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Exhibit B
Tab 1

Final
Demand Side Management
2014 Annual Report

December 4, 2015

unionGas
A Spectra Energy Company

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Glossary of Terms

Adjustment Factor The adjustment factor reflects the percentage of savings being claimed. Typically, adjustment factor inputs include the percentage of participants who installed a prescriptive measure (and kept it installed) which is determined by conducting verification studies.

Audit The Audit is an annual process to validate Union's DSM results. A third party auditor is hired to conduct the Audit. While hired by Union, the auditor is independent and ultimately serves to protect the interests of ratepayers with respect to Union's DSM claims.

Audit Committee ("AC") The AC consists of four members: three intervenor members selected by the DSM Consultative and one representative from Union.

Avoided Costs Avoided costs are a measurement of the reduction in the delivered costs of supplying all resources (natural gas, electricity and water) to customers as a consequence of a program.

Base Case The base case is a projection of the future without the effects of the utility's DSM program. The difference between the base case and the energy efficient case represents the saving attributable to the energy efficient measure.

Building Envelope The building envelope refers to the exterior surfaces (such as walls, windows, roof and floor) of a building that separate the conditioned space from the outdoors.

Channel Partner A Channel Partner is a company that, in the course of its business, can influence consumers to choose gas over competing fuels, or one method of increasing energy efficiency over another. Examples of Channel Partners include appliance retailers, HVAC contractors, engineers and architects.

Cost Effectiveness Cost effectiveness refers to the analysis that determines whether or not the benefits of a project/measure are greater than the costs. It is based on the net present value of savings over the equipment life of the measures.

Demand Side Management ("DSM") DSM is the modification in end-use customer demand for natural gas through conservation programs. While the focus of Union's DSM is natural gas savings and the reduction in greenhouse gases emissions, it may also result in the saving of a number of other resources such as electricity, water, propane, and heating fuel oil.

Demand Side Management Incentive Deferral Account ("DSMIDA") The account to record the shareholder incentive amount earned by Union as a result of its DSM programs.

Demand Side Management Variance Account ("DSMVA") The account used to track the variance between actual DSM spending by rate class versus the budgeted amount included in rates by rate class. Union may record in the DSMVA in any one year, a variance amount of no more than 15% above its DSM budget for that year.

Direct Access ("DA") Budget Mechanism The DA budget mechanism is offered to Union's largest industrial customers (Rate T2 and Rate 100). It provides each customer dedicated access to the customer incentive budget they pay in their rates to support energy efficiency projects and studies on an annual basis.

Discount Rate The interest rate used to calculate the net present value of expected yearly benefits and costs. The Ontario Energy Board ("the Board") directed the Utilities to use a rate equal to the approved weighted average cost of capital ("WACC").

DSM Incentive The incentive available to Union for achieving Board-approved performance targets.

Effective Useful Life ("EUL") EUL is the length of time that a piece of equipment or measure is anticipated to last and perform as expected.

Evaluation, Measurement & Verification ("EM&V") The activities undertaken to assess the implementation and performance of a program.

Free Ridership Free riders are program participants who would have installed the energy efficient measure without the influence of Union's DSM programs. Free rider rates are estimated based on research, market penetration studies or through negotiations in prior evaluation processes. The free rider rates are applied to the gross program savings results to derive actual savings.

Incentive An incentive is a payment from Union to DSM participants to encourage participation in a DSM program.

Incremental Cost The incremental cost is the difference in price between the high efficiency case and the base case.

Input Assumptions Assumptions such as operating characteristics and associated units of resource savings for a list of DSM technologies and measures. These cover a range of typical DSM activities, measures and technologies with residential, low-income, commercial and industrial applications.

Lifetime Cumulative cubic meters ("cumulative m^3") Total natural gas savings over the effective useful life of a DSM measure. Frequently used at the measure or program level and can also summarize the benefits of an entire portfolio.

Lost Revenue Adjustment Mechanism ("LRAM") The LRAM is the Board's approved method by which utilities recover the lost distribution revenues associated with DSM activity. These lost revenues are calculated for contract rate classes impacted by DSM energy efficiency programs.

Market Transformation Market Transformation facilitates fundamental changes that lead to greater market shares of energy efficient products and services.

Measure A measure is any particular energy efficient technology (e.g. a low-flow showerhead, an energy recovery ventilator, condensing boiler, etc.).

National Account National Account customers are those customers that have multiple property locations and are similar in design and use. National Account customers include retail chains, property management firms and foodservice chains.

Net Present Value ("NPV") The NPV is the sum of the discounted yearly benefits arising from an investment over the lifetime of that investment.

Net-to-Gross Ratio Gross impacts are the program impacts prior to accounting for program attribution effects. These attribution effects are free ridership and spillover. Net impacts are the program impacts once program attribution effects have been accounted for. The net-to- gross ratio is defined as 1 – (free ridership ratio) + (spillover ratio).

Offering A DSM offering exists where there are either bundles of energy efficiency measures or performance/maintenance based enhancements to existing measures marketed together (e.g. energy savings kits, home retrofit measures, custom equipment/process/O&M) or where support is delivered through a suite of services (e.g. customer engagement, site energy assessments, etc.).

Part 3 Building The Ontario Building Code lists a Part 3 Building as exceeding 600m^2 in building area or greater than three storeys in height. Classified as assembly occupancies, care or detention occupancies, high hazard industrial occupancies, residential occupancies, business and personal services occupancies, mercantile occupancies, or medium and low hazard industrial occupancies.

Part 9 Building The Ontario Building Code lists a Part 9 Building as three or fewer storeys in building height and having a building area not exceeding 600m^2. Classified as residential occupancies, business and personal services occupancies, mercantile occupancies, or medium and low hazard industrial occupancies.

Participants The units used by Union to measure participation in its DSM programs. Participant units of measurement include customers, projects and measures or technologies installed. Not all participants result in energy savings.

Persistence Persistence is the extent to which a DSM measure remains installed and performing as originally predicted. Persistence of DSM savings takes into account how long a DSM measure is kept in place relative to its useful life, the net impact of the measure relative to the base case scenario, and the impact of technical degradation.

Prescriptive Offering A prescriptive DSM offering is a natural gas savings measure/technology that is based on previously substantiated and pre-approved inputs. Prescriptive DSM measures apply to all of Union's customer market segments including residential, low-income, commercial and industrial.

Program A program is the utility specific approach to providing one or more DSM offerings to customers.

Program Costs DSM program include the following components:

- Development and Start-up
- Promotion
- Delivery
- Evaluation, Measurement and Verification ("EM&V") and Monitoring
- Administration

Of the above costs, only start-up, promotion, delivery, and a portion of the evaluation and verification costs are applicable to individual programs. Other costs related to the design and deliveries of DSM programs are appropriately considered at the DSM portfolio level. These include development, a portion of the evaluation costs, monitoring, tracking and administration costs.

Program Evaluation Program evaluation refers to activities related to the collection, analysis, and reporting of data for purposes of measuring program impacts from past, existing or potential program impacts.

Realization Rate A realization rate is the ratio that compares verified and audited savings to the savings originally calculated for custom projects. Realization rates are used to extrapolate verified and audited savings from a sample of projects on to all projects.

Research Costs Research costs are Union's costs associated with the research and evaluation of DSM programs. They are not included in direct costs because they may affect more than one program.

Resource Acquisition Programs that seek to achieve direct, measurable savings customer-by-customer through the incenting/promotion of specific energy efficiency upgrades.

Social and Assisted Housing Residential social housing includes all non-profit housing developed, acquired or operated under a federal, provincial or municipally funded program including shelters and hostels.

Spillover Spillover effects refer to customers that adopt energy efficiency measures because they are influenced by a utility's program related information and marketing efforts, but do not actually participate in the program.

Technical Evaluation Committee ("TEC") The TEC consists of seven individuals: three intervenors members selected by intervenors, a representative from Union, a representative from Enbridge, and two independent members with technical and other relevant expertise. The goal of the TEC is to establish DSM technical and evaluation standards for natural gas utilities in Ontario. The TEC makes recommendations to the Board on the annual Technical Reference Manual ("TRM") update.

Total Resource Cost Test ("TRC") The TRC Test provides a measure of the benefits and costs that accrue as a result of the installation of a DSM measure.

Trade Allies Trade allies include organizations (e.g. architectural and engineering firms, building contractors, appliance manufacturers and dealers, and banks) that influence the energy-related decisions of customers who might participate in DSM programs.

Units Units provided within report tables can represent different items, such as the number of measures installed or homes retrofitted, depending on the program being reported on. Units are not equivalent to the number of participants since a single participant can install several units.

Executive Summary

2014 is the eighteenth year that Union Gas Limited (Union) has delivered natural gas savings to its customers through cost effective Demand Side Management (DSM) programs. Union's DSM programs support residential, low-income, commercial and industrial customers to realize energy savings and environmental benefits by providing energy efficiency education, awareness and incentives. To date, Union's commitment to DSM initiatives has translated to approximately 1.400 billion m^3 of annual natural gas savings, equivalent to more than $2.786 billion in net Total Resource Cost benefits. As the third year within the construct of EB-2011-0327, 2014 represented opportunities to drive deeper savings for customers.

Success in 2014 includes strong program performance within the Resource Acquisition, Low-Income and Market Transformation scorecards. Of particular note are an increase in participation in the Residential Home Reno Rebate program; a rebranding of the Low-Income Home Weatherization Program offering to target specific market segment needs; partnering with over 25 key associations to communicate the benefits of Commercial/Industrial energy conservation programs; and having over 25% of the top 50 home builders in Union's franchise area build a portion of their respective housing stock to efficiencies 20% higher than the current Ontario Building Code.

Key evaluation priorities at the Technical Evaluation Committee (TEC) included the development of the Technical Reference Manual as well as the launch of the custom net-to-gross impact evaluation study, which both contribute to the continual improvement of DSM technical and evaluation standards for natural gas utilities in Ontario.

The company is pleased to report that the 2014 DSM portfolio generated 1.889 billion m^3 of cumulative natural gas savings with a program spend that was $33.714 million, or 5.19% over the 2014 DSM budget of $32.049 million. This achievement earned Union a Utility Shareholder Incentive of $8.988 million.

Union celebrates the success of its 2014 DSM programs and the associated significant energy reductions that ratepayers have realized.

1. Introduction

This Demand Side Management (DSM) Annual Report presents a retrospective of Union's energy efficiency initiatives and results in terms of scorecards, budget spend, DSM Incentive, and Lost Revenue Adjustment Mechanism (LRAM) for 2014. It also provides an avenue for Union to benchmark the results in this third year under the 2012-2014 multi-year DSM plan, highlight successes and lessons learned, and summarize evaluation work conducted.

Union's 2014 DSM portfolio included programs directed towards Residential, Commercial/Industrial, Low-Income, Market Transformation and Large Volume Rate T1, Rate T2/Rate 100 customers as listed below:

Residential Program

- Energy Savings Kit Offering
- Home Reno Rebate Offering

Commercial/Industrial Program

- Prescriptive and Quasi-Prescriptive Offering
  - Water Heating Initiatives
    - Condensing Gas Water Heaters
    - Ozone Laundry Equipment
  - Space Heating Initiatives
    - Air Curtain Technology
    - Condensing Boilers
    - Condensing Make-up Air Units
    - Destratification Fans
    - Energy Recovery Ventilators and Heat Recovery Ventilators
    - High Efficiency Non-Condensing Boilers
    - Infrared Heaters
    - Demand Control Ventilation
  - Commercial Kitchen Initiatives
    - Energy Star Fryers
    - Demand Control Kitchen Ventilation
    - Energy Star Dishwashers
- Custom Offering
  - Customer Engagement – Communication and Education
  - Engineering Feasibility and Process Improvement Studies
  - Operation and Maintenance
  - New Equipment and Processes
  - Energy Management

Low-Income Program

- Home Weatherization Program Offering
- Affordable Housing Conservation Offering

Large Volume Program

- Custom Offering
  - Customer Engagement – Communication and Education
  - New Equipment and Processes
  - Operations and Maintenance
  - Process Improvement Studies
  - Engineering Feasibility Studies
  - Steam Trap Surveys
  - Boiler Tune-ups
  - Infrared Anti-Condensate Polyethylene Plastic

Market Transformation Program

- Optimum Home

Major cumulative m^3 drivers for the 2014 DSM efforts are outlined in Figure 1.0.

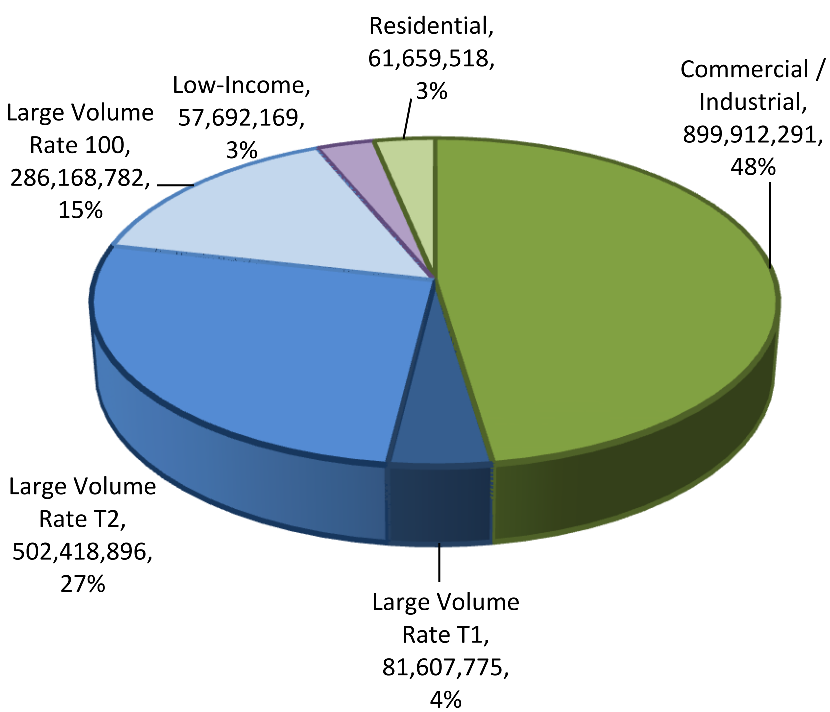

Figure 1.0, Major Drivers in Natural Gas Savings (Cumulative m^3 and Percentage)

2. Demand Side Management Framework

2.1 Union Gas 2012 – 2014 DSM Plan

In 2014, Union entered the third year of the EB-2011-0327 multi-year 2012-2014 DSM Plan which was filed on September 23, 2011 in accordance with the Board's Demand Side Management Guidelines for Natural Gas Utilities ("Guidelines") EB-2008-0346. Union subsequently entered into a settlement process with all intervening parties.

On January 31, 2012, Union filed its Settlement Agreement ("Agreement") and on February 21, 2012, the Board approved Union's 2012-2014 DSM plan based on the terms outlined in the Agreement.

Union's Large Volume DSM program filed in the 2012-2014 DSM Plan Settlement Agreement in EB-2011-0327 applied for 2012 only. As part of the Agreement, Union committed to file a new application and evidence with the Board supporting a Large Volume Rate T1 and Rate 100 DSM plan for 2013 and 2014. A decision on this Large Volume DSM Plan EB-2012-0337 was rendered on March 19, 2013 approving 2013-2014 DSM programming for Large Volume customers, as described in section 6.1.

In Union's 2013 Cost of Service Application EB-2011-0210, it was proposed to split Rate T1 into two rate classes to address diversity between smaller and larger customers within the T1 rate class. This rate change was effective as of January 1, 2013 and remained in place for 2014.

Union's DSM activities are continuing to drive market change through focused efforts on delivering natural gas savings and related customer benefits.

2.2 Terms of Reference for Stakeholder Engagement

As part of the Guidelines, the Board recommended that Union and Enbridge consult with their stakeholders with respect to their DSM plans and develop joint Stakeholder Engagement Terms of Reference (ToR) for the purpose of outlining a stakeholder engagement process. Following a series of joint utility stakeholder consultation sessions, a joint ToR was developed and filed with the Board.

The ToR goes beyond the minimum requirements for consultation as presented in the Guidelines, Section 16.1. The objective and purpose of the ToR is to clarify and define the roles and responsibilities of intervenors, other stakeholders, the utilities, and the Board with respect to participating in the DSM stakeholder engagement process. These include processes relating to program design, DSM measure input assumptions, evaluation research, and the audit of DSM program annual results.

As described in the ToR, the stakeholder engagement process includes the establishment of a common Technical Evaluation Committee (TEC) and a separate Audit Committee (AC) for each utility.

2.3 Technical Evaluation Committee

The goal of the TEC is to establish DSM technical and evaluation standards for natural gas utilities in Ontario.

As described in the ToR, the TEC will endeavor to:

- Make recommendations to the Board on the annual Technical Reference Manual (TRM). This manual will document measure savings assumptions and all other cost effectiveness screening data;
- Produce and maintain a prioritized annual work list (by consensus);
- Establish evaluation priorities and specify future evaluation studies to be undertaken – execution of all work defined by the TEC is subject to the utilities' resource constraints (such as funding, personnel resources, time limitations); and
- Review and reach consensus on the design and implementation of evaluation studies.

The TEC is comprised of three intervenor representatives, representatives from both natural gas utilities, and two independent members. The 2014 TEC members were as follows: Jay Shepherd (School Energy Coalition), Julie Girvan (Consumers Council of Canada), Chris Neme (Green Energy Coalition), Ravi Sigurdson (Enbridge Gas), Tina Nicholson (Union), Ted Kesik (Ph.D., professor of building science at University of Toronto), and Bob Wirtshafter (Ph.D., DSM planning and evaluation, market research and program design expert).

In 2014 the TEC proceeded with various evaluation priorities as identified by the TEC. The details of these efforts are outlined in Section 9.

2.4 Audit Committee

The purpose of the AC is to ensure that there is, each year, an effective and thorough audit of the utility's DSM results.

The AC's scope of work includes:

- Establish the standard scope of the annual audit for the term 2012 to 2014 – goals versus tasks;
- Utilize the standard scope for the 2012 to 2014 term as part of the Request for Proposal (RFP) and the AC may alter the scope annually based on consensus;
- Provide the auditor with input and guidance; and
- Make recommendations on the Audit Report regarding the utility's claims regarding DSM results and DSMVA, LRAM and utility incentives and future targets through the AC Report submitted to the Board.

The AC consists of four members; three intervenor members and one utility representative. The 2014 AC members are as follows: Vince DeRose (Canadian Manufacturers and Exporters), Judy Simon (Low-Income Energy Network), Kai Millyard (Green Energy Coalition) and Tina Nicholson (Union).

2.5 Program and Portfolio Design

As prescribed in the Guidelines, Union's DSM program activities fall within three program types:

- Resource Acquisition
- Low-Income
- Market Transformation

Resource Acquisition programs seek to achieve direct, measureable savings for an individual customer and involve the installation of energy efficient equipment.

Low-Income programs are similar in nature to Resource Acquisition programs, but are treated independently to recognize the unique needs of this customer base and that they may result in lower TRC net savings than non low-income programs.

Market Transformation programs focus on facilitating fundamental changes that lead to greater market shares of energy efficient products and services. They influence consumer behaviour and attitudes in support of reducing natural gas consumption.

2.6 Cost Effectiveness Screening

The Board mandates cost effectiveness screening as the means for determining the economic value of a DSM program. As per the Guidelines, the Total Resource Cost (TRC) test is used to screen for cost effectiveness at the program level. TRC benefits include the avoided costs associated with natural gas, electricity, and water savings over the life of the energy efficient equipment. TRC costs include the incremental equipment costs[1] associated with the energy efficient equipment in relation to its less-efficient equivalent, as well as any program, administrative, and evaluation costs attributed directly to the program.[2] Resource Acquisition programs are considered cost effective if the ratio of the *present value of the TRC benefits* to the *present value of the TRC costs* exceeds 1.0. To recognize that low-income natural gas programs may result in benefits not captured by the TRC test, these programs are screened using a TRC threshold of 0.7. Market Transformation programs are assessed on their own merits based on the objectives of the program.

2.7 Program Evaluation

There are two broad categories of evaluations: impact evaluation and formative evaluation. Impact evaluations focus on participation and related savings resulting from DSM programs, while formative evaluations focus on the effectiveness of program design and delivery, and assess why program outcomes occur.

One of the guiding principles of the TEC is to provide stakeholder input to the development of evaluation priorities for the natural gas utilities. From a broader DSM framework perspective, program impact and formative evaluation activities as well their associated budgets are managed by the utilities.

[1] Incremental costs include capital, cost of removal less salvage value, installation, operating and maintenance and/or fuel costs.

[2] By definition of the TRC test, incentive costs provided to program participants are benefits to participants and are not included as TRC costs.

As part of Union's commitment to DSM, impact evaluation studies are performed annually to examine the accuracy of claimed savings. Impact evaluations undertaken in 2014 are presented in Section 8 of this report.

2.8 Audit of the 2014 DSM Annual Report

To substantiate Union's DSM Portfolio results, this DSM Annual Report is subject to an independent external audit. The AC selected Evergreen Economics to conduct the audit for the 2014 program year. The intention of the audit is to confirm to the Board stakeholders that claimed DSM savings are correct and that the DSM Incentive and LRAM calculations are appropriate. The Auditor provides a final opinion on whether the claimed DSM Incentive amount, LRAM, and Demand Side Management Variance Account (DSMVA) have been correctly calculated using reasonable assumptions. As described in Section 2.4, Union's 2014 AC plays an advisory role throughout the audit to facilitate the achievement of the audit objectives.

3. Overall 2014 DSM Program Results

With spending of $33,713,796, Union's DSM program generated 1,889,459,431 cumulative m³ in natural gas savings for customers. As illustrated in Figure 3.0, the Commercial / Industrial program delivered the largest portion of savings in 2014, followed by the Large Volume, Low-Income and Residential programs respectively.

Figure 3.0, 2014 Cumulative Gas Savings by Program (Percentage)

Table 3.0 summarizes Union's DSM results by program for 2014, including annual and cumulative natural gas savings, number of units, expenditures, and the associated net TRC and TRC ratio.

Table 3.0 - 2014 Program Results

Program	Annual Net Gas Savings (m3)	Cumulative Net Gas Savings (m3)	Units	Expenditures	Net TRC	TRC Ratio
Residential	4,130,902	61,659,518	46,967	$ 3,687,750	$ 7,496,238	1.98
Commercial / Industrial	54,199,307	899,912,291	3,914	$ 12,741,393	$ 18,019,127	1.18
Low-Income	2,724,216	57,692,169	1,947	$ 8,529,346	$ (1,498,788)	0.81
Large Volume	70,770,597	870,195,452	207	$ 4,101,725	$ 86,957,726	4.15
Optimum Home	NA	NA	NA	$ 1,262,958	NA	NA
Program Subtotal	**131,825,022**	**1,889,459,431**	**53,035**	**$ 30,323,172**	**$ 110,974,303**	**1.79**
Portfolio Costs				$ 3,390,624		
Portfolio Total				**$ 33,713,796**	**$ 107,724,898**	**1.75**

DSM costs are detailed on a program level in Table 3.1.

Table 3.1 - 2014 Direct DSM Program Costs

Program	Administration	Evaluation	Promotion	Incentives	2014 Total
Residential	$ 532,284	$ 173,300	$ 1,280,974	$ 1,701,192	$ 3,687,750
Commercial/ Industrial	$ 2,786,916	$ 103,687	$ 1,184,752	$ 8,666,038	$ 12,741,393
Low-Income	$ 825,767	$ 243,580	$ 1,235,066	$ 6,224,933	$ 8,529,346
Large Volume	$ 771,923	$ 108,595	$ 3,446	$ 3,217,761	$ 4,101,725
Optimum Home	$ 400,117	$ 0	$ 114,717	$ 748,124	$ 1,262,958
Program Total	**$ 5,317,007**	**$ 629,162**	**$ 3,818,955**	**$ 20,558,048**	**$ 30,323,172**
Portfolio Costs					
Research					$ 834,986
Evaluation					$ 398,782
Administration					$ 2,156,856
Portfolio Total					**$ 3,390,624**
Total 2014 Spend	**$ 5,317,007**	**$ 629,162**	**$ 3,818,955**	**$ 20,558,048**	**$ 33,713,796**

Net annual and cumulative savings[3] are provided in Table 3.2.

Table 3.2 - 2014 Net Natural Gas Savings

Program	Offering	Annual Net Gas Savings (m3)	Cumulative Net Gas Savings (m3)
Residential	Energy Savings Kit	2,788,541	35,141,167
	Home Reno Rebate	1,342,361	26,518,351
Residential Total		**4,130,902**	**61,659,518**
Commercial/Industrial	Prescriptive	11,275,675	216,057,244
	Custom	42,923,632	683,855,047
Commercial/Industrial Total		**54,199,307**	**899,912,291**
Low-Income	Affordable Housing Conservation	1,277,353	21,586,843
	Home Weatherization Program	1,446,863	36,105,327
Low-Income Total		**2,724,216**	**57,692,169**
Large Volume	Rate T1	4,194,776	81,607,775
	Rate T2	40,465,390	502,418,896
	Rate 100	26,110,432	286,168,782
Large Volume Rate T1, Rate T2, and Rate 100 Total		**70,770,597**	**870,195,452**
Optimum Home		NA	NA
Optimum Home Total		**NA**	**NA**
Portfolio Total		**131,825,022**	**1,889,459,431**

[3] Gross annual and cumulative gas savings total 267,465,238 m^3 and 3,752,365,743 m^3 respectively. Gross savings refer to the results of Union's 2014 DSM programs without the exclusion of free riders.

4. Resource Acquisition Scorecard

Union has three performance metrics on its resource acquisition scorecard with results attributable to programs addressing the residential and commercial/industrial markets. Resource acquisition programs are programs that seek to achieve direct, measureable savings for customers through the installation of energy efficient equipment and/or energy management systems, as well as identifying and implementing process improvements and/or operation and maintenance activities.

For residential customers, these programs are oriented toward rebates for installing energy efficient water or space heating equipment or home building envelope upgrades.

Programs designed for commercial customers include incentives to invest in energy efficient technologies geared for new and existing commercial buildings such as the purchase and installation of efficient heating, ventilating and air conditioning (HVAC) systems, and custom solutions specific to the customer's building and/or process needs. Due to the unique nature of industrial customers, solutions for these customers tend to be custom designed and engineered to meet the requirements of the customer's facility.

Union recognizes the inherent value contained in the educational content of its programs and continues to develop and refine the customer awareness and educational components of its resource acquisition programs.

Table 4.0 presents the results of the resource acquisition scorecard, which illustrates an achievement of 150% of the overall scorecard target, resulting in an incentive of $5.667 million.

Table 4.0 - 2014 Resource Acquisition Scorecard Results

Metrics	Metric Target Levels			Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
	Lower Band	Target	Upper Band				
Cumulative Natural Gas Savings (m^3)	591,060,012	788,080,016	985,100,020	90%	961,571,810	144%	130%
Deep Savings – Residential	204	254	304	5%	996	842%	42.1%
Deep Savings - C/I	8.97%	9.97%	10.97%	5%	7.88%	-5%	0%
						Total Scorecard Target Achieved	150%[4]
						Scorecard Incentive Achieved	$5,666,634

As outlined in the Settlement Agreement, for the purpose of the Residential Deep Savings scorecard metric, homes have only been included if they a) achieve a minimum gas savings of 11,000 cumulative m^3 (based on HOT2000 software used in EnerGuide mode), and b) implement a minimum of two major measures. In addition, the aggregate of all of the homes counted towards the Residential Deep Savings metric must have achieved on average at least a 25% reduction in annual gas usage for space and water

[4] Scorecard is capped at 150%. Actual scorecard achievement is 172%.

heating (also based on HOT2000 software used in EnerGuide mode). Free ridership and spillover do not get included in the calculations for this metric. The current major measures are:

- Heating system replacement
- Water heating system replacement
- Attic insulation
- Wall insulation
- Basement insulation
- Draft-proofing (minimum reduction of at least 10% as measured by a blower door test)
- Window replacements
- Drain water heat recovery

Commercial/Industrial Deep Savings calculations are based on the percentage of baseline consumption achieved within all Commercial/Industrial custom projects undertaken in the program year. Union has calculated this metric by comparing the forecast weather normalized annual gas savings for all Commercial/Industrial custom projects against the actual consumption of the participants in those projects for the immediately preceding year. Actual 2013 consumption data for commercial customers with weather sensitive loads has been weather normalized for this calculation, whereas industrial process demands do not fluctuate as a result of weather and therefore have not been weather normalized. For any customer who completed a Commercial/Industrial custom project and also had a prescriptive measure installed, the savings relating to the prescriptive measure have also been included for the purpose of calculating the normalized annual gas savings. Savings associated with custom projects for new construction were not included in this metric.

Table 4.1 presents the results of the Residential and Commercial/Industrial resource acquisition programs. The total spend includes all program costs including incentives.

Table 4.1 - 2014 Resource Acquisition Program Results

Program	Offering	Units	Annual Net Gas Savings (m^3)	Cumulative Net Gas Savings (m^3)	Total Spend	Net TRC	TRC Ratio
Residential	Energy Savings Kit	45,967	2,788,541	35,141,167	$ 3,687,750	$ 7,496,238	1.98
	Home Reno Rebate	1,000	1,342,361	26,518,351			
Commercial/ Industrial	Prescriptive	3,326	11,275,675	216,057,244	$ 4,957,137	$ 10,878,036	1.77
	Custom	588	42,923,632	683,855,047	$ 7,784,256	$ 7,141,092	1.09
2014 Resource Acquisition Total		**50,881**	**58,330,209**	**961,571,810**	**$ 16,429,143**	**$ 25,515,365**	**1.24**

4.1 Residential Program

Residential offerings are designed to achieve savings related to space and water heating for Union's residential individually metered residences. These offerings are marketed to residential customers and are delivered through a variety of channels including direct mail and third party delivery agents. Strategic efforts to cost effectively promote energy efficiency within Union's residential customer base included working with new partnerships, existing trade allies and partners, as well as customer promotions. In 2014, Union focused on the Energy Saving Kit (ESK) offering (Section 4.1.1) and the Home Reno Rebate (HRR) offering (Section 4.1.2).

Table 4.2 shows the results of the Residential program and Table 4.3 breaks down the total spend into its components.

Table 4.2 - 2014 Residential Program Results

Program	Offering	Units	Annual Net Gas Savings (m^3)	Cumulative Net Gas Savings (m^3)	Total Spend	Net TRC	TRC Ratio
Residential	Energy Savings Kit	45,967	2,788,541	35,141,167	$ 3,687,750	$ 7,496,238	1.98
	Home Reno Rebate	1,000	1,342,361	26,518,351			
2014 Residential Total		**46,967**	**4,130,902**	**61,659,518**	**$ 3,687,750**	**$ 7,496,238**	**1.98**

Table 4.3 - 2014 Residential Program Spend

Item		Total
Incentives	$	1,701,192
Administration	$	532,284
Evaluation	$	173,300
Promotion	$	1,280,974
2014 Total Residential Program Spend	**$**	**3,687,750**

Table 4.4 shows the calculation of the Residential program's TRC ratio. With a TRC ratio of 1.98, the Residential program's net TRC benefits are nearly double its net TRC costs.

Table 4.4 - 2014 Residential Program Cost-Effectiveness

	TRC Benefits (a)	TRC Costs (b)	Net TRC (c)=(a-b)	TRC Ratio (d)=(a/b)
Measures	$ 15,133,938	$ 5,651,142	$ 9,482,796	2.68
Administration		$ 532,284		
Evaluation		$ 173,300		
Promotion		$ 1,280,974		
Residential Program Total	**$ 15,133,938**	**$ 7,637,700**	**$ 7,496,238**	**1.98**

4.1.1 Energy Savings Kit Offering

In 2014 Union distributed 45,967 Energy Savings Kits (ESKs). As the market saturates, the future strategy will be to reduce, but not eliminate this offering to ensure that the residential market as a whole continues to have access to low cost/no cost energy efficiency measures.

ESKs are pre-packaged measures designed to reduce a customer's energy demand and water consumption. Each ESK contains the following components:

- Energy efficient showerhead (1.25 GPM)
- Energy efficient kitchen aerator (1.50 GPM)
- Energy efficient bathroom aerator (1.0 GPM)
- Pipe wrap (two 1 meter lengths)
- 1 roll of Teflon tape for ease of showerhead installation
- ESK Installation Guide and MyAccount paperless brochure
- $25 Programmable Thermostat rebate coupon

Target Market

The ESK offering is targeted to Union residential customers who have not previously received a kit and who live in detached or semi-detached houses or individually metered row townhouses. Customers must also have a natural gas water heater. Customers must have a natural gas furnace to be eligible for the programmable thermostat.

Market Incentive

All water saving measures in the ESK are provided at no cost to the customer. A $25 coupon for the programmable thermostat is also included in the ESK.

Market Delivery

In 2014, the primary delivery approach for the ESK offering was the ESK door-to-door initiative. This was one of the most strategic delivery methods for ESKs as it specifically targets those remaining customers who have not yet received an ESK. A secondary delivery approach taken by Union was online ordering through the Union website. These two delivery methods were supported by a combination of other channels that included pick-up depots, Heating Ventilation and Air Conditioning (HVAC) partnerships and coupons received through bill inserts. HVAC partnerships and pick-up depots were phased out in June 2014, because they were determined to be a less cost effective means of distribution than door-to-door or online ordering.

Calculation of Savings
Union conducted an impact evaluation for the ESK offering to verify installation and usage of measures. This impact evaluation determined the number of ESK measures that were installed and remained installed for 2014, the portion of showering that was attributable to the ESK showerhead, and the percentage of ESK recipients that used a natural gas water heater to heat their home's water. Through these efforts, the impact evaluation provides adjustment factors that are applied to the savings claims. See section 8.1.1 of this report for further details.

ESK Door-to-Door Distribution Initiative

In 2014, Union continued to use a door-to-door distribution approach to reach customers who had not yet received an ESK. The door-to-door distribution made participation simple and easy for customers. Union's delivery agent deployed technicians in field to visit pre-identified customers with free ESKs in the following cities:

- London
- Milton
- Oakville
- Hamilton

A week prior to field visits, Union mailed a marketing promotional postcard to each pre-identified customer notifying them that Union would be in their neighbourhood delivering a free ESK through its delivery agent over the next few days.

Figure 4.0, Marketing Promotional Postcard for Door-to-Door Distribution

Delivery agent technicians wore a uniform and were equipped with an identification badge that also featured the Union logo. Customers that received an ESK were asked to sign a customer acknowledgment form for tracking and reporting purposes and if a customer was not home, a door-hanger was left behind to encourage customers to call a toll free number or go to www.uniongas.com/esk to order an ESK. A total of 33,399 ESKs were delivered through the door-to-door channel.

Figure 4.1, Door Hanger for Door-to-Door Distribution

Pick-up Depots Partnership Initiative

Union continued to partner with strategically located retail stores that served as distribution centres for ESKs within Union's franchise until this ESK delivery approach was phased out June 30th, 2014. Examples of these stores were Home Depot and Sears as well as HVAC partners who own a showroom. In 2014, customers accessed a total of 1,717 ESKs through pick-up depots.

HVAC Partnership Initiative

This channel is designed to influence energy conservation decisions at the point of purchase. Incentives are paid directly to HVAC partners for the distribution or installation of an ESK or programmable thermostat. For 2014, the following incentives were available to qualified HVAC partners:

- $20 for the distribution of an ESK to a qualified Union customer;
- $40 for the installation of an ESK to a qualified Union customer; and
- $25 for the sale and installation of a programmable thermostat.

The result of these HVAC partnership initiatives in 2014 amounted to 175 ESKs installed and 2,420 ESKs distributed.

Union phased out this delivery channel at the end of June 2014.

Figure 4.2, ESK Pick-up Depot Promotional Material

Bill Insert Coupons and Online Initiative

In 2014, Union continued to provide awareness to customers of its ESK offering through bill inserts in February and April 2014. The bill insert provided information on the components of the ESK and directed customers to Union's website to order an ESK online. Alternatively, the customer could complete the ESK coupon on the bill insert and send it to Union by mail.

In 2014, customers received a total of 5,978 ESKs by ordering online. An additional 2,278 ESKs were provided by filling in an ESK coupon and sending it to Union by mail.

Figure 4.3, ESK Bill Insert Promotional Material

As described above, Union used a multi-channel approach to deliver ESKs to the residential market. The results for each are shown in Table 4.5.

Table 4.5 - 2014 ESK Distribution Summary by Channel

Door-to-Door	Pick-up Depots	HVAC Installed	HVAC Distributed	Online Requests	Bill Insert Coupons	Total
33,399	1,717	175	2,420	5,978	2,278	45,967

Programmable Thermostat

In 2014, Union promoted a $25 on-bill rebate for the purchase and installation of a programmable thermostat to its customers. This rebate, offered in the form of a coupon, was distributed through a number of channels:

- Bill inserts
- ESK insert
- HVAC dealers
- Union website

Figure 4.4, Programmable Thermostat Bill Insert

In order to receive the on-bill rebate, customers are required to submit their active Union account on the completed coupon indicating whether they are replacing a non-programmable thermostat and provide proof of purchase for the programmable thermostat.

Partnership with Green Impact Guelph (GIG)

A partnership between Union, City of Guelph, Guelph Hydro and Guelph Environmental Leadership (GEL) was part of the City of Guelph's delivery strategy that offers a free personalized in-home basic audit, completed by GEL. The audit aims to identify water and energy saving opportunities and conducts retrofits on-site where appropriate, including installation of ESK components.

Figure 4.5, Green Impact Guelph Program Overview

The GIG pilot program was promoted using flyers, posters, door hangers and through collaboration with local neighbourhood groups and community groups/institutions (i.e. schools, churches, etc.). All promotions focused solely on the targeted neighbourhood and did not include the broader community.

To be eligible, a participant must be:

- A resident of a detached, semi-detached or townhouse/row-house located in the city of Guelph constructed prior to 1996, with permission from the owners; and
- Be serviced by city of Guelph municipal water and wastewater system, Guelph Hydro Electric Systems Inc. and Union.

As a result of Union completing a door-to-door campaign in the Guelph market, Union ended its involvement in this partnership in 2014.

4.1.2 Home Reno Rebate Offering

The Home Reno Rebate (HRR) offering encourages homeowners to install two or more measures in their homes to:

- Achieve significant energy and money savings each year;
- Put a stop to costly home energy loss;
- Enjoy a home that is warmer in the winter and cooler in the summer;
- Avoid unsightly mould and condensation that can be caused by poor insulation; and
- Improve health through better indoor air quality.

In 2014, HRR measures had a 15 year effective useful life (EUL) if renovations included a furnace replacement and a 25 year EUL if renovations did not include a furnace replacement.

Deep Savings Homes

Deep Savings Homes must achieve a minimum gas savings of 11,000 lifetime m^3 (based on pre-installation and post-installation energy modelling using HOT2000 software in EnerGuide mode) and implement a minimum of two major measures.

In 2014, the HRR offering included 996 Deep Savings Homes.

Table 4.6 outlines the total number of measures installed in Deep Savings Homes as well as the percentage of total gas savings each measure type represents. Table 4.7 shows total cumulative gas savings of Deep Savings Homes based on whether or not the homes installed a new furnace.

Table 4.6 - 2014 Deep Savings Homes Measure Summary

Measure	Number Installed	Percentage of Total Deep Homes Savings*
Attic Insulation	407	11%
Basement Insulation	370	16%
Draft Proofing	946	17%
Furnace	534	36%
Wall Insulation	291	16%
Water Heater	77	1%
Window	279	3%

*When two or more measures are installed in a home, interactive effects between measures may lead to reduced total savings in comparison to savings expected from the same measures installed in isolation. The reported percentages omit any interactive effects.

Table 4.7 - 2014 Deep Savings Homes With and Without Furnace Installs

Install Type	Number of Homes	Average Annual Gas Savings (m^3)	Total Cumulative Gas Savings (m^3)
With Furnace	534	1,547	10,533,859
Without Furnace	462	1,623	15,929,893

Non-Deep Savings Homes

Non-Deep Savings Homes are homes that did not achieve the minimum gas savings of 11,000 lifetime m^3 (based on HOT2000 software used in EnerGuide mode). In 2014, 4 homes were considered Non-Deep Savings Homes.

Table 4.8 outlines the total number of measures installed in Non-Deep Savings Homes as well as the percentage of total gas savings each measure type represents. Table 4.9 shows total cumulative gas savings of Non-Deep Savings Homes. Three of the Non-Deep Savings Homes installed a new furnace.

Table 4.8 - 2014 Non-Deep Savings Homes Measure Summary

Measure	Number Installed	Percentage of Total Non-Deep Homes Savings*
Attic Insulation	1	3%
Basement Insulation	1	16%
Draft Proofing	4	9%
Furnace	3	61%
Window	3	12%

*When two or more measures are installed in a home, interactive effects between measures may lead to reduced total savings in comparison to savings expected from the same measures installed in isolation. The reported percentages omit any interactive effects.

Table 4.9 - 2014 Non-Deep Savings Homes With and Without Furnace Installs

Install Type	Number of Homes	Average Annual Gas Savings (m^3)	Total Cumulative Gas Savings (m^3)
With Furnace	3	710	27,145
Without Furnace	1	1,292	27,455

Target Market

The HRR offering targets Union's residential customers who own a detached, semi-detached or duplex home with a natural gas heating system. In 2014, HRR was offered to all of central and southwestern Ontario.

Market Incentive

Table 4.10 outlines the measures of the HRR offering with the corresponding criteria and incentive.

Table 4.10 - HRR Offering Rebates*

Measure	Criteria		Incentives
Attic Insulation	Increasing attic insulation to at least R50 from R12 or less	$	500
	Increasing attic insulation to at least R50 from R13 to R25	$	250
	Increasing cathedral/flat roof insulation by at least R14	$	500
Basement Insulation	Adding at least R23 to 100% of basement	$	1,000
	Adding at least R12 to 100% of basement	$	500
Crawl Space Insulation	Adding at least R23 to 100% of crawl space wall	$	800
	Adding at least R10 to 100% of crawl space wall	$	400
	Adding at least R24 to 100% floor above crawl space	$	450
Exterior Wall Insulation	Adding at least R9 to 100% of building to achieve a minimum of R12	$	1,500
	Adding at least R3.8 to 100% of building to achieve a minimum of R12	$	100
Draft Proofing	Achieving 10% or more above base target	$	150
	Achieving base target	$	100
Furnace/Boiler	Replacing a low or mid-efficiency heating system with 95% AFUE or higher condensing natural gas furnace or 90% AFUE or higher ENERGY STAR® condensing gas boiler	$	500
Water Heater	Replacing a water heater with an ENERGY STAR and ecoENERGY-qualified instantaneous natural gas water heater with EF of 0.82 or higher	$	200
Window/Door/Skylight	For each window, door or skylight replaced with ENERGY STAR-models	$	40

*Eligibility criteria required customers to complete pre and post audits, for which they were eligible for a $500 incentive.

Market Delivery

In 2014, Union expanded partnership with service organizations to provide turn-key delivery service for customers to ten firms. Services included managing a toll-free number, administering pre and post audits, and tracking and reporting results. The service organizations were:

- Amerispec of Canada
- Barrier Sciences Group
- BuyWise Consulting
- Direct Energy
- Eco Advantage Energy Advisors
- Energuy Canada
- EnerTest Corporation
- F2 Energy
- Green Communities Canada (REEP, Green Venture and ELORA Environment)
- Ridge Energy Consultants

Customers have the option to choose the suppliers and installers for measure upgrades, or complete the installations themselves.

Direct Mail

To support service organizations and to create additional market traction, Union developed and launched promotional efforts including a direct mail campaign targeting customers who live in detached or semi-detached homes in Guelph, Kitchener, Halton Hills, Owen Sound and Sarnia.

Figure 4.6, HRR Direct Mail

Local Newsprint, Radio and Online Marketing

Union launched local newsprint campaigns targeting customers to generate awareness on the benefits and cost savings associated with home renovations. The newsprint ads directed customers to call one of the service organizations and/or to visit Union's website for additional details. The newsprint campaign ran in Brantford, Burlington, Chatham, London, Waterloo, and Windsor.

Union also launched a 30-second radio ad that ran in Brantford, Hamilton, London, Waterloo, Windsor and Chatham, as well as a geo-coded online marketing campaign that ran on Kijiji (www.Kijiji.ca), Style at Home (www.styleathome.com) and Rogers Home Channel (www.rogers.com).

