERS has worked with energy efficiency program administrators in Ontario, Quebec, Nova Scotia, and New Brunswick in the past 3 years.

[1] *How to Design a Gas Program Impact Evaluation,* Jonathan B. Maxwell, Energy & Resource Solutions (ERS), College Station, TX, Kathryn Parlin, West Hill Energy & Computing, Chelsea, VT, AESP National Conference, January 2011.

Enbridge Audit Project Team

ERS believes that a relatively small team will best serve the project and AC by enabling the providers to focus on the task. As such we have constructed the team shown in Figure 2.1. Other ERS professionals will be available to supplement the core team if peak period levels of effort require it.

Figure 2-1. Organization Chart



This team has a 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. **While the primary objective of an audit is to provide an unbiased opinion on savings estimates, the independence required to perform this task is not synonymous with insular ivory tower research. Program administrators and ratepayers are best served by progressive thinking and interaction with interested parties to continuously improve the state of the art in program delivery and evaluation. Such interaction is easiest when the auditor understands the perspective of all parties. As noted previously, our team members have held many of the same responsibilities as the OEB stakeholders. These include:**

- **Operating programs with performance incentives**
- **Advocating for energy efficiency policy**
- **Evaluating energy efficiency programs**
- **Auditing program operation and evaluating results**
- **Advising regulatory entities**

This rare multi-faceted perspective enables our team members to listen to and understand all points of view and work productively with them to provide the products that constituents need. We can do this despite the different agendas of interveners, ratepayer advocates, and industry and program administrators. Our perspective, combined with relentless focus on the technical methodologies and on quantitative results, gives ERS auditors the credibility to productively work with these diverse stakeholders and deliver the common product desired: trustworthy opinions and practical advice on efficient service delivery.

Brian McCowan, LC, is Senior Vice President of Technology and Development at ERS with interdisciplinary skills in the energy engineering, lighting, environmental, and renewable technology consulting fields and particular expertise in consensus building for multi-client organizations such as NEEP and research committees. As a licensed construction supervisor and certified lighting designer, he has expertise in project design and management that is utilized throughout ERS's scope of services. Additionally, Brian has more than 20 years of experience in the training of energy system professionals. He has spent considerable time providing consulting services in support of enhanced compliance with new energy codes and developing web-based resources to support energy code understanding and compliance. Brian holds a BS degree from the University of Southern Maine.

Jonathan Maxwell, PE, LEED AP, is the Vice President of Engineering and Evaluation at ERS with more than 20 years of experience in energy efficiency program evaluation and implementation. Mr. Maxwell led this past year's Enbridge audit. He has managed major field data collection efforts for evaluation and load research and has trained more than 200 energy professionals on a wide variety of topics, mostly related to field data collection and analysis. Jon has conducted more than one hundred C&I site visits and led start-up, hiring, training, and daily project management for four energy audit programs that provided a combined 1,600 audits per year to utility customers. He has also designed Excel- and SAS-based building simulation models. He directed four industrial compressed-air program design and evaluation and market potential studies in New England and New Jersey.

Jon has published extensively, with more than thirty papers and formal presentations. He is a Professional Engineer registered in Maryland and Texas, a LEED Accredited Professional, and an EPA Green Lights Surveyor Ally. He holds an MS in Mechanical Engineering from Oregon State University and a BSE in Mechanical Engineering and History from Duke University.

Nick Collins is a Project Engineer for ERS and a LEED Accredited Professional. His areas of expertise include the monitoring and verification of energy efficiency projects and the analysis of energy efficiency and demand-limiting measures in commercial and industrial facilities. Nick is also proficient in project and construction management, with an emphasis on sustainable design and building methods in commercial construction, including significant experience with LEED and Core Performance rating systems and project delivery. He received his BS in Mechanical Engineering from the University of Maine.

Richard Doughty, PE, CEM, LEED AP, CBCP, a Senior Engineer at ERS, is a Professional Engineer licensed in the State of Maine, a Certified Energy Manager, a Certified Building Commissioning Professional, and a LEED Accredited Professional. He has 25 years of diverse engineering experience in the field of energy conservation, including the analysis, identification, development, implementation, and verification of cost-effective energy-saving measures. He also has extensive knowledge of a wide variety of energy-related technologies and a high degree of understanding of energy markets. Richard's current work at ERS includes serving as the lead engineer providing technical assistance for the Efficiency Maine Business Program, effectively performing net-to-gross engineering savings calculations in advance of measure installation to increase the program's cost-effectiveness. He holds a BS in Chemical Engineering from the University of Maine.

Betsy Ricker, PE, LEED AP BD&C, is a Senior Engineer for ERS. Her key areas of expertise include energy modeling, monitoring and verification of energy efficiency projects, and analysis of energy efficiency and demand-limiting measures in commercial and industrial facilities. She is proficient in engineering field data collection, lighting design using AGI-32 and SPOT, simulation modeling of building energy consumption using eQUEST and EnergyPlus, and gas and electric efficiency measure analysis using Microsoft Excel. She is also experienced in uncertainty analysis, especially as it pertains to building energy modeling and simulation. Betsy holds a BS in Mechanical Engineering from Tufts University and an MS in Mechanical Engineering from the Massachusetts Institute of Technology.

Isaac Wainstein is a Project Engineer at ERS. He has participated in impact evaluations associated with various types of measures, a coincidence factor analysis of Long Island, and a high-level savings analysis for the Gillette manufacturing facility in Boston. Isaac has provided overall data management and quality control for multiple utility incentive program evaluations. Specifically, he developed tablet software for evaluation of more than 220 sites to improve efficiency of analyses and data quality control. Before joining ERS, Isaac interned at ISO New England, where he performed a peak-day NO_X emission analysis to reduce harmful emissions within New England and was a member of the department that authored the annual ISO Regional System Plan, which details all the generation and transmission projects needed to provide reliable and economic generation, as well as the capacity analysis needed to meet a growing demand over a 10-year horizon. Isaac graduated magna cum laude from the University of Massachusetts, Amherst, with a BS in Industrial Engineering.

SEC INTERROGATORY #1

INTERROGATORY

[Ex. B/1/1, p. 62]

Please provide a detailed calculation of the DSMIDA of $5,265,185 for Resource Acquisition Programs for 2012. Please show the calculations of the 92% allocated to volumes, the 4% allocated to Residential Deep Savings, and the 4% allocated to Commercial-Industrial Deep Savings. Please show all calculations of percentage performance for each category relative to target, and DSMIDA impact. Please include the algorithm for calculation of each component of the DSMIDA. Please provide an Excel spreadsheet showing all calculations, and reconciling to Table 15.

RESPONSE

Table 1 below shows the percentage performance relative to target (score), and DSMIDA impact for each component of the Resource Acquisition scorecard.

Table 1

			Performance Band				
Program Type	**Result**	**Weight**	**50%**	**100%**	**150%**	**Score**	**Metric DSMIDA**
Resource Acquisition Total							
Resource Acquisition Res/Comm/Ind CCM	1000.86	92%	615.30	820.40	1,025.50	144%	$ 5,498,484
Commercial/Industrial Deep Savings %	25%	4%	40%	45%	50%	-103%	$ (525,714)
Residential Deep Savings # Customers > 25%	209	4%	120	160	200	161%	$ 292,415
					Weighted Score	**135%**	
RA Total DSMIDA			**$ -**	**$ 2,576,346**	**$ 6,440,865**	**$ 5,265,185**	**$ 5,265,185**

Calculations are as per the Demand Side Management Guidelines for Natural Gas Utilities, EB-2008-0346, page 32.

Due to the amount of confidential customer information on the master results spreadsheet, Enbridge declines to make publicly available the excel spreadsheets as requested. The Company notes that it supplied the requested excel spreadsheets to the independent Auditor and to the three Audit Committee members under confidentiality agreements during the course of the Audit process. The Enbridge Audit

Witnesses: F. Oliver-Glasford
R. Sigurdson

committee was selected via an election process by the DSM Consultative members to provide representation of the consultative during the audit process.

SEC INTERROGATORY #2

INTERROGATORY

[B/2/1. P. 15]

Please confirm that, of the total audited result of 1,000,860,923 cumulative lifetime m_3 for resource acquisition volumes, 806,740,394 cumulative lifetime m_3 are the result of custom programs. If this is not the correct number, please provide the correct number, and the calculation from which it is derived, including any Excel spreadsheet supporting that calculation. Please provide a table showing a breakdown of these custom m^3 into Industrial, Commercial, New Construction, and Low Income custom projects. If there are any other categories, please identify them and show the volumes in the table.

RESPONSE

The cumulative lifetime m^3 for Resource Acquisition Commercial and Industrial custom projects is 870,733,009.

The cumulative lifetime m3 for Low Income Commercial custom projects is 32,439,466.

Table 1

Program Type	Sector	Cumulative Lifetime Savings (m3)
Low Income	Low Income Custom	32,439,466
Low Income Total		**32,439,466**
Resource Acquisition	Commercial Custom	432,052,392
	New Construction Custom	132,765,211
	Industrial Custom	305,915,406
Resource Acquisition Total		**870,733,009**
Total Portfolio Custom Projects		**903,172,475**

Based on commercial and industrial custom projects.

Due to the amount of confidential customer information on the master results spreadsheet, Enbridge declines to make publicly available the excel spreadsheets as requested. The Company notes that it supplied the requested excel spreadsheets to

Witnesses: F. Oliver-Glasford
R. Sigurdson

the independent Auditor and to the three Audit Committee members under confidentiality agreements during the course of the Audit process. The Enbridge Audit committee was selected via an election process by the DSM Consultative members to provide representation of the consultative during the audit process.

Witnesses: F. Oliver-Glasford
R. Sigurdson

SEC INTERROGATORY #3

INTERROGATORY

[B/1/1, p. 61]

Please confirm that, for every 100 cumulative lifetime m^3 in excess of target, and below the maximum, the Applicant is entitled under the formula to an incentive of $1.73. Please confirm that a 10% reduction in the cumulative lifetime m^3 would result in a reduction to the DSMIDA of $1.735 million. If either of these numbers is not correct, please provide the correct number, together with all calculations from which it is derived, including any Excel spreadsheet supporting those calculations.

RESPONSE

These numbers are correct.

Witnesses: F. Oliver-Glasford
R. Sigurdson

SEC INTERROGATORY #4

INTERROGATORY

[B/1/1, p. 78]

Please provide the full reports of MMM Group and Building Innovations.
Please provide their time dockets for all of the work they did to verify savings and prepare the reports. Please provide a table showing, for each of the projects reviewed by 2 either of MMM Group or Building Innovations, and for each assumption they used to calculate the cumulative lifetime m3:

a. The original assumption in the application;

b. The assumption used by the CPSV contractor, and, if it was different, the reason why it was different, if known;

c. The final assumption approved by the Auditor, and, if it was different from the assumption used by the CPSV contractor, the reason for the difference;

d. The process that resulted in each change in assumption or calculation method from the original application, including any input provided by Enbridge related to the change; and

e. The impact (in lifetime m3) of each change in assumption or calculation method.

RESPONSE

Attachment 1 and 2 are the redacted Engineering Reviews of the 2012 Commercial Sector Custom Project reports by both MMM Group Ltd. and Building Innovations Inc. The Enbridge CPSV firms are contracted on a per project basis and do not keep time dockets for each project reviewed.

Responses to above questions a) through e) are summarized in a Table provided in Attachment 3.

Witnesses: F. Oliver-Glasford
R. Sigurdson

BUILDING innovation

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Engineering Review of Enbridge Gas Distribution Custom Projects 2012

Mar 2013

BUILDING Innovation

Table of Contents

1.0 BACKGROUND

Enbridge Gas Distribution (EGD) retained Building Innovation Inc. (BII) to conduct an engineering review of the energy savings for a subset of projects in the 2012 Commercial Sector Custom Projects selection.

The purpose of this review is to provide an objective opinion of the reasonableness of the energy savings claimed by the custom projects in 2012 through a review of a statistically representative sample of projects.

BUILDING *innovation*

2.0 SELECTED PROJECTS

BII was provided the following projects selected for review. The following table describes the projects in more detail.

DSM Code	Building Type	New / Retrofit	Claimed Gas Savings [m³]	Claimed Electrical Savings [kWh]	Claimed Water Savings [kl]
NC.002.12	Recreational	New Construction	275,395	863,580	
NC.005.12	Laboratory	New Construction	283,734	196,632	
RA.PRO.EX.038.12	Office	Retrofit	227,556	27,728	
EX.089.12	Retail	Retrofit	36,449	21,521	
EX.080.12	Retail	Retrofit	35,719	4,294	
		Claimed Gas Savings:	858,853	1,113,755	--

Table 1 Selected Projects - 2012

BUILDING *innovation*

3.0 METHODOLOGY

3.1 Documentation Review

BII conducted a review of documentation related to each selected project. In particular, the following was completed:

- The information within the Energy Efficiency Project Application (EEP File) was reviewed in detail, including the assumptions, calculation methodology, and data used to support the savings estimates.
- In the case of missing, incomplete, or ambiguous information, BII worked with EGD to obtain the appropriate data.
- Where clarification was required, BII interviewed EGD staff and/or other project stakeholders to gain a better understanding of project details.
- BII reviewed available third party modeling reviews, modeller notes, and available simulation files.

3.2 Site Visits

BII completed site visits with project contacts provided by EGD. The purpose of the site visits was to:

- Clarify project scope and timing.
- Confirm installation details.
- Provide or clarify details about the building, systems, and equipment.

3.3 Savings Calculations Review

BII reviewed the available simulation reference model against Ontario Building Code requirements in force at the time of building permit. The following elements of the reference building design were reviewed:

- Lighting and equipment power density assumptions.
- Infiltration assumptions.
- Window to wall area and average U-value.
- Window, wall, roof, and underground surface U-values.
- Equipment efficiencies.
- Code required heat recovery.

BII also compared energy intensity information (i.e., gas consumption per suite or per square foot) for end-use components where such information was available. This information was used to direct questions or requests for additional information to EGD or site contacts in cases where utility use in a particular end-use component deviated significantly from benchmarks.

3.4 Assumptions and Limiting Conditions

This report is subject to the following assumptions and limiting conditions:

- BII may have relied on verbal information or site documentation without confirming its accuracy.
- Independent utility analysis, simulation, and utility balance were not undertaken.
- A comprehensive review of installed equipment against simulated equipment was not performed.
- Code compliance reviews and design reviews were not undertaken.
- BII makes no warranty that assumptions, methodologies or calculation results deemed "reasonable" will be accurate, only that the assumptions, and methodologies used to calculate the savings figures are reasonable, within the context of standard industry practice.

BUILDING innovation

4.0 RESULTS ANALYSIS

4.1 Results Summary

The results from the review are summarized below.

DSM Code	Adjusted Gas Savings [m³]	Adjustment [%]	Adjusted Electrical Savings [kWh]	Adjustment [%]	Adjusted Water Savings [kl]	Adjustment [%]
NC.002.12	275,395	0.0%	863,580	0.0%		
NC.005.12	283,734	0.0%	196,632	0.0%		
RA.PRO.EX.038.12	134,233	-41.0%	140,026	405.0%		
EX.089.12	36,449	0.0%	21,521	0.0%		
EX.080.12	35,719	0.0%	4,294	0.0%		
	765,530	-10.9%	1,226,053	10.1%	-	

Table 2 Review Results

BUILDING *Innovation*

4.2 Results

The findings are summarized below. Additional details, and calculations for the adjustments provided may be found in the detailed auditing sheets provided under separate cover.

.1 RA.REC.NC.002.12

Project Information

Project Code:	NC.002.12
Building Type:	Recreational
Project Description:	Construction of new recreation building.
Project Details:	Measures include occupancy sensors, low emissivity ceilings, high efficiency chillers and boilers, heat recovery, and VFDs on pumps and cooling tower.
Implementation Date:	Mar 2011 to Sep 2011
Gas Savings:	275,395-m3
Electrical Savings:	863,580-kWh
Adjusted Gas Savings:	275,395-m3
Adjusted Electrical Savings:	863,580-kWh

Savings Calculation Methodology

The savings from the new construction program result from a simulation of the new facility under Toronto Better Buildings Partnership New Building Construction Program (NBCP). The simulation was completed using the DOE eQuest building energy simulation tool. The use of the eQuest software, unlike the EE4 software, requires the modeler to manually input the assumptions for the reference case building. A "proposed" simulation of the building was created using design drawings and specifications. This information was modified for the "reference" building, and savings were derived from the differences in utility use between the two simulations.

The project documentation included a detailed report on modeling and reference building assumptions and methodology. Appendices were originally missing from this report, although these, along with the DOE simulation files, were able to be obtained directly from the business provider.

Review Information

The site installation was in general conformance to the project application. The following information was gathered through review of the simulation reports, site review, and staff interviews:

- The building permit was dated in March 2011, indicating that the Ontario Building Code Supplemental Standard SB-10 (SB-10), July 1, 2011 update was not yet in force.

This indicates the "minimum code" building may be derived from either ASHRAE 90.1-2004 with SB-10 requirements, or Model National Energy Code of Canada for Buildings (MNECB)-1997 with SB-10 requirements.

- The modeling notes indicates that NRCan's "Arena Technical Guide" was reportedly followed for creation of the reference building, along with OBC SB-10.
- At the time of the site visit, construction was not fully completed on the site, although major equipment and systems were installed, but not commissioned.
- The building comprised arenas, a gymnasium, a pool, and other recreational facilities.
- Benchmarks of the reference building were in line with average benchmarks for existing facilities.
- The MNECB-1997 5.4.3.2 requires arenas to have some form of heat recovery from the refrigeration plant. A review of the simulation file indicated the reference simulation included heat recovery into the Service Water loop.
- This building and simulation is involved in a LEED accreditation process, and has likely been reviewed through that process as well.

Discussion

The benchmarks demonstrated the reference building energy use for gas and electricity was similar to utility benchmark data from typical existing arenas. The electricity use per square meter was 12% less, and the gas use per square meter was 3% higher. This and the fact that the building has likely been reviewed through the LEED accreditation process lends credibility to the simulation.

The SB-10 requirements include several paths for compliance. All of these paths, including the least stringent MNECB-1997 5.4.3.2, require arenas to have some form of heat recovery from the refrigeration plant. A review of the simulation files indicated the reference simulation did include a degree of heat recovery into the service water heating.

The simulation report indicated the reference building was modeled using electric rink sub-floor heating. No requirements were found prohibiting electric heating of rink sub-floors in arenas, and this modeling practice was recommended in the Natural Resources Canada Eco-Energy "Arena EE Wizard" guide.

No adjustments were made.

.2 RA.UNIV.NC.0005.12

Project Information

Project Code:	NC.005.12
Building Type:	Laboratory
Project Description:	Construction of new laboratory facility.
Project Details:	Measures included occupancy sensors, improved windows, glycol heat recovery, and low flow fixtures.
Implementation Date:	Dec 2009 to May 2011

Gas Savings:	283,734-m3
Electrical Savings:	196,632-kWh

Savings Calculation Methodology

The savings from the new construction program result from a simulation of the new facility using the DOE eQuest building energy simulation tool. The use of the eQuest software, unlike the EE4 software, requires the modeler to manually input the assumptions for the reference case building. The project documentation included a detailed report on modeling and reference building assumptions and methodology.

The savings from the new construction program result from a simulation of the new laboratory facility under the High Performance New Construction program (HPNC). The simulation was completed using the DOE eQuest building energy simulation tool. The use of the eQuest software, unlike the EE4 software, requires the modeler to manually input the assumptions for the reference case building. A "proposed" simulation of the building was created using design drawings and specifications. This information was modified for the "reference" building, and savings were derived from the differences in utility use between the two simulations.

The project documentation included a detailed report on modeling and reference building assumptions and methodology, although appendices were missing from this report. Several versions of simulation files were provided for review.

Review Information

The site installation was in general conformance to the project application. The following information was gathered through review of the simulation reports, site review, and staff interviews:

- The building permit was dated in March 2010, indicating that the Ontario Building Code Supplemental Standard SB-10 (SB-10), July 1, 2011 update was not yet in force. This indicates the "minimum code" building may be derived from either ASHRAE 90.1-2004 with SB-10 requirements, or Model National Energy Code of Canada for Buildings (MNECB-1997) with SB-10 requirements.
- Review comments indicated that the campus was served by an onsite hydro-electric generation station. Although the modelling notes indicated adjustments were made to account for this, details referenced in the report were missing from the file.
- Although ASHRAE 90.1-2004 (with SB-10) requires laboratory buildings to have heat recovery, the MNECB-1997 (with SB-10) does not. This allows a "minimum code" interpretation of a reference building without heat recovery to be valid.
- Building envelope U-values were in line with maximum SB-10 allowances.
- The window to total wall (i.e., window plus wall) areas of 22%, matched the modeling notes and SB-10 requirements.
- Electrical savings of 12.0% over reference building, and gas savings of 51.0% over the reference building were claimed.
- The building energy use per square meter, benchmarked very high against other simulated buildings.

- Lighting electricity use increased with the proposed building.

Discussion

The new building benchmarked very high in gas use, which is reasonable considering the high outdoor air requirements of the lab fume hoods. The high gas savings resulted from the high outdoor air volumes used in lab facilities and the absence of heat recovery in the reference model.

The modeling approach resulted in a negative savings amount being claimed for lighting. The approach reportedly compared specified fixture counts and types against SB-10 lighting power densities per area.

SB-10 allows for different compliance paths, some of which require air handlers with certain characteristics to have heat recovery. Although this is the case, the least stringent of these codes for heat recovery is the MNECB-1997 which does not require heat recovery for laboratory buildings. Based on this, including the savings resulting from simulated heat recovery is compliant with simulation rules.

The [redacted] campus reportedly has hydro-electric generation. The simulation demand savings were adjusted lower by a somewhat arbitrary factor of 10% to account for the fact that the demand reductions seen by the grid might be offset by site generated power. Electricity consumption was not adjusted.

Attempts were made to obtain data regarding the degree to which the hydro-electric generation station offset the electricity use on campus. Depending on the load profile and seasonal variation in campus electricity use, it is likely there will be hours where the university is using any power from the grid.

Despite the above, it was reported that the [redacted] sold excess power to the grid. Assuming this was happening, any reduction in electricity resulting from this incentive would still be "saved" in the context that additional "green" electricity would be available to the grid.

No adjustments were made, although it is recommended that clarification regarding on-site or campus generation be given within the context of these applications. See Section 4.3 for further discussion.

.3 RA.RET.EX.038.12

Project Information

Project Code:	RA.PRO.EX.038.12
Building Type:	Office
Project Description:	Reduced outdoor air volumes and AHU scheduling.
Project Details:	Measures included air side heat recovery, new BAS system, reduction in operating hours, night set back temperature,
Implementation Date:	Nov 2011 to Oct 2012
Gas Savings:	227,556-m3

Electrical Savings:	27,728-kWh
Adjusted Gas Savings:	134,233-m3
Adjusted Electrical Savings:	140,026-kWh

Savings Calculation Methodology

The provided savings were calculated using a combination of the EGD E-Tools program, and manual methods. Calculations were provided by a third party, although these calculations were using an incorrect formula.

The building was heated primarily through district steam, although some independent gas-fired units were installed as part of this measure. A single district steam meter served two buildings making it difficult to accurately isolate steam use. A steam use profile was estimated by pro-rating the steam meter by floor space - a reasonable technique as long as the buildings have similar uses.

E-Tools was used to calculate the AHU savings. Incorrect assumptions were made about pre-retrofit operating hours, and supply air temperatures. The E-Tools calculation also excluded steam savings from humidification reductions from the newly installed Enthalpy wheel. An unconventional method was used to calculate savings resulting from building shell losses by using the air handler tool. Although the approach is sound, the results relied on the questionably high, and uncertain, estimate of heating use in the facility.

Review Information

The site application did not describe the project, or base case in detail. The following information was gathered through site review, and staff communications:

- The building was originally built in 1956 and was renovated in 2011 to 2012 in a comprehensive refit of an office building. A detailed breakdown of costs was not available. An estimate of $800,000 was provided, although a total cost breakdown was not included. The project included only the "heating" component of this, at $400,000, although the file was vague on exactly what this included, and how the savings were derived from these costs.
- The pre-retrofit MUA unit was only operating 12 hours a day, not 24. Similarly, the MUA unit supplies air at around 13°C during winter months. There is no reheating of the air in the zones or compartment unit air handlers.
- The building uses District steam and chilled water for heating and cooling. The new renovations also included some new gas-fired units.
- The building has one make-up air (MUA) unit with a nameplate 38,000-cfm that supplies outdoor air to each compartment unit and perimeter fan coil units. The fan was observed to be operating at approximately 18,000-cfm.
- The non-seasonal gas consumption per area benchmarked unreasonably high.
- The project included new windows, insulation, ductwork, air handlers, heat exchangers, BAS, and perimeter fan coil units.

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Discussion

The steam use for the two office buildings showed a non-seasonal steam component that was much higher than that attributable to domestic hot water use. The larger building has some restaurants which may explain the high non-seasonal component, or possibly this is attributable to summer standing losses. Regardless, this component was removed from the in the analysis to obtain a better assessment of the heating steam use. After this adjustment, the heating use for the building benchmarked at the 99th percentile. Interpretations regarding total building energy use from metered steam use is subject to a high degree of uncertainty due to sharing of the steam use between two buildings.

The extent of the renovations included demand controlled ventilation, variable speed control of the MUA units, variable air volume damper control of the outdoor air into the compartment units, variable air volume control of the zones, new perimeter fan coils, and a new BAS control system.

There is likely savings resulting from many of the above measures over the original building, although exactly what elements were included in this project were not well defined.

For the purposes of this review, a project boundary was defined in order to calculate savings. The cost of $400,000, the categorization of the project as "Advancement", and the Project Description in the Energy Efficiency Project Application were reviewed to determine the following measures for calculation:

- Demand Controlled Ventilation
- Enthalpy Recovery Wheel
- Setback Controls

It should be noted that Setback Controls are a mandatory requirement of the MNECB-1997, and under the "New Construction" path would likely not be eligible. From this viewpoint, the client would have proceeded with the project regardless of the incentive, and the incentive provides funds to allow them to exceed minimum code.

This project was categorized as "Advancement". Under the "Advancement" path, the incentive is intended to promote the client to proceed with a project rather than keep maintaining existing equipment. In this case, the use of the base case of the existing operation may be justified even though the retrofit may simply meet existing codes. In this case, the Setback Controls would be included. With "Advancement", the cost of the whole equipment is included in the project cost for TRC calculations, whereas with "Replacement" or "New Construction", incremental costs are used.

If the project were categorized as "Replacement", and the replacement was subject to a building permit, the new code provisions would apply and Setback Controls would be required as part of the base case and would not be included in the savings.

Reconciliation of these viewpoints is subjective requiring speculation on the intent of the owner. To the extent that in completing the renovation, reusing or refurbishing the old perimeter fan-coil units was a reasonable option, and but for the incentive may have been chosen, the "Advancement" classification is appropriate.

Given the extent of the renovations, it is likely that most owners would choose to replace the old fan coil units rather than refurbish them. For this reason the "Replacement" option is more likely. The perimeter fan coil units were changed from a 2-pipe to a 4-pipe system, which might be viewed as a "material change" by building departments, triggering requirements for setback controls.

Gas and electrical savings associated with the Setback Controls measure were calculated to be an additional 22,421 m3 and 20,903 kWh respectively. These calculations were based on the new assumed U-values for walls and windows.

For the purposes of this review, savings was based on the project being classified as "Advancement", and the above Setback Controls savings have been included in the adjusted totals above.

It is recommended that the TRC implications of this project be considered for re-classification as a "Replacement" project, although such a re-classification is outside of the scope of this review. The costs under this classification would decrease since only incremental costs need be included. Likewise, the Setback Controls measure would be excluded from the savings using this classification.

There is further discussion about these issues in 4.3 Future Considerations.

.4 RA.RET.EX.089.12

Project Information

Project Code:	EX.089.12
Building Type:	Retail
Project Description:	Demand controlled ventilation of air handling units.
Project Details:	Installation of CO2 sensors on four rooftop units for demand controlled ventilation.
Implementation Date:	Oct 2012 to Sep 2012
Gas Savings:	36,449-m3
Electrical Savings:	21,521-kWh

Savings Calculation Methodology

The provided savings were calculated using a third party modeling tool. A note from the engineering firm indicated the Honeywell tool had been verified against an eQuest simulation, although details and information supporting this assertion were not provided.

Gas information from Jan 2009 to Dec 2009 was used to create a weather normalized baseline, separated into seasonal and non-seasonal components.

The savings calculation methodology was not provided, although information about the equipment and assumptions were provided.

Review Information

The site installation was in general conformance to the project application. The following information was gathered through review of the simulation reports, site review, and staff interviews:

- The seasonal gas consumption per area benchmarked relatively low (36% below average).
- The one floor retail building is heated from rooftop units. 4 units were equipped with CO2 sensors located in the return plenum of the rooftop unit.
- Each rooftop unit has a thermostat located directly below each unit mounted approximately at eye level.
- The rooftop units that serve the retail area have occupied and unoccupied heating and cooling setpoints.

Discussion

The building benchmarked about 36% lower than benchmarks for typical retail buildings in Ottawa. Possible explanations for the lower than average results were not evident from the site visit.

The calculations were reviewed for reasonableness by comparing running the air handlers during occupied hours at default ASHRAE 62.1-2010 minimum air flow, compared to varying the occupant component of ventilation to a typical retail occupancy profile.

Using these assumptions, the results were similar to the Honeywell measurement tool result for this application.

No adjustments were applied.

.5 RA.RET.EX.089.12

Project Information

Project Code:	EX.080.12
Building Type:	Retail
Project Description:	Demand controlled ventilation of air handling units.
Project Details:	Installation of CO2 sensors on four rooftop units for demand controlled ventilation.
Implementation Date:	Oct 2012 to Sep 2012
Gas Savings:	35,719-m3
Electrical Savings:	4,294-kWh

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Savings Calculation Methodology

The provided savings were calculated using a third party modeling tool. A note from the engineering firm indicated the Honeywell tool had been verified against an eQuest simulation, although details and information supporting this assertion were not provided.

Gas information from Jan 2009 to Dec 2009 was used to create a weather normalized baseline, separated into seasonal and non-seasonal components.

Calculation methodology and savings assumptions were unclear, although the method used was reasonable. It did appear the calculations were based on the older ASHRAE 62 code rather than the new ASHRAE 62.1 ventilation rate procedure.

Review Information

The site installation was in general conformance to the project application. The following information was gathered through review of the simulation reports, site review, and staff interviews:

- The seasonal gas consumption per area benchmarked was in line with average benchmarks (14% below average).
- The two floor building comprises of strictly rooftop units in which three of them are equipped with CO2 sensors located in the return plenum of the rooftop unit.
- The building shares the first floor with two other tenants who have sub meters on their rooftop units.
- Each rooftop unit has a thermostat located in the zone that it serves - mounted approximately at eye level.
- The rooftop units that serve the retail area have occupied and unoccupied heating and cooling setpoints.

Discussion

The building benchmarked in line with average retail facilities.

The calculations were reviewed for reasonableness by comparing running the air handlers during occupied hours at default ASHRAE 62.1-2010 minimum air flow, compared to varying the occupant component of ventilation to a typical retail occupancy profile.

Using these assumptions, the results were similar to the Honeywell measurement tool result for this application.

No adjustments were applied.

4.3 Future Considerations

.1 Power Generation

The treatment of incentives for electricity reduction in projects with on-site or district generation can lead to confusion and/or inconsistent treatment of these cases. For example, where on-site generation is not being sold back to the grid, reductions in electricity use will offset generation, resulting in the reductions not affecting the grid. This, however, may still have environmental benefits depending on how "clean" the generation source is.

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In cases where excess "green" generation is being sold back to the grid, a reduction in electricity use in a project would have environmental benefits since the reductions would allow more "green" power to be available to the grid.

.2 Comprehensive Projects

Comprehensive projects are projects that involve multiple changes to buildings. These can range from projects involving multiple "measures" to complete refitting of a space including changing of the envelope and building usage.

There are issues relating to the classification of such projects considering that EGD has a "new construction" program that differs has included complete refitting of projects. Savings calculations between the two differ in that "new construction" projects use minimum code as the base case, whereas retrofit may use the existing building operation as a base case. There is a potential for overlap and inconsistencies within this spectrum that should be addressed through policy. In general, the "new construction" path should be used to the degree that these apply:

- building is unoccupied during construction.
- building permits have been obtained.
- building use, schedule, or occupancy has changed.
- type or zoning of HVAC systems have been changed to a degree that constitutes a "material alteration" according to Ontario Building Code.

A degree of judgement will be needed when making this classification since the interpretation of what constitutes a "material alteration" is often not consistent between jurisdictions and planning departments.

Other challenges lie when claiming a subset of a comprehensive retrofit across a wide range of building systems as a project. Although the entire project may have proceeded to construction, EGD may include the costs and savings associated with a subset of this project. This may be caused by eligibility restrictions, or attempts to define a project that meets TRC limitations.

This practice may lead to lack of clarity regarding what portions of the project is included. Furthermore, savings associated with the project may be impacted by the other measures that were included in the project, but not claimed. For example, lighting retrofit measures often reduce the heat contributed by lighting systems resulting in increased gas use when these measures are implemented. When such measures are implemented, but not accounted for in the EGD application, distortions in gas savings can result.

It is recommended that documentation be provided regarding the total project that proceeded, and a clear definition of the project, costs, and the incentive that is being claimed. It is also recommended that project savings be calculated *after* the impact of all other implemented measures not included in the application are accounted for.

MMM Group Limited

Engineering Review of Enbridge Gas Distribution 2012 Custom Projects

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Submitted: April 04, 2013

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1.0 EXECUTIVE SUMMARY

MMM Group Limited (MMM) was retained by Enbridge Gas Distribution (EGD) to perform an engineering savings review for the 2012 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 2012 through a review of statistically representative sample of projects. Twenty-two (22) projects were assigned to MMM in two packages. Selected projects for the entire project are tabulated below.

Report Section	DSM Code	Building Type	New / Retrofit	Claimed Gas Savings (m^3)	Claime Electricity Savings (kWh)	Claimed Water Savings (m^3)
3.1	RA.PRO.NC.001.12	Office	New Construction	438,494	278,992	0
3.2	RA.UNIV.NC.004.12	College/University	New Construction	360,971	312,475	0
3.3	RA.GOV.EX.006.12	Office	Retrofit	291,503	2,021,753	0
3.4	RA.PRO.EX.008.12	Office	Retrofit	137,346	0	0
3.5	RA.GOV.EX.010.12	Office	Retrofit	106,587	0	0
3.6	RA.PRO.EX.006.12	Office	Retrofit	50,688	29,952	0
3.7	RA.MR.EX.072.12	Multi Residential	Retrofit	65,384	0	0
3.8	RA.MR.EX.095.12	Multi Residential	Retrofit	22,423	0	0
3.9	RA.MR.EX.122.12	Multi Residential	Retrofit	39,428	59,091	0
3.10	RA.MR.EX.090.12	Multi Residential	Retrofit	29,434	42,541	0
3.11	RA.MR.EX.109.12	Multi Residential	Retrofit	22,706	6,104	0
3.12	RA.MR.EX.086.12	Multi Residential	Retrofit	13,609	12,058	0
3.13	RA.UNIV.EX.007.12	College/University	Retrofit	751,609	4,145,392	0
3.14	RA.COM.NC.002.12	Office	New Construction	14,637	98,995	0
3.15	RA.UNIV.NC.001.12	College/University	New Construction	248,539	351,672	0
3.16	RA.MR.EX.229.12	Multi Residential	Retrofit	26,246	40,445	0
3.17	RA.MR.EX.199.12	Multi Residential	Retrofit	55,717	40,187	0
3.18	RA.MR.EX.237.12	Multi Residential	Retrofit	52,343	43,566	0
3.19	RA.LOG.EX.002.12	Warehouse	Retrofit	215,256	-55,665	0
3.20	RA.HC.NC.001.12	Healthcare	New Construction	2,105,452	4,402,186	0
3.21	RA.PRO.EX.064.12	Office	Retrofit	68,150	13,096	0
3.22	RA.MR.EX.274.12	Multi Residential	Retrofit	123,040	0	0
			Claimed Savings	5,239,562	11,842,840	0

Table 1 Selected 2012 Projects

Please note that the claimed savings outlined in the table above for High Performance New Construction (HPNC) projects only represents the portion claimed by EGD and not the total modeled savings. The total modeled savings are outlined in more detail in the body of the report.

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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 *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.

3.0 RESULTS

The results from the twenty-two (22) projects that were assigned to MMM are as follows:

Report Section	DSM Code	Adjusted Gas Savings (m^3)	Natural Gas Savings Adjustment (%)	Adjusted Electricity Savings (kWh)	Electricity Savigns Ajustment (%)	Adjusted Water Savings (m^3)	Water Savings Adjustment (%)
3.1	RA.PRO.NC.001.12	438,494	0.00%	278,992	0.00%	0	0.00%
3.2	RA.UNIV.NC.004.12	360,971	0.00%	312,475	0.00%	0	0.00%
3.3	RA.GOV.EX.006.12	264,012	-9.43%	2,877,951	42.35%	0	0.00%
3.4	RA.PRO.EX.008.12	125,596	-8.56%	0	0.00%	13,783	100.00%
3.5	RA.GOV.EX.010.12	73,797	-30.76%	0	0.00%	0	0.00%
3.6	RA.PRO.EX.006.12	52,648	3.87%	3,680	-87.71%	0	0.00%
3.7	RA.MR.EX.072.12	45,367	-30.61%	0	0.00%	0	0.00%
3.8	RA.MR.EX.095.12	22,423	0.00%	0	0.00%	0	0.00%
3.9	RA.MR.EX.122.12	40,030	1.53%	63,973	8.26%	0	0.00%
3.10	RA.MR.EX.090.12	29,434	0.00%	56,677	33.23%	0	0.00%
3.11	RA.MR.EX.109.12	20,752	-8.61%	20,523	236.22%	0	0.00%
3.12	RA.MR.EX.086.12	11,822	-13.13%	6,426	-46.71%	0	0.00%
3.13	RA.UNIV.EX.007.12	848,464	12.89%	4,564,728	10.12%	0	0.00%
3.14	RA.COM.NC.002.12	14,637	0.00%	98,995	0.00%	0	0.00%
3.15	RA.UNIV.NC.001.12	248,539	0.00%	351,672	0.00%	0	0.00%
3.16	RA.MR.EX.229.12	20,411	-22.23%	31,906	-21.11%	0	0.00%
3.17	RA.MR.EX.199.12	43,957	-21.11%	47,311	17.73%	0	0.00%
3.18	RA.MR.EX.237.12	52,343	0.00%	43,566	0.00%	0	0.00%
3.19	RA.LOG.EX.002.12	477,904	122.02%	-55,665	0.00%	0	0.00%
3.20	RA.HC.NC.001.12	2,105,452	0.00%	4,402,186	0.00%	0	0.00%
3.21	RA.PRO.EX.064.12	0	-100.00%	0	-100.00%	0	0.00%
3.22	RA.MR.EX.274.12	121,776	-1.03%	0	0.00%	0	0.00%
		5,418,829	3.42%	13,105,396	10.66%	13,783	100.00%

Table 2 Review Results

3.1 *RA.PRO.NC.001.12*

Project Information

ESM File #: 1-76991055-06-07-12

Building Type: Office

Project Description: Construction of a new office building in downtown [redacted].

Project Details: Building included high efficiency condensing boilers, heat recovery ventilators, heat recovery chiller, VFD motors on pumps and fans and improvements to building envelope and lighting.

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The buildings houses office spaces, meeting rooms, data center, three commercial stores on the first floor, and three levels of underground parking. The 471,500 ft^2 building comprises twenty (20) above ground floors and three-levels of underground parking areas. Currently three (3) floors are vacant. The total occupants of the building vary between 900~1200. Vacant spaces will be able to accommodate 100-150 occupants in future.

Implementation Date: 20 January 2010 to 20 March 2012

Project Savings Summary

Total Natural Gas and Electricity Savings Summary			
Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas [m^3/year]	465,065	465,065	0
Electricity [kWh/year]	295,898	295,898	0
Water [m^3/year]	Not Applicable	Not Applicable	Not Applicable

Total natural gas and electricity savings are shared between OPA and EGD using the Environmental Attributes Calculator. The ratios for claiming/sharing energy savings attributed by electricity and natural gas between OPA and EGD are determined as follows:

$$\text{Energy Apportioning Ratio for EGD} = \frac{\text{Natural Gas Energy Saved (ekWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

$$\text{Energy Apportioning Ratio for OPA} = \frac{\text{Electrical Energy Saved (kWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

The shared savings are shown below:

Natural Gas and Electricity Savings Summary Claimed by **Enbridge Gas Distribution**				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	EGD Ratio for Sharing Savings [%]
Natural Gas [m^3/year]	438,494.3	438,494	0	94.3
Electricity [kWh/year]	278,992.4	278,992	0	
Water [m^3/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Natural Gas and Electricity Savings Summary Claimed by OPA				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	OPA Ratio for Sharing Savings [%]
Natural Gas [m³/year]	26,570.7	26,570.7	0	5.7
Electricity [kWh/year]	16,905.6	16,905.6	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Energy Efficient Case

The building has the following energy efficient features:

- Efficient lighting system controlled via building automation system with occupancy sensors (OS) in washrooms, board room, meeting rooms. The lighting system also has day light (DS) harvesting for all office floor perimeter zones using continuous dimming.
- Windows are double glazed, argon filled with thermal break. High thermal insulation for walls and roofs. The proposed building has a 53% window to wall ratio.
- Cooling towers are equipped with variable speed drive motors.
- Three (3) 4,000 MBH, 95% efficient condensing boiler are used for space heating
- Two (2) high efficiency base building chillers and two (2) heat recovery chillers for server cooling.
- The effectiveness of the heat recovery units is 0.66.
- Low flow plumbing fixtures for water supply in lavatory faucets (1.9 l/min) and shower head (5.7 l/min).
- Four (4) 130 gallon, 400 MBH, 96% efficient domestic hot water boilers.

Savings Calculation Methodology

The savings from the high performance new construction program resulted from the simulation of the new facility using EE4 software, developed by the CANMET Energy branch of Natural Resources Canada. The EE4 software front-end is interfaced to the DOE-2 building modeling system developed by the US Department of Energy.

The EE4 software generates two building models. The baseline/reference building represents a building that meets the minimum energy code of Ontario Building Code (OBC) and the proposed building represents how the actual building will perform in theory.

The energy simulation model was peer reviewed by a third-party Energy Consultant and adjusted appropriately showing the anticipated savings as mentioned above.

Review Information

The site installation was in general conformance with the project application. The following information was gathered through observation and site survey:

- Incremental cost of energy conservation measures was 1.2% of total project cost
- The total gas consumption of the building is 19% of total building energy which seems very low as compared to a typical office building in [redacted]
- The building has been modeled using 298 W/m^2 connected electrical loads for a central data center.
- The energy model indicated 3% electricity savings, 77% gas energy savings and an overall energy savings of 40% with respect to OBC reference building.
- The HPNC Program Results Summary Report claimed that the reference building was updated to OBC – SB:10 requirement using EE4-OBC energy simulation software.
- The peer reviewed and modified simulation files were not submitted for further review. After verification of all the reports and documents, we found that the final energy model was modified to reflect the above savings and the project was in compliance with the rules and intent of the HPNC program.
- A site visit was conducted on December 6, 2012 to verify the following:
    - Installation of the main energy savings equipment of the building
    - Basic physical and operational characteristics of the building.
- During the site visit, Chief Engineer of the [redacted] Real Estate Office of [redacted] was interviewed.
- Methodology used while verifying the savings:

The energy simulation methodology was already peer-reviewed by a third part energy consulting firm, available energy modeling report and associated application documents were reviewed to verify savings and a site visit was conducted to confirm equipment installation.

Discussion

For new construction projects, we recommend to provide peer-reviewed and modified simulation files for audit purpose. We also recommend providing the complete HPNC application package including the summary compliance report and assumptions related to various inputs used for modeling purposes and shop drawings for major HVAC equipment and building systems.

The energy conservation measures are advancement for new construction as compared to the baseline building referred in the OBC.

Incremental cost analysis:

- The total incremental cost was reported as $ 1,008,586 for the major energy conservation measures which seems reasonable.

Life cycle cost analysis:

- The enhanced building envelope and the condensing boilers will save approximately 372,050 m³/year and considering a 25 year life cycle span for both the systems, the life cycle savings is 9,301,250 m³/life cycle of condensing boilers and building envelope.

- The heat recovery ventilators will save approximately 93,000 m³/year and considering a 15 year life cycle span for the HRV, the life cycle savings is 1,395,000 m³/life cycle of heat recovery ventilators.

The end-use breakdown of the proposed building indicated high energy consumption for receptacle load and fan power. Comparatively, space heating energy seems lower than normal for an office building in Ottawa, Ontario. High electrical loads especially in server room, heat recover chiller, energy recovery ventilators and condensing boilers can contribute to significant gas energy savings.

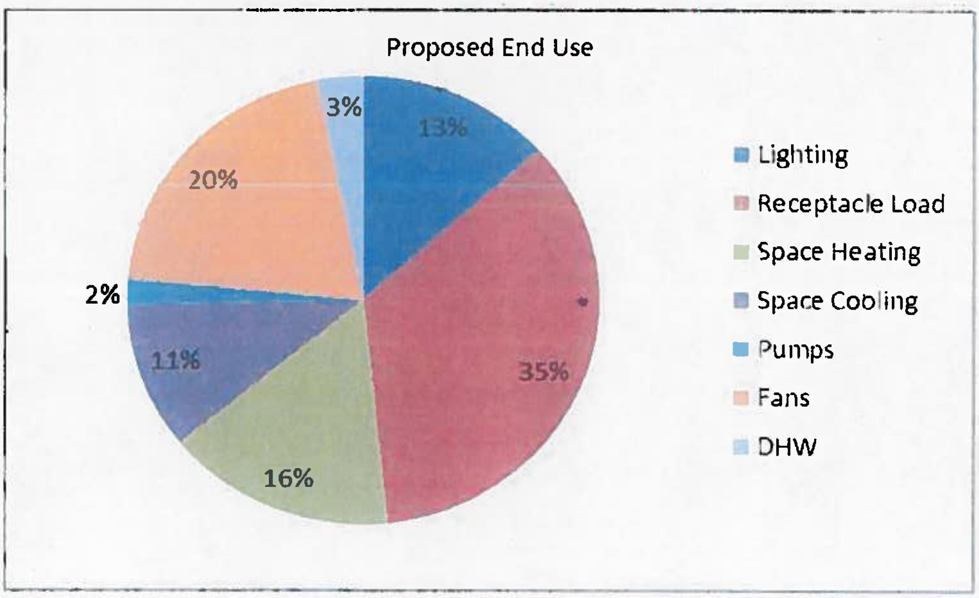

Figure 1 Proposed End Use

As per our site survey, the building is already commissioned and all equipment is operating as intended. Currently there is no on-going commissioning plan in place for this building.

It would be beneficial if during the audit process we could have verified the actual utility bills to evaluate the validity of the peer reviewed energy simulation data as compared to the actual performance of the building. This would help in confirming if the plug loads and scheduling assumptions were valid in the model and that, if commissioning was completed, the building was operating as expected.

According to the peer-reviewed energy simulation model the anticipated site energy intensity of the proposed building is 214 ekWh/m² while the reference building is 357 ekWh/m². For a high performance building the savings reduction percentage and energy intensity benchmarks are in line with new construction simulations methodology prescribed by EE4 modeling guideline. No adjustments to the proposed savings were made.

3.2 *RA.UNIV.NC.004.12*

Project Information

ESM File #: 1-75035761-26-12

Building Type: College/University

Project Description: Construction of new building academic building in [redacted]

Project Details: Building included high efficiency condensing boilers, heat recovery ventilators, demand control ventilation using CO_2 sensors, hybrid heat pumps, solar domestic hot water, solar PV, and improvements to building envelope and lighting.

The buildings houses classrooms, workshops and student seating areas. The 190,000 ft² building comprises six (6) floors and a small exterior parking area. The total occupants of the building vary between 1200~1500.

Implementation Date: 24 November 2010 to 8 December 2011

Project Savings Summary

Total Natural Gas and Electricity Savings Summary			
Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas [m³/year]	390,730	390,730	0
Electricity [kWh/year]	338,236	338,236	0
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable

Total natural gas and electricity savings are shared between OPA and EGD using the Environmental Attributes Calculator. The ratios for claiming/sharing energy savings attributed by electricity and natural gas between OPA and EGD are determined as follows:

$$\text{Energy Apportioning Ratio for EGD} = \frac{\text{Natural Gas Energy Saved (ekWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

$$\text{Energy Apportioning Ratio for OPA} = \frac{\text{Electrical Energy Saved (kWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

The shared savings are shown below:

Natural Gas and Electricity Savings Summary Claimed by **Enbridge Gas Distribution**				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	EGD Ratio for Sharing Savings [%]
Natural Gas [m³/year]	360,970.5	360,970.5	0	92.4
Electricity [kWh/year]	312,474.7	312,474.7	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Natural Gas and Electricity Savings Summary Claimed by OPA				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	OPA Ratio for Sharing Savings [%]
Natural Gas [m³/year]	29,759.5	29,759.5	0	7.6
Electricity [kWh/year]	25,761.3	25,761.3	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Energy Efficient Case

The building has the following energy efficient features:

- Efficient lighting system controlled via building automation system with occupancy sensors (OS) in meeting rooms, board room, washrooms.
- High efficiency lighting fixtures and ballasts with HID, T5's and T'8.
- Windows are double glazed. A portion of the roof is green. High thermal insulation for walls and roofs. Window to wall ratio is approximately 33%.
- Centralized demand control ventilation using CO_2 sensors
- Cooling towers are equipped with variable speed drive motors.
- 92% efficiency condensing boiler is used for space heating
- The effectiveness for the heat recovery units was 0.77.
- Low flow plumbing fixtures for water supply in lavatory faucets (1.9 l/min) and shower head (5.7 l/min) with grey-water collection system for the toilets.
- Domestic hot water integrated with Solar heating system.
- Hybrid heat pump system.
- Solar PV

Savings Calculation Methodology

The savings from the high performance new construction program resulted from the simulation of the new facility using EE4 software, developed by the CANMET Energy branch of Natural Resources Canada. The EE4 software front-end is interfaced to the DOE-2 building modeling system developed by the US Department of Energy.

The EE4 software generates two building models. The baseline/reference building represents a building that meets the minimum energy code of Ontario Building Code (OBC) and the proposed building represents how the actual building will perform (in theory).

The energy simulation model was peer reviewed by a third-party Energy Consultant and adjusted appropriately showing the anticipated savings as mentioned above.

Review Information

The site installation was in general conformance to the project application. The following information was gathered during the documentation review and site survey:

- Incremental cost of energy conservation measures was 1.2% of total project cost.
- The total gas consumption of the building is 30% of total building energy which seems slightly lower than a typical building in Ottawa.
- The building has some major un-regulated electrical process loads in various workshops.
- The solar DHW and solar PV were installed in the building.
- The energy model indicated 18% electricity savings, 85% gas energy savings and an overall energy savings of 66% with respect to the OBC reference building.
- The HPNC Program Results Summary Report claimed that the reference building was updated to OBC requirements using the EE4-OBC energy simulation software.
- We received the originally submitted EE4 modeling files for audit purposes; however, the peer reviewed and modified simulation files were not submitted for further review. After verification of all the reports and documents, we found that the final energy model was modified to reflect the above savings and that the project was in compliance with the rules and intent of the HPNC program.
- A site visit was conducted on December 6, 2012 to verify the following:
  - Installation of the main energy savings equipment of the building.
  - Basic physical and operational characteristics of the building.
- During the site visit, MMP/Team Leader of the Facility Operations and Maintenance Service/Physical Resources department of [redacted] was interviewed.
- Methodology used while verifying the savings:

The energy simulation methodology was already peer reviewed by a third part energy consulting firm, most of the supporting documents were provided by professional engineers, all available reports and originally submitted EE4 files were reviewed to verify the reasonableness of the savings. A site visit was conducted to confirm equipment installation.

Discussion

For new construction project, we recommend to provide peer-reviewed and modified simulation files for audit purpose.

The energy conservation measures are advancement for new construction as compared to the baseline building referred in the OBC.

Incremental cost analysis:

- The total incremental cost was reported as $ 957,800 for the major energy conservation measures which seems reasonable.

Life cycle cost analysis:

- The enhanced building envelope and the condensing boilers have saved approximately 347,750 m³/year and considering a 25 year life cycle span for both the systems, the life cycle savings is 8,693,750 m³.
- The heat recovery ventilators have saved approximately 42,980 m³/year and considering a 15 year life cycle span the HRV, the life cycle savings are 644,700 m³.

The end-use breakdown of the proposed building indicated high a energy consumption for lighting, fan power and domestic hot water. Comparatively, space heating energy seems lower than normal for a building in Ottawa, Ontario. Demand control ventilation, energy recovery ventilators and condensing boiler with hybrid heat pump system can contribute to significant gas energy savings.

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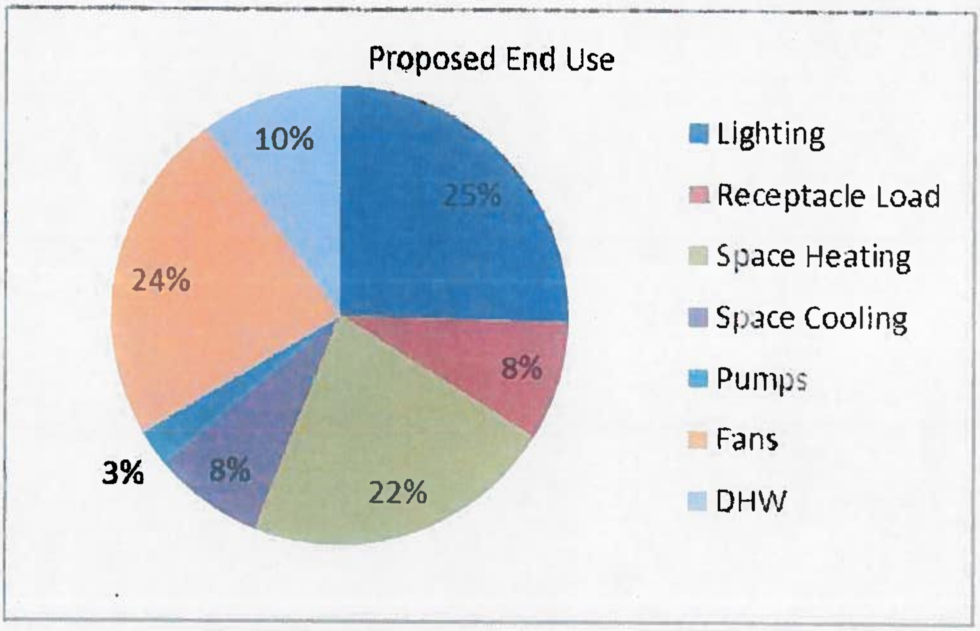

Figure 2 Proposed End Use

As per our site survey, the building is already commissioned and all equipment is operating as intended. Currently there is no on-going commissioning plan in place for the building.

It would be beneficial if during the audit process we could have verified actual utility bills to evaluate the validity of the peer reviewed energy simulation data as compared to the actual performance of the building. This would help in confirming if the plug loads and scheduling assumptions were valid in the model and that, if commissioning was completed, the building was operating as expected.

According to the peer-reviewed energy simulation model the anticipated site energy intensity for the proposed building is 135 ekWh/m² while the reference building is 400 ekWh/m². For a high performance building the savings reduction percentage and energy intensity benchmarks are in line with new construction simulations methodology prescribed by EE4 modeling guideline. No adjustments to the proposed savings were made.

3.3 *RA.GOV.EX.006.12*

Project Information

ESM File #:	1-53465476-05-20-11
Building Type:	Office
Project Description:	BAS scheduling of building AHU
Project Details:	All AHUs have been scheduled to shutdown at night when the building is unoccupied.

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Implementation Date: September, 2011

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	291,503	264,012	-9.4
Electricity (kWh)	2,021,753	2,877,951	42.2
Water (m^3)	0	0	0

Base Case

The building is an office building that consists of two towers and a common podium. The building uses Enwave steam for their heating and DHW requirements. Prior to the retrofit, all AHUs operated 24/7.

Energy Efficient Case

New damper controls, control valves and BAS programming have been installed to allow scheduling of the AHUs to shutdown at night and on weekends. Each unit is scheduled individually and the schedules varied on each unit, however, the majority of the units operate on weekdays from 4:00am to 8:30pm or 16.5 hours per day. Most units are turned off during the weekend. Some of the units serving the specialty areas in the podium operate on reduced schedules on weekends from 10am to 7pm. Only one unit which serves the mayor's office remains on a 24/7 operating schedule. Economizer mode operation has been added to the units.

Savings Calculation Methodology

The building uses Enwave steam for all building heating. Due to the complexity of the building and the scale of the retrofit, the applicant opted to use monthly steam consumption data before and after the retrofit was completed to estimate the savings. The applicant uses utility management software called Energy Cap which was used to determine the savings. The management software uses historical building consumption data and weather data to determine the building baseline consumption.

The applicant used actual steam consumption data from the seven months after the retrofit was completed to estimate the savings. The energy management software was used to determine the predicted baseline consumption that the building would have used in the same months. The steam savings were calculated by subtracting the actual building consumption from the predicted building consumption. The natural gas savings were determined by converting the steam savings to equivalent natural gas assuming steam pressure of 15psi and that the overall plant and transmission efficiency of Enwave is 70%.

Review Information

MMM scheduled a site visit with [redacted] and [redacted] to perform interviews and review the installation. In addition to the document review provided by EGD, MMM observed and gathered the following additional information:

- The AHU installations were verified and all new actuator and control valves have been installed.
- The BAS front end was reviewed to confirm the operation parameters of all units. The majority of the ventilation equipment was scheduled from 4:00am to 8:30pm Monday to Friday and did not operate on weekends.
- Approximately half of the units served perimeter heating and half of the units served the interior. All units had economizer operation modes. The units serving the perimeter of the building had a supply temperature reset schedule based on the outdoor air temperature. The units serving the interior of the building had a supply temperature reset schedule based on the return air temperature.
- [redacted] provided the steam consumption tables and calculations that were submitted with the application as well as electrical utility bill data.
- Additional steam consumption data was provided.

Discussion

Due to the complexity of the building systems, it was determined that it was not practical to calculate the savings using a bin table analysis. The monthly building steam consumption was provided by the building operator for September 2009 to November 2012. Utility bill analysis on the steam consumption data was performed to verify the applicant's savings calculations. The building retrofit work was started in September 2010 and completed in September 2011. This data was not used in our calculation due to the continuously changing building performance characteristic.

The monthly steam consumption for September 2009 to August 2010 was used to establish the base condition building consumption. The monthly steam consumption was compared to the monthly heating degree days. Linear regression analysis was performed on the data using a building balance temperature of 16°C. The intercept from the regression analysis was used to establish the building base load and the x variable was used to determine the building consumption per heating degree day. The R squared value for the linear regression analysis was 0.972, indicating that the fit is good.

A similar analysis was performed on the consumption data for September 2011 to October 2012 to establish the post-retrofit consumption using a building balance temperature of 16°C. The R squared value for this analysis was 0.947 indicating a good fit.

To adjust for weather fluctuations, the above calculated base loads and consumption per heating degree day were applied to the statistics Canada 30 year average heating degree day data to determine the weather normalized steam savings.

The calculated steam savings were converted to equivalent gas savings by assuming the same overall Enwave distribution and plant efficiency of 70% as indicated in the original calculation. Using this method we estimate the natural gas savings at approximately 264,012 m^3 which represents an adjustment of approximately -9.4% from the original application. The difference in the savings is most likely due to the slightly different method of analyzing the data. We used the linear regression analysis to normalize both the base consumption and the proposed consumption to the average heating degree days. The applicant's calculations only normalized the base consumption and compared it directly to the actual consumption of the current post-retrofit months. The savings resulting from this retrofit represent approximately 22% of the annual building natural gas consumption.

Electrical savings were also verified and the audited electrical savings have increased compared to the application savings. The application savings calculation included only supply fan power and assumed all units were scheduled to operate 16.5 hours per day, 7 days per week. MMM used the actual schedule for each fan as observed on site and included the return fans in the savings calculation. This resulted in a 42% increase in the estimated electrical savings compared to the applicant's savings calculation.

The life measure savings for this retrofit was based on an expected measure life of 13 years. For a BAS controls upgrade, the expected life is 15 years; therefore, we would recommend adjusting the total life savings for this project to 3,960,180 m^3.

The total cost for this project was claimed to be $349,000. Based on the observed scope of work for the controls upgrades, including new damper actuators and control valves on 38 AHUs, we believe this implementation cost to be reasonable.

3.4 *RA.PRO.EX.008.12*

Project Information

ESM File #:	1-73377811-12-20-11
Building Type:	Office
Project Description:	Steam Condensate Recovery System
Project Details:	Recovering heat from steam condensate and using it to pre-heat the air in two AHUs
Implementation Date:	October, 2011

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	137,346	125,596	-8.6
Electricity (kWh)	0	0	0
Water (m^3)	0	13,783	100

Base Case

The building is a fifty-six (56) story high office tower that uses Enwave Steam for building heating, DHW and for one major tenant who uses the steam for their business operations. The steam is used during the heating season only and an alternative heat source is used for DHW and the tenant during the cooling season.

The steam condensate is collected at multiple points in mechanical rooms throughout the building where steam is being used. It is used to pre-heat DHW for tanks in mechanical rooms locate on the 55th, 43rd, 14th and basement levels. The condensate from all floors is collected in a main condensate receiver tank located in the P-3 parking level of the building. Before discharging to drain, the condensate is mixed with DCW to bring the temperature down below 140°F.

Energy Efficient Case

A new plate heat exchanger has been installed and the pre-heat coils in two AHUs serving the podium floor of the office tower have been replaced and connected to a new glycol loop connected to the condensate heat exchanger. Condensate from the main condensate receiver tank is pumped through the heat exchanger at a rate of 70 GPM. New circulating pumps circulate at 130 GPM through the heat exchanger and serve the pre-heat coils in the two AHUs. There are three-way valves installed on the pre-heat coils which modulate to attempt to maintain 110°F return temperature from the pre-heat coils.

The two AHUs operate 24/7 and have mixed outdoor and return air. The pre-heat coils have been sized for a 115°F temperature rise across the coils at peak load.

Due to the distance that the condensate travels through the building before reaching the final condensate receiver tank and due to some of the condensate heat already being used for pre-heating the DHW, it was observed on site that the actual condensate temperature when it enters the heat exchanger was 164°F. This temperature was reconfirmed during a second site visit.

Savings Calculation Methodology

The applicant used the building steam consumption data for 2007 and 2008 to determine the average yearly steam consumption. The total available steam condensate was calculated from this average annual steam consumption. The savings were estimated as 50% of the total energy available when reducing the steam condensate temperature from 200°F to 120°F.

Review Information

Site visits were conducted on December 12th, 2012 and January 3th, 2013.

The following information was gathered during the initial site visit:

- MMM met on site on December 12th, 2012 with the property manager [redacted]. and was shown the system installation.

- The system was not operating at the time of the December 12th site visit because the controls were not functioning properly. Additional system information was provided including additional steam consumption data and the design drawings for the system.

- The BAS front end was reviewed, but the system was not fully functional at the time of the visit and the schedule and set points of the AHUs were not verified.

The following information was gathered during the second site visit:

- MMM met on site with the base building's contractor, [redacted] The system was operating correctly during this visit. The condensate supply temperature to the heat exchanger was confirmed to be 164°F and the return temperature was 125°F. The supply and return temperatures for the glycol heating loop were 140°F and 118°F respectively. The outdoor air temperature at the time was 19°F.

- The BAS front end was operating and the operating schedule and temperature set points for the two AHUs were verified.

Discussion

The steam consumption data provided was used to perform a linear regression analysis to determine the steam consumption per heating degree day (HDD). This was then used with weather data from the last 30 years to determine the average weather adjusted yearly steam consumption. The final calculated weather adjusted annual steam consumption was 78,509,188 lbs/year. The condensate pump flow rate of 70 GPM was used to determine the number of hours the condensate pumps will operate for at each temperature bin given the total condensate produced.

Bin temperature analysis was performed on the two AHUs served by the steam condensate recovery system to determine the maximum heat that can be extracted from the condensate at each temperature bin. We were not able to verify the percentage of outdoor air that is supplied. The pre-heat loop temperatures, outdoor air temperature, building return air temperature and supply air temperature after the pre-heat coil at the time of the second site visit were used to estimate the percentage of outdoor air, which was determined to be 10%. The actual percent of outdoor air is controlled through the BAS and will vary, but the schedule could not be verified on site and therefore for the purpose of this calculation, it was assumed that the quantity of outdoor air is constant at the calculated quantity.

Assuming the building design day temperature is -4°F and the building balance temperature is 64°F, the total annual steam consumption was divided into consumption per temperature bin. An iterative approach was used to determine this by adjusting an assumed peak building consumption rate until the calculated total yearly consumption matched the weather adjusted yearly consumption from the building utility data. The condensate pumps are rated for 70 GPM, however, this flow rate exceeds the condensate production rate in the building and therefore the condensate pumps will cycle on and off as the condensate receiver tank is filled and drained. Based on the available condensate and pump rate of 70 GPM, the total running hours for the pumps was determined for each temperature bin.

For savings estimation purposes, it was assumed that the heating loop supply temperature observed on site is fixed at 140°F and the condensate supply temperature is fixed at 164°F as per observations on site. The return temperature for the heating loop was calculated for each temperature bin based on the calculated coil load. The temperature difference between the heating loop return and the condensate return was observed on site to be 7°F (the heating loop return temperature was 118°F and the condensate return temperature was 125°F). For calculation purposes, it was assumed that this temperature difference will be constant and, therefore, the condensate return temperature was calculated to be 7°F higher than the calculated heating loop return temperature. This condensate temperature difference and the condensate flow rate of 70GPM were used to calculate the MBH of heat recovered for each temperature bin. In this way, we have simulated how the system will respond at different outdoor air temperature and calculated the heat transfer. The calculated MBH of heat recovered this way was compared to the calculated required heat in the two AHU calculated previously and the lower of the two values was used for the final calculated MBH savings. The MBH for each temperature bin was multiplied by the number of hours the condensate pumps will be operating to determine the total MBTUs saved. This number was converted into equivalent natural gas with an assumed 70% plant efficiency for the Enwave system and an assumed 95% building heating system efficiency and the final natural gas savings was determined to be 123,907 m^3.

The reduction in the natural gas savings is attributed to the fact that the condensate heat is being recovered at a temperature of 164°F instead of 200°F and we have attempted to simulate the actual condensate that can be used by the installed system instead of simply assuming that 50% of all available heat will be recovered.

The water savings was calculated to be 13,783 m^3 per year due to the minimized need for city water for the purposes of steam condensate quenching.

The life time savings included in the application assumes the system will operate for 22 years. The new equipment installed for this saving measure includes new heating coils in existing MUA, a new plate heat exchanger and new pumps. Of these, the new heating coils will have the shortest expected life of between 10 to 15 years if properly maintained. Based on this, we recommend reducing the expected life cycle to 15 years, which reduces the lifetime savings to 1,883,940 m^3 of natural gas.

The project cost of this measure is $382,000. Including engineering design fees and construction fees, we find this to be a reasonable cost for this project.

3.5 *RA.GOV.EX.010.12*

Project Information

ESM File #:	1-78801104-08-29-12
Building Type:	Office
Project Description:	Heating water and domestic hot water system retrofit
Project Details:	Replace two existing non-condensing domestic hot water boilers with condensing boilers. Replace two existing heating boilers with new near-condensing boilers.
Implementation Date:	August 31, 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	106,587	73,797	-30.8
Electricity (kWh)	0	0	0
Water (m^3)	0	0	0

Base Case

The building space heating was provided by two atmospheric heating boilers (Raypak, Model 3690TA), with a total input capacity 7380 MBH. The domestic hot water heating was provided by two atmospheric domestic hot water boilers (A.O.Smith, Model RC 399-750S), with a total input capacity of 798 MBH.

Energy Efficient Case

The two existing heating boilers (Raypak, Model 3690TA) were removed from the heating plant, and were replaced by two new near-condensing boilers (Camus, Model DFX3501). The total capacity of the new heating boilers is 7000 MBH. The new boilers have a nameplate efficiency of 88%.

The two existing domestic hot water boilers (A.O.Smith, Model RC 399-750S) were removed from the heating plant, and were replaced by two condensing boilers (Camus, Model DFM 392). The total capacity of the new domestic hot water boilers is 798 MBH. The new boilers have a nameplate efficiency of 97%.

The energy savings stem from the following:

- The new boilers have a higher thermal efficiency when compared to the existing heating system
- The new boilers come complete with features such as force draft fans and automatic flue vent dampers which can help to improve the seasonal efficiency

Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools program. Gas information from September 2008 to August 2009 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. The weather relative component savings were calculated by multiplying the percentage improvement in heating system efficiency to the corresponding weather relative natural gas consumption. The non-weather relative savings and the weather relative savings were then added up to obtain the total savings.

Review Information

The site installation was in general conformance to the project application. The actual piping configuration was investigated, and major operating parameters observed during the site visit were collected and depicted in the diagram below.