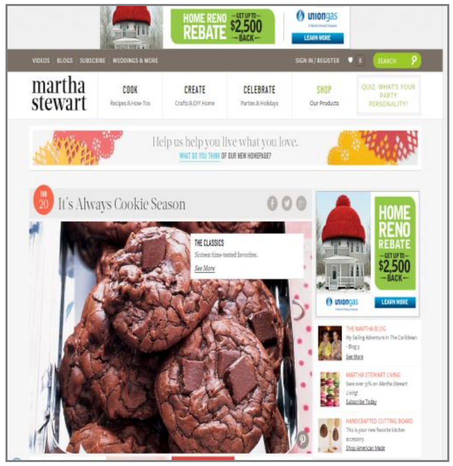

Figure 4.7, HRR Online Advertising

Customer Brochure

A customer brochure was developed to be used by service organizations during their customer calls to explain the offering and as a leave behind for customer reference.

Figure 4.8, HRR Customer Brochure

Door Hangers

Door hangers were used by service organizations and sales teams to promote the offering during their visits. After a visit, the service organization representatives would distribute the door hangers to other homes on the same street.

Figure 4.9, HRR Door Hangers

4.1.3 Education and Awareness

Education and awareness efforts in the residential sector affecting consumer decisions are crucial to the success of Union's DSM programs. Union targets educational outreach to customers to empower them to manage their energy costs. In 2014, Union continued to disseminate educational materials through a variety of media:

- Interactive website
- Wise Energy Guides
- *InTouch* monthly bill inserts
- Residential HVAC Newsletter

Residential Energy Efficiency Website

Energy efficiency, environmental stewardship and conservation are a central focus of the Union website. Within the residential section of the site, there is a dedicated Energy Conservation menu heading (http://www.uniongas.com/residential/save-money-energy) with the following sub-sections:

- **Rebates & Promotions:** Information on Union rebates and promotions to help customers save money and energy;
- **Upgrades & Renovations:** Information about do-it-yourself projects and upgrades to help customers reduce heating and cooling operating costs;
- **Tips to Save Money:** Tips and videos to help customers manage home energy usage; and
- **Energy Saving Resources:** Link to resources about energy efficiency labels and conservation websites.

Features on the site include:

- Online videos (topics include ESKs, draft proofing, and programmable thermostats);
- A downloadable programmable thermostat rebate coupon;
- Downloadable educational materials;
- An online order form for customers to request an ESK and have it delivered to their home; and
- An overview of energy efficiency rebate programs offered in the province, as well as links to third party organizations involved in energy conservation.

MyAccount

MyAccount is Union's online account management tool for residential and small business customers. After logging into MyAccount, customers can access personalized tools to help them better understand their energy use including:

- An archive containing 24 months of natural gas use and billing history;
- A "compare bills" feature to graph consumption or bill amounts from two or more months; and
- A download feature to export energy data into a spreadsheet or energy management software.

These tools provide customers with feedback that can:

- Break "bad habits" related to energy use and form new persistent habits;
- Build a greater understanding of how actions/behaviours relate to energy consumption; and
- Influence motivations related to the use of energy.

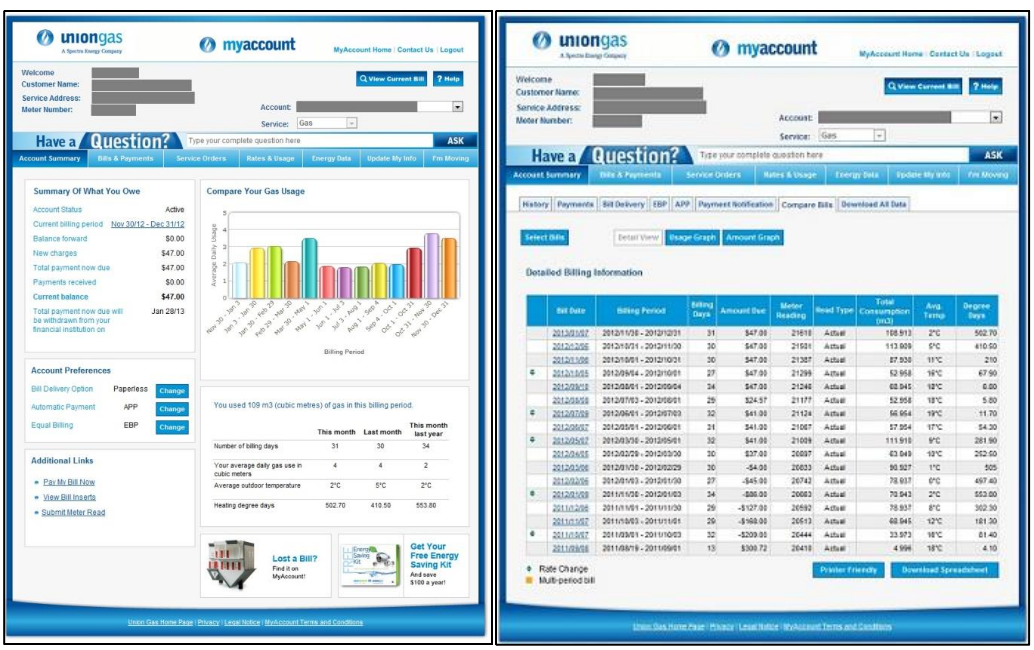

Figure 4.10, MyAccount

Wise Energy Guide

In 2014, Union continued to distribute copies of the Wise Energy Guide to customers. The guide includes up-to-date tips and solutions to reduce heat loss, suggestions to solve moisture problems, natural gas equipment options, and an easy-to-use checklist to assist customers to achieve greater energy efficiency in the home. The primary distribution method is Union's website, where customers can view a digital copy or order a printed version.

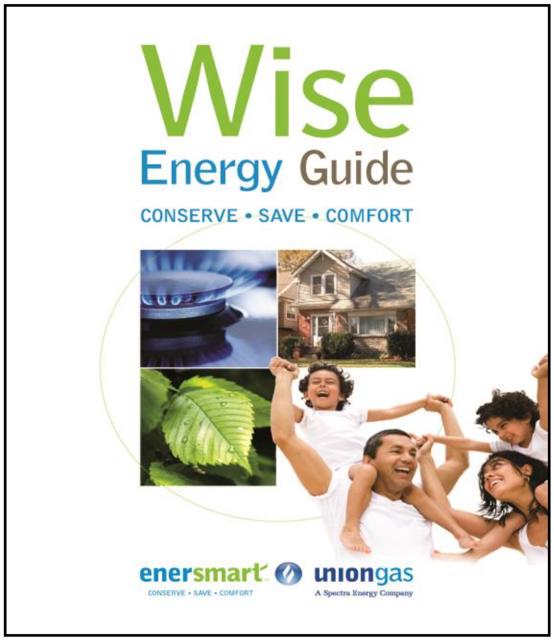

Figure 4.11, Wise Energy Guide

***intouch* Monthly Newsletter**

Union continues to distribute the monthly *intouch* residential customer newsletter both in print and online. The newsletters include educational messages about energy efficiency, natural gas safety and the environmental and financial savings related to using natural gas.

Feature topics included:

- The importance of annual equipment inspections;
- The importance of caulking and weather stripping;
- How to avoid high natural gas bills; and
- Energy conservation programs available.

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JULY 2013
TOPICS
Save Money this Summer
Call Before You Dig

intouch
customer information newsletter

Easy Ways to Save Money this Summer

Take advantage of the summer months to cut energy bills and still manage to stay comfortable on the hottest days of the year.

Keep the heat outside before it turns your home into an oven by sealing leaks around windows and doors with caulking and weatherstripping, and remember to close windows and lower blinds on sunny days.

To avoid heating up the house during the day, run dishwashers and washing machines at night when time of use pricing for electricity is lower, too. Limit indoor cooking on hot days and consider drying wet towels and laundry on a line or drying rack outside.

If you have central air conditioning, use your programmable thermostat to control your costs. Turn it up a few degrees when you'll be away at work or on vacation and program cooling again for your return home. If you don't have a programmable thermostat, print a coupon at uniongas.com/energyefficiency for a $25 credit on your natural gas bill when you buy one.

Order Your Energy Saving Kit Online for More Savings

To reduce your water and energy costs by up to a $100 a year, order and install a free Union Gas Energy Saving Kit, available at uniongas.com/esk. We'll send your ESK, valued at $60, straight to your home. It's an easy do-it-yourself project that will save you money season after season and year after year.

FREE ENERGY SAVING KIT

You should also enrol in MyAccount to track your energy consumption and see how much you've saved!

Visit uniongas.com/energyefficiency for more energy and money saving tips.

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Call Before You Dig – It's the Law!

Any digging project can be big enough to cause serious problems. If your digging damages the network of underground utilities and cables on your property, the result can be worse than inconvenient – a damaged natural gas line could cause a dangerous leak and increase the risk of a fire or explosion.

Homeowners or their contractors who cause damage are liable for the cost of repairs and could incur a costly lawsuit if property is damaged or someone is injured as a result. Under Ontario regulations, it's against the law to dig without having natural gas lines located.

To avoid problems, contact Ontario One Call for a free utility line locate at least five full working days before you plan to dig. Your request will be relayed to local utilities and their locate service providers will mark the areas where pipes, lines and cables are hidden so you can avoid them and stay safe. This service is available 24 hours a day, every day, at on1call.com and 1 800 400-2255.

ON1CALL
on1call.com
1 800 400-2255

Call Before Clearing Blocked Sewer Lines Too!

Natural gas lines occasionally intersect with sewer lines underground, a situation known as a cross bore. There's no danger unless the gas line is damaged, which can happen when clearing a blocked sewer line with water-jetting or motorized equipment. So, before clearing a blocked sewer beyond the exterior walls of a building, call Ontario One Call for a free sewer pipe inspection.

Go to uniongas.com/safety to find out more about natural gas line and sewer pipe safety.

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A Spectra Energy Company

Figure 4.12, *intouch* Newsletter

Residential HVAC Newsletter

In 2014, Union continued to target residential HVAC contractors through the GasFacts newsletter. This newsletter provides updates to the HVAC community related to Union's energy efficiency programs, codes and standards, recalls and manufacturers' notifications, as well as rebate offers from Union and third party organizations.

Dedicated HVAC Webpage

The HVAC partners section of the Union website has been designed to inform HVACs and the industry of relevant information, updates, codes and standards, in addition to driving further energy conservation messages and measures in the new construction and retrofit markets. The website hosts past GasFacts editions as well as FAQs, rebate and incentive information, equipment and technical support, and other information.

4.1.4 Lessons Learned

ESK Offering

1. ***ESK door-to-door distribution***
   As the market continues to saturate, door-to-door delivery of ESKs has proved to be the most effective way to target the remaining customers who have not yet participated in the program, while keeping costs low. Union has also seen a strong response from customers ordering ESKs online and this continues to be an effective supporting delivery method that is also cost effective.

Home Reno Rebate Offering

1. ***HVAC barriers***
   Some HVAC contractors are reluctant to promote the HRR offering for reasons including eligibility criteria, the need for a pre-installation audit, and requirements for paperwork.

   Union recommended that a key HRR service organization conduct a Q&A session for HVAC contractors to address their concerns. The service organization saw an increase in HRR participation through contractors that attended the session. Union then held conference calls with all service organizations to discuss how to address similar HVAC concerns.

2. ***Semi-detached homes***
   In 2013 Union had exclusively targeted single detached homes for the HRR offering. However, feedback from service organizations indicated that semi-detached homes represented an untapped opportunity for energy conservation. In 2014 Union expanded the target market to include semi-detached homes. Eligibility criteria must still be met to participate.

3. ***Age of homes***
   In previous years, Union targeted homes built 1995 or earlier. Feedback from service organizations indicated that having the age criteria creates confusion in qualifying customers. In 2014 Union removed the age criteria – all customers that implemented two major measures and met the minimum gas savings threshold qualified for the offering.

4. ***Service organization network***
   Success of service organizations depends on the strength of their network of HVACs, insulation contractors and window installers. The stronger and more diverse the network, the more referrals the service organization will receive.

4.2 Commercial/Industrial Program

A portfolio of energy efficient technology related incentives were available to commercial/industrial customers in 2014. Union uses the EnerSmart Business brand platform to promote the adoption of high efficiency natural gas technologies, processes, energy audits, surveys, studies and customer education. Union's Commercial/Industrial Program is divided into two offerings: prescriptive and custom.

Program savings results, budget spend, and program TRC are presented in Tables 4.11, 4.12 and 4.13 below.

Table 4.11 - 2014 Commercial/Industrial Program Results

Program	Offering	Units	Annual Gas Savings (m^3)	Cumulative Gas Savings (m^3)	Total Spend	Net TRC	TRC Ratio
Commercial/ Industrial	Prescriptive	3,326	11,275,675	216,057,244	$ 4,957,137	$ 10,878,036	1.77
	Custom	588	42,923,632	683,855,047	$ 7,784,256	$ 7,141,092	1.09
2014 Commercial/Industrial Total		**3,914**	**54,199,307**	**899,912,291**	**$ 12,741,393**	**$ 18,019,127**	**1.18**

Table 4.12 - 2014 Commercial/Industrial Program Spend

Item		Total
Incentives	$	8,666,038
Administration	$	2,786,916
Evaluation	$	103,687
Promotion Costs	$	1,184,752
2014 Total Commercial/Industrial Program Spend	**$**	**12,741,393**

Table 4.13 - 2014 Commercial/Industrial Program Cost-Effectiveness

	TRC Benefits (a)	TRC Costs (b)	Net TRC (c)=(a-b)	TRC Ratio (d)=(a/b)
Measures	$ 116,114,261	$ 94,019,779	$ 22,094,482	1.23
Administration		$ 2,786,916		
Evaluation		$ 103,687		
Promotion		$ 1,184,752		
Commercial/Industrial Program Total	**$ 116,114,261**	**$ 98,095,134**	**$ 18,019,127**	**1.18**

4.2.1 Prescriptive and Quasi-Prescriptive Offering

Union continues to offer a full suite of DSM prescriptive and quasi-prescriptive measures to more than 110,000 commercial/industrial customers. These customers are made up of office, retail, multi-unit residential, foodservice, hotel/motel, manufacturing, agriculture, warehouse, entertainment & recreation, and education & healthcare segments. All of these segments fall within the following commercial/industrial rate classes: M1, M2, M4, M5, M7, R01, R10 and R20.

- **Prescriptive Measures:** These measures have pre-determined fixed savings based on the size and classification of the equipment.
- **Quasi-Prescriptive Measures:** Energy savings for these technologies are 'quasi-prescriptive' meaning that there will be one or more variable input that needs to be known for each installation in order to determine gas savings. An example of an input is the size or rating of the equipment (e.g. CFM or BTU).

Target Market

Union continues to approach segments within the commercial/industrial market uniquely based on the business/industry type. Segmenting based on business type means that Union targets each segment with customized, relevant communications. This approach allows Union to use resources more effectively in order to educate business customers about potential energy savings. Segmenting based on business type also provides Union with market insights, allowing for a better understanding of Union's commercial/industrial customer base and barriers for DSM uptake.

Market Incentive

In 2014, Union offered prescriptive incentives as outlined in Table 4.14 as well as additional incentives discussed below.

Table 4.14 - Commercial/Industrial Prescriptive Offering Incentives

Initiative	Measure	Customer Incentive	Service Provider	Distributor Incentive
Water Heating	Condensing Gas Water Heaters - 100, 500 & 1,000 gal/day/tank	$ 350	$ 100	$ 50
	Laundry Washing Equipment with Ozone - ≤ 120 lbs & 100,000 - 199,999 lbs/yr	$ 1,000	$ 100	
	Laundry Washing Equipment with Ozone - ≤ 120 lbs & ≥ 200,000 lbs/yr	$ 1,500	$ 100	
	Laundry Washing Equipment with Ozone - > 120 lbs & ≥ 260,000 lbs/yr	$ 6,000	$ 100	
Space Heating	Air Curtains - ≥ 48ft^2 and < 96ft^2 – Pedestrian	$ 250	$ 100	
	Air Curtains - ≥ 96ft^2 – Pedestrian	$ 500	$ 100	
	Air Curtains - ≥ 64ft^2 and < 96ft^2 - Shipping and Receiving	$ 1,000	$ 100	
	Air Curtains - ≥ 80ft^2 and < 100ft^2 - Shipping and Receiving	$ 1,000	$ 100	
	Air Curtains - ≥ 100ft^2 - Shipping and Receiving	$ 1,500	$ 100	
	Condensing Boiler - ≤ 299 MBtu/hr	$ 600	$ 100	$ 50
	Condensing Boiler - 300 to 999 MBtu/hr	$ 1,500	$ 100	$ 50
	Condensing Boiler - ≥ 1,000 MBtu/hr	$ 4,500	$ 100	$ 50
	Condensing Rooftop Units (MUA) Improved efficiency 1,000 – 4,999 CFM	$ 500	$ 100	
	Condensing Rooftop Units (MUA) Efficiency + 2 speed 1,000 – 4,999 CFM	$ 1,000	$ 100	
	Condensing Rooftop Units (MUA) Improved efficiency ≥ 5,000 CFM	$ 1,200	$ 100	
	Condensing Rooftop Units (MUA) Efficiency + VFDs 1,000 – 4,999 CFM	$ 1,400	$ 100	
	Condensing Rooftop Units (MUA) Efficiency + 2 speed ≥ 5,000 CFM	$ 1,800	$ 100	
	Condensing Rooftop Units (MUA) Efficiency + VFDs ≥ 5,000 CFM	$ 2,600	$ 100	
	Destratification Fan	$ 1,300	$ 100	
	ERV - ≤ 1,999 CFM	$ 600	$ 100	$ 50
	ERV - ≥ 2,000 CFM	$ 1,500	$ 100	$ 50
	HRV Multi Family, Health Care, Nursing	$ 400	$ 100	$ 50
	HRV 500 - 1,999 CFM - Hotel, Rest, Retail, Rec, School, Off, Warehouse, Man	$ 400	$ 100	$ 50
	HRV ≥ 2,000 CFM - Hotel, Rest, Retail, Rec, School, Off, Warehouse, Man	$ 700	$ 100	$ 50
	Infrared Heating*	$ 300	$ 100	$ 50
	Non Condensing Boiler - ≤ 299 MBtu/hr	$ 250	$ 100	$ 50
	Non Condensing Boiler - 300 to 999 MBtu/hr	$ 1,000	$ 100	$ 50
	Non Condensing Boiler - ≥ 1,000 MBtu/hr	$ 3,500	$ 100	$ 50
	Demand Control Ventilation (DCV) Retail, Rooftop Unit (RTU)/MUA < 5,000 sq ft	$ 150	$ 50	
	DCV Retail RTU/MUA ≥ 5,000 sq ft	$ 350	$ 50	
	DCV Office RTU/MUA < 2,500 sq ft	$ 100	$ 50	
	DCV Office RTU/MUA ≥ 2,500 sq ft	$ 200	$ 50	
Commercial Kitchen	Energy Star Dishwasher - Stationary Rack & Under counter	$ 100	$ 50	
	Energy Star Dishwasher - Rack Conveyor - Single & Multi Tank	$ 400	$ 50	
	Cooking Equipment - Energy Star Fryer	$ 200	$ 50	
	DCKV Fast Food - ≤ 4,999 CFM	$ 1,200	$ 100	
	DCKV Full Menu - 5,000 – 9,999 CFM	$ 3,000	$ 100	
	DCKV Dinner House - 10,000 – 15,000 CFM	$ 4,000	$ 100	

*Service Provider Incentive to HVAC Contractors only.

National Account Multi Unit Incentive

National Account customers are those that have multiple property locations throughout Union's franchise with similar design and use, such as retail chains, property management firms and foodservice chains. National Account customers have the ability to install various different energy efficient technologies within numerous locations across Union's franchise. Recognizing that this customer group has a greater number of savings opportunities, Union designed a multi-unit installation bonus incentive. The following bonus was offered in 2014:

- 25% incentive increase on 6-30 installations per National Account
- 50% incentive increase on 30 or more installations per National Account

Hotel and Motel Ozone Laundry incentive

Hotel and motel customers are sometimes reluctant to install ozone laundry due to high costs and low awareness of the technology's benefits. Union offered the following additional incentive to hotel and motel customers who participated in the Ozone Laundry initiative in 2014:

- $200 per unit – Washer Extractor (WE) < 120 lbs capacity & 100,000 - 199,000 lbs laundry/year
- $500 per unit – WE < 120 lbs capacity & >200,000 lbs laundry/year
- $800 per unit – WE > 120 lbs capacity & > 260,000 lbs laundry/year

Commercial/Industrial Limited Time Offer Incentive

Union implemented a limited time offer across its commercial/industrial market in the spring of 2014 to increase market adoption of key technologies. The limited time offer was an additional incentive to further motivate financially constrained customers to move ahead with upgrades within a defined period of time. The offer featured a 50% increase to the base incentive when customers installed an eligible technology and submitted an application form before August 31, 2014.

The following technologies were included as part of the limited time offer:

- Condensing Make-up Air Units (MUAs)
- Energy Recovery Ventilation (ERVs)
- Heat Recovery Ventilation (HRVs)
- Destratification fans
- Air curtains

Market Delivery

To reach commercial/industrial customers, Union executes on one or more of the following approaches:

- **Direct Sales Approach.** With this approach, Union works directly with the end-user customer to educate them on potential options to improve the energy efficiency of their facilities, offerings available to facilitate those options, and how the application process works. The direct sales approach requires working with multiple contacts within an organization as well as service providers, manufacturers and distributors who are instrumental in affecting a decision to install energy efficiency technologies;
- **Mass Market Approach.** Union uses a number of mass marketing techniques to target the end-user customer such as the Union webpage, bill inserts, direct mails, email blasts, and

advertising. Union also uses event based marketing including tradeshows and other similar events to reach a large number of customers and industry partners; and

- **National Account Approach.** Union's National Account Managers communicate and influence end-user customers who make decisions using a top-down, centralized approach. National Account customers are those that have multiple property locations throughout Union's franchise with similar design and use, such as retail chains, property management firms and foodservice chains.

Not only does Union reach and influence through the above direct sales, mass market and national account approaches, but support is also provided by a network of industry partners. These industry partners specify or install energy efficient equipment and/or directly educate or influence Union's customers to adopt natural gas energy efficient equipment. Maintaining and cultivating relationships with each of the following industry partners ensures that they are informed of Union's programs and that they can present the savings, benefits and incentives to customers:

- **Service Providers.** Architectural consultants, builders, HVACs, engineering consultants and energy service companies all carry significant influence with end use customers;
- **Associations.** Associations align with segment specific approaches to market and provide industry insight necessary to designing programs that resonate with customers and drive action;
- **Manufacturers.** Manufacturers of the technologies that Union promotes provide insight into product key benefits, as well as effective methods to influence the market; and
- **Distributors.** Distributors influence the market and their contractor customers. Contractors then influence the end-user customers installing the equipment.

By employing various market approaches and tailoring initiatives to specific business segments, Union is able to ensure communication with customers is relevant to their needs. For the purpose of this report, prescriptive and quasi-prescriptive measures are grouped in terms of 'initiatives' for Water Heating, Space Heating, and Kitchen as detailed below.

4.2.1.1 Water Heating Initiative

The Water Heating initiative is designed to reduce a customer's energy use and water consumption. In 2014, Union offered incentives for the following:

- **Condensing Gas Water Heater.** High efficiency gas water heaters that operate at 95% thermal efficiency. This thermal efficiency is higher than that of conventional tank type water heaters, which operate at 80% efficiency. Installation of high efficiency gas water heaters results in faster hot water cycle times and therefore reduces building operating and energy costs; and
- **Ozone Laundry**. A piece of auxiliary equipment added onto a new or existing commercial washing machine which reduces the amount of chemicals, detergents and hot washing and drying times required to achieve the same standard of cleaning.

Target Market

Within the Water Heating initiative, there are specific target markets depending on the technology:

- Condensing gas water heaters were targeted to multi-unit residential, foodservice, education, entertainment, recreation, and healthcare customers; and
- Ozone laundry was marketed to customers with large volumes of laundry such as hotels, motels, laundry services and long-term care segments.

Market Incentive

The following incentives were offered to the end-user customer:

- Condensing gas water heater: $350 per unit
- Ozone laundry
    - Ozone WE =< 60 lbs cap & 100,000 to 199,999lbs/yr: $1,000 per unit
    - Ozone WE =< 60 lbs cap & =>200,000lbs/yr: $1,500 per unit
    - Ozone WE > 60 lbs and =< 120lbs cap & => 200,000 lbs/yr: $1,500 per unit
    - Ozone WE > 120 lbs and < 500lbs cap & > 260,000 lbs/yr: $6,000 per unit

Union offered a special segment-specific additional incentive of $200, $500, $500 and $800 per unit corresponding to the bullet list above to hotel/motel and retail customers with laundry facilities to encourage uptake of ozone laundry.

Market Delivery

Water heating marketing efforts included promotion through direct sales, mass marketing, bill inserts and National Accounts. Union also collaborated with technology manufacturers and service providers to effectively reach and influence early technology adopters. In addition, the Union Business webpage (uniongas.com/business) offered online education tools and resources that helped inform the mass market on how to manage energy use. Finally, Union exhibited at tradeshows and association events targeted to National Accounts retail and hotel/motel customers.

Figure 4.13, Ozone Laundry Bill Insert

4.2.1.2 Space Heating Initiative

The Space Heating initiative is designed to stimulate customer action towards retiring older inefficient space heating equipment and installing new energy efficient space heating equipment. In 2014, Union offered incentives for the following:

- **Air Curtains**. This technology delivers a controlled stream of air that separates the indoor and outdoor environment. Air curtains reduce infiltration of cold or hot outside air through doorways, significantly reducing natural gas heating in winter and air conditioning in summer. Air Curtains are often used where doors stay open for long periods of time. Typical examples include shipping docks and retail or office entrances;
- **Condensing Boilers**. Condensing boilers recover energy that would normally be discharged into the atmosphere through a flue. This improves heating efficiency by approximately 15-20% compared to a conventional boiler, resulting in reduced gas bills. It also requires less space, offering more flexibility in small space environments;
- **Condensing Make-Up Air Units (MUAs)**. These units are indirect gas fired and provide fresh air to common areas in commercial buildings. The majority of furnaces built into rooftop units are mid efficiency units with efficiencies ranging from 78% to 82%. Condensing technology offers improved efficiencies of 90% and above and a high ‘turn down’ feature results in lower

operating costs, better control, and increased comfort. There are three sub-categories for this technology:

  - Improved efficiency
  - Efficiency + 2 speed
  - Efficiency + Variable Frequency Drives (VFDs)

- **Destratification Fans**. Large downdraught destratification fans range from 8 to 24 feet in diameter. They offer an inexpensive and efficient way to bring heat down from the ceiling to mix with cooler floor temperature air, ensuring a consistent and comfortable temperature where it is most needed. Facilities with large stratified temperature differences have the greatest potential for energy savings; typically, the greater the ceiling height, the greater the potential for savings in the heating load;
- **Energy Recovery Ventilation (ERV) and Heat Recovery Ventilation (HRV)**. ERVs capture heat and moisture, while HRVs capture heat. The recovered heat energy from the indoor air is used to heat air entering the building. ERVs and HRVs reduce the energy use associated with heating the space and related energy costs, and make the ventilation system operate more efficiently;
- **High Efficiency Non-Condensing Boilers**. High efficiency non-condensing boiler technology is used for space heating, domestic water heating or a combination of both applications. Union sunset the delivery of this program in Q1 of 2014;
- **Infrared Heaters**. Infrared heaters help customers conserve energy and money, as they deliver heat directly to where it is needed instead of heating the air within a space, like traditional forced air heating systems. Efficiency for this technology is especially evident in large volume buildings that do not require a steady state of heat or where there is a large amount of air exchange, such as near a loading dock; and
- **Demand Control Ventilation (DCV)**. This technology uses carbon dioxide sensors designed to control the amount of air exchanged (fresh air coming in, stale air leaving the building) based upon occupancy. Occupancy is measured by the amount of carbon dioxide in the air through sensors that control the amount of air exchanged from the rooftop/MUA units.

Target Market

Within the Space Heating initiative, there are specific target markets depending on the technology as detailed below:

- Air curtains were targeted to warehouse, retail and manufacturing segments;
- All commercial/industrial customers were eligible for the condensing boiler measure; however Union focused on healthcare, multi-unit residential and education customers;
- Condensing MUAs were targeted primarily to multi-unit residential and healthcare segments as well as all other segments where the technology is appropriate;
- Destratification fans were targeted to warehouse, manufacturing and retail customers whose facilities have high ceilings;

- All commercial/industrial customers were eligible for ERVs/HRVs provided an engineer stipulates that it is not a code requirement. Union mainly targeted healthcare and education customers;
- Infrared heaters were targeted to warehouse, agriculture, retail and manufacturing customers; and
- DCV were targeted to office and retail customers.

Market Incentive

The incentives in Table 4.15 were offered to the commercial/industrial customer.

Table 4.15 - Commercial/Industrial Space Heating Initiative Incentives

Measure	Customer Incentive (per Unit)
Air Curtains (Shipping Doors)	\$ 1,000 - \$ 1,500
Air Curtains (Pedestrian Doors)	\$ 250 - \$ 500
Condensing Boilers	\$ 600 - \$ 4,500
Condensing MUAs (Improved Efficiency)	\$ 500 - \$ 1,200
Condensing MUAs (Efficiency + 2 Speed)	\$ 1,000 - \$ 1,800
Condensing MUAs (Efficiency + VFDs)	\$ 1,400 - \$ 2,600
Destratification Fans	\$ 1,300
ERVs	\$ 600 - \$ 1,500
HRVs	\$ 400 - \$ 700
Infrared Heaters	\$ 300
DCV retail RTU/MUA < 5,000 sq ft	\$ 150
DCV retail RTU/MUA ≥ 5,000 sq ft	\$ 350
DCV office RTU/MUA < 2,500 sq ft	\$ 100
DCV office RTU/MUA ≥ 2,500 sq ft	\$ 200

In addition to the regular incentives, a limited time offer to all commercial/industrial customers included a 50% increase on top of the base incentive if they installed an eligible energy efficient technology and submitted an incentive application form before August 31, 2014. The following measures were included as part of the limited time offer:

- MUAs
- ERVs
- HRVs
- Destratification fans
- Air curtains

Market Delivery

In 2014, promotion of space heating technologies included direct sales, mass marketing, bill inserts and National Account market approaches with a focus on building and maintaining relationships with industry partners to ensure education and awareness of Union's programs. In addition, the Union Business webpage offered online education tools and resources to help the mass market learn how to manage their energy use. Union also ran advertising campaigns and targeted tradeshows, workshops and industry events to highlight incentives available.

Figure 4.14, Limited Time Offer Bill Insert

Figure 4.15, National Account Multi-Unit Installation Brochure

4.2.1.3 Commercial Kitchen Initiative

The Commercial Kitchen initiative is designed to encourage food establishment owners and operators to install high efficiency technologies that are designed to reduce hot water consumption and natural gas use. In 2014, Union offered incentives for the following:

- **Energy Star Fryers**. Energy Star rated fryers are 20-50% more efficient than traditional cooking equipment;
- **Demand Control Kitchen Ventilation (DCKV)**. Traditional ventilation systems operate at only one speed, whereas the speed of DCKV systems automatically respond to changes in cooking volume and heat, resulting in much greater efficiency. The prescriptive savings for DCKV were based on three ranges of total range hood exhaust: 0 – 4,999 CFM, 5,000 – 9,999 CFM, and 10,000 – 15,000 CFM; and
- **Energy Star Dishwashers**. Energy Star rated commercial dishwashers reduce energy and water consumption and improve performance. On average, they are 25% more energy efficient and 25% more water efficient than standard models. Models include under counter, stationary and conveyor.

Target Market

Energy Star fryers, DCKV, and Energy Star dishwashers were targeted to the following commercial kitchen customer segments: foodservice, hotel/motel, education, and healthcare.

Market Incentive

- Energy Star fryers: $200 per unit
- DCKV
  - Up to 4,999 CFM: $1,200 per unit
  - 5,000 to 9,999 CFM: $3,000 per unit
  - 10,000 to 15,000 CFM: $4,000 per unit
- Energy Star dishwasher
  - Under counter and stationary rack: $100 per unit
  - Rack conveyor: $400 per unit

Market Delivery

Union utilized a targeted National Accounts approach in the foodservice segment to capitalize on program uptake from key chains within Union's franchise. To further enhance these efforts, Union focused on continued relationship management with manufacturers to support awareness of Union's offerings and to ensure that they were being promoted to their customers.

Union marketed the benefits of DCKV through industry trade magazine advertisements, information packages and trade show participation.

A two pronged approach was utilized to promote Energy Star dishwashers. Union partnered with dishwasher distributors to reach foodservice end users as well as a National Accounts strategy for key chains within Union's franchise.

Marketing efforts for Energy Star fryers included a National Accounts strategy targeting decision makers of foodservice chains.

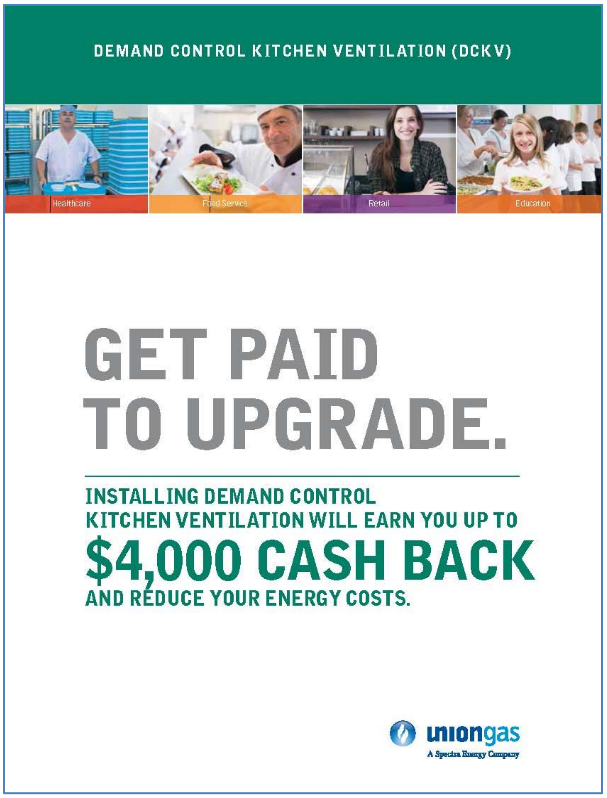


Figure 4.16, DCKV Brochure

2014 Prescriptive and Quasi-Prescriptive Offering Highlights

- Program education and awareness:
    - A customized information booklet was provided to Union's municipal customers to influence and support the development of an energy plan. The Union Energy Planning booklet outlined energy saving programs available to all customers present in their municipality.
- Focus on associations:
    - Industry associations are a credible source of information that Union customers trust. In 2014, Union partnered with over 25 key associations to communicate the benefits of its energy conservation programs. Union's participation included presentations at association events, exhibiting at tradeshows and sponsorship; and
    - Union is an active participant and supporter of community improvement initiatives. Union's employees strive to volunteer their time and expertise to improve upon the communities within which they work and live. Specifically, Union is a proud sponsor of the Race to Reduce and its expansion into Union's franchise areas of Burlington, Oakville, Milton and Hamilton. The Race to Reduce is a program that promotes collaboration between office building landlords and tenants to encourage energy saving behaviour.

4.2.2 Custom Offering

Union also focuses on advancing customer energy efficiency and productivity by providing a mix of custom incentives, education and awareness to commercial and industrial customers across all segments. The objective of the Custom offering is to generate long-term and cost effective energy savings for Union customers.

Target Market

The Custom offering covers opportunities where energy savings are linked to unique building specifications, design concepts, processes and new technologies that are outside the scope of prescriptive and quasi-prescriptive measures. The offerings and incentives are targeted directly to the end user, while trade allies involved in the design, engineering and consulting communities assist to expand the message of energy efficiency.

Market Incentive

Various incentives are available for custom participants specific to education and audit assessments, however the resource acquisition incentive value for projects is \$0.10 per annual m^3 of natural gas saved.

Market Delivery

There are numerous approaches to delivering the Custom offering, many of which involve customer education designed to increase awareness of energy efficiency opportunities and benefits. These include the following:

Customer Engagement - Communication and Education
Union provided education, training and technical expertise and offered a wide variety of materials aimed at building an increased awareness of energy efficiency opportunities and benefits.

Engineering Feasibility and Process Improvement Studies
Union supported the completion of studies to identify and quantify potential energy savings measures. Furthermore, Union supported comprehensive process improvement studies to determine and assess financial costs and benefits of energy efficiency opportunities, supporting the customer's internal decision making process.

Operation and Maintenance
Union assisted customers maintain equipment standards at optimal performance levels by providing financial incentives for implementing operations and maintenance practices that save natural gas through repairs, replacements or retrofits of existing equipment.

New Equipment and Processes
Union provided financial incentives to support the installation of new equipment and processes, which result in saving natural gas, energy efficiency gains and/or improvements in the productivity of

customer's operations. These incentives were available for customers with or without an engineering feasibility or process improvement study.

Energy Management
Union provided financial incentives to support the installation of energy meters, monitoring and management systems, allowing customers to manage the energy intensity of their operations actively and continuously.

2014 Custom Offering Highlights

Union continues to utilize a rigorous quality control process for all custom projects. Professional Engineers (P.Eng), licensed to practice in Ontario, assist customers with the quantification of energy savings prior to application submission. After application submission, all custom projects undergo a secondary professional engineering review to validate the reasonableness of the savings calculations, while ensuring appropriate supporting documentation is provided.

All custom projects utilize the Project Application Summary (PAS) sheet to summarize all key project inputs and specific details. The use of the PAS sheet continues to strengthen Union's secondary professional engineering review, and assists in the annual verification of custom projects.

In 2014, Union added one new standard calculator to the selection. The value of these standard calculators is to consistently estimate natural gas savings for common commercial custom projects. The standard calculators currently being used are as follows:

- Formula 1 laundry
- Destratification fan
- Make-up air VFD retrofit
- Make-up air
- High extraction washer (>300G)
- Hot water heating
- Roof insulation
- Boiler combustion control
- Window
- NEW in 2014 – Dock door seals

4.2.3 Education and Awareness

Union offers a wide variety of materials and workshops aimed at building awareness for energy efficiency in the customer's facility. The focus is on educating the customer and their employees on how to identify energy conservation opportunities and supply them with the resources to research and evaluate possible solutions. For example, Union and NRCan supported the Canadian Healthcare Engineering Society (CHES) in its initiative to educate healthcare officials interested in energy planning and opportunity identification. Other specific customer education and awareness efforts included:

Steam System Training Workshop
Union conducted a 'TAP your steam system' training workshop for its commercial/industrial customers in March 2014. Three, one-day workshops were held in Sudbury, Cambridge, and Windsor with 52 customer attendees. The workshop focused on ten action points (TAP) for best practice management of a steam system.

Canadian Boiler Society (CBS) Educational Days: High Performance Boiler Solutions that Improve Your Bottom Line

Union partnered with the Canadian Boiler Society to deliver educational forums in London, Burlington, and Toronto to over 80 attendees. Information shared with participants included common boiler solutions to increase energy efficiency and how to save natural gas, with a focus on boiler selection and sizing, operation and maintenance, burner upgrades for lower emissions, and improved performance.

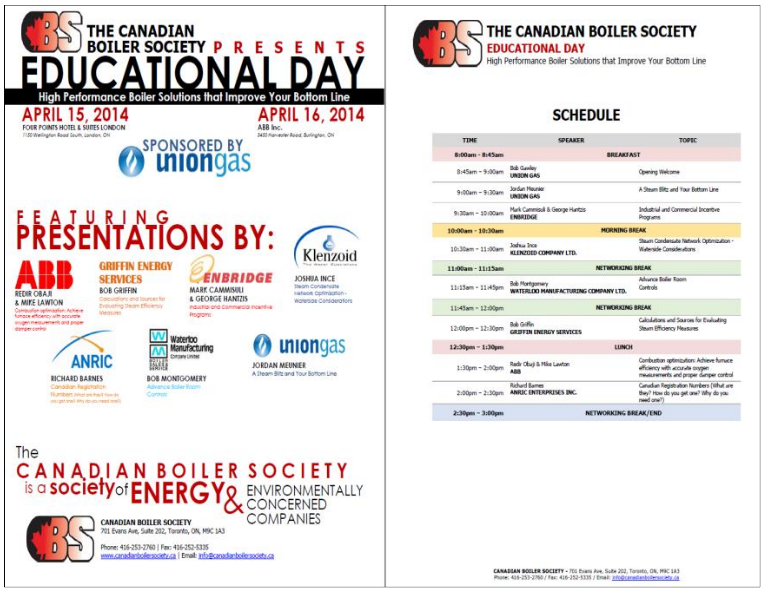


Figure 4.17, Educational Day Brochure

NRCan Dollars to $ense Energy Workshops

In collaboration with Ontario municipalities, electric utilities, and NRCan, Union sponsored and participated in Dollars to $ense workshops. The workshops highlighted energy efficiency opportunities with a focus on lower operating and production costs.

Conference Presentations

Union sponsored and participated in energy conservation panel discussions and presented at a number of conferences throughout 2014, including:

- Consortium for Energy Efficiency (CEE) Industry Partners Meeting;
- Energy Summit 2014 with the Excellence in Manufacturing Consortium, NRCan, and Canadian Industry Program for Energy Conservation;
- Ontario Power Engineers Annual Conference; and
- Energy 2014: Competitive Advantage through Energy with Canadian Manufacturers and Exporters.

HVAC Energy Savings Workshop

Union conducted an 'Identifying and Achieving HVAC Savings' workshop for its commercial/industrial customers in December 2014. Two, one-day workshops were held in London and Burlington with 40 customer attendees. The workshop focused on best operating and maintenance practices for HVAC systems, and identifying and quantifying savings opportunities.

4.2.4 Lessons Learned

Prescriptive and Quasi-Prescriptive Offering

1. ***Industry Partners***
   Small to medium-size business customers continue to be difficult to reach and influence as they are often resource constrained and are not fully informed of the benefits of energy efficient technologies. Industry partners play a key role for small to medium-size business owners in their decision making process for purchase, installation and maintenance of these technologies. Union is currently exploring how to further enhance its relationships with industry partners to better reach small business customers.

2. ***Targeted Awareness Strategies***
   Low awareness of energy conservation is sometimes present in commercial/industrial customer segments. For the purpose of improving overall energy efficiency literacy in the commercial/industrial market and to drive participation in DSM programming, Union will explore opportunities to provide targeted education and awareness strategies through program design.

3. ***Technology Diversification***
   Technology diversification of the prescriptive portfolio is required for continued success in delivering energy savings to all business customers in all segments. Without diversification Union will be limited in its ability to offer cost effective incentives for energy efficient technologies that are applicable to all segments and building types.

Custom Offering

1. ***Development of New Custom Measures/Technologies***
   Union continues to expand the custom offerings to the commercial and industrial customers through development of new measures for energy savings.

   In 2014, Union had two new custom measures:

   - Polyvinylidene Fluoride (PVDF) insulated steam humidification tubes, which decrease condensation and more efficiently treat incoming cold makeup air through a commercial HVAC humidification system.
   - Greenhouse destratification and humidity control – a new destratification fan technology has been introduced for the Ontario greenhouse market to better manage air circulation and plant transpiration. Unlike conventional horizontal axial flow fans, which circulate air longitudinally through a greenhouse, the new fan technology

improves air circulation and more uniformly manages humidity in localized areas, resulting in reduced air exchange and humidity control by ventilation.

2. New standard calculator

The new dock door seal calculator was developed to complement Union's growing suite of standard calculators. These calculators allow for consistent calculation of natural gas savings across common commercial custom projects.

5. Low-Income Scorecard

Low-Income programs are similar in nature to resource acquisition programs, but are separated to recognize the specific needs of this customer group. They may result in lower TRC net savings than non-low-income programs although they provide various other benefits that are difficult to quantify.[5] These programs also more adequately address the challenges involved in identifying and providing DSM programs that meet the special needs of this consumer segment. Like resource acquisition programs, low-income programs seek to achieve direct, measureable savings customer-by-customer and involve the installation of energy efficient equipment.

Table 5.0 presents the results of the Low-Income Scorecard. Union achieved 150% of the overall scorecard target, resulting in an incentive of $2.764 million.

Table 5.0 - 2014 Low-Income Scorecard Results

Metrics	Metric Target Levels			Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
	Lower Band	Target	Upper Band				
Cumulative Natural Gas Savings from Single Family (m^3)	19,500,000	26,000,000	32,500,000	60%	36,105,327	178%	107%
Cumulative Natural Gas Savings from Multi-Family (m^3)	13,200,000	17,600,000	22,000,000	40%	21,586,843	145%	58%
						Total Scorecard Target Achieved	***150%***[6]
						Scorecard Incentive Achieved	***$2,763,699***

The Single Family metric consists of cumulative gas savings from the Home Weatherization Program (HWP) offering. The Multi-Family metric consists of cumulative gas savings from the Affordable Housing Conservation (AHC) offering.