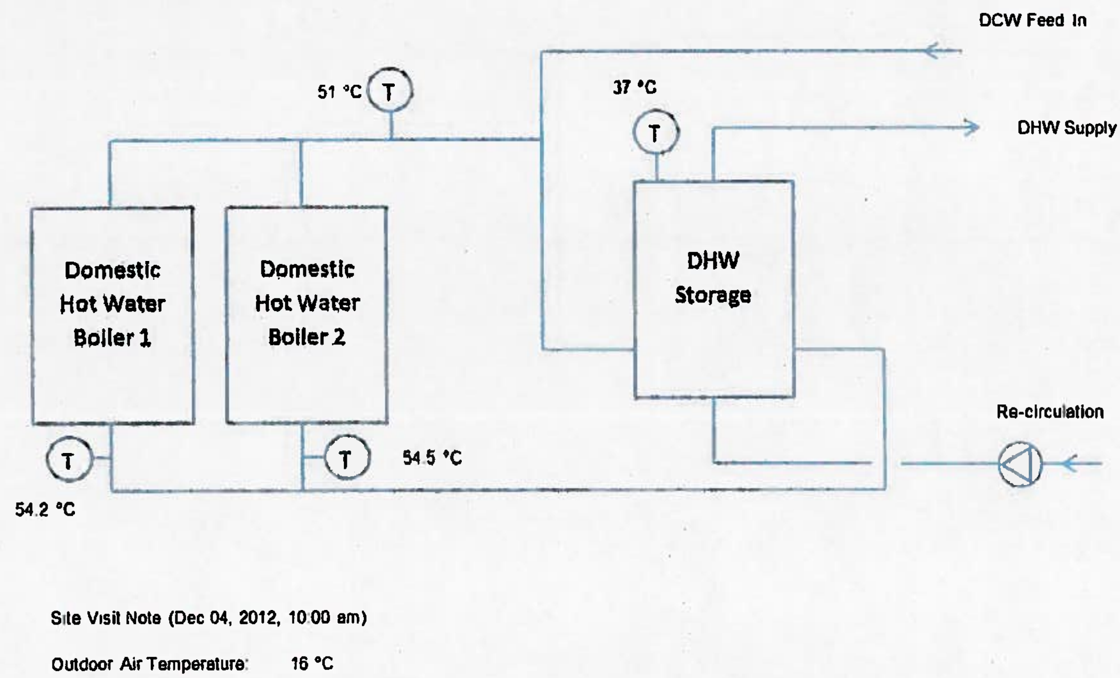

Figure 3 Domestic Hot Water System Schematic

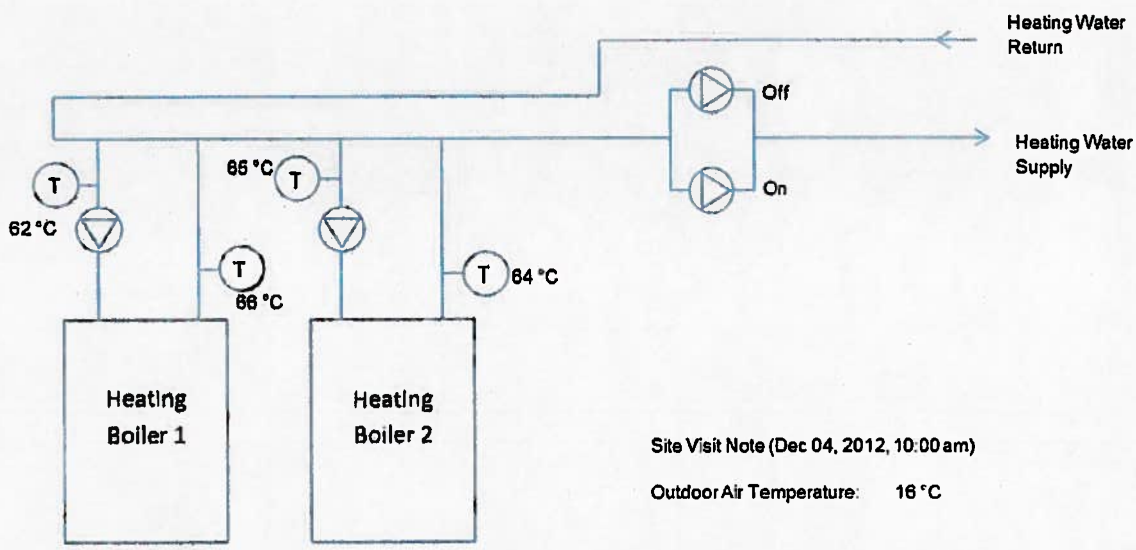

Figure 4 Heating Water System Schematic

Some major operation parameters recorded at the time of the site visit are tabulated below:

Parameters	Reading	
Outdoor air temperature	16 °C	
DHW Boilers Setpoint (from boiler controller)	51°C (125°F)	
DHW Storage Tank Temperature	37 °C	
DHW Boilers Inlet Temperature	54.2°C / 54.5°C	
DHW Boilers Outlet Temperature	51 °C	
Heating Boilers Setpoint (from boiler controller)	On:	57.2°C (135°F)
	Modulation:	60.0°C (140°F)
	Off:	65.6°C (150°F)
Heating Boiler Outdoor Reset	Off	
Heating Boiler Status	On (20% firing rate) / Standby	
Heating Boilers Inlet Temperature	62°C / 65°C	
Heating Boilers Outlet Temperature	66°C / 64°C	

Table 3 System Parameters

In addition, the following information was gathered from our interview of building staff:

- Typical heating season starts in the middle of October, ends in the middle of May
- The domestic water system does not have a mixing valve to control supply water temperature, and the domestic hot water is maintained at 40 °C

To examine the interactions between the facility's natural gas usage and the weather data, a linear regression analysis was performed using MS Excel. Aimed for better precision, instead of using twelve (12) month records that the EGD E-Tools used, we extended the period to four (4) years for the period from August 2008 to July 2012. The utility data was pre-treated through adjustment of the meter reading intervals before the analysis. This needed to be done in order to align the consumption with the appropriate weather data. The meter reading day of September 2011 was not available. In an effort to filter out any man-made error this month and the two adjacent months were excluded from the regression analysis. In addition, instead of using a fixed building balance temperature to calculate the heating degree days, we used "trial and error" to determine the building temperature that can yield the highest correlation coefficient between natural gas usage and the weather condition. Using this method we determined that the best fit balance temperature for this building is 17.5 °C. This number was then rounded up to 18 °C, which happens to be the same balance temperature that was used in the E-Tools analysis. The hourly temperature data were retrieved from the Weather Canada webpage (Toronto Lester B. Pearson International Airport, Climate ID 6158733, Latitude: 43°40'38.000" N, Longitude: 79°37'50.000" W).

The regression results were then used to establish a weather corrected baseline. The weather correction is a statistical process designed to remove the impact of extreme weather conditions. Enbridge uses a thirty-year (30) average condition to normalize the baseline. We believe that using the average conditions of recent years may produce a better projection of natural gas saving. Our rational will be detailed later in the report. To compare the differences of the two baseline scenarios we have conducted two separate normalization processes, where one uses thirty-year average weather data and another one used the average weather data of the latest four years from August 2008 to July 2012.

Using the thirty-year average weather, the normalized annual non-weather relative and weather relative natural gas usage were 34,440 m^3 and 323,785 m^3, respectively. Comparing to E-tools results as 20,173 m^3 for non-weather relative usage and 372979 m^3 for weather relative usage, the differences are 14,267 m^3 and -49,174 m^3 respectively.

Using the last four years average weather, the normalized non-weather relative and weather relative natural gas usage were 34,440 m^3 and 289,235 m^3, respectively. Comparing to E-tools results as 20,173 m^3 for non-weather relative usage and 372,979 m^3 for weather relative usage, the differences are 14,267 m^3 and -83,744 m^3 respectively.

Please note, that MMM reported the audited natural gas savings using the average weather data from the last thirty (30) years versus the last four (4) years.

The existing heating system seasonal efficiency was estimated to be 65%, which was based on the following factors:

- According to the Raypak catalogue (published in 1984), the TA series boilers are equipped with automatic modulating control (turn down ratio 5:1). For boilers with modulating firing rate a better efficiency can be achieved at reduced inputs due to the increase in the ratio of heat exchanger surface area to heat input. In addition the boilers have been designed with some special features to decrease standby loss.

- According to the facility manager, the existing boilers were lead-lag sequenced, and manually switched periodically to maintain an equal operation time.

- The ASHRAE 2008 HVAC Systems and Equipment (Chapter 31, Boilers Figure 8) estimates the differences of boiler overall efficiencies and combustion efficiencies at various load condition of approximately 4%. Considering the efficiency decrease due to vintage of the existing boilers, and the on/off loss during low load condition (when load is less than 20%), we have estimated a conservative decrease in efficiency of approximately 8%.

The seasonal efficiency of the existing domestic hot water heating system was estimated to be 65%, based on our literature reviews of some boiler manufacturer publication and ASHRAE reports regarding domestic hot water boiler performance at various operating temperature. The tank temperature at time of the site visit was recorded at 100°F, we were informed by the operator that the temperature set point for the tank is 40°C (104°F). The system old or new did not have a mixing valve after the storage tank, and due to tenant complaints the temperature was reduced in the tank from the maximum residential standard of 50°C to 40°C.

The new domestic water heating boiler seasonal efficiency was estimated to be 91% which is in line with the E-Tools estimate. The decrease in the estimated efficiency over the efficiency used in E-Tools results from the fact that the temperature re-set features are not currently explored as indicated in the E-Tools run. Refer to the following picture.

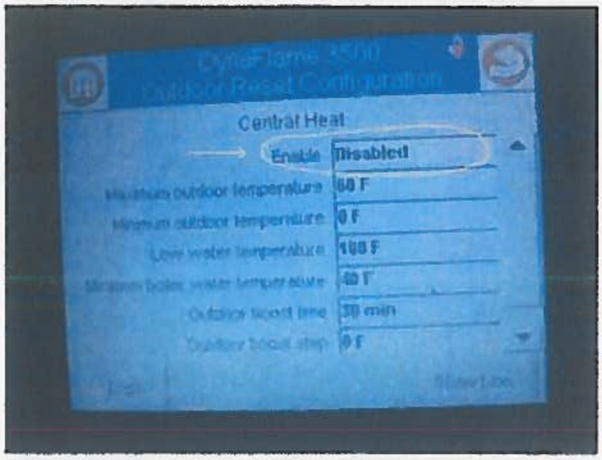

Figure 5 Control Screen Shot

Then natural gas savings of the heating water system and the domestic hot water system were calculated by applying the seasonal efficiencies for the existing boilers and the new boilers, to the pre-established weather corrected baseline consumptions. For the first scenario in which the baseline consumption was calculated using thirty-year (30) average weather, the projected annual natural gas consumption was calculated to be 284,427 m^3. For the second scenario in which the baseline consumption was calculated using the last four years average weather, the projected annual natural gas consumption was calculated to be 256,702 m^3.

Discussion

EGD E-Tools is an Excel based tool used to analyze heating energy demand under existing conditions and alternative energy converting and distributing solutions. It utilizes utility bill regression analysis to develop a baseline, and energy savings are calculated based on the potential improvement of relevant sectors of energy converting and distribution process. The savings estimate of the E-Tools model relies on many factors. In this particular project, E-Tools natural gas potential is different due to following reasons:

- The common approach to determine the base load is to use statistics to calculate both the non-weather relative demand and the weather relative demand using the method outlined in 2007 ASHRAE Handbook – HVAC Application Chapter 35 Energy use and management. It appears that E-Tools used a different approach.
- In the original calculation, E-Tools chose a year (Sep 2008 – Aug 2009) with the highest energy usage to develop the baseline. In comparison, the baseline year energy usage was 46% higher than the annual usage from Sep 2009 to Aug 2010, and was 14% higher than the annual usage from Sep 2010 to Aug 2011. Due to inherent fluctuations in natural gas consumption that occur during a particular year, using this year as a baseline inflated the normalized consumption. This can be avoided by performing a regression analysis for a period of two (2) or more years. By doing using this method some of these irregularities are minimized.

- The existing domestic hot water and heating system operating temperatures are lower than E-Tool input; heating system temperature reset was not enabled with the new system control.

Please note that verification of savings through a post implementation utility analysis was investigated, however, there was not sufficient data to draw an accurate conclusion. The post retrofit utility data indicated that natural gas savings are being achieved.

The total reported project cost of $158,717appears reasonable for the scope of work that was required for this retrofit.

Enbridge used a measure life cycle of 25 years to calculate the measure life savings, which is in line with the measure life assumptions that were provided. In light of the decrease in audited annual savings, MMM recommends that the life measure savings be adjusted to 1,844,925 m^3.

3.6 *RA.PRO.EX.006.12*

Project Information

ESM File #:	676624-17-05-10
Building Type:	Office
Project Description:	Upgrades to damper controls and BAS
Project Details:	Added new modulating damper controls for fresh air, return air and exhaust air to allow for economizer operation.
Implementation Date:	April 1, 2011

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	50,688	52,648	3.9
Electricity (kWh)	29,952	3,680	-87.7
Water (m^3)	0	0	0

Base Case

This incentive is for the energy savings achieved from the modifications to one AHU that serves the perimeter induction units in the building. We were not able to confirm how the system operated before the retrofit. From observations on site, it is believed that the operation of the AHU was with fixed dampers that had a fixed return air volume and a fixed amount of exhaust and fresh air. It could not be determined what the exact volume of outdoor air was before the retrofit. The air handling unit is equipped with a humidification section, a cooling section, and a hydronic heating section.

The existing unit was scheduled to operate from 6am to 6pm, Monday to Friday.

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Energy Efficient Case

Modulating damper controls have been installed and programmed to maintain a fixed mixed air temperature of 70°F before the humidification section. The outdoor air damper has a minimum position of 10%. This allows the unit to open the outdoor air damper during the shoulder seasons to use outdoor air for space cooling. Under normal conditions, it would be expected that the modification of adding economizer mode to the AHU would result in cooling savings only, not heating savings. However, utility bills were provided that clearly show some gas savings after the project was completed. Since the volume of outdoor air before the retrofit is not known, it is assumed that the additional gas savings from this project is due to the outdoor air volume being reduced as part of the new operating and controls programming.

There was no schedule change on the unit, the operating schedule remains from 6am to 6pm, Monday to Friday.

Savings Calculation Methodology

The applicant performed a utility analysis of the natural gas consumption data to estimate the savings for this retrofit. The building operating data was then input into the AHU ventilation load section of the E-Tools calculator and the input assumptions and operating schedule were adjusted to make the calculated gas savings in E-Tools match the savings from the gas consumption analysis. This resulted in the gas savings calculation in E-Tools being equivalent to a reduction of the operating schedule from 12 hours per day to 10 hours per day. This method of using E-Tools gave an accurate equivalent natural gas savings to the actual savings from the damper controls.

The application electrical savings was taken from the same E-Tools AHU ventilation load calculation and was based on a reduction of the AHU's operating schedule from 12 hours/day to 10 hours/day. Since, in reality, the savings stem from damper controls and not a reduction in the operating schedule, this approach of using E-Tools to estimate the electrical savings was incorrect.

Review Information

MMM met on site with the [redacted] and [redacted] from [redacted] and building operator [redacted] The site audit and resulting discussions with staff revealed the following:

- The BAS front end was reviewed to confirm the operating schedule of the AHU and the new operating controls.
- The installation of the new dampers and actuators was also confirmed on site.
- Interviews with the building operator did not reveal the system operation prior to the retrofit.
- The new operation of the system is to set the mixed air temperature to 70°F and modulate the return air and outdoor air to achieve the set-point temperature. The minimum position set point for the outdoor air damper was 10%. The exhaust dampers modulate to maintain a set static pressure.

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- At the time of the site visit, the outside temperature was 47°F, the outdoor air damper was set to 36% open, the humidification spray pump was operating, the cooling coil was at 70% load and the heating coil was off.

- The applicant utilized metered interval data which recorded the buildings natural gas consumption for a period of time. The savings were based on data recorded 15 months prior and 12 months after the retrofit. This data was provided to MMM.

Discussion

The gas consumption data provided by the applicant was used to perform gas savings analysis. The data sample was acceptable, with 15 months of data before the retrofit and 12 months of data after the retrofit. The building uses natural gas only for building heating, and not for domestic hot water heating. Therefore, there is no base load for this building. This was reflected in the data as there was no gas consumption during the summer months from June to September.

The data was consolidated into monthly consumption and compared to the heating degree days with a building balance temperature of 18 °C. A linear regression analysis was performed on the data, with a forced zero intercept to determine the building consumption per heating degree day. The fit was good for both cases, with R squared values of 0.974 and 0.985 respectively for base and proposed. The regressed pre and post data was then normalized and compared. The weather adjusted gas consumption savings was calculated to be 52,648 m^3 of gas.

The MMM normalized savings calculation from the building natural gas consumption data came to within 5% of the applicant's savings calculation of 50,688 m^3 of gas. Overall, we are in agreement with the gas savings calculated for this application. The audited savings of 52,648 m^3 represents a 17.2% reduction in the annual normalized natural gas consumption.

The E-Tools calculation included electrical savings for this measure based on a reduced operating schedule for the fan of 2 hours per day. Based on our review of the BAS, there was no change to the operating schedule of the fan and therefore there will be no electrical savings associated with the fan operation. The new controls system is programmed to use economizer mode during the shoulder season to reduce the cooling load on the chillers and therefore there will be some electrical savings from this control upgrade. A temperature bin analysis was performed for the AHU to estimate the cooling savings achieved with the economizer mode. For this analysis, an overall cooling system efficiency of 1 KW per ton was assumed and the mixed air temperature set point of 70°F observed on site was used to calculate the total electrical savings of 3,680 kWh per year.

The total reported project cost of $26,550.00 appears reasonable for the scope of work that was required for this retrofit.

Enbridge used a measure life cycle of 13.2 years to calculate the measure life savings, which is less than the recommended 15 years for control upgrade. MMM agrees with the reduction in the measure life cycle due to the fact that the system is relatively old, and may require replacement before the control does. In light of the increase in audited annual savings, MMM recommends that the life measure savings be adjusted to 694,954 m^3.

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3.7 *RA.MR.EX.072.12*

Project Information

ESM File #:	1-78725424-0821-12
Building Type:	Multi Residential
Project Description:	Heating water and domestic hot water system retrofit
Project Details:	Replace one of two existing non-condensing heating boilers with one condensing boiler. Retrofit piping configuration so that boilers serve both heating and domestic water heating. Revise operation to lead-lag control with condensing boiler as lead boiler and existing Teledyne Laars as lag boiler.
Implementation Date:	July 12, 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	65,384	45,367	-30.6
Electricity (kWh)	0	0	0
Water (m^3)	0	0	0

Base Case

The building space heating was provided by two heating boilers (RBI HB 1685; and Teledyne Laars HH 1670), with total input capacity 3355 MBH. The domestic hot water was provided by a dedicated boiler (Raypak), with input capacity of 1060 MBH.

Energy Efficient Case

The system has been retrofitted to a combined system with common boilers to produce both space heating, and domestic hot water by means of heat exchanger built into the domestic water storage tanks. The existing domestic water boiler and one of the existing heating boiler (RBI HB 1685), were disconnected and removed from the heating plant. A new condensing boiler (Viessmann Vitocrossal 200) was installed. In addition, all domestic water storage tanks were replaced with new tanks.

The increase in efficiency stems from primarily delivering heat via a condensing boiler versus non-condensing boiler, and a reduction in stand-by losses from the elimination of one boiler.

Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools program. Gas information from January 2011 to December 2011 was used to create a weather normalized baseline, separated into seasonal and non-seasonal components. The savings were calculated by multiplying the percentage improvement in seasonal heating plant efficacy to the corresponding gas component.

Review Information

The site installation was in general conformance to the project application. The actual piping configuration was investigated, and major operating parameters observed during the site visit were collected and depicted in the diagram below.

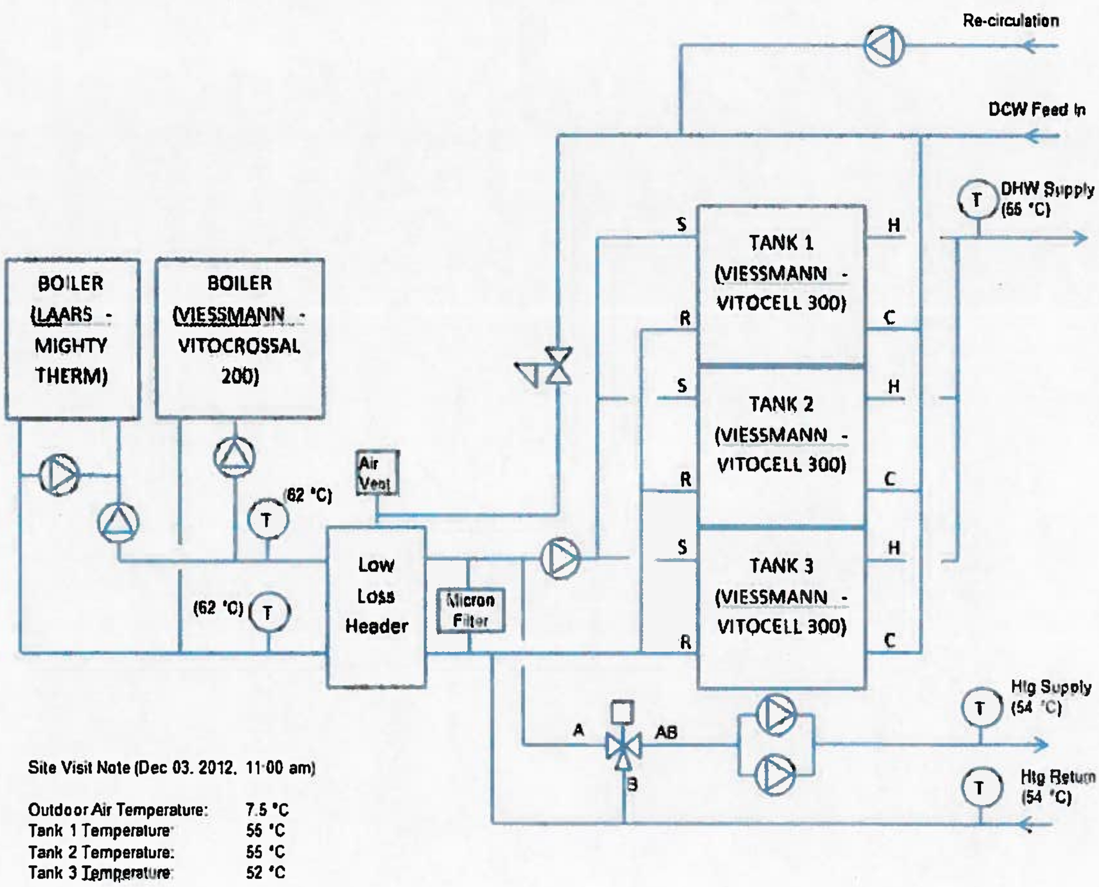

Figure 6 Heating System Schematic

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Some major operation parameter recorded during the site visit are tabulated below:

Parameters	Reading
Outdoor air temperature	7.5 °C
Boiler return water temperature	62 °C
Boiler Setpoint (from boiler controller)	72°C
Boiler On/Off count	Condensing boiler: 1 time/15 min duration
	Non-condensing boiler: off
Domestic hot water supply temperature	55 °C
DHW tank temperature (top, middle, low)	55°C, 55°C, 52°C
Heating water supply/return temperature	54°C/54°C

Table 4 System Parameters

In addition, the ollowing information was gathered during staff interviews:

- Typical heating season starts in the middle of September, ends in the middle of June
- Based on outdoor temperature and tenant feedback, heating water supply temperature is typically maintained from 62°C to 72°C, and is controlled by the property manager

The condensing boiler efficiency at different supply/return water temperature was determined using ASHRAE handbook 2008 HVAC Systems and Equipment, Chapter 31, Figure 6 (see chart below). The atmospheric boiler efficiencies as functions of outdoor air temperature and partial load condition were extracted from a white paper (ASHRAE transactions 1994).

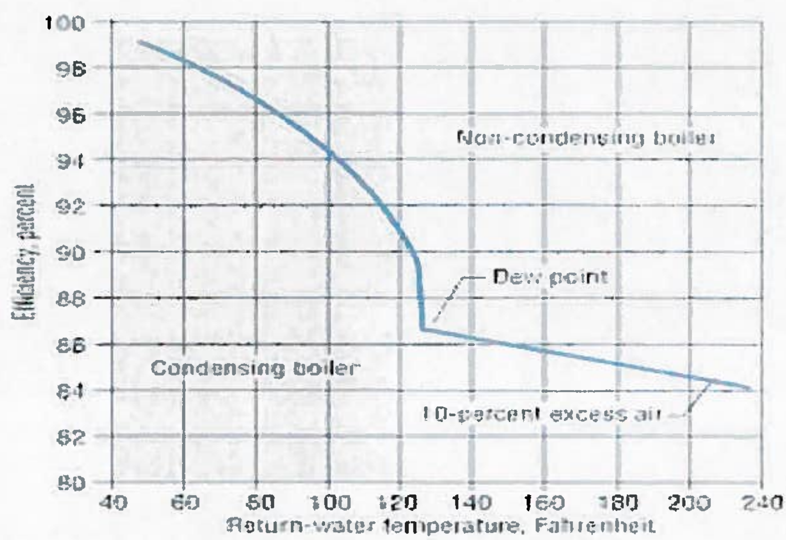

Figure 7 Condensing Boiler Efficiency

Based on the above information, we utilized the ASHRAE bin temperature method to calculate the natural gas saving. The bin method refers to a procedure where annual weather data is sorted into discrete groups (bins) of weather conditions. Each bin contains the number of hours of occurrence of a particular weather condition range over a year. Bin method considers heating load variety and occurrence frequency and addresses part-load performance of the condensing boiler.

Discussion

Condensing boilers can recover latent heat from water produced during combustion and minimize cycling losses and thus have the potential to improve overall heating system efficiency. A sufficiently low return water temperature is required for the boiler to reach such high efficiencies. However, due to the current configuration of the heating system it is unlikely that such high efficiencies will be achieved. Some factors that impinge on the condensing boiler performance are:

- During the heating season the heating water has to be maintained to a higher temperature to satisfy the building space heating. It is unlikely that the equipment within the building is operated at significantly lower temperatures than what was intended in the original design.
- The domestic hot water is maintained at a high temperature, to prevent development of Legionella.
- The adoption of low loss header design mixes the boiler return water with supply water and thus increases the return water temperature to the boiler. It also prevents the cold water from reaching the condensing boiler.

Please note that verification of savings through a post implementation utility analysis was investigated, however, there was not sufficient actual data to draw an accurate conclusion. The gas meter for this facility is manually recorded every other month, and estimated for the remaining months. Also, the commissioning of the project went on well into the heating season, and as such some of the data is not entirely representative of the final system operation.

The total reported project cost of $160,475.25 appears reasonable for the scope of work that was required for this retrofit.

Enbridge used a measure life cycle of 20 years to calculate the measure life savings, which is less than 25 years as recommended by ASHRAE. MMM agrees with the reduction in the measure life cycle due to the fact that the new boiler will always be the lead boiler, and will therefore be in constant use. In light of the decrease in audited annual savings, MMM recommends that the life measure savings be adjusted to 907,340 m^3.

3.8 *RA.MR.EX.095.12*

Project Information

ESM File #: 1-78725424-0821-12

Building Type: Multi Residential

Project Description: Installation of heat reflector panels for baseboard heaters

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Project Details: The heat reflectors were installed on the wall behind hot water baseboard heaters to reflect radiant heat, thus resulting in reduced heating requirements.

Implementation Date: August 28, 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	22,423	22,423	0
Electricity (kWh)	0	0	0
Water (m^3)	0	0	0

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 make-up air units located on the roof-top. The make-up air units do not have heating modules. The domestic hot water is provided by a separate domestic water heater.

Energy Efficient Case

Reflector panels were installed directly behind the convective baseboard heaters. These reflector panels act as an insulator and radiation barrier on the wall behind the hydronic heating equipment, thus reducing the heat loss through the wall at this location.

Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools program. Gas information from January 2011 to December 2011 was used to create a weather normalized baseline, separated into seasonal and non-seasonal components. The savings were calculated by multiplying the estimated improvement in the building heating performance.

Review Information

Our auditor randomly selected several apartment units to evaluate the completion of the installation. Based on this review, the auditor confirmed that the reflectors installation conforms to the project application.

Literature reviews where conducted to research the energy saving potential. Throughout the reviews of measurement and verification reports of previous radiator panel installation in residential sectors, it was determined that the heating energy saving potential ranges from 8% to 20%, with 10% the most likely savings amount. The factor of 10% was equal to the factor that E-Tools has used. Therefore no adjustment of saving calculation was made.

Discussion

The approach and factors that E-Tools used to conduct energy saving calculation for this type of application is appropriate.

Please note that verification of savings through a post implementation utility analysis was investigated, however, there was not sufficient actual data to draw an accurate conclusion. The gas meter for this facility is manually recorded every other month, and estimated for the remaining months. It will be very useful to verify the savings once a full year of actual natural gas data is available.

The total reported project cost of $17,146.80 appears reasonable for the scope of work that was required for this retrofit.

Enbridge used a measure life cycle of twelve (12) years to calculate the measure life savings. Twelve (12) years appears to be conservative, considering the nature of the retrofit. It is recommended to re-evaluate the life cycle figure used for this type of retrofit.

3.9 *RA.MR.EX.122.12*

Project Information

ECM File #:	1-78859992-08-29-12
Building Type:	Multi Residential
Project Description:	Addition of VFD to make-up air units
Project Details:	Installation of VFD on two (2) make-up air units serving the corridor to decrease fresh air ventilation during specific periods.
Implementation Date:	December 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	39,428	40,030	1.52
Electricity (kWh)	59,091	63,973	8.26
Water (m^3)	0	0	0

Base Case

The building comes equipped with two (2) packaged roof-top make-up air units. The units supply conditioned make-up air to the corridors of the building. Each 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.

These units were operated at 100% capacity all year long. The supply air temperature is manually adjusted from 68°F during the heating season to 74°F during the cooling season.

Energy Efficient Case

A VFD for each of the two make-up air units was installed to modulate the fresh air delivered to the corridors based on a pre-set schedule.

The following schedule was observed during the site visit conducted on January 3rd, 2012:

Hour	Speed (%)	Frequency (Hz)
24:00 – 6:00	60	36
6:00 – 8:00	80	48
8:00 – 9:00	100	100
9:00 – 10:00	80	48
10:00 – 12:00	60	36
12:00 – 13:00	80	48
13:00 – 14:00	100	60
14:00 – 24:00	80	48

Table 5 System Schedule

Savings Calculation Methodology

The provided savings were calculated using the EGD E-Tools software. Savings resulting from the VFD control of the MUA's were derived using EGD Ventilation Load model. This model is based on assumptions/actual data on air temperatures, air handler nameplate information.

Review Information

Site visits were conducted on December 7th, 2012 and January 3th, 2013.

The following information was gathered during the initial site visit:

- There are two (2) MUAs versus one (1) as indicated in the application
    - Combined airflow of both MUAs is equivalent to the airflow submitted in the application
- Existing MUAs have cooling capabilities
    - Heating season set-point at 68°F
    - Cooling season set-point at 74°F
- Cooling performance of equipment was not available from nameplate information or manufacturer
    - Assumed EER of 9.3

- Unit manufactured in 2005
- ASHRAE 90.1- 2004 minimum efficiency was 9.3 for this size and type of unit

- VFD's were installed on both units
  - VFD's were not commissioned and were operating consistently at 100%.
- The efficiencies of the motors were observed to be 93% for the 15 HP motor and 91.7% for the 10 HP motor. The blended efficiency was estimated at 92.5% versus 85% as used in the application.

The following information was gathered during the final site visit:

- VFD schedule was reviewed and noted to be different than the schedule outlined in the application
- The actual schedule is outlined in the energy efficient case above

Discussion

Based on the information collected during the site visit, EGD recalculated the saving using E-Tools. The new calculation reflected the change in the schedule, the addition of cooling savings, and the increase in actual motor efficiency. The revised savings estimate using the adjusted inputs resulted in a natural gas savings increase of 1.52% and an increase in electricity savings of 8.26%. A 40,030 m^3 reduction in annual natural gas consumption represents a 14.3% decrease in annual natural gas consumption when compared to the baseline.

The total project cost was reported as $22,230 seems reasonable for the scope of work completed. The total cost included the cost for material, installation, and commissioning.

Enbridge based the life measure savings estimate on retrofit life expectancy of 12 years. This appears reasonable since the VFDs added to existing rooftop units. Due to the difference in audited savings, we recommend increasing the life measure savings to 480,360 m^3.

3.10 *RA.MR.EX.090.12*

Project Information

Project Code:	1-76125738-04-27-12
Building Type:	Multi Residential
Project Description:	DHW boiler controls upgrade and addition of VFD to make-up air units
Project Details:	Installation of VFD on make-up air units serving common spaces to decrease fresh air ventilation levels during specific times. Upgrade DWH pump operation from continuous to

intermittent pumping.

Implementation Date: July 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	29,434	29,434	0
Electricity (kWh)	42,541	56,677	33.23
Water (m^3)	0	0	0

Base Case

The building comes equipped with four (4) Raypak heating boilers located in the mechanical room on the roof. Each boiler is rated at 825 MBTH input.

There are two (2) Raypak domestic hot water boilers. Each boiler is rated at 726 MBTH input and is equipped with 1/6 HP pump. Based on the interview with the building operator and sheets provided by Enbridge, the pumps were running continuously.

The fresh air to the common spaces is provided via two (2) Engineered Air make-up air units located on the roof. Each unit is rated at 8,500 CFM. Each 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.

Based on the interview with the building operator and sheets provided by EGD the units were working at 100% fresh air all year long.

Energy Efficient Case

The domestic hot water boilers pumps have been upgraded to run intermittently, therefore they won't circulate hot water into the DHW boiler when the boiler is not firing. This will reduce standby losses and therefore reduces gas consumption.

A VFD for each of the two make-up air units was installed to modulate the fresh air delivered to the corridors based on a pre-set schedule.

Based on the information provided by the installer and site observations, VFDs are operating based on the following schedule:

Hour	Speed (%)	Frequency (Hz)
7:30 AM – 9:30 AM	90	54
9:30 AM – 11:30 AM	70	42
11:30 AM – 1:30 PM	90	54
1:30 PM – 4:30 PM	70	42
4:30 PM – 8:30 PM	90	54
8:30 PM – 7:30 AM	70	42

Table 6 System Schedule

Savings Calculation Methodology

The provided savings were calculated using the E-Tools program. Gas information from Jan 2011 to Dec 2011 was used to create a weather normalized baseline. Non-seasonal load was separated based on the average of gas consumption during summer months. Seasonal load was calculated using HDD and balance temperature of 18C. The seasonal load was then subdivided to Boiler load and MUA load based on assumption regarding MUA air flow, supply air temperature, and operating hours.

The saving were calculated by multiplying the parentage improvement in DHW boiler annual efficiency (due to the reduction in standby losses), and percentage reduction in fresh air volume for the MUAs.

Review Information

Site visits were conducted on December 4th, 2012 and on December 7th, 2012. Building operator and management office were interviewed during the visit and following documents were provided:

- Operation manual for domestic hot water boilers
- Energy report performed by installer
- Invoices

The site installation was in general conformance with the project application. The following information was gathered through observation and staff interview:

- During the site visits the DHW boilers were in standby mode and the associated circulation pumps were not working.
    - The DHW boiler control upgrade is working as it is expected.
- The VFDs were installed on the MUAs.
    - The VFD programming was checked using the instruction given by installer. Each VFD has two mode of operation: Low speed @ 70% and high speed at 90%. This numbers match the input used in E-Tool.

   - The actual performance of the VFD was checked during various times of the day and confirmed to be operating as indicated. There is a slight difference in the peak hours that were reported by Enbridge and the hours that the unit is actually operating at, however, the duration of Peak Supply and Partial Supply is the same. Therefore, this issue won't affect the gas saving.

- Existing MUAs have cooling capabilities
   - EER of 6.6 as provided by the manufacturer

Discussion

During the site visit it was confirmed that VFDs are scheduled as stated in the original application. No adjustment is required.

The method used by E-Tools to calculate the increase in DHW annual efficiency resulting from control upgrade is acceptable and can be used for prediction.

The total gas saving calculated for this project is in good agreement with the E-Tools calculation and no adjustment is required. This retrofit will result in annual gas saving of 13.3%.

The electricity saving from upgrading DHW boiler control as well as cooling saving was not included in the original application. EGD recalculated the saving using E-Tools. The new calculation reflected the addition of cooling savings. E-Tools is not capable of predicting the saving from DHW boiler control upgrade, therefore it was calculated separately. The revised savings estimate an increase in electricity savings of 33%.

The project cost includes supplying and installing the VFDs on MUA units and DHW boiler control upgrade. The project cost is within the acceptable range.

The life measure savings was calculated based on a 12 year life. Given that this application includes controls that have been added to existing equipment, a 12 year life cycle for these measures is reasonable.

3.11 *RA.MR.EX.109.12*

Project Information

ESM File #:	1-76455211-05-13-12
Building Type:	Multi Residential
Project Description:	Addition of VFD to make-up air units
Project Details:	Installation of VFD on make-up air units serving common spaces to reduce the fresh air delivered to the building at specific times of the day.
Implementation Date:	July 2012

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Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	22,706	20,752	-8.6
Electricity (kWh)	6,104	20,523	232.2
Water (m^3)	0	0	0

Base Case

The fresh air to the common spaces is provided via two (2) make-up air units located on the roof. Each 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 MUA units are very old and have been refurbished over the years. Therefore, there was no nameplate information and the only information that we could use was what the business partner had provided. Based on the information provided by the installer, each unit is rated at 6,400 CFM, but the actual air delivered prior to the retrofit was 5,450 CFM and 5,600 CFM.

Energy Efficient Case

Each make-up air unit will be equipped with Variable Frequency Drive (VFD). Based on the information provided by installer and site observations, the VFDs are operated at two (2) distinct modes:

Winter Mode

The motors speed has been reduced by adjusting the sheaves to satisfy the minimum air requirements across the heat exchanger during the heating mode. The VFD is reduced from 5,600 CFM and 5,450 CFM and maintained at 90% or 4000 CFM. This value of 4000 CFM has been provided to us by the business partner. There were no documents available to verify this value.

Summer Mode

During the summer mode the Drive operates with a "time of day" program which utilizes the internal clock function. The following operating schedule is used during the summer.

Hour	Speed (%)	Frequency (Hz)
7:30 AM – 9:30 AM	90	54
9:30 AM – 11:30 AM	70	42
11:30 AM – 1:30 PM	90	54
1:30 PM – 4:30 PM	70	42
4:30 PM – 8:30 PM	90	54
8:30 PM – 7:30 AM	70	42

Table 7 System Schedule

Savings Calculation Methodology

The provided savings were calculated using the E-Tools program. Gas information from Jan 2009 to Dec 2009 was used to create a weather normalized baseline. Non-seasonal load was separated based on the average of gas consumption during summer months. Seasonal load was calculated using HDD and a balance temperature of 18 °C.