5.1 Low-Income Program

The Low-Income program is designed to reduce the energy burden facing low-income single family and multi-family dwelling customers. In 2014, Union's low-income single family HWP offering consisted of building envelope measures. Details for this offering are located in section 5.1.1. Union's multi-family market AHC offering provided municipalities and social and assisted housing owners with enhanced incentives on all multi-family prescriptive and custom measures currently offered in the Commercial/Industrial program. Details of this offering are located in section 5.1.2.

[5] These various benefits not captured by the traditional net TRC savings measure may include reduction in arrears management costs, increased home comfort, improved safety and health of residents, avoided homelessness and dislocation, and reductions in school dropouts from low-income families.

[6] Actual scorecard achievement result is 165%. Maximum achievement is capped at 150%.

Table 5.1 shows the results of the Low-Income program. The total spend for the Low-Income program is administered on a program level. Table 5.2 breaks down the total spend into its components.

Table 5.1 - 2014 Low-Income Program Results

Program	Offering	Units	Annual Gas Savings (m^3)	Cumulative Gas Savings (m^3)	Total Spend	Net TRC	TRC Ratio
Low-Income	Affordable Housing Conservation	142	1,277,353	21,586,843	$ 8,529,346	$ (1,498,788)	0.81
	Home Weatherization Program	1,805	1,446,863	36,105,327			
2014 Low-Income Total		1,947	2,724,216	57,692,169	$ 8,529,346	$ (1,498,788)	**0.81**

Table 5.2 - 2014 Low-Income Program Spend

Item		Total
Incentives	$	6,224,933
Administration	$	825,767
Evaluation	$	243,580
Promotion	$	1,235,066
2014 Total Low-Income Program Spend	**$**	**8,529,346**

Table 5.3 shows the calculation of the Low-Income program's TRC ratio.

Table 5.3 - 2014 Low-Income Program Cost-Effectiveness

		TRC Benefits (a)		TRC Costs (b)		Net TRC (c)=(a-b)	TRC Ratio (d)=(a/b)
Measures	$	6,422,173	$	5,616,548	$	805,625	1.14
Administration			$	825,767			
Evaluation			$	243,580			
Promotion			$	1,235,066			
Low-Income Program Total	**$**	**6,422,173**	**$**	**7,920,961**	**$**	**(1,498,788)**	**0.81**

5.1.1 Home Weatherization Program Offering

The HWP offering provides low-income customers living in single family homes with a free home energy audit and upgrades including attic insulation, wall insulation, basement insulation and draft-proofing measures. Basic measures including showerheads, aerators, pipe insulation and programmable thermostats are provided to qualified customers at the time of the home energy audit if they have not previously received them.

Target Market

This offering targets customers who meet the following criteria:

- Income is at or below 135% Low-Income Cut-Off (LICO); and
- Occupants of a single detached or low-rise multi-family housing (3 stories or less);

And are either:

- Private homeowners or tenants who pays his or her own gas bills; or
- Tenants residing in social and assisted housing, regardless of who pays the gas bills.

Income verification is required to participate in this offering.

In 2014 Union expanded the geographic reach of the HWP offering into new communities. These new communities include Grey & Bruce County, Goderich, Owen Sound, Belleville, Cobourg, Cornwall, Sarnia and St. Thomas. Union also continued to focus on Southwestern Ontario communities, including Cambridge, Hamilton, Waterloo, Windsor and London, as well as Northern Ontario communities, including Sudbury, Thunder Bay and North Bay.

Market Incentive

The HWP offering is delivered at no cost to the customer. Customers participating in this program can receive all recommended thermal envelope upgrades as determined through the free energy audit at no cost. Customers can expect to reduce gas consumption, lower gas bills, and benefit from a much more quiet and comfortable home.

Market Delivery

Union's main approach to delivering the HWP offering is to work with experienced and reliable delivery agents to perform energy audits and measure installation. Measures that are installed in the home are determined by a free home energy audit performed by a Certified Energy Auditor. All measures that screen at 0.7 TRC ratio or greater are installed in the home. After the measures are installed, a second home energy audit is conducted to verify the gas savings realized.

Figure 5.0, HWP Offering Brochure

Union was successful in delivering the HWP offering to 932 customers in the social housing market and 696 customers in the private market for a total of 1,628 customers. Approximately 37% of realized gas savings were derived from social housing and 63% from the private market.

Table 5.4 illustrates the distribution and gas savings of HWP offering customers both by region and housing market.

Table 5.4 - HWP Offering Distribution

Region	Homes Completed in Social Housing	Homes Completed in Private Market	Total m³ Social Housing	Total m³ Private	Total m³ Saved	% of Total m³
Belleville		21		525,350	525,350	1.5%
Brantford	2	13	31,800	229,328	261,128	0.7%
Bruce County		6		241,325	241,325	0.7%
Burlington	53	2	588,579	60,875	649,454	1.8%
Cambridge	25	12	249,103	234,301	483,404	1.3%
Chatham-Kent		81		2,623,418	2,623,418	7.3%
Cornwall		37		1,154,975	1,154,975	3.2%
Goderich	69	2	1,089,250	110,675	1,199,925	3.3%
Grey County	22	13	247,475	277,999	525,474	1.5%
Guelph		2		46,200	46,200	0.1%
Hamilton	253	120	3,825,902	3,495,367	7,321,269	20.3%
Kingston		3		85,748	85,748	0.2%
London	7	61	211,680	2,086,898	2,298,578	6.4%
Longlac	12		126,575		126,575	0.4%
North Bay	68	17	1,357,485	698,395	2,055,880	5.7%
Oakville	75		816,900		816,900	2.3%
Orillia		11		231,750	231,750	0.6%
Owen Sound	65	23	1,016,500	759,825	1,776,325	4.9%
Sarnia		12		486,913	486,913	1.3%
Sault Ste. Marie	156	33	2,628,098	1,391,218	4,019,316	11.1%
Sudbury		11		344,558	344,558	1.0%
Thunder Bay	1	88	14,800	2,979,232	2,994,032	8.3%
Timmins		1		9,350	9,350	0.0%
Waterloo	103		793,225		793,225	2.2%
Windsor	12	118	125,193	4,473,865	4,599,058	12.7%
Wingham	9	1	92,950	28,925	121,875	0.3%
Woodstock		8		313,322	313,322	0.9%
Total	**932**	**696**	**13,215,515**	**22,889,812**	**36,105,327**	

Social and Assisted Housing Strategies

Union continued to have success in targeting and addressing single and multi-family homes managed by social and assisted housing providers that require building envelope upgrades. These homes were targeted by leveraging existing strong relationships with 27 municipal social and assisted housing providers in Union's franchise area. A direct sales approach targeting key influencers and decision makers within each of these municipal housing providers was utilized to determine program participation potential. This approach significantly contributed to addressing the needs of over 900 homes in 2014.

Private Market Strategies

Union continues to leverage a turn-key private market approach to augment the existing lead generation process in the social and assisted housing market. In the first quarter of 2014 the offering was rebranded from "Helping Homes Conserve," to "Home Weatherization Program." Input from social service agencies and customers suggested that a new infographic style could help overcome language and educational barriers. New materials were created for direct mail initiatives, advertorials and web marketing channels.

Union Gas program provides relief for Ontario residents

It seemed too good to be true. This past winter, McKellar homeowner Judith received a direct mail letter from Union Gas, offering to insulate her home free of charge. Skeptical but curious, she phoned about the program.

After a Union Gas contractor explained the details and income eligibility criteria for the utility's home weatherization program, Judith filled out an application, photocopied her Notice of Assessment from last year's tax return and mailed it in.

In a matter of days, she received a call from a certified energy adviser, Don Rutledge, to schedule an energy audit of her home. The audit revealed that the attic and basement of her 85-year-old house were under-insulated.

Over the past year, Don has helped over 125 area residents take advantage of the Union Gas weatherization program. He calculated the energy savings, submitted the work plan and within two weeks, Judith's basement walls were neatly clad in a blanket of R-12 insulation.

"The basement has always been quite cold in the winter and damp and humid in the summer," noted Judith. "I was amazed how almost immediately the basement felt much warmer."

The insulation contractor also added nine inches of cellulose fibre to the existing insulation in her attic.

For a retiree living on a fixed income, free home energy improvements worth \$3,750, along with estimated savings of \$250 in annual heating costs, provide welcome relief.

"I made sure my neighbour signed up for the program," she said.

To find out more about the Union Gas Home Weatherization Program go to uniongas.com/weatherization.

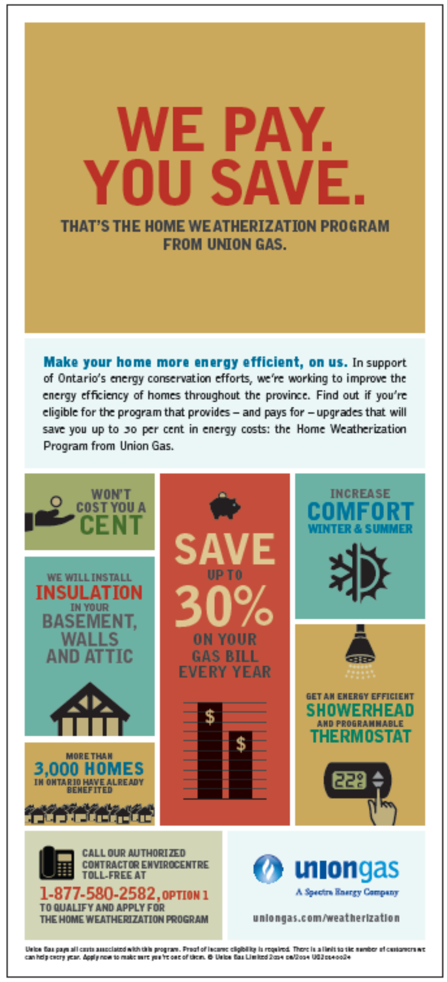


Figure 5.1, Sample of Advertorial for the HWP Offering

Web Strategy

Secondary target market web campaign

A new strategy in 2014 was designed to engage a secondary target market – those individuals who provide care for their elderly parents on a fixed income. As the secondary target market is more likely to be internet savvy, Union targeted this market via web banners placed on the Kijiji website (www.Kijiji.ca) and The Weather Network website (www.theweathernetwork.com).

Union's HWP offering webpage

Union's HWP offering webpage (www.uniongas.com/weatherization) allows private homeowners, renters and social housing providers to explore the benefits of participating, and informs viewers on eligibility criteria and means of registration.

In 2014, Union enhanced the web content by providing the ability to use assistive reading technologies, in order to meet standards of the AODA (Accessibility for Ontarians with Disabilities Act). The website was also rebranded to present a consistent brand across all marketing material and saw improvements in navigation.

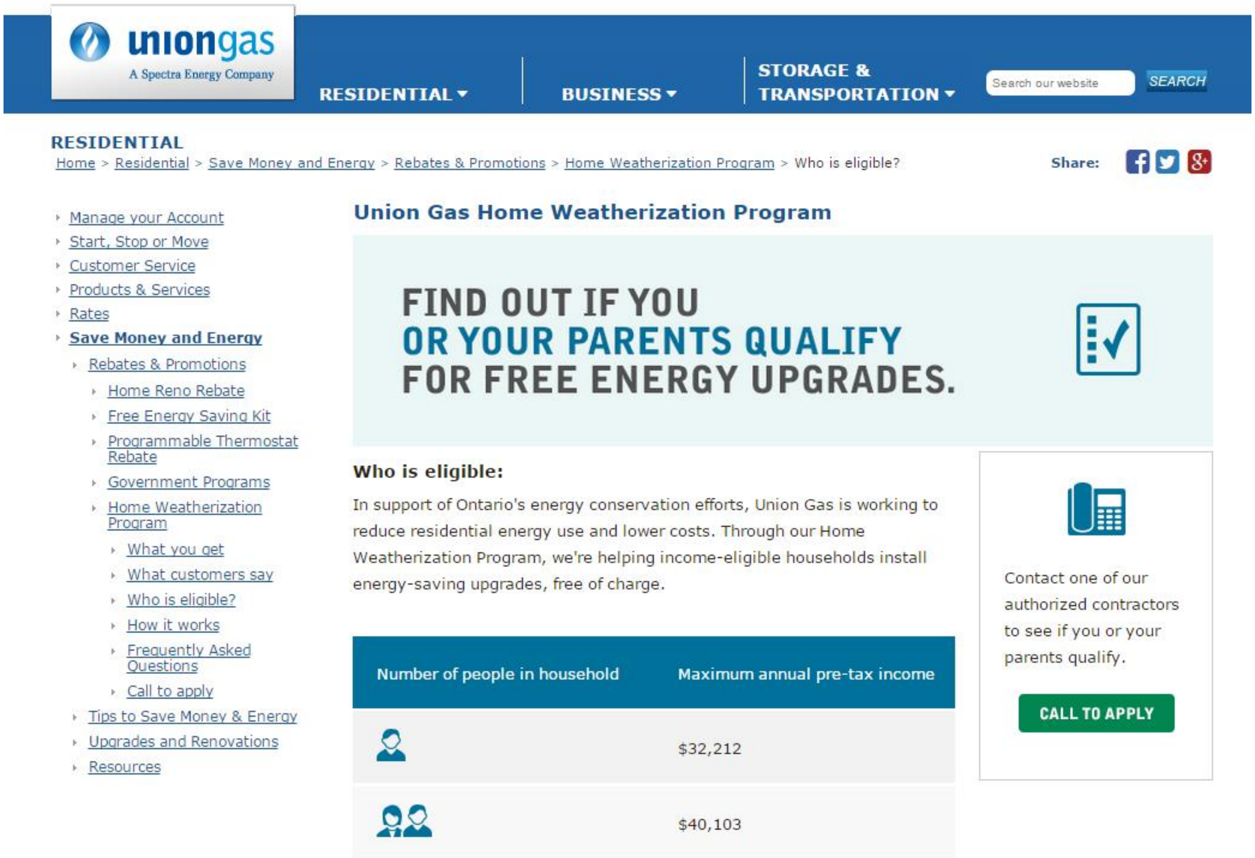


Figure 5.2 Screenshot of the HWP Offering Webpage

Partnership Strategies

Union works with several organizations in its franchise area to deliver the HWP offering to low-income customers.

Winter Warmth Emergency Assistance Program

Winter Warmth is coordinated and delivered to customers by the United Way through a network of community agencies across Union's franchise area. The Winter Warmth program provides low-income customers with one-time financial assistance if they are unable to pay their gas bill. To qualify, individuals must have a Union bill in arrears, have recently received a disconnection notice, and/or are experiencing personal circumstances that make it difficult to pay a current natural gas bill. Customers who are eligible for Winter Warmth funding are also income eligible for the HWP offering. In 2014, Union continued to support the Winter Warmth program by launching an email campaign with each community agency and providing an information sheet for distribution with information on the HWP offering.

Partnership with the United Way of Grey Bruce
In the third quarter of 2014, Union connected with the United Way for Grey Bruce regarding the HWP offering. The United Way of Grey Bruce subsequently issued a statement to the media that encouraged customers to call 2-1-1 (an Ontario information and referral helpline) to find out about home efficiency updates, including those provided by the HWP offering. The partnership with the United Way of Grey Bruce was leveraged into talks with 2-1-1 held in December 2014 regarding educating all 2-1-1 provincial call centres on the HWP offering.

London Home Builder's Association (LHBA)
The LHBA initiated a project in 2014 to encourage citizens to participate in insulation and home energy conservation. The LHBA identified several homes with Community Living London and Craigwood Group Homes that are eligible for the HWP offering.

Chatham Community Information Fair
The Municipality of Chatham-Kent held a community information fair designed to inform Social Service Agency members about various programs available in the area. Union's delivery agent for the area provided information to approximately 60-70 organizations regarding the HWP offering.

Health and Safety Initiative
Union developed a Health and Safety Policy in 2012 to avoid disqualifying homes that had treatable environmental hazards within the building envelope. Hazards can include inadequate ventilation, combustion safety, mould, moisture, asbestos, vermiculite, excessive clutter, and lead paint. The issues are often the result of poor structural design, age of the home, as well as the inability of the homeowner to address maintenance concerns due to lack of time, knowledge, and money. In 2014, Union continued the policy of addressing treatable environmental hazards identified during the audit, prior to the commencement of any installation work.

5.1.2 Affordable Housing Conservation Offering
The AHC offering targets the multi-family social and assisted housing market with custom and prescriptive measures. In recognition of the limited capital available for upgrades in social housing, Union offers enhanced incentives for these providers to implement any energy efficient measures available to commercial multi-family customers. These improved incentives aim to help this market segment achieve greater long term energy and cost savings.

Target Market

The AHC offering targets social and assisted housing providers that manage multi-family housing stock. Social and assisted housing is defined as housing developed, acquired or operated under a federal, provincial or municipally funded program.

Examples of social and assisted housing are:

- Non-profit corporations as outlined in the Social Housing Reform Act, 2000;
- Public housing corporations owned by municipalities directly or through Local Housing Corporations;
- Non-profit housing co-operatives as defined in the Co-operative Corporations Act, 1990;
- Non-profit housing corporations that manage/own rural and native residential housing; and
- Non-profit housing corporations that manage/own residential buildings developed under the AHC offering.

Union has established strong relationships with 27 municipal social housing providers in its franchise area. Union assists them to proactively plan their energy efficiency upgrades. The majority of these 27 municipal housing providers have participated in the AHC offering over the past three years. In 2014, Union sharpened its focus on the 400+ smaller housing providers, including non-profit housing providers, low-income co-operative housing providers as well as faith- and ethnic-based providers. This targeted approach enabled Union to broaden its reach to low-income customers in 2014.

Market Incentive

Prescriptive Measures
The AHC offering includes all of the prescriptive measures offered to the multi-family segment within the standard Commercial portfolio. However, the incentive levels offered to the low-income sub-segment of the market are higher in recognition of the capital barriers that face this group. Participating social and assisted housing providers were responsible for sourcing service providers for installation of these measures. They received the appropriate incentives from Union upon project completion as outlined in Table 5.5 below. Service providers include architectural consultants, builders, HVACs, engineering consultants and energy service companies.

Table 5.5 - AHC Offering Incentives

Measure	End-user Incentive			Service Provider Incentive
Condensing Boiler – up to 299 MBtu/h	$	0.10	per cumulative m^3	$ 100
Condensing Boiler – 300 to 999 MBtu/h	$	0.10	per cumulative m^3	$ 100
Condensing Boiler – over 1,000 MBtu/h	$	0.10	per cumulative m^3	$ 100
Condensing Gas Water Heater (1000 gal/day)	$	1,900	flat incentive	$ 100
Condensing Gas Water Heater (500 gal/day)	$	1,000	flat incentive	$ 100
Condensing Gas Water Heater (100 gal/day)	$	500	flat incentive	$ 100
ERV Multi-family	$	0.10	per cumulative m^3	$ 100
HRV Multi-family	$	0.10	per cumulative m^3	$ 100
MUA Unit Improved Efficiency	$	0.10	per cumulative m^3	$ 100

Note: There is a prescriptive incentive cap of 50% of the eligible costs of the project.

Custom Initiative

Custom measures were also made available to social and assisted housing providers where there was an opportunity for significant energy savings. Participating social and assisted housing providers were responsible for driving the installation process for these measures and they received the incentives for participation as outlined below:

- \$0.10 per cumulative m^3 of gas saved; and
- Incentive cap: 50% of the eligible costs of the project.

Building Assessments

Building assessments identify prescriptive and custom upgrade opportunities in social and assisted housing multi-family buildings. Union offered social and assisted housing providers funding for a comprehensive building assessment service for their multi-family buildings. These assessments resulted in a report that identified prescriptive and custom measure upgrade recommendations. Multi-family site assessments were funded up to a maximum of \$5,000 per site and up to a maximum of \$25,000 per entity per year. Union follows existing commercial market protocols for assessing energy auditor reports and site assessment subsidization.

Free Showerhead Installation Initiative

This initiative offers energy efficient showerheads and aerators. Union provides free installation of showerheads to eligible multi-unit social and assisted housing properties.

Market Delivery

Union focused its market delivery efforts on housing managers and decision makers within 27 municipal social housing providers in the Union franchise area. While the prospect of significant subsidization of capital expenditures through Union's offerings may seem like an easy decision, there are many barriers to adoption. Social housing managers are extremely busy, under resourced and face tight budget constraints. To maximize program adoption, Union took two main approaches for outreach: direct sales and association marketing.

Figure 5.3, AHC Offering Sales Package

Direct Sales
Union met directly with its customers in municipal and non-profit housing sectors to present Union's suite of offerings and to elicit participation. A sales package clearly and concisely conveyed the offerings available to all multi-family and single-family stock managed by the social and assisted housing provider.

Qualified prescriptive and custom measures were identified by the housing provider and a building assessment was considered if there was potential to discover projects.

Social and assisted housing managers were responsible for sourcing contractors to implement prescriptive and custom measures, which were followed by the applicable incentive payment from Union.

Association Marketing
To support the direct sales efforts, Union developed and fostered relationships with relevant housing and social service associations while educating them on Union's suite of offerings in the social and assisted housing sector.

Partnership with the Ontario Non-Profit Housing Association (ONPHA)
Union partnered with the Ontario Non-Profit Housing Association (ONPHA) by sponsoring regional meetings in Hamilton, London and Windsor to further promote energy conservation, in addition to placing advertisements in their bi-monthly newsletter Quick Connections. Moreover, Union sponsored and exhibited at the 2014 ONPHA tradeshow, which provided the opportunity to promote the AHC offering. Union found that this partnership was an effective means of educating social and assisted housing providers on the cost benefits of Union's AHC offering for multi-unit properties in order to drive participation.

Partnership with Housing Services Corporation (HSC)
HSC is a non-profit organization that delivers province wide programs that benefit Ontario's affordable housing sector. HSC has been a long standing key partner for Union in promoting Union's low-income program offerings. In 2014, Union was a key sponsor for Measuring Matters Conference, which focused on providing practical energy efficiency solutions for social housing providers. Real-life case studies were used to illustrate how to reduce natural gas consumption by understanding and integrating energy benchmarking data, overcoming technical and organizational challenges, and maximizing human and financial resources. Several housing managers highlighted the AHC offering and discussed how their organization had participated and benefitted from significant natural gas savings in several multi-family buildings. The conference also provided Union with the opportunity to connect with housing providers.

Enercase
In 2014 Union produced its first Low-Income Enercase study, which outlines a specific energy efficient technology for multi-family housing. This Enercase study illustrated the benefits of implementing a heat recovery wheel for a make-up air unit. This technology was selected because of its low take-up with municipal customers and its energy savings potential.

Figure 5.4, Enercase Study

5.1.3 Market Research

Low-Income DSM Offerings to Market-Rate Multi-Family Buildings

This secondary research project was agreed to in the 2012-2014 Settlement Agreement. The objective of this study was to evaluate the viability of offering low-income programming to market-rate multi-family housing providers, in addition to the existing programming targeting social housing.

In 2014, Union consulted with key stakeholders to reach agreement on building eligibility, customer eligibility, targets, incentives, and other program parameters. To accomplish this, Union used both external and internal sources to identify low-income areas and ascertain the expected viable market potential within each major city in Union's franchise area.

Consolidated Municipal Service Manager Office & Non-profit/ Co-op Housing Providers

In 2014, Union continued to enhance its understanding of Ontario's social housing landscape. Specifically, Union focused on the role of the Consolidated Municipal Service Manager offices, or CMSMs (formerly Service Manager Offices). The CMSMs manage the distribution of subsidies and technical services to all social housing providers in a given municipality, including municipal, non-profit and co-operative housing organizations. Within the offices, technical staff oversee the building condition assessments of the housing portfolios, so they have an understanding of the building condition as well as the financial viability. In 2014, Union continued to leverage CMSM relationships to gain insights into the social housing market structure, funding models, building condition assessments and decision making processes associated with the different types of housing.

5.1.4 Education and Awareness

Education has been, and will continue to be, an important part of the Low-Income program. Union recognizes that there is a need not only to provide conservation programs directed to low-income customers, but also to educate customers on the direct benefits of energy efficient behaviour. To date, Union has focused education efforts on private market customers through targeted education brochures and education workshops hosted at the community level.

In the spirit of education and awareness, Union continued to leverage a short educational video on weatherization through the Low-Income program webpage to promote low-cost and no-cost energy saving tips and tricks for around the home.[7]

5.1.5 Lessons Learned

HWP Offering

1. ***Private single family market***
   Through the success of the HWP offering over the past three years, Union has addressed over 3,400 homes managed by municipal housing providers. Union addressed the social housing properties most in need of building envelope upgrades in each municipal provider's portfolio, and then worked through other homes within the portfolio that meet the HWP offering requirements. In view of this success, the building envelope improvement opportunities within properties managed by municipal housing providers have largely been addressed, resulting in Union now placing a greater emphasis on the private single family market segment.

2. ***Partnership with Winter Warmth Agencies***
   Union has educated Winter Warmth delivery agencies on the benefits of the HWP offering. However, agency intake workers are resource constrained and may not have the time to properly inform customers about the program. Union will apply the learning gained from its partnership with the United Way of Grey Bruce to help agencies find new delivery strategies that lessen resource constrains.

3. ***Web Strategy***
   Promoting the HWP offering through www.Kijiji.ca was effective in building awareness. However, Kijiji promotion did not result in many customers contacting a delivery agent. Prior to the launch of the Weather Network campaign in the third quarter, three steps were taken to address this:

   - Targeting efforts towards the website with the most traffic by the secondary target market (caregivers for the elderly); this resulted in cancelling advertisements with Kijiji and focusing on The Weather Network;

[7] The video can be found at http://www.uniongas.com/residential/save-money-energy/tips-save-money-energy/energy-saving-videos.

- Redesigning banner content to speak more to the secondary target market caregiver, instead of the homeowner; and
- Rebranding the material on the HWP offering website and making the site searchable from the Union homepage.

AHC Offering

1. ***Social Housing Landscape***
   CMSMs manage the distribution of subsidies to all social housing providers within a given municipality, and are an important part of Ontario's social housing landscape. Union needs to further develop service manager relationships across the franchise area in order to reach more social housing providers, especially the smaller non-profit and co-operative housing providers that have yet to participate in the AHC offering. The vast majority of these non-profit and co-operative housing providers struggle financially and could greatly benefit from Union's incentive program when dealing with capital replacements or improvements.

2. ***Importance of Low Income Segmentation***
   Union recognized the importance of tailoring communications to each of the three main low-income segments.

   - CMSM offices
   - Non-profit and co-op housing provider decision makers
   - Municipal social housing management

   As such, Union engaged in a rebranding of the AHC offering. The thrust of the new messaging is to speak directly to these three separate market segments in their own respective languages and terminology, addressing specific needs and considerations.

6. Large Volume Scorecard (Rate T1, Rate T2/Rate 100)

The Large Volume scorecard consists of cumulative m^3 saved from customers within Rate T1, and Rate T2/Rate 100. Table 6.0 presents the results of the Large Volume scorecard. Union achieved 6% of the overall scorecard target, which is below the threshold that earns Union an incentive.

Table 6.0 - 2014 Large Volume Rate T1, Rate T2/Rate 100 Scorecard Results

Metrics	Metric Target Levels			Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
	Lower Band	Target	Upper Band				
Rate T2 / Rate 100 Cumulative Natural Gas Savings (m^3)	795,074,195	1,060,098,927	1,325,123,659	40%	788,587,677	49%	*20%*
Rate T1 Cumulative Natural Gas Savings (m^3)	156,530,251	208,707,001	260,883,751	60%	81,607,775	-22%	*-13%*
						Total Scorecard Target Achieved	***6%***
						Scorecard Incentive Achieved	***$0***

6.1 Large Volume Program

Consistent with 2013, Union continued to encourage the adoption of energy efficient equipment, technologies, and actions through direct customer interaction. As noted in section 2.1, Union's Large Industrial DSM programming filed in the 2012-2014 DSM Plan Settlement Agreement applied to 2012 only, and was replaced by the Large Volume DSM Program for 2013-2014 (EB-2012-0337).

The 2014 program continues to use a Direct Access budget mechanism for the customer incentive budget process for Rate T2/Rate 100 customers. In lieu of an aggregate pool approach, at the beginning of the year these customers each have direct access to the full customer incentive budget they pay in rates. Customers must use these funds to identify and implement energy efficiency projects, or lose the funds which will consequently become available for use by other customers in the same rate class. This 'use it or lose it' approach ensures each customer has first access to the amount of incentive budget funded by their rates. The Direct Access budget mechanism was introduced in direct response to feedback received from Union's largest customers. The incentive approach for Rate T1 customers remains unchanged from the aggregate pool approach offered in 2013.

Union's Large Volume program is aligned under one brand platform, EnerSmart. This ensures a seamless, recognizable brand throughout Union's franchise.

For large volume customers, the EnerSmart program was designed with a particular focus on achieving savings in a process-specific energy application. Account Managers market the program directly to customers and indirectly through trade allies, channel partners, Energy Service Companies (ESCOs), engineering firms, and equipment manufacturers. Account Managers work to cost effectively promote energy efficiency within Union's Large Volume Rate T1, Rate T2/Rate 100 customer base.

Large Volume custom projects are jointly delivered through Union's Account Managers and Technical Project Managers. Success is achieved by combining strong engineering expertise with the relationships established through the direct account-management approach. This approach is critical to influencing the market and achieving successful implementation of the program.

Table 6.1 shows the results of the Large Volume program and Table 6.2 breaks down the total spend into its components.

Table 6.1 - 2014 Large Volume Program Results

Program	Offering	Units	Annual Gas Savings (m^3)	Cumulative Gas Savings (m^3)	Total Spend	Net TRC	TRC Ratio
Large Volume	Rate T2	98	40,465,390	502,418,896			
	Rate 100	56	26,110,432	286,168,782	$ 4,101,725	$ 86,957,726	4.15
	Rate T1	53	4,194,776	81,607,775			
2014 Large Volume Total		**207**	**70,770,597**	**870,195,452**	**$ 4,101,725**	**$ 86,957,726**	**4.15**

Table 6.2 - 2014 Large Volume Program Spend

Item	Total
Incentives	$ 3,217,761
Administration	$ 771,923
Evaluation	$ 108,595
Promotion	$ 3,446
2014 Total Large Volume Rate T1, Rate T2 and Rate 100 Program Spend	**$ 4,101,725**

Table 6.3 shows the calculation of the Large Volume program's TRC ratio. With a TRC ratio of 4.15, the Large Volume program's net TRC benefits are approximately four times greater than its net TRC costs.

Table 6.3 - 2014 Large Volume Program Cost-Effectiveness

	TRC Benefits (a)	TRC Costs (b)	Net TRC (c)=(a-b)	TRC Ratio (d)=(a/b)
Measures	$ 114,592,924	$ 26,751,234	$ 87,841,690	4.28
Administration		$ 771,923		
Evaluation		$ 108,595		
Promotion		$ 3,446		
Large Volume Rate T1, Rate T2 and Rate 100 Program Total	**$ 114,592,924**	**$ 27,635,198**	**$ 86,957,726**	**4.15**

6.1.1 Program Offerings

Given the low level of new build activity in this sector, the large volume market is not differentiated into new build and existing buildings. The large volume market is highly heterogeneous, with most projects tied directly to unique processes or technology requirements.

The Large Volume program goal is to generate long-term and cost-effective energy savings for Union customers. The program offerings are consistent with 2013 and are outlined below.

Customer Engagement - Communication and Education
Union provided education, training and technical expertise and offered a wide variety of materials aimed at building an increased awareness of energy efficiency opportunities and benefits.

New Equipment and Processes
Union's role in promoting and implementing energy efficient options continued to help companies control energy costs and remain competitive in today's global economy. The instability of the current economic climate is a threat to the industrial customer base in Union's franchise. With the continual focus on cost reduction, many industries lack the resources required to analyze potential energy saving opportunities. Union helps fill this gap with its reliable, knowledgeable and reputable Technical Project Managers in conjunction with incentives designed to influence equipment choices.

Operations and Maintenance
Union assisted customers maintain equipment standards at optimal performance levels by providing financial incentives for implementing operations and maintenance practices that save natural gas through repairs, replacements or retrofits of existing equipment.

Process Improvement Studies
Union provided customer incentives for conducting detailed engineering analysis and designing specific process equipment or operational improvements identified with or without a general plant audit. The program works to support performance testing and analyses of industrial boilers, total steam plants, thermal fluid heaters, vaporizers, furnaces and special process equipment. Testing identifies and quantifies energy saving opportunities, cost saving opportunities, implementation costs and payback periods as well as NO_x and CO_2 impacts.

Engineering Feasibility Studies
Engineering feasibility studies that included an analysis of natural gas equipment as well as electricity, compressed air, water and wastewater were provided. These feasibility studies helped customers formulate a priority list of energy efficiency projects geared to site-specific energy plans and budgets. Union also assisted the customer's technical staff in generating business cases to enable the customer to secure corporate capital funding for energy efficient equipment and/or process changes.

Steam Trap Surveys
Steam trap surveys conducted by qualified service companies are designed to reduce losses from steam distribution systems. Each survey identifies leaking, over-sized or under-sized, blocked and/or flooded traps, as well as the need for improvements in condensate return systems.

Boiler Tune-ups
Union provided an incentive to large volume industrial customers for the optimization of their facilities' boiler air-to-fuel ratio, ensuring efficient combustion and natural gas savings.

Infrared Anti-Condensate (IRAC) Polyethylene Plastic
For large greenhouse customers, Union provided an incentive for the installation of IRAC polyethylene plastic to assist greenhouses in saving natural gas.

Similar to the Commercial/Industrial custom offering, Union continued a rigorous quality control process for all Large Volume custom projects. Professional Engineers (P.Eng), licensed to practice in Ontario, assisted customers with the quantification of energy savings prior to application submission. All custom projects were then subjected to a secondary professional engineering review to validate the reasonability of the claimed savings, while ensuring appropriate supporting documentation is contained in the project files.

All custom projects utilize the Project Application Summary (PAS) to summarize all key project inputs and details. The use of this PAS sheet continues to strengthen Union's secondary professional engineering review, as well as support annual verification of Large Volume custom projects.

6.1.2 Large Volume Program Incentives

Table 6.4 and Table 6.5 show the incentive guidelines for the 2014 Large Volume Rate T1 and Rate T2/ Rate 100 offerings respectively.

Table 6.4 - 2014 Incentive Guidelines for Rate T1

Offer	Incentive
Engineering Feasibility Study	50% of the cost, up to $10,000
Process Improvement Study	66% of the cost, up to $20,000
Steam Trap Survey	50% of the cost, up to $6,000
New Equipment	$0.08 per cumulative m^3, up to $40,000
Operations & Maintenance	$0.08 per cumulative m^3, up to $20,000
Boiler Tune-Up	$250 per boiler
Meters – Gas/Steam/Hot-water	50% of the cost, up to $1,000
Infrared Polyethylene – IR Poly	$400 per growing acre
Demonstration of New Technologies	25% of the cost, up to $75,000

Table 6.5 - 2014 Incentive Guidelines for Rate T2/Rate 100

Offer	Incentive
Engineering Feasibility Study	50% of the cost, up to $10,000
Process Improvement Study	66% of the cost, up to $20,000
Steam Trap Survey	50% of the cost, up to $6,000
Direct Access Budget (DAB) New Equipment	$0.08 per cumulative m^3, up to $40,000
Aggregate Pool Funded (LVAP) New Equipment	$0.05 per cumulative m^3, up to $20,000
Direct Access Budget (DAB) Operations & Maintenance	$0.08 per cumulative m^3, up to $20,000
Aggregate Pool Funded (LVAP) Operations & Maintenance	$0.05 per cumulative m^3, up to $10,000
Meters – Gas/Steam/Hot-water	50% of the cost, up to $1,000
Demonstration of New Technologies	25% of the cost, up to $75,000

6.1.3 Education and Awareness

Customers have repeatedly told Union that they find significant value in the training and educational material provided.

Union continues to expand and broaden distribution of the following educational and promotional tools, which contain information specifically geared towards Rate T1, Rate T2/Rate 100 customers:

- GasWorks newsletter;
- EnerSmart brochures;
- EnerCase reports;
- Workshops to promote the efficient use of natural gas and increase the awareness of energy savings opportunities;
- Sponsorship of specific educational forums;
- Promotion and attendance at independent professional development groups, trade organizations, and government workshops; and,
- Developed an online calculator for greenhouse customers that lets them compare the cost of burning natural gas and extracting CO_2 to the cost of burning natural gas and buying liquid CO_2.

GasWorks is a technology and energy conservation newsletter, designed to assist large users of natural gas to better manage their business. *GasWorks* provides industry trend, technology and energy efficiency information to help businesses improve process productivity, enhance reliability of equipment and control energy expenses. The newsletter provides links to Union’s website and energy efficiency programming as well as various tools, calculators, an online resource library, and an “Ask an Expert” service to provide technical advice.

Below is a summary of the top five most accessed articles of 2014:

- The Polar Vortex Winter Weather Pattern: Impacts on Ontario Natural Gas Supplies and Prices
- Best Practices for Reducing Natural Gas Consumption
- Ask an Expert- Are There Health and Energy – Saving Benefits from Duct Cleaning?

- Stop Steam Trap Leaks with Wireless Monitoring
- 2014 Summer Energy and Fuel Outlook

Union's webpage, dedicated to the EnerSmart program[8], contains an application form, technology information, conversion calculations, technical presentations from customer meetings, a series of links for additional references, and an expanding library of *EnerSmart* and *EnerCase* brochures. These brochures include customer challenges and the solutions that Union provided.

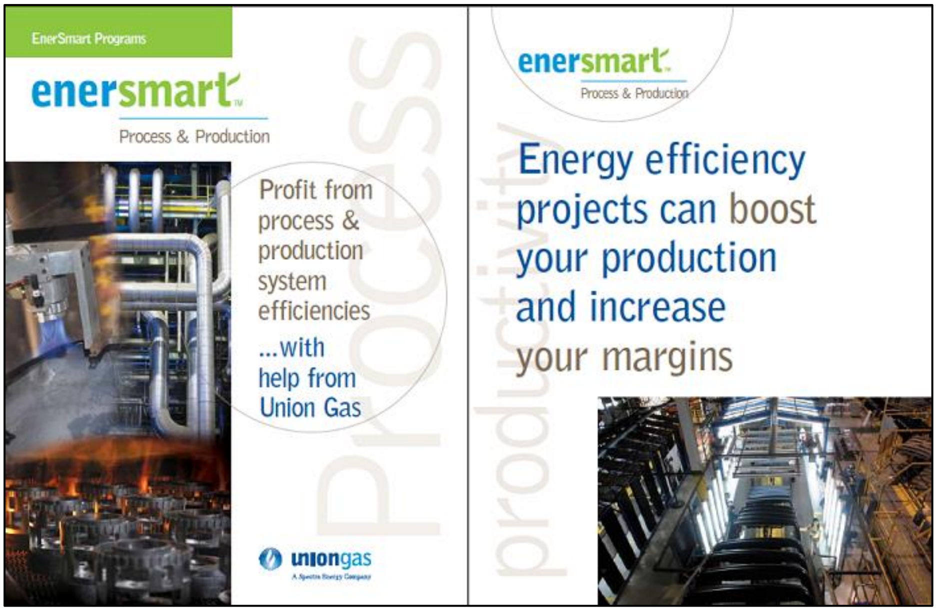


Figure 6.0, EnerSmart Process and Production Brochure

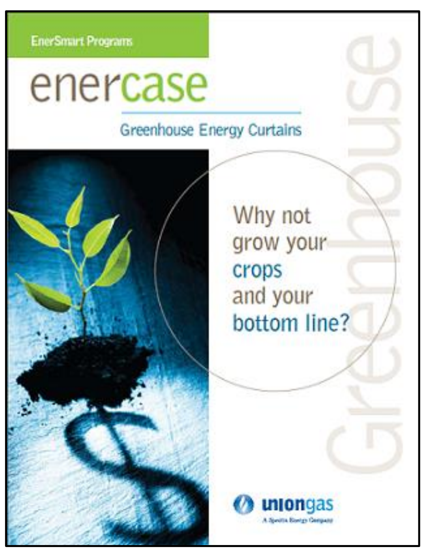
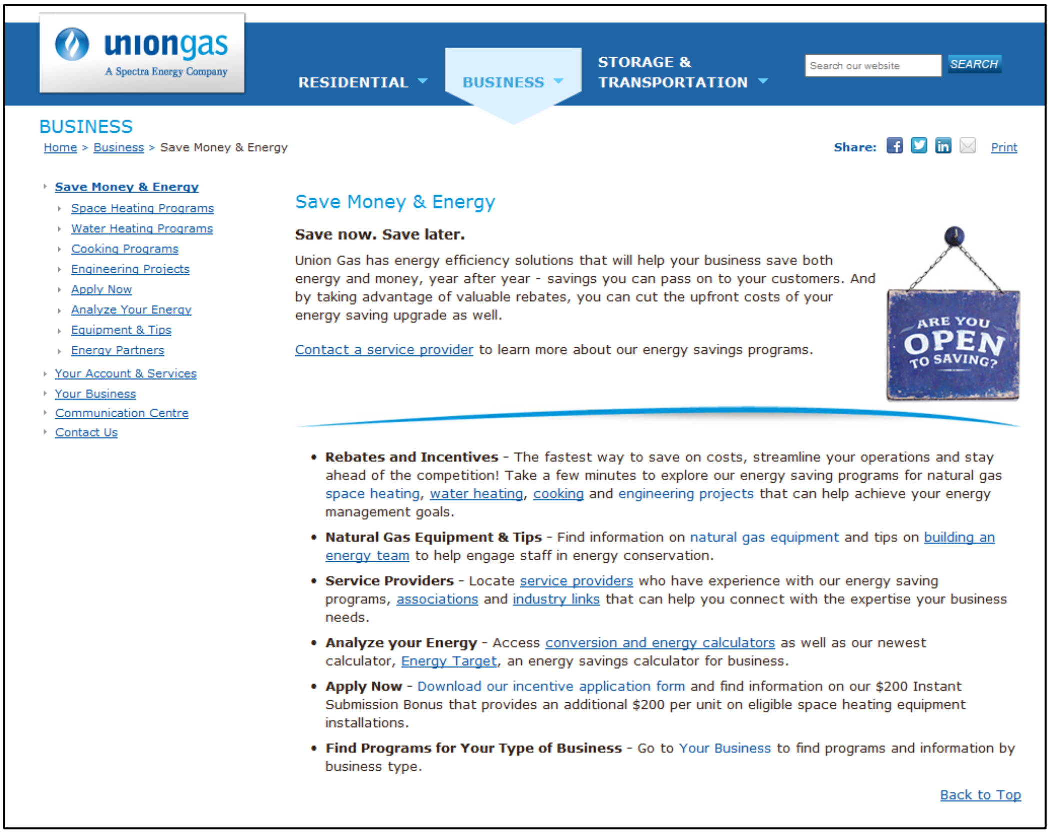


Figure 6.1, EnerCase Greenhouse Energy Curtains Brochure

[8] http://www.uniongas.com/business/save-money-and-energy



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Save Money & Energy

Save now. Save later.

Union Gas has energy efficiency solutions that will help your business save both energy and money, year after year - savings you can pass on to your customers. And by taking advantage of valuable rebates, you can cut the upfront costs of your energy saving upgrade as well.

Contact a service provider to learn more about our energy savings programs.

ARE YOU OPEN TO SAVING?

- **Rebates and Incentives** - The fastest way to save on costs, streamline your operations and stay ahead of the competition! Take a few minutes to explore our energy saving programs for natural gas space heating, water heating, cooking and engineering projects that can help achieve your energy management goals.
- **Natural Gas Equipment & Tips** - Find information on natural gas equipment and tips on building an energy team to help engage staff in energy conservation.
- **Service Providers** - Locate service providers who have experience with our energy saving programs, associations and industry links that can help you connect with the expertise your business needs.
- **Analyze your Energy** - Access conversion and energy calculators as well as our newest calculator, Energy Target, an energy savings calculator for business.
- **Apply Now** - Download our incentive application form and find information on our $200 Instant Submission Bonus that provides an additional $200 per unit on eligible space heating equipment installations.
- **Find Programs for Your Type of Business** - Go to Your Business to find programs and information by business type.

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Figure 6.2, EnerSmart Webpage Screenshot

Table 6.6 lists Union hosted seminars held in 2014 to promote energy conservation to Rate T1, Rate T2/Rate 100 customers.

Table 6.6 - Union Hosted Industrial Seminars

Name of Seminar	Date
Tap Your Steam System Training	March 2014
Achieving HVAC Savings Workshop	December 2014

In addition to hosting seminars, Union also showcased its program offerings and industry knowledge by attending industry tradeshows. Table 6.7 lists the tradeshows specific to large volume customers that Union attended in 2014.

Table 6.7 - Industry Tradeshow Participation

Industry Tradeshow Attendance	Date
Canadian Boiler Society Education & Training Forum	April 2014
Energy Summit 2014 (NRCAN)	May 2014
CBS Tech Fair and Education	June 2014
Forest City National Customer Meeting	June 2014
Greenhouse Growers Luncheon	September 2014

Education does not stop with customer training and seminars. Union prides itself on providing highly valued energy expertise, technical support, and resources for Large Volume Rate T1, Rate T2/Rate 100 customers. As a leader in energy efficiency committed to working closely with government, efficiency, environmental and professional organizations, Union fully understands the latest trends and technologies. This is not limited to potential solutions for individual customers, but also includes the co-benefit of shared learning. Some examples of industry partnerships include:

Consortium for Energy Efficiency (CEE)
Through this partnership, Union networked with efficiency program administrators from across the United States and Canada with a focus on developing common approaches to advancing energy efficiency.

Energy Solutions Centre (ESC)
Through the ESC, Union collaborated with energy utilities, municipal energy authorities, equipment manufacturers, and vendors to accelerate the acceptance and deployment of new energy efficient, gas-fuelled technologies.

Natural Resources Canada (NRCan)
Union's involvement with NRCan includes participating in research activities, providing funding of industry-specific benchmark studies, and offering Union customers assistance in obtaining government funding for energy efficiency projects. Specific NRCan departments include:

- Office of Energy Efficiency (OEE)
- Canadian Industry Program for Energy Conservation (CIPEC)
- CANMET Energy Technology Centre

Canadian Boiler Society (CBS)
Union partnered with the Canadian Boiler Society to provide technical training to Union customers that will help them operate their equipment at optimum efficiency.

6.1.4 Lessons Learned

1. ***Direct Access Budget***
   The Direct Access budget mechanism for Rate T2/Rate 100 was designed in consultation with large volume customers. The following outlines some key observations of the program in 2014:

   - 100% of Rate T2/Rate 100 customers participated by submitting energy efficiency plans;
   - 95% of Rate T2/Rate 100 customers submitted energy efficiency plans and at least one project;
   - 62% of Rate T2/Rate 100 customers utilized all of their budget;
   - 51% of Rate T2/Rate 100 customers received additional funding from the Aggregate Pool; and
   - Approximately 36% of the total Rate T2/Rate 100 program savings were funded by the Aggregate Pool.

   The Direct Access budget mechanism will continue to be an important component of Union's Large Volume program in 2015.

2. ***Improve Direct Access Project Completion***
   Customers prioritize energy efficiency plan projects amongst other competing priorities. Union's Account Managers and Project Managers work with customers to implement project management principles, such as project prioritization, scheduling, progress tracking and reporting. This involves providing dedicated energy efficiency expertise, meeting with key decision makers, and 'making the case' for energy efficiency. Union has learned that these interactions, coupled with financial incentives are crucial in ensuring customers make the most of their Direct Access budgets and move forward on energy efficiency projects.

3. ***T1 Project Opportunities***
   Union experienced a decrease in custom project opportunities for T1 customers in 2014. T1 customers were unable to marshal plant resources and/ or internal funding capacity to pursue their previous levels of DSM custom projects. Union's ability to drive DSM results continues to be challenged by customers' operational priorities at the plant level, which are impacted by a number of factors.

7. Market Transformation Scorecard

In 2014, Union continued its market transformation efforts on the Optimum Home program.

Table 7.0 presents the results of the market transformation scorecard. Union achieved over 150% of the overall scorecard target, resulting in an incentive of $0.557 million.

Table 7.0 - 2014 Market Transformation Scorecard Results

Metrics	Metric Target Levels			Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
	Lower Band	Target	Upper Band				
New Participating Builders	2	4	10	40%	3	75%	*30%*
Prototype Homes Built	50%	60%	70%	40%	86.36%	232%	*93%*
Homes Built (>20% above OBC 2012) by Participating Builders	3%	6%	9%	20%	14.73%	246%	*49%*
						Total Scorecard Target Achieved	***150%***[9]
						Scorecard Incentive Achieved	***$557,358***

The ‘New Participating Builders’ metric refers to the number of ‘top builders’ who signed up for the Optimum Home program by signing a participation contract in 2014. A builder is considered a ‘top builder’ based on its number of housing starts in Union’s franchise in the prior calendar year. Top builders are discussed further in Section 7.1.

The ‘Prototype Homes Built’ metric is the number of top builders who have signed up for the program in 2012, 2013 or 2014 and have built at least one prototype home. This number of builders is reported as a percentage of all top builders that have ever enrolled in the Optimum Home program. Prototype homes are discussed as Discovery Homes in Section 7.1.

The ‘Homes Built (>20% above OBC 2012) by Participating Builders’ metric is calculated as the percentage of homes built by enrolled builders in 2014 to a 20% higher energy efficiency standard than the 2012 Ontario Building Code (OBC) in relation to the total number of homes built in 2014 by builders who remain enrolled in the program. Only homes that have an activated gas service are included in this metric. These homes are discussed as high performance homes in Section 7.1.

Table 7.1 shows Union’s total spend on the Optimum Home program.

[9] Scorecard is capped at 150%. Actual scorecard achievement is 172%.

Table 7.1 - 2014 Market Transformation Results

Scorecard	Program	Item	Result	Total Spend
Market Transformation	Optimum Home	Builders Signed in 2014	3	$ 1,262,958
		Total Prototype Homes built in 2014	19	
		Homes Built (>20% above OBC 2012) by Participating Builders in 2014	365	
2014 Market Transformation Total				$ 1,262,958

Table 7.2 breaks down the total spend for the Optimum Home program into its components.

Table 7.2 - 2014 Market Transformation Spend

Item	Total
Optimum Home Program Incentives	$ 748,124
Optimum Home Program Administration	$ 400,117
Optimum Home Program Evaluation	$ 0
Optimum Home Program Promotion	$ 114,717
Total Market Transformation Spend	**$ 1,262,958**

7.1 Optimum Home Program

The Optimum Home program is based on a whole-home consultant based approach. The objective of the Optimum Home program is to accelerate residential home builders' energy efficiency practices. The program prepares builders prior to an increase in minimum building efficiency standards expected in the next release of the OBC in 2017. This is achieved by supporting the builders toward building to 20% above the current OBC 2012. The program is not based on a single technology and is not tied to a specific label.

The Optimum Home program is targeted to the top fifty most active builders in Union's franchise area based on the number of housing starts in Union's franchise in the prior calendar year. Builders that sign up for the Optimum Home program enter into a multi-year consulting process. This process partners participating builders with a leading building science expert who can provide cutting edge advice on how to build residential homes to 20% above current OBC 2012. These experts are the leading group of consultants in Ontario's residential building industry, which reinforces the value proposition for builders. They are Gord Cook, Al Schmidt, Michael Leo, Tex McLeod, and Andy Oding.

The outcome of advanced building practices is achieved through a process that identifies and addresses barriers to energy efficient construction. The consulting process deals with every aspect of the builder's business including marketing, sales, contracts, construction, services and trades.

The Optimum Home program recognizes that every builder is different. Consultants tailor their advice offered to suit each builder's individual needs. Consultants work with the builder to develop capacity within its organization to effectively build to a higher efficiency, and to understand opportunities to mitigate any incremental costs through business process improvements. The Optimum Home program consists of three phases:[10]

- **Phase One – Discovery.** Union pairs participating top builders with a leading building science consultant to develop a baseline by benchmarking current product and business practices and by conducting an on-site audit. The consultant will lead discussion on new technologies, building practices and options, resulting in a customized handbook of building specifications to assist the builder to build 20% above OBC 2012. The builder will then build at least one prototype home (Discovery Home) to meet this requirement. On behalf of the builder, a Certified Energy Advisor (CEA) must demonstrate that the Discovery Home is indeed 20% above OBC 2012. Cost of this evaluation work is covered by the builder.
- **Phase Two – Production.** The builder will work with the consultant to test the new building specifications, examine lessons learned, establish training requirements, conduct training as required, commence building high performance housing stock to 20% above OBC 2012 and conduct performance testing of these houses.
- **Phase Three – Transformation.** The consultant will work with the builder towards full implementation of the new specifications as identified throughout the Optimum Home program process. The consultant sets out a sustainability plan to maintain momentum of building to the new level of efficiency in the future. A wrap up session is then held with the consultant, the builder and any trades people involved where significant gains, technological advancements, and efficiencies achieved as a result of the program are discussed.

During the first half of2014, Union successfully recruited three new builders into the program, bringing the total participating builder group to twenty two. Nineteen of these builders have now built Discovery Homes that are 20% above OBC 2012.

In the second half of 2014, the focus shifted towards getting builders to start building stock of high performance homes. By the end of 2014, fourteen builders completed production of high performance homes and CEAs have confirmed that these homes are indeed 20% above OBC 2012. As a result, Union influenced builders to build 12% of their housing stock to Optimum Home program requirements, thus doubling its target of 6%.

By the end of 2014, Union also had three builders complete Phase Three of the program. These builders along with their building science experts each held a wrap up session to discuss program accomplishments and learnings. They also addressed how to create a plan to maintain momentum in building high performance homes in the future.

Optimum Home Education Workshops

The Optimum Home Education Workshops were launched in 2013 to facilitate transformation of the broader builder market. A technical workshop provided builders with the information and tools needed to build to 20% above OBC 2012 in a cost effective manner. A sales & marketing workshop provided information on how to market and sell the features and benefits of high performance homes. In the first

[10] Up to 30 Consultant days are available to each builder over the three phases of the program.

quarter of 2014, Union offered the two workshops to all interested builders, including those not in the top fifty most active builders in Union's franchise area.

Figure 7.0, Brochure for Optimum Home Education Workshops

Figure 7.1, Optimum Home Education Workshop Email Communication to Builders

Target Market

The Optimum Home program targets the top fifty builders in Union's franchise based on the previous year's housing starts.

The following groups play a secondary role in influencing a builder's decision to participate in the Optimum Home program. Influencing these parties will help drive demand for high performance homes, and in turn, will raise builder interest in the Optimum Home program:

- New home buyers, who will ultimately purchase the higher efficiency homes; and
- Builder sales centres, who work on behalf of builders to promote and sell new homes directly to new home buyers. They greatly influence customers' choices and selection of upgraded features. Under the builder's direction, they will promote the programs and features that they believe will generate the most customer interest. There are many competing companies attempting to influence design/sales centres (such as manufacturers of faucets, cabinets, and countertops), which can make it difficult for energy efficiency products to gain footing.

Market Incentive

Builder Incentive
The Optimum Home program is delivered at no cost to the builder. Participating builders receive the following:

- Up to 30 free days of consultation by renowned industry experts;
- Trades, sales and marketing training;
- Continuous cost savings and process efficiencies; and
- $2,500 incentive towards the construction of a Discovery Home.[11]

Builders attending the Optimum Home Education Workshops receive information and training on meeting the Optimum Home program building standard of 20% above OBC 2012. Union funds 50% of the workshop fee of $199.

Customer Incentive
Between January and October 2014, Union offered a $1,000 limited-time incentive to home buyers of Optimum Homes. The objectives of the offer were to create awareness in the new homes market and influence customers into investing in a high performance home.

[11] To be provided upon completion and evaluation. Limited to one Discovery Home built in Phase One.

Figure 7.2, Optimum Home Program Customer Incentive Offer Brochure

Market Delivery

A profile of the top fifty builders in Union's franchise was completed in order to determine which builders would be targeted for builder recruitment in 2014. Union's delivery agent was leveraged to add additional market intelligence to the top fifty builder list including key contact information and labelling practices. Union led the builder recruitment process and collaborated with its delivery agent and the consultants to conduct builder outreach where Union did not have established builder relationships.

Union continued to utilize the Builder Partnership Package, developed in 2012, to formally sign builders up for the Optimum Home program. The package includes a builder partnership agreement between the participating builder and Union and a non-disclosure agreement. The Optimum Home program builder portfolio also included a brochure outlining the Optimum Home program and its key benefits, a consultant biography piece to highlight the experience and credentials of the leading building science consultants, a testimonial piece and a PowerPoint presentation that further described the Optimum Home program.

Figure 7.3, Optimum Home Program Brochure

Marketing Support

Union provided each participating builder with a press release/editorial and key message document that could be released to media at the opening and display of the builder's Discovery Home. Banners were also provided for each Discovery Home site to attract customers and encourage them to ask for more information regarding high performance homes.

Each builder was encouraged to create its own high performance home brand and market it to its customers.

Figure 7.4, Discovery Home Signage (Doug Tarry and Dussin)

Ontario Home Builders' Association (OHBA) Partnership

As part of Union's ongoing commitment to the builder community, Union partnered with the Ontario Home Builders' Association. Support from the OHBA has provided Union with the ability to boost its brand profile amongst multiple stakeholders and enhance market intelligence related to energy efficiency, sustainability and better building in the new housing market. Union participated in the 2014 OHBA Builder and Reno Forum held in February and attended various events throughout the year with the OHBA's local chapters.

7.2 Lessons Learned

1. ***Addressing market barriers***
   Union has been engaged with builders and building science experts to identify remaining market barriers. These include:

   - Helping builders work through unanticipated technical issues such as increased tightness of the home, and use of new energy efficient technologies/building materials;
   - Continuing to assist builders and their sales teams in 'selling' higher efficiency homes. Many builders were initially more focused on building higher efficiency homes. There is now a need to shift attention towards selling these homes; and
   - Ensuring energy efficiency is a top of mind for home buyers, who tend to value factors such as location, builder reputation, and aesthetic upgrades ahead of 'hidden' energy efficiency.

2. ***Greater building community***
   Union recognizes that in order for market transformation to be effective, program knowledge and experiences must be shared across the greater building community. Union engaged the building community beyond the top 50 builders across its franchise through its Optimum Home Education Workshops. However, Union's workshops were met with low attendance as the workshop market is very saturated in the builder community. In order to engage this market Union must utilize other means.

3. ***Marketing support required for customers and builders***
   In 2014, Union created demand in the market to support builders in the Optimum Home program by offering customers a $1,000 on-bill credit incentive and by creating marketing collateral to create consumer awareness of the benefits of a high performance home.

4. ***Improvement in technology and building practices***
   Over the past three years, Union discovered that many of the issues that impact a builder's ability to build to 20% above OBC 2012 are very similar. For example:

   - Builders have traditionally been resistant to new innovations such as smaller HVAC systems and advanced insulation and air barrier systems. Working with consultants who have had successful experience in utilizing these measures is making builders less resistant to incorporate these technologies in their production;
   - One of the common problems in advanced construction is moisture problems in air tight homes. With their experience in the Optimum Home program, participating building science experts are now more confident in providing corrective recommendations to solve these problems – whether it is utilizing HRVs to control overall relative humidity levels, or special wall membranes that do not trap moisture; and
   - Many production related issues revolve around trades training. Union's experience through the Optimum Home program has allowed its consultants to recommend a few standard training programs with their trades to deal with common production issues, such as dealing with air leakages issues and optimizing their HVAC systems.

8. Evaluation, Measurement and Verification

For the purpose of validating the accuracy of claimed savings, Union undertakes several impact evaluations each year. These impact evaluations are designed to ensure that the claimed participation and installation rates for technologies delivered through Union's programs are accurate. Union commissioned an impact evaluation for the Residential ESK offering as well as a verification of claimed savings obtained through its custom projects. For 2014, custom project savings verification included the Low-Income Custom initiative, Commercial/Industrial Custom offering and Large Volume program with a total of 56 project verifications.

8.1 Residential Impact Evaluation

Union conducted an impact evaluation of the Residential ESK offering to validate the program offering's energy savings. Beslin Communications Group Inc. was contracted to provide a statistically representative sample at the 90:10 confidence level and conduct the impact evaluation via a telephone survey. The details of the impact evaluation and its findings are outlined below.

8.1.1 Energy Savings Kit Offering Impact Evaluation

Union conducted an impact evaluation across three channels for the ESK offering to ensure the savings were accurate, as outlined in Table 8.0. This impact evaluation determined the number of ESK measures that were installed and remained installed for 2014. Additionally, since the savings associated with ESK showerheads relate to showering for an entire home, the impact evaluation also established the portion of showering that was attributable to the ESK showerhead. Furthermore, the impact evaluation determined the percentage of ESK recipients that used a natural gas water heater to heat their homes' water. Through these efforts, the evaluations provide adjustment factors that are applied to savings claims.

Table 8.0 - Summary of Residential ESK Impact Evaluation

ESK Channel	Participants	Source	Primary Objectives
Pull	Customers who received an ESK by responding to bill inserts and through online requests	Beslin Communications Group Inc.	- Verify measure installation - Verify continued use of the measure - Verify percentage of showering under the efficient showerhead - Verify water heater type
Push	Customers who received an ESK through HVAC partners visiting their home	Beslin Communications Group Inc.	- Verify measure installation - Verify continued use of the measure - Verify percentage of showering under the efficient showerhead - Verify water heater type
Door-to-Door (Push)	Customers who received an ESK through the door-to-door initiative	Beslin Communications Group Inc.	- Verify measure installation - Verify continued use of the measure - Verify percentage of showering under the efficient showerhead - Verify water heater type

Some participants also received an ESK kit through a fourth ESK delivery channel, known as the ESK Install channel. This delivery channel provided ESK kits to customers who elected to have the showerhead installed during a home visit from an HVAC partner. Since only 175 kits were delivered via this channel, it was not included in the 2014 ESK impact evaluation. Rather, adjustment factors determined during the 2012 ESK impact evaluation were applied to the 2014 savings claimed from the 2014 ESK Install channel.

The final adjustment factors for the four delivery channels are presented in Tables 8.1, 8.2, 8.3, and 8.4.

Table 8.1 - Adjustment Factors: ESK Pull

Measure	Measure Verified Installed	Measure Remained Installed	% Showering Under Low-Flow Showerhead	% With Natural Gas Hot Water Heaters	Adjustment Factor
Energy-efficient Showerhead	84%	83%	66%	100%	55%
Kitchen Faucet Aerator	78%	71%		100%	71%
Bathroom Faucet Aerator	82%	81%		100%	81%
Pipe Wrap	98%	98%		100%	98%

Table 8.2 - Adjustment Factors: ESK Push

Measure	Measure Verified Installed	Measure Remained Installed	% Showering Under Low-Flow Showerhead	% With Natural Gas Hot Water Heaters	Adjustment Factor
Energy-efficient Showerhead	76%	75%	72%	100%	54%
Kitchen Faucet Aerator	74%	65%		100%	65%
Bathroom Faucet Aerator	79%	79%		100%	79%
Pipe Wrap	96%	96%		100%	96%

Table 8.3 - Adjustment Factors: ESK Door-to-door

Measure	Measure Verified Installed	Measure Remained Installed	% Showering Under Low-Flow Showerhead	% With Natural Gas Hot Water Heaters	Adjustment Factor
Energy-efficient Showerhead	79%	79%	64%	100%	50%
Kitchen Faucet Aerator	72%	68%		100%	68%
Bathroom Faucet Aerator	81%	80%		100%	80%
Pipe Wrap	95%	95%		100%	95%

Table 8.4 - Adjustment Factors: ESK Install from 2012 ESK Impact Evaluation

Measure	Measure Verified Installed	Measure Remained Installed	% Showering Under Low-Flow Showerhead	% With Natural Gas Hot Water Heaters	Adjustment Factor
Energy-efficient Showerhead	95%	92%	78%	100%	72%
Kitchen Faucet Aerator	87%	82%		100%	82%
Bathroom Faucet Aerator	92%	92%		100%	92%
Pipe Wrap	100%	100%		100%	100%

8.2 Low-Income Impact Evaluations

In 2014, Michaels Energy conducted the Low-Income custom project savings verification.

Union did not contract for the completion of an impact evaluation of the HWP offering basic measures (low-flow bathroom and kitchen aerators, pipe insulation and low-flow showerheads) since only 55 participants received basic measures.[12] Rather, the results of the impact evaluation for the 2012 Helping Homes Conserve (HHC) offering – now rebranded as the HWP offering –are applied to the savings claimed from the 2014 HWP offering. The impact evaluations used in 2014 and their results are outlined in the sections below.

8.2.1 Home Weatherization Program Offering Impact Evaluation

In 2012, Beslin Communication Group Inc. on behalf of Union conducted an impact evaluation of basic measures offered as part of the 2012 HHC offering, as outlined in Table 8.5. Similar to the Residential ESK offering impact evaluation, the installation and persistence rates of showerheads, kitchen aerators, bathroom aerators and pipe wrap were determined. The percentage of showering in the home that used the HHC showerhead and the percentage of recipients that have a natural gas water heater in their home were also determined. Beslin Communications Group Inc. conducted the impact evaluation on a statistically representative sample of 2012 HHC offering participants at the 90:10 confidence level.

Table 8.5 - 2012 HHC Offering Impact Evaluation Parameters

Participants	Source	Primary Objectives
Customers who received a showerhead, bathroom aerator and kitchen aerator through the 2012 HHC offering	Beslin Communications Group Inc.	- Verify measure installation - Verify continued use of the measure - Verify percentage of showering under the efficient showerhead - Verify water heater type

[12] As noted in Section 5.1.1, basic measures were only provided to the HWP offering participants installing weatherization measures if they had not previously received them.

The resulting adjustment factors in Table 8.6 have been applied to the 2014 claimed savings.

Table 8.6 - Adjustment Factors: HWP Offering from 2012 HHC Impact Evaluation

Measure	Measure Verified Installed	Measure Remained Installed	% Showering Under Low-Flow Showerhead	% With Natural Gas Hot Water Heaters	Adjustment Factor
Energy-efficient Showerhead	93%	92%	87%	100%	80%
Kitchen Faucet Aerator	85%	81%		100%	81%
Bathroom Faucet Aerator	86%	86%		100%	86%
Pipe Wrap	94%	94%		100%	94%

8.2.2 Low-Income Custom Project Savings Verification

In 2014, Michaels Energy conducted the Low-Income custom project savings verification.

Table 8.7 - Low-Income Custom Project Savings Verification Sample

Description	n (Stratum)	Cumulative Natural Gas (m^3)
Large	2	1,899,867
Medium	5	763,140
Small	3	169,727
Total Projects Sampled	**10**	**2,832,734**
Low-Income Custom Total Project Population	27	4,362,120
% of Population Sampled		**65%**

As shown in Table 8.7, Navigant pulled a sample of 10 projects for the 2014 Low-Income custom project savings verification based on cumulative gas savings strata to achieve a 90:10 confidence interval. All of these projects were verified by Michaels Energy. Of the 10 projects, all were verified on-site.

The sample projects represent 65% of the total population in terms of cumulative natural gas (m^3). In completing the verifications, the focus was to validate whether or not the claimed savings reported through the custom projects were accurate and recommend any adjustment factors to the savings if required. At a high level, the objective of the custom project savings verification is to:

- Determination of whether the natural gas savings calculations in the application were reasonable based on information available at the time of verification;
- Review of the assumptions used in calculations;
- Discussion of variations between the project and savings;
- Recommend adjustment factors based on the variance between the projected and evaluated savings; and
- Verify that the equipment installation was completed at the site.

Low-Income Custom Project Savings Verification Results

Adjustment factors determined through the Low-Income custom project savings verification are presented in Table 8.8 below.

Table 8.8 - 2014 Low-Income Custom Project Savings Verification Results*

Resource	Claimed Savings	Verification Savings	Realization Rate
Cumulative Natural Gas Savings (m^3)	2,832,734	1,581,935	**55%**
Water Savings (L)	0	**0**	100%
Electricity Savings (kWh)	39	13,642	100%
Incremental Cost	$ 891,063	$ 507,238	57%

*The claimed and verified results represent the total population.

**The realization rate for cumulative natural gas savings has been calculated as per the TEC approved Sampling Methodology for Custom C/I Programs prepared by Navigant. Realization rates are calculated for each sample stratum and applied to each respective population for calculating total savings.

***Adjustments to water and electricity are based on sample realization rates, which were designed to be statistically significant for natural gas only. Union applied the sample realization rates for water and electricity to the population to calculate population savings.

8.3 Commercial/Industrial Impact Evaluations

Union contracted Byron Landry & Associates to conduct the Commercial/Industrial custom project savings verification to provide confidence that the savings claimed were accurate. The sampling for this verification effort was conducted by Navigant to achieve a 90:10 confidence level.

8.3.1 Commercial Custom Project Savings Verification

Table 8.9 - Commercial Industrial Custom Project Savings Verification Sample

Description	n (Stratum)	Cumulative Natural Gas (m^3)
Large	9	113,511,807
Medium	8	27,481,206
Small	7	4,107,454
Total Projects Sampled	**24**	**145,100,467**
C/I Custom Total Project Population	587	814,113,151
% of Population Sampled		**18%**

As shown in Table 8.9, Navigant pulled a sample of 24 projects for the 2014 Commercial/Industrial custom project savings verification based on cumulative gas savings strata to achieve a 90:10 confidence interval. All 24 projects were verified on-site.

The sample projects represent 18% of the total population in terms of cumulative natural gas. In completing the verifications, the focus was to validate whether or not the claimed savings reported through the custom projects were accurate and recommend any adjustment factors to the savings if required. The objectives of the custom project savings verification are to:

- Determination of whether the natural gas savings calculations in the application were reasonable based on information available at the time of verification;
- Review of the assumptions used in calculations;
- Discussion of variations between the project and savings;
- Recommend adjustment factors based on the variance between the projected and evaluated savings; and
- Verify that the equipment installation was completed at the site.

Commercial/Industrial Custom Project Savings Verification Results

Adjustment factors determined through the Commercial/Industrial custom project savings verification are presented in Table 8.10 below.

Table 8.10 - 2014 Commercial/Industrial Custom Project Savings Verification Results*

Resource	Claimed Savings	Verification Savings	Realization Rate
Cumulative Natural Gas Savings (m^3)	145,100,467	134,260,867	92%
Water Savings (L)	22,083,232	14,803,615	67%
Electricity Savings (kWh)	7,606,071	7,606,071	100%
Incremental Cost	$ 50,425,480	$50,552,620	100%

*The claimed and verified results represent the total population.

**The realization rate for cumulative natural gas savings has been calculated as per the TEC approved Sampling Methodology for Custom C/I Programs prepared by Navigant. Realization rates are calculated for each sample stratum and applied to each respective population for calculating total savings.

***Adjustments to water and electricity are based on sample realization rates, which were designed to be statistically significant for natural gas only. Union applied the sample realization rates for water and electricity to the population to calculate population savings.

8.4 Large Volume Custom Project Savings Verification

A sample of 22 custom projects from the Large Volume Rate T1, Rate T2/Rate 100 program was selected for verification by Navigant. The 2014 Large Volume scorecard includes two separate metrics, T1 and Rate T2/Rate 100, with a 60% and 40% respective weighting. The TEC approved sampling methodology for the Large Volume program is stratified based on size of projects in terms of cumulative gas savings to achieve a 90:15 confidence interval for each metric and a 90:10 confidence interval overall. Table 8.11 and Table 8.12 summarize the Large Volume Rate T1, Rate T2/Rate 100 sample.

Table 8.11 - Large Volume Custom Project Savings Verification – Rate T1 Sample

Description	n (Stratum)	Cumulative Natural Gas (m^3)
Large	4	39,939,196
Medium	4	7,518,689
Total Projects Sampled	**8**	**47,457,885**
Rate T1 Custom Total Project Population	41	94,144,979
% of Population Sampled		**50%**

Table 8.12 - Large Volume Custom Project Savings Verification – Rate T2/Rate 100 Sample

Description	n (Stratum)	Cumulative Natural Gas (m^3)
Large	6	307,675,249
Medium	6	71,092,817
Small	2	3,543,611
Total Projects Sampled	**14**	**382,311,678**
Rate T2/R100 Custom Total Project Population	148	1,010,144,441
% of Population Sampled		**38%**

The 22 sampled projects represent 50% of the total unadjusted cumulative gas savings of Rate T1 custom projects and 38% of Rate T2/Rate 100 custom projects based on the original claimed savings. On-site verification was conducted by Diamond Engineering. In completing this work, the focus was to validate whether or not the claimed savings reported through the custom projects were accurate and recommend any adjustment factors to the savings if required. The objectives of the custom project savings verification included:

- Determination of whether savings calculations in the application were reasonable based on information available at the time of verification;
- Review of the assumptions used in calculations;
- Discussion of variations between project and savings;
- Recommend adjustment factors based on the variance between the projected and evaluated savings; and,
- Verify that the equipment installation was completed at the site.

Large Volume Custom Project Verification Results

The results of the Large Volume custom project verification are presented in Table 8.13 and Table 8.14 below.

Table 8.13 - 2014 Large Volume Custom Project Verification Results* – Rate T1 Sample

Resource	Claimed Savings	Verification Savings	Realization Rate
Cumulative Natural Gas Savings (m^3)	47,457,885	53,843,920	109%
Water Savings (L)	93,552,946	104,587,440	112%
Electricity Savings (kWh)	0	0	100%
Incremental Cost	$ 1,216,728	$ 1,216,728	100%

* The claimed and verified results represent the total population.

**The realization rate for cumulative natural gas savings has been calculated as per the TEC approved Sampling Methodology for Custom C/I Programs prepared by Navigant. Realization rates are calculated for each sample stratum and applied to each respective population for calculating total savings.

***Adjustments to water and electricity are based on sample realization rates, which were designed to be statistically significant for natural gas only. Union applied the sample realization rates for water and electricity to the population to calculate population savings.

Table 8.14 - 2014 Large Volume Custom Project Verification Results* – Rate T2/Rate 100 Sample

Resource	Claimed Savings	Verification Savings	Realization Rate
Cumulative Natural Gas Savings (m^3)	382,311,678	398,625,438	99%
Water Savings (L)	178,417,791	208,002,340	117%
Electricity Savings (kWh)	0	0	100%
Incremental Cost	$ 2,024,796	$ 2,096,405	104%

*The claimed and verified results represent the total population.

**The realization rate for cumulative natural gas savings has been calculated as per the TEC approved Sampling Methodology for Custom C/I Programs prepared by Navigant. Realization rates are calculated for each sample stratum and applied to each respective population for calculating total savings.

***Adjustments to water and electricity are based on sample realization rates, which were designed to be statistically significant for natural gas only. Union applied the sample realization rates for water and electricity to the population to calculate population savings.

9. 2014 TEC Evaluation Activities

The TEC, which sets evaluation priorities, focused on the following activities in 2014:

- Technical Reference Manual (TRM)
- Custom Net-to-Gross (NTG) study
- Custom Project Savings Verification (CPSV) Terms of Reference and coversheet template
- CPSV Sampling Methodology update
- Updates to current Measure Inputs and Assumptions list

The TEC has authored quarterly reports for public dissemination. The Q1, Q2, Q3, and Q4 reports can be found in Appendix A for reference.

Technical Reference Manual

The TRM project was initiated in March 2013. Review of prescriptive measures by the Consultant (ERS Inc.) and the TEC subcommittee continued throughout 2014. In 2014, the TEC remained focused on increasing the pace of the project without sacrificing the quality of substantiation documents delivered.

The TEC endorsed final versions of the following measure substantiation documents in 2014:

- High efficiency water heaters
- Demand control ventilation
- Ozone laundry
- Energy Star dishwashers
- Energy Star convection ovens
- Energy Star fryers
- Bathroom faucet aerators
- Kitchen faucet aerators

At the end of 2014, there remained 13 measures under review with the TEC subcommittee and 24 measures not yet received from the Consultant. Completion of the TRM project is currently estimated in Q2 2015.

Custom Net-to-Gross (NTG) Study

The TEC selected DNV GL as the Consultant in February 2014 and the study was initiated in March 2014. A subcommittee consisting of J.Shepherd, B.Wirtshafter, Union and Enbridge was assigned for the NTG study.

Following the March 2014 kick-off meeting with the Consultant, the TEC endeavoured to resolve several project methodology elements. The primary project element that remained unresolved involves the type of NTG ratio the study will measure. Members observed that the draft Guidelines released in September 2014 do not provide the TEC with direction on this issue. The Committee sought additional guidance from the Consultant on the topic. The Consultant advised against developing an approach that considered multiple means of determining a NTG ratio.

At the end of 2014, the NTG study remained deferred pending guidance from the Board on the future of existing TEC evaluation activities within the upcoming 2015-2020 DSM Framework.

As a result of the March 2015 TEC Meeting, Board Staff outlined that the work on the NTG Study should recommence. The TEC will endeavour to reach consensus on project methodology. Additional clarity on the Board's direction regarding specific EM&V roles and responsibilities within the new DSM Framework will be provided in the upcoming months.

Custom Project Savings Verification Terms of Reference and Coversheet Template
Following input from the utilities' respective Auditors and Audit Committees, the TEC revised and updated the joint Terms of Reference for CPSV. The Terms of Reference was finalized in the fourth quarter of 2014 and was included in each utility's 2014 CPSV Request for Proposal.

A new CPSV coversheet template was created by the TEC as a result of utility Auditor feedback. The intent of the new CPSV coversheet template is to assist the CPSV firms in developing a high level summary for each project that provides all of the information required to validate their review. The template reflects the scope of the CPSV Terms of Reference and any relevant differences between commercial and industrial projects. The TEC endorsed the template in the fourth quarter of 2014 and it was provided for use to the 2014 CPSV firms.

CPSV Sampling Methodology Update
In October 2014, the CPSV Sampling Methodology received minor modifications. In the original report, two illustrative sections used net annual savings when they should have used gross cumulative savings. The sampling firms should always employ gross cumulative savings as a basis for sample selection. The revised Sampling Methodology was updated by the Consultant to properly reflect the correct methodology and it was given to the sampling Consultant for use in the 2014 CSPV process.

Updates to Current Measure Inputs and Assumptions List (EB-2014-0354)
The TEC has initiated a comprehensive TRM development project; however the Utilities are required to jointly file an annual Measure Inputs and Assumptions List update with the Board. Therefore, the TEC agreed that the Utilities would file an update to the current inputs and assumptions to capture changes based on the 2013 Audit outcomes, new measures, as well as updates to gain consistency on a select number of measures. The Utilities filed a joint submission with TEC support, as per the current DSM Guidelines, on March 27, 2015 (EB-2014-0354).

10. Status Updates for 2013 Audit and 2013 AC Recommendations[13]

Overarching Recommendations

Recommendation #1
Increase annual evaluation spending to 3-5% of the program implementation budget. This will allow for (at a minimum) additional baseline research, an annual free ridership study for custom projects, and a full process and impact evaluation of the market transformation program as recommended below.

Status Update:
Resolved – The 2013 AC agreed with the Auditor that a Budget in the range of 3-5% is appropriate for Union's future Evaluation Budget.

Recommendation #2
Strive for accuracy in verifying savings and develop a thorough and independent estimate of project impacts, rather than merely confirming whether or not the initial savings estimates are reasonable or conservative.

Status Update:
Resolved – The 2013 AC accepted the Auditor's recommendation. Union referred this recommendation to the TEC for consideration in the 2014 CPSV Terms of Reference (ToR). The TEC stated that CPSV verifiers should perform according to the TEC endorsed CPSV Terms of Reference.

Recommendation #3
Structure the audit process so that only one round of reviews is conducted of the custom projects. Meetings for these reviews should be given higher priority by Union and the Audit Committee members so that more days are available for meetings and consequently the timeline for the audit process can be compressed. If a similar evaluation and audit process is to be followed in 2015, the timeline in the evaluation and audit RFPs should be adjusted accordingly.

Status Update:
Resolved – The 2013 AC did not accept the Auditor's recommendation that one round of reviews of custom projects is necessarily sufficient to adequately satisfy the audit requirements. Union referred the Auditor's recommendation to the 2014 Union and Enbridge ACs for a collective discussion and/or clarification of Auditor expectations in the 2014 Auditor RFP. The collective decision of the ACs was to have Union clearly communicate expectations as part of the audit kick-off process.

[13] As of April 1, 2015.

Recommendation #4
If the auditor is expected to make punitive adjustments to savings in those cases where Union does not adequately support their impact estimates, this needs to be made explicitly clear in the RFP and contracting phase of the project.

Status Update:
Resolved – Union referred this recommendation to the 2014 Union and Enbridge ACs for a collective discussion and/or clarification in the 2014 Auditor RFP. Clarifying language around Auditor expectations was added to the RFP.

Recommendation #5
Conduct a new custom free ridership study every year (beginning in 2014) using a sample from the current year's custom participants.

Status Update:
Pending – The 2013 AC agreed that it is not reasonable to conduct a Net-to-Gross (NTG) study for use in the 2014 audit.

The Board has outlined in the final 2015-2020 DSM Guidelines (EB-2014-0134) that it will take on the coordination function of the EM&V process. As a result of the March 2015 TEC Meeting, Board Staff outlined that the work on the NTG Study should recommence. The TEC will endeavour to reach consensus on project methodology. Additional clarity on the Board's direction regarding specific EM&V roles and responsibilities will be provided in the upcoming months.

Recommendation #6
The annual custom free ridership study should have separate and robust samples for behavioral and maintenance-related projects.

Status Update:
Pending – The AC agrees to interpret the Auditor's recommendation as recommending separate and robust samples for behavioral and maintenance-related projects included in a free ridership study and not about the frequency of free ridership studies.

The AC agrees that when sampling for free ridership surveys, customized questions dealing properly with the difference between baseline and free ridership issues should be posed for behavioural and maintenance projects (see #8 below). The topic will be referred to the TEC for further discussion.

The Board has outlined in the final 2015-2020 DSM Guidelines (EB-2014-0134) that it will take on the coordination function of the EM&V process. As a result of the March 2015 TEC Meeting, Board Staff outlined that the work on the NTG Study should recommence. The TEC will endeavour to reach consensus on project methodology. Additional clarity on the Board's direction regarding specific EM&V roles and responsibilities will be provided in the upcoming months.

Recommendation #7
Interactions between Union and customers need to be documented in the project file as they occur if they are to be used as support for claiming projects are not free riders.

Status Update:
Resolved – The 2013 AC accepted the Auditor's recommendation. Union continues to refine the custom project documentation included in project files.

Recommendation #8
Savings from projects that are obvious safety hazards (e.g., gas leaks or very large steam leaks) or are otherwise obviously free riders should not be eligible for Union incentives. Discussions as to whether other broad classes of maintenance or behavioral projects (e.g., steam traps tests and repairs, pipe insulation) should be eligible for the program should be determined at the policy level prior to the beginning of the program year.

Status Update:
Pending – The AC accepts the Auditor's recommendation in principle that savings from projects that are obvious safety hazards should not be eligible for incentives. The AC also agrees that if classes of projects are to be made ineligible that this policy should be established in advance.

The AC agrees that in the future Union will not claim projects involving fixing gas leaks for DSM savings.

There are classes of projects, generally O&M projects (e.g. cleaning heat exchangers, fixing steam leaks or steam traps) for which there might be an increased potential of overlap between the concepts of baseline and free ridership. The AC does not propose to prohibit savings from these projects, but rather clearly delineate how baseline and free ridership should be treated. In last year's report the parties agreed that

> *Where the conservation measure is of a behavioural or maintenance nature, the information about the customer's current practises (prior to participation in the program) must be collected.*

Free ridership should then be evaluated by a separate set of questions in free ridership surveys to ensure that there is no overlap between the concepts of baseline (the customer's current practices prior to participation in the program) and free ridership. Adjusting the baseline to reflect customer's current practice would require re-evaluation of existing free ridership to prevent overlap between the two concepts. Union will refer this to the TEC for discussion in the context of the net to gross work currently being done. Recommendation #6 above provides for identifying this subset of projects so that customized survey questions can be asked.

Recommendation #9
If a free ridership rate is being applied, savings from individual projects that appear to be free riders should not be zeroed out in the custom impact analysis sample as the free ridership has already been accounted for in the adjustment factor. Note that this does not apply to obvious safety and performance issues as discussed in Recommendation #8.

Status Update:
Resolved – The 2013 AC agreed to interpret the Auditor's recommendation as referring to the concept that Union should not apply project-specific free ridership rates to individual custom projects since a portfolio-level free ridership rate has already been applied; application of a project-specific free ridership rate would be a double adjustment. Note that this does not apply to obvious safety and performance issues as discussed in Recommendation #8.

The 2013 AC accepted the Auditor's recommendation.

Recommendation #10
Do not revise EULs for individual custom projects from the values established in the original program filing documents.

Status Update:
Resolved – The custom project effective useful lives by measure filed in the joint submission 'Union Gas and Enbridge Gas Distribution New and Updated DSM Measures' (EB-2013-0430) are a guide. "Where site specific information or a relevant prescriptive Equipment Useful Life (EUL) is available to support an alternate EUL value for a specific custom project Union will use the alternate value for that custom project."

Union referred the Auditor's recommendation to the TEC for consideration in the 2014 CPSV Terms of Reference. Clarifying language was added to the CPSV ToR.

Recommendation #11
Use measure component savings (rather than costs) to calculate an average EUL for a project.

Status Update:
Resolved – Union referred the Auditor's recommendation to the TEC for consideration in the 2014 CPSV Terms of Reference. Clarifying language was added to the CPSV ToR.

Recommendation #12
Ensure that projects that will likely affect incremental costs in future years have these costs correctly incorporated into the cost effectiveness calculations for the program.

Status Update:
Resolved – Union referred the Auditor's recommendation to the TEC for consideration in the 2014 CPSV Terms of Reference. The TEC considered the recommendation and determined that the existing ToR sufficiently covered the recommendation.

Recommendation #13
In future program years, do not apply a free ridership adjustment to the incremental costs used in the TRC calculation for direct install or giveaway measures. Treating costs this way in the TRC provides an additional incentive to minimize free ridership in the program.

Status Update:

Resolved – The 2013 AC did not accept the Auditor's recommendation. Union calculates TRC consistent with the methodology outlined in *Demand Side Management Guidelines for Natural Gas Utilities* EB-2008-0346, which indicates that "equipment costs associated with free riders are excluded from the TRC test" (Section 5.1.1 Net Equipment Costs, p.13) but "all program costs associated with free riders should be included in the TRC analysis (Section 5.1.2 Program Costs, p.15).

Resource Acquisition Scorecard – Residential Program

Recommendation #14

Conduct an on-site survey to a sample of homes to determine a more accurate and current baseline assumptions for the ESKs.

Status Update:

Resolved – The 2013 AC did not accept the Auditor's recommendation. Union confirms that ESK savings are only counted for households that have not previously received an ESK. As such, the 2013 AC agreed that it is redundant to conduct an on-site survey to a sample of homes to determine more accurate and current baseline assumptions for the ESKs.

Recommendation #15

All of the ESK costs should be included in the TRC calculation for this program, even for those households that are removed from the final savings calculations due to removal of units or previous program participation.

Status Update:

Resolved – The 2013 AC accepted the Auditor's recommendation and agreed with the Auditor's finding that Union already correctly includes in the TRC calculation costs associated with households that are removed from final savings calculations.

Market Transformation (Optimum Home) Scorecard Recommendations

Recommendation #16

Require 10% of homes or at least 3 new homes (whichever is less) to be built to program specifications. Additionally, require a specific commitment from participating builders to build x number or x percent of qualifying homes in the next 2 years.

Status Update:

Resolved – Union has taken this recommendation under advisement in next generation planning of the Optimum Home program.

Recommendation #17

Set participation goals (both builders and numbers of homes) in terms of the percentage of new homes built in Union Gas territory. As part of a market/process evaluation the size and composition of the market should be investigated to determine whether program goals are attainable and likely to be reached in a given timeframe. An important part of this investigation will be determining the relative roles of production and custom builders, both in the market and in the program.

Status Update:
Resolved – Union has taken this recommendation under advisement in next generation planning of the Optimum Home program.

Recommendation #18
Establish a Union Gas Optimum Home label or certification that builders can display on new homes. Since the standard is 20% more efficient than the Ontario Building Code, the qualifying standard can automatically change as the code requirements change. A process evaluation should help determine how home buyers, lenders and real estate agents perceive the program, including the value of a standard certification relative to builder-specific labels. Note that this process has already been established for Energy Star Canada.

Status Update:
Resolved – Union has taken this recommendation under advisement in next generation planning of the Optimum Home program.

Recommendation #19
It is acceptable to have the builder be responsible for the testing **if** they use an approved tester (such as the Certified Energy Evaluators currently used by the program) who should be subject to qualification and spot-checking by Union Gas or its contractors. Since it seems that program qualification is based on the results of model runs (HOT2000), there also must be a formal inspection/Quality Assurance process to verify that homes are built as designed. A thorough impact and process evaluation should be conducted to confirm that homes are built as designed, that testing is thorough and accurate, and that there is a process for identifying and addressing problems.