The natural gas saving was calculated by multiplying the percentage reduction in fresh air volume for the MUAs.

Review Information

The site visit and building operator interviews were conducted on December 4th, 2012. The site installation was in general conformance to the project application. The following information was gathered through observation and staff interview:

- VFDs were installed on the MUAs.
    - Schedule was verified as outlined in the energy efficient case description above
- Actual site conditions indicated that the units had cooling capabilities via direct expansion
    - Cooling performance of equipment was not available from nameplate information or manufacturer
    - Assumed EER of 6.8 as per ASHRAE minimum EER requirements for this size and vintage of equipment.
- Based on the information provided by installer, the fresh air flow rate has been reduced from 5,600 CFM and 5,450 CFM to 4000 CFM during the winter season while the VFD is operating at 90%. It can be assumed that the VFD is set in a constant speed and the maximum average fresh air volume of both units is reduced to 73% of the original air flow.

Discussion

In the original calculation done by E-Tools the schedule is based on an 80% load during the peak supply and 60% during partial supply. As described the system is running at constant speed during the heating mode which translates to an average of 73% of the original system.

Based on the information collected during the site visit, EGD recalculated the saving using E-Tools. The new calculation reflected the change in the schedule and the addition of cooling savings. The revised savings estimate as per E-Tools and the adjusted inputs resulted in a natural gas savings decrease of 8.6% and an increase in electricity savings of 135%. The audited natural gas savings represents an annual reduction of 19.8%.

The project cost includes supplying and installing the VFD and is within the acceptable range.

The life cycle analysis for each measure was calculated based on a 12 year life. Given that this application includes controls that have been added to existing equipment, a 12 year life cycle for these measures is reasonable.

3.12 *RA.MR.EX.086.12*

Project Information

ESM File #:	1-9955196-09-20-10
Building Type:	Multi Residential
Project Description:	MUA unit replacement with new scheduling
Project Details:	Two MUA units, 3000 CFM each with timers
Implementation Date:	May 2, 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	13,609	11,822	-13.1
Electricity (kWh)	12,058	6,426	-46.7
Water (m^3)	0	0	0

Base Case

The building is a three story condominium townhouse complex which utilized two rooftop make-up air units that were equipped with natural gas heating and DX cooling. The old rooftop units had cracked heat exchangers and were not operating properly. Both roof top units were scheduled to run 24 hours/day, 7 days/week.

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Energy Efficient Case

The rooftop make-up air units have been replaced and timers have been added to allow for scheduling of the units. The units were to be replaced for maintenance reasons and there are no gas savings from the unit replacements. Gas savings are achieved from the timers, based on a reduced operating schedule.

Savings Calculation Methodology

The applicant used E-Tools to calculate the gas and electrical savings, based on a schedule of 16hr/day on and 8hr/day off.

Review Information

The following information was gathered during the documentation review and site survey:

- MMM met on site with the installer, [redacted], from [redacted]
- The rooftop units were inspected and the model and size of the units was confirmed.
- The programming of the timers was reviewed and the schedule was observed to be operating from 6:00am to 12:00am (18 hours per day) and shut down from 12:00am to 6:00am.
- The make and model of the rooftop units was recorded and the manufacturer's specifications were found on the manufacturer's website. The units' burner efficiency and dx cooling efficiency was confirmed.
- The additional information observed on site and determined from the manufacturer's specifications was used to update the E-Tools calculations for the project savings. The revised E-Tools calculations are included with this report.

Discussion

The E-Tools savings calculation was updated based on the programmed schedule observed on site during the site visit. After meeting with Enbridge representatives to review the E-Tools program, it was determined that for this type of project, the savings calculation can be determined more accurately using the "VFD" section of the Ventilation Load MUA section of the E-Tools calculator. Inputting the timer schedule into the "Peak Supply" section and inputting 0% for the "Partial Supply" allowed adjustment for the additional heating savings due to the units being shut-down at night when it is generally cooler than day time. This also reduced the electrical savings calculated from the cooling load due to the night time shutdown period.

Overall, the heating savings was adjusted due to the rooftop units operating two additional hours per day compared to the submitted schedule and the electrical savings dropped significantly due to a lower COP rating for the cooling from the manufacturer's data as well as the additional two hours of operating time per day.

The audited natural gas savings of 11,822 m^3 represents a 26.3% reduction in the annual normalized natural gas consumption.

MMM GROUP

The total project cost of $2,695 seems reasonable and within industry standards for the work that was completed.

The life measure savings was calculated based on a 12 year life. Given that this application includes controls that have been added to existing equipment, a 12 year life cycle for these measures is reasonable. It is recommended to decrease the life cycle savings to 141,864 m^3 due to the decrease in audited annual savings.

3.13 *RA.UNIV.EX.007.12*

Project Information

Project Code:	RA.UNIV.EX.007.12
Building Type:	College/University
Project Description:	Addition of VFDs to supply and/or return fan motors for 20 air systems serving the building.
Project Details:	The VFDs were utilized to alter the delivered fresh air from a schedule which delivered 100% fresh air 168hour/week to a reduced schedule.
Implementation Date:	December 2012 (Adjustments to schedule continued to mid-March 2013)

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	751,609	848,464	12.9
Electricity (kWh)	4,145,392	4,564,728	10.1
Water (m^3)	0	0	0

Base Case

There are twenty (20) air systems which will be affected by the application of VFDs and the resulting adjustment to their control. These twenty systems are divided into four distinct groups, where six (6) serve the laboratory air system, six (6) serve the laboratory support areas air systems, six (6) serve the lecture rooms air systems, and the last two (2) serve the animal area air systems.

The six (6) systems serving the laboratory come complete with six (6) supply fans which are equipped with VFDs, three (3) exhaust fans which operate at 100% 168 hours/week, and fume hood exhaust fans. The combined supply air capacity of all systems is 299,000 CFM. The VFDs serving the supply fan dynamically respond to the operation of the hoods. Each hood comes equipped with a dedicated exhaust fan which is turned off when the exhaust hoods are not in use; this in turn alters the fresh air supply flow. These systems come complete with heating coils, cooling coils, humidification, and re-heat coils.

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The six (6) laboratory support area air systems come complete with a total of six (6) supply fans and three (3) return fans which were operated at 100% for 168 hours/week. These are mixed air systems which deliver approximately 15% fresh air of the total 268,000 CFM system capacity. These systems come complete with heating coils, cooling coils, humidification, and re-heat coils.

The six (6) systems serving the lecture rooms come complete with a total of six (6) supply fans and six (6) return fans which were operated at 100% 168hours/week. The combined supply air capacity of all systems is 318,000 CFM, however, only 15% (47,700 CFM) of that was fresh air. These systems come complete with heating coils, cooling coils, humidification, and re-heat coils.

The two (2) systems serving the animal areas are 100% fresh air systems which are operated 168hours/week at 100% flow. These systems come complete with heating coils, cooling coils, humidification, and re-heat coils. These systems come complete with heating coils, cooling coils, humidification, and re-heat coils.

Energy Efficient Case

VFDs were installed on the supply and/or return fan motors for twenty (20) air system. The addition of the VFDs to the air systems was intended to facilitate modulation of the fresh air supply to the building according to the following operation schedule.

Type of Air System	Occupied Schedule		Partial Occupied Schedule		Non-Occupied Schedule	
	Time (h/day)	Flow (%)	Time (h/day)	Flow (%)	Time (h/day)	Flow (%)
Laboratories	11	100	7	80	6	70
Lectruc Rooms	11	100	7	50	6	0
Lab Support Areas	11	100	7	60	6	40
Animal Area	24	100	-	-	-	-

Table 8 Proposed System Schedule

Operating the systems according to the above outlined schedule will result in cooling, heating, re-heat, humidification, and fan power energy savings.

Savings Calculation Methodology

The natural gas savings and electricity savings where calculated by the applicant using the following major steps:

- The building steam usage was determined to be the total recorded steam usage minus the absorption chiller steam usage.
- The remaining steam usage data was then inserted into the E-Tools software to determine the normalized weather dependent and non-dependent steam usage.
- The steam usage was converted to natural gas usage using a plant efficiency of 80%, which was determined through a boiler system study that had been previously performed by the University.

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- The existing air flow was determined using the equipment rated capacity, to which the proposed VFD schedule was applied to in order to determine the proposed total and fresh air flows.
- The required heating energy was calculate for both the existing and proposed control strategies, using the calculated fresh air flow and temperature differential of the outdoor air and space temperature set-point.
- The required humidification energy was calculated for both the existing and proposed control strategies using the fresh air flow and enthalpy differential of the outdoor air and space temperature set-point.
- The required cooling and de-humidification energy was calculated for both the existing and proposed control strategy using the calculated total air flow and the enthalpy differential of mixed air (outdoor air for 100% fresh air systems) and dew-point temperature corresponding to the supply air set-points for temperature and relative humidity.
- The required re-heat energy was calculated for both the existing and proposed control strategy using the temperature differential of the air downstream of the cooling coil and the space temperature set-point.
- The sum of the existing energy consumption from steps 4 to 8 was compared to the determined baseline in order to calculate a calibration factor. This calibration factor was then applied to the total calculated proposed consumption in order to determine a calibrated proposed energy usage.
- The calculated savings from the above step where then discounted by an additional 20% to account for factor that may have been overlooked.
- A weighted average air flow for all four air systems of different operation periods was calculated. This average flow was applied to the fan flow to determine the electricity savings.

Review Information

MMM conducted a site visit on March 15th, 2013. Building operator and operation manager were interviewed and an inspection of the affected equipment and systems was carried out. MMM gathered the following information during this site visit:

- The twenty (20) systems in question had all been equipped with VFD control as was indicated in the application.
- All of the installed VFDs were operating properly, and had been connected to the BAS system which allowed for full controllability of the systems.
- Temperature set-points were reviewed and note to be as indicated in the original application.
- The schedules of all four (4) types of systems was reviewed and noted to differ from the application. The actual system schedule was observed to be as follows:

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Type of Air System	Occupied Schedule		Partial Occupied Schedule		Non-Occupied Schedule	
	Time (h/day)	Flow (%)	Time (h/day)	Flow (%)	Time (h/day)	Flow (%)
Laboratories	17	100	-	-	7	70
Lectrue Rooms Weekdays	11	95	6	50	7	0
Lecture Room Weekends	24	0	-	-	-	-
Lab Support Areas	11	95	6	60	7	40
Animal Area	24	90	-	-	-	-

Table 9 Actual System Schedule

MMM also reviewed the applicant calculation methodology in detail, including: all parameters, assumptions, and equations that were used to determine the electricity and natural gas savings.

Discussion

In general MMM agrees with the approach that was used by the applicant to estimate the savings resulting from the application of VFDs to the air systems within the facility. MMMs audited savings differ as a result of the difference from the proposed and actual schedule, and the following alterations to the original calculation methodology:

- MMM reviewed the balance reports for the systems and utilized the actual air flow rather than the rated airflow to update the calculation.
- For the re-heat energy calculation, the applicant used a temperature after the cooling coil that would be sufficient to satisfy dehumidification. However, in reality some air systems did not have specific dehumidification control, and as such the temperature leaving the cooling coil was higher than the value used by the applicant. In this instance MMM used a temperature that was between the ideal and actual to better represent the conditions for all systems.
- For the re-heat energy calculation, the applicant calculation did not take into account the internal heat gain. To account for this, MMM used the balance temperature rather than the space temperature to calculate the re-heat energy requirement.
- For the motor electricity savings the applicant calculation was based on the weighted average of the flow change, while MMM used the weighted average of the fan power since the average of the cubic is not equal to the cubic average.
- MMM also used curve fitting from VFD performance rather than the cubic law to estimate the motor electricity savings, however, this difference was minimal.

The audited natural gas savings represent a 17.4% reduction in annual natural gas consumption for the building.

The total project cost of $517,950 seems reasonable and within industry standards for the work that was completed.

The life measure savings was calculated based on a 13.2 year life. Given that this application includes controls that have been added to existing equipment, a 13.2 year life cycle for these measures is reasonable. It is recommended to increase the life cycle savings to 11,199,725 m^3 due to the increase in audited annual savings.

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3.14 *RA.COM.NC.002.12*

Project Information

ESM File # — OPP 1-77325841-06-26-12

Building Type: — Office

Project Description: — Construction of new production facility for [redacted] at [redacted]

Project Details: — Building included condensing boilers, an efficient lighting system, demand control ventilation, and improvements to building envelope and lighting.

This is a state-of-the art [redacted] distribution centre in [redacted], Ontario, replacing three [redacted] centres that were located in [redacted]. For this application **only the office space, [redacted] rooms and high bay area were modeled**, which comprised **48%** of the total facility. The entire facility has a total GFA 136,000 ft².

The modeled 64,831 ft² office area has two (2) above-ground floors, a basement, and a large exterior parking area around the building.

Implementation Date: — August 8, 2009 through October 28, 2011

Substantial Completion: — September 6, 2011

Building occupied: — February 2012

Project Savings Summary

Total Natural Gas and Electricity Savings Summary			
Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas [m³/year]	24,065	24,065	0
Electricity [kWh/year]	162,760	162,760	0
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable

Total natural gas and electricity savings are shared between OPA and EGD using the Environmental Attributes Calculator. The ratios for claiming/sharing energy savings attributed by electricity and natural gas between OPA and EGD are determined as follows:

$$\text{Energy Apportioning Ratio for EGD} = \frac{\text{Natural Gas Energy Saved (ekWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

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$$\text{Energy Apportioning Ratio for OPA} = \frac{\text{Electrical Energy Saved (kWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

The shared savings are shown below:

Natural Gas and Electricity Savings Summary Claimed by **Enbridge Gas Distribution**				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	EGD Ratio for Sharing Savings [%]
Natural Gas [m³/year]	14,636.9	14,636.9	0	60.8
Electricity [kWh/year]	98,994.7	98,994.7	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Natural Gas and Electricity Savings Summary Claimed by OPA				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	OPA Ratio for Sharing Savings [%]
Natural Gas [m³/year]	9,428.1	9,428.1	0	39.2
Electricity [kWh/year]	63,765.3	63,765.3	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Energy Efficient Case

The building has the following energy efficient features:

- Efficient lighting system controlled by occupancy sensors (OS) using Encellium control system.
- High efficiency lighting fixtures and ballasts with T5's, T'8 and CFLs.
- Double glazed windows with low-e coating. High thermal insulation for walls and roofs. Window to wall ratio is approximately 24%.
- High efficiency condensing boilers for space heating.
- Demand control ventilation using CO_2 sensors.
- VFD for major HVAC pumps and fans.
- Low flow plumbing fixtures for water supply in lavatory faucets (1.9 l/min) in washroom and shower head (5.7 l/min) for bathroom.

Savings Calculation Methodology

The savings from the high performance new construction program resulted from the simulation of the new facility using EE4 software, developed by the CANMET Energy branch of Natural Resources Canada. The EE4 software front-end is interfaced to the DOE-2 building modeling system developed by the US Department of Energy.

The EE4 software generates two building models. The baseline/reference building represents a building that meets the minimum energy code of the Ontario Building Code (OBC) and the proposed building represents how the actual building will perform (in theory).

The energy simulation model was peer reviewed by a third-party Energy Consultant and adjusted appropriately showing the anticipated savings as mentioned above.

Review Information

The site installation was in general conformance to the project application. The following information was gathered through observation and site survey:

- Incremental cost of energy conservation measures was 5% of total project cost.
- The total gas consumption comprised only space heating, therefore gas energy of the building is 43% of total building energy. Here the domestic hot water system was not modeled at all. The domestic hot water within this building is primarily used for the process load.
- The building has major non-regulated process loads related to the production facility, humidification, laboratory, IT equipment and cooling for data center, snow melt system which was not modeled here.
- The energy model indicated 26% electricity savings, 42% gas energy savings and an overall energy savings of 33.5% with respect to the OBC reference building.

Item	Electricity	Gas	Total Energy	% Gas saved as compared to the Annual Gas Consumption.
Proposed [MBTU]	1,611	1,201	2,812	72%
Reference [MBTU]	2,166	2,063	4,229	
% Savings	25.6%	41.8%	33.5%	
Electricity Saved [kWh/yr]	162,760			
Natural Gas Saved [m^3/yr]		24,065		

Table 10 Proposed Project Savings

- The HPNC Program Results Summary Report claimed that the reference building was updated to OBC requirement using EE4-OBC energy simulation software.

- We received the peer reviewed and modified simulation files for further review. After verification of all the submitted reports and documents, we found that the final energy model was modified to reflect the above savings and the project was in compliance with the rules and intent of HPNC program.

- A site visit was conducted on March 12, 2013 to verify the following:

  - Installation of the main energy savings equipment of the building.

  - Basic physical and operational characteristics of the building.

- During the site visit, Site Manager, [redacted] Facilities Management Department, of [redacted] was present.

- Methodology used while verifying the savings:

  The energy simulation methodology was already peer reviewed by a third party energy consulting firm, most of the supporting documents were provided by professional engineers, all available reports and originally submitted EE4 files were reviewed to verify savings.

  A site visit was conducted to confirm equipment installation by examining the screen-shots of the building automation system, nameplates of major HVAC equipment and walking through the building.

  Additionally the shop drawings and issued-for-construction drawing set were reviewed to confirm if the modeling inputs were correct.

Discussion

For new construction project, peer-reviewed and modified simulation files were submitted for audit purpose.

The Energy conservation measures are advancement for new construction as compared to the baseline building referred to in the OBC.

Incremental cost analysis:

- The total incremental cost was reported as $ 241,400 for the major energy conservation measures which seems reasonable. The TRC ratio is 0.97.

Life cycle cost analysis:

- The enhanced building envelope and the condensing boilers have saved approximately 24,000 m³/year and considering 25 year life cycle span for both the systems, the life cycle savings is 600,000 m³/life cycle of condensing boilers and building envelope.

Four (4) condensing boilers, each with a rated thermal efficiency of 98.5% provide space heating and ventilation air heating. Supply and return water temperatures are 140 °F and 120 °F respectively.

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Three (3) AHUs serve VAV boxes in office areas.

Overall, the weighted average thermal resistance of glazing system is R-1.8. The solar heat gain co-efficient (SHGC= 0.33) seems reasonable for the glazing system.

The wall insulation has 4" spray and cellular polyurethane while the roof has 8" polyurethane.

The end-use breakdown of the proposed building indicated high energy consumption for space heating and lighting as shown below. Demand control ventilation, condensing boilers, and enhanced envelope system can contribute to significant gas energy savings.

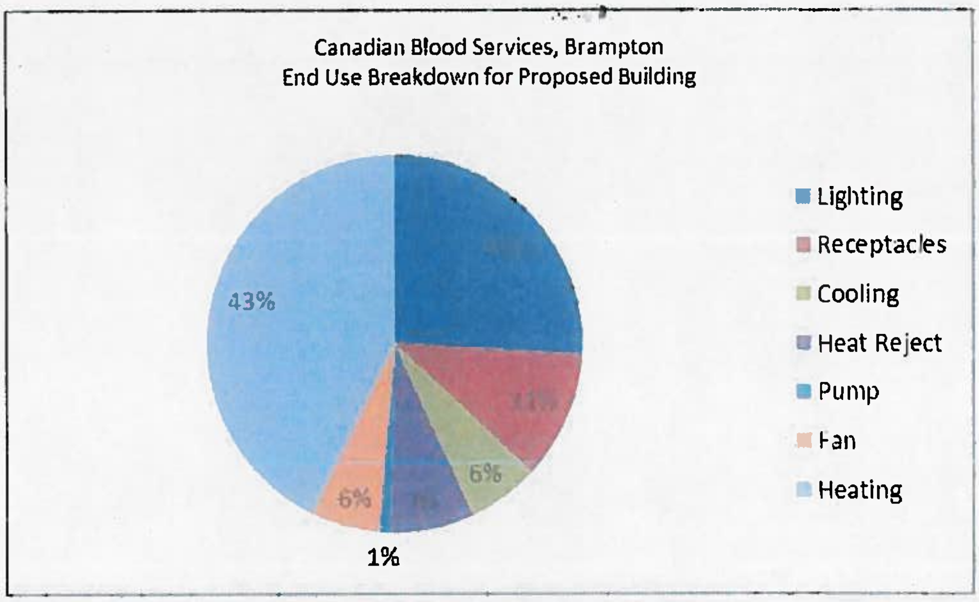

Figure 8 Energy Use Breakdown

It would be beneficial if during the audit process we could have verified actual utility bills to evaluate the validity of the peer reviewed energy simulation data as compared to the actual performance of the building. This would have helped while confirming if the plug loads and scheduling assumptions were valid in the model and also, if commissioning was completed and the building was operating as expected. Unfortunately, the gas bills were collected but due to the unavailability of sub-meter data and the fact that only 48% of the entire facility was modeled using EE4 software tool, the available model could not be calibrated appropriately to compare actual energy performance with the calibrated model output.

As seen from the comparison chart below, the major energy savings were realized from the space heating gas energy (42% energy is saved for space heating as compared to the OBC reference building).

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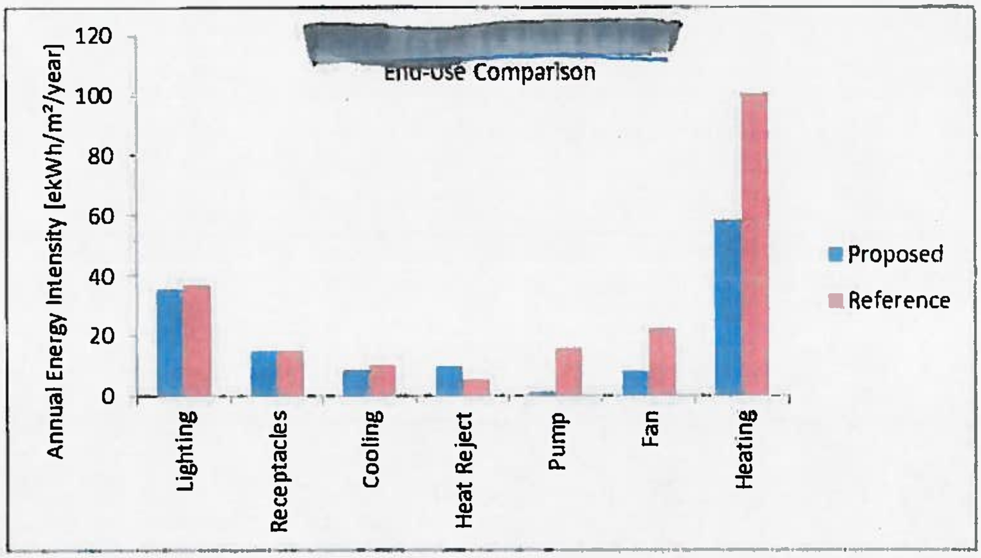

Figure 9 End-Use Comparison

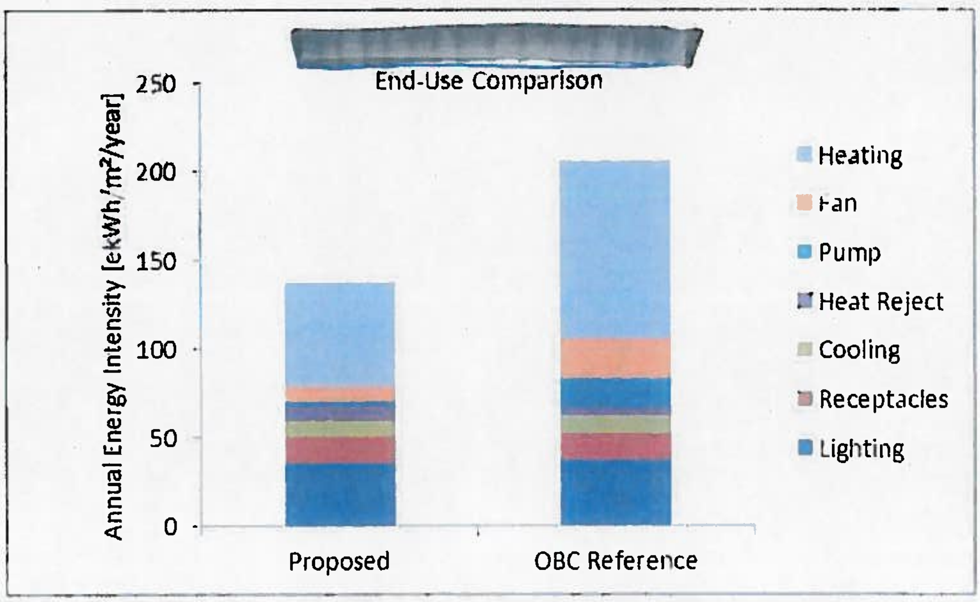

Figure 10 End-Use Comparison

According to the peer-reviewed energy simulation model the anticipated site energy intensity of the proposed building was 137 ekWh/m²/year while the OBC reference base building is at roughly 206 ekWh/m²/year.

For a high performance building the savings reduction percentage and energy intensity benchmark are in line with new construction simulations methodology prescribed by EE4 modeling guideline. Moreover, the energy intensity of the proposed building is approximately

65% lower than that of a typical hospital/office building in Canada, as surveyed by Natural Resources Canada[1].

No adjustments were made on the submitted savings calculation.

3.15 *RA.UNIV.NC.001.12*

Project Information

ESM File #	OPP 1-74083695-01-24-12
Building Type:	College/University
Project Description:	Construction of new [redacted] for a University in Ontario.
Project Details:	Building included a modular chiller unit tied with a ground source heat pump system, energy recovery ventilators on majority of outdoor air units, demand control ventilation in classrooms/lecture halls, enhanced insulation to building envelope and efficient lighting. The 142,871 ft^2, three-storey University building includes numerous classrooms/lecture rooms from 40 to 150 seat capacity, a 500 seat auditorium, a 350 seat auditorium, seminar rooms, computer labs, study space, a food service area and a Technology Resource Centre
Implementation Date:	March 18, 2010 through June 2011
Building occupied:	August 2011

Project Savings Summary

Total Natural Gas and Electricity Savings Summary			
Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas [m³/year]	282,032	282,032	0
Electricity [kWh/year]	399,062	399,062	0
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable

Total natural gas and electricity savings are shared between OPA and EGD using the Environmental Attributes Calculator. The ratios for claiming/sharing energy savings attributed by electricity and natural gas between OPA and EGD are determined as follows:

[1] SURVEY OF COMMERCIAL AND INSTITUTIONAL ENERGY USE – BUILDINGS 2009. Natural Resources Canada

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$$\text{Energy Apportioning Ratio for EGD} = \frac{\text{Natural Gas Energy Saved (ekWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

$$\text{Energy Apportioning Ratio for OPA} = \frac{\text{Electrical Energy Saved (kWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

The shared savings are shown below:

Natural Gas and Electricity Savings Summary Claimed by **Enbridge Gas Distribution**				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	EGD Ratio for Sharing Savings [%]
Natural Gas [m³/year]	248,539.5	248,539.5	0	88.1
Electricity [kWh/year]	351,671.6	351,671.6	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Natural Gas and Electricity Savings Summary Claimed by OPA				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	OPA Ratio for Sharing Savings [%]
Natural Gas [m³/year]	33,492.5	33,492.5	0	11.9
Electricity [kWh/year]	47,390.4	47,390.4	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Energy Efficient Case

The building has the following energy efficient features:

- Efficient lighting system controlled via occupancy sensors (OS) for almost all areas except for stairways. Mechanical/electrical rooms have timers for lighting control (maximum 3 hours).
- Efficient lighting fixtures and ballasts with T8, T5HO and CFL throughout the hallways.
- Double glazed windows with low-e coating. High thermal insulation for walls and roofs. Window to wall ratio is approximately 27%.
- Modular heat pump chiller unit tied to the ground loop. The pipes for the ground loop are installed 550 feet below the soccer field adjacent to the North Building.
- 0.49 effectiveness for energy recovery units serving five air handling units.
- Demand control ventilation in classrooms/lecture halls using CO_2 sensors.

- Low flow plumbing fixtures for water supply in lavatory faucets (1.9 l/min) for toilets and shower head (5.7 l/min).

Savings Calculation Methodology

The savings from the high performance new construction program resulted from the simulation of the new facility using eQUEST 3.64 software, supported as a part of the Energy Design Resources program funded by California utility customers. The eQUEST software front-end is interfaced to the DOE-2 building modeling system developed by the US Department of Energy.

The eQUEST software requires two building models. The baseline/reference building represents a building that meets the minimum energy code of Ontario Building Code (OBC) following the ASHRAE 90.1-1999 modified by supplementary standard SB-10. The proposed building represents how the actual building will perform in theory. This is compliant with the rules and intent of the High Performance New Construction program.

The energy simulation models were peer reviewed by a competent third-party Energy Consultant and adjusted appropriately showing the anticipated savings as mentioned above.

Review Information

The site installation was in general conformance to the project application. The following information was gathered through observation and site survey:

- Incremental cost of energy conservation measures was 2.3% of total project cost.
- The proposed building does not have any natural gas consumption. All space heating is supplied by the heat pump chiller unit tied to the ground source heat pump system. The supplementary back-up natural gas heating system has never been operated since the building was occupied, proving that the GSHP system is adequately sized and designed to meet the heating and cooling load of the building.
- The domestic hot water is heated by steam supplied from the central plant. The DHW system consists of an instantaneous heat exchanger, a storage tank and a DHW recirculation pump. The water temperature set point is 60 °C. The DHW system was modeled as natural gas-fired water heaters in both reference and proposed design with 80% and 70% thermal efficiency respectively. However, the energy savings for DHW is realized due to low flow fixture, where hot water usage is reduced from 8.3 L/min to 1.9 L/min for lavatory faucets.
- The building has some un-regulated electrical process loads in various computer laboratories, AV equipment loads in class rooms/lecture halls and process equipment loads in cafeteria which was not modeled in eQUEST.
- There is a 24 kW solar PV system installed in the building which is part of the FIT program, however, this system has not yet been connected to the grid.
- According to the shop drawings, the heat recovery effectiveness of the heat wheels is 0.48 and according to the architectural drawing, the major wall structure has 6" semi-rigid insulation and 4" rigid insulation between brick veneer and concrete blocks, and the

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roof insulation includes a 6" poly-isocyanurate. All major HVAC pumps and fans in the air handling units are equipped with variable frequency drives.

- The peer reviewed energy model indicated 13% electricity savings, 98% gas energy savings and an overall energy savings of 56% with respect to OBC reference building meeting ASHRAE 90.1 modified by SB-10 as shown below.

Item	Peer-reviewed Energy Model data as found on the final Application		
	Electricity	Gas	Total Energy
Proposed [MBTU]	8,774	197	8,971
Reference [MBTU]	10,136	10,302	20,438
% Savings	13.4%	98.1%	56.1%
Electricity Saved [kWh/yr]	399,164		
Natural Gas Saved [m³/yr]		282,787	

Table 11 Proposed Project Savings

The building does not have any gas consumption except a small amount of gas equivalent energy which is used for domestic hot water heating for which steam is used from the central plant. This equivalent gas energy consumption for DHW is only 2% of the total building energy consumption, therefore the majority of gas savings are contributed by the fuel switchover from the use of ground-source heat pump system in the proposed building.

- The HPNC Program Results Summary Report claimed that the reference/base building was updated to meet the ASHRAE 90.1-1999 requirement using eQUEST energy simulation software.

- The peer reviewed and modified simulation files were not submitted for further review. However, after verification of all submitted reports and documents, we found that the final energy model was modified to reflect the above savings and that the project was in compliance with the rules and intent of the HPNC program.

- A site visit was conducted on March 5, 2013 to verify the following:
  - Installation of the main energy savings equipment of the building.
  - The basic physical and operational characteristics of the building.

- During the site visit, representative from the Facilities Management and Planning department of [redacted] were present.

- Methodology used while verifying the savings:

  The energy simulation methodology was already peer reviewed by a third part energy consulting firm, most of the supporting documents were provided by professional engineers, all available reports and originally submitted eQUEST files were reviewed to verify savings.

A site visit was conducted to confirm equipment installation by examining the screen-shots of the building automation system, nameplates of major HVAC equipment and walking through the building.

Additionally the shop drawings and issued-for-construction drawing set were reviewed to confirm if the modeling inputs were correct.

Discussion

For new construction project, peer-reviewed and modified simulation files were submitted for audit purpose.

The Energy conservation measures are advancement for new construction as compared to the baseline building referred in the OBC.

Incremental cost analysis:

- The incremental cost was shown only for the ground source heat pump system, which is reasonable. However, the incremental cost for heat recovery wheels and envelope upgrades were not mentioned. This additional cost might change the TRC calculation.

Life cycle cost analysis:

- From the modeling report it was observed that approximately 55,800 m³ was saved annually via heat recovery units. For a 15 year life cycle of heat recovery units, the estimated life cycle savings is 837,000 m³/life cycle of Heat Recovery Units.

- The ground source system along with enhanced building envelope has saved approximately 225,000 m³/year and considering a 25 year life cycle span for both systems, the life cycle savings is 5,625,000 m³/life cycle of GSHP and building envelope.

The end-use breakdown of the proposed building indicated comparatively lower energy consumption for space heating i.e., 18% of total building energy. This is reasonable since demand control ventilation, energy recovery ventilators, enhanced thermal insulation of building envelope and the ground source heat pump system contribute to significant space heating energy savings. The HRV, higher thermal resistance of envelope and the internal heat gain from lighting, equipment and people during occupied hours enable the building to not operate the refrigeration units for heating purposes hence lower heating energy as shown in the following figure.

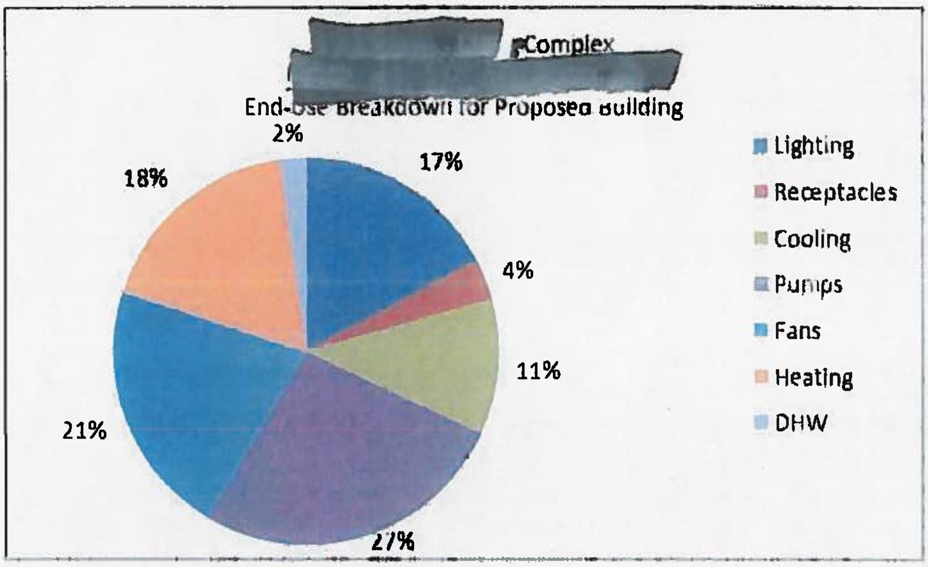

Figure 11 End-Use Breakdown

As seen from the following comparison chart, the major natural gas savings are realized from the space heating gas energy (87% energy is saved for space heating as compared to the OBC reference building). Also, the electrical energy for cooling and HVAC pumps increased for proposed building by 24% and 67% respectively. However, the overall 13% electricity savings was achieved due to 47% electrical energy savings for ventilation fans due to VFD installation on all fans and demand control ventilation in classrooms/lecture halls. Moreover, it was observed that the seasonal COP improvement for heating with the modular chiller tied to the ground-loop for the proposed building was 30% better than that of the reference building modeled as water-loop heat pump system.