Status Update:
Resolved – The 2013 AC accepted the Auditor's recommendation. Union confirmed that approved testers and an inspection/Quality Assurance process are already in use. Union also confirmed that its quality assurance process ensures that homes are built as designed, that testing is thorough and accurate, and that there is a process for identifying and addressing problems.

Recommendation #20
There should be an indication of what the plans are to support attainment of "above code" efficiencies as the codes themselves improve. Whenever possible, the Optimum Home program/Union Gas should promote a set of building techniques that will prepare builders to both meet and exceed the next round of the code.

Status Update:
Resolved – Union has taken this recommendation under advisement in next generation planning of the Optimum Home program.

Recommendation #21
If homes are built with good insulation and minimum air infiltration, there will probably need to be some sort of mechanical ventilation to ensure acceptable indoor air quality. The Oregon code, for

example, has requirements for this so that builders cannot simply put in a bathroom fan. Either way, a minimum number of air changes per hour should be part of the program requirements. Note that this is also a requirement for the current Energy Star Canada label.

Status Update:
Resolved – Union has taken this recommendation under advisement in next generation planning of the Optimum Home program.

Recommendation #22
The outreach efforts for the program need to include working with subcontractors rather than with builders alone. Especially for higher volume builders, subcontractors may handle most of the critical construction and installation tasks; builders themselves basically never do HVAC or duct work (as, for example, in the FortisBC new homes program, where HVAC contractors are doing the heat pump installations more often than the builders). A process evaluation should investigate the extent to which subcontractors are responsible for key aspects of constructing a qualifying home and how they are being trained in the techniques needed for compliance.

Status Update:
Resolved – Union has taken this recommendation under advisement in next generation planning of the Optimum Home program.

Recommendation #23
Conduct a formal evaluation of the market transformation that includes development of the program theory and logic model. Using the program theory and logic model, key metrics of program progress can be developed and tracked that will help ensure that the program activities are helping to achieve the long term market transformation goals.

Status Update:
Resolved – Union has taken this recommendation under advisement in next generation planning of the Optimum Home program.

Low-Income Custom Program — Specific Project Recommended Adjustments

Recommendation #24
2013-COM-0271. The measure installed in this project was a controls system that only affects the operation of hot water valves. Savings for this project were calculated using regressions of billing data against weather data (i.e., heating-degree days) from the baseline and post-installation periods. However, the baseline data reflect hot water valves that were malfunctioning due to improper installations. These valve malfunctions were not discovered until the building owner and the controls vendor investigated the poor performance of the heating system following project implementation. After valve repairs were conducted, the system began operating correctly. The verified savings credited to the project include the effects of the repaired valves, which were not identified in the project application, were not incentivized by Union Gas, and no recorded evidence of Union Gas's participation in the valve repairs was provided. The verifier's reference to continued involvement by Union Gas does not constitute appropriate documentation. While the valve-related savings may have come about as an

unintended consequence of the project, they were not part of the incentivized project, and should not be included in the savings totals that are extrapolated to the entire population of Low Income projects. As the verification calculations do not discriminate between the controls and valve savings, the most equitable approach to reduce the claimed savings is to divide the savings evenly between the two.

Status Update:
Resolved – The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus although Union disagrees with the Auditor's interpretation of the project.

Recommendation #25
2013-COM-0240 and 2013-COM-0016. The claimed savings values for insulation were adjusted downward to reflect a decrease in insulation performance over the life of the measure. The adjusted savings also take into account the jacketing material type (e.g., metal or plastic) of new insulation, which is likely to be more resistant to mechanical or moisture damage than baseline materials. Savings has been reduced by 25% to account for these effects.

Status Update:
Resolved – The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus although Union disagrees with the Auditor's findings.

Commercial/Industrial Custom Program — Specific Project Recommended Adjustments

Recommendation #26
2013-IND-0196. This project involved a gas leak, which for safety reasons would require immediate repair. Therefore, this project should be considered part of a routine maintenance procedure that is required regardless of program incentives and therefore no savings should be awarded. Consequently, we have revised the savings to zero for this project.

Status Update:
Resolved – The 2013 AC accepted the Auditor's recommendation but Union disagrees with the characterization of this project as a safety issue whose repair would be considered part of a routine maintenance procedure. The gas piping leaks at this facility were located on the roof, which emitted gas directly to the outdoor environment, and therefore did not pose a safety hazard.

Union confirms that it no longer claims projects involving fixing gas leaks for DSM savings.

Recommendation #27
2013-IND-0037 and 2013-IND-0055. The claimed savings values for insulation were adjusted downward to reflect a decrease in insulation performance over the life of the measure. The adjusted savings also take into account the jacketing material type (e.g., metal or plastic) of new insulation, which is likely to be more resistant to mechanical or moisture damage than baseline materials. Savings were reduced by 25% to account for these effects.

Status Update:
Resolved – The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus although Union disagrees with the Auditor's findings.

Recommendation #28
2013-IND-0185. The audit EUL takes into account behavioral measures such as dock door closures and makeup air filter maintenance that have 5-year lives, while a 1-day/week temperature setback of 3 degrees Celsius is assumed to have 20-year life. Since the setback accounts for only one-third of savings and all other measures have a 5-year life, the savings-weighted average yields a 10-year life.

Status Update:
Resolved – The 2013 AC accepted the Auditor's recommendation that multi-measure claims should use a savings-weighted average EUL.

Recommendation #29
2013-IND-0177. Taking into account energy savings, the weighted average life of the components incentivized through Union yields a 15-year EUL for this project.

Status Update:
Resolved – The 2013 AC accepted the Auditor's recommendation.

Large Volume Custom Program — Specific Project Recommended Adjustments

Recommendation #30
2013-IND-0348. Coke oven gas (COG) impurities such as tars and naphthalene can be expected to accrete within the new pipeline at the same rate as the previously installed pipe. Consequently, this reduces COG capacity to the same capacity as the baseline equipment over the measure's life and results in an adjusted average savings equal to 50 percent of verified first-year savings.

Status Update:
Resolved – The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus.

Recommendation #31
2013-IND-0123. The verifier assumed blowing losses equal to 50 percent for leaking traps. The adjusted savings assumes a more realistic estimate of 20 percent. Additionally, the repair of blocked traps is unlikely to have an effect on steam consumption, although properly operating traps have functional steam losses. The adjusted savings takes this into account and assumes blocked traps will have an increased steam consumption of 1.5 lbs/hour following repair.

Status Update:
Resolved – The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus.

Recommendation #32

2013-IND-0101. The base case should reflect conditions absent the efficiency measure in question (i.e. no HRSG) and the adjusted savings accounts for this. The absence of a HRSG indicates the absence of steam-driven chillers so the baseline assumption of an existing boiler powering steam-driven chillers is not tenable. Moreover, chillers were not installed at the time of verification. Regarding project measure life, a reasonable estimate for HRSG that is not in continuous use is 20 years. This is also the default value for custom projects. Insufficient evidence was presented in the CPSV report to justify a longer EUL.

Status Update:

Resolved – The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus although Union disagrees with the Auditor's interpretation of the project.

In principle, Union disagrees with the Auditor's recommendation that custom project EULs should not be revised from the values established in the original program filing documents (discussed in Recommendation # 10). For this project, Union understands that the adjustment to EUL may result from insufficient evidence provided, on the part of the verifier, to support the change in EUL. As a result, Union accepted the adjustment to EUL for this project.

Recommendation #33

2013-IND-0450, 2013-IND-0451, 2013-IND-0179, 2013-IND-0072 and 2013-IND-0204. The claimed savings values for insulation were adjusted downward to reflect a decrease in insulation performance over the life of the measure. The adjusted savings also take into account the jacketing material type (e.g., metal or plastic) of new insulation, which is likely to be more resistant to mechanical or moisture damage than baseline materials. Savings has been reduced by 25% to account for these effects.

Status Update:

Resolved – The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus although Union disagrees with the Auditor's findings.

Recommendation #34

2013-IND-0117. The verified project EUL is based on a weighted average of three components new greenhouse components with heating controls having an EUL of 10 years, and both structure and heating system having EULs of 30 years. The adjusted EUL modifies the structure and heating system EUL to 20 years, which yields a weighted average EUL equal to 14 years. Additionally, although the Virtual Grower software used to calculate savings did not provide savings by component, total project life should be based on an energy-savings-weighted average rather than component cost weights.

Status Update:

Resolved – Union notes that this project was not based on a cost-weighted average EUL. Both the Large Volume custom project Verifier and Union employed a savings-weighted approach to determine EULs.

The 2013 AC accepted, for 2013 only, the Auditor's recommendation for the purpose of reaching consensus although Union disagrees with the Auditor's revision of the EUL for the reasons discussed in recommendation #10.

11. Lost Revenue Adjustment Mechanism

The Board approved Lost Revenue Adjustment Mechanism (LRAM) allows Union to recover the lost distribution revenues associated with DSM activity.

Prior to 2014, LRAM was claimed for each rate class impacted by DSM energy efficiency programs. Starting in 2014, the LRAM claim previously made for General Service rate classes (Rate M1, Rate M2, Rate 01, Rate 10) will be included in the Normalized Average Consumption (NAC) adjustment. Union will continue to claim LRAM for contract rate classes only. This change is as filed in Union's 2014 Rates Proceeding (EB-2013-0365) and consistent with Union Board-approved 2014-2018 Incentive Regulation Application, Evidence and Settlement Agreement (EB-2013- 0202).

The LRAM claim for contract rate classes was calculated using the following formula:

$$\Sigma(\text{Contract Rate Class Volume Reduction x 2014 Delivery Rate}) = \text{LRAM Claimed}$$

Under the Guidelines, LRAM is calculated on a monthly basis using the volumetric impact of the measures implemented in that month. This approach ensures that LRAM amounts closely reflect the actual timing of the implementation of the DSM measures.

For 2014, the LRAM amount of \$0.310 million is based on 2014 delivery rates and annual natural gas savings of 73.7 million m^3. The 2014 LRAM statement is detailed in Table 11.0 on the following page.

Table 11.0 - 2014 LRAM Statement

Rate class	January	February	March	April	May	June	July	August	September	October	November	December	Total Volumes (10^3 m^3) (a)	2014 Delivery Rates (\$/10^3 m^3) (b)	Revenue Impact (a) x (b)
	DSM Volumes (10^3 m^3)														
South															
M4 Industrial	4,314	1,144	638	264	217	488	238	99	270	110	23	0	7,805	10.060	$ 78,521
M5 Industrial	3,940	920	57	68	133	115	478	473	59	41	0	101	6,386	22.940	$ 146,491
M7 Industrial	4,220	683	301	264	265	92	203	316	0	81	21	0	6,446	3.365	$ 21,691
T1 Industrial	1,542	0	0	203	294	55	246	130	15	248	2	0	2,733	0.720	$ 1,968
T2 Industrial	18,789	0	1,376	161	3,076	1,165	1,053	221	2,304	901	8	0	29,054	0.078	$ 2,266
South Total	**32,806**	**2,747**	**2,372**	**960**	**3,985**	**1,916**	**2,217**	**1,239**	**2,648**	**1,381**	**53**	**101**	**52,424**		**$ 250,937**
North															
20 Industrial	2,286	9	0	155	144	147	115	72	635	294	99	0	3,956	5.461	$ 21,606
100 Industrial	9,191	16	706	853	1,175	823	796	2,855	576	143	167	0	17,300	2.163	$ 37,421
North Total	**11,477**	**24**	**706**	**1,009**	**1,319**	**970**	**911**	**2,927**	**1,211**	**437**	**266**	**0**	**21,257**		**$ 59,027**
Total	**44,283**	**2,771**	**3,078**	**1,969**	**5,304**	**2,886**	**3,128**	**4,166**	**3,859**	**1,818**	**319**	**101**	**73,681**		**$ 309,964**

The 2014 LRAM statement is prepared by using the best available input assumptions at the time of the audit. These inputs include measure-level gas saving assumptions, participant numbers and measure install month. Install date and participation numbers are captured by Union's internal databases. Savings assumptions are found in Appendix D.

12. DSM Incentive

For 2014, Union is eligible to earn a shareholder incentive based on its performance against DSM targets presented within four separate scorecards: Resource Acquisition; Low-Income; Large Volume Rate T1, Rate T2/Rate 100; and Market Transformation. The target and maximum incentive for each scorecard is detailed in Table 12.0.

Table 12.0 – Target and Maximum 2014 DSM Incentive per Scorecard

Scorecard	Target DSM Incentive		Maximum DSM Incentive	
Resource Acquisition	$	2,266,653	$	5,666,634
Large Volume Rate T1, Rate T2/Rate 100	$	732,839	$	1,832,098
Low-Income	$	1,105,479	$	2,763,699
Market Transformation	$	222,943	$	557,358
Total	**$**	**4,327,915**	**$**	**10,819,788**

The DSM incentive payments earned by Union for each scorecard is calculated using the methodology approved by the Board in EB-2011-0327:

- No incentive will be provided for achieving a scorecard weighted score of less than 50%;
- Union will earn 40% of the DSM incentive for achieving a scorecard weighted score of 100%, with the remaining 60% available for performance up to the 150% target level;
- Scorecard results will be linearly interpolated between the scorecard metric target levels;
- The incentive amount will be capped at the scorecard weighted score of 150%.

Union's 2014 results for each scorecard are presented in Tables 12.1, 12.2, 12.3, and 12.4 below.

Table 12.1 - 2014 Results - Resource Acquisition Scorecard

Metrics	Metric Target Levels			Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
	Lower Band	Target	Upper Band				
Cumulative Natural Gas Savings (m^3)	591,060,012	788,080,016	985,100,020	90%	961,571,810	144%	130%
Deep Savings – Residential	204	254	304	5%	996	842%	42.1%
Deep Savings - C/I	8.97%	9.97%	10.97%	5%	7.88%	-5%	0%
						Total Scorecard Target Achieved	**150%**[14]
						Scorecard Incentive Achieved	$5,666,634

[14] Scorecard is capped at 150%. Actual scorecard achievement is 172%.

Table 12.2 - 2014 Results - Low-Income Scorecard

Metrics	Metric Target Levels Lower Band	Target	Upper Band	Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
Cumulative Natural Gas Savings from Single Family (m^3)	19,500,000	26,000,000	32,500,000	60%	36,105,327	178%	107%
Cumulative Natural Gas Savings from Multi-Family (m^3)	13,200,000	17,600,000	22,000,000	40%	21,586,843	145%	58%
						Total Scorecard Target Achieved	***150%***[15]
						Scorecard Incentive Achieved	***$2,763,699***

Table 12.3 - 2014 Results - Large Volume Rate T1, Rate T2/Rate 100 Scorecard

Metrics	Metric Target Levels Lower Band	Target	Upper Band	Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
Rate T2 / Rate 100 Cumulative Natural Gas Savings (m^3)	795,074,195	1,060,098,927	1,325,123,659	40%	788,587,677	49%	*20%*
Rate T1 Cumulative Natural Gas Savings (m^3)	156,530,251	208,707,001	260,883,751	60%	81,607,775	-22%	*-13%*
						Total Scorecard Target Achieved	***6%***
						Scorecard Incentive Achieved	***$0***

Table 12.4 - 2014 Results - Market Transformation Scorecard

Metrics	Metric Target Levels Lower Band	Target	Upper Band	Weight	Achievement	% of Metric Achieved	Weighted % of Scorecard Achieved
New Participating Builders	2	4	10	40%	3	75%	*30%*
Prototype Homes Built	50%	60%	70%	40%	86.36%	232%	*93%*
Homes Built (>20% above OBC 2012) by Participating Builders	3%	6%	9%	20%	14.73%	246%	*49%*
						Total Scorecard Target Achieved	**150%**[16]
						Scorecard Incentive Achieved	***$557,358***

[15] Actual scorecard achievement result is 165%. Maximum achievement is capped at 150%.
[16] Scorecard is capped at 150%. Actual scorecard achievement is 172%.

Union achieved a total of $8.988 million in DSM incentive as a result of its program performance results in 2014 as shown in Table 12.5.

Table 12.5 - Summary of 2014 DSM Incentive Achieved

Scorecard	DSM Incentive Achieved	
Resource Acquisition	$	5,666,634
Large Volume Rate T1, Rate T2/Rate 100	$	0
Low-Income	$	2,763,699
Market Transformation	$	557,358
Total	**$**	**8,987,690**

The Resource Acquisition, Low-Income and Market Transformation scorecards each achieved its respective maximum incentive. The DSM incentive breakdown by rate class is shown in Table 12.6 below.

Table 12.6 - Breakdown of DSM Incentive by Rate Class

Line No.	Rate Class	2014 Amount	
	South		
1	M1	$	3,656,392
2	M2	$	1,939,386
3	M4	$	725,127
4	M5	$	492,595
5	M7	$	490,128
6	T1	$	0
7	T2	$	0
8		**$**	**7,303,628**
	North		
9	Rate 01	$	939,576
10	Rate 10	$	369,204
11	Rate 20	$	375,283
12	Rate 100	$	0
13		**$**	**1,684,063**
14	**Total**	**$**	**8,987,690**

13. Budget

Union's 2014 DSM Budget as approved by the Board was $32.0 million. The total spend for 2014 was $33.7 million.

13.1 Budget Overspend

As per the Guidelines, Union can spend above the approved annual DSM budget to allow it to aggressively pursue DSM programs that are successful. The total amount of the overspend must not exceed 15% of the total DSM budget, and can only be used on scorecards once they have achieved their weighted scorecard target (i.e. 100%) on a pre-audit basis.

As part of the EB-2011-0327 Settlement Agreement ("the Settlement"), Union filed a 2014 DSM budget allocation for the 2014 Residential, Commercial/Industrial, Low-Income and Market Transformation programs.[17] As part of EB-2012-0337, Union filed a DSM budget allocation for the Large Volume program. In all filings, 2014 budgets were reported based on 2012 budgets and an assumed inflation factor. Actual 2014 budgets reflect an updated inflation factor, as described in Section 2.3 of the Settlement.

Parties within the Settlement agreed that actual spending would be limited to an increase of 100% of the budgeted amount in any rate class (not including Rate T1, Rate T2/Rate 100). As outlined in EB-2012-0337, a maximum of $0.500 million of the program budget allocated to Rate T1, Rate T2 or Rate 100 can be transferred to Rate T1, Rate T2 or Rate 100 respectively. Union adhered to this guideline and the overall under spend following this transfer allocation for the Large Volume program is credited in the DSMVA. In addition, Union did not transfer budget dollars from any other part of the overall DSM budget into Rate T1, Rate T2 or Rate 100 rate classes. The Guidelines require Union to inform the Board and stakeholders if cumulative fund transfers between DSM programs exceed 30% of the approved annual DSM budget for an individual natural gas DSM program. In 2014, Union surpassed the weighted scorecard target on a pre-audit basis on three of the four scorecards (Resource Acquisition, Low Income, Market Transformation). The overspend was used for the Resource Acquisition and Low-Income scorecards. The overspend adhered to all overspend rules for the two scorecards, and Union did not transfer more than 30% of the approved annual DSM budget between programs.

13.2 Integrated Energy Management Systems Spend

The $0.639 million budget associated with Integrated Energy Management Systems (IEMS) was allocated according to the provisions in section 6.1 of the Settlement. If any of this budget was not spent, it could be transferred to another program on the basis that the Resource Acquisition target

[17] For continuity, the Settlement also included budgets for a 2014 Large Industrial Rate T1 and Rate 100 program but stated that "Participating Parties [of the Settlement] have agreed that the DSM Plan for 2013 and 2014 relating to Large Industrial Rate T1 Rate 100 will not be included in this Agreement, and Union hereby withdraws its request for approvals of that part of its Plan as set forth in the Application. Union agrees to file a new application and evidence with the Board supporting a Large Industrial Rate T1 / Rate 100 DSM plan for 2013 and 2014…" Union filed EB-2012-0337, which sought approval of the Large Volume Rate T1, Rate T2 and Rate 100 program for the years 2013 and 2014.

would be increased by 150 m^3 for every dollar transferred in excess of 50% of the IEMS budget. Otherwise, the unspent amount would be returned to ratepayers.

In 2014, Union transferred $0.300 million, less than 50% of the IEMS budget, to the Commercial/Industrial program. $0.100 million was spent on the IEMS initiative, and the remaining $0.239 million was returned to ratepayers.

13.3 Evaluation Spend

As part of the Settlement, Parties agreed to a budget of $1.129 million plus inflation for evaluation spend, including portfolio evaluation and specific program evaluation. If any of this budget was not spent, it could not be transferred elsewhere and would be returned to ratepayers.

In 2014, the evaluation budget was $1.203 million. Union spent $0.399 million on portfolio evaluation and $0.629 million on specific program evaluation, for a total evaluation spend of $1.028 million. The remaining $0.175 million will be returned to ratepayers.

13.4 Spend and Budget Summary

Table 13.0 tracks the variance between 2014 spend and budget. Total DSMVA amount is $1.664 million.

Table 13.0 - Summary of 2014 Spend and Budget

	2014 Spend	2014 Budget	Variance	Budget Transfers	Total DSMVA
	A	B	C=A-B	D	E=C-D
Program Budget					
Resource Acquisition Scorecard					
Residential Program Incentives/Promotion/Admin	$ 3,514,450	$ 3,347,187	$ 167,263	$ (81,056)	$ 248,319
Residential Evaluation	$ 173,300	$ 21,302	$ 151,998	$ 151,998	$ 0
Commercial/Industrial Incentives/Promotion/Admin	$ 12,537,705	$ 10,863,448	$ 1,674,258	$ 230,561	$ 1,443,697
Commercial/Industrial Evaluation	$ 103,687	$ 63,906	$ 39,781	$ 39,781	$ 0
IEMS	$ 100,000	$ 639,061	$ (539,061)	$ (300,000)	$ (239,061)
Large Volume Scorecard (Rate T1, T2/R100)					
Large Volume T1 Incentives/Promotion	$ 667,373	$ 1,282,852	$ -615,479	$ 0	$ (615,479)
Large Volume T2/R100 Incentives/Promotion	$ 2,553,834	$ 2,537,669	$ 16,165	$ 0	$ 16,165
Large Volume T1/T2/R100 Administration	$ 771,923	$ 965,527	$ (193,604)	$ (134,553)	$ (59,051)
Large Volume T1/T2/R100 Evaluation	$ 108,595	$ 42,604	$ 65,991	$ 65,991	$ 0
Low-Income Scorecard					
Low-Income Program Incentives/Promotion/Admin	$ 8,285,766	$ 7,241,363	$ 1,044,403	$ 0	$ 1,044,403
Low-Income Evaluation	$ 243,580	$ 42,603	$ 200,977	$ 200,977	$ 0
Market Transformation Scorecard					
Optimum Home Incentives/Promotion/Admin	$ 1,262,958	$ 1,468,963	$ (206,005)	$ (206,005)	$ 0
Programs Sub-total	$ 30,323,172	$ 28,516,484	$ 1,806,688	$ (32,306)	$ 1,838,994
Portfolio Budget					
Research	$ 834,986	$ 816,085	$ 18,901	$ 18,901	$ 0
Evaluation	$ 398,782	$ 1,032,178	$ (633,396)	$ (458,747)	$ (174,649)
Administration	$ 2,156,856	$ 1,684,704	$ 472,152	$ 472,152	$ 0
Portfolio Sub-total	$ 3,390,624	$ 3,532,967	$ (142,343)	$ 32,306	$ (174,649)
Total 2014 DSM Budget	$ 33,713,796	$ 32,049,450	$ 1,664,345	$ 0	$ 1,664,345

14. 2015 Scorecards

The 2015 scorecards presented in Section 14 are those proposed by Union based on its 2014 results. Scorecards are subject to change pending decisions made on Union's 2015-2020 DSM Plan (EB-2015-0029). 2015 scorecards are provided here for illustrative purposes only.

The 2015 scorecard metrics for the Resource Acquisition; Low-Income; Large Volume Rate T1, Rate T2/Rate100; and Market Transformation scorecards are provided below. As outlined in Union's 2015 DSM Plan:

- Derivation of the Resource Acquisition scorecard is consistent with the derivation of the 2014 Resource Acquisition scorecard as per the EB-2011-0324 Settlement Agreement (Tables 14.0 – 14.2);
- The 2015 Low-Income scorecard is a roll-over of the 2014 Low-Income scorecard (Table 14.3);
- Derivation of the Large Volume Rate T1, Rate T2/Rate 100 scorecard is consistent with the derivation of the 2014 Large Volume scorecard as per the EB-2012-0337 Decision (Tables 14.4 – 14.6); and
- The 2015 Market Transformation scorecard reflects a metric on high efficiency homes built by participating builders (Table 14.7).

The 2015 Resource Acquisition scorecard metrics are based upon Union's performance results of 2014 as shown in Table 14.0.

Table 14.0 - Metric-Setting Methodology - 2015 Resource Acquisition Scorecard

Metrics	Metric Target Levels			Weight
	Lower Band	Target	Upper Band	
Cumulative Natural Gas Savings (m^3)	75% of target	2014 Post-audit scorecard cost effectiveness (m^3 per promotion and incentive dollar spent) times $10.684M times 1.02	125% of target	90%
Deep Savings - Residential (Homes)	75% of target	2014 actual times 1.25	125% of target	5%
Deep Savings - C/I (% of Baseline Consumption)	The higher of i) 2014 actual ii) 4.5%	The higher of i) 2014 actual + 1% ii) 5.5%	The higher of i) 2014 actual + 2% ii) 6.5%	5%

The 2015 Resource Acquisition cost-effectiveness factor is 74.93 as shown in Table 14.1.

Table 14.1 - 2015 Resource Acquisition Cost Effectiveness Factor

Program		2014 Promotion & Incentive Budget Spend (a)	2014 Cumulative Natural Gas Savings (m^3) (b)	2014 Cost Effectiveness (m^3/$) (c) = (b)/(a)
Commercial Prescriptive	$	3,752,305	216,057,244	57.58
Commercial Custom	$	909,534	71,319,880	78.41
Small Industrial Custom	$	2,783,873	327,307,913	117.57
Greenhouse & Agriculture Custom	$	2,405,078	285,227,253	118.59
Commercial/Industrial Program Total	**$**	**9,850,790**	**899,912,291**	**91.35**
Residential Program Total	$	2,982,166	61,659,518	20.68
Resource Acquisition Total	**$**	**12,832,956**	**961,571,810**	**74.93**

The 2015 Resource Acquisition scorecard is thus as shown in Table 14.2.

Table 14.2 - 2015 Resource Acquisition Scorecard

Metrics	Metric Target Levels			Weight
	Lower Band	Target	Upper Band	
Cumulative Natural Gas Savings (m^3)	612,421,363	816,561,818	1,020,702,272	90%
Deep Savings - Residential (Homes)	934	1,245	1,556	5%
Deep Savings - C/I (% of Baseline Consumption)	7.88%	8.88%	9.88%	5%

The 2015 Low-Income scorecard is a roll-over of the 2014 Low-Income scorecard as shown in Table 14.3.

Table 14.3 - 2015 Low-Income Scorecard

Metric	Metric Target Levels			Weight
	Lower Band	Target	Upper Band	
Cumulative Natural Gas Savings from Single Family (m^3)	19,500,000	26,000,000	32,500,000	60%
Cumulative Natural Gas Savings from Multi-Family (m^3)	13,200,000	17,600,000	22,000,000	40%

Derivation of the 2015 Large Volume scorecard, which is consistent with the EB-2012-0337 Decision on the 2014 Large Volume scorecard, is provided in Table 14.4.

Table 14.4 - 2015 Large Volume Rate T1, Rate T2/Rate 100 Scorecard

Metric	Metric Target Levels			Weight
	Lower Band	Target	Upper Band	
Rate T2/Rate 100 Cumulative Natural Gas Savings (m^3)	75% of target	Three-year rolling average (2012-2014) post-audit Rate T2/Rate 100 customer incentive cost effectiveness (m^3 per customer incentive dollar spent) × (2015 customer incentive budget for Rate T2/Rate 100)	125% of target	40%
Rate T1 Cumulative Natural Gas Savings (m^3)	75% of target	Three-year rolling average (2012-2014) post-audit Rate T1 customer incentive cost effectiveness (m^3 per customer incentive dollar spent) × (2015 customer incentive budget for Rate T1)	125% of target	60%

The rolling three year cost effectiveness and 2015 customer incentive budgets are provided in Table 14.5.

Table 14.5 - Cost Effectiveness and Customer Incentive Budgets Used for the 2015 Large Volume Scorecard Target Setting

Rate Class	2012 Cost Effectiveness	2013 Cost Effectiveness	2014 Cost Effectiveness	Three-year Average Cost Effectiveness	2015 Customer Incentive Budget
Rate T2/Rate 100	360.35	627.35	308.79	432.16	$ 2,383,000
Rate T1	286.07	151.49	122.92	186.83	$ 1,104,000

The 2015 Large Volume scorecard is thus as shown in Table 14.6.

Table 14.6 - 2015 Large Volume Scorecard

Metric	Metric Target Levels			Weight
	Lower Band	Target	Upper Band	
Rate T2/Rate 100 Cumulative Natural Gas Savings (m^3)	772,381,040	1,029,841,387	1,287,301,734	40%
Rate T1 Cumulative Natural Gas Savings (m^3)	154,692,013	206,256,017	257,820,021	60%

The 2015 Market Transformation scorecard metric is based upon Union's performance results of 2014 on high efficiency homes built by participating builders as shown in Table 14.7.

Table 14.7 - Metric-Setting Methodology - 2015 Market Transformation Scorecard

Metric	Metric Target Levels			Weight
	Lower Band	Target	Upper Band	
Homes Built (>20% above OBC 2012) by Participating Builders	2014 Actuals + 10%	2014 Actuals + 15%	2014 Actuals + 20%	100%

The 2015 Market Transformation scorecard is thus as shown in Table 14.8.

Table 14.8 - 2015 Market Transformation Scorecard

Metric	Metric Target Levels			Weight
	Lower Band	Target	Upper Band	
Homes Built (>20% above OBC 2012) by Participating Builders	24.73%	29.73%	34.73%	100%

14.1 2015 Avoided Costs

The avoided costs for 2015 are found in Table 14.8. Avoided gas costs reflect an updated methodology discussed in Union's 2015 DSM Plan.

Table 14.8 - 2015 Avoided Costs

Gas Avoided Costs						
	Residential and Commercial				Industrial	
	Baseload (\$/m^3)		Weather Sensitive (\$/m^3)		Baseload (\$/m^3)	
	Rate	NPV	Rate	NPV	Rate	NPV
1	0.21378	0.21378	0.22071	0.22071	0.20537	0.20537
2	0.19684	0.39620	0.20449	0.41024	0.20114	0.39179
3	0.19620	0.56473	0.20266	0.58431	0.19798	0.56184
4	0.20730	0.72974	0.21387	0.75455	0.20911	0.72830
5	0.23174	0.90071	0.23841	0.93044	0.23358	0.90063
6	0.25035	1.07188	0.25714	1.10626	0.25222	1.07308
7	0.24863	1.22944	0.25553	1.26819	0.25053	1.23184
8	0.25157	1.37718	0.25859	1.42005	0.25350	1.38072
9	0.26925	1.52373	0.27639	1.57049	0.27122	1.52834
10	0.25862	1.65419	0.26588	1.70461	0.26063	1.65981
11	0.27435	1.78244	0.28173	1.83632	0.27639	1.78902
12	0.27612	1.90208	0.28363	1.95921	0.27819	1.90956
13	0.29855	2.02196	0.30618	2.08215	0.30065	2.03028
14	0.30166	2.13423	0.30941	2.19730	0.30380	2.14334
15	0.32465	2.24620	0.33253	2.31199	0.32682	2.25606
16	0.32743	2.35086	0.33545	2.41922	0.32964	2.36143
17	0.33257	2.44938	0.34072	2.52016	0.33482	2.46062
18	0.33925	2.54253	0.34755	2.61558	0.34154	2.55440
19	0.35307	2.63237	0.36150	2.70757	0.35540	2.64483
20	0.36264	2.71789	0.37122	2.79511	0.36501	2.73091
21	0.37758	2.80041	0.38630	2.87954	0.37998	2.81396
22	0.38851	2.87911	0.39738	2.96003	0.39096	2.89315
23	0.39977	2.95416	0.40878	3.03677	0.40225	2.96866
24	0.41135	3.02573	0.42052	3.10993	0.41388	3.04067
25	0.42328	3.09398	0.43260	3.17969	0.42585	3.10934
26	0.43556	3.15907	0.44503	3.24619	0.43817	3.17482
27	0.44820	3.22114	0.45783	3.30960	0.45086	3.23726
28	0.46121	3.28034	0.47101	3.37006	0.46392	3.29681
29	0.47461	3.33680	0.48457	3.42770	0.47736	3.35359
30	0.48840	3.39065	0.49853	3.48267	0.49120	3.40775

Water and Electricity Avoided Costs				
	Residential/Commercial/Industrial			
	Water (\$/m^3)		Electricity (\$/kWh)	
	Rate	NPV	Rate	NPV
1	2.27294	2.27294	0.11280	0.11280
2	2.31113	4.41486	0.11470	0.21910
3	2.34996	6.43331	0.11663	0.31928
4	2.38944	8.33540	0.11859	0.41368
5	2.42958	10.12784	0.12058	0.50263
6	2.47039	11.81695	0.12260	0.58646
7	2.51190	13.40870	0.12466	0.66546
8	2.55410	14.90868	0.12676	0.73990
9	2.59701	16.32220	0.12889	0.81005
10	2.64064	17.65424	0.13105	0.87616
11	2.68500	18.90949	0.13325	0.93846
12	2.73011	20.09237	0.13549	0.99716
13	2.77597	21.20707	0.13777	1.05248
14	2.82261	22.25751	0.14008	1.10462
15	2.87003	23.24740	0.14244	1.15374
16	2.91825	24.18023	0.14483	1.20004
17	2.96727	25.05928	0.14726	1.24367
18	3.01712	25.88766	0.14974	1.28478
19	3.06781	26.66828	0.15225	1.32352
20	3.11935	27.40391	0.15481	1.36003
21	3.17175	28.09713	0.15741	1.39443
22	3.22504	28.75038	0.16006	1.42685
23	3.27922	29.36598	0.16274	1.45740
24	3.33431	29.94610	0.16548	1.48619
25	3.39033	30.49277	0.16826	1.51332
26	3.44728	31.00793	0.17109	1.53889
27	3.50520	31.49339	0.17396	1.56298
28	3.56409	31.95087	0.17688	1.58569
29	3.62396	32.38197	0.17985	1.60708
30	3.68485	32.78823	0.18287	1.62724

The inflation rate used in Table 14.8 is 1.68%. The discount factor is 7.9%.

Appendix A – TEC 2014 Quarterly Reports

Ontario Natural Gas Technical Evaluation Committee

2014 1st Quarter Report

The Technical Evaluation Committee (TEC; “the Committee”) publicly reports its discussions and activities on a quarterly basis. This report reflects work conducted for the period of January 1, 2014 to March 31, 2014. Previous quarterly reports are available on the Ontario Energy Board (OEB) website.

1. TEC-Related Audit Recommendations

In Q4 2013, the Committee prioritized 14 recommendations[1] (13 for Union; 1 for Enbridge) raised during the utilities’ respective 2012 audits. In Q1 2014, the TEC sought resolution on three of Union’s recommendations, with a view to prioritize and address the remaining 10 recommendations for Union and one recommendation for Enbridge in the second half of 2014.

The three Union recommendations that were addressed included:

UG#1 - Regarding the current use of natural gas hot water heaters, change all “Don’t Know” responses collected through surveys supporting the Energy Savings Kits (ESKs) verification study to “No” responses, and change the adjustment factors for the ESK Residential Push/Pull measures accordingly. The Auditor recommends using this approach until the Technical Evaluation Committee (TEC) is able to address this issue.

The TEC discussed the general treatment of “Don’t Know” responses collected through surveys. Though several members agreed that standard best market research practice was followed by Union, consensus on this issue was not reached.

The TEC agreed that the treatment of “Do Not Know” responses should be recommended by the market research firm up front and ahead of survey deployment. If the Auditor disagrees with the determined treatment, the utilities will work through the matter with their respective Audit Committees.

[1] One additional audit recommendation for EGD (improvements to the CPSV process) was addressed in Q4 2013. Likewise, one additional recommendation for UG was slated for discussion as part of the next DSM plan.

UG#21 – In future verification studies, Union should request that Verification Consultants use zero decimal places when reporting verified gas savings in order to match number of decimal places used in original claim.

The TEC agreed that the verification consultant should never use decimal places when reporting verified gas savings. The TEC also agreed that the verification consultant should use best engineering practice and round to the number of significant figures that carries meaning in contributing to the precision of the verified gas savings.

UG#28 – Develop guidelines about how to differentiate issues related to baselines, EUL, and free riders.

The TEC agreed that baselines, EUL and free riders will be dealt with in the next generation framework as the current Natural Gas DSM Guidelines provide provision on how to deal with these issues. The TEC can make recommendations to inform the next generation framework.

2. Custom Commercial and Industrial Net to Gross (NTG) Study

The TEC received five proposals for the NTG Study on December 23, 2013. The TEC discussed their evaluation and proposal rankings. Following a Request for Proposals process, interviews were held with consultants shortlisted by the TEC. DNV KEMA (now DNV GL) was selected as the project consultant.

Members from DNV GL joined the TEC in March 2014 to kick-off the project. DNV GL walked the TEC through their kick-off presentation while allowing for significant question, answer, and discussion time.

The Committee and DNV GL acknowledged that the primary objective of this project is to develop a transparent, reputable study that produces strong, credible, and defensible NTG ratios to be used on a go forward-basis. The potential for 'scope creep' is a concern of several members of the TEC and DNV GL. Having identified some challenges in conducting customer surveys in the summer months (June-August), an updated project completion date will be proposed by DNV GL.

3. Technical Reference Manual (TRM)

The TRM project was initiated in March 2013. Review of prescriptive measures by the consultant (ERS Inc.) and the TEC subcommittee is ongoing. The TEC endorsed a final version of the High Efficiency Water Heater substantiation document, the first measure completed for the TRM project. This document aims to serve as the template from which the remaining substantiation documents will be developed. Measures currently under review include:

- New Measures: Demand Control Ventilation
- Ozone Laundry

3.1 Software Vendor Selected:

To inform its selection of software to support the Technical Reference Manual wiki platform, a representative from MindTouch was invited to present to the TEC. ERS Inc. also provided a demonstration of the functionalities of a second software option. The TEC selected MindTouch as the platform for the TRM project, pending MindTouch's ability to work out minor issues (i.e. printing of entire TRM site in .pdf format).

3.2 TRM Project Budget Update

To date, ERS has been billing the utilities on a milestone basis and ERS has spent approximately two thirds of the allocated budget. ERS indicated that they have put in more effort than initially expected and are not on track to deliver the project on budget. The TEC asked ERS to prepare and deliver a variance analysis outlining the discrepancies that are due to ERS' planning and those resulting from the Committee's review processes.

4. 2013 New and Updated DSM Measures

The TEC endorsed the following measures and values as part of the 2013 New and Updated DSM Measures filing:

- 15% free ridership value on savings claimed through Enbridge's Community Energy Retrofit (CER) offering and Union's Home Reno Rebate (HRR) offering. The TEC agreed that there is likely to be spillover but there was not consensus on whether the evidence was compelling enough to include a spillover value.

- Addition of Exposed Floor Insulation as a major measure for Enbridge's CER offering and Union's HRR offering.
- Update to Measure Life applied to the utilities' respective Low Income Weatherization offerings – 25 years;
- Update to 2.0GPM Low Flow Showerhead (EGD) for Low Income Single Family, Low Income Multi Residential and Multi Residential;
- New Prescriptive Measure: High Efficiency Water Heater substantiation document;
- Update to Measure Life for Enbridge's CER and Union's HRR: Installations including a high efficiency furnace – 15 year; and
- Update to Measure Life for Enbridge's CER and Union's HRR: Installations excluding a high efficiency furnace – 25 years.

Future meetings: April 14 2014; May 15, 2014; June 12, 2014

Ontario Natural Gas Technical Evaluation Committee

2014 2nd Quarter Report

The Technical Evaluation Committee (TEC; "the Committee") publicly reports its discussions and activities on a quarterly basis. This report reflects work conducted for the period of April 1, 2014 to June 30, 2014. Previous quarterly reports are available on the Ontario Energy Board (OEB) website online.

1. Custom Commercial and Industrial Net-to-Gross (NTG) Study

A subcommittee consisting of J. Shepherd, B. Wirtshafter, Union, and Enbridge was assigned for the NTG Study. The Committee discussed the TEC's role vs. the NTG subcommittee's role in relation to the NTG Study. A TEC endorsed Project Logistics document reflects the results of this discussion.

The Committee discussed outstanding issues identified by the Consultant (DNV GL) after the NTG kick-off meeting in March 2014. The parking lot items discussed consisted of:

1. How much contact should the evaluation have with program staff regarding specific projects?
    - Agreements:
        - The Consultant should determine the extent of contact it requires with utility program staff, in order to be fully informed on the customer's relationship with each utility prior to conducting the Net to Gross survey, given the complexity of the project and the contents of the project files. The Consultant will follow up as required with the utilities.
        - The TEC is comfortable with the Consultant constructing the survey instrument to include probes providing leading questions are not included.
        - A rationale for the use of probing questions should be included when the survey instrument is drafted, and added in the final report.
        - The TEC will review survey questions and probing instructions prior to fielding interviews.

2. Can the evaluation determine which portions of the attribution were due to financial incentives, which were other services, etc.?
    - Agreements:
        - Qualitative information on the influence of program activities will be gathered and reported to the extent this can be done within the defined project scope and budget.
        - The Consultant will maintain the database of raw data. Further conversation with the Consultant is required around what the Consultant can provide to the TEC in terms of the raw data. The TEC will decide later if there is desire or budget to look into this further.

3. Do we want to make a concerted effort to talk to self-direct customers who only spent a portion of their incentive money? As opposed to customers who used it all because they lose it otherwise.
    - Agreements:
        - Consultant's expert judgment would be helpful on this issue;
        - Final stratification should be representative;

4. The utilities report lifetime savings; should the evaluation use a dual baseline net-to- gross calculation? If so, how will the evaluation determine existing efficiency baseline savings without doing the full verified gross savings calculation process?
    - Consultant Action Item: Consultant to provide a simplified explanation of the two approaches, Life Cycle Net Savings (LCNS) versus Year One Net Savings (Y1NS) and the pros and cons of each.
    - TEC Net to Gross Action Item: Determine whether to pursue both Y1NS and LCNS methods, or select one. Resolution needed prior to starting analysis.

5. There is uncertainty about when influence occurred and what it means for NTG, largely around projects that receive incentives and are free riders in the current program year but were not free riders when they participated the first time in a past program year. How many historical program years should be taken into account by the study in determining NTG?
    - Agreements:

    - Specific program activities that influenced the project in question will be taken into account no matter when they had influence. This applies primarily to the long sale cycles.
    - TEC to discuss further and decide which approach to take (one year versus cumulative years) or whether to attempt to measure both.
    - Deciding on one or the other prior to reporting is important to avoid higher stakes debates once results are known.
- TEC Net to Gross Action Item: Decide which approach is preferred or whether surveys and interviews should attempt to capture both types of program effects.
  Decision required prior to survey instrument development.

6. Should the evaluation do spillover analysis with the large industrial customers in Union Gas' new self-direct program, even though there hasn't been much time for them to complete projects? It would give the TEC something to use going forward, even if it's understated.
    - Agreement:
        - Consultant's expert opinion will be sought on this question.
    - Consultant Action Item: Consultant will recommend to the TEC a course of action for estimating spillover for the Union self-direct program once more information has been reviewed.

2. Technical Reference Manual (TRM)

2.1 Measure Update

Review of the utilities' prescriptive measures by the Consultant (ERS Inc.) and the TEC subcommittee is ongoing. The Committee reviewed and endorsed the final Demand Control Ventilation (DCV) substantiation documents (Retrofit and New Construction). Measures currently under review include Ozone Laundry, Dishwashers, and Tankless Water Heaters.

2.2 TRM Budget Update

The TEC received a budget variance analysis in a memorandum issued by the Consultant. The TEC agreed that any increase in budget would need to be accompanied by a revised set of progress milestones, with specific payments from the remaining portion of budget tied to achievement of those milestones.

The TRM Subcommittee (C. Neme, T. Kesik, Union, and Enbridge) provided the Consultant with a listing of project conditions and revised billing milestones. The Consultant agreed to the TEC's proposal. The TRM Subcommittee requested clarity from the Consultant on a project completion date and schedule for reviewing remaining measures.