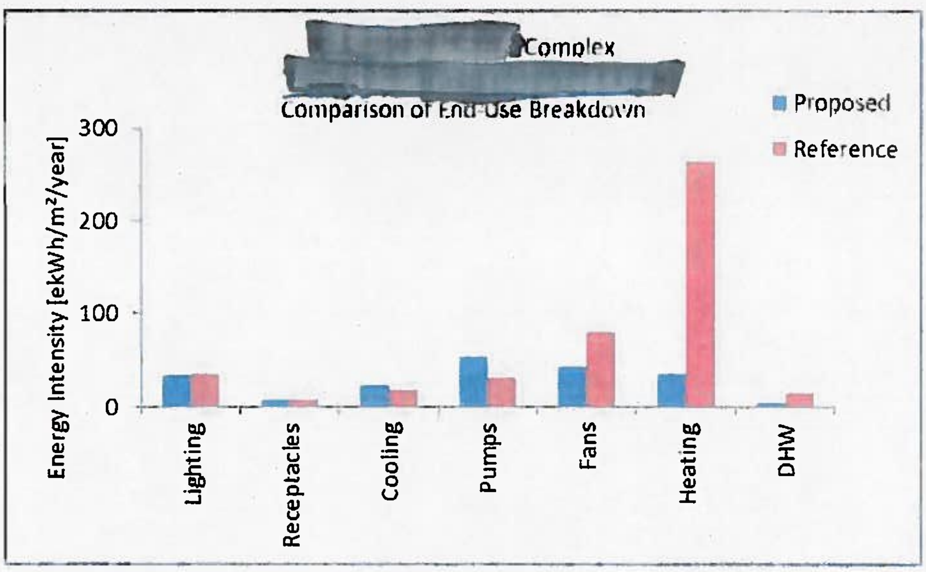

Figure 12 End-Use Breakdown Comparison

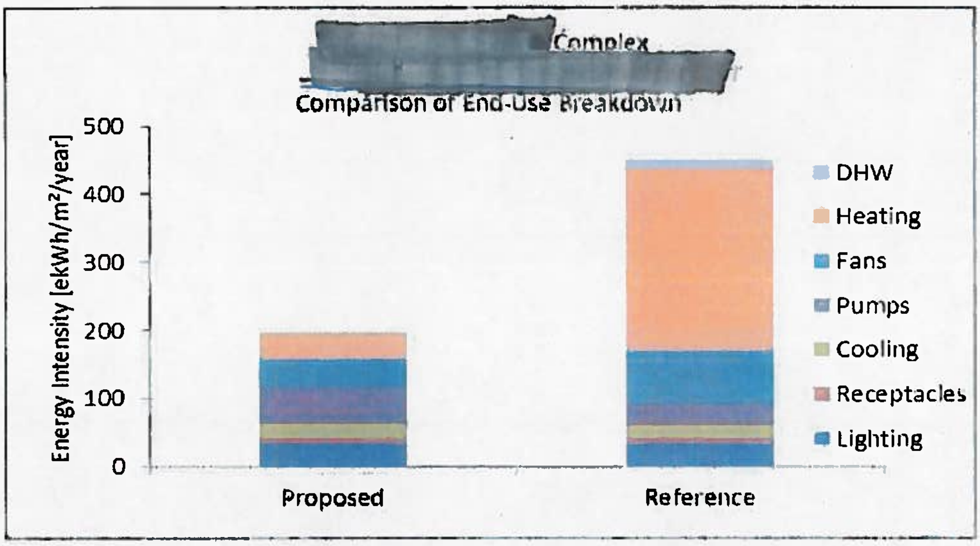

Figure 13 End-Use Breakdown Comparison

According to the available final energy simulation model the anticipated site energy intensity of the proposed building was 198 ekWh/m²/year and the OBC réference building was at 435 ekWh/m²/year. For a high performance building, the savings reduction percentage and energy intensity benchmark are in line with new construction simulations methodology prescribed by the eQUEST modeling guideline. Moreover, the energy intensity of the proposed building is approximately 65% lower than that of a typical University campus building in Canada, as surveyed by Natural Resources Canada[2].

No adjustments were made on the submitted savings calculation.

3.16 *RA.MR.EX.229.12*

Project Information

ECM File #:	OPP-1-75237428-03-26-12
Building Type:	Multi Residential
Project Description:	Addition of VFD to air handling unit
Project Details:	Installation of VFD on air handling unit serving common spaces to reduce the fresh air delivered to the building at specific times of the day.
Implementation Date:	February 2013

[2] Consumption of Energy Survey for Universities, Colleges and Hospitals, 2003. Natural Resources Canada.

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	26,246	20,411	-22.2
Electricity (kWh)	40,445	31,906	-21.1
Water (m^3)	0	0	0

Base Case

The building comes equipped with four (4) Raypak heating boilers (Model E962WTD-N-2P) which supply heating water to the air handling unit (AHU) located in the penthouse mechanical room, fan coils, and glycol snow melting system.

The fresh air to the common spaces is provided by one (1) AHU which is located in the penthouse mechanical room. The AHU comes equipped with a heating/cooling coil which receives its heating/chilled water supply from the heating and chiller plants. The system is switched over from heating to cooling during the shoulder seasons.

Based on interviews with the building operator and sheets provided by EGD it was determined that the AHU was working at 100% fresh air all year long.

Energy Efficient Case

A VFD was installed on the AHU supply fan to modulate the fresh air delivered to the corridors based on a pre-set schedule.

The following schedule was observed during the site visit conducted on February 26th:

Hour	Speed (%)	Frequency (Hz)
7:30 – 9:30	90	54
9:30 – 11:30	70	42
11:30 – 13:30	90	58
13:30 – 16:30	70	42
16:30 – 20:30	90	58
20:30 – 7:30	70	42

Table 12 System Schedule

Savings Calculation Methodology

The provided savings were calculated using the E-Tools software. Gas information from Jan 2009 to Dec 2009 was used to create a weather normalized baseline. The non-seasonal load was determined by averaging out the summer consumption. The weather dependent seasonal load was calculated using HDD and a balance temperature of 18 °C.

The natural gas savings were calculated by multiplying the percentage reduction in fresh air volume for the AHU.

Review Information

Site visits were conducted on February 26th, 2013. MMM took the opportunity to interview the building operator during this time.

The site installation was in general conformance to the project application. The following information was gathered through observation and staff interview:

- The VFD was installed on the AHU.
    - The VFD programming was checked; each VFD has two (2) modes of operation: low speed at 70% and high speed at 90%.
        - The low speed was noted to be different than what was indicated in the application. The speed was recorded at 70% versus 60% as indicated in the application.
- The actual performance of the VFD was checked during various times of the day and the VFDs were running as indicated in the previous table above. There is a slight difference in the schedule that was included in the application and observed on site, however, the duration of peak supply hours and partial supply hours was the same.
- The motor power inputs used in the E-Tools calculation matched the motor nameplate.

Discussion

During the site visit it was observed that the VFD schedule is different than what was indicated in the application. EGD recalculated the saving using E-Tools to reflect the actual schedule in the calculation. The revised savings estimate resulted in a decrease of 22% in natural gas savings and a decrease of 21% in the electricity saving. The revised annual natural gas savings represent 13.8% of the total annual natural gas consumption.

It should be noted that following MMMs site visit, MMM was informed that the VFD retrofit was not fully commissioned at the time of the site visit. Based on this information, the VFD has been commissioned since then, and the schedule has now been updated to match the schedule which was presented in the application.

The project cost includes supplying and installing the VFD and is within the acceptable range.

The life measure savings for the retrofit was calculated based on a 12 year life. Given that this application includes controls that have been added to existing equipment, a 12 year life cycle for this measure appears to be reasonable. MMM recommends decreasing the life measure savings to 244,932 m^3 to better represent the audited savings.

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3.17 *RA.MR.EX.119.12*

Project Information

Project Code:	RA.MR.EX.199.12
Building Type:	Multi Residential
Project Description:	VFD controls on MUA unit and intermittent pumping boiler controls
Project Details:	VFDs were installed on two 11,000 CFM MUA units to control the volume of fresh air. New controls were added to the boilers to shut down the boiler circulation pumps when the boilers are not operating.
Implementation Date:	September 15, 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	55,717	43,957	-21.1
Electricity (kWh)	40,187	47,311	17.7
Water (m^3)	0	0	0

Base Case

The building has three (3) boilers piped in parallel that are staged to sequence on and off with the building heating demand. The boilers serve the heating water and DHW requirements for two towers in the complex. Each boiler is equipped with a 200 GPM circulating pump. The circulating pumps did not have any controls and operated 24/7.

There is one (1) roof top MUA unit in each tower to serve the MUA requirements. The units are equipped with indirect natural gas heating and DX cooling. Each unit supplies 11,000 CFM and operates 24/7.

Energy Efficient Case

A boiler control system has been installed that controls the boiler circulating pumps. The pumps are turned on when there is call for heat and automatically turned off after a set time delay when the boiler cycles off.

VFD controls have been added to the MUA units to vary the supply air volume during non-peak periods of the day.

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Savings Calculation Methodology

Regression analysis was performed on the natural gas utility bills for 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 boilers and MUA units were determined.

The MUA unit manufacturer's data and temperature set point was input into the MUA savings section of E-Tools for the two MUA units. E-Tool uses a thirty (30) year average historical weather data to calculate the gas consumption required to heat outside air to the supply air set point temperature. This was used to separate the seasonal heating load for the MUA from the seasonal heating load for the boilers.

The total annual non-seasonal load for domestic hot water and the portion of the building heating load on the boilers were summed to determine the weather adjusted annual natural gas consumption from the boilers.

Information about the boilers and boiler operation were input into E-Tools to produce an estimated seasonal boiler efficiency, which takes into account the part load of the boilers throughout the heating season. The seasonal boiler efficiency with continuous pumping and intermittent pumping were estimated and used with the total annual boiler natural gas consumption to calculate the savings.

Review Information

MMM met on site with [redacted] to review the installation. The following information was collected during the site visit:

- The new boiler controls were reviewed on site and verified to be operating. At the time of our site visit, only one boiler was required to meet the building load and the circulating pumps for the remaining two boilers were off.
- The make, model and capacity of each boiler was verified
- The supply and return water temperatures for the system were observed to be 160°F supply and 140°F return. We confirmed with [redacted] that these were the existing set-point and that it had not changed.
- We verified that the domestic hot water is supplied from the same boilers providing the building heating. This was accomplished with a hot water tank, circulating pump and a heat exchanger. The circulating pump was controlled on and off to circulate the domestic hot water in the tank through the heat exchanger to maintain the set-point temperature.
- We reviewed the MUA unit on the roof and verified the capacity and heating efficiency from the nameplate data on the unit.
- The VFD control was installed inside the MUA unit and was operating at 48Hz (80%) at the time of our visit. From interviewing [redacted] ey have been programmed to operate at 80% fan speed 24/7. This change from the original application was due to balancing issues. They were not able to properly balance the air supply in the building

when the CFM was reduced to 70%, so they decided to run it at 80% all the time instead of 70% for 16 hours and 90% for 8 hours.

- We verified the temperature set point of the MUA unit in the unit controller. It was programmed to supply 68°F in winter and 72°F in summer.

Discussion

Based on the site conditions observed during our review, we instructed EGD to update the E-Tools calculations with boiler supply and return temperatures at 140°F and 160°F respectively. The lower supply and return temperatures reduced the losses through the boiler and decreased the gas savings for this measure by approximately 50%. This reduction is due to incorrect information being input into the application calculations.

The savings calculation is based on inputting the operating parameters of the boilers and from this information, the seasonal efficiency of the boilers is estimated. The change in the seasonal efficiency from continuous pumping to intermittent pumps was 3%. This is reasonable given the lower supply and return water temperatures.

In addition to the gas savings, this measure also includes electrical savings from the circulating pumps. Each boiler was equipped with a 200 GPM, 25 ft head pressure pump which will use approximately 1.5kW to operate. We estimated the savings to be approximately 13,000 kWh per year.

For the MUA savings, the new operating conditions observed on site were input into the E-Tools calculation. Operating at 80% volume 24/7 instead of 70% for 16 hours and 90% for 8 hours decreased the natural gas savings, however, the increase in supply air temperature increased the natural gas savings so that the overall change in natural gas savings was minimal.

Overall, due to the lower boiler operating temperature, the audited natural gas savings have been adjusted 21% lower than in the original application savings and due to additional electrical savings from the boiler circulating pumps, the audited electrical savings have been increased by 17%. The audited gas savings of 43,957 m^3 represents a 11.5% decrease in annual natural gas consumption.

Please note that verification of savings through a post implementation utility analysis was investigated, however, there was not sufficient actual data to draw an accurate conclusion. A CUSUM analysis was performed by EGD, however, due to the limited data there were only two points calculated. The points indicate that there is a reduction in natural gas consumption.

The total reported project cost of $17,160.00 appears reasonable for the scope of work that was required for this retrofit.

The life cycle analysis for each measure was calculated based on a 12 year life. Given that this application includes controls that have been added to existing equipment, a 12 year life cycle for these measures is reasonable.

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3.18 *RA.MR.EX.237.12*

Project Information

Project Code:	RA.MR.EX.237.12
Building Type:	Multi Residential
Project Description:	Parking garage ventilation upgrades
Project Details:	CO monitoring system to control parking garage exhaust fans and control dampers on fresh air intakes.
Implementation Date:	November 27, 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	52,343	52,343	0
Electricity (kWh)	43,566	43,566	0
Water (m^3)	0	0	0

Base Case

The parking garage had six (6) exhaust fans that operated 24/7 and two (2) fresh air intake openings that were open all the time and had no dampers. The parking garage was heated with hydronic unit heaters installed throughout the parking garage. From observations on site, four (4) hydronic unit heaters were at various stages of partial operation and as result only two (2) were fully operational. Each unit heater is controlled by individual thermostats that were set to max temperature to cause the unit heaters to operate 24/7 to put as much heat as possible into the garage. There were no backdraft dampers on the exhaust fans. An unheated parking garage for the neighbouring building is connected to this building's parking garage. The hot water supply temperature to the unit heaters was 180°F.

Energy Efficient Case

Eight (8) CO monitoring sensors have been installed throughout the parking garage and are interlocked with the exhaust fans to only run when the CO levels exceed 30 PPM. New back draft dampers have been installed on the exhaust fans to prevent air from entering the garage when the exhaust fans are off. Control dampers have been added to the intake louvers and have been interlocked with the exhaust fans to only open when the exhaust fans are operating. An air curtain has been added at the opening to the neighbouring unheated garage to stop heated air from transferring into the unheated garage. It was brought to our attention after our site visit that new control valves have been added to the heating water system to bring the supply temperature down from 180°F to 140°F.

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Savings Calculation Methodology

The application savings calculations used the E-Tools MUA calculation tool to estimate the gas savings. It was assumed that the air drawn into the parking garage by the exhaust fans would be heated to 40°F before being exhausted outside. The seasonal efficiency of the boiler and heating system was estimated by the E-Tools seasonal efficiency tool to be 55.8%. This efficiency is low, but is reasonable given that the heating water piping inside the garage is not insulated. It was assumed that with the new CO controls, the exhaust fans will operate 8 hours per day instead of 24/7. Using this method, the savings were estimated to be 52,343m^3 of natural gas.

Review Information

We met on site with the onsite building operator, and observed the following during our visit:

- The new CO monitoring sensors were installed. Three (3) of the exhaust fans were off at the time of our visit and three (3) of the exhaust fans were operating. They were making some repairs to the exhaust fans at the time.
- The unit heaters were inspected and tested. All had thermostats that were set to max temperature and the following was noted:
    - Two (2) unit heaters were operating with heat and fan supplying heat into the space
    - Two (2) unit heaters had heat being supplied to them, but the fan was not operational, despite the thermostat set-point calling for heat
    - One (1) unit heater had the fan operating, but there was no heating water being supplied to the unit heater
    - One (1) unit heater had no heating water supplied to it and the fan was not operational.
- The control dampers on the air intake louvers were confirmed to be installed and were closed at the time of our visit. Given that all the louvers were closed, we believe that the three (3) exhaust fans that were operating at the time were due to the repairs being carried out.
- The backdraft dampers were confirmed to be installed on the exhaust fans.
- We noted that there was no insulation on the ceiling of the parking garage.
- According to the thermostats, the temperature inside the parking garage was approximately 60°F at the time of our visit.
- The CO monitoring sensors were all reading between 5 and 10 PPM.
- The neighbouring building parking garage is also connected to the parking garage for [redacted] and the neighbouring parking garage is not heated. A new air

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curtain has been installed at the opening between the two garages to mitigate heat transfer between the parking garages.

- According to information received from the applicant after our site visit, there have been control valves added to the parking garage heating loop to reduce the heating loop temperature to 140°F instead of 180°F. MMM was not made aware of this at the time of our site visit and therefore did not verify this on site.

Discussion

The applicant used the E-Tools MUA calculator to estimate the savings. We reviewed the inputs, and have the following comments:

- This calculation assumes the unit heaters inside the garage are capable of heating the outdoor air from design day temperature up to 40°F. Based on 30,000 CFM and a design day temperature of 0°F, the energy required to heat the outdoor air to 40°F is 1,300,000 Btu/hr. Since there were six unit heaters installed, this equals a capacity for each unit heater of 217,000 Btu/hr. We were not able to confirm the capacity of the unit heaters on site, but based on the dimensional size of the unit heaters and a supply water temperature of 180°F to the unit heaters, this is reasonable.

- This calculation assumes the unit heaters are operated in a reasonable fashion with all unit heaters maintained and operating at a reasonable temperature set point of 40°F or 50°F.

- The calculation assumes that on average, with the new CO monitoring system installed, the exhaust fans will operate 8 hours per day to keep the CO levels below the set point of 30 PPM. Based on our engineering calculations and experience, and considering this is a residential underground parking garage where most vehicles will be small cars and will not idle for long periods of time inside the garage, this is a conservative assumption for operating hours.

- The calculation assumes the heating system efficiency to the unit heaters is 55.8%, which is low for a typical hydronic heating system, but may not be unreasonable considering the age of the boiler system.

The intent of this project was to attain energy savings through multiple changes in the parking garage that significantly reduce the heat loss from the garage and the amount of cold outdoor air that is introduced into the garage. From our site visit, all the intended upgrades have been completed and therefore the anticipated electrical and natural gas savings should be achievable.

However, the natural gas savings is tied into the source of the heating for the garage which is the unit heaters. The operation of the unit heaters has been compromised due to the incorrect set points of the thermostats and poor maintenance of the unit heaters and this called into question the validity of the natural gas savings.

We analyzed the current situation and even with the unit heaters set to an unrealistic temperature set point that causes them to operate 24/7, the energy efficiency measures that have been implements will still contribute to natural gas savings. The change in the water supply temperature to the unit heaters from 180°F to 140°F will reduce the heat output from the unit heaters by approximately 30% and the increased temperature in the parking garage will reduce the heat losses from other parts of the building into the parking garage.

After reviewing all factors, based on our engineering calculations and judgment, we believe the original application savings are still reasonable even though the heating system is not being operated as per the original intent.

CUSUM analysis was performed on the two utility bills for December 2012 and January 2013 to verify the savings. With only two months of post-retrofit data, this analysis can only be used to indicate the general trend. When comparing the actual consumption in the two months to the predicted baseline consumption, there is approximately 23% savings in the first two months. If this is applied to the total annual baseline consumption, the indication is a savings of over 200,000 m^3 of natural gas.

There was a second application filed with EGD for gas savings at this site for boiler control upgrades and MUA unit upgrades which had a total savings of approximately 150,000m^3 of natural gas. The savings for this project have not been reviewed and have not been verified by MMM. When combined with the 52,343 m^3 of natural gas savings predicted for this application, the trend is showing that the combined predicted savings are being realized.

We have reviewed the life time savings based on 12 years of operation. This is reasonable based on this being majority controls additions to existing equipment.

The implementation cost is reasonable for the scope of work required.

3.19 *RA.LOG.EX.002.12*

Project Information

ESM File #	OPP-620262-01-09-09
Building Type:	Warehouse
Project Description:	Installation of de-stratification fans in warehouse areas to reduce heat loss through the roof and to improve heating system performance.
Project Details:	The building is a single-story facility serving as an open warehouse and distribution centre; with slab on grade floor; and, office areas comprising approximately 10% of total floor space. The floor space of the north section is 30,600 m^2, and the floor space of the south section is 59,200 m^2; both sections are attached by a dividing wall. Heating to the open warehouse is provided by 76 overhead hanging gas-fired unit heaters, located along the perimeter of the building and along the dividing wall; no mechanical ventilation serves the warehouse. Heating, cooling and mechanical ventilation to the office areas are provided by 8 packaged roof-top units with gas-fired heating and DX

cooling.

Twenty (20) propeller fans were installed near the underside of the roof structure to transfer the warm air to the lower working areas during the heating season, and to increase the circulation of air during the cooling season; ultimately to create a uniform space temperature from floor to ceiling.

Implementation Date: March 9, 2012

Project Savings Summary

Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas (m^3)	215, 256	477,904	122
Electricity (kWh)	-55,665	-55,665	0
Water (m^3)	0	0	0

Base Case

The base case is without de-stratification fans. The ceiling to floor height is 32 feet. Unit heaters are installed at approximately 27ft above the floor. Due to high ceilings and stratification of air, the unit heaters have to work harder to maintain the temperature that will satisfy the thermostat set-point which is installed at a height of 5 ft above the finished floor. Stratified air causes a larger delta-T across the roof deck, increasing the rate of heat loss through the envelope.

The applicant recorded a temperature difference from floor to ceiling of approximately 14°F; thermostat to ceiling of approximately 12 °F. The base case temperature distribution was recorded as follows:

- At floor level = 70.0 °F;
- At thermostat level = 72.0 °F;
- At mid-height level = 80.6 °F; and,
- At ceiling level = 84.2 °F.

Energy Efficient Case

Twenty (20) de-stratification fans were installed in the warehouse that operate continuously at 15% speed during the heating season and at 75% speed during the cooling season; the seasonal switch over is automatic. The de-stratification fans thoroughly mix or de-stratify the air, and therefore minimize the temperature differential across the roof-deck.

Savings Calculation Methodology

The applicant used E-Tools to calculate the de-stratification energy savings. Using this method, the normalized natural annual gas savings were estimated to be 215,256 m^3.

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Review Information

A site audit was conducted on March 6, 2013, at [redacted] Ontario. The audit was conducted in the presence of site personnel and with the supplier of the de-stratification fans. The following observations were made during this site visit:

- The de-stratification fans were observed to be operating at low speed. Each fan was equipped with one 2 HP electric motor.
- The average temperature profile was measured as follows: thermostat height temperature was 72.5 °F, mid-height temperature was 72.9 °F, and ceiling height temperature was 74.3 °F; therefore, the temperature differential reduced from 12 °F to 2 °F.
- Set points for rooftop units were set between 71.0 °F and 73.0 °F ; and, 72.0 °F for unit heaters; except unit heaters serving overhanging doors which were set to 68.0 °F.
- Site personnel indicate that no modifications were made to any part of the building or HVAC equipment during or post implementation of the de-stratification fans; occupancy averaged between 450 and 650 personnel with 24-hour occupancy during the week day, and 8-hours of occupancy on each weekend day.

Discussion

The savings calculation method used by the applicant using E-Tools was reviewed, and gas bill data were analyzed. The following are comments:

Energy conservation measure implementation date was July 21, 2010; implementation completion date was March 22, 2012.

Utility bill data during the period of March 23, 2012 through February 21, 2013 was analyzed; a cumulative sum analysis indicated a normalized natural gas savings of 477,904 m^3 per year; in contrast, the ESC application estimated normalized gas savings of 215,256 m^3 per year; bill data reported savings that were 122% greater than estimated.

Simple calculations were performed and the building's original design air-changes-per-hour was calculated at 0.76 ACH; in contrast, the value used in the E-Tools application was 0.2 ACH, effectively underestimating normalized savings.

Insulation R values are likely closer to R-15 and R-14 for ceilings and walls respectively for this facility; in contrast, R-20 and R-19 for ceilings and walls respectively were reported on the E-Tools application, effectively underestimating normalized savings.

Finally, set points for unit heater thermostats remained at 72 °F, unchanged from the pre-implementation setting; in contrast, the E-Tools application applied a post-implementation thermostat reduction factor of 2 °F, allowing for reduced heat loss by lowering of space temperature, effectively increasing the estimated normalized savings.

Based on the CUSUM analysis we recommend increasing the savings for his retrofit to 477,904 m^3 of natural gas annually. The audited gas savings of represents a 34.8% decrease in annual natural gas consumption.

The total reported project cost of $263,330 appears reasonable for the scope of work that was required for this retrofit.

The life cycle analysis for each measure was calculated based on a 13.2 year life expectancy, we cannot comment on this figure since the measure life assumptions do not include de-stratification fans. In light of the adjustment in annual savings, we recommend increasing the life measure savings to 6,308,333 m^3 over a 13.2 year life cycle.

The electricity deduction was reviewed and is deemed reasonable given the reported operating parameters for the fans.

3.20 *RA.HC.NC.001.12*

Project Information

ESM File #	OPP 365179-24-11-06
Building Type:	Healthcare
Project Description:	Construction of new hospital [redacted]
Project Details:	Building included condensing boilers, heat recovery ventilators on majority of outdoor air units, heat recovery chiller and improvements to building envelope and lighting. This hospital is a replacement facility for the [redacted]. It has [redacted] beds of which [redacted] of the rooms are single patient rooms. The hospital has an Emergency Department and Urgent Care Centre (ambulatory services). The hospital will also provide radiation cancer care and therapy, cardiac catheterization and longer-term mental health. It will be the kidney care hub for dialysis patients. It also has surgical services, and supports women, babies and children's health. The 969,687 ft^2 hospital building comprises [redacted] floors, a large exterior parking area and .
Implementation Date:	3 December 2012
Substantial Completion:	26 November 2012
Building occupied:	24 March 2013

Project Savings Summary

Total Natural Gas and Electricity Savings Summary			
Utility	Claimed Savings	Audited Savings	Adjustment (%)
Natural Gas [m³/year]	2,524,708	2,524,708	0
Electricity [kWh/year]	5,278,787	5,278,787	0
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable

Total natural gas and electricity savings are shared between OPA and EGD using the Environmental Attributes Calculator. The ratios for claiming/sharing energy savings attributed by electricity and natural gas between OPA and EGD are determined as follows:

$$\text{Energy Apportioning Ratio for EGD} = \frac{\text{Natural Gas Energy Saved (ekWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

$$\text{Energy Apportioning Ratio for OPA} = \frac{\text{Electrical Energy Saved (kWh)}}{\text{Electrical Energy Saved (kWh)} + \text{Natural Gas Energy Saved (ekWh)}}$$

The shared savings are shown below:

Natural Gas and Electricity Savings Summary Claimed by **Enbridge Gas Distribution**				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	EGD Ratio for Sharing Savings [%]
Natural Gas [m³/year]	2,105,452.2	2,105,452.2	0	83.4
Electricity [kWh/year]	4,402,185.8	4,402,185.8	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Natural Gas and Electricity Savings Summary Claimed by OPA				
Utility	Claimed Savings	Audited Savings	Adjustment (%)	OPA Ratio for Sharing Savings [%]
Natural Gas [m³/year]	419,255.8	419,255.8	0	16.6
Electricity [kWh/year]	876,601.2	876,601.2	0	
Water [m³/year]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Energy Efficient Case

The building has the following energy efficient features:

- Efficient lighting system controlled via Douglas Lighting Controls with occupancy sensors (OS).
- High efficiency lighting fixtures and ballasts with T5's and T8.
- Variable speed drive motors for all supply air, return air, exhaust air fans, heat wheels in air handling units and heat recovery units, hot water, chilled water and condenser water pumps.
- Double glazed windows with low-e coating. High thermal insulation for walls and roofs. Window to wall ratio is approximately 17%.
- Heat recovery chiller
- 85% efficiency for near-condensing boilers for space heating
- 85% efficiency for steam boilers with flue gas heat recovery for domestic hot water, humidification and sterilization.
- 0.79 effectiveness for heat recovery units.

Low flow plumbing fixtures for water supply in lavatory faucets (1.9 l/min) for washrooms and shower head (5.7 l/min) for bathrooms.

Savings Calculation Methodology

The savings from the HPNC program resulted from the simulation of the new facility using eQUEST 3.64 software, supported as a part of the Energy Design Resources program funded by California utility customers. The eQUEST software front-end is interfaced to the DOE-2 building modeling system developed by the US Department of Energy.

The eQUEST software requires two building models. The baseline/reference building represents a building that meets the minimum energy code of Ontario Building Code (OBC-2006) following the MNECB compliance supplemental, modified by supplementary standard SB-10. The proposed building represents how the actual building will perform in theory. This is compliant with the rules and intent of HPNC program.

The energy simulation models were peer reviewed by a competent third-party Energy Consultant and adjusted appropriately showing the anticipated savings as mentioned above.

Review Information

The site installation was in general conformance to the project application. The following information was gathered through observation and site survey:

- Incremental cost of overall energy conservation measures was 0.25% of total project cost.

- The total gas consumption of the building is 47% of total building energy which seems reasonable for a complex hospital building in Ontario.

- The building has many un-regulated electrical process loads in the building which are not modeled in eQUEST. (Such as AV/security/nurse call center equipment, elevators, parking area lighting, medical equipment, gas usage for sterilization and other process use, gas use for kitchen. Cafeteria, IT equipment and cooling for data center, laboratory equipment, loading dock etc.)

- According to the shop drawings heat recovery effectiveness of the heat wheels is 0.79 and according to the architectural drawing, the major wall structure has 6" semi-rigid insulation and 4" rigid insulation between brick veneer and concrete blocks, and the roof insulation includes 5" poly-isocyanurate. All major HVAC pumps, fans and heat wheels in the air handling units are equipped with variable frequency drives.

- The peer reviewed energy model indicated a 19% electricity savings, 57% gas energy savings and an overall energy savings of 43% with respect to the OBC reference building.

Item	Electricity	Gas	Total Energy	% Gas saved as compared to the Annual Gas Consumption.
Proposed [MBTU]	75,547	68,893	144,440	131%
Reference [MBTU]	93,563	159,347	252,910	
% Savings	19%	57%	43%	
Electricity Saved [kWh/yr]	5,278,787			
Natural Gas Saved [m³/yr]		2,524,708		

Table 13 Modeled Savings

- The HPNC Program Results Summary Report claimed that the reference/base building was updated to meet the MNECB requirement using eQUEST energy simulation software.

- The peer reviewed and modified simulation files were submitted for further review. After verification of all the reports and documents, we found that the final energy model was modified to reflect the above savings and the project was in compliance with the rules and intent of the HPNC program.

- A site visit was conducted on March 7, 2013 to verify the following:
    - Installation of the main energy savings equipment of the building.
    - Basic physical and operational characteristics of the building.

- During the site visit, representatives from [redacted] and Facilities Department [redacted] were interviewed.

- Methodology used while verifying the savings:

The energy simulation methodology was already peer reviewed by a third party energy consulting firm, most of the supporting documents were provided by professional engineers, all available reports and originally submitted eQUEST files were reviewed to verify savings.

A site visit was conducted to confirm equipment installation by examining the screen-shots of the building automation system, nameplates of major HVAC equipment and a walk through the building.

Additionally the shop drawings and issued-for-construction drawing set were reviewed to confirm if the modeling inputs were correct.

Discussion

For new construction project, peer-reviewed and modified simulation files were submitted for audit purpose.

The Energy conservation measures are advancement for new construction as compared to the baseline building referred in the OBC.

Incremental cost analysis:

- The total incremental cost was reported as $1,914,000 for the major energy conservation measures which seems reasonable.

Life cycle cost analysis:

- From the eQUEST modeling report it was observed that approximately 1.6 million m^3 natural gas will be saved annually via heat recovery units. For a 15 year life cycle of heat recovery units, the estimated life cycle savings is roughly 24 million m^3. Annual gas savings via heat recovery units constituted approximately 60% of total gas savings.
- The eQUSET model indicated that the heat recovery chiller was modelled with a COP of 5 that enabled energy saving of 6% of total building's gas consumption leading to an annual savings of 110,000 m^3. This heat recovery chiller contributed 6% of total gas saved. Considering 15 years lifecycle, the life cycle savings will be $500,000 annually.
- The enhanced building envelope and the near-condensing boilers have saved approximately 540,000 m^3/year and considering a 25 year life cycle span for both the systems, the life cycle savings is approximately 13,500,000 m^3.

The three (3) steam boilers having a rated thermal efficiency of 85% and are equipped with flue gas heat recovery. The steam is used for heating domestic hot water, humidification and sterilization. Sterilization steam was not modeled since it is a non-regulated process load.