3. Input Assumptions Update (EB-2013-0430)

The Joint Input Assumptions filing was circulated to the TEC for support prior to filing with the Ontario Energy Board. The joint application updates the common Table of Measure Assumptions and Substantiation Documents. With respect to this update, the TEC endorsement spoke only to the following measure assumptions:

- High Efficiency Water Heaters;
- Update to 2.0 GPM Low-Flow Showerheads for Low Income Single Family, Low Income Multi Residential and Multi Residential;
- Revised Measure Lives for Community Energy Retrofit (Enbridge), Home Reno Rebate (Union Gas), Low Income Weatherization (Enbridge) and Low Income Weatherization (Union Gas); and
- Revised Free Ridership value for Community Energy Retrofit (Enbridge) and Home Reno Rebate (Union Gas).

Further, the TEC endorsed the addition of a new major measure to Community Energy Retrofit (Enbridge) and Home Reno Rebate (Union Gas).

The Committee offered input on a communication from OEB staff (May 30, 2014) requesting inclusion of an estimation of the simple payback period for all appropriate measures, and the market penetration or market share for all appropriate measures in future filings of measures as part of the Technical Reference Manual project. It was agreed that this additional work should not be incorporated into the TRM project currently underway due to the variable nature of the information in addition to the already defined scope of work of the TRM Consultant. The Committee's comments will inform discussions between the utilities and Board Staff, if applicable.

4. TEC-Related Audit Recommendations

The Committee reviewed and prioritized the 2012 TEC-related audit recommendations for Union Gas and Enbridge.

5. Discussion Regarding Restrictions on Participation by TEC Members in OEB Proceedings

The Committee discussed a memo titled "Restrictions on Participation by TEC Members in OEB Proceedings", which was provided to the Committee members by J. Shepherd in April 2014.

The TEC discussed several topics including:

- Normal rules of confidentiality should always apply to confidential information (e.g. customer names).
- There are different categories of information (facts, opinions, and negotiating positions) that exist within TEC discussions and the treatment of each of those categories of information may differ in future proceedings. Specifically, which categories, if any, can be relayed outside of TEC meetings in future proceedings and which categories of information should remain privileged?
- When the TEC reaches consensus on an issue or project and moves forward, can that issue or topic be contested by TEC Members in future proceedings?

The utilities will consider and respond to the TEC on this topic.

<u>Future meetings</u>: July 16, 2014; September 10, 2014; October 8, 2014

Ontario Natural Gas Technical Evaluation Committee

2014 3rd Quarter Report

The Technical Evaluation Committee (TEC; "the Committee") publicly reports its discussions and activities on a quarterly basis. This report reflects work conducted for the period of July 16, 2014 to September 10, 2014. Previous quarterly reports are available on the Ontario Energy Board (OEB) website online.

1. Committee Business: TEC Intervenor Members' Terms

In light of a new DSM framework for 2015 and beyond, the Consultative and TEC agreed that extending the current intervenor TEC Members' terms until the end of 2014 is the most practical approach. The current intervenors (Chris Neme, Jay Shepherd and Julie Girvan) agreed to remain on the Committee. Nominations and subsequent election (if required) will be held at the end of the year.

2. Custom Commercial and Industrial Net-to-Gross (NTG) Study

2.1 Project on Hold

The Committee agreed to postpone the consultant's work on the Net to Gross study, pending the release of the next generation DSM guidelines (mid-September 2014).

2.2 Matters for Resolution

The TEC discussed two unresolved Parking Lot items as a group and also during a call with the Consultant:

Parking Lot Item #5: *"There is dissention about when influence occurred and what it means for NTG, largely around projects that receive incentives and are free riders in the current program year but were not free riders when they participated the first time in a past program year. How many historical years should be taken into account by the study in determining NTG?"*

The Committee discussed the differences in capturing long sales cycle program effects versus capturing "in program" spillover effects (projects rebated in current year that were free riders based on current year program effects, but attributable to prior program participation). The design and delivery structure of the utilities' Commercial and Industrial Custom Programs was considered in determining whether these effects should be captured in the free ridership or spillover portion of the study. The TEC agreed that both long sales cycle program effects and "in program" spillover effects should be captured in some form but the distinction and labeling of the savings from these effects is an item that remains unresolved.

Current guidelines lack clarity and with the imminent new framework for Natural Gas Utilities from the Ontario Energy Board, the TEC felt it prudent to gain clarity prior to continuing with the NTG study,

Parking Lot Item #4: *"The utilities report lifetime savings; should the evaluation use a dual baseline net- to-gross calculation? If so, how will the evaluation determine the existing efficiency baseline savings without doing the full verified gross savings calculation process?"*

The Committee discussed the Consultant's summary document pertaining to the difference between the two proposed calculation methodologies, "Year One Net Savings" (Y1NS) and "Lifecycle Net Savings" (LCNS). The Committee agreed that the LCNS method would require a general rather than specific estimation approach for dual baselines, making it less accurate than its original intended design. Thus, the NTG Study will use the Year One Net Savings method with lifetime savings.

3. Technical Reference Manual (TRM)

Review of the utilities' prescriptive measures by the Consultant (ERS Inc.) and the TEC subcommittee is ongoing.

Regarding the current status of the TRM Project:

- 1 measure (2%) is TEC-approved and filed with the OEB;
- 2 measures (4%) are TEC-approved and awaiting filing;
- 14 measures (31%) have received an initial review by ERS / TRM Subcommittee;
- 28 measures (62%) have not yet received an initial review by ERS.

The TEC expressed desire for an updated project timeline. The goal is to have all measures ready for TEC approval by December 31, 2014.

4. Evaluation Budgets

Members observed that given changes in the timelines and deliverables of the Committee's primary projects, there may be available budget space for further evaluation work in 2014. The TEC will explore whether other evaluation work is feasible in 2014.

5. Prescriptive Free Ridership: Demand Control Ventilation

The Committee refined its process for determining Free Ridership values for new prescriptive measures. To inform discussions on Free Ridership, information will be provided by the utilities, at a future meeting, in the form of a brief written proposal. Information outlined will include details on the design of the utilities' respective Demand Control Ventilation offerings in addition to a return on investment calculation, underpinning research, and relevant jurisdictional reviews.

6. Privileged TEC Discussions

Building on prior TEC discussions, the Committee addressed whether its discussions should remain privileged. While the Committee agreed on the need for transparency, it also acknowledged the need to provide a forum for frank and open debate and negotiation. The TEC agreed that portions of the remaining TEC meetings may occur under privilege, contingent on Committee consensus.

7. Custom Project Savings Verification (CPSV)

7.1 Verifiers' Term

The TEC agreed that there is currently no standard protocol for the CPSV Verifiers' term (i.e. total years a Verifier can work without a rebid). In light of the upcoming new framework, the TEC agreed that the practical approach for 2014 is that each utility can continue with their current CPSV verifiers.

7.2 2012 Union Audit Recommendations

The TEC addressed four 2012 audit recommendations relating to the Custom Project Savings Verification.

Recommendation # 13

Union's sampling consultant should either not retroactively reclassify sample points to other strata or if so explain the rationale for this reclassification.

Resolution: The TEC accepts the recommendation.

Recommendation # 14

In future audits, the sampling consultant should provide more details about their definition of the 90% one-sided confidence interval and more details about calculations, such as showing the absolute errors.

Resolution: The definition of the 90/10 confidence interval is appropriate. No action required.

Recommendation # 15

Union should confirm with the sampling consultant that the sample within each stratum is truly randomly selected with equal probability of selection and without bias. The Auditor was concerned that smaller sites within strata may have been omitted from the sample selection process. While the sampling consultant did this with the "Very Small" stratum, and reported that they did this, it would be inappropriate to sample within each stratum non-randomly. However, there is no evidence that the sampling consultant biased the selection in this way apart from the "Very Small" stratum.

Resolution: The TEC observed that the auditor did not find any evidence of non-random sampling other than omission of very small projects from the "small" stratum. Since omissions of very small projects were part of the sampling protocol that the TEC had already endorsed, it saw no need for any further action on this item.

Recommendation #16

Union should include a note in the annual report that adjustments to water and electricity are based on sample realization rates, which were designed to be statistically significant for natural gas. Union Gas applied the sample realization rates for water and electricity to the population to calculate population savings. Although this is not the appropriate approach to assessing population savings based on a sample, since these results are not used in financial calculations, there is no impact on LRAM or performance incentives.

Resolution: The TEC accepts the recommendation.

The CSPV Sampling Methodology will be updated in addendum to reflect relevant audit recommendations and circulated for comment by the TEC.

7.3 2013 Enbridge Audit Recommendations

The TEC addressed five 2013 audit recommendations relating to the Custom Project Savings Verification.

Recommendation #2

Develop a standardized coversheet template for use by the CPSV TEs. Providing a coversheet template would assist the CPSV TEs in developing more consistent reports that provide all of the information required to validate their review. The template should stress the importance of including all relevant project assumptions, inputs, and calculation methodologies. The inclusion of all relevant project information in a consistent format and level of detail will allow the Auditor to perform their task without having to request the full project file from Enbridge. Auditor review of Enbridge project files for clarification or to obtain missing data is a redundant and inefficient effort. The template will also allow the Auditor to easily locate data and information within each CPSV TE project write-up leading to a more streamlined CPSV audit review process.

Resolution: The TEC agrees a template is appropriate. The template should reflect the scope of the Terms of Reference and any differences between Commercial and Industrial projects. The utilities will draft and circulate to the TEC a coversheet template highlighting relevant custom project data to inform the CPSV process.

Recommendation #3

Request that the CPSV TEs estimate the remaining useful life of the existing equipment in cases where the energy efficiency measure is an "add-on" to existing equipment for both the commercial and industrial sectors. For example, if the measure is an efficiency control on an existing boiler, the CPSV TE should determine if the existing boiler will be in place for the entire measure life of the efficiency control. If not, then a baseline (or measure life) adjustment should be made to account for the existing boiler being replaced with a more efficient boiler prior to the end of the measure life. Alternatively, develop one or more deemed measure lives for these types of projects, which are not currently included in the OEB measure life tables.

Resolution: The TEC agrees the CPSV Terms of Reference should be updated to address this recommendation. Utilities to develop draft revisions to the Terms of Reference and provide to the TEC for feedback and discussion.

Recommendation #4

Document the custom project realization rate calculation methodology. The 2012 Audit provided guidance on the correct process to calculate realization rates, but there is no formal stand-alone document that lists all the agreed upon steps. The method employed by Enbridge's realization rate contractor for 2013 contained process errors that Optimal needed to correct as part of its audit review.

Resolution: Comments are needed in addendum to the CPSV Sampling Methodology (see Action Item #10).

Recommendation #6

Provide clear instructions to the CPSV TEs to focus on evaluation of annual gas savings and measure lives, the inputs used to determine CCM. The sole DSMIDA metric for custom projects is CCM. Given tight timelines and the need to use ratepayer funds efficiently, the CPSV TEs should not spend time reviewing non-gas savings values or measure cost data.

Resolution: Utilities to communicate to the CPSV Verifier that it should focus on gas savings, but provide its assessment of any non-gas savings estimates found to be noteworthy.

Recommendation #8

Proper IPMVP protocols should be followed to verify project savings. While most projects employ sound measurement and verification methodologies, it was not always clear that CPSV contractors followed proper IPMVP protocols. Access and schedule issues as well as budget limitations may prevent CPSV contractors from performing the level of on-site measurement necessary to comply with IPMVP guidelines. Future CPSV contractors should endeavor to clearly identify which IPMVP option was employed and provide a thorough description of how that option was implemented. For example, if "Option A. Retrofit Isolation: Key Parameter Measurement" is determined to be the best option for a given project, the contractor should clearly establish which parameters are measured, which are estimated, and the methodology used to calculate savings. Presenting the verification results within the framework of IPMVP would lead to more justifiable savings estimates and facilitate review by future Auditors.

Resolution: The CPSV Verifier should indicate the IPMVP Option it followed in its review of each CPSV project. Where the CPSV Verifier deviates from the Option it selected, the CPSV Verifier should provide an explanation.

Future meetings: October 8, 2014; November 21, 2014; December 10, 2014

Ontario Natural Gas Technical Evaluation Committee

2014 4th Quarter Report

The Technical Evaluation Committee (TEC; "the Committee") publicly reports its discussions and activities on a quarterly basis. This report reflects work conducted for the period of October 8, 2014 to December 10, 2014. Previous quarterly reports are available on the Ontario Energy Board (OEB) website online.

1. Committee Business: TEC Intervenor Member Election

Members discussed the TEC Intervenor member election that was previously scheduled to occur at the end of 2014. Given the pending release of the final DSM Framework and Guidelines, the TEC Intervenor member election will be postponed to Q1 2015. Upon the release of the final DSM Framework and Guidelines, the TEC will assess how to move forward with the TEC Intervenor member election and communicate the process to the Consultative.

Given the pending release of a new DSM Framework and Guidelines for 2015 and beyond, the TEC discussed the uncertain future of the TEC, noting that if the Committee were to continue its work into 2015, endorsement of its intervenor and independent members would be needed from the Consultative. The Committee also considered how much time would be needed to complete some of its priority projects. All members agreed that guidance should be sought from the OEB on whether the Committee should plan to continue its work in Q1 2015, highlighting its work to date on the (Technical Resource Manual) TRM and (Net-to-Gross) NTG projects. In the event the TEC is mandated to continue its work in 2015, the Committee identified future meeting dates.

2. Custom Commercial and Industrial Net-to-Gross (NTG) Study

The Committee discussed the next steps for the Custom Commercial and Industrial Projects NTG Study. The primary project element that remains unresolved involves the type of NTG ratio the study will measure; a current program effects NTG ratio or a cumulative program effects NTG ratio. Members observed that the draft Guidelines released in September do not provide the TEC with direction on this issue. Given the Consultant's initial recommendation not to measure both types of NTG ratios due to the complexity involved, the Committee sought additional guidance from the Consultant on the topic by asking a follow-up question:

> Is the additional complexity of measuring both types of NTG ratios such that it would negate any work done if the Consultant moves forward now with the Study and additional direction was provided later (January 2015)?

Members noted DNV GL's response that advised against developing a survey instrument and scoring algorithm that took both cumulative and current year program effects into account. Additionally, since contract negotiations are nearing completion, this is a required step prior to sharing utilities' customer data with the consultant. As a result, the NTG Study remains on hold pending final DSM Framework and Guidelines.

3. Technical Reference Manual (TRM)

4.1. Measure Review

Review of the utilities' prescriptive measures by the Consultant and the TEC subcommittee is ongoing.

Regarding the current status of the TRM Project:

- 1 measure is TEC-approved and filed with the OEB;
- 7 measures are TEC-approved and awaiting filing;
- 13 measures are currently under review (i.e. substantiation document drafted);
- 24 measures are awaiting review (i.e. no substantiation document drafted).

4.2. Project Timeline

The Consultant's most recent revised work schedule aims to have all measures ready for TEC endorsement by December 31. The subcommittee recommended refinements to the schedule. It seems unlikely that all TRM measures will be ready for TEC endorsement by this date. Rather, completion is currently estimated in Q1 2015. Members expressed a desire to ensure the quality of substantiation documents delivered is not sacrificed due to the increased pace of the project. The TRM Subcommittee stated that the quality of delivered substantiation documents in the last month has been acceptable.

4.3. Online Platform

The Committee discussed whether to re-engage MindTouch for the online portion of the TRM project, given uncertainty about the project's and Committee's future. The Committee will seek Board guidance regarding the MindTouch portion of the TRM project, highlighting TEC work undertaken to consider key software functionalities and select a vendor for the online platform.

4. Evaluation Budgets

A budget update was shared with the Committee that illustrated the respective 2014 Evaluation Budgets and forecasted spend for both Enbridge and Union. The utilities indicated that their respective budgets are forecasted as fully spent for 2014.

5. Prescriptive Free Ridership: Demand Control Ventilation

A written proposal containing utility and market data (i.e. incentive levels, program design, market penetration values, manufacturer commentary) was shared to inform a discussion on a Free Ridership value for Demand Control Ventilation. Members observed that market penetration is not a reliable proxy for Free Ridership but that it is a useful data input into the analysis and discussion. Similarly, due to barriers in customers' awareness of a measure, low simple payback does not directly translate to high customer uptake. The Committee used all available sources of data to inform its decision on an appropriate Free Ridership value. Utility program design was also presented and thoroughly considered. Due to noted differences in the Retrofit and New Construction markets, the Committee felt that a 5% Free Ridership value for the Retrofit application and a 20% value for the New Construction application were appropriate. These values will remain effective until January 1, 2016.

6. Privileged TEC Discussions

Continuing on prior TEC discussions, the Committee established final operating guidelines regarding privileged TEC discussions. The TEC endorsed the following guidelines:

- Portions of the remaining TEC Meetings may occur under privilege, contingent on Committee consensus.
- Discussions involving opinions on vendors will remain privileged.
- When consensus through negotiation is reached, members can disclose information about their own negotiating positions but not the negotiating positions of others.

7. Custom Project Savings Verification (CPSV)

7.1 Union's 2013 CPSV Related Audit Recommendations

The TEC addressed four 2013 audit recommendations relating to Union's Custom Project Savings Verification.

Recommendation # 2

Strive for accuracy in evaluating savings and develop a thorough and independent estimate of project impacts, rather than merely confirming whether or not the initial savings estimates are reasonable or conservative. Reference.

Recommendation # 10

Do not revise EULs for individual custom projects from the values established in the original program filing documents.

Resolution: The TEC rejects the recommendation.

Recommendation # 11

Use measure component savings (rather than costs) to calculate an average EUL for a project.

Resolution: The TEC agrees with the recommendation. The TEC added language to reflect this in the 2014 CPSV Terms of Reference.

Recommendation #12

Ensure that projects that will likely affect incremental costs in future years have these costs correctly incorporated into the cost effectiveness calculations for the program.

Resolution: The TEC accepts the recommendation.

7.2 CPSV Terms of Reference and Coversheet Template

The Committee reviewed and made minor revisions to the 2014 CPSV Terms of Reference. The new CPSV Coversheet Template was shared and members provided feedback on the content. The Committee endorsed the template with the addition of five sub-headings (Project Basics, Baseline, Annual Savings Estimate, Measure Life, and Results).

8. Input Assumptions Update

The TEC discussed next steps in filing updated input assumptions with the Board. Members noted the small number of measures that are ready for filing, relative to those that could potentially be ready in January 2015. In consideration of this and the anticipated TRM completion date, a filing in Q1 2015 will ensure a more comprehensive package of measure substantiation documents. The Committee agreed that a TEC-endorsed letter should be sent to the Board indicating that due to the ongoing TRM process, the 2014 updated input assumptions will be jointly filed by the utilities for Board approval in Q1 2015.

Appendix B – Sampling Methodology for Custom C&I Projects

Due to the size of the report - A Sampling Methodology for Custom Commercial and Industrial Programs by Navigant Consulting, Inc. (October 28, 2014 revision), the document is available on the OEB website at

http://www.ontarioenergyboard.ca/documents/TEC/Evaluation%20Studies%20and%20Other%20Reports/TEC%20SC%20-%20Sampling%20Method%20-%20Final%20Report%2020141028.pdf

Appendix C – Custom Project Verification

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NAVIGANT

Memorandum

To: **Eric Buan, Tina Nicholson, Muhammad Saleem – Union Gas Ltd.**

From: **Brad Rogers, Dan Violette – Navigant Consulting**

Date: **November 17, 2015**

Re: **Sample Design and Evaluation Results for Audited Union Gas 2014 Custom Projects**

This memorandum presents the sample design and results for the evaluation of Union Gas custom projects completed during the 2014 program year including custom projects in the Large Volume Rate T1, Rate T2/R100 program, the Commercial/Industrial (C/I) program, and the Low Income (LI) program. This memorandum is organized according to the following section headings:

1. Summary of the Custom Program Population
2. Description of the Sample Frame
3. Determination of Evaluation Sample Sizes
4. Approach to Selecting the Sample
5. Summary of the Selected Sample
6. Sampled Project Evaluation Results
7. Evaluation Study Results

The approach taken to design and analyze the sample for 2014 Custom Programs reflects the prescribed methodology. [1,2] The audited cumulative savings results of the evaluation study are:

- **T2/R100 audited cumulative savings of 787,147,667 m^3 with a RR of 0.78**
- **T1 audited cumulative savings of 80,745,807 m^3 with a RR of 0.86**
- **LV (T2/R100 & T1 combined) audited cumulative savings of 867,893,474 m^3 with a RR of 0.79**
- **C/I audited cumulative savings of 685,951,005 m^3 with a RR of 0.84**
- **LI audited cumulative savings of 2,400,531 m^3 with a RR of 0.55**

All precision levels are specified for a 90% one-tailed confidence interval and calculated per the prescribed Sample Methodology. The precision results are presented in Section 7 of this memo.

[1] "A Sampling Methodology for Custom C&I Programs." Prepared for the Technical Evaluation Committee, Union Gas, and Enbridge by Navigant Consulting Inc. (Violette, D. M., and B. Rogers), November 12, 2012. Revised October 28, 2014.

[2] For the rationale underlying the approaches used, see the Sampling Methodology Report cited in footnote 1, available from Union Gas.

1. Summary of the Custom Program Population

Figure 1 below shows that 803 custom projects were implemented during the 2014 project year. All custom projects in the population reported cumulative gas savings, which served as the basis for grouping projects into size-based strata.

Figure 1. Reported Cumulative Savings (m^3) for Union 2014 Custom Projects

Stratum	Projects (N)	Reported Custom Cumulative Gas Savings (m3)	% of Total Custom Cumulative Gas Savings by Program
T2/R100	148	1,010,144,441	53%
T1	41	94,144,979	5%
C/I	587	814,113,151	42%
LI	27	4,362,120	0.2%
Total	**803**	**1,922,764,690**	**100%**

The Large Volume custom program T2/R100 rate class accounts for about one-fifth of the total number of custom projects, but represents about one-half of the reported custom cumulative gas savings. The C/I custom program accounts for about three-fourths of the projects, but represents less than half of reported savings. The Large Volume custom program T1 rate class accounts for about five percent of the projects and five percent of reported savings. The LI custom program represents three percent of the projects, but only two-tenths of a percent of reported savings.

2. Description of the Sample Frame

Separate samples were designed for each of the custom programs (T2/R100, T1, C/I, and LI). Precision targets were set individually for each program, but also for combined Large Volume (T2/R100 and T1). Within each program, strata were defined based on the amount of reported cumulative gas savings. Stratifying by project size reduced the overall sample size (i.e., number of sites drawn) by taking advantage of the concentrations of savings when relatively few projects contribute to a large fraction of total impacts. Per the prescribed methodology, the very small sites representing 3% or less of each program's cumulative gas savings were excluded from the sample selection in order to ensure cost-effective use of evaluation budget. [3]

Figure 2 through Figure 5 below illustrate how the large projects represent a larger fraction of program savings, while the very small projects contribute much less.

[3] "A Sampling Methodology for Custom C&I Programs." Prepared for the Technical Evaluation Committee, Union Gas, and Enbridge by Navigant Consulting Inc. (Violette, D. M., and B. Rogers), November 12, 2012. Revised October 28, 2014. (See Sections 5.1 and 5.4)

Figure 2. Distribution of Cumulative Savings from Union's Large Volume Custom Program – Rate T2/R100

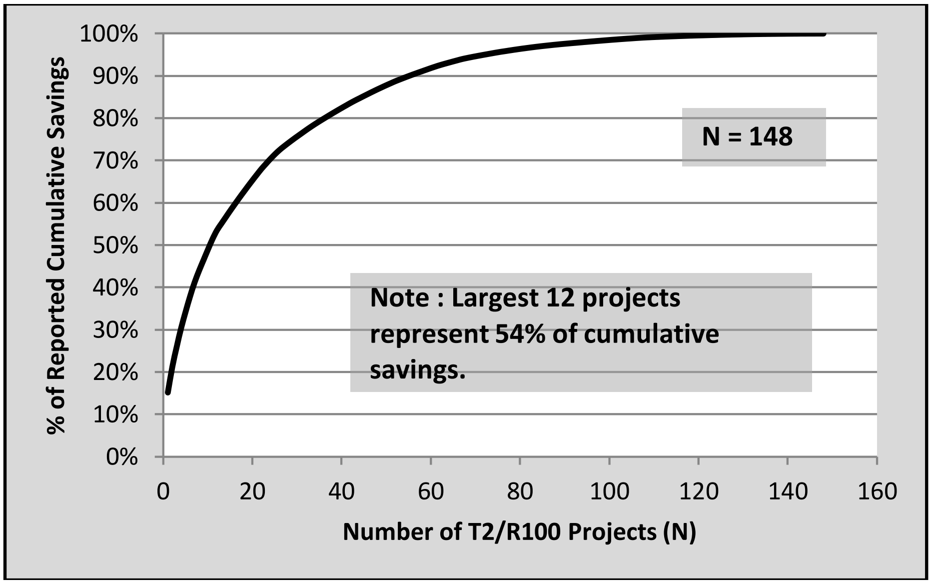

Figure 3. Distribution of Cumulative Savings from Union's Large Volume Custom Program – Rate T1

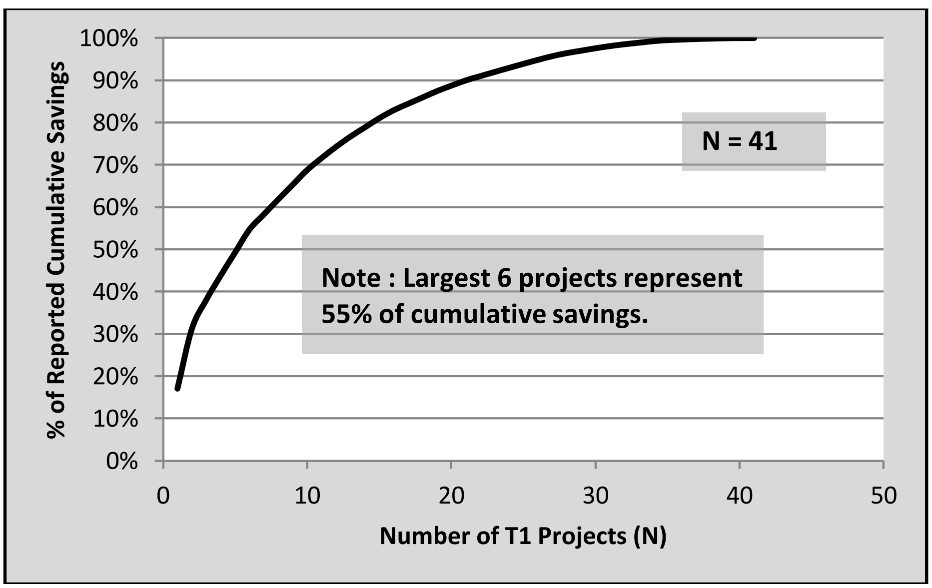

Figure 4. Distribution of Cumulative Savings in Union's C/I Custom Program

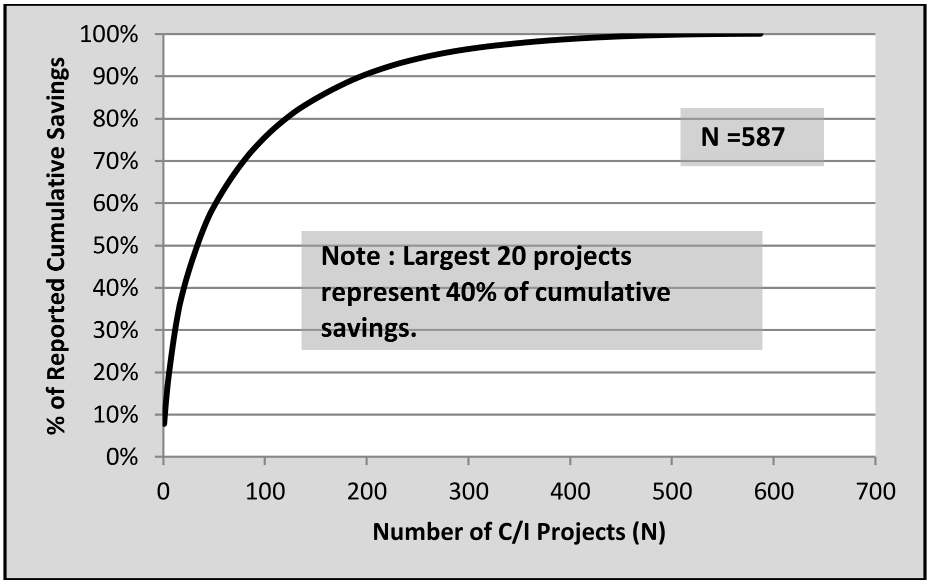

Figure 5. Distribution of Cumulative Savings in Union's LI Custom Program

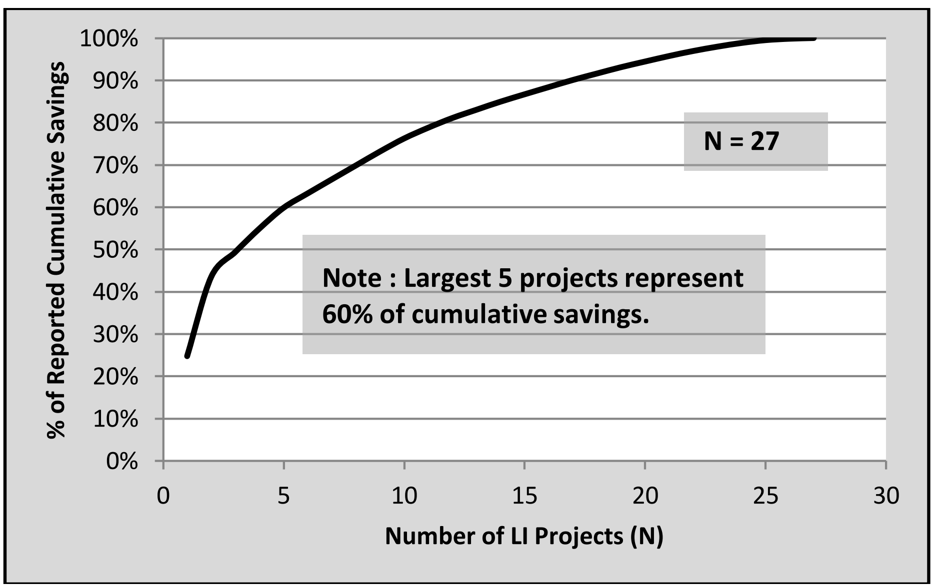

Figure 6 below indicates the cumulative gas savings thresholds applied to each stratum.

Figure 6. Program Segmentation Thresholds (Based on Reported Cumulative Gas Savings)

Stratum	T2/R100	T1	C/I	LI
Large	> 30,000,000 m^3	> 5,000,000 m^3	> 6,000,000 m^3	> 500,000 m^3
Medium	> 5,000,000 m^3	> 500,000 m^3	> 2,000,000 m^3	> 100,000 m^3
Small	> 500,000 m^3	-	> 100,000 m^3	> 10,000 m^3
Very Small	<500,000 m^3	< 500,000 m^3	< 100,000 m^3	< 10,000 m^3

Figure 7 below indicates the number of projects, the cumulative gas savings, and the percent contribution to total program cumulative gas savings represented in each stratum.

Figure 7. Program Reported Cumulative Savings Characteristics

Program	Stratum	Population	Reported Cumulative Gas Savings (m^3)	% of Program Gas Savings
T2/R100	Large	8	391,426,336	39%
	Medium	44	494,392,750	49%
	Small	58	115,230,857	11%
	Very Small	38	9,094,498	0.9%
	Total	**148**	**1,010,144,441**	**100%**
T1	Large	6	51,533,975	55%
	Medium	24	40,338,545	43%
	Very Small	11	2,272,458	2.4%
	Total	**41**	**94,144,979**	**100%**
C/I	Large	28	374,963,438	46%
	Medium	69	234,088,792	29%
	Small	329	197,964,154	24%
	Very Small	161	7,096,767	0.9%
	Total	**587**	**814,113,151**	**100%**
LI	Large	2	1,899,867	44%
	Medium	10	1,637,349	38%
	Small	14	817,722	19%
	Very Small	1	7,182	0.2%
	Total	**27**	**4,362,120**	**100%**

3. Determination of Evaluation Sample Sizes

The samples were designed to target 90% confidence that the actual population gas savings would exceed 90% of the sample estimate (i.e., 90/10 one-sided confidence interval) for combined Large Volume, C/I, and LI; an additional 90/15 target was used for T2/R100 and T1 individually. Coefficients of variation (CV) of 0.35 were applied for the Large Volume custom programs based on historically observed results from Union custom programs. A CV of 0.4 was used for C/I since this program had a higher observed variance in the 2013 study. For LI, 0.4 was used for the large stratum and 0.35 was used for the medium and small strata. [4] The finite population correction factor was applied in order to take advantage of the concentrations of benefits in the large project strata. Strata were weighted based on their contribution to total program cumulative gas savings. T-values were applied to standard errors in order to estimate the relative precision for 90% one-sided confidence coverage.

These assumptions were applied to estimate the minimum sample sizes required to hit the 90/10 or 90/15 one-sided confidence interval targets by appropriately allocating sample projects to each stratum based on reported cumulative gas savings.

Figure 8 below indicates the designed sample sizes for each stratum that intended to achieve the desired precision targets.

Figure 8. Sample Sizes by Custom Program Segment

Stratum	T2/R100	T1	C/I	LI
Large	6	4	9	2
Medium	6	4	8	5
Small	2	-	7	3
Very Small	0	0	0	0
Total	**14**	**8**	**24**	**10**

A sample size of 14 is estimated for the T2/R100 program, 8 for the T1 program, 24 for the C/I program, and 10 for the LI program.[5]

[4] The observed 2013 results of the C/I program sample indicated a slightly higher CV of 0.42, while the other custom programs achieved CV lower than 0.35. Per the recommendation of the 2013 study this variance assumption was raised. However the variance this 2014 cycle for C/I was actually lower than previous years while T1 and LI variances were higher.

[5] "A Sampling Methodology for Custom C&I Programs." Prepared for Union Gas and Enbridge by Navigant Consulting Inc. (Violette, D. M., and B. Rogers), November 12, 2012. Revised October 28, 2014.

4. Approach to Selecting the Sample

The sample was designed based on reported cumulative gas savings. Projects were randomly selected from each stratum to meet the target sample size for each stratum. Each stratum sample was developed as per the prescribed sampling methodology.

5. Summary of the Selected Sample

Figure 9 through Figure 12 below show the percent of the population projects and population savings represented by the sample for each stratum in each program.

Figure 9. T2/R100 Sample Summary

Stratum	Sample Size (n)	Populatio n (N)	% of Stratum Population Covered by Sample		Sample Reported Cumulative Gas Savings (m3)	Population Reported Cumulative Gas Savings (m3)	% of Stratum Reported Savings Covered by Sample
Large	6	8	75%		307,675,249	391,426,336	79%
Medium	6	44	14%		71,092,817	494,392,750	14%
Small	2	58	3%		3,543,611	115,230,857	3%
Very Small	0	38	0%		-	9,094,498	-
Total	**14**	**148**	**9%**		**382,311,678**	**1,010,144,441**	**38%**

Figure 10. T1 Sample Summary

Stratum	Sample Size (n)	Population (N)	% of Stratum Population Covered by Sample		Sample Reported Cumulative Gas Savings (m3)	Population Reported Cumulative Gas Savings (m3)	% of Stratum Reported Savings Covered by Sample
Large	4	6	67%		39,939,196	51,533,975	78%
Medium	4	24	17%		7,518,689	40,338,545	19%
Very Small	0	11	0%		-	2,272,458	-
Total	**8**	**41**	**20%**		**47,457,885**	**94,144,979**	**50%**

Figure 11. C/I Sample Summary

Stratum	Sample Size (n)	Population (N)	% of Stratum Population Covered by Sample		Sample Reported Cumulative Gas Savings (m3)	Population Reported Cumulative Gas Savings (m3)	% of Stratum Reported Savings Covered by Sample
Large	9	28	32%		113,511,807	374,963,438	30%
Medium	8	69	12%		27,481,206	234,088,792	12%
Small	7	329	2%		4,107,454	197,964,154	2%
Very Small	0	161	0%		-	7,096,767	-
Total	**24**	**587**	**4%**		**145,100,467**	**814,113,151**	**18%**

Figure 12. LI Sample Summary

Stratum	Sample Size (n)	Population (N)	% of Stratum Population Covered by Sample	Sample Reported Cumulative Gas Savings (m3)	Population Reported Cumulative Gas Savings (m3)	% of Stratum Reported Savings Covered by Sample
Large	2	2	100%	1,899,867	1,899,867	100%
Medium	5	10	50%	763,140	1,637,349	47%
Small	3	14	21%	169,727	817,722	21%
Very Small	0	1	0%	-	7,182	-
Total	**10**	**27**	**37%**	**2,832,734**	**4,362,120**	**65%**

6. Sampled Project Evaluation Results

Figure 13 through Figure 16 below summarize the reported, verified and audited savings for sampled projects from the T2/R100, T1, C/I, and LI programs respectively.

Figure 13. T2/R100 Sample Results

Identification No.	Pop. Stratum	Reported Annual Gas Savings (m^3)	Reported Measure Life (yrs)	Free Rider Rate	Reported Cumulative Gas Savings (m^3)	Verified Annual Gas Savings (m^3)	Verified Measure Life (yrs)	Verified Cumulative Gas Savings (m^3)	Audit Adj. Rate	Audited Cumulative Gas Savings (m3)	Audited Site RR
2014-IND-0612	Large	7,226,580	20.00	0.54	66,484,536	7,259,000	20.00	66,782,800	1.00	66,782,800	1.00
2014-IND-0630	Large	5,353,144	20.00	0.54	49,248,925	4,908,000	20.00	45,153,600	1.00	45,153,600	0.92
2014-IND-0609	Large	5,340,742	30.00	0.54	73,702,240	5,984,000	30.00	82,579,200	0.67	55,048,200	0.75
2014-IND-0667	Large	4,354,483	20.00	0.54	40,061,244	6,016,000	20.00	55,347,200	1.00	55,347,200	1.38
2014-IND-0615	Large	3,902,000	20.00	0.54	35,898,400	3,980,000	20.00	36,616,000	1.00	36,616,000	1.02
2014-IND-0608	Large	3,063,761	30.00	0.54	42,279,902	2,895,000	30.00	39,951,000	0.67	26,647,800	0.63
2014-IND-0543	Medium	3,964,367	7.00	0.54	12,765,262	4,630,000	7.00	14,908,600	0.50	7,454,300	0.58
2014-IND-0522	Medium	2,217,522	7.00	0.54	7,140,421	3,353,000	7.00	10,796,660	0.50	5,398,330	0.76
2014-IND-0670	Medium	1,856,905	20.00	0.54	17,083,526	976,000	19.54	8,772,678	0.51	4,489,600	0.26
2014-IND-0632	Medium	1,775,872	20.00	0.54	16,338,022	1,631,000	20.00	15,005,200	1.00	15,005,200	0.92
2014-IND-0487	Medium	1,292,155	20.00	0.54	11,887,826	855,200	20.00	7,867,840	0.50	3,933,920	0.33
2014-IND-0622	Medium	1,277,774	10.00	0.54	5,877,760	2,569,000	10.00	11,817,400	1.00	11,817,400	2.01
2014-IND-0620	Small	2,745,230	2.00	0.54	2,525,612	2,943,000	1.50	2,030,670	1.00	2,030,670	0.80
2014-IND-0664	Small	316,149	7.00	0.54	1,018,000	309,500	7.00	996,590	0.50	498,295	0.49

Figure 14. T1 Sample Results

Identification No.	Pop. Stratum	Reported Annual Gas Savings (m^3)	Reported Measure Life (yrs)	Free Rider Rate	Reported Cumulative Gas Savings (m^3)	Verified Annual Gas Savings (m^3)	Verified Measure Life (yrs)	Verified Cumulative Gas Savings (m^3)	Audit Adj. Rate	Audited Cumulative Gas Savings (m3)	Audited Site RR
2014-IND-0649	Large	1,747,225	20.00	0.54	16,074,470	1,954,000	20.00	17,976,800	0.50	8,988,400	0.56
2014-IND-0452	Large	1,446,878	20.00	0.54	13,311,278	1,612,000	30.00	22,245,600	1.00	22,245,600	1.67
2014-IND-0431	Large	589,960	20.00	0.54	5,427,632	36,870	20.00	339,204	1.00	339,204	0.06
2014-IND-0675	Large	557,154	20.00	0.54	5,125,817	615,200	20.00	5,659,840	1.00	5,659,840	1.10
2014-IND-0356	Medium	1,045,885	7.00	0.54	3,367,750	1,174,000	7.00	3,780,280	0.50	1,890,140	0.56
2014-IND-0299	Medium	248,696	20.00	0.54	2,288,003	92,830	20.00	854,036	1.00	854,036	0.37
2014-IND-0287	Medium	103,192	20.00	0.54	949,366	152,000	20.00	1,398,400	1.00	1,398,400	1.47
2014-IND-0371	Medium	99,301	20.00	0.54	913,569	172,800	20.00	1,589,760	1.00	1,589,760	1.74

Figure 15. C/I Sample Results

Identification No.	Pop. Stratum	Reported Annual Gas Savings (m^3)	Reported Measure Life (yrs)	Free Rider Rate	Reported Cumulative Gas Savings (m^3)	Verified Annual Gas Savings (m^3)	Verified Measure Life (yrs)	Verified Cumulative Gas Savings (m^3)	Audit Adj. Rate	Audited Cumulative Gas Savings (m3)	Audited Site RR
2014-IND-0178	Large	2,787,038	10.00	0.54	12,820,375	1,684,467	10.00	7,748,548	0.50	3,874,274	0.30
2014-IND-0569	Large	2,754,000	20.00	0.54	25,336,800	2,754,000	20.00	25,336,800	1.00	25,336,800	1.00
2014-IND-0025	Large	1,676,703	14.00	0.54	10,797,967	1,676,703	13.00	10,026,684	1.00	10,026,684	0.93
2014-IND-0024	Large	1,158,947	15.00	0.54	7,996,734	1,158,947	14.00	7,463,619	1.00	7,463,619	0.93
2014-IND-0114	Large	1,131,090	15.00	0.54	7,804,521	1,160,603	15.00	8,008,161	1.00	8,008,161	1.03
2014-IND-0021	Large	2,727,061	16.00	0.54	20,071,169	2,727,061	15.00	18,816,721	1.00	18,816,721	0.94
2014-IND-0022	Large	1,970,483	16.00	0.54	14,502,755	1,970,483	15.00	13,596,333	1.00	13,596,333	0.94
2014-IND-0570	Large	718,537	20.00	0.54	6,610,540	718,537	20.00	6,610,540	1.00	6,610,540	1.00
2014-COM-0240	Large	822,929	20.00	0.54	7,570,947	747,828	20.00	6,880,018	1.00	6,880,018	0.91
2014-IND-0112	Medium	327,010	20.00	0.54	3,008,492	348,784	20.00	3,208,813	0.50	1,604,406	0.53
2014-IND-0166	Medium	265,793	20.00	0.54	2,445,296	265,793	20.00	2,445,296	1.00	2,445,296	1.00
2014-IND-0056	Medium	517,813	20.00	0.54	4,763,880	366,540	14.00	2,360,518	1.00	2,360,518	0.50
2014-COM-0079	Medium	300,820	20.00	0.54	2,767,544	281,768	20.00	2,592,266	0.50	1,296,133	0.47
2014-COM-0051	Medium	319,540	14.00	0.54	2,057,838	514,195	16.00	3,784,475	1.00	3,784,475	1.84
2014-IND-0172	Medium	594,534	20.00	0.54	5,469,713	604,538	20.00	5,561,750	1.00	5,561,750	1.02
2014-COM-0320	Medium	499,488	14.00	0.54	3,216,703	538,335	14.00	3,466,877	1.00	3,466,877	1.08
2014-IND-0333	Medium	407,798	20.00	0.54	3,751,742	434,687	14.00	2,799,384	1.00	2,799,384	0.75
2014-COM-0087	Small	12,964	20.00	0.54	119,269	13,974	20.00	128,561	1.00	128,561	1.08
2014-IND-0183	Small	73,092	20.00	0.54	672,446	47,291	15.00	326,308	1.00	326,308	0.49
2014-IND-0210	Small	123,571	20.00	0.54	1,136,853	158,754	14.00	1,022,376	1.00	1,022,376	0.90
2014-IND-0115	Small	104,655	20.00	0.54	962,826	100,630	20.00	925,796	0.50	462,898	0.48
2014-IND-0261	Small	17,281	20.00	0.54	158,985	21,221	20.00	195,233	1.00	195,233	1.23
2014-IND-0345	Small	148,257	11.00	0.54	750,180	117,183	10.00	539,042	1.00	539,042	0.72
2014-COM-0239	Small	33,358	20.00	0.54	306,894	45,299	20.00	416,751	1.00	416,751	1.36

Figure 16. LI Sample Results

Identification No.	Pop. Stratum	Reported Annual Gas Savings (m^3)	Reported Measure Life (yrs)	Free Rider Rate	Reported Cumulative Gas Savings (m^3)	Verified Annual Gas Savings (m^3)	Verified Measure Life (yrs)	Verified Cumulative Gas Savings (m^3)	Audit Adj. Rate	Audited Cumulative Gas Savings (m3)	Audited Site RR
2014-COM-0313	Large	75,912	15.00	0.05	1,081,746	44,141	15.00	629,009	1.00	629,009	0.58
2014-COM-0306	Large	28,706	30.00	0.05	818,121	21,722	30.00	619,077	1.00	619,077	0.76
2014-COM-0300*	Medium	7,567	20.00	0.05	143,773	1,396	20.00	6,631	1.00	6,631	0.05
2014-COM-0179	Medium	15,121	10.00	0.05	143,650	3,941	15.00	56,159	1.00	56,159	0.39
2014-COM-0181	Medium	14,142	10.00	0.05	134,349	2,982	15.00	42,494	1.00	42,494	0.32
2014-COM-0312	Medium	7,033	15.00	0.05	100,220	0	15.00	0	0.00	0	0.00
2014-COM-0302*	Medium	12,692	20.00	0.05	241,148	11,736	20.00	66,833	1.00	66,833	0.28
2014-COM-0299*	Small	3,911	20.00	0.05	74,309	4,129	20.00	20,468	1.00	20,468	0.28
2014-COM-0095	Small	2,021	20.00	0.05	38,399	3,112	20.00	59,128	1.00	59,128	1.54
2014-COM-0282	Small	6,002	10.00	0.05	57,019	5,764	15.00	82,137	1.00	82,137	1.44

*2014-COM-0300, 2014-COM-0302 and 2014-COM-0299 were verified as having a dual baseline. Verified and audited annual gas savings presented here are first-year savings only.