Eleven (11) AHUs for supplying 100% fresh air have their own heat recovery wheels, twenty-three (23) AHUs are fed outdoor air from the main five (5) heat recovery units and only the remaining six (6) AHUs serving autopsy, material management/waste, basement shops, CSR, food services do not have any heat recovery units. From the BAS screenshots the heat wheel effectiveness was calculated as shown in Appendix B. The lower than rated effectiveness indicates that the building is not commissioned properly yet, the rated outdoor air volume flow

SEC Interrogatory #4

#	EGD reported annual gas savings	Measure life	Lifetime Savings (CCM)	Technical Parameters	Verifier adjusted annual gas savings	Measure life	Adjusted Lifetime Savings (CCM)	Technical Parameters	Auditor adjusted annual gas savings	Measure life	Adjusted Lifetime Savings (CCM)	Technical Parameters		CCM Difference from Claimed Amount to Audited Amount
	Original Assumptions in the Application				Assumptions used by Verifier				Final Assumptions approved by auditor				Process for each change	CCM Impact
	m3	yrs	m3		m3	yrs	m3		m3	years	m3			m3
1	438,494	25	8,112,145	Base case OBC 2006, Building simulation model	438,494	25	8,112,145	Model Verified accepted	438,494	25	8,112,145	Agree with Verifier		0
2	360,971	25	6,677,954	Base case OBC 2006, Building simulation model	360,971	25	6,677,954	Model Verified accepted	360,971	25	6,677,954	Agree with Verifier		0
3	291,503	15	3,847,840	Energy savings was calculated using a CUSUM approach, comparing energy consumption before and after the energy efficiency	264,012	15	3,484,958	CUSUM Analysis used to verify savings, actual data available for analysis	264,012	15	3,484,958	Agree with Verifier		-362,882
				measure. Calculated savings values were also check using a ventilation calculation method. Multiple Fresh air ventilator										0
				were adjusted totalling 565,070 cfm of fresh air, initially runing 24/7, at a delivery temperature of 67 F										0
				The saving measure is to reduce the operating time of these ventilators a schedule was provided and results in approximately										0
				16.5 hrs run time, approximately 22.5% of the air circulated is fresh air, the steam system efficiency was used for Enwave										0
				The calculated savings closely matched the actual savings statistical values										0
														0
4	137,346	25	3,021,612	Consulting Engineers assessment of 50% Condensate heat recovery	125,596	25	2,763,112	Bin analysis, Heating degree day temperature -20 C, Balance Temperature 18 C,	125,596	15	1,657,867	Agreed with energy savings from Verifier	With the new measur description the measure life was changed to 15 years	-1,363,745
				Condensate supply 200 F and return 120 F				space temperature 22C, MUA Supply air temperature 29.4C,				Disagree with description of measure, request this be identified as "heat exchanger"	The result was a reduction in CCM, no reduction for annual gas saved	0
				Actual steam consumption averaged (no summer months, 95% condensate return)				Condensate pump 70 GPM, heating water flow rate 130 gpm, Supply fan				Heat exchanger accepted measure life is 15 years	EGD argument, was that this was a non-presurized steam condensate drain heating city water	0
				70 GPM condensate pump				Flow 32800 l/s, % outdoor air, Normalized annual steam consumption 78,509,188 lbs/year,					entering the building, the same as drain water heat exchangers	0
								Building base load steam consumption 946 lbs/hr,						0
								peak building steam usage at design temperature 24,616 lbs/hr,						0
								Condensate supply temperature 164 F, Heating water supply temperature 140F,						0
								Heat exchanger approach temperature 7 F, building heating efficiency 95%, steam plant efficiency 70%						0
5	106,587	25	2,344,914	Existing baseline gas consumption based on 12 months consumption ending september 2009,	73,797	25	1,623,534	Annual consumption was calculated based on 4 years of data,	73,797	25	1,623,534	Agree with Verifier	They believe the one year data selected for the eTool run did not reflect a normal year data.	-721,380
				eTools used to estimate seasonal boiler efficiency and calculate savings with approved base case;				Seasonal and non-seasonal load statistically generated,					They identified that the new system boiler temperature reset was not activated and based on	0
				existing boiler ; system features, Atmospheric boiler, continuous circulation, no flue damping,				Existing boiler seasonal efficiency estimated 65%, New system seasonal efficiency estimated					conversation with the building owner they believe there was never a DHW mixing valve these	0
				1.3 oversize ratio, design supply water temperature 180F, Return water temperature 160 F,				as 81% seasonal, and 91% non-seasonal.					two issues were incorrectly represented in the eTools run.	0
				No boiler reset control, no air fuel control, no purge cycles;										0
				base case 80.5 thermal efficiency, with traditional boiler reset controls (all other feature same as existing)										0
				New boiler										0
6	65,384	25	1,307,680	Baseline gas consumption based on 2011 actual consumption, eTools used to estimate boiler system seasonal efficiency,	45,367	25	907,340	Boiler efficiency was estimated from ASHRAE document that used 10 % excess air wheras	45,367	25	907,340	Agree with Verifier		-400,340
				existing boilers atmospheric, accounted for, supply water peak desing 180 F, return 160 F,				this viessman product has 2% to 3 % excess air, bin analysis was then used.						0
				Traditional boiler reset temperature control, no air fuel mix control, no purge cycle, DHW supply water temp 150 F,										0
				return 130 F, Old temperature control, no insulation on storage tank; Base case boilers separate,										0
				80.5 % thermal efficieny, all other features same as existing; New combined boiler system, boiler system features,										0
				Intermittent pumping, flue control burner fan, air fuel control modulating, boiler reset										0
				Viesseman computer controlled, pre and post combustion purge control,										0
				new storage tanks with good insulation, boiler new temperature set point 160 F										0
7	50,688	15	669,082	Installation of new fresh air dampers and control system was assumed to	52,648	15	694,954	Actual gas consumptions was used to confirm saving using statistical analysis	52,648	15	694,954	Agree with Verifier	Statistical analysis was used to verify savings because there was no other way to validate	25,872
				have reduced the fresh air on time from 12 hr a day to 10 hrs a day									the original assumption.	0
8	29,434	15	353,208	Base year energy consumption 2011, DHW Boilers Atmospheric 73% Thermal efficiency, Continuous pumping, no flue damping,	29,434	15	353,208	Agree with EGD data. Field verified installation complete, and operating as proposed	29,434	15	353,208	Agree with Verifier		0
				140 F supply temp, 120 F return, Old controls, no Air fuel mix control, No purge cycle, good insulation on tank.										0
				17000 cfm MUA unit, 65F delivery temp, running 24 hrs.										0
				New system, DHW control changed to Intermittent pumping, VFD installed on MUA and Schedule changed,										0
				8 hrs at 90% air flow, remainder at 70%, target temperature 65 F										0
9	22,706	15	272,472	base year data 2009, assumed MUA airflow 1000 cfm running 24/7 air set temperature 65 F at 80% efficiency;	20,752	15	249,024	Base year data accepted, Base ventilation rate accepted, New system ventilation rate 11050 cfm,	20,752	15	249,024	Agree with Verifier		-23,448
				New VFD system scheduled to vary speed, 8 hr at 80%, and remainder at 60%. Electric space heating				scheduled to run at 72.5% 100% of heating operation						0
10	22,423	15	269,074	Base year gas consumption 2011, Building has DHW and Space heating only, energy saved for reflective panels	22,423	15	269,074	Agree with EGD base year, and Verified installation of product and boiler setting	22,423	15	269,074			0
				based on space heating portion of projected energy use, Boiler supply water temperature lowered										0
11	13,609	15	163,308	NO DHW, Base Gas consuption calculated on MUA operating 24/7, 6000 cfm, set temperature 65 F, 80% efficiency	11,822	15	141,864	Agree with EGD Base case, New system shut down at night running 18 hr, set temperature 65 F	11,822	15	141,864	Agree with Verifier	schedule difference was found during site visit	-21,444
				New system, running on timer running 16 hrs per day, set temperature 68 F									EGD Schedule provided by customer	0
12	283,734	25	5,249,082	Base case OBC 2006, Building simulation model	283,734	25	5,249,082		283,734	25	5,249,082			0
13	275,395	25	5,094,808	Base case OBC 2006, Building simulation model	275,395	25	5,094,808		275,395	25	5,094,808			0
14	39,428	15	473,136	Base consuption data from 2011, MUA unit 20400 CFM, 68 F set temperature, 80% efficiency, 24/7 operation	40,030	15	480,360	Agree with EGD base case, Schedule 8 hr at 60%, 2 hrs at 100%, remainder at 80%, set temperature 68F	40,030	15	480,360	Agree with verifier	Schedule difference found during site visit	7,224
				New system, VFD installed, schedule 6 hrs at 100%, 6 hrs at 60%, 12 hrs 70%									EGD Schedule provided by customer	0
15	248,539	25	4,597,972	Base case OBC 2006, Building simulation model	248,539	25	4,597,972		248,539	25	4,597,972			0
16	68,150	15	899,580	Base year gas consumption 2011, Ventilation system 50000 cfm, set temperature 68 F, running 12 hrs a day 7 days	69,104	15	912,173	Agreed that savings was possible, equipment delivered but not completely installed and commissioned	68,150	14.5	869,594	The work had been completed by May 27 2013, therefore the savings was reinstated	two site visits held by Verifier, althougth equipment delivered and installed it was not commissioned	-29,986
				Designer of system identified 20% reduction in fresh air, savings calculated as difference of 100% air and 80%				Reduction stated due to incomplete nature of system during site review				with a reduced measure life resulting from the delay startup.	and therefore they claimed they could not verify the operational characteristics to support energy savings	0
				over evening hours (14 hr) ventilation set temperature reduced to 65 F									calculation. The system was commissioned in May and the auditor reinstated the savings	0
17	55,717	15	668,604	Base year gas data 2011, DHW from space ehating boiler, 3 atmospheric boilers, 73 % thermal efficiency,	43,957	15	527,484	Agreed with base year, boiler operating features updated to supply 160 F return 140 F	43,957	15	527,484	Agreed with Verifier	Site visit indicated differences from EGD assumptions. These were accepted and eTools calculator	-141,120
				Continuous pumping, no Flue damping, no adjustment for Oversizing, 180 F set supply temperature, 160 F return				Ventilation schedule changed to 80% 24/7					rerun to establish savings in boiler and MUA	0
				traditional boiler reset control, staged air fuel control, no combustion purge,				Confirmed all other aspects of EGD evaluation						0
				New boiler operation same as above, but with new Intermittent circulation pump control										0
				MUA, 22000 cfm, set temperature 65 F, 80% Efficiency, 24/7 operation										0
				VFD installed allowing schedule, new schedule 8 hrs at 90% air flow, remainder at 70% ar flow, set temperature 65F										0
18	26,246	15	314,976	Base year gas data 2009, 8800 cfm MUA, 68 F set temperature, 24/7 operation,	20,411	15	244,932	Agreed with base year, and all other assumptions, Schedule changed to 8 hrs at 90% air flow,	20,411	15	244,932	Agreed with Verifier	site visit indicated differences in EGD identifed schedule, new values were updated in eTools and accepted	-70,044
				heated from boiler seasonal efficiency 61.4%				Remainder 70% airflow.						0
				New schedule, 8 hrs at 90% air flow, remainder at 60% airflow, 68 F set temperature										0

SEC Interrogatory #4														
	Original Assumptions in the Application				Assumptions used by Verifier				Final Assumptions approved by auditor				Process for each change	CCM Impact
19	52,343	15	628,116	Base year gas consumption 2011, Garage Ventilation 30,000 cfm, estimated garage temperature 40 F, 24/7 operation	52,343	15	628,116	Agreed on base year consumption, Verified that CO sensors were installed and connected to the exhaust	52,343	15	628,116	Agreed with Verifier	Energy savings calculation proved to be very difficult so savings was verified from actual	0
				new schedule estimated to run 8 hr, heat provided from old central boiler seasonal efficiency 55.8%				fans, CO sensor reading 5-10 PPM, garage temp 60 F, unit heater thermostats set to max,					gas meter savings.	0
								not all unit heaters running properly, new air door installed to separated unheated space						0
								backdraft dampers installed on exhaust units, water temperature reduced to fixed 140 F						0
								Actual gas consumption was analysed for the 2 winter months available and saving adjusted						0
								from other estimated energy savings at this site, the result compared well with the estimated savings.						0
20	123,040	25	2,460,800	Base year gas consumption 2011, all (2) atmospheric boilers, 73 % Thermal Efficiency, continuous pumping,	121,776	25	2,435,520	Agreed with base year consumption data, Site visit confirmed all equipment as stated,	121,776	25	2,435,520	Agreed with Verifier	site visit identified more complex operation of DHW, new operations characteristics updated in	-25,280
				Burner fan flue damping, No oversize factor, supply water setting 180F, return water setting 160 F,				Operation of equipment did not match EGD document. Supply temperature was higher than stated,					energy model and savings modified.	0
				Traditional boiler reset control, staged air fuel control, Pre and post combustion purge,				the boiler reset was an updated BAS system, and the domestic hot water boiler runs independantly in DHW.						0
				Existing DHW boiler, Atmospheric 73% thermal Efficiency, continuous pumping, no flue damping,				These features were updated in the energy model and the final energy savings accepted.						0
				supply water temperature 140F, return 120 F, Old controller, No air fuel mix, no purge cycle, good tank insulation				The Verifier estimated the seasonal efficiency of the new boilers and confirmed that the energy model was						0
				New combined (4) boiler system, 92 % thermal efficiency, Continuous pumping, Burner fan flue damping,				conservative.						0
				170 F supply temperature, 150 return temperature, Characterized boiler reset controls,										0
				Modulating Air fuel control, Pre and post combustion purge										0
21	14,637	25	270,783	Base case OBC 2006, Building simulation model	14,637	25	270,783		14,637	25	270,783			0
22	215,256	15	2,841,379	Base year gas consumption 2009, Energy saving calculated using measure room temperatures, ceining height 32 ft,	477,904	15	6,308,333	Agreed with base year, system had been in service for one year so gas billing information was	477,904	15	6,308,333	Agreed with Verifier	Site visit confirmed system installationn and operation, temperature measurements ceiling 74.3 F,	3,466,954
				Ceiling temperature 84.2 F, temperature at unit heater height 80.6F, thermostat height 72F, floor level 70F				used to calculate actual savings. Linear regression was use on the base year data, linear regress					thermostat 72.5F, Unit heater and rooftop units set at 71 to 73 F. Verifier requested the saving	0
				Insulation levels conservatively estimated for envelop, roof R20, walls R19, area dimensions, length 799 ft, width 799 ft				was applied to the consumption data after the conversion, this data along with the climate average data					calculator to be changed to reflect the findings and more reasonable warehouse insulation levels,	0
				height 32 ft, 4480 ft2 windows R15, 90% destratification coverage, temperature set point 72F, Balance point 60.8 F,				from Environment Canada was used to determine the Normalized year savings. A balance temperature of					R15 ceilings, R14 walls.	0
				seasonal heating efficiency 65%, passive ventilation 0.2 ACH				17.1 C was identifed as the best fit and applied to the analysis.						0
				Destrativication setting new system, Ceiling temperature 72F, floor level 69.6F,										0
				Energy saved based on heat loss through walls and ceiling.										0
23	2,105,452	25	38,950,866	Base case OBC, Building simulation model	2,105,452	25	38,950,866		2,105,452	25	38,950,866			0
24	751,609	15	9,921,239	Base year gas consumption November 2007 to Oct 2008, Reduction in air flow by 5%, over 168hr week	848,464	15	11,199,725	Agreed with base consumption year, site visit identified different actual system schedule, and air flow	848,464	15	11,199,725	Agreed with Verifier	site visit confirmed the actual operating parameters which were used to complete the savings calculation.	1,278,486
				area 1, 299000 cfm, existing 100% fresh air, 100% airflow; changed to, 7 hr at 100%, 7 hr at 80%, 6 hr at 70 %				area 1, (air flow not provided), 17 hrs at 100%, 7 hrs at 70%					The Verifier agreed with the analysis spread sheet that had been provided by EGD, with adjustments	0
				area 2,318000 cfm, existing 15% fresh air, 100% airflow, changed to, 11 hrs at 100%, 7 hrs at 50%, 6 hrs at 0%				area 2, (air flow not provided), weekdays, 11 hrs at 95%, 6 hrs at 50%, 7 hrs off					to the following. For reheat calculation the delivery air temperature was split between the ideal	0
				Area 3, 268000 cfm, existing 15% fresh air, 100% airflow, changed to, 11 hr at 100%, 7 hr at 60%, 6 hr at 40%				area 2, (air flow not provided), weekends, 24 hrs off					and the set point room temperature. In addition the to account for heat gain the balance point	0
				Area 4,77000 cfm, existing 100% fresh air, 100% airflow, changed to 100 airflow 24 hrs				area 3, (air flow not provided), 11 hrs at 95%, 6 hrs at 60%, 7 hrs at 40 %					temperature was used rather than the space set temperature.	0
				set point temperature 68F, 80% system efficiency, Relative humidity setpoint 40%, cooling setpoint 70 F				area 4, (air flow not provided), 24 hrs at 90%						0
				a excel calculation sheet was assembled with normalized bin temperatures for Toronto and calculated with a balance										0
				point of 18 C, sensible latent and reheat energy savings was calculated.										0
				The consumption was calibrated to the actual base gas usage, and a safety factor of 20% was discounted.										0
25	227,556	15	3,003,739	Building on steam, steam billing used, One steam meter for two buildings (one not part of this savings)	134,233	15	1,771,876	The existing AHU operated 12 hr a day not 24 hr operation, weekends and holidays off	134,233	15	1,771,876	Agreed with Verifier	Since the average existing heating energy use for this building exceeded norms for this	-1,231,863
				steam was aportioned based a building floor area.				Measure included new MUA unit with Heat recovery wheel, new fresh air flow 38000,					building type the Verifier was not confident that the base energy calculated was reasonable	0
				AHU air flow 38000 cfm 100% fresh air existing, supply air temperature 72 F, 75.2% system efficiency				Enthalpy wheel effectiveness 82% (latent and sensible), schedule from BAS ventilation on 6 am to 6 pm					and therefore developed his own estimated based on the steam data and the building floor area.	0
				new system capable of recirculating 30% air, therefore only 70% fresh air heating needed.				off weekends and holidays. Heating balance point of 15 C. existing set temperature 22.2C					The Verifier changed the measure to include a new AHU with heat recovery and and night setback controls	0
				new AHU schedule, daytime 12 hrs at 70% fresh air, at 72 F, nightime 12 hrs at 70% fresh air, at 65 F				new setback temperature 18.3 C, estimated floor area 214,455 ft2, window to wall area 50%						0
								building assumed insulation level MNECB 1997						0
								target RH 30%						0
26	36,449	15	481,127	Base year gas consumption data 2009, base case, fresh air dampers on AHU fixed and providing design required	36,449	15	481,127	Agreed with the base year gas consumption, the building gas usage was benchmarked against	36,449	15	481,127	Agreed with Verifier		0
				fresh air, New system signal of CO2 concentration used to adjust fresh air flow into building. CO2 set points				average retail facilities (below average), Verifier assemble their own computer model to estimated energy usage,						0
				adjust minimum and maximum ventilation load. Honeywell DCV calculator used to estimate energy savings.				results were comparable with EGD proposed values.						0
				6 rooftop units total 21987 cfm ventilation capacity max, floor area 110,365 sq ft, retail area 73,292 sq ft										0
				RTU unit heating efficiency 80%, building set temperature 70F										0
														0
27	35,719	15	471,491	Base year gas consumption data 2009, base case, fresh air dampers on AHU fixed and providing design required	35,719	15	471,491	Agreed with base year gas consumption, the building gas usage benchmarked against	35,719	15	471,491	Agreed with Verifier		0
				fresh air, New system signal of CO2 concentration used to adjust fresh air flow into building. CO2 set points				average retail facilities (below average), Verifier assembled their own computer model to estimate energy usage,						0
				adjust minimum and maximum ventilation load. Honeywell DCV calculator used to estimate energy savings.				results were comparable with EGD proposed values.						0
				11 rooftop units total 22016 cfm ventilation capacity max, floor area 133777 sq ft, retail area 67274 sq ft										0
				RTU unit heating efficiency 80%, building set temperature 70F										0

SEC INTERROGATORY #5

INTERROGATORY

[B/1/1, p. 80]

Please provide the full report of Byron J. Landry, and their time dockets for all of the work they did to verify savings and prepare the report. Please provide a table showing, for each of the projects reviewed by the CPSV contractor, and for each assumption they used to calculate the cumulative lifetime m3:

a. The original assumption in the application;

b. The assumption used by the CPSV contractor, and, if it was different, the reason why it was different, if known;

c. The final assumption approved by the Auditor, and, if it was different from the assumption used by the CPSV contractor, the reason for the difference;

d. The process that resulted in each change in assumption or calculation method from the original application, including any input provided by Enbridge related to the change; and

e. The impact (in lifetime m3) of each change in assumption or calculation method.

RESPONSE

Attachment 1 is a redacted Engineering Review of 2012 Industrial Sector Custom Projects report by Byron J. Landry & Assoc., Inc. The Enbridge CPSV firms are contracted on a per project basis and do not keep time dockets for each project reviewed.

Responses to above questions a) through e) are summarized in a Table provided in Attachment 2.

Witnesses: F. Oliver-Glasford
R. Sigurdson

Enbridge Gas Distribution Inc.
DSM, Research & Evaluation Dept.

Engineering Review of 2012 Industrial Sector Custom Projects Review of Random Sample Files

Final Report

April 2, 2013

Prepared for:

ENBRIDGE

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Appendices

EXECUTIVE SUMMARY

Byron J. Landry & Associates Inc. was contracted by Enbridge Gas Distribution (EGD) to complete an engineering review of (17) Custom Application Industrial and Agricultural Energy Efficiency Projects spanning the Year 2012and the results are presented in this report.

The objectives of these reviews are to verify that the energy efficiency projects were installed and are operational, and to estimate the gas volume savings of the projects as implemented compared to the estimated savings in the project application submission.

It is noted that this assignment was completed within the stated scope of work and does not constitute a detailed engineering study. This assignment was limited to observations at readily accessible locations, interviews with site personnel and a review of data provided.

Because of the variability of energy rates, this report is based on projected savings in units of energy (i.e. cubic meters of natural gas).

The results of the Year 2012 review of the sample files are summarized in the table on the following page, for reference. Overall, a downward adjustment of 440,232 m^3/yr (-1.9% overall variance) for natural gas savings was made. Originally projected electricity consumption savings were adjusted upward by 769,060 kWh/yr (+6% overall variance). Projected annual water savings were adjusted downward by 12,317 m^3/yr (-12% overall variance).

For all cases reviewed, the customer's site contacts expressed satisfaction regarding the installation and operation of the implemented measures and the level of technical/financial support they have received from Enbridge. In general, the energy saving projections in the Custom Application files were well supported with background documentation that was based on sound engineering practice. In some of the reviews, additional information from plant energy information systems (PLC, DCS, SCADA) needed to be requested on site to view key operating parameters which formed the basis of the calculation summaries that were presented in the EGD file. *Since this type of data is only available post-installation for the energy measure, this emphasizes the value of a mandatory site visit in the review process.*

Three plants experienced considerable downward adjustment in natural gas savings projections. These adjustments are explained as follows:

<u>RA.AGR.EX.NRT.001.12</u>
The approach adopted in the project file to estimate energy savings is based on a comparison of energy intensity for the before/after new installation. A review of updated natural gas use and production data with plant management on site offered more current data than that used in the EGD file assumptions, yielding an adjusted energy intensity in both cases.

<u>RA.IND.EX.RT.018.12</u>
The EGD project file calculations are based on a certain reclaim water flow rate. The site visit revealed that while 2/3 of the intended heated water sources have been connected and are operating as intended to date, a 3rd source has yet to be connected. *While there appears to be a high likelihood of this source being connected to the reclaim system in the near future*, no definitive evidence on time frames for installation could be obtained from capital allocation plans or scheduled maintenance records from site. (The scope of work that is involved would not appear to be complex).

<u>RA.IND.EX.NRT.041.12</u>
The EGD project file calculations are based on [redacted] This negatively affects 40% of the potential heating and ventilation savings. It must be emphasized that plant personnel have expressed a strong intent to restore the project to full retrofit conditions as soon as possible, given the loss of energy savings and resources expended to date on this project. *While there appears to be a high likelihood of this situation being remedied*, no definitive evidence on time frames for this action could be obtained from capital allocation plans or scheduled maintenance records from site. (The scope of work could be as simple as modifying the PLC programs that control the operation of the makeup air units).

Feedback received from the sites reinforce the view that Enbridge's DSM Programs continue to be well managed and all customers acknowledged that these incentive programs were key to overcoming internal capital constraint barriers to implementing the energy efficiency projects in their organizations. In many cases, this support has motivated businesses to select higher initial cost, energy efficient technologies over conventional designs or to probe deeper into their operating behaviour to realize improved life cycle performance through energy efficiency. Additional positive feedback includes the following:

- Enbridge customer reps know the industrial setting and context. This increases customer confidence in the assistance being received.
- The interface between Enbridge customer reps and the plant contacts is perceived as an extension of the plant's "Energy Team", offering an educational aspect that the plant would not otherwise have access to under the current environment of limited time and resources.
- Enbridge is equipped with the portable measurement devices (eg. combustion analysers) that the plant would not likely have.

2012 Random Sample Custom Projects Independent Review

EGD Project Code	Sector	Measure	Annual NG Savings (m^3)			Annual Electricity Savings (kWh)			Annual Water Savings (m^3)		
			EGD file	Reviewer Adjusted	% variance	EGD file	Reviewer Adjusted	% variance	EGD file	Reviewer Adjusted	% variance
RA.IND.EX.RT.003.12	Pharmaceutical	Steam Boiler Plant Condensing Economizer.	1,224,675	1,367,663	12%	0	-26,350	N/A; div by "0"	0	0	0%
RA.IND.EX.NRT.007.12	Paving Mixtures	Replacement and Refurbishment of Industrial Equipment.	93,135	93,135	0%	0	0	0%	0	0	0%
RA.IND.EX.RT.001.12	Manufacturing	Chiller Heat Recovery.	89,396	95,533	-4%	0	0	0%	0	0	0%
RA.IND.EX.RT.012.12	Steel	Furnace Sealing Improvement.	551,852	551,852	0%	0	0	0%	0	0	0%
RA.IND.EX.NRT.009.12	Manufacturing	Upgraded Selection of Industrial Equipment.	206,565	206,565	0%	8,873	1,872	-79%	0	0	0%
RA.AGR.EX.NRT.001.12	Grain Handling	Replacement of Industrial Equipment.	151,298	114,800	-24.1%	0	0	0%	0	0	0%
RA.IND.EX.NRT.012.12	Food & Beverage	Process Boiler Replacement.	81,726	81,726	0%	0	0	0%	0	0	0%
RA.IND.EX.RT.014.12	Food & Beverage	Process Water Recycling & Heat Reclaim.	50,715	86,810	71%	0	0	0%	11,938	11,938	0%
RA.IND.EX.RT.018.12	Automotive Parts Manufacturing	Process Water Recycling & Heat Reclaim.	341,227	288,267	-16%	-3,667	0	0%	38,916	31,133	-20%
RA.IND.EX.NRT.039.12	Automotive	Replacement of HVAC EMS System	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0%	0	0	0%
RA.IND.EX.NRT.040.12	Automotive	Replacement of HVAC EMS System	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0%	0	0	0%
RA.IND.EX.NRT.041.12	Automotive	[redacted]	1,311,369	785,375	-40%	471,822	400,334	-15%	11,304	6,770	-40%
RA.IND.EX.RT.033.12	Petroleum Products	Steam Trap Replacement	439,394	439,394	0%	0	0	0%	0	0	0%
RA.IND.EX.RT.021.12	Pulp & Paper	[redacted]	[redacted]	[redacted]	0%	0	0	0%	0	0	0%
RA.IND.EX.NRT.038.12	Automotive	Ventilation Reduction Through Equipment Scheduling	[redacted]	[redacted]	0%	0	880,023	N/A; div by "0"	0	0	0%
RA.IND.EX.NRT.028.12	Food & Beverage	Steam Boiler Replacement with High Efficiency Condensing Boiler	77,055	77,055	0%	0	0	0%	0	0	0%
RA.IND.EX.RT.024.12	Brewery	Heat Exchanger Heat Transfer Improvement & CIP Optimization	429,109	429,103	0%	0	-9,791	N/A; div by "0"	44,303	44,303	0%
		TOTAL	22,794,941	22,354,709	-1.9%	12,090,556	12,859,616	6%	106,461	94,144	-12%

1. INTRODUCTION AND SCOPE OF REVIEW

Enbridge Gas Distribution Inc. encourages its customers to efficiently utilize natural gas. Demand Side Management (DSM) energy efficiency programs of Enbridge include educational materials, technical assistance and financial incentives. These programs offer energy efficiency audits/studies and financial support in implementing an energy management project. Industrial applications are referred to as Custom Applications Projects with the savings for each project requirement determined separately, based on project specifics.

Byron J. Landry & Associates Inc. was contracted by Enbridge Gas Distribution Inc. to complete a third party engineering review of the results of (17) Custom Applications Projects in the Industrial and Agricultural sectors, applying to Year 2012.

This report provides an independent review of the Enbridge selected, random sample projects. The following are the primary objectives of this report:

- verify that the energy efficiency project was installed;
- verify that the system is operational; and
- estimate the gas volume savings of the project as implemented compared to the original project savings included in the application form.

The general approach used for the evaluation consisted of:

- review of the original application submission from which the savings were estimated;
- conduct a site visit to verify that the project was implemented, determine operating practices, collect design and operating data, discuss the project with the plant staff; and
- review available information to estimate the actual savings.

It is noted that this assignment was completed within the stated scope of work and does not constitute a detailed engineering study. It was limited to observations at readily accessible locations, interviews with site personnel and a review of data provided.

The random sampling process for Custom Application file selection for review was completed by a separate 3rd party consultant retained by Enbridge. The selected files were then forwarded to Byron J. Landry & Associates Inc. for review according to the following submission dates:

- (Q1-Q3): (8) files (November 2, 2012)
- (Q4): (9) files (February 12, 2013)

Because of the potential variability of energy rates, this report is based on projected savings in units of energy (i.e. cubic meters of natural gas).

This report is confidential and contains sensitive information about the operations of the Customers. It is intended only for internal use within Enbridge and review by its external auditor for the DSM Program.

2. INDUSTRIAL CUSTOM PROJECT REVIEW SUMMARIES

Detailed summaries for each Custom Application project, with review comments and adjustments, are presented on the pages which follow.

2.1. Opinion of Measure Life

It must be emphasized that the evaluation of the sustainability or life of an energy efficiency measure is not a precise exercise. It is based on limited information and in many instances is influenced by factors which have not yet occurred. (An example would include retroactive rulings by regulatory agencies which would require immediate upgrade or replacement of equipment). This evaluation represents a judgment based on accepted industry standards and industry published data, including (but not limited to) the following reference sources:

- " Life Cycle Cost Data", A.J. Delelsola and S.J. Kirk
- ASHRAE ("Estimates of Service Lives of Various System Components")
- "Updates on improving refractory lining service life", Maity, M. , SABIC Technology Centre
- Thermal Insulation Handbook, W.C. Turner and J.F. Malloy
- "Optimizing Dryer Performance" - Chemical Engineering Journal: March '98
- Industrial Ventilation (CADDET Analyses Series No. 10)
- AEE Journal Vol. 104, No. 3: "Exhaust Ventilation Energy Saving in Car Manufacturing and Other Industries"
- "Learning from Experiences with Process Heating in the Metals Industry" (CADDET Analyses Series No. 11)
- "Working Guide to Process Equipment", N. P. Lieberman and E.T. Lieberman

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL (Pharmaceutical) Stated Measure Life: 15 years Reviewer's Opinion: Conservative; 20 years could be assigned with high confidence level	EGD PROJECT CODE No. RA.IND.EX.RT.003.12 SITE INVESTIGATION DATE: November 30, 2012
MEASURE	Steam boiler plant condensing economizer.	
PROJECT [redacted]	[redacted]	

APPROXIMATE IN-SERVICE DATE	February 17, 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	Increase annual natural gas avoidance by 142,988 m^3. Increase electricity consumption by 26,350 kWh/yr.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
1,224,675	1,367,663	0	(-26,350)	

REASON FOR ADJUSTMENT:

The EGD ETools calculations in the project file are based on sound engineering and actual boiler test data. The system is well instrumented and performance data is trended and archived. The factors which were observed on site and led to an upward adjustment of the estimated annual savings are outlined as follows:

1. [redacted]
2. The performance trend for the entire month of Sept. 2012 (prior to the major boiler plant outage)indicates an average heat recovery of 4,335,390 BTUH. A copy of this trend summary (from the plant data archives) is appended for reference.
3. ETools is based on a makeup water flow rate of 52 USgpm. Flow data trended for Sept. 2012 indicates 68 USgpm. *Additional electrical loading from new glycol pump installation is projected to add 26,350 kWh per year.* (Refer to Appendix 'A' for revision calculations).
4. ETools is based on a temperature exit of 200 °F to the deaerator; trended data shows 185 °F.
5. ETools is based on a makeup water temperature of 50 °F entering the condensing economizer heat recovery system; trended data shows 58 °F.

The higher makeup water flow rate viewed in the data trends (even the year-to-date with downtime factored has averaged 59 USgpm) has more than compensated for the lower temperature differential compared to ETools. The factors outlined in the foregoing lead to an upward adjustment of the energy savings estimates since the entire plant is maintaining its current operating and production profile (8,500 hrs/yr).

FILE SUPPORTING DOCUMENTATION :
Project file includes boiler plant system narrative, Enbridge Industrial ETool printouts, cogen. and boiler daily log performance data for 2010, consulting engineer's calculations and tendered constructed cost data.

REVIEWED BY: Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE: 'A'

ENBRIDGE GAS DISTRIBUTION **DSM, Research and Evaluation Dept.** **Engineering Review of 2012 Custom Projects**	**DOCUMENTATION REVIEW SECTOR** **INDUSTRIAL (Paving Mixtures)** **Stated Measure Life: 20 years** **Reviewer's Opinion: High confidence level**	**EGD PROJECT CODE No.** **RA.IND.EX.NRT.007.12** **SITE INVESTIGATION DATE:** **December 5, 2012**
PROJECT MEASURE	**Replacement and Refurbishment of Industrial Equipment**	
PROJECT DESCRIPTION	The plant process involves the [redacted] in a drum mixer that is equipped with a burner to heat and dry the aggregate. Liquid asphalt cement is added as a binder to the hot mix before it is transferred to holding silos. The first project measure involves replacement of the old (worn) dryer flights with an improved design to create more resistance to the flow of flue gas in the dryer drum and improve heat retention. The second related measure was to install a secondary burner in the flue gas duct prior to the bag-house. This smaller burner (8 MMBH) is aimed at reducing over-firing of the larger main burner (125 MMBH) in order to maintain bag-house temperatures above 200 °F to avoid condensation within the bag-house.	

APPROXIMATE IN-SERVICE DATE	**April 25, 2012**	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	**AGREED.**

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		**Water (m^3)**		**Electricity (kWh)**
EGD file	**Reviewer Adjusted**	**EGD file**	**Reviewer Adjusted**	**EGD file**
93,135	**93,135**			

OBSERVATIONS & REASON FOR AGREEMENT:

The savings related to natural gas consumption reduction for dryer systems [redacted] are difficult to quantify because of the complex variables involved. The performance of these dryers is seasonally dependent on outside air temperature and relative humidity. The project file factors combustion calculations and also correlates actual natural gas consumption with production levels. The base case is calculated on the previously maintained drum exhaust temperature of 320 °F and retrofit case is based on a reduced temperature of 250 °F. All calculations were reviewed and appear sound. As a site check, control room instrumentation parameters were observed under normal operating conditions with the drum exhaust temperature at 229 °F while bag-house temperature was maintained at 206 °F. (Relevant photos are appended for reference). As another cross-check from a different perspective, records of energy intensity (m^3 of natural gas/tonne of asphalt) were reviewed with the plant's chief accountant. Energy intensity improved from 9.82 from May-August in 2011 (pre-retrofit) to 8.31 for the same time frame in 2012. For year-to-date Fall season, this performance metric improved from 9.46 in Sept/Oct 2011 to 8.29 for the same time frame in 2012. While the control room instrumentation display and energy performance data represent "snapshots" in time, all observations revealed improved performance and increased the confidence level of the reviewer to accept the calculated savings without adjustment.

FILE SUPPORTING DOCUMENTATION :

Project file includes process description narrative, combustion calculation summary and base case fuel consumption, related to production data. Installed cost is supported by copies of paid contractor invoices.

REVIEWED BY: **Byron Landry, P. Eng., CEM, CEA** **Byron J. Landry & Associates Inc.**	**REFERENCE APPENDIX FOR AGREEMENT RATIONALE: 'B'**

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	**DOCUMENTATION REVIEW SECTOR** **INDUSTRIAL (Manufacturing)** **Stated Measure Life: 15 years** **Reviewer's Opinion: Conservative; 20 years could be assigned with a high confidence level**	**EGD PROJECT CODE No.** **RA.IND.EX.RT.001.12** **SITE INVESTIGATION DATE:** December 6, 2012

PROJECT MEASURE	**Chiller Heat Recovery**
PROJECT DESCRIPTION	A water-glycol heat exchanger captures waste heat from #2 Chiller (250 Ton rating) condensing water circuit and uses this heat reclamation for preheating makeup air to the plant's (2) x 12,000 cfm air handling units. The heat exchanger is rated to recover 725,227 BTUH. The supply air temperature setpoint on the makeup air handling units is 18 °C/64 °F. This space temperature normally results in a plant building exhaust temperature of 60 °F. Heat recovery is calculated on the basis of displacing natural gas heating on the makeup air handling units when outdoor temperatures drop below 10 °F of the plant air exhaust temperature; namely, 50 °F outside air temperature. Except for holidays, plant production (to which the heat recovery and chiller operation are linked) is tracking 6 d/wk X 24 h/d operation.

APPROXIMATE IN-SERVICE DATE	October , 2012	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	**Decrease annual natural gas avoidance by 3,863 m^3.**

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Water (m^3)		Electricity (kWh)
EGD file	**Reviewer Adjusted**	**EGD file**	**Reviewer Adjusted**	**EGD file**
99,396	95,533			

OBSERVATIONS & REASON FOR ADJUSTMENT:
During the site visit, it was observed on the system control screen that # 2 Chiller offers ample heat source available for recovery (ie. calculated at 1,281,600 BTUH/107 TR) on the basis of the following parameters for the condensing water circuit:

- **21.4 °C/70.5 °F supply temperature**
- **17.4 °C/63.3 °F return temperature**
- **356 USgpm flow**
- **-5.3 °C outside air temperature**

While the project file calculations were based on a block number of annual hourly occurrences below 50 °F with 20% deduct for holidays and shifts, this evaluation adopted another level of refinement though the use of 30 year monthly mean temperatures published by Environment Canada and the plant's current operating production profile. This was done to identify part-load performance of heat recovery in the shoulder season months when the heat exchanger capacity exceeds the ventilation load. Conversely, the heat exchanger capacity constrains the potential for increased heat recovery to match greater winter heating loads. The spreadsheet calculations which form the basis of this review are appended for reference. This approach yielded a slight variance to the calculated values in the project file.

FILE SUPPORTING DOCUMENTATION :
Project file includes heat source/heat sink calculations by EGD rep, system narrative, photos of heat exchanger installation and sample calculations by vendor. Installed cost is supported by vendor quote.

REVIEWED BY: **Byron Landry, P. Eng., CEM, CEA**	**REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE:'C'**

ENBRIDGE GAS DISTRIBUTION **DSM, Research and Evaluation Dept.** **Engineering Review of 2012 Custom Projects**	**DOCUMENTATION REVIEW SECTOR** [redacted] **Stated Measure Life: 18 years** **Reviewer's Opinion: Moderate confidence level; higher confidence level at aggregated 15 years (given robust environment plus refractory would be closer to 10 years, even though it is not the dominant component of the project)**	**EGD PROJECT CODE No.** **RA.IND.EX.RT.012.12** **SITE INVESTIGATION DATE:** **November 30, 2012**
PROJECT MEASURE	**Furnace sealing improvement.**	
PROJECT DESCRIPTION	This plant produces [redacted] which are then pulled [redacted] All three measures are aimed at minimizing heat loss through the furnace charging and discharge ends.	

APPROXIMATE IN-SERVICE DATE	**January 18, 2012**	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	**AGREED.**

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
551,852	551,852	0	0	0

REASON FOR AGREEMENT:
The projected savings for this furnace upgrade were calculated on the basis of a regression analysis of before/after [redacted] natural gas consumption vs production. Updated data was reviewed on site and it indicates a 7.9% improvement in energy intensity, which is in close agreement to the 7.2% improvement originally projected in the project file. Given the linear regressions for both the before/after curves offer an R^1 value above 0.92, this indicates the data offers a reasonably strong correlation. Given the plant has demonstrated its ability to sustain the projected savings and is tracking both operation and production levels that were used as the basis of the file's savings estimates, this review enables the author to support the calculation estimates presented, without a suggested variance.

FILE SUPPORTING DOCUMENTATION :
Project file includes process description narrative with burner data , furnace arrangement drawings and before/after retrofit photos. Heat loss improvement calculation methodology is based on regression analysis of metered gas consumption, correlated to production levels. Installed cost breakdown is tabulated in narrative.

REVIEWED BY:	**REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE:**
Byron Landry, P. Eng., CEM, CEA **Byron J. Landry & Associates Inc.**	**N/A**

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL (Manufacturing) Stated Measure Life: 20 years Reviewer's Opinion: High confidence level		EGD PROJECT CODE No. RA.IND.EX.NRT.009.12 SITE INVESTIGATION DATE: November 28, 2012
PROJECT MEASURE	Upgraded Selection of Industrial Equipment		
PROJECT DESCRIPTION	Plant expansion required the purchase of a new dryer to complement the existing dryer. Energy efficiency influenced the investment decision to include VFD modulation of dryer exhaust to minimize heat loss plus heat recovery from exhaust gases to preheat process whitewater. Existing dryer is equipped with (3) x 1.5 MMBH burners and (3) x 1,800 cfm exhaust fans. New dryer has single 1.8 MMBH burner and (2) exhaust fans controlled according to VFD for improved heat retention in dryer (estimated operating exhaust flow of 720 cfm). Heat recovery feature is rated at 400 MBH.		
APPROXIMATE IN-SERVICE DATE	July, 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	Decrease annual electricity avoidance by 7,001 kwh.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
206,565	206,565	8,873	1,872	0

REASON FOR AGREEMENT/ADJUSTMENT:

Natural Gas:

The projected savings for this more energy efficient dryer selection were calculated on the basis of a detailed heat and mass balance of both existing and new energy efficient dryers. The heat balance information summarized from the Enbridge Industrial ETools is compatible with cursory check calculations by the reviewer and internal conveyor temperatures measured with an IR gun by the reviewer during the site visit. The ETools calculations are based on the existing dryer exhausting at 300 °F and a value of 302 °F was measured by the reviewer through an open port on the dryer internals at a point close to the exhaust. (Unfortunately, it was not possible to reliably measure temperature at the dryer exhaust stacks due to stainless steel surfaces having a much lower emissivity than the device's calibration, giving a lower temperature than one would expect). Production levels are trending upwards for future years. The methodology and rigor devoted to the calculations outlined in the project documentation and general site observations with respect to operating temperature setpoints enable the author to support the calculation estimates presented, without a suggested variance.

Electricity:

The project file outlined a sound attempt to quantify electricity savings on the basis of correlating fan power to air flow; however, amp draw measurements taken under normal operating conditions during the site visit with plant personnel revealed he following:

- **Existing unit (Zone #3 exhaust fan) 1.2 A @ 575 V x (3) zones ≈ 3.23 kW**
- **New unit (combined exhaust fan draw) 2.2 A @ 607 V ≈ 2.08 kW (Zone #1 VFD @ 65%; Zone #2 @ 50%)**
- **ΔkW = 1.15 kW x 5,760 hrs → 6,624 kWh**
- **deduct circulation pump load (4,752 kWh from file) yields 1,872 kWh net savings projection.**

FILE SUPPORTING DOCUMENTATION:

Project file includes process description narrative with specification data for existing and new dryers, Enbridge Industrial ETools printouts with detailed heat and mass balances, e-mail communications printouts with equipment suppliers regarding key performance data and assumptions. Installed cost is supported by a copy of vendor's quotation for materials, shipping and installation.

REVIEWED BY:	REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE:
Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	N/A

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	**DOCUMENTATION REVIEW SECTOR** INDUSTRIAL (Food & Beverage) Stated Measure Life: 25 years Reviewer's Opinion: High confidence level		**EGD PROJECT CODE No.** RA.IND.EX.NRT.012.12 **SITE INVESTIGATION DATE:** November 29, 2012
PROJECT MEASURE	Process Boiler Replacement.		
PROJECT DESCRIPTION	This plant produces [redacted] The implemented project consists of the replacement of (3) [redacted] hot water boilers (3 x 3.5 MMBH capacity) with a single, more energy efficient [redacted] forced draft water-tube boiler (7 MMBH capacity).		
APPROXIMATE IN-SERVICE DATE	May 12, 2012	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	AGREED.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
81,726	81,726	0	0	0

REASON FOR AGREEMENT:

The atmospheric boilers used previously are not as efficient as the forced draft water tube boiler replacement. While the EGD file includes the results of testing done prior to replacement, which yielded a calculated boiler efficiency of 68.9%, a 65% efficiency is usually regarded as generous but generally accepted in the industry. Given these boilers are open to atmosphere and combustion air is not controlled due to stack draft effect, cycling is an important factor and can easily bring that efficiency down to the 50% range. The testing process was quite rigorous and included thermographic scanning to determine boiler shell loss. (3.25% of total fuel input vs 1%-2 for the replacement boiler). These considerations lead the reviewer to conclude that while the test process was sound, it would likely yield a generous efficiency for the existing atmospheric boilers and yield a conservative savings estimate (which is prudent for the purposes of this evaluation).
Also tested on site was an upsized version of the replacement boiler [redacted] to assist in establishing the likely performance of the new replacement boiler. These tests offered a firm basis for comparison of the before/after scenarios and enabled "right sizing" of the replacement boiler to be determined prior to purchase. All calculations included in the project file were reviewed and found to be in close agreement with cursory check calculations completed by the reviewer. Load factor assumptions made in the EGD file were also conservatively factored. Site observations which indicated to the reviewer the magnitude of the old boiler's high losses include the following:

- a review of process data prior to the boiler replacement showed a production range of 200-220 [redacted] improved capacity after the new boiler
- the previous [redacted] boilers were limited to a tested outlet hot water temperature of 193 °F; a 230 °F outlet gage temperature was observed (and 227 °F with IR temperature gun measurement) during the site visit, which is indicative of improved performance.

The foregoing considerations enable the author to support the fuel savings estimates as presented in the project file, without a suggested variance.

FILE SUPPORTING DOCUMENTATION :
Project file includes photos of infrared camera imaging measurements, combustion analyzer strip chart copies, water flow measurements and graphical profiling, supply & return temperature measurement data, boiler performance data and calculations. Installed cost is supported by detailed material & labour invoices.

REVIEWED BY: Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	**REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE:** N/A

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL (Food & Beverage) Stated Measure Life: 20 years Reviewer's Opinion: High confidence level	EGD PROJECT CODE No. RA.IND.EX.RT.014.12 SITE INVESTIGATION DATE: November 29, 2012
MEASURE	Process Water Recycling and Heat Reclaim.	
PROJECT DESCRIPTION	The implemented project consists of recirculation of warm process water that was previously piped to drain in a once-through arrangement. This was accomplished by the installation of holding tanks and circulation pumps.	

APPROXIMATE IN-SERVICE DATE	July, 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	Increase annual natural gas avoidance by 36,095 m^3.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
50,715	86,810	0	0	11,938

REASON FOR ADJUSTMENT:

Water: The EGD project file calculations identify a 27 Lpm water flow rate. This was established by timed bucket flow tests prior to installing the closed loop system. This water must flow continuously to prevent solidification within the process line.

Natural Gas: The project file bases it's savings calculations on a water temperature of 107 °F. During the site visit, a check measurement with a digital temperature probe of water flowing into the holding tank revealed a temperature of 133 °F. (Plant personnel acknowledge the original temperature estimate was low, in order to conservatively project the savings). Given the measured heat build-up of recirculated water and the project file's allowance of a 10% loss factor in the heat savings calculations, the savings estimates appear to be conservative in nature. The foregoing considerations enable the author to adjust the fuel savings estimates that were presented in the project file as follows:

500 x7.13 USgpm x (133-50) = 295,895 BTUH

At 0.75 boiler plant efficiency and continuous operation, this yields 96,456 m^3/yr of equivalent natural gas. Applying a 10% loss factor (as in project file) yields 86,810 m^3/yr of equivalent natural gas.

FILE SUPPORTING DOCUMENTATION :

Project file includes photos of the holding tank, recirculation pump and associated piping. Calculations supporting savings estimates are outlined. Installed cost is supported by plant's material & labour breakdown, communicated by e-mail message to EGD customer representative.

REVIEWED BY: Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE: N/A

ENBRIDGE GAS DISTRIBUTION **DSM, Research and Evaluation Dept.** **<u>Engineering Review of 2012 Custom Projects</u>**	**DOCUMENTATION REVIEW SECTOR** **INDUSTRIAL**[redacted] **Stated Measure Life: 20 years** **Reviewer's Opinion: High confidence level**	**EGD PROJECT CODE No.** **RA.IND.EX.RT.018.12** **SITE INVESTIGATION DATE:** **March 7, 2013**
MEASURE	**Process Water Recycling and Heat Reclaim.**	
PROJECT DESCRIPTION	The implemented project consists of reclaiming warm (RO) process water that was previously piped to drain (at ≈ 120 °F) in a once-through arrangement. This water is now pumped to a holding tank and natural gas direct fired heater (91% efficiency), which reheats the water from nominal temperatures of 120 °F to 160 °F to displace rinse water in nearby process lines, where heated city water was previously used. Savings on heating fuel are realized on two levels; namely, the reclaimed heat content of water that would otherwise be drained plus the improved efficiency of temperature boost to 160 °F from 56%[redacted]% for the new direct fired heater.	

APPROXIMATE IN-SERVICE DATE	**December, 2012**	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	**Decrease annual water reclaim by 7,783 m^3 and natural gas avoidance by 52,960 m^3.**

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Water (m^3)		Electricity (kWh)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
341,227	288,267	38,916	31,133	-3,667

REASON FOR ADJUSTMENT:
<u>Water</u>: The EGD project file calculations are based on a 25 USgpm reclaim water flow rate. The site visit revealed that while 2/3 of the intended heated water sources have been connected and are operating as intended to date (15 + 5 USgpm), a 3rd source (5 USgpm) has yet to be connected. While there appears to be a high likelihood of this washer being connected to the reclaim system in the near future, no definitive evidence on time frames for installation could be obtained from capital allocation plans or scheduled maintenance records from site. (The scope of work would comprise the installation of approximately 100 ft. of 1 1/2" pipe).
<u>Natural Gas</u>: The 5 USgpm shortfall in reclaimed water flow warrants a corresponding adjustment to the natural gas savings calculations. The associated savings adjustment calculations are outlined in Appendix 'D' of this report for reference.

FILE SUPPORTING DOCUMENTATION :
Project file includes plant layout drawing of washer equipment sources with flow rate data, detailed steam boiler efficiency data, heat transfer calculations for Base case and New Operation, new gas water heater data, mass flow and temperature balance sketch. Calculations supporting savings estimates are outlined. Installed cost is supported by plant's material & labour breakdown; however, *the original installed cost of* [redacted] ***on*** [redacted].

REVIEWED BY: **Byron Landry, P. Eng., CEM, CEA** **Byron J. Landry & Associates Inc.**	**REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE:** **Appendix 'D'**

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL [redacted] Stated Measure Life: 15 years Reviewer's Opinion: High confidence level	EGD PROJECT CODE No. RA.IND.EX.NRT.039.12 SITE INVESTIGATION DATE: March 1, 2013
PROJECT MEASURE	Replacement of HVAC EMS System	
PROJECT DESCRIPTION	The plant's former EMS system, which controlled the operation of [redacted] was obsolete and remained out of service due to the unavailability of spare parts. This limited the control of fan scheduling to largely non-stop operation with occasional manual intervention. The new EMS allows central control, scheduling and monitoring of building [redacted] was primarily achieved by rewiring plant [redacted] and installing a server and custom software for control and scheduling. This project measure focuses on control of [redacted] that ventilate the [redacted] area of the plant.	

APPROXIMATE IN-SERVICE DATE	November, 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	AGREED.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Water (m^3)		Electricity (kWh)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
[redacted]	[redacted]			[redacted]

OBSERVATIONS & REASON FOR AGREEMENT:

The EGD savings estimates are calculated according to bin temperature analysis in E-Tools. These were reviewed and are deemed to be sound. The savings are based on reducing continuous ventilation of [redacted] cfm to requirements of [redacted] during production periods and [redacted] non-production periods. This is accomplished by reducing the concurrent operation of [redacted] during production periods and to [redacted] during non-production periods. Additionally, the new control enabled reduction of outside air flow from 50% during production periods to 25% during non-production periods. Prior to this measure, it was reported that space temperatures varied considerably due to negative air balance. The retrofit control is aimed at maintaining operational setpoints so that a positive pressure is always achieved in this plant area.

While no trend data was available for viewing during the site visit, the capabilities of the EMS system were viewed, in conjunction with a cursory inspection of the units being controlled. Requests were made for random viewing of fan status for production and non-production periods. Appendix 'E' includes screen captures of fan operation status at 4:20 am and 6:33 am for Feb. 28/13 (to serve as an example). Also included are the screen captures that validate the positive air balance condition being maintained in the [redacted] area during both production and non-production periods at these time frames. Given the new EMS system appears to be controlling in accordance with its intended operation, no further adjustment on the savings projections is warranted.

FILE SUPPORTING DOCUMENTATION:

Project file includes E-Tools calculation spreadsheet analysis and summary, system energy use description narrative and fan schedule cfm data. Installed cost is supported by plant internal e-mail correspondence.

REVIEWED BY: Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	REFERENCE APPENDIX FOR AGREEMENT RATIONALE: 'E'

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL [redacted] Stated Measure Life: 15 years Reviewer's Opinion: High confidence level	EGD PROJECT CODE No. RA.IND.EX.NRT.040.12 SITE INVESTIGATION DATE: March 1, 2013
PROJECT MEASURE	Replacement of HVAC EMS System	
PROJECT DESCRIPTION	The plant's former EMS system, which controlled the operation of [redacted] was obsolete and remained out of service due to the unavailability of spare parts. This limited the control of fan scheduling to largely non-stop operation with occasional manual intervention. The new EMS allows central control, scheduling and monitoring of building [redacted]. This was primarily achieved by rewiring plant [redacted] and installing a server and custom software for control and scheduling. This project measure focuses on control of [redacted] that ventilate the [redacted] area of the plant.	

APPROXIMATE IN-SERVICE DATE	November, 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	AGREED.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Water (m^3)		Electricity (kWh)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
[redacted]	[redacted]			[redacted]

OBSERVATIONS & REASON FOR AGREEMENT:

The EGD savings estimates are calculated according to bin temperature analysis in E-Tools. These were reviewed and are deemed to be sound. The savings are based on reducing continuous ventilation of [redacted] cfm to requirements of [redacted] during non-production periods. This is accomplished by reducing the concurrent operation of [redacted] during non-production periods.

While no trend data was available for viewing during the site visit, the capabilities of the EMS system were viewed, in conjunction with a cursory inspection of the units being controlled. Requests were made for random viewing of fan status for production and non-production periods. Appendix 'E' includes screen captures of fan operation status at 4:20 am and 6:33 am for Feb. 28/13 (to serve as an example). Appendix 'F' illustrates the ON/OFF profiles of [redacted] and BVIF3-06, representing (3) out of the [redacted] indirect gas fired air handling units serving this area being evaluated. These profiles are in general conformance with the scheduled production and non-production hours that are outlined in the EGD file documentation Given the new EMS system appears to be controlling in accordance with its intended operation, no further adjustment on the savings projections is warranted.

FILE SUPPORTING DOCUMENTATION :

Project file includes E-Tools calculation spreadsheet analysis and summary, system energy use description narrative and fan schedule cfm data. Installed cost is supported by plant internal e-mail correspondence.

REVIEWED BY: Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	REFERENCE APPENDIX FOR AGREEMENT RATIONALE: 'E' & 'F'

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. <u>Engineering Review of 2012 Custom Projects</u>	**DOCUMENTATION REVIEW SECTOR** **INDUSTRIAL (Automotive)** **Stated Measure Life: 15 years** **Reviewer's Opinion: High confidence level**	**EGD PROJECT CODE No.** **RA.IND.EX.NRT.041.12** **SITE INVESTIGATION DATE:** **March 1, 2013**
MEASURE	[redacted]	
PROJECT DESCRIPTION	The plant's [redacted] has conditioned (heated, humidified, cooled and re-heated) process air supplied by [redacted] a "once-through" system that admits 100% outdoor air, without any heat reclaim. This project measure cascades various exhaust air streams from [redacted] and building exhausts (which would otherwise be relieved to the outdoors) to supply unattended [redacted] This was accomplished by capping off the exhaust air ducts in occupied zones and also blocking off the outside air intake for heated makeup air. Various air steams are collected in the plant's [redacted]	

APPROXIMATE IN-SERVICE DATE	**December, 2012**	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	**Decrease annual natural gas avoidance by 525,994 m^3; electricity by 71,488 kWh and water reclaim by 4,534 m^3.**

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	**Reviewer Adjusted**	**EGD file**	**Reviewer Adjusted**	**Reviewer Adjusted to 6,770** **EGD file**
[redacted]	[redacted]	[redacted]	400,334	11,304

REASON FOR ADJUSTMENT:

<u>Natural Gas and Water</u>: The EGD project file calculations are based on a total [redacted] cfm being impacted from the capping and removal from service of [redacted] The site visit revealed that while both units were capped off in late Year 2012, humidification control issues on the process side prompted the re-instatement o[redacted] back into service for an indeterminate period of time. This removes [redacted] cfm from cascade mode and leaves a remainder [redacted] in sustained cascade mode. Since the natural gas heating and water savings are calculated in direct proportion to the total 126,900 cfm, the savings adjustment will also be in proportion to the nominal 40% air supply that has been re-instated back into service. (deduct o[redacted] m^3 The water savings from evaporative cooling effect would also be adjusted accordingly.

<u>Electricity</u>: The electricity savings outlined in the EGD file were calculated on the basis of the full contribution o[redacted] in the Base Case (Summer+Winter) modes of operation, *less* Summer & Winter Cascade modes, outlined as follows:

Summer (824,950) + Winter (1,289,685) - [redacted]) = 471,822 kWh

Removal of [redacted] kWh avoidance as follows would adjust the electricity savings by:

Summer (124,992) + Winter (195,407) - [redacted]) = 71,488 kWh savings decrease

It must be emphasized that plant personnel have expressed a strong intent to remov[redacted] from service again and bring it back to cascade mode as soon as possible, given the loss of energy savings and [redacted] the plant. While there appears to be a high likelihood of this situation being remediated, no definitive evidence on time frames for return of this unit back to cascade mode could be obtaine[redacted] from site. (The scope of work could be as simple as modifying the PLC programs that control the operation of the Air Houses). Until closure is brought to this work-in-progress, the reviewer must defer to applying the adjustments that are outlined in the foregoing.

FILE SUPPORTING DOCUMENTATION :

Project file includes E-Tools calculation spreadsheet analysis and summary, system energy use description narrative and fan schedule cfm data. Installed cost is supported by plant internal e-mail correspondence.

REVIEWED BY: **Byron Landry, P. Eng., CEM, CEA** **Byron J. Landry & Associates Inc.**	**REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE:** **N/A**

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL [redacted] Stated Measure Life: 5 years Reviewer's Opinion: High confidence level		EGD PROJECT CODE No. RA.IND.EX.RT.033.12 SITE INVESTIGATION DATE: February 26, 2013
MEASURE	Steam Trap Replacement		
PROJECT DESCRIPTION	Following the completion of a steam trap survey by an external testing agency, leakage was found in approximately 38% of [redacted] steam traps in this plant. Working within the constraints of the plant's resources, the plant replaced [redacted] defective thermodynamic steam traps. The plant operates continuously except for a planned 8 hour shutdown of the boiler per year.		
APPROXIMATE IN-SERVICE DATE	(ongoing but all completed by December, 2012)	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	AGREED.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
439,394	439,394			

REASON FOR AGREEMENT:
Plant steam loads can range from a baseload o[redacted]. Given that the projected 1,759 lb/hr projected steam saving is small in comparison to total steam generation, the impact of this measure is difficult to verify by steam load trending analysis on plant data archives. As such, verification relies on an analytical approach. The performance analysis of a defective steam trap is complex and subject to differing results among equally competent technical resources in the industry. Performance calculations can vary according to assumed factors that are applied in the calculation equations. The following considerations illustrate the inexact science of estimating energy loss from a malfunctioning trap:

- determination of "leaking" vs "blowing" is subjective for each observer
- further complications from both steam and condensate flowing through the orifice of a failed trap
- imperfect orifice in a steam trap does not lend itself to normal calculation methods and other trap internals create unpredictable flow restrictions
- the degree to which a trap is oversized determines the effect that condensate volume has on the amount of steam that can simultaneously pass through the trap orifice.

The inconsistencies in savings calculations from different vendors prompted EGD to commission a bench testing study with the Centre for Thermal Technology at Ecole de Technologie Superieure, per ASTM Performance Test Code PTC 39.1. EGD then adjusted the performance contracting calculations to default values learned from the results of these bench tests. Weighing the inexact nature of widely accepted calculation methods vs the amount of rigor that was put into the bench testing effort, the reviewer must defer to the latter approach and agreement with the calculation methodology by EGD to support the savings claim.

FILE SUPPORTING DOCUMENTATION :
Project file includes steam trap survey report by [redacted] spreadsheet calculations. Installed cost is supported by internal e-mail summary of Labour & Material breakdown. Project file includes detailed [redacted] alculation spreadsheet analysis and EGD calculations that apply bench test correction factors.

REVIEWED BY:	REFERENCE APPENDIX FOR AGREEMENT RATIONALE:
Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	N/A

ENBRIDGE GAS DISTRIBUTION **DSM, Research and Evaluation Dept.** **Engineering Review of 2012 Custom Projects**	**DOCUMENTATION REVIEW SECTOR** **INDUSTRIAL[redacted]** **Stated Measure Life: 25 years** **Reviewer's Opinion: High confidence level**		**EGD PROJECT CODE No.** **RA.IND.EX.RT.021.12** **SITE INVESTIGATION DATE:** **February 27, 2013**
MEASURE	[redacted]		
PROJECT DESCRIPTION	The [redacted] generates [redacted] with embedded energy) that is typically sent to [redacted] This plant currently receives [redacted] from [redacted] of its corporate sources, with an intended receipt of a [redacted] source in the near future. *Partial* burning of this [redacted] to generate steam was formerly accomplished by an [redacted] with the balance of [redacted] still diverted to landfill. In 2012, a [redacted] was installed to replace the [redacted] This enabled *all* [redacted] to be [redacted] to raise steam. Natural gas savings are realized by capturing the embedded energy in a waste stream that would otherwise be sent to [redacted] plus the increased steam generation allows for the least efficient boiler to be idled.		
APPROXIMATE IN-SERVICE DATE	**(commissioning in progress; operation began in August 2012)**	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	**AGREED.**

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m³)		Electricity (kWh)		Water (m³)
EGD file	**Reviewer Adjusted**	**EGD file**	**Reviewer Adjusted**	**EGD file**
[redacted]	[redacted]			

REASON FOR AGREEMENT:
The EGD file's process narrative is well supported by a natural gas and steam energy balance schematic for both the Base Case and Retrofit Case. Also included is an E-Tools based spreadsheet model of fuel and steam for the (3) conventional steam boilers and [redacted] (which was retained following the retrofit). Given the dynamics of many parameters, the outcome of net natural gas offset with the new [redacted] equipmen[redacted] burned/stabilization fuel consumed by [redacted]team generation from natural gas fuel/steam generated by FBB), this review focused on an evaluation of plant metered data for these various parameters. This extensive monitored data is presented in plant daily log spreadsheets, with associated summaries. A copy of the 6-month summary for th[redacted] included in Appendix 'G' for reference) shows a 6-month average [redacted] natural gas consumption o[redacted] SCFH and average steam production of 33,648 lb/hr. These performance parameters were checked against the plant DCS screens during the site visit with photos in Appendix 'G' indicating a firing rate of 33,930 SCFH and steam generation of 34,231 lb/hr, which correlates closely to the archived data averages. A noteworthy observation is that th[redacted] spreadsheet summary indicates a 6-month net natural gas offset of 3,890,103 m³. (This is with only 2/3 of the [redacted] sources and 68% uptime average running percentage, mostly due to a variety of operating trips during commissioning). A simple 12-month linear extrapolation would yield a natural gas offset o[redacted] Also, given the number of trips is expected to decrease and an 80% uptime is projected after year "1", followed by a 90% uptime in Year "2", the system appears to be tracking its expected performance. On the basis of the foregoing, supported by monitored data, the reviewer accepts the savings projections.

FILE SUPPORTING DOCUMENTATION :
Project file includes a process narrative, calculated steam and natural gas flow schematics, E-Tools boiler modeling and vendor proposal data. Installed cost is supported by detailed Labour & Material breakdown.

REVIEWED BY: **Byron Landry, P. Eng., CEM, CEA** **Byron J. Landry & Associates Inc.**	**REFERENCE APPENDIX FOR AGREEMENT RATIONALE:** **Appendix 'G'**

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL [redacted] Stated Measure Life: 15 years Reviewer's Opinion: Moderate confidence level since ventilated area is now rented to outside plant suppliers.	EGD PROJECT CODE No. RA.IND.EX.NRT.038.12 SITE INVESTIGATION DATE: February 25, 2013

MEASURE: Ventilation Reduction Through Equipment Scheduling

PROJECT DESCRIPTION: The plant's conditioned space (formerly operated as the [redacted] area) is now rented to outside suppliers. Utilities are still supplied by the Customer [redacted] Prior to the change in use and occupancy of the space, the servers and hubs which controlled the HVAC system were leased through an IT service provider. Following the change, this leased service was terminated and all control connectivity was lost to the respective HVAC units. This would have left the space in an over-ventilated, heated and cooled mode with all units operating continuously. Accordingly, plant personnel de-commissioned the [redacted] in the poorest condition and refurbished the airhouses required to provide the listed reduced ventilation. The remaining [redacted] then programmed individually through local PLCs to match current production.

APPROXIMATE IN-SERVICE DATE	Began in Fall 2011; all completed by December 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	Add estimated annual electricity savings of 880,023 kWh.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
2,706,940	2,706,940	0	880,023	0

REASON FOR AGREEMENT:

Natural Gas Savings: The EGD file is well documented with calculations based on *measured* exhaust and makeup air volumes before/after the remaining HVAC units were refurbished. Since the (former [redacted] is now operated by an outside [redacted], there is no production output on which to compare energy intensity metrics and plant utilities are only bulk metered. As such, the review had to focus on the documented data and deemed savings estimates, which are sound. The EGD savings estimates are calculated according to bin temperature analysis in E-Tools. The savings are based on reducing continuous ventilation of [redacted] to requirements [redacted] cfm during production periods. This is accomplished by reducing the concurrent operation of [redacted] During non-production periods, continuous ventilation of [redacted] cfm is altered t[redacted] cfm. This is accomplished by reducing the concurrent operation of [redacted] Also included is a reduction in direct fired gas heated ventilation from 80,000 cfm to 40,000 cfm for all times. Spot checks of hand-held digital displays of programmed setpoints were made during the plant walk-through and along with discussions with the programming technician, this effort supported the confidence level on the viability of this project. (As such, no natural gas savings adjustment).

Electricity Savings Adjustment:

Cooling coil and air supply fan estimated electricity consumption is outlined in EGD file as follows:

Base Case: Production [redacted] + non-Prod. [redacted] + Dir. Fired Unit [redacted] = [redacted] kWh

Energy Project: Production [redacted] + non-Prod. [redacted] + Dir. Fired Unit ([redacted] = [redacted] kWh

FILE SUPPORTING DOCUMENTATION:
Project file includes measured air balance data, calculations summary, E-Tools ventilation heating and cooling load modeling and project narrative. Installed cost is supported by internal e-mail cost explanation.

REVIEWED BY:	REFERENCE APPENDIX FOR AGREEMENT RATIONALE:
Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	N/A (Reviewer's site observations are in line with electricity consumption numbers outlined in the EGD file).

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL (Food & Beverage) Stated Measure Life: 25 years Reviewer's Opinion: High confidence level	EGD PROJECT CODE No. RA.IND.EX.NRT.028.12 SITE INVESTIGATION DATE: February 28, 2013
MEASURE	Steam Boiler Replacement with High Efficiency Condensing Boiler	
PROJECT DESCRIPTION	The plant replaced a coil tube steam boiler (rated at 13 MMBH) with (2) high efficiency condensing boilers ([redacted]), each rated at 4.2 MMBH. The boilers serve CIP/Sanitation hot water loads, at a temperature requirement of 150 °F. Energy savings are realized by the removal of an oversized boiler (with its radiation loss), avoidance of blowdown losses and efficiency loss factor of steam/hot water heat exchange, plus the efficiency gain from the condensing feature.	
APPROXIMATE IN-SERVICE DATE	September 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS: AGREED.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
77,055	77,055			

REASON FOR AGREEMENT:

The new boiler bank is equipped with both natural gas and hydronic water meters; however, these have yet to be connected to the plant DCS for data retrieval (due to a dispute with the installation contractor). This situation offers no historical data for comparison following the installation. As such, the review process focused on the data and calculation methodology that is outlined in the project's EGD file. Natural gas fuel savings are estimated on the basis of a 95% boiler efficiency for the new condensing boilers vs 66.3% average net steam/fuel efficiency that is calculated though E-Tools. The temperature assumptions that form the basis of the EGD file calculations were checked against temperature gauge readings on site (observed range of 150 °F to 160 °F hot water temperature to process) and a pipe surface temperature of 46 °F (as measured with the IR temperature gun). Given these observations are in close agreement with the temperature assumptions made in the file and the fact that the calculations took care in factoring the 2,500 hours of usage for the CIP cleaning cycle instead of the full plant operating hours, the reviewer accepts the analysis as presented, with no further adjustments.

FILE SUPPORTING DOCUMENTATION :
Project file includes E-Tools boiler modeling and calculation summary. Installed cost is supported by the plant's identified line items in its Purchase Order to the contractor.

REVIEWED BY:	REFERENCE APPENDIX FOR AGREEMENT RATIONALE:
Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	N/A

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	DOCUMENTATION REVIEW SECTOR INDUSTRIAL [redacted] Stated Measure Life: 20 years Reviewer's Opinion: High confidence level	EGD PROJECT CODE No. RA.IND.EX.RT.024.12 SITE INVESTIGATION DATE: March 6, 2013
MEASURE	Heat Exchanger Heat Transfer Improvement & CIP Optimization	
PROJECT DESCRIPTION	The [redacted] cools [redacted] to reduce temperature for [redacted] through [redacted] heat exchanger. The CIP piping was formerly configured in a long loop, resulting in more frequent CIP cycles being needed to deal with higher than expected fouling of the heat exchanger (impeding optimum heat transfer). Fouling was reduced by modifying the [redacted] pump valves and piping arrangement to enable CIP flow reversal and backwash of the heat exchanger. The addition of this short CIP loop reduces the amount of preheated water usage and prompted a reduction in CIP frequency by optimizing the CIP operating strategy.	

APPROXIMATE IN-SERVICE DATE	November, 2012	AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:	Increase electricity consumption by 9,791 kWh/yr.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Electricity (kWh)		Water (m^3)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
429,103	429,103	0	(-9,791)	44,303

REASON FOR ADJUSTMENT:

Natural Gas: The [redacted] (not continuous) and as such, the water heating loads are calculated on the basis of [redacted] and CIP temperature setpoints. These (confidential) production records (manually recorded) were reviewed on site along with observed temperatures of the day (outlined in Appendix 'H'). Although the CIP temperature of 171 °F varied slightly from the 176 °F temperature that forms the basis of the EGD file calculations, the incoming water temperature was lower and the same ΔT was maintained for the heating. The water (and associated heating savings) are realized by the difference in the [redacted]ater push (15 HL) vs long push (30 HL) and the new CIP requirements (80 HL) vs the base case CIP cycle of (150 HL). The long CIP loop is only activated when they change the [redacted] (For every [redacted]uns they used to do on the long loop, they now only [redacted]. On the basis of the foregoing observations, the estimated natural gas savings are accepted without adjustment.

Electricity: The EGD project file makes no adjustment for the addition of the 20 hp CIP flush pump, which is equipped with VFD (but largely to offer "soft start" capability). Additional electrical loading from new pump installation is projected to add 9,791 kWh per year. (Refer to Appendix 'H' for revision calculations).

FILE SUPPORTING DOCUMENTATION :
Project file includes brewing process narrative, batch process data with associated calculations. Installed cost is supported by detailed Labour & Material cost breakdown.

REVIEWED BY: Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE: Appendix 'H'

3. AGRICULTURAL CUSTOM PROJECT REVIEW SUMMARIES

Detailed summaries for each Custom Application project, with review comments and adjustments, are presented on the pages which follow.

ENBRIDGE GAS DISTRIBUTION DSM, Research and Evaluation Dept. Engineering Review of 2012 Custom Projects	**DOCUMENTATION REVIEW SECTOR** AGRICULTURAL ([redacted] **Stated Measure Life: 20 years** **Reviewer's Opinion: High confidence level**	**EGD PROJECT CODE No.** RA.AGR.EX.NRT.001.12 SITE INVESTIGATION DATE: December 4, 2012
PROJECT MEASURE	Replacement of Industrial Equipment	
PROJECT DESCRIPTION	The plant replaced its 1980-vintage dryer with a more energy efficient, cross-flow, recirculating [redacted] dryer. This site handles and [redacted] Independent performance testing by a third-party consultant from the University of Guelph yielded an energy performance of 1,437 BTU/lb. This result is in close agreement to the dryer manufacturer's claims of the dryer design offering a *moisture removal rate* of 1,400 BTU/lb.	

APPROXIMATE IN-SERVICE DATE	July, 2011 (initial) January, 2012 (refinement commissioning)	**AGREEMENT OR ADJUSTMENT ON ANNUAL SAVINGS PROJECTIONS:**	Decrease annual natural gas avoidance by 36,498 m³.

GROSS ANNUAL ENERGY AND WATER SAVINGS PROJECTIONS

Natural Gas (m^3)		Water (m^3)		Electricity (kWh)
EGD file	Reviewer Adjusted	EGD file	Reviewer Adjusted	EGD file
151,298	114,800			

OBSERVATIONS & REASON FOR ADJUSTMENT:
The savings related to natural gas consumption reduction fo[redacted]dryer systems are difficult to quantify because of the complex variables involved. The performance of these dryers is subject to [redacted] moisture content and is seasonally dependent on [redacted] Historicall[redacted] was received with moisture content ranging from [redacted] During the site visit, a nominal 20% moisture content of [redacted] was observed in the plant's sampling labs. Personnel remarked that this was indicative of 2012 [redacted] due to [redacted] experienced during the [redacted]. As such, estimates of annual energy savings will be subject to varying influencing factors. The approach adopted in the project file to estimate energy savings is based on a comparison of energy intensity for the before/after new installation, since plant instrumentation only displays moisture content, drying temperature an[redacted] auger RPM, with no long term data archiving. The project file establishes a Year 2010 energy intensity of [redacted]/MT for fuel based on [redacted] m³ per total production o[redacted]. A review of updated production data *(ie. type and weigh*[redacted]*rocessed)* with plant management on site revealed the total gas use in 2010 remained unchanged, but total production was [redacted] MT. *This yields an adjusted energy intensity of*[redacted]*/MT.* Also, the project file establishes a Year 2011 energy intensity of [redacted] m³/MT for fuel based on 82,011 m³ per total production of [redacted] MT. A review of updated data with plant management revealed the [redacted] gas use in 2011 was [redacted] m³ per total production of 65,621 MT. *This yields an adjusted energy intensity of* [redacted] *m³/MT.* Year-to-date 2012 production is nominally 66,000 MT, with year-end projections tracking 70,000 MT. Accordingly, the revised energy savings projection would be ([redacted] m³/MT x [redacted] MT = 114,800 m³ of natural gas.