7. Evaluation Study Results

The primary goal of the evaluation study was to estimate the total cumulative gas savings by program. Figure 17 through Figure 21 below present the audited cumulative gas savings for each program by stratum and in total. All realization rate and precision calculations were conducted in accordance with the prescribed Sampling Methodology. All precision levels are specified for a 90% one-tailed confidence interval

Figure 17. T2/R100 Evaluation Results

Stratum	Population Size (N)	Reported Cumulative Gas Savings (m3)	Audited Realization Rate	Audited Cumulative Gas Savings (m3)	Achieved Precision (rel)
Large	8	391,426,336	0.93	363,336,471	7.9%
Medium	44	494,392,750	0.68	334,487,704	39.8%
Small	58	115,230,857	0.71	82,236,671	48.7%
Very Small	38	9,094,498	0.78	7,086,821	
Total	**148**	**1,010,144,441**	**0.78**	**787,147,667**	**16.1%**

Figure 18. T1 Evaluation Results

Stratum	Population Size (N)	Reported Cumulative Gas Savings (m3)	Audited Realization Rate	Audited Cumulative Gas Savings (m3)	Achieved Precision (rel)
Large	6	51,533,975	0.93	48,042,197	42.5%
Medium	24	40,338,545	0.76	30,754,579	53.3%
Very Small	11	2,272,458	0.86	1,949,031	
Total	**41**	**94,144,979**	**0.86**	**80,745,807**	**28.7%**

Figure 19. Large Volume (T2/R100 & T1 Combined) Evaluation Results

Stratum	Population Size (N)	Reported Cumulative Gas Savings (m3)	Audited Realization Rate	Audited Cumulative Gas Savings (m3)	Achieved Precision (rel)
T2/R100	148	1,010,144,441	0.78	787,147,667	16.1%
T1	41	94,144,979	0.86	80,745,807	28.%7
Total	**189**	**1,104,289,420**	**0.79**	**867,893,474**	**14.5%**

Figure 20. C/I Evaluation Results

Stratum	Population Size (N)	Reported Cumulative Gas Savings (m3)	Audited Realization Rate	Audited Cumulative Gas Savings (m3)	Achieved Precision (rel)
Large	28	374,963,438	0.89	332,355,313	9.4%
Medium	69	234,088,792	0.85	198,633,163	20.2%
Small	329	197,964,154	0.75	148,982,974	20.1%
Very Small	161	7,096,767	0.84	5,979,555	
Total	**587**	**814,113,151**	**0.84**	**685,951,005**	**8.1%**

Figure 21. LI Evaluation Results

Stratum	Population Size (N)	Reported Cumulative Gas Savings (m3)	Audited Realization Rate	Audited Cumulative Gas Savings (m3)	Achieved Precision (rel)
Large	2	1,899,867	0.66	1,248,086	0%
Medium	10	1,637,349	0.23	369,284	30%
Small	14	817,722	0.95	779,208	76%
Very Small	1	7,182	0.55	3,952	-
Total	**27**	**4,362,120**	**0.55**	**2,400,531**	**18.5%**

Appendix D – Measure Inputs

Table D1 - Measure Inputs

	Measure Name	Equip Life	Energy Load	Free Rider	Adj. Factor	Natural Gas Savings m^3/Unit	Water Savings L/Unit	Elec Savings kWh/Unit	Inc Costs $/Unit
NC/ BR[1]	Air Curtains-Shipping >=64 sq ft & < 80 sq ft	15	Weather Sensitive	5%	100%	7,565	0	-5,380	$8,242.00
	Air Curtains-Shipping >=100 sq ft	15	Weather Sensitive	5%	100%	20,605	0	-936	$10,170.00
	Condensing Boiler SH - 300 to 999 MBtu/hr	25	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler SH - 300 to 999 MBtu/hr LIMF	25	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler SH - => 1,000 MBtu/hr	25	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler SH - => 1,000 MBtu/hr LIMF	25	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler WH - 300 to 999 MBtu/hr	25	Baseload	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler WH - 300 to 999 MBtu/hr LIMF	25	Baseload	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler WH - => 1,000 MBtu/hr	25	Baseload	5%	100%	Quasi	0	0	Quasi
	Condensing Gas Water Heater 1- 100gal/day	13	Baseload	5%	100%	332	0	0	$2,230.00
	Condensing Gas Water Heater 2- 500gal/day	13	Baseload	5%	100%	873	0	0	$2,230.00
	Condensing Gas Water Heater 3- 1000gal/day	13	Baseload	5%	100%	1,551	0	0	$2,230.00
	Condensing Gas Water Heater 3- 1000gal/day LIMF	13	Baseload	5%	100%	1,551	0	0	$2,230.00
	Custom Equip Baseload	Actual	Baseload	5% LI; 54% CI	100%	Actual	Actual	Actual	Actual
	Custom Equip Baseload/Weather	Actual	Baseload	54%	100%	Actual	Actual	Actual	Actual
	Custom Equip Weather	Actual	Weather Sensitive	5% LI; 54% CI	100%	Actual	Actual	Actual	Actual
	Custom Infrared Poly Baseload	Actual	Baseload	54%	100%	Actual	Actual	Actual	Actual
	DCKV < 5000 cfm	15	Weather Sensitive	5%	100%	4,801	0	13,521	$10,000.00
	DCKV 5000 - 9999 cfm	15	Weather Sensitive	5%	100%	11,486	0	30,901	$15,000.00
	Destratification Fan	15	Weather Sensitive	10%	100%	Quasi	0	Quasi	$7,021.00
	Dishwasher - Rack Conveyor Multi HT	20	Baseload	27%	100%	2,124	304,677	9,668	$970.00
	Dishwasher - Rack Conveyor Single HT	20	Baseload	27%	100%	560	80,303	4,247	$2,050.00
	Dishwasher - Stationary Rack Door Type HT	15	Baseload	20%	100%	922	132,263	4,167	$770.00
	Dishwasher - Stationary Rack Door Type LT	15	Baseload	20%	100%	2,120	304,205	0	$0.00
	Dishwasher - Stationary Rack Single Rack HT	15	Baseload	20%	100%	922	132,263	4,167	$770.00
	Dishwasher - Undercounter HT	10	Baseload	40%	100%	142	20,371	1,790	$120.00
	Dishwasher - Undercounter LT	10	Baseload	40%	100%	333	47,827	0	$50.00
	Energy Star Fryer	12	Baseload	20%	100%	1,408	0	0	$3,405.00
	Infrared Heating 1- 20-99 MBtu/hr 1-Stage	20	Weather Sensitive	33%	100%	Quasi	0	Quasi	Quasi
	Infrared Heating 2- 100-300 MBtu/hr 1-Stage	20	Weather Sensitive	33%	100%	Quasi	0	Quasi	Quasi
	Infrared Heating 3- 20-99 MBtu/hr 2-Stage	20	Weather Sensitive	33%	100%	Quasi	0	Quasi	Quasi
	Infrared Heating 4- 100-300 MBtu/hr 2-Stage	20	Weather Sensitive	33%	100%	Quasi	0	Quasi	Quasi
	MUA 01- MURB&LTC Imp Effic 1000-4999cfm	15	Weather Sensitive	5%	100%	Quasi	0	0	$2,190.00
	MUA 01- MURB&LTC Imp Effic 1000-4999cfm LIMF	15	Weather Sensitive	5%	100%	Quasi	0	0	$2,190.00
	MUA 02- MURB&LTC Imp Effic =>5000 cfm	15	Weather Sensitive	5%	100%	Quasi	0	0	$3,148.00
	MUA 02- MURB&LTC Imp Effic =>5000 cfm LIMF	15	Weather Sensitive	5%	100%	Quasi	0	Quasi	$3,148.00
	MUA 04- MURB&LTC Effic + 2 speed =>5000 cfm	15	Weather	5%	100%	Quasi	0	Quasi	$8,788.00

[1] New Construction / Building Retrofit (or Replacement)

	Measure Name	Equip Life	Energy Load	Free Rider	Adj. Factor	Natural Gas Savings m^3/Unit	Water Savings L/Unit	Elec Savings kWh/Unit	Inc Costs $/Unit
			Sensitive						
	MUA 05- MURB&LTC Effic + VFD 1000-4999 cfm LIMF	15	Weather Sensitive	5%	100%	Quasi	0	Quasi	$2,910.00
	MUA 06- MURB&LTC Effic + VFD => 5000 cfm	15	Weather Sensitive	5%	100%	Quasi	0	Quasi	$2,910.00
	MUA 06- MURB&LTC Effic + VFD => 5000 cfm LIMF	15	Weather Sensitive	5%	100%	Quasi	0	Quasi	$2,910.00
	MUA 07- Other Comm Imp Effic 1000-4999 cfm	15	Weather Sensitive	5%	100%	Quasi	0	0	$4,758.50
	MUA 09- Other Comm Effic + 2 speed 1000-4999cfm	15	Weather Sensitive	5%	100%	Quasi	0	Quasi	$8,788.00
	MUA 11- Other Comm Effic + VFD 1000-4999 cfm	15	Weather Sensitive	5%	100%	Quasi	0	Quasi	$2,910.00
	MUA 12- Other Comm Effic + VFD =>5000 cfm	15	Weather Sensitive	5%	100%	Quasi	0	Quasi	$11,274.00
	Non-Condensing Boiler SH - 300 to 999 MBtu/hr MF	25	Weather Sensitive	20%	100%	Quasi	0	0	Quasi
	Non-Condensing Boiler SH - =>1,000 MBtu/hr MF	25	Weather Sensitive	20%	100%	Quasi	0	0	Quasi
	Non-Condensing Boiler SH - =>1,000 MBtu/hr NMF	25	Weather Sensitive	12%	100%	Quasi	0	0	Quasi
	Non-Condensing Boiler WH - 300 to 999 MBtu/hr MF	25	Baseload	20%	100%	Quasi	0	0	Quasi
	Non-Condensing Boiler WH - =>1,000 MBtu/hr MF	25	Baseload	20%	100%	Quasi	0	0	Quasi
	Non-Condensing Boiler WH - =>1,000 MBtu/hr NMF	25	Baseload	12%	100%	Quasi	0	0	Quasi
	Ozone WE =< 60 lbs cap & 100,000 to 199,999lbs/yr	15	Baseload	8%	100%	Quasi	Quasi	Quasi	Quasi
	Ozone WE =< 60 lbs cap & => 200,000 lbs/yr	15	Baseload	8%	100%	Quasi	Quasi	Quasi	Quasi
	Ozone WE >60 lbs & =< 120lbs & => 200,000 lbs/yr	15	Baseload	8%	100%	Quasi	Quasi	Quasi	Quasi
	Ozone WE > 120lbs & <500lbs & => 260,000 lbs/yr	15	Baseload	8%	100%	Quasi	Quasi	Quasi	Quasi
NC only	Condensing Boiler SH - up to 299 MBtu/hr	25	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler WH - up to 299 MBtu/hr	25	Baseload	5%	100%	Quasi	0	0	Quasi
	DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan	10	Weather Sensitive	20%	100%	Quasi	0	0	$1,050.00
	DCV-Retail-RTU/MUA up to 4999 sq ft-w/o plan	10	Weather Sensitive	20%	100%	Quasi	0	0	$1,050.00
	DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan	10	Weather Sensitive	20%	100%	Quasi	0	0	$1,050.00
	ERV 1- up to 1999 cfm MURB,Healthcare,Nursing	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 2- => 2000 cfm MURB,Healthcare,Nursing	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 3- up to 1999 cfm Hotel,Restaurant,Retail	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 4- => 2000 cfm Hotel,Restaurant,Retail	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 5- up to 1999 cfm Off,Whse,Ed & All Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 6- => 2000 cfm Off,Whse,Ed & All Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	HRV 1- 500 to 1999cfm-Hotel,Restaurant,Retail,Rec	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	HRV 2- =>2,000cfm-Hotel,Restaurant,Retail,Rec	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	HRV 3- 500 to 1999cfm-Off,Whse,Man,Ed,Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi

	Measure Name	Equip Life	Energy Load	Free Rider	Adj. Factor	Natural Gas Savings m^3/Unit	Water Savings L/Unit	Elec Savings kWh/Unit	Inc Costs $/Unit
	HRV 4- =>2,000cfm-Off,Whse,Man,Ed,Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	HRV 5- MURB,Healthcare,Nursing	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
BR only	Air Curtains-Pedestrian >=48 sq ft & < 96 sq ft	15	Weather Sensitive	5%	100%	667	0	172	$1,650.00
	Air Curtains-Pedestrian >=96 sq ft	15	Weather Sensitive	5%	100%	1,529	0	1,023	$2,500.00
	Basic-Faucet Aerator-Bath	10	Baseload	1%	100%	6	2,501	0	$0.60
	Basic-Faucet Aerator-Kitchen	10	Baseload	1%	100%	12	4,516	0	$1.14
	Basic-Pipe Insulation - 2m	15	Baseload	1%	100%	31	0	0	$1.64
	Basic-Showerhead-1.25 gpm existing 2.0-2.5	10	Baseload	1%	100%	46	14,294	0	$3.79
	Basic-Showerhead-1.25 gpm existing 2.6+	10	Baseload	1%	100%	88	22,580	0	$3.79
	Basic-Thermostat-Programmable	15	Weather Sensitive	1%	100%	53	0	54	$26.95
	Condensing Boiler SH - up to 299 MBtu/hr	25	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler SH - up to 299 MBtu/hr LIMF	25	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler WH - up to 299 MBtu/hr	25	Baseload	5%	100%	Quasi	0	0	Quasi
	Condensing Boiler WH - up to 299 MBtu/hr LIMF	25	Baseload	5%	100%	Quasi	0	0	Quasi
	Custom O&M Baseload	Actual	Baseload	54%	100%	Actual	Actual	Actual	Actual
	Custom O&M Baseload/Weather	Actual	Baseload	54%	100%	Actual	Actual	Actual	Actual
	Custom O&M Weather	Actual	Weather Sensitive	54%	100%	Actual	Actual	Actual	Actual
	DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan	10	Weather Sensitive	5%	100%	Quasi	0	0	$1,350.00
	DCV-Office-RTU/MUA => 2500 sq ft-w/o plan	10	Weather Sensitive	5%	100%	Quasi	0	0	$1,350.00
	DCV-Retail-RTU/MUA up to 4999 sq ft-w/o plan	10	Weather Sensitive	5%	100%	Quasi	0	0	$1,350.00
	DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan	10	Weather Sensitive	5%	100%	Quasi	0	0	$1,350.00
	Deep Measure-no Furnace	25	Weather Sensitive	15%	100%	Actual	Actual	Actual	Actual
	Deep Measure-with Furnace	15	Weather Sensitive	15%	100%	Actual	Actual	Actual	Actual
	Non-Deep Measure-no Furnace	25	Weather Sensitive	15%	100%	Actual	Actual	Actual	Actual
	Non-Deep Measure-with Furnace	15	Weather Sensitive	15%	100%	Actual	Actual	Actual	Actual
	ERV 1- up to 1999 cfm MURB,Healthcare,Nursing	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 2- => 2000 cfm MURB,Healthcare,Nursing	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 3- up to 1999 cfm Hotel,Restaurant,Retail	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 4- => 2000 cfm Hotel,Restaurant,Retail	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 5- up to 1999 cfm Off,Whse,Ed & All Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ERV 6- => 2000 cfm Off,Whse,Ed & All Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
	ESK Install - Energy-efficient Showerhead	10	Baseload	10%	72%	44	13,885	0	$3.79
	ESK Install - Kitchen Faucet Aerator	10	Baseload	33%	82%	12	4,516	0	$1.14
	ESK Install - Bathroom Faucet Aerator	10	Baseload	33%	92%	6	2,501	0	$0.60
	ESK Install - Pipe Wrap	15	Baseload	4%	100%	31	0	0	$1.64
	ESK Pull - Energy-efficient Showerhead	10	Baseload	10%	55%	44	13,885	0	$3.79
	ESK Pull - Kitchen Faucet Aerator	10	Baseload	33%	71%	12	4,516	0	$1.14
	ESK Pull - Bathroom Faucet Aerator	10	Baseload	33%	81%	6	2,501	0	$0.60
	ESK Pull - Pipe Wrap	15	Baseload	4%	98%	31	0	0	$1.64

Measure Name	Equip Life	Energy Load	Free Rider	Adj. Factor	Natural Gas Savings m^3/Unit	Water Savings L/Unit	Elec Savings kWh/Unit	Inc Costs $/Unit
ESK Push - Energy-efficient Showerhead	10	Baseload	10%	54%	44	13,885	0	$3.79
ESK Push - Kitchen Faucet Aerator	10	Baseload	33%	65%	12	4,516	0	$1.14
ESK Push - Bathroom Faucet Aerator	10	Baseload	33%	79%	6	2,501	0	$0.60
ESK Push - Pipe Wrap	15	Baseload	4%	96%	31	0	0	$1.64
ESK D2D - Energy-efficient Showerhead	10	Baseload	10%	50%	44	13,885	0	$3.79
ESK D2D - Kitchen Faucet Aerator	10	Baseload	33%	68%	12	4,516	0	$1.14
ESK D2D - Bathroom Faucet Aerator	10	Baseload	33%	80%	6	2,501	0	$0.60
ESK D2D - Pipe Wrap	15	Baseload	4%	95%	31	0	0	$1.64
HHC-Whole Home-Private Home	25	Weather Sensitive	0%	100%	Actual	Actual	Actual	Actual
HHC-Whole Home-Social Housing	25	Weather Sensitive	0%	100%	Actual	Actual	Actual	Actual
HRV 1- 500 to 1999cfm-Hotel,Restaurant,Retail,Rec	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
HRV 2- =>2,000cfm-Hotel,Restaurant,Retail,Rec	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
HRV 3- 500 to 1999cfm-Off,Whse,Man,Ed,Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
HRV 4- =>2,000cfm-Off,Whse,Man,Ed,Other Comm	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
HRV 5- MURB,Healthcare,Nursing	14	Weather Sensitive	5%	100%	Quasi	0	0	Quasi
Astat - WIFI $25	15	Weather Sensitive	43%	100%	53	0	54	$25.00
Pstat- D2C $25	15	Weather Sensitive	43%	100%	53	0	54	$25.00
Pstat- HVAC $25	15	Weather Sensitive	43%	100%	53	0	54	$25.00
Pstat- HVAC No Incent$	15	Weather Sensitive	43%	100%	53	0	54	$25.00
Smart thermostats $25	15	Weather Sensitive	43%	100%	53	0	54	$25.00

Appendix E – 2014 Gas Savings by Scorecard and Measure

Table E1 - Gas Savings by Measure for the Resource Acquisition Scorecard

Segment	Measure	Average Net Cumulative Gas Savings (m^3/Unit)	Units	Net Cumulative Gas Savings (m^3)
Commercial/ Industrial	Air Curtains-Pedestrian >=48 sq ft & < 96 sq ft	9,505	21	199,600
	Air Curtains-Pedestrian >=96 sq ft	21,788	6	130,730
	Air Curtains-Shipping >=64 sq ft & < 80 sq ft	107,801	1	107,801
	Air Curtains-Shipping >=100 sq ft	293,621	3	880,864
	Condensing Boiler SH - up to 299 MBtu/hr	52,861	163	8,616,371
	Condensing Boiler SH - 300 to 999 MBtu/hr	124,530	224	27,894,698
	Condensing Boiler SH - => 1,000 MBtu/hr	442,535	119	52,661,635
	Condensing Boiler WH - up to 299 MBtu/hr	53,609	10	536,085
	Condensing Boiler WH - 300 to 999 MBtu/hr	87,917	27	2,373,746
	Condensing Boiler WH - => 1,000 MBtu/hr	333,901	12	4,006,815
	Condensing Gas Water Heater 1- 100gal/day	4,100	18	73,804
	Condensing Gas Water Heater 2- 500gal/day	10,782	34	366,573
	Condensing Gas Water Heater 3- 1000gal/day	19,155	94	1,800,556
	Custom Equip Baseload	756,048	86	65,020,094
	Custom Equip Baseload/Weather	2,261,975	175	395,845,560
	Custom Equip Weather	465,856	63	29,348,934
	Custom Infrared Poly Baseload	165,603	50	8,280,139
	Custom O&M Baseload	432,512	24	10,380,287
	Custom O&M Baseload/Weather	1,135,407	149	169,175,590
	Custom O&M Weather	141,572	41	5,804,445
	DCKV < 5000 cfm	68,414	8	547,314
	DCKV 5000 - 9999 cfm	163,676	18	2,946,159
	DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan	2,070	26	53,829
	DCV-Office-RTU/MUA => 2500 sq ft-w/o plan	4,138	18	74,481
	DCV-Retail-RTU/MUA up to 4999 sq ft-w/o plan	6,674	33	220,232

Segment	Measure	Average Net Cumulative Gas Savings (m^3/Unit)	Units	Net Cumulative Gas Savings (m^3)
	DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan	31,489	86	2,708,094
	Destratification Fan	163,239	87	14,201,764
	Dishwasher - Rack Conveyor Multi HT	31,010	1	31,010
	Dishwasher - Rack Conveyor Single HT	8,176	6	49,056
	Dishwasher - Stationary Rack Door Type HT	11,064	45	497,880
	Dishwasher - Stationary Rack Door Type LT	25,440	57	1,450,080
	Dishwasher - Stationary Rack Single Rack HT	11,064	11	121,704
	Dishwasher - Undercounter HT	852	8	6,816
	Dishwasher - Undercounter LT	1,998	22	43,956
	Energy Star Fryer	13,517	95	1,284,096
	ERV 1- up to 1999 cfm MURB,Healthcare,Nursing	14,670	144	2,112,415
	ERV 2- => 2000 cfm MURB,Healthcare,Nursing	291,716	31	9,043,190
	ERV 3- up to 1999 cfm Hotel,Restaurant,Retail	31,277	42	1,313,621
	ERV 4- => 2000 cfm Hotel,Restaurant,Retail	249,614	12	2,995,373
	ERV 5- up to 1999 cfm Off,Whse,Ed & All Other Comm	19,707	230	4,532,598
	ERV 6- => 2000 cfm Off,Whse,Ed & All Other Comm	121,741	69	8,400,095
	HRV 1- 500 to 1999cfm-Hotel,Restaurant,Retail,Rec	29,397	8	235,172
	HRV 2- =>2,000cfm-Hotel,Restaurant,Retail,Rec	120,072	2	240,145
	HRV 3- 500 to 1999cfm-Off,Whse,Man,Ed,Other Comm	16,399	48	787,175
	HRV 4- =>2,000cfm-Off,Whse,Man,Ed,Other Comm	177,731	35	6,220,590
	HRV 5- MURB,Healthcare,Nursing	24,233	24	581,600
	Infrared Heating 1- 20-99 MBtu/hr 1-Stage	10,588	345	3,652,822
	Infrared Heating 2- 100-300 MBtu/hr 1-Stage	26,388	748	19,737,878
	Infrared Heating 3- 20-99 MBtu/hr 2-Stage	21,421	71	1,520,873
	Infrared Heating 4- 100-300 MBtu/hr 2-Stage	43,196	145	6,263,468
	MUA 01- MURB&LTC Imp Effic 1000-4999cfm	41,727	2	83,455

Segment	Measure	Average Net Cumulative Gas Savings (m^3/Unit)	Units	Net Cumulative Gas Savings (m^3)
	MUA 02- MURB&LTC Imp Effic =>5000 cfm	83,993	3	251,980
	MUA 04- MURB&LTC Effic + 2 speed =>5000 cfm	221,160	1	221,160
	MUA 06- MURB&LTC Effic + VFD => 5000 cfm	416,100	2	832,200
	MUA 07- Other Comm Imp Effic 1000-4999 cfm	17,475	10	174,749
	MUA 09- Other Comm Effic + 2 speed 1000-4999cfm	85,500	2	171,000
	MUA 11- Other Comm Effic + VFD 1000-4999 cfm	74,682	11	821,505
	MUA 12- Other Comm Effic + VFD =>5000 cfm	318,614	5	1,593,071
	Non-Condensing Boiler SH - 300 to 999 MBtu/hr MF	114,867	3	344,600
	Non-Condensing Boiler SH - =>1,000 MBtu/hr MF	341,054	6	2,046,326
	Non-Condensing Boiler SH - =>1,000 MBtu/hr NMF	572,643	15	8,589,644
	Non-Condensing Boiler WH - 300 to 999 MBtu/hr MF	62,000	4	248,000
	Non-Condensing Boiler WH - =>1,000 MBtu/hr MF	199,100	2	398,201
	Non-Condensing Boiler WH - =>1,000 MBtu/hr NMF	528,627	4	2,114,508
	Ozone WE =< 60 lbs cap & 100,000 to 199,999lbs/yr	56,521	5	282,605
	Ozone WE =< 60 lbs cap & => 200,000 lbs/yr	127,273	35	4,454,554
	Ozone WE >60 lbs & =< 120lbs & => 200,000 lbs/yr	166,372	3	499,116
	Ozone WE > 120lbs & <500lbs & => 260,000 lbs/yr	234,634	6	1,407,807
Commercial/Industrial Total			**3,914**	**899,912,291**
Residential	ESK Install- HVAC	834	175	145,933
	ESK Pull	744	9,973	7,424,213
	ESK Push- Door to Door	709	33,399	23,663,330
	ESK Push	726	2,420	1,757,041
	Pstat	453	4,746	2,150,650
	Deep Measure-no Furnace	34,480	462	15,929,893
	Deep Measure-with Furnace	19,726	534	10,533,859
	Non-Deep Measure-no Furnace	27,455	1	27,455

Segment	Measure	Average Net Cumulative Gas Savings (m^3/Unit)	Units	Net Cumulative Gas Savings (m^3)
	Non-Deep Measure-with Furnace	9,048	3	27,145
Residential Total			**46,967**	**61,659,518**
Resource Acquisition Scorecard Total			**50,881**	**961,571,810**

Table E2 - Gas Savings by Measure for the Low-Income Scorecard

Segment	Measure	Average Net Cumulative Gas Savings (m^3/Unit)	Units	Net Cumulative Gas Savings (m^3)
Low-Income Single Family	Basic-Faucet Aerator-Bath	54	51	2,779
	Basic-Faucet Aerator-Kitchen	93	45	4,171
	Basic-Pipe Insulation - 2m	432	41	17,719
	Basic-Showerhead-1.25 gpm existing 2.0-2.5	364	4	1,457
	Basic-Showerhead-1.25 gpm existing 2.6+	697	37	25,788
	Basic-Thermostat-Programmable	787	6	4,722
	HHC-Whole Home-Private Home	33,154	689	22,842,935
	HHC-Whole Home-Social Housing	14,169	932	13,205,755
Low-Income Single Family Total			**1,805**	**36,105,327**
Low-Income Multi-Family Custom	Custom Equip Baseload	76,250	3	228,751
	Custom Equip Weather	90,434	24	2,170,415
Low-Income Multi-Family Custom Total			**27**	**2,399,166**
Low-Income Multi-Family Prescriptive	Condensing Boiler SH - up to 299 MBtu/hr LIMF	50,339	14	704,740
	Condensing Boiler SH - 300 to 999 MBtu/hr LIMF	135,480	8	1,083,836
	Condensing Boiler SH - => 1,000 MBtu/hr LIMF	419,900	10	4,199,000
	Condensing Boiler WH - up to 299 MBtu/hr LIMF	67,417	3	202,250
	Condensing Boiler WH - 300 to 999 MBtu/hr LIMF	81,969	12	983,628
	Condensing Gas Water Heater 3- 1000gal/day LIMF	19,155	16	306,478
	ERV 2- => 2000 cfm MURB,Healthcare,Nursing	922,827	4	3,691,309
	HRV 5- MURB,Healthcare,Nursing	96,460	9	868,139
	MUA 01- MURB&LTC Imp Effic 1000-4999cfm LIMF	20,594	2	41,189
	MUA 02- MURB&LTC Imp Effic =>5000 cfm LIMF	89,775	2	179,550
	MUA 04- MURB&LTC Effic + 2 speed =>5000 cfm	276,450	1	276,450
	MUA 05- MURB&LTC Effic + VFD 1000-4999 cfm LIMF	104,959	22	2,309,105
	MUA 06- MURB&LTC Effic + VFD => 5000 cfm LIMF	361,834	12	4,342,004

Segment	Measure	Average Net Cumulative Gas Savings (m^3/Unit)	Units	Net Cumulative Gas Savings (m^3)
Low-Income Multi-Family Prescriptive Total			**115**	**19,187,677**
Low-Income Scorecard Total			**1,947**	**57,692,169**

Table E3 - Gas Savings by Measure for the Large Volume Rate T1 and Rate T2/Rate 100 Scorecard

Segment	Measure	Average Net Cumulative Gas Savings (m^3/Unit)	Units	Net Cumulative Gas Savings (m^3)
Large Industrial T1	Air Curtains-Shipping >=100 sq ft	293,621	1	293,621
	Custom Infrared Poly Baseload	462,492	7	3,237,442
	Infrared Heating 1- 20-99 MBtu/hr 1-Stage	9,648	1	9,648
	Infrared Heating 2- 100-300 MBtu/hr 1-Stage	30,552	9	274,968
	Infrared Heating 4- 100-300 MBtu/hr 2-Stage	64,856	1	64,856
	Custom Equip Baseload/Weather	2,224,962	17	37,824,360
	Custom O&M Baseload/Weather	2,347,228	17	39,902,880
Large Industrial T1 Total			**53**	**81,607,775**
Large Industrial T2	Destratification Fan	112,502	6	675,014
	Custom Equip Baseload/Weather	4,806,224	12	57,674,684
	Custom O&M Baseload/Weather	5,550,865	80	444,069,199
Large Industrial T2 Total			**98**	**502,418,896**
Large Industrial Rate 100	Custom Equip Baseload/Weather	11,422,798	12	137,073,582
	Custom O&M Baseload/Weather	3388527.267	44	149,095,200
Large Industrial Rate 100 Total			**56**	**286,168,782**
Large Volume Scorecard Total			**207**	**870,195,452**

Appendix F: DSM Tracking & Reporting Processes

Tracking Systems Overview

Union Gas uses two 2003 Windows web-based proprietary applications, DSMt and AIMS. Both applications interact with Banner and utilize Crystal Reports to pull data from the applications. The following are descriptions of these four components, their respective functions and how they are connected.

Banner

Banner is Union's customer information and billing (CIS) system that is used to store current customer information including rate class and historical consumption.

DSMt

DSMt is a custom 2003 Windows web-based database that is run using Oracle 11G. DSMt stores all information required to track customer-specific applications and produce DSM reporting requirements specific to the current DSM Framework. DSMt also receives automated uploads from Banner to ensure that customer information remains up-to-date. Uploads are constant and every time an account is accessed, the most current Banner rate class info is provided. DSMt content includes:

- Customer information including name, address, rate class, sector, measures installed, installation date;
- Measure details or input assumptions for each DSM measure including number of units, measure life, resource savings, incremental cost, project description, basecase, and net-to-gross adjustment factors; and
- Customer incentive details.

AIMs

Account Information Management System (AIMS) is a custom 2003 Windows web-based application that is run using Oracle 11G. AIMS houses Customer and Service provider information including mailing addresses and customer contact information for customer and service providers that participate in custom DSM programs. Custom project details, including all attachments associated with the custom project submission, are housed in AIMS.

Crystal Reports

Crystal Reports is used to extract data and generate reports from the information contained in DSMt. There are several pre-defined monthly reports produced in DSMt that contain information such as cumulative gas savings, LRAM amounts, and incentive dollars paid by rate class. A General Extraction Report of most data fields tracked in DSMt is also generated monthly and used for additional reporting. The general extraction of data is referred to as the End User Measure (EUM) report. This report is generated automatically from DSMt and is exported directly into Excel. The EUM report is found as the EUM tab in the 2014 Audit Tool.

Data Collection and Data Entry

Customer applications, participant forms and rebate forms come from multiple sources depending on the offering. The following table summarises how data is collected for each of Union's DSM offerings.

Table F1 - Data Collection Method for Various Program Offerings

Offering	**Data Collection Method**
C/I Prescriptive and Quasi-Prescriptive Offering	Account managers are responsible for completing C/I prescriptive applications on behalf of the participant. Completed applications are received by DSM Tracking & Reporting (DSM T&R) directly from account managers via email. Applications are verified for completeness and eligibility as per Union's QA protocol by DSM T&R and entered accordingly by the DSM T&R.
C/I Custom and Large Industrial Custom Offerings	Custom applications are first entered into the AIMS application by account managers and project managers. The files are then reviewed by another team of engineers in the Commercial Industrial Energy Efficiency Program group (CIEEP) prior to submission into DSMt, where the customer information and incentive levels are validated by DSM T&R. The custom project files, including all the supporting documents are retained in the AIMS application.
Residential ESKs and Programmable Thermostat Offerings	Customers complete an application for an ESK kit and/or a free programmable thermostat on the Union Gas website.[1] Customers can also receive an ESK kit via door-to-door delivery or from an HVAC pick-up depot; in these instances the service provider and customer complete a tracking form onsite and the service provider/HVAC submits the forms to DSM T&R for processing. A final delivery option is via direct mail bill inserts where the customer completes a coupon for an ESK and/or a programmable thermostat and submits this coupon directly to DSM T&R. The applications are verified for completeness and eligibility as per Union's QA protocol by DSM T&R and entered accordingly.
Low Income HWP Offering	Delivery Agents submit a workplan to the Low Income marketing team. The marketing team reviews all of the documents for accuracy and completion and submits a final tracking sheet to DSM T&R for entry into DSMt. The applications are verified for completeness and eligibility as per Union's QA protocol by DSM T&R and entered accordingly.
Low Income Affordable Housing Conservation Offering	The data collection method for this offering is the same as for C/I Prescriptive and Quasi-Prescriptive Offering & C/I Custom Offerings.
Residential HRR Offering	Delivery Agents submit a workplan to the Residential marketing team. The marketing team reviews all of the documents for accuracy and completion and submits a final tracking sheet to DSM T&R for entry into DSMt. The applications are verified for completeness and eligibility as per Union's QA protocol by DSM T&R and entered accordingly.

Quality Assurance Protocol

[1] The energy conservation webpage can be accessed at http://www.uniongas.com/residential/save-money-energy/rebates-promotions

Union Gas has QA protocol that ensures that data entered into DSMt meets the rigour required to accurately track program participation and eligibility requirements, as well as calculate resource savings, LRAM amounts, customer incentives and company DSM incentives. All applications are screened for completeness and accuracy by the DSM T&R team. Each incentive payment is also reviewed and approved by the DSM T&R Manager to ensure it falls within the guidelines of each program. The following is a list of items verified as part of Union's tracking system QA process:

- Is the customer a valid Union Gas customer?
- Is the customer's application or project claim a duplicate of an existing entry?
- Are the correct program and program offering selected?
- Is customer information (name, address, phone number, account number, account status) to Banner complete?
- Does customer meet program and incentive eligibility criteria?
- Does the measure or project type meet program and incentive eligibility requirements?
- Is the number of installed measures correctly captured?
- Are measure details sufficient to calculate TRC, LRAM, customer incentives and DSM incentives?
- Are the project description and basecase adequately captured in the database?
- Is the measure eligible upon the basis of commission or application date?
- Are all required data fields populated?
- Are the checklists complete and all appropriate documentation for custom projects attached to the AIMS project?

Customers and measures that are identified as not being eligible for any reason continue to be tracked in DSMt with a Does Not Qualify (DNQ) demarcation. An email is sent to the Account Managers notifying them that their application has been disqualified for follow-up with a customer.

Appendix G – Final Report Following an Impact Evaluation of the Union Gas ESK Residential Program: Door-to-Door Drop-off Initiative 2014

Final Report Following
An Impact Evaluation of the Union Gas
ESK Residential Program:
Door-to-Door Drop-off Initiative 2014

Introduction

This Report follows our administration of a telephone survey involving householders who received an Energy Savings Kit (ESK) in conjunction with Union Gas' ESK—Door-to-Door Drop-off Initiative.

Our firm conducted this Impact Evaluation in January and February 2015, employing the methodology outlined on Page 2 of this Report and information in Tracking Sheets collected by Union Gas. Comprising a separate Union Gas database, the tracking sheet files contain customer information (name, address & phone number), program identifier and delivery information re products/measures.

The **key objectives** for this research project are:

- To validate customers' awareness of the measures/products received in the kit and determine the measures that were actually installed and remain installed.

- To determine customers' usage habits with respect to the measures installed, as well as their satisfaction with the kit and the products they received.

This research project has been conducted according to generally accepted guidelines designed to ensure objectivity and personal confidentiality. Research-gathering procedures have yielded statistically valid results. We are confident our analysis of findings represents and interprets accurately the views and perspectives of respondents, who were co-operative and forthright in sharing information with us.

In submitting this report, we wish to express our appreciation to the staff of Union Gas for their active participation and support during the project. We particularly appreciate the assistance provided internally by Erin Dunlop, Analyst, DSM Research & Evaluation, who served as Project Coordinator.

Respectfully submitted by:

Ralph Beslin

Ralph Beslin, ABC
President

Methodology for the ESK Program Impact Evaluation: Door-to-Door Drop-off Initiative

Telephone Surveying of End-Users

Random selection techniques were used to create a survey sample from files within Union Gas databases containing approximately 33,000 Tracking Sheet records submitted by Union Gas representatives (technicians). Controls were applied and monitored to ensure appropriate representation of segments within the customer base. Segmentation criteria included: city (area code) and age group of the kit recipients.

We employed a survey instrument approximately 7 minutes in length. This was administered to randomly selected end-users—all of whom were qualified as kit recipients—within a survey population comprised of customers who received Energy Savings Kits during a front-door visit by a Union Gas representative (technician) in 2014.

A total of 165 survey completions was achieved, which was the target number set for this impact evaluation. The number of completions results in a high level of confidence in the findings: 99% ± 10%.

Readers are encouraged to consult the survey instrument for exact wording of questions and response options.

End-User Response Groups Profile: ESK-Residential-Door-to-Door Drop-off Impact Evaluation re 2014 Initiative

Total Completions = 165

Distribution Channel	Total completions
Visit by UG rep (technician) to front door	165 (100%)

Area Code = # (%)	Age Group = # (%)
416/647 = 15 (9%)	18-34 = 31 (19%)
519/226 = 60 (36%)	35-44 = 63 (38%)
905/289 = 85 (52%)	45-54 = 38 (23%)
Other = 5 (3%)	55-64 = 21 (13%)
	65+ = 12 (7%)

Executive Summary

Objective: Awareness & Installation of Products Received

- Information in the Union Gas database regarding receipt of the kit was confirmed: All respondents received the kit at home from a Union Gas representative (technician); and all verified the site/address of the front-door visit. In addition, 100% of total respondents verified that they have a natural gas water heater in their home.
- Information related to individual products received was verified as extremely accurate for all products: Showerhead (100%), kitchen faucet aerator (96%), bathroom faucet aerator (91%) and pipe wrap insulation (100%).
- Regarding installation of individual products, more than 70% of total respondents indicated they had installed each of the four products: Showerhead (79%), kitchen faucet aerator (72%), bathroom faucet aerator (81%) and pipe wrap insulation (95%). Verification rates from 95% - 100% strongly indicate that once installed, products remain installed in the home.

Objective: Customers' Usage Habits & Satisfaction

- Approximately one-third (31%) of respondents who indicated the showerhead item is still installed indicated all of the showering done in their home is now done under the new showerhead. Additionally, almost two-thirds (62%) indicated about half is done under the new showerhead.
- Almost all (94%) respondents indicated they are satisfied with the kit they received, including 38% who indicated they are very satisfied.
- Almost all (99%) respondents indicated they are satisfied with the encounter with the Union Gas representative (technician) who delivered the kit, including 47% who indicated they are very satisfied.

ESK-Residential-Door-to-Door Drop-off Research Findings
Findings re Awareness & Installation of Products Received

Findings related to Project Objective:

- **To validate consumers' awareness of the measures/products received in the kit and determine the measures that were actually installed and remain installed.**

Verification of Consumers' Awareness and Installation of Products Received (Qs #1-7 & 9a)

D2D-1 Information regarding receipt of the kit was verified by 100% of total respondents. (Q#1)

- Ownership of a natural gas water heater was verified by 100% of total respondents. (Q#4)
- Approximately 41% of total respondents indicated they used the $25 Programmable Thermostat Rebate Coupon included in the ESK package. (Q#9a)
- Regarding individual products in the kit, verification was as noted in the following table (Q#5)

Table 1 **ESK-Residential-Door-to-Door Drop-off: Products Verified Received in 2014** **(Total = 165 completions)**	**Column A Respondents: # Verified—Received**	**Column B Respondents: Total # survey completions**	**Column C Respondents: % Verified—Received**
Energy-efficient Showerhead	165	165	100%
Kitchen Faucet Aerator	158	165	96%
Bathroom Faucet Aerator	150	165	91%
Pipe Wrap Insulation	165	165	100%
$25 Programmable Thermostat Rebate Coupon	125	165	76%
Hot Water Handbook (Installation Instructions)	150	165	91%
	Yes	**No**	**No response**
$25 Programmable Thermostat Rebate Coupon Used in 2014?	67 (41%)	58 (35%)	40 (24%)
Do you have a natural gas water heater?	165 (100%)	0 (0%)	0 (0%)

D2D-2 Information related to the home address of the recipient of the kit was verified as extremely accurate. (Q#3)

- In response to our request for verification regarding the site address, 100% of respondents indicated the Tracking Sheet information was correct.

D2D-3 All (100%) respondents indicated they received the kit during a front-door visit by a Union Gas representative/technician. (Q#2)

D2D-4 More than 70% of total respondents indicated they had installed the products they received.

In Column D note that verification rates ranging from 95-100% indicate the once installed, the products remain installed. (Qs#6 & 7)

Table 2 ESK-Residential-Door-to-Door Drop-off: Products Verified Installed in 2014 (Total = 165 completions)	**Column A** **Respondents: # Verified—Installed**	**Column B** **Respondents: % Verified—Installed** ***(Base=165)***	**Column C** **Respondents: # Verified—Still Installed**	**Column D** **Respondents: % Verified—Still Installed** ***(Base=# in Col A)***
Energy-efficient Showerhead	131	79%	130	99%
Kitchen Faucet Aerator	119	72%	113	95%
Bathroom Faucet Aerator	133	81%	132	99%
Pipe Wrap Insulation	156	95%	156	100%

ESK—Residential-Door-to-Door Drop-off Research Findings
Findings re Customers' Usage Habits & Satisfaction

Findings related to Project Objective:

- **To determine customers' usage habits with respect to the measures installed, as well as their satisfaction with the kit and the products they received**

Verification of Usage Habits re Installed Products and Satisfaction Level (Qs# 8, 14 & 15)

D2D-5 Regarding the Energy-efficient Showerhead, a specific question regarding showering was asked to respondents (Total=130) who indicated this is still installed. (Q#8)

The following findings are noted:

- Almost one-third (31%) of respondents whose showerhead is still installed indicated all of the showering in their home now is done under this new showerhead. Additionally, almost two-thirds (62%) indicated about half of the showering in their home now is done under a new showerhead.