FILE SUPPORTING DOCUMENTATION :
Project file includes process description narrative and energy intensity calculation summary, based on historical fuel consumption, related to production data. Incremental cost for energy efficient features is referenced through correspondence written by the site's Operations Manager.

REVIEWED BY: Byron Landry, P. Eng., CEM, CEA Byron J. Landry & Associates Inc.	REFERENCE APPENDIX FOR ADJUSTMENT RATIONALE: N/A

4. CONCLUDING REMARKS

The site visits offered a visual confirmation that all projects were installed and operating as intended, with the exception of the air handling unit that is returned to service for an indeterminate period of time (RA.IND.EX.NRT.041.12).

Recognizing that metering is a necessary component of an Energy Management Information System and performance monitoring for sustainability, the following table summarizes the observed status of natural gas and water or steam flow sub-metering at the Custom Project sites that were sampled in this review. In (10) out of (17) projects, sub-metering did not exist or was not yet commissioned but this did not impede the review as performance estimates could easily be inferred through analytical techniques, combustion flue gas analysis plus portable flow and temperature measurement by the EGD personnel and other related site data.

EGD Project Code	Status of Natural Gas sub-metering to monitor Energy Measure:
RA.IND.EX.RT.003.12	Equipped with BTU sub-metering for integrated and instantaneous rate of heat recovery.
RA.IND.EX.NRT.007.12	Bulk metering is sufficient to confirm performance as the Project represents about 95% of the natural gas load. Control room is instrumented for critical temperatures.
RA.IND.EX.RT.001.12	Critical Supply/Return temperatures and flows are displayed on PLC screen.
RA.IND.EX.RT.012.12	Equipped with natural gas sub-metering.
RA.IND.EX.NRT.009.12	No natural gas sub-metering. Performance had to be inferred.
RA.IND.EX.NRT.012.12	No natural gas sub-metering. Performance had to be inferred.
RA.IND.EX.RT.014.12	No natural gas sub-metering. Performance had to be inferred.
RA.AGR.EX.NRT.001.12	Bulk metering is sufficient to confirm performance as the Project represents almost all of the natural gas load
RA.IND.EX.RT.018.12	No natural gas sub-metering. Performance had to be inferred.
RA.IND.EX.NRT.039.12	No natural gas sub-metering. Performance had to be inferred.
RA.IND.EX.NRT.040.12	No natural gas sub-metering. Performance had to be inferred.
RA.IND.EX.NRT.041.12	No natural gas sub-metering. Performance had to be inferred.
RA.IND.EX.RT.033.12	Steam savings small in proportion to steam trending data. Performance had to be inferred.
RA.IND.EX.RT.021.12	Equipped with natural gas and steam sub-metering. Critical parameters are displayed on DCS screen.
RA.IND.EX.NRT.038.12	No natural gas sub-metering. Performance had to be inferred.
RA.IND.EX.NRT.028.12	Equipped with both natural gas and hydronic water sub-meters; however, these have yet to be connected to the plant DCS for data retrieval. Performance had to be inferred.
RA.IND.EX.RT.024.12	No natural gas sub-metering. Performance had to be inferred.

Appendix A. Natural Gas and Electricity Savings Adjustment Supporting Data for EGD Project Code RA.IND.EX.RT.003.12 (30-day Performance Trend for Condensing Economizer and Glycol Pump Data)

REDACTED

Appendix B. Natural Gas Savings Agreement rationale for EGD Project Code RA.IND.EX.NRT.007.12 (Control Room Instrumentation Capture)

REDACTED

Appendix E. Natural Gas Savings Agreement rationale for EGD Project Code RA.IND.EX.NRT.039.12 (EMS Screen Capture)

[redacted]

REDACTED

Appendix H. Natural Gas Savings Agreement supporting data and Electricity Adjustment rationale for EGD Project Code RA.IND.EX.RT.024.12 (Plant process data log summary and DCS Screen Captures of new CIP Pump)

REDACTED

SEC Interrogatory #5

	Original Assumptions in the Application				Assumptions used by the Verifier				Final Assumptions Approved by the Auditor				Process for Each Change	CCM Impact
	EGD Reported Annual Gross Gas Savings	Measure Life	Lifetime Savings (CCM)	Technical Parameters	Verifier Adjusted Annual Gas Savings	Measure Life	Adjusted Lifetime Savings (CCM)	Technical Parameters	Auditor Adjusted Annual Gas Savings	Measure Life	Adjusted Lifetime Savings (CCM)	Technical Parameters		CCM Difference from Claimed Amount to Audited Amount
	m3	yrs	m3		m3	yrs	m3		m3	yrs	m3			
1	1,224,675	15	9,185,070	Makeup water (MUW) rate = 52 usgpm, MUW Temp = 50 F Temp entering economizer = 200 F Operating hours = 8500 Heat source: 15.4 MMBtu/hr, Heat Sink = 3.84 MMBtu/hr	1,367,663	15	10,257,473	Makeup water (MUW) rate = 68 usgpm, MUW Temp = 58 F Temp entering economizer = 185 F Operating hours = 8500 Heat source: 15.4 MMBtu/hr, Heat Sink = 4.335 MMBtu/hr	1,367,663	15	10,257,473	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	The Verifier reviewed EGD assumptions and calculations and compared EGD technical parameters with the data gathered during site visit. the Verifier revised calculations , using revised performance data and adjusted the final claim accordingly.	1,072,403
2	93,135	20	931,360	Base Case Exhaust Temp = 320 F, EE Case Temp = 250 F Base Case Energy Intensity = 9.82, EE Case EI = 8.31	93,135	20	931,360	EE Exhaust Temp = 229 F EE Case EI = 8.29	93,135	20	931,360	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
3	99,396	15	745,470	MUA Unit flow = 2 x 12,000 cfm, Delta T = 28 F Hours = 3,988, Boiler Eff. = 80% Heat Exchanger Capacity = 725,227 Btu/hr	95,533	15	716,498	Glycol loop flowrate: 356 usgpm, Tsup = 70.5 F, Tret = 63.3 F when Toutdoor = 22 F Hours from Environment Canada Data, Eff. 80% Heat Exchanger Capacity = 725,227 Btu/hr	95,533	15	716,498	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	The Verifier reviewed EGD assumptions and calculations and compared EGD technical parameters with the data gathered during site visit. the Verifier revised calculations , using revised performance data and adjusted the final claim accordingly.	(28,973)
4	551,852	18	4,966,668	Annual Production = 200,000 tpy Base Case Reg, Yb=10.308 * P + 2472.1 , r2 = 0.93 EE Case Reg, Yn=9.1067 P + 2622.4, R2=0.92	551,852	18	4,966,668	Site visit verified that the parameters used in the regression were correct.	551,852	18	4,966,668	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
5	206,565	20	2,065,660	Throughput = 5,275,348 lb/yr, moisture = 73% Base Case: Burners (3 x 1.5MMBtu/hr), 3 x 1800 cfm exh fans EE Case: Burners (1 x 1.8 MMBtu/hr), 2 x 720 cfm VFD exh fans Texh = 300 F Base Case Input Energy = 131,12 MMBtu/yr EE Case Input Energy = 5,769 MMBtu/yr	206,565	20	2,065,660	Equipment specification same as in Application Texh = 302 F (spot reading considered to be close to the average used in the Application Reviewed and confirmed saving calculations	206,565	20	2,065,660	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
6	81,726	25	1,021,575	Base Case Boilers (3 x 3.5 MMBtu/hr) EE Case Boilers (1 x 9 MMBtu/hr) Base Case gas consumption = 639,246 m3/yr Base Case Measured Boiler Eff. = 68.9 % EE Case Measured Boiler Eff. = 79%	81,726	25	1,021,575	Base Case Eff. = 65% (agreed with EGD value to be conservative) Base Case production = 200 - 220 units Base Case Water Tout =193 F EE Case Water Tout = 230 F (increased output @ higher eff.)	81,726	25	1,021,575	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
7	50,715	20	507,160	Water flow = 6 gpm Tin = 50 F, Tout = 107, Boiler Eff. = 75%	86,810	20	868,100	Water flow = 27 liter per min (7.13 usgpm) Tin = 50 F, Tout = 133 F (actual measurements) Boiler Eff. = 75%	86,810	20	868,100	The Auditor reviewed Verifier's changes via a conference call and agreed with the justification to increase the savings.	The Verifier reviewed EGD assumption, followed by on-site measurements. The verifier discussed the changes with EGD and Auditor over the phone. Two sources of discrepancy were identified: I). EGD had considered 6 gpm to be as USgpm whereas it was measured in Imperial gpm ii). EGD had used a lower Tout (107 F vs. 133 F)	360,940
8	341,227	20	3,412,280	Base Case: Water flowrate = 25 usgpm Tin = 55 F, Tout =150 F of Heater (Eff 56%) Tin to steam HX = 150 F, Tout of steam HX = 170 F Base Case Gas Consumption = 472,555 m3/yr EE Case: Recover 25 usgpm @ 120 F and heat to 170 F in a new heater (Eff 91%) EE Gas Consumption = 131,329 Gas Savings = 341,227 m3/yr	288,267	20	2,882,670	Recovered Water flowrate = 20 usgpm Tin = 53 F, Tout =120 F of Heater (Eff 56%) Heat Content of that would be drained = 1,232,143 Btu/hr Displaced old heater load to heat water (122 F to 160 F) =714,286 Btu/hr New direct fire heater load (122 F to 160 F) = 439,560 Btu/hr Steam HX from 160 F to 170 F constant for before and after (net zero) Net Savings = 1,232,143 - 439,560 + 714,286) Btu/hr Nat gas equivalent = 288,267 m3/yr	341,227	20	3,412,270	Recovered Water flowrate = 25 usgpm (reinstated) The savings from this project come as a result of capturing waste heat from a process water chain. During the CPSV process and site visit, only 20 gpm of the intended 25 gpm of recovery flow had been connected and commissioned. Though the intent to complete the project was apparent, the CPSV firm with the support of the auditor, opted to verify only those savings achieved as of the site visit In May the auditor was informed by Enbridge that the balance of the project had been completed and commissioned. Supporting statements and photos from the participant were provided as a means of verification of project completion. The Auditor deemed it appropriate to reinstate the full annual savings originally claimed.	The Verifier's site visit revealed that only 80% of the intended heat reclaim sources were connected. The Auditor reviewed Verifier's changes via a conference call and agreed with the justification to decrease the savings, pending project completion. The remaining 20% reclaim source was connected and verified by EGD. Customer confirmation and pictures were provided to the Auditor to show the project completion. After reviewing the documentation, the Auditor reinstated the full saving originally claimed by EGD.	
9	4,744,064	15	35,580,480	Base Case: Outside air during Production = X cfm (confidential) Outside air during non-Production = X cfm (same as above) Balance point = 42.5 F Fresh air = 50% EE Case: Outside air during Production = 47% of X cfm Outside air during non-Production = 19% of X cfm Balance point = 42.5 F Fresh air Production = 50% Fresh air non-Production = 25% Environment Canada Weather Bin Data used for both cases	4,744,064	15	35,580,480	Verified capabilities and operation of the EMS, inspected AHUs, captured and analyzed EMS screen data, validated positive air balance conditions, reviewed site conditions. Agreed with technical parameters reported in the original application.	4,744,064	15	35,580,480	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
10	2,716,995	15	20,377,470	Base Case: Outside air during Production = Y cfm (confidential) Outside air during non-Production = Y cfm (confidential) Balance point = 42.5 F Fresh air = 50% EE Case: Outside air during Production = Y cfm (confidential) Outside air during non-Production = 6% of Y cfm Balance point = 42.5 F Fresh air Production = 50% Fresh air non-Production = 25% Environment Canada Weather Bin Data used for both cases	2,716,995	15	20,377,470	Verified capabilities and operation of the EMS, inspected AHUs, captured and analyzed EMS screen data, validated positive air balance conditions, reviewed site conditions. Agreed with technical parameters reported in the original application.	2,716,995	15	20,377,470	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
11	1,311,369	15	13,113,700	Base Case: Air balance: 100% fresh air All process and building exhaust goes to atmosphere EE Case: Recover and reuse exhaust air volume = 126,900 scfm Winter mode: Air Temp (Inline 43 C, Evap Cooler 22 C) Humidity = 65% Summer mode: Air Temp (C. coil 19.5 C, Reheat Coil 22.7 C) Humidity = 65%	785,375	15	7,853,750	Site visit verified that ,of the 126,900 cfm claimed, only 76,000 cfm were recovered and reused. The other 50,900 cfm had to be removed from the exhaust heat recovery to avoid humidity control issues resulting from the full reuse and reclaim of all 126,900 cfm. Since the cfm is directly proportionaly to gas saving, the saving adjustment was made accordingly to account for reduced amound of exhaust cfm reclaimed.	785,375	15	7,853,750	The Auditor reviewed Verifier's analysis and kept the file open to see if the remaining (126,900 - 76,000 = 50,900 cfm)will be recovered as suggested by the customer during the Verifiers site visit. The Auditor reported the reduced savings in the final report to reflect site conditions since the full savings did not materialize due to operational issues.	The Verifier's site visit revealed that only 60% of the intended exhaust air was recovered and reused for process air heating and humitdy control. Customer explained the reason for not recovering the total amount of exhaust air - It was causing operational issues. Customer had planned to modify control strategy during the 2013 Spring shut to recover the remaining 40% of exhaust air volumes, but could not do it for various reasons. The Auditor reported the reduced saving in the final report.	(5,259,950)
12	439,394	5	1,098,485	Steam loss = 1759 pph Operating hours = 8760 Boiler Eff. 75%	439,394	5	1,098,485	The Verifier reviewed the total steam load and confirmed that the steam trap losses are only ess than 3% of total steam produced. The reviewer checked the steam loss calculations and agreed with the savings claimed.	439,394	5	1,098,485	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
13	7,569,342	25	94,616,775	Modeled the existing steam plant using EGD Industrial eTools. Calibrated model using actual combustion test data and steam plant gas consumption data. Modeled the new steam plant steam production and gas consumption profile Compared the new profile with the base case to calculate Gas Savings	7,569,342	25	94,616,775	The Verifier used the actual 6-month steam production and gas consumption data to verify gas savings. The Reviewer analysis showed that the claimed savings were on conservative.	7,569,342	25	94,616,775	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
14	2,706,940	15	20,302,050	Base Case: Air volume = Z1 cfm during production (confidential) Air volume = Z2 cfm during non-production (confidential) Air volume in a direct fired MUA unit = 80,000 cfm EE Case: Air volume = 52% of Z1 cfm during production Air volume = 52% of Z2 cfm during non-production Air volume in a direct fired MUA unit = 40,000 cfm Environment Canada Weather Bin Data used for both cases	2,706,940	15	20,302,050	During the site visit, the Verifier validated technical parameters used in the application. Reviewed saving calculations and verified saving claim.	2,706,940	15	20,302,050	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
15	77,055	25	963,200	Base Case: Steam Boiler = 13 MMBtu/hr Fuel-to-steam efficiency = 66.3 % Steam flow = 2416 pph EE Case: Condensing Hydronic Boilers = 2 x 4.2 MMBtu/hr Boiler efficiency = 95% Hot water flowrate = 48 usgpm Water supply temp = 150 F Savings based on EGD Ind eTool	77,055	25	963,200	Equipment specification same as in Application Water supply temp = 150 to 160 F (measured) Tsurface = 46 F Reviewed and confirmed saving calculations	77,055	25	963,200	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
16	429,103	20	4,291,040	Base Case: Water used = 660,000 HL/yr Delta T = 126 F EE Case Water used = 216,000 HL/yr Delta T = 126 F	429,103	20	4,291,040	During the site visit, the Verifier validated technical parameters used in the application. Reviewed saving calculations and verified saving claim.	429,103	20	4,291,040	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	Not applicable	
17	151,298	20	1,815,580	Base Case Energy Intensity = 3.37 m3/ MT Base Case Production = 56,668 MT EE Case Energy Intensity = 1.23 m3/MT EE Case Production = 66,785 MT	114,800	20	1,377,600	During the site visit, the Verifier found discrepancies in the technical parameters used in the application as compared to site conditions The Verifier adjusted the gas savings using the following parameters: Base Case Energy Intensity = 2.92 m3/MT Base Case Production = 65,341 MT EE Case Energy Intensity = 1.28 m3/MT EE Case Production = 70,000 MT	114,800	20	1,377,600	The Auditor reviewed Verifier's analysis and agreed with his assumptions and conclusions	The Verifier review EGD assumptions and calculations. The site visit revealed discrepancy between the EGD data and the actual data. the Verifier revised calculations , using revised performance data and adjusted claim downwards accordingly.	(437,980)

SEC INTERROGATORY #6

INTERROGATORY

[B/2/1, p. 12]

Please provide complete details of the oversight and review of the CPSV studies and results, by both the Auditor and the Audit Committee, relating to the 2012 results. Please provide details of all changes that have been made to the process of implementation, oversight and review of CPSV studies of custom projects subsequent to the review of the 2011 results.

RESPONSE

The Custom Project Savings Verification ("CPSV") is an annual process conducted by independent third party engineering firms, retained by Enbridge, to review the reasonableness of a random sample of claimed custom project savings. The 2012 CPSV process occurred from November 2012 to March 2013. The process was divided into two Waves - Wave 1 based on a random sample of custom projects claimed from January to September 2012 and Wave 2 from a random sample of custom projects claimed from January to December 2012.

The 2012 random sample was based on the 2012 Sampling Methodology developed by Navigant Consulting through the TEC.

The contract for the 2012 Auditor was awarded on January 7, 2013, much earlier in the CPSV process than in 2011, where the contract was awarded on February 29th, 2012. The intention was to allow the Auditor the opportunity to review, discuss, and recommend on the CPSV Wave 1 Draft Reports and participate in "real time" reviews of Wave 2 projects. The Auditor also had two conference calls with the Audit Committee ("AC") during their work on the CPSV to provide useful insights and seek guidance from the AC. These meetings were scheduled on an as needed basis. The level of involvement of the Auditor as well as the elected AC members in the 2012 CPSV process was substantially greater than in 2011.

Witnesses: F. Oliver-Glasford
R. Sigurdson

SEC INTERROGATORY #7

INTERROGATORY

[B/1]

Please confirm that it is Enbridge's policy that a customer will not be solicited for a DSM program if it is already known that they will be a free rider. By way of example, and without limiting the generality of the question, if a customer has already announced or made a commitment to implement an energy conservation measure without any knowledge of the relevant Enbridge DSM program, Enbridge employees will not solicit the customer to participate in that DSM program, nor will Enbridge provide an incentive to that customer.

RESPONSE

The intent of DSM is to promote energy efficiency to all of our customers and impact their purchasing decisions such that they undertake better options.

Through evaluation and audit processes Enbridge establishes that it provides influence on customer's decisions to participate in DSM programs. In particular, free riders applied at the aggregate level are designed to identify the percentage of customers that would have undertaken the projects without our involvement, and ensure that the Company does not achieve an incentive for those free riders.

As part of the 2012 Audit recommendations, Enbridge has agreed to provide the required documentation to substantiate the Company's involvement for each project prior to project completion.

Witnesses: P. Goldman
F. Oliver-Glasford
J. Paris
R. Sigurdson
J. Tideman

SEC INTERROGATORY #8

INTERROGATORY

[B/2/1, p. 12 et seq.]

Please provide details of how Enbridge reflects in custom project reviews and results the advancement of a measure that would have otherwise been implemented by the customer at a later date. How is advancement treated differently from replacement at the time old equipment fails, for example? How is the baseline 3 calculated differently depending on whether it is known that a measure would have been implemented, without Enbridge's program, in a subsequent year? What direction is given to CPSV contractors, or the Auditor, with respect to either the treatment of advancement, or the calculation of baselines, for custom projects?

RESPONSE

The Enbridge boiler advancement measure is applied only to "boilers", which have not reached their measure life expectancy, are still in service and are maintained. If the term "old equipment fails" infers that the boiler is beyond the measure life and can no longer be serviced then the boiler advancement process would not be applied; the boiler replacement process would be applicable.

To receive the boiler incentive where the boiler advancement measure applies (as stated above) the installed boiler must exceed the base case boiler requirements of that year. The advancement time is the difference between the install date and the measure life of the boiler and the savings calculation requires three seasonal efficiencies: existing boiler system, base case boiler system, and higher efficiency boiler system. Since the measure life provides a reasonable lifetime of the product then a change out of the boiler prior to end of measure life represents a savings greater than the boiler replacement measure, and our incentive program is only provided if a high efficiency boiler system is installed (exceeded the base case). Since the customer is making their choice to install the boiler in this year as opposed to future subsequent years (i.e. when the boiler has reached its measure life) the base case used is for this year. The present "base case" (assumption that this is what is referred to as "Baseline" in the question) calculation is the same for the boiler advancement and boiler replacement measures.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead

The CPSV Contractors and the Auditor have been informed that Enbridge has a boiler advancement measure and a boiler replacement measure and as to the differences in calculations between the two measures, (as indicated above). They have also been informed and advised as to how the CCM and the base case are calculated for custom DSM boiler projects.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead

SEC INTERROGATORY #9

INTERROGATORY

[B/2/1, p. 12]

Please provide a complete list of all changes that any of the CPSV contractors made to their preliminary views or conclusions subsequent to communications relating to those conclusions with Enbridge employees. In each case where a change occurred, please provide the CPSV contractor's initial opinion, the input from Enbridge, and the final conclusion in their report. Please provide copies of all communications between Enbridge and the CPSV contractor with respect to each such change.

RESPONSE

The three Contractors that were retained by Enbridge were engaged to complete independent reviews of the custom projects which are identified in the reports of the Contractors. Consistent with this, Enbridge did not direct or dictate to the contractors any results or findings which would have influenced the independence of the Contractors and their opinions. Contrary to the assumption which underlies this interrogatory, Enbridge did not require the Contractors to change their views or findings. There are therefore no communications which instruct the Contractors to change their views. The Company did provide each of the Contractors with voluminous materials and information at various times which relate to the custom projects which are the subject of their reports. The reports and opinions of the Contractors are based upon the materials and information provided as well as their professional expertise.

Given the above, Enbridge does not understand that the question asks for the production of all of the voluminous materials and information provided to the Contractors. Accordingly, the Company has not spent the considerable time that would be required to consolidate and produce these materials in the response to this interrogatory. In addition, Enbridge questions how the production of these voluminous materials would be of assistance to the parties and the Board.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

In the interests of confirming the integrity of the process, the following is a summary of the Company's response to the changes proposed by a CPSV Contractor.

List of Projects where Commercial CPSV Contractor made a Change to Original Claim

PROJECT CODE	Measure	EGD Reported Annual Gas Savings	Lifetime Savings (CCM)	Verifier Adjusted Annual Gas Savings	Adjusted Lifetime Savings (CCM)	Auditor Adjusted Annual Gas Savings	CCM
		m3	m3	m3	m3	m3	m3
RA.GOV.EX.006.12	BAS Scheduling of building AHU, ventilation	291,503	3,847,840	254,939	3,365,195	264,012	3,484,958
RA.PRO.EX.008.12	Steam condensate Drain Water Heat Recovery	137,346	3,021,612	123,846	2,724,612	125,596	1,657,867
RA.LOG.EX.002.12	Destratification fans	215,256	2,841,379	215,256	2,841,379	477,904	6,308,333
RA.PRO.EX.038.12	new recirculation air ducting and controls to reduce Ventilation air, addition of night setback control	227,556	3,003,726	106,627	1,407,476	134,233	1,771,876

Project: RA.GOV.EX.006.12
Project Title: BAS scheduling of building AHU, ventilation

CPSV Contractors Initial Position	Input from Enbridge	Final Conclusion in the report
This was a very difficult project to calculate saving for as there were several air handling units involved most where the schedule is the same however several had differenct schedules, also the building uses steam generated by natural gas offsite which makes the project that much more difficult. Verifier decided to use actual steam billling information to confirm energy savings using their own spread sheet for this project.	The Verifier's CUSUM spread sheet utilized a balance point temperature of 15 C in the base case and 17 C for the proposed and Normalized case. These were not the values that EGD calculated. EGD requested the Verifier to examine these input assumptions.	The Verifier agreed that the balance point temperatures were not reasonable and corrected these to 16 C balance point for all components of the analysis.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

Project: RA.PRO.EX.008.12
Project Title: Steam condensate Drain Water Heat Recovery

CPSV Contractors Initial Position	Input from Enbridge	Final Conclusion in the report
The Verifier created their own temperature bin analysis spread sheet to calculate the projected energy savings for this measure. Key to this spread sheet is the normalized annual steam consumption assumption. Their original normalization approach was to average 5 consequtive years prior to the conversion.	EGD pointed out that the accepted method of normalizing weather data is to use canadian climate design data. Which would increase the annual steam consumption for this site	The Verifier agreed with EDG and used climate design data to calculate the normalized steam consumption. This updated value was input into their spread sheet providing the final result

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

Project: RA.LOG.EX.002.12
Project Title: De-stratification fans

CPSV Contractors Initial Position	Input from Enbridge	Final Conclusion in the report
The savings measure had been installed and is working as expected. They confirm that the savings was calculated based on the EGD destratification calculation method which calculates the reduction of energy loss through the building envelope when the indoor air temperature is destratified. Temperature measurements taken confirm the destratification process however they could not confirm the original conditions used as the base case, or confirm the envelope insultaion level or infiltration rate. Therefore actual gas billing information was used to trend the savings. Their initial evaluation convirmed that the ongoing savings was exceeding the EGD calculated value therefore they elected to accept the original EGD savings and be conservative.	Updated gas billing information was provided for the 2 billing accounts for this building. A CUSUM statistical analysis was provided outlining the actual saving for 2012 and a normalized projection of saving, a balance point of 17.1C was established	The Verifier was satisfied that the statistical CUSUM analysis projected normalized gas saving was reasonable and was attributed to the savings measure.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

Project: RA.PRO.EX.038.12

Project Title: new recirculation air ducting and controls to reduce Ventilation air, addition of night setback control

CPSV Contractors Initial Position	Input from Enbridge	Final Conclusion in the report
Verifier confirmed that a significant group of ventilation DSM measure were installed in this building however they believed the EGD documents did not clearly evaluate them. They produced their own evaluation and definition of the HVAC measures installed. In addition, this building and another not part of the measure are on the same steam metering device therefore it was unclear what the base energy consumption is. The Verifier reduced the steam base load to be more in line with the highest consuming office buildings.	The building HVAC scheduling identified by the Verifier did not match what EGD had been told. The Verifier was informed and the operating issues were addressed to the building with a request for operation details. The building operator provide greater clarity of the system operation, in emails.	With the additional clarification of the HVAC operation solicited by EGD the Verifier made adjustments to their saving calculation.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

List of Projects where Industrial CPSV Contractor made a Change to Original Claim

EGD Project Code	Measure	EGD Reported Annual Gross Gas Savings	Liftime Savings (CCM)	Verifier Adjusted Annual Gas Savings	Adjusted Lifetime Savings (CCM)	Auditor Adjusted Annual Gas Savings	Adjusted Lifetime Savings (CCM)
		m3	m3	m3	m3	m3	m3
RA.IND.EX.RT.003.12	Steam Boiler Plant Condensing Economizer	1,224,675	9,185,070	1,367,663	10,257,473	1,367,663	10,257,473
RA.IND.EX.RT.001.12	Chiller Heat Recovery	99,396	745,470	95,533	716,498	95,533	716,498
RA.IND.EX.RT.014.12	Process Water Recycling and Heat Reclaim	50,715	507,160	86,810	868,100	86,810	868,100
RA.IND.EX.RT.018.12	Process Water Recycling and Heat Reclaim	341,227	3,412,280	288,267	N/A	341,227	3,412,270
RA.IND.EX.NRT.041.12	Reuse of Conditioned HVAC Air by a Cascade System	1,311,369	13,113,700	785,375	7,853,750	785,375	7,853,750
RA.AGR.EX.NRT.001.12	Replacement of Industrial Equipment	151,298	1,815,580	114,800	1,377,600	114,800	1,377,600

Project: RA.IND.EX.RT.003.12
Project Title: Steam Boiler Plant Condensing Economizer

CPSV Contractor's Initial Opinion	Input from Enbridge	Final Conclusion in the Report
EGD claim is based on a lower makeup water flowrate. The actual flowrate is higher, contribution to higher amount of heat recovered by the condensing economizer	EGD took a conservative approach at the time of submitting the project.	Upward adjustment in the original claim

Project: RA.IND.EX.RT.001.12
Project Title: Chiller Heat Recovery

CPSV Contractor's Initial Opinion	Input from Enbridge	Final Conclusion in the Report
EGD methodology was based on a block number of annual hourly occurrences below 50 F . The contractor used a different approach and broke down the amount of heat recovered to match with the monthly heating load, based on monthly mean temperatures published by Environment Canada.	EGD agreed with Contractor's approach	A slight downward adjustment in the original claim

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

Project: RA.IND.EX.RT.014.12
Project Title: Process Water Recycling and Heat Reclaim

CPSV Contractor's Initial Opinion	Input from Enbridge	Final Conclusion in the Report
The EGD project file had used a water flowrate of 6 gpm at a temperature of 107 F. The saving calculations had assumed the water flowrate to be in US gallons whereas it was measured in Imperial gallons. During the site visit, the CPSV consultant also measured the water temperature to be at 133 F vs. 107 F reported in saving calculations.	EGD agreed with corrections and associated energy saving calculations as suggested by the Contractor	Upward adjustment in the original claim

Project: RA.IND.EX.RT.018.12
Project Title: Process Water Recycling and Heat Reclaim

CPSV Contractor's Initial Opinion	Input from Enbridge	Final Conclusion in the Report
The EGD file calculations are based on 25 usgpm reclaim water flowrate. The site visit revealed that 20 ugpm is reclaimed as intended, whereas a 3rd source (5 usgpm) has yet to be connected. There appears to be high likelihood of this 3rd source to be connected to the reclaim system in the near future. The revised energy savings were calculated at 234,371 m3.	• EGD agreed with Contractor's site observations and promised to follow up with the customer to determine the cause of delay in connecting the 3rd source. • EGD reviewed Contractor's savings calculations and identified a discrepancy in a calculation that was using 72.6% efficiency instead of 56%. • The 3rd washer was connected as intended during a	The Auditor ("ERS") reinstated the original claim since hot water from all sources (25 usgpm) was being reclaimed.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

	plant shutdown in May. The Auditor (ERS) was advised about this upgrade with supporting documentation (pictures, customer email)	

Project: RA.IND.EX.NRT.041.12
Project Title: Reuse of Conditioned HVAC Air by a Cascade System

CPSV Contractor's Initial Opinion	Input from Enbridge	Final Conclusion in the Report
The EGD calculations are based on recovering and reusing 126,900 cfm of exhaust air to heat the process air. Although the total amount of heat was recovered as intended when the project started, humidity control issues prompted to remove 50,900 cfm from the exhaust heat recovery. Since gas savings are directly proportional to the amount of exhaust heat reclaimed, the savings were adjusted to account for reduced air volumes. Although plant personnel have expressed strong opinion to start recovering the full amount of exhaust cfm, the Contractor did not see a definitive plan in place to start recovering the full amount of exhaust air.	• EGD agreed with Contractor's site observations. • EGD followed up with customer to determine if and when the full amount of heat could be reclaimed • Customer suggested they will try to implement during Easter shut down. • Provided customer response to the CPSV firms. • Customer was unable to implement during Easter shutdown	The savings were reduced by 40%.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

Project: RA.IND.EX.NRT.001.12
Project Title: Replacement of Industrial Equipment

CPSV Contractor's Initial Opinion	Input from Enbridge	Final Conclusion in the Report
The EGD claim is based on a Base Case (Before) energy intensity of 3.37 m3/MT, using 2010 data for gas consumption and production. The Contractor's review of updated production data during site visit revealed a higher production for 2010, reducing the energy intensity to 2.92 m3 / MT. The project file establishes an energy intensity of 1.23 m3/MT for the Energy Efficiency (After) case. A review of the updated data with the plant management revealed an energy intensity of 1.28 m3 / MT.	• Advised CPSV firm that EGD energy intensity was calculated based on the data provided by the customer. There must be a discrepancy in the data provided to EGD and the CPSV firm. • EGD agreed with the CPSV firms energy intensity calculations.	The savings were reduced by 25%.

Witnesses: F. Oliver-Glasford
R. Sigurdson
T. Whitehead
A. Zaidi

IGUA INTERROGATORY #1

INTERROGATORY

[Reference: ExB/T1/S1/p.59]

Please explain the “-8%” allocation number for Rate 115 at the right hand side of the table, which number is repeated in a separate list following the table.

RESPONSE

The -8% number reflects the contribution of the rate 115 volume variance of 794,350m^3 to the total volume variance of 9,830,426m^3.

Witnesses: F. Oliver-Glasford
R. Sigurdson

IGUA INTERROGATORY #2

INTERROGATORY

[Reference: ExB/T1/S1/p.66]

The table indicates that Rate 115 DSM programming accessed $702,852 in program spending during 2012 in addition to the amount budgeted for spending in this rate class. This additional spending is driving the roughly $9,000 average annual bill impact on rate 115 customers proposed for approval in this application (see Ex.B/T4/S1/p. 2).

(a) Please indicate the budgeted spending amount for rate 115 in 2012.

(b) Please provide details of how the additional, unbudgeted funds were spent for rate 115 DSM programming in 2012.

(c) Please confirm adherence to the parameters of the Settlement Agreement applicable to 2012 in respect of DSM spending for rate 115, providing or reproducing copies of the relevant passages from the Settlement Agreement in support of such confirmation.

RESPONSE

(a) The budgeted spending amount for rate 115 in 2012 was $349,479 as shown in Table 1 below. This includes Program Costs, contribution to Low Income costs and Overheads.

Table 1

Rate 115 Budgeted DSM spending

Rate	Program Costs	Low Income	Overheads	Total Budget
115	$247,885	$34,276	$67,319	$349,479

Witnesses: F. Oliver-Glasford
R. Sigurdson

(b) The budgeted program spending for Rate 115 was $247,885 as shown in Table 2 below.

In 2012, there were more projects than expected from Rate 115 customers, resulting in incremental program spending of $576,383 for Rate 115.

The DSMVA (shown in Table 2. Exhibit , Tab 1, Schedule 1, page 66) includes the variance in all DSM spending: Program costs, Low Income and Overheads. As with all rates, Rate 115 supported a portion of the Low Income program costs which were over budget by 14%. As well, the Rate 115 allocation of overhead costs reflects the increase in program spending over budget for this rate class.

Table 2 below shows the budget and actual costs for Rate 115 in all three categories and the total DSMVA for Rate 115 ($702,852)

Table 2

		Rate 115		
	Program costs	Low Income	Overheads	Total
Budget	$247,885	$34,276	$67,319	$349,479
Actual	$824,268	$39,909	$188,154	$1,052,331
Variance	($576,383)	($5,633)	($120,835)	($702,852)

(c) As per the Settlement Agreement, the program spending (excluding overheads and Low Income) for rates 110, 115, and 170 is capped at $2,709,000.

> However, the parties agree, for 2012 only, that the total budget spent on programs and activities (not including overheads, Market Transformation, and Low Income Allocations) for all customers in rate classes 110, 115 and 170 shall not exceed $2,709 million, of which the total budget spent on programs and activities (not including overheads and low Income Allocations) for industrial customers in those rate classes shall not exceed $1,797 million. (EB-2011-0295, Exhibit B, Tab 2, Schedule 9, Page 14-15.)

As shown in Table 3 below, program spending for the 3 rates was $1,616,738, well within the cap of $2,709,000.

Witnesses: F. Oliver-Glasford
R. Sigurdson

Table 3

Rate	Program Costs
110	$459,338
115	$824,268
170	$333,132
Total	$1,616,738
Cap	$2,709,000

Witnesses: F. Oliver-Glasford
R. Sigurdson