Table 3 **ESK-Door-to-Door Drop-off** **Showerhead Product installed in 2014** **(Total = 165 completions)**	A. Respondents: # Verified—Installed	**B. Respondents: # Verified—Still Installed**	
Energy-efficient Showerhead	131	**130**	*(Base = 130)*
Of all the showering done in your home, how much is done under the New Showerhead? (# & % of total still installed: Col B)		All (100%) = 40 Most (75%+) = 0 Half (50%) = 81 1/3 (30%) or less = 9 None =0	All (100%) = 31% Most (75%+) = 0% Half (50%) = 62% 1/3 (30%) or less= 7% None = 0%

D2D-6 Regarding level of satisfaction with the kit, almost all (94%) respondents indicated they are satisfied with the kit and the products they received, including 38% who are very satisfied. (Q#14)

D2D-7 Regarding level of satisfaction with the encounter with the Union Gas representative (technician) who delivered the kit, almost all (99%) respondents indicated they are satisfied, including 47% who are very satisfied. (Q#15)

Appendix H – Final Report Following an Impact Evaluation of the Union Gas ESK Residential Program Pull Initiative 2014

Final Report Following
An Impact Evaluation of the Union Gas
ESK—Residential Program:
Pull Initiative 2014

Introduction

This Report follows our administration of a telephone survey involving customers who received an Energy Savings Kit (ESK) as a result of a request by coupon or via the Union Gas website or picking up a kit at a designated depot, in conjunction with Union Gas' ESK Residential-Pull Initiative.

Our firm conducted this Residential-Pull Impact Evaluation in Dec 2014/Jan 2015, employing the methodology outlined on Page 2 in this Report and information in Tracking Sheets collected by Union Gas. Comprising a separate Union Gas database, the tracking sheet files contain customer information (name, address & phone number), program identifier and delivery information re products/measures.

The **key objectives** for this research project are:

- To validate customers' awareness of the measures/products received in the kit and determine the measures that were actually installed and remain installed

- To determine customers' usage habits with respect to the measures installed, as well as their satisfaction with the kit and the products they received.

This research project has been conducted according to generally accepted guidelines designed to ensure objectivity and personal confidentiality. Research-gathering procedures have yielded statistically valid results. We are confident our analysis of findings represents and interprets accurately the views and perspectives of respondents, who were co-operative and forthright in sharing information with us.

In submitting this report, we wish to express our appreciation to the staff of Union Gas for their active participation and support during the project. We particularly appreciate the assistance provided internally by Erin Dunlop, Analyst, DSM Research & Evaluation, who served as Project Coordinator.

Respectfully submitted by:

Ralph Beslin

Ralph Beslin, ABC
President

Methodology for the ESK Program Impact Evaluation: Residential-Pull Initiative

Telephone Surveying of End-Users

Random selection techniques were used to create a survey sample from a population encompassing approximately 10,000 Union Gas Tracking Sheet records. Controls were applied and monitored to ensure appropriate representation of segments within the customer base. Segmentation criteria included area code; distribution channel (i.e. ordered kit directly from Union Gas website, via coupon or picked it up at a designated pick-up depot); and age group of the kit recipients.

We used a survey instrument approximately 7 minutes in length. It was administered to randomly selected end-users—all of whom were qualified as kit recipients—within a survey population of customers who received Energy Savings Kits from Union Gas in 2014.

A total of 165 survey completions was achieved, representing the target number (165) set for this impact evaluation. The number of completions results in a high level of confidence in the findings: 99% ± 10%.

Readers are encouraged to consult the survey instrument for exact wording of questions and responses.

End-User Response Groups Profile: ESK-Residential-Pull Impact Evaluation re 2014 Initiative

Total completions = 165

Distribution Channel	*# (%)*
Requested kit via Union Gas Website	100 (61%)
Picked kit up from a local pick-up depot	30 (18%)
Requested a kit by using a Coupon	35 (21%)
Area Code = # (%)	Age Group = # (%)
416/647 = 10 (6%)	18 to 34 = 36 (22%)
519/226 = 85 (52%)	35 to 44 = 25 (15%)
613 = 15 (9%)	45 to 54 = 55 (33%)
705 = 15 (9%)	55 to 64 = 22 (13%)
807 = 5 (3%)	65 + = 27(16%)
905/289 = 35 (21%)	

Executive Summary

Objective: Awareness & Installation of Products Received

- Information in the Union Gas database regarding receipt of the kit (100%) and address of the recipients (100%) was confirmed. In addition, all respondents (100%) verified that they have a natural gas water heater in their home.

- Information related to individual products received was verified as extremely accurate for the showerhead (100%); kitchen faucet aerator (96%); bathroom faucet aerator (91%) and pipe wrap insulation (100%).

- Regarding installation of individual products, more than three-quarters of respondents indicated they had installed each of the four products they received: Showerhead (84%), kitchen faucet aerator (78%), bathroom faucet aerator (82%) and pipe wrap insulation (98%). Verification rates from 91% - 100% strongly indicate that once installed, products remain installed in the home.

Objective: Customers' Usage Habits & Satisfaction

- Some 33% of respondents who indicated the showerhead item is still installed also indicated all of the showering done in their home is now done under the new showerhead. Additionally, 4% indicated most (more than three-quarters) is done under the new showerhead; and approximately 59% indicated about half is done under the new showerhead.
- Almost all (98%) respondents indicated they are satisfied with the kit they received, including 44% who indicated they are very to extremely satisfied.

ESK—Residential-Pull Research Findings

Findings re Awareness & Installation of Products Received

Findings related to Project Objective:

- **To validate customers' awareness of the measures/products received in the kit and determine the measures that were actually installed and remain installed**

Verification of Customers' Awareness and Installation of Products Received (Qs#1-6, 8a & 17)

PLL-1 Information re receipt of the kit was verified by 100% of total respondents. (Q#1)

- Ownership of a natural gas water heater, a requirement for receipt of the kit, was verified by 100% of respondents. (Q#3)
- A majority (55%) of total respondents indicated they had used the Programmable Thermostat Rebate Coupon that was included in the package. (Q#8a)
- Regarding individual products in the kit, verification was as noted in the following chart (Q#4):

Table 1 ESK-Residential-Pull: Products Verified Received in 2014 (Total = 165 completions)	Column A Respondents: # Verified— Received	Column B Respondents: Total # survey completions	Column C Respondents: % Verified— Received
Energy-efficient Showerhead	165	165	100%
Kitchen Faucet Aerator	158	165	96%
Bathroom Faucet Aerator	150	165	91%
Pipe Wrap Insulation	165	165	100%
$25 Programmable Thermostat Rebate Coupon	137	165	83%
	Yes	**No**	**No response**
$25 Programmable Thermostat Rebate Coupon Used in 2014?	**91 (55%)**	**46 (28%)**	**28 (17%)**
Do you have a natural gas water heater?	165 (100%)	0 (0%)	0 (0%)

PLL-2 Information related to home address of the recipient of the kit was verified as extremely accurate (Q#2).

- In response to our request for verification of the customer's address identified on the Tracking Sheet, all (100%) respondents indicated the information was correct.

PLL-3 Information related to how respondents received the kit was verified as accurate. (Q#17)

- Of the 165 respondents, all (100%) indicated they received the kit via the channel identified in the Union Gas database.

PLL-4 Of the four products in the kit that require installation, all of the products were installed by more than three-quarters (78-98%) of respondents who received the item, as noted in the following table.

In Column D, note that verification rates ranging from 91% to 100% strongly indicate that once installed, the products remain installed in the home. (Qs#5&6)

Table 2 ESK-Residential-Pull: Products Verified Installed in 2014 (Total = 165 completions)	**Column A** **Respondents: # Verified— Installed**	**Column B** **Respondents: % Verified— Installed** *(Base=165)*	**Column C** **Respondents: # Verified— Still Installed**	**Column D** **Respondents: % Verified— Still Installed** *(Base=# in Col A)*
Energy-efficient Showerhead	139	84%	137	99%
Kitchen Faucet Aerator	128	78%	117	91%
Bathroom Faucet Aerator	135	82%	134	99%
Pipe Wrap Insulation	161	98%	161	100%

ESK—Residential-Pull Research Findings
Findings re Customers' Usage Habits & Satisfaction

Findings related to Project Objective:

- **To determine customers' usage habits with respect to the measures installed, as well as their satisfaction with the kit and the products they received**

Verification of Usage Habits re Installed Products and Satisfaction Level (Qs# 7 & 13)

PLL-5 With respect to the Showerhead, a specific question regarding their showering was asked to those respondents (Total =137) who verified this item is still installed in their home. (Q#7)

The following findings are noted:

- Some 33% of respondents whose showerhead item is still installed indicated all of the showering done in their home is now done under the new showerhead. Additionally, 4% indicated most (more than three quarters) is done under the new showerhead; and approximately 59% indicated about half is done under the new showerhead.

Table 3 **ESK—Residential-Pull** **Showerhead Product installed in 2014**	A. Respondents: # Verified—Installed	**B. Respondents: # Verified—Still Installed**	
Energy-efficient Showerhead	139	137	*(Base = 137)*
Of all the showering done in your home, how much is done under the New Showerhead? (# & % of total still installed—Col B)		All (100%) = 45 Most (75%+) = 5 Half (50%) =81 1/3(30%) or less = 6 Don't know = 0	All (100%) = 33% Most (75%+) = 4% Half (50%) = 59% 1/3(30%) or less=4% Don't know = 0%

PLL-6 Almost all (98%) respondents indicated they are satisfied with the kit they received, including 44% who indicated they are very to extremely satisfied. (Q#13)

Appendix I – Final Report Following an Impact Evaluation of the Union Gas ESK Residential Program Push Initiative 2014

Final Report Following
An Impact Evaluation of the Union Gas
ESK—Residential Program:
Push Initiative 2014

Introduction

This Report follows our administration of a telephone survey involving customers who received an Energy Savings Kit (ESK) that was provided by an HVAC partner in conjunction with Union Gas' ESK Residential-Push Initiative.

Our firm conducted this Residential-Push Impact Evaluation in Dec 2014/Jan 2015, employing the methodology outlined on Page 2 in this Report and information in Tracking Sheets collected by Union Gas. Comprising a separate Union Gas database, the tracking sheet files contain customer information (name, address & phone number), program identifier and delivery information re products/measures.

The **key objectives** for this research project are:

- To validate customers' awareness of the measures/products received in the kit and determine the measures that were actually installed and remain installed.

- To determine customers' usage habits with respect to the measures installed, as well as their satisfaction with the kit and the products they received.

This research project has been conducted according to generally accepted guidelines designed to ensure objectivity and personal confidentiality. Research-gathering procedures have yielded statistically valid results. We are confident our analysis of findings represents and interprets accurately the views and perspectives of respondents, who were co-operative and forthright in sharing information with us.

In submitting this report, we wish to express our appreciation to the staff of Union Gas for their active participation and support during the project. We particularly appreciate the assistance provided internally by Erin Dunlop, Analyst, DSM Research & Evaluation, who served as Project Coordinator.

Respectfully submitted by:

Ralph Beslin

Ralph Beslin, ABC
President

Telephone Surveying of End-Users

Random selection techniques were used to create a survey sample from a population encompassing approximately 2,300 Union Gas Tracking Sheet records. Controls were applied and monitored to ensure appropriate representation of segments within the customer base. Segmentation criteria included area code; delivery with/without an incentive of twenty dollars provided to HVAC partners; and age group of the kit recipients.

We used a survey instrument approximately 7 minutes in length. It was administered to randomly selected end-users—all of whom were qualified as kit recipients—within a survey population of customers who received Energy Savings Kits from Union Gas in 2014.

A total of 165 survey completions was achieved, representing the target number (165) set for this impact evaluation. The number of completions results in a high level of confidence in the findings: 99% ± 10%.

Readers are encouraged to consult the survey instrument for exact wording of questions and responses.

End-User Response Groups Profile: ESK-Residential-Push Impact Evaluation re 2014 Initiative *Total completions = 165*	
Distribution Channel	# (%)
Received kit from HVAC partners who received a $20 Incentive	80 (49%)
Received kit from HVAC partners who did not receive a $20 Incentive	85 (51%)
Area Code = # (%)	Age Group = # (%)
416/647 = 5 (3%)	18 to 34 = 38 (23%)
519/226 = 110 (67%)	35 to 44 = 24 (15%)
613 = 5 (3%)	45 to 54 = 50 (30%)

705 = 20 (12%)	55 to 64 = 26 (16%)
807 = 5 (3%)	65 + = 27(16%)
905/289 = 20 (12%)	

Executive Summary

Objective: Awareness & Installation of Products Received

- Information in the Union Gas database regarding receipt of the kit (100%) and address of the recipients (100%) was confirmed. In addition, all respondents (100%) verified that they have a natural gas water heater in their home.

- Information related to individual products received was verified as extremely accurate for the showerhead (99%); kitchen faucet aerator (95%); bathroom faucet aerator (90%) and pipe wrap insulation (100%).

- Regarding installation of individual products, at least three-quarters of respondents indicated they had installed each of the four products they received: Showerhead (76%), kitchen faucet aerator (74%), bathroom faucet aerator (79%) and pipe wrap insulation (96%). Verification rates from 89% - 100% strongly indicate that once installed, products remain installed in the home.

Objective: Customers' Usage Habits & Satisfaction

- Some 33% of respondents who indicated the showerhead item is still installed also indicated all of the showering done in their home is now done under the new showerhead. Additionally, 24% indicated most (more than three-quarters) is done under the new showerhead; and approximately 41% indicated about half is done under the new showerhead.
- Almost all (95%) respondents indicated they are satisfied with the kit they received, including 34% who indicated they are very to extremely satisfied.

ESK—Residential-Push Research Findings
Findings re Awareness & Installation of Products Received

Findings related to Project Objective:

- **To validate customers' awareness of the measures/products received in the kit and determine the products that were actually installed and remain installed**

Verification of Customers' Awareness and Installation of Products Received (Qs#1-6, 8a & 17)

PSH-1 Information re receipt of the kit was verified by 100% of total respondents. (Q#1)

- Ownership of a natural gas water heater, a requirement for receipt of the kit, was verified by 100% of respondents. (Q#3)
- About one-third (36%) indicated they had used the Programmable Thermostat Rebate Coupon that was included in the package. (Q#8a)
- Regarding individual products in the kit, verification was as noted in the following chart (Q#4):

Table 1 **ESK-Residential-Push:** ***Products Verified Received in 2014*** ***(Total = 165 completions)***	**Column A Respondents: # Verified—Received**	**Column B Respondents: Total # survey completions**	**Column C Respondents: % Verified—Received**
Energy-efficient Showerhead	164	165	99%
Kitchen Faucet Aerator	156	165	95%
Bathroom Faucet Aerator	148	165	90%
Pipe Wrap Insulation	165	165	100%
$25 Programmable Thermostat Rebate Coupon	118	165	72%
	Yes	**No**	**No response**
$25 Programmable Thermostat Rebate Coupon Used in 2014?	60 (36%)	56 (34%)	49 (30%)
Do you have a natural gas water heater?	165 (100%)	0 (0%)	0 (0%)

PSH-2 Information related to home address of the recipient of the kit was verified as extremely accurate (Q#2).

- In response to our request for verification of the customer's address identified on the Tracking Sheet, all (100%) respondents indicated the information was correct.

PSH-3 Information related to how respondents received the kit was verified as accurate. (Q#17)

- Of the 165 respondents, all (100%) indicated they received the kit via the delivery channel identified in the Union Gas database.

PSH-4 Of the four products in the kit that require installation, all of the individual products were installed by at least three-quarters (74-96%) of respondents, as noted in the following table.

In Column D, note that verification rates ranging from 89% to 100% strongly indicate that once installed, the products remain installed in the home. (Qs#5&6)

Table 2 ESK-Residential-Push: ***Products Verified Installed in 2014*** *(Total = 165 completions)*	**Column A** **Respondents: # Verified— Installed**	**Column B** **Respondents: % Verified— Installed** *(Base=165)*	**Column C** **Respondents: # Verified— Still Installed**	**Column D** **Respondents: % Verified— Still Installed** *(Base=# in Col A)*
Energy-efficient Showerhead	126	76%	124	98%
Kitchen Faucet Aerator	122	74%	108	89%
Bathroom Faucet Aerator	131	79%	130	99%
Pipe Wrap Insulation	159	96%	159	100%

ESK—Residential-Push Research Findings
Findings re Customers' Usage Habits & Satisfaction

Findings related to Project Objective:

- **To determine customers' usage habits with respect to the measures installed, as well as their satisfaction with the kit and the products they received**

Verification of Usage Habits re Installed Products and Satisfaction Level (Qs# 7 & 13)

PSH-5 With respect to the Showerhead, a specific question regarding their showering was asked to those respondents (Total =124) who verified this item is still installed in their home. (Q#7)

The following findings are noted:

- Some 33% of respondents whose showerhead item is still installed indicated all of the showering done in their home is now done under the new showerhead. Additionally, 24% indicated most (more than three quarters) is done under the new showerhead; and approximately 41% indicated about half is done under the new showerhead.

Table 3 ESK—Residential-Push *Showerhead Product installed in 2014*	A. Respondents: # Verified—Installed	**B. Respondents: # Verified—Still Installed**	
Energy-efficient Showerhead	126	124	*(Base = 124)*
Of all the showering done in your home, how much is done under the New Showerhead? (# & % of total still installed—Col B)		All (100%) = 41 Most (75%+) =30 Half (50%) =51 1/3(30%) or less = 2 Don't know = 0	All (100%) = 33% Most (75%+) = 24% Half (50%) = 41% 1/3(30%) or less=2% Don't know = 0%

PSH-6 Almost all (95%) respondents indicated they are satisfied with the kit they received, including approximately 34% who indicated they are very to extremely satisfied. (Q#13)

Appendix J – Final Report Following An Audit of the Union Gas ESK Residential Program - Install Initiative 2012

Final Report Following An Audit of the Union Gas ESK—Residential Program Install Initiative (2012)

Introduction

This Report follows our administration of a survey involving householders who received an Energy Savings Kit (ESK) in conjunction with Union Gas' ESK—Install Initiative. The Initiative offers financial support/incentives to registered Channel Partners to help promote the use of high-efficiency natural gas products and accessories amongst residential customers.

Our firm conducted this Audit in February 2013, employing the methodology outlined on Page 3 of this Report. The primary purpose of this research project was to validate the accuracy of information on Tracking Sheets sent to Union Gas by Partners claiming incentives. Comprising a separate Union Gas database, the tracking sheet files contain customer information (name, address & phone number), program identifier and product/installation information. Installation sites included only residential locations.

Additional objectives for this research project were to understand end-users' knowledge of energy efficiency and their motivations for installing the items, as well as determine their usage habits and satisfaction level regarding the items in the kit.

This research project has been conducted according to generally accepted guidelines designed to ensure objectivity and personal confidentiality. Research-gathering procedures have yielded statistically valid results. We are confident our analysis of findings represents and interprets accurately the views and perspectives of respondents, who were co-operative and forthright in sharing information with us.

In submitting this report, we wish to express our appreciation to the staff of Union Gas for their active participation and support during the project. We particularly appreciate the assistance provided internally by Haris Ginis, Analyst, DSM Research & Evaluation, who served as Project Coordinator.

Respectfully submitted by:

Ralph Beslin

Ralph Beslin, ABC
President

Objectives of this ESK—Residential—Install Initiative Audit

The **primary objectives** for this Audit research project were as follows:

1. To validate consumers' awareness of the products received from participating channel partners and determine the products that were actually installed and remain installed.

2. To determine customers' satisfaction with the products in the kit they received and their usage habits with respect to the measures installed

The **secondary objectives** for this Audit research project were as follows:

3. To gauge residential end-users' understanding regarding the benefits of energy- efficient products

4. To determine the factors affecting residential end-users' decision to install the products and who actually installed the products

Methodology for the ESK—Residential—Install Initiative Audit
Telephone Surveying of End-Users

Random selection techniques were used to create a survey sample from files within Union Gas databases containing approximately 150 Tracking Sheet records submitted by registered Channel Partners and Union Gas representatives. Controls were applied and monitored to ensure appropriate representation of segments within the customer base. Segmentation criteria included: region (area code) of the province where the kit was delivered; and a qualifying question was used to ensure the kit was delivered directly by a channel partner (contractor) during a visit to a residence.

We employed a modified version of the survey instrument used in other ESK audits—approximately 7 minutes in length. This was administered to randomly selected end-users—all of whom were qualified as kit recipients—within a survey population comprised of customers who received Energy Savings Kits during a home visit by a contractor. Size and segmentation of the survey population are identified in the chart below. Readers are encouraged to consult the survey instrument for exact wording of questions and response options. *(See questionnaire in the Appendix.)*

A total of 38 survey completions was achieved, representing a satisfactory level of confidence for this audit—approximately one-quarter of the survey population. NB: There were a large number of declines, attributed primarily to lack of time; however, a strong majority of declining respondents confirmed they had received the kit and were very satisfied with items they received.

End-User Response Groups Profile: ESK-Residential-Install Audit re 2012 Initiative *Total Completions = 38*	
Distribution Channel	Total completions
Contractor visit to home	100 (100%)
Area Code	*Age Group*
519 =30 (80%)	*18 - 34 = 2 (5%)*
705 = 2 (5%)	*35 - 44 = 7 (18%)*
905 = 6 (15%)	*45 - 54 = 8 (21%)*
	55 - 64 = 16 (42%)
	65+ = 5 (13%)

Executive Summary

Primary Objective: Awareness & Installation of Products Received

- Information in the Union Gas database regarding receipt of the kit was confirmed [100%]. With respect to respondents who indicated they received the kit at home from a contractor, the site of the visit (100%) was verified as extremely accurate. In addition, 100% of total respondents verified that they have a natural gas water heater in their home.
- Information related to individual products received was verified as extremely accurate for all products: Showerhead (100%), kitchen faucet aerator (97%), bathroom faucet aerator (100%) and pipe wrap (100%).
- Regarding installation of individual products, almost nine in ten respondents indicated they had installed each of the four products: Showerhead (95%), kitchen faucet aerator (89%), bathroom faucet aerator (92%) and pipe wrap (100%). Verification rates from 94% - 100% strongly indicate that once installed, products remain installed in the home.

Objective #2: Customers' Usage Habits with respect to the Measures Installed

- Slightly more than half (54%) of respondents who installed the showerhead item indicated all of the showering done in their home is now done under the new showerhead. Additionally, 3% indicated most (more than three quarters) is done under the new showerhead; and approximately 43% indicated half is done under the new showerhead.

Objective #3: Understanding re Benefits of Energy-Efficient Products

- Almost all (95%) of total respondents indicated they are knowledgeable about energy efficiency in the home, including more than one-third (37%) who indicated very knowledgeable.
- Some 89% indicated they believe high-efficiency heating equipment can play a significant role in saving money on home heating costs; including 29% who said it could be very significant.
- Some 82% of total respondents agreed the products in the kit will help them save money on home energy costs, including 26% who strongly agreed.

Objective #4: Factors Affecting End-Users' Decision to Install Kit Products

- The main reasons end-users decided to install products are to conserve energy, to save money on the heating bill and because of the contractor's advice.
- It appears more likely that the recipient will install the aerators and pipe wrap, while in almost all cases the contractor will install the showerhead.

ESK—Res—Install Research Findings—Section 1:
Findings re Awareness & Installation of Products Received

Findings related to Project Objectives #1 & 2:

To validate consumers' awareness of the products received from participating channel partners and to determine the products that were actually installed / remain installed, as well as usage habits regarding products that are still installed and general satisfaction level with the kit

Verification of Consumers' Awareness, Installation of Products Received and Usage Habits re Products that are Installed (Qs #1, 2 6, 7, 11)

INS-1.1 All (100%) respondents indicated they received the kit at home during a routine visit by a contractor. (Qs#1&2)

- In response to our request for verification regarding the site, 100% of respondents indicated the Tracking Sheet information was correct.

INS-1.2 Information re receipt of the kit was verified by 100% of total respondents. (Q#1) Regarding individual products in the kit, verification was as noted in the following table (Q#3).

- Ownership of a natural gas water heater was verified by 100% of total respondents. Ownership of a natural gas furnace also was verified by 100% of total respondents. (Q#2)

ESK-Residential-Install Audit: Products Received in 2012	Column A Respondents: # Verified—Received	Column B Respondents: Total # survey completions	Column C Respondents: % Verified—Received
Energy-efficient Showerhead	38	38	100%
Kitchen Faucet Aerator	37	38	97%
Bathroom Faucet Aerator	38	38	100%
Pipe Wrap	38	38	100%
	Yes	**No**	**Don't know**
Does your home have a natural gas water heater?	100 (100%)	0 (0%)	0 (0%)

INS-1.3 Almost all total respondents indicated they had installed the products they received. Once installed, the products remain installed. (Qs#6&7)

ESK-Residential-Install **Products installed in 2012 (Total = 38 completions)**	**A. Respondents: # Verified—Installed**	**B. Respondents: % Verified—Installed** *(Base=38)*	**C. Respondents: # Verified—Still Installed**	**D. Respondents: % Verified—Still Installed** *(Base=# in A)*
Energy-efficient Showerhead	36	95%	35	97%
Kitchen Faucet Aerator	33	89%	31	94%
Bathroom Faucet Aerator	35	92%	35	100%
Pipe Wrap	38	100%	38	100%

INS-1.4 Regarding level of satisfaction with the kit, all (100%) respondents indicated they are satisfied with the kit and the products they received, including 79% who are very or extremely satisfied. (Q#11)

ESK—Residential-Install Initiative Research Findings—Section 2: Findings re End-User Understanding of the Benefits of Energy-Efficient Products and Energy Efficiency

Findings related to Project Objective #3:

To gauge end-users' understanding regarding the benefits of energy-efficient products

Measurement of ESK—Residential-Install End-Users' Knowledge Level re Energy-Efficient Products (Qs #4, 5, 12, 13)

INS-2.1 Almost all respondents indicated the furnace in their home is a high-efficiency model. (Q#5)

- Some 92% of total respondents verified their furnace is a high-efficiency model.

INS-2.2 Respondents appear to be knowledgeable about energy efficiency in the home. (Qs#4, 12)

- Almost 95% of total respondents indicated they are knowledgeable about energy efficiency in the home, including 37% who indicated they are very knowledgeable.

INS-2.3 Respondents displayed indecisiveness as to whether higher-efficiency heating products can play a significant role in saving money on home heating costs (Q#4).

- Some 89% of total respondents believe high-efficiency heating products can play a significant role in saving money on home heating costs, yet only 29% said it could be very significant.
- Some 82% of total respondents agreed that the products they received in the kit will help to save money on home energy costs; yet only 26% strongly agreed.

INS-2.4 With respect to other types of incentives to encourage energy efficiency in homes, respondents who installed items in this kit indicated the following would be useful to them: (Q#13—aided)

- Insulation products = 20 (53%)
- Weather-stripping products = 12 (32%)
- Rebates after purchasing high-efficiency products = 3 (8%)
- None of the above / No response = 3 (8%)

ESK—Residential-Install Research Findings—Section 3: Findings re Factors Affecting End-Users' Decision to Install & Usage Habits re Installed Products

Findings related to Project Objectives #2 & 4:

To determine the factors affecting residential end-users' decision to install the products, who actually installed them and end-users' usage habits regarding products that are still installed

Identification of Factors Affecting End-Users' Installation Decision and Usage Habits re Products that are Still Installed (Qs# 6-10)

INS-3.1 Almost all respondents indicated they had installed the products they received. Once installed, the products remain installed. (Qs#6&7)

ESK-Residential- Install Products installed in 2012 (Total = 38 completions)	A. Respondents: # Verified—Installed	B. Respondents: % Verified—Installed *(Base=38)*	C. Respondents: # Verified—Still Installed	D. Respondents: % Verified—Still Installed *(Base=# in A)*
Energy-efficient Showerhead	36	95%	35	97%
Kitchen Faucet Aerator	33	89%	31	94%
Bathroom Faucet Aerator	35	92%	35	100%
Pipe Wrap	38	100%	38	100%

INS-3.2 Regarding installation of products, it was more likely that the respondent or someone else in the household installed the aerators and pipe wrap, while in almost all cases the contractor installed the showerhead. (Q#7)

ESK-Residential-Install Products Installed in 2012	Column A Products: Total # Verified—Installed	Column B Products: #(%) Installed by respondent *(Base=# in A)*	Column C Products: #(%) Installed by other in household *(Base=# in A)*	Column D Products: #(%) Installed by Contractor *(Base=# in A)*
Energy-efficient Showerhead	36	2 (6%)	4 (11%)	30 (83%)
Kitchen Faucet Aerator	33	24 (73%)	4 (12%)	5 (15%)
Bathroom Faucet Aerator	35	26 (74%)	4 (11%)	5 (14%)
Pipe Wrap	38	29 (76%)	4 (11%)	5 (13%)

NB: Three reasons were cited by respondents who did not install products they received: The products were not compatible (i.e. did not fit) or they have no time now but do plan to install the products or they are currently renovating their home and plan to install the products eventually.

INS-3.3 The following table contains the complete list of factors presented to respondents, as well as the percentages of total respondents who, on an aided basis, identified a factor as their main reason for installing some or all of the items in the kit (Q#10):

ESK-Residential-Install 2012 Audit: Main Reason for Installing Product(s)—Aided	Main Reason (% of total respondents who installed items—Cite one only)
To conserve energy/Use energy wisely	16%
To save money on my heating bill	18%
Recommended by relatives/friends	0%
Because of the contractor's advice	34%
To conserve energy/use energy wisely AND to save money on my heating bill*	32%
** Unaided—cited both combined as main reason*	

INS-3.4 Specifically regarding the Energy-efficient Showerhead, two questions were asked to respondents who received this item. (Qs#8-9) The following findings are noted:

- Most respondents (61%) who received the showerhead(s) indicated they have two showers in their home; the remainder indicated they have one shower (34%) or three showers (5%).
- Approximately half (54%) of total respondents who received showerhead(s) indicated all of the showering in their home now is done under a new showerhead. Slightly less than half of total respondents indicated that most (3%) or about half (43%) of the showering in their home now is done under a new showerhead.

Table 2: ESK-Install Products installed in 2012 (Total = 38 completions)	A. Respondents: # Verified—Installed	B. Respondents: % Verified—Installed *(Base=38)*	C. Respondents: # Verified—Still Installed	D. Respondents: % Verified—Still Installed *(Base=# in Col A)*
Energy-efficient Showerhead	36	95%	35	97%
Of all the showering done in your home, how much is done under a New Showerhead? (# & % of total still installed—Col C)			*All (100%) = 19 Most (75%+) = 1 Half (50%) =15 1/3 (30%) or less = 0 None =0*	*NB: Base = 35 (Col C) All (100%) = 54% Most (75%+) = 3% Half (50%) = 43% 1/3 (30%) or less= 0% None = 0%*

Appendix K – Final Report Following An Audit of the Union Gas ESK Helping Homes Conserve (HHC) Program – Low Income Initiative 2012

Final Report Following An Audit of the Union Gas ESK—Helping Homes Conserve—HHC—Program Low-income Initiative 2012

Introduction

This Report follows our administration of a survey involving low-income householders who received an Energy Savings Kit (ESK) in conjunction with Union Gas' ESK Helping Homes Conserve Program—Low-income Initiative. The Initiative offers financial support/incentives to registered Channel Partners to help promote the use of high-efficiency natural gas products and accessories amongst residential customers.

Our firm conducted this Audit in two waves in Nov/Dec.12, employing the methodology outlined on Page 3 of this Report. The primary purpose of this research project was to validate the accuracy of information on Tracking Sheets sent to Union Gas by Partners claiming incentives. Comprising a separate Union Gas database, the tracking sheet files contain low-income customer information (name, address & phone number), program identifier and product/installation information. Installation sites included only residential locations.

Additional objectives for this research project were to understand end-users' knowledge of energy efficiency and their motivations for installing the items.

This research project has been conducted according to generally accepted guidelines designed to ensure objectivity and personal confidentiality. Research-gathering procedures have yielded statistically valid results. We are confident our analysis of findings represents and interprets accurately the views and perspectives of respondents, who were co-operative and forthright in sharing information with us.

In submitting this report, we wish to express our appreciation to the staff of Union Gas for their active participation and support during the project. We particularly appreciate the assistance provided internally by Haris Ginis, Analyst, DSM Research & Evaluation, who served as Project Coordinator.

Respectfully submitted by:

Ralph Beslin

Ralph Beslin, ABC
President

Objectives of this ESK—Residential—HHC Program: Low-income Initiative Audit

The **primary objectives** for this Audit research project were as follows:

1. To validate consumers' awareness of the products received from participating channel partners and determine the products that were actually installed and remain installed.

2. To determine customers' usage habits with respect to the measures installed

The **secondary objectives** for this Audit research project were as follows:

3. To gauge residential end-users' understanding regarding the benefits of energy- efficient products

4. To determine the factors affecting residential end-users' decision to install the products and who actually installed the products

Methodology for the ESK—Residential—HHC: Low-income Initiative Audit Telephone Surveying of End-Users

Random selection techniques were used to create a survey sample from files within Union Gas databases containing approximately 7,500 Tracking Sheet records submitted by registered Channel Partners and Union Gas representatives. Controls were applied and monitored to ensure appropriate representation of segments within the customer base. Segmentation criteria included: region (area code) of the province where the kit was delivered and whether the kit was delivered directly by a channel partner during a visit to a residence or as a result of an installation booking after seeing a brochure.

We employed a modified version of the survey instrument used in the previous year's audit—approximately 7 minutes in length. This was administered to randomly selected end-users—all of whom were qualified as kit recipients—within a survey population comprised of customers who received Energy Savings Kits during a home visit by a contractor, during a door-to-door delivery, or as a result of a booking after seeing a brochure. Size and segmentation of the survey population are identified in the chart below.

A total of 165 survey completions was achieved, the target number set for this audit. The number of completions results in a high level of confidence in the findings: 99% ± 10%, the target level set for this survey.

Readers are encouraged to consult the survey instrument for exact wording of questions and response options. *(See questionnaire in the Appendix.)*

End-User Response Groups Profile: ESK-Residential-HHC Low-income Audit re 2012 Initiative *Total Completions = 165*		
Distribution Channel	Total completions	
Contractor visit to home	153 (93%)	
Booking after seeing brochure	12 (7%)	
Area Code	*Type of Dwelling*	*Age of Dwelling*
289 = 12 (7%)	*Detached house = 92 (56%)*	*Less than 10 years = 2 (1%)*
416 = 1 (1%)	*Semi-detached = 40 (24%)*	*10-20 years = 10 (6%)*
519 = 45 (27%)	*Townhouse = 16 (10%)*	*20-30 years = 23 (14%)*
613 = 20 (12%)	*Apt/Condo = 12 (7%)*	*30 -40 years = 33 (20%)*
705 = 10 (6%)	*Duplex = 5 (3%)*	*40-50 years = 71 (43%)*
905 = 77 (47%)	*Own=140 (85%)/ Rent=25 (15%)*	*50+ years = 26 (16%)*

Executive Summary

Primary Objective: Awareness & Installation of Products Received

- Information in the Union Gas database regarding receipt of the kit was confirmed [100%]. With respect to respondents who indicated they received the kit at home from a contractor, the site of the visit (100%) was verified as extremely accurate. In addition, all (100%) of total respondents verified that they have a natural gas water heater in their home.
- Information related to individual products received was verified as extremely accurate for all products: Showerhead (99%), kitchen faucet aerator (95%), bathroom faucet aerator (90%) and pipe wrap (96%).
- Regarding installation of individual products, more than four in five of total respondents indicated they had installed each of the four products: Showerhead (93%), kitchen faucet aerator (85%), bathroom faucet aerator (86%) and pipe wrap (94%). Verification rates from 96% - 100% strongly indicate that once installed, products remain installed in the home.

Objective #2: Customers' Usage Habits with respect to the Measures Installed

- Some 74% of respondents who installed the showerhead item indicated all of the showering done in their home is now done under the new showerhead. Additionally, 2% indicated most (more than three quarters) is done under the new showerhead; and approximately 23% indicated half is done under the new showerhead.

Objective #3: Understanding re Benefits of Energy-Efficient Products

- Some 86% indicated they believe high-efficiency heating equipment can play a significant role in saving money on home heating costs; including 41% who said it could be very significant.
- Respondents appear to be knowledgeable about energy-efficiency in the home, as almost 98% of total respondents indicated they are knowledgeable, including 69% who indicated they are very knowledgeable.
- More than two-thirds (70%) of total respondents indicated the furnace in their home is a high-efficiency model.
- Approximately 90% of total respondents indicated they use weather stripping in their home.

Objective #4: Factors Affecting End-Users' Decision to Install Kit Products

- The main reasons end-users decided to install products are to conserve energy and save money on the heating bill.
- It appears most likely that the recipient will install all items (although in this audit, almost 40% of respondents indicated the contractor installed the showerhead).

ESK—Res—HHC: L-I Initiative Research Findings—Section 1: Findings re Awareness & Installation of Products Received

Findings related to Project Objectives #1 & 2:

To validate consumers' awareness of the products received from participating channel partners and to determine the products that were actually installed / remain installed, as well as usage habits regarding products that are still installed

Verification of Consumers' Awareness, Installation of Products Received and Usage Habits re Products that are Installed (Qs#2, 3, 7)

HHC-1.1 Amongst respondents who received the kit at home, the site of the contractor's visit was verified as extremely accurate (Q#2).

- In response to our request for verification regarding the site, 100% of respondents indicated the Tracking Sheet information was correct.

HHC-1.2 Information re receipt of the kit was verified by 100% of total respondents. (Q#1) Regarding individual products in the kit, verification was as noted in the following table (Q#3).

- Ownership of a natural gas water heater was verified by 100% of total respondents. Ownership of a natural gas furnace was verified by 95% of total respondents. (Q#2)

ESK-Residential-HHC: Low-income Audit: Products Received in 2012	Column A Respondents: # Verified—Received	Column B Respondents: Total # survey completions	Column C Respondents: % Verified—Received
Energy-efficient Showerhead	164	165	99%
Kitchen Faucet Aerator	156	165	95%
Bathroom Faucet Aerator	148	165	90%
Pipe Wrap	158	165	96%
	Yes	**No**	**Don't know**
Do you have a natural gas water heater?	165 (100%)	0 (0%)	0 (0%)

HHC-1.3 Almost all respondents indicated they had installed the products they received. Once installed, the products remain installed. (Q#7)

ESK-Residential HHC: Low-income **Products Installed in 2012** **Total survey completions = 165**	**Column A** **Respondents: # Verified—Installed**	**Column B** **Respondents: % Verified—Installed** *(Base=165)*	**Column C** **Respondents: # Verified—Still Installed**	**Column D** **Respondents: % Verified—Still Installed** ***(Base=# in Col A)***
Energy-efficient Showerhead	153	93%	151	99%
Kitchen Faucet Aerator	140	85%	134	96%
Bathroom Faucet Aerator	142	86%	142	100%
Pipe Wrap	155	94%	155	100%
NB: Amongst respondents who did not install one or more items, the most often cited reasons for non-installation were: item not compatible and plan to install after renovation.				

ESK—Res-HHC: L-I Initiative Research Findings—Section 2: Findings re End-User Understanding of the Benefits of Energy-Efficient Products and Energy Efficiency

Findings related to Project Objective #3:

To gauge end-users' understanding regarding the benefits of energy-efficient products

Measurement of ESK—HHC-LI End-Users' Knowledge Level re Energy-Efficient Products (Qs#4-5, 14-17, 20)

HHC-2.1 Most respondents indicated the furnace in their home is a high-efficiency model. (Q#5)

- Some 70% of total respondents verified their furnace is a high-efficiency model.
- Approximately 90% of total respondents indicated they use weather stripping in their home.
- Only 20% of total respondents indicated they use window film in their home.

HHC-2.2 Respondents appear to be knowledgeable about energy efficiency in the home. (Q#4)

- Almost 98% of total respondents indicated they are knowledgeable about energy efficiency in the home, including 69% who indicated they are very knowledgeable.

HHC-2.3 Respondents appear to be somewhat indecisive as to whether higher-efficiency heating products can play a significant role in saving money on home heating costs (Q#4).

- While some 86% of total respondents believe high-efficiency heating products can play a significant role in saving money on home heating costs, less than a majority (41%) said it could be very significant.

HHC-2.4 Respondents were asked—on an aided basis—to describe the current level of natural gas usage, as well as the level of insulation and replacement of windows, in their home. (Qs#14-17)

Tabulated responses appear in the following table:

ESK-Residential-HHC: Low-income 2012 Initiative **Current Natural Gas Usage / Insulation Levels / Replacement of Windows**	**High**	**Med**	**Low**	**None/ Nothing**	**Don't know**	**Don't have**
% of Total Respondents (165)						
Natural Gas Usage	5%	84%	11%			
Insulation Levels						
Attic	13%	63%	7%	-	-	17%
Main Walls	41%	59%	-	-	-	-
Basement	21%	62%	9%	-	-	8%
	Yes	**No**	**Don't know**			
Have your windows been replaced in the last 20 years?	38%	53%	9%			

HHC-2.5 Respondents were asked whether they had previously participated in any other conservation program in the past—either through the government or a utility. Tabulated responses were as follows: (Q#20)

- Yes = 93 (56%)
- No = 42 (26%)
- Don't know = 30 (18%)

ESK—Res-HHC: LI Initiative Research Findings—Section 3: Findings re Factors Affecting End-Users' Decision to Install

Findings related to Project Objectives #2 & 4:

To determine the factors affecting residential end-users' decision to install the products, who actually installed them and end-users' usage habits regarding products that are still installed

Identification of Factors Affecting End-Users' Installation Decision and Usage Habits re Products that are Still Installed (Qs# 7-12)

HHC-3.1 Almost all respondents indicated they had installed the products they received. Once installed, the products remain installed. (Q#7)

ESK-Residential HHC: Low-income Initiative Products Installed in 2012 Total survey completions = 165	Column A Respondents: # Verified—Installed	Column B Respondents: % Verified—Installed *(Base=(165)*	Column C Respondents: # Verified—Still Installed	Column D Respondents: % Verified—Still Installed *(Base=# in Col A)*
Energy-efficient Showerhead	153	93%	151	99%
Kitchen Faucet Aerator	140	85%	134	96%
Bathroom Faucet Aerator	142	86%	142	100%
Pipe Wrap	155	94%	155	100%

HHC-3.2 Regarding installation of products, it was more likely that the respondent or someone else in the household installed the aerators and pipe wrap. However a significant percentage (39%) of respondents indicated that the contractor installed the showerhead. (Q#8)

ESK-Residential-HHC: Low-income Initiative Products Installed in 2012	Column A Products: Total # Verified—Installed	Column B Products: #(%) Installed by respondent *(Base=# in A)*	Column C Products: #(%) Installed by other in household *(Base=# in A)*	Column D Products: #(%) Installed by Contractor *(Base=# in A)*
Energy-efficient Showerhead	153	75 (49%)	19 (12%)	59 (39%)
Kitchen Faucet Aerator	140	98 (70%)	34 (24%)	8 (6%)
Bathroom Faucet Aerator	142	97 (68%)	37 (26%)	8 (5%)
Pipe Wrap	155	110 (71%)	40 (26%)	5 (3%)

NB: Two reasons were cited by respondents who did not install products they received: The products were not compatible (i.e. did not fit) or they are currently renovating their home and planned to install the products eventually.

HHC-3.3 The following chart contains the complete list of factors presented to respondents, as well as the percentages of total respondents who, on an aided basis, identified a factor as their main reason for installing some or all of the items in the kit (Qs#9&12):

ESK-Residential-HHC: Low-income Initiative 2012 **Main Reason for Installing Product(s)—Aided**	**2012 Main Reason** (% of total respondents—Cite one only)	***Compare 2011 Main Reason*** (% of total respondents—Cite one only)
To conserve energy/Use energy wisely	14	*16*
To save money on my heating bill	20	*22*
To conserve energy/use energy wisely AND to save money on my heating bill*	65	*62*
Because of the contractor's advice	1	*0*
** Unaided—cited both combined as main reason*		

HHC-3.4 Specifically regarding the Energy-efficient Showerhead, several questions were asked to respondents who received this item. (Qs#9-10) The following findings are noted:

- Most respondents (56%) who received the showerhead(s) indicated they have one shower in their home; the remainder indicated they have two showers (42%) or three showers (2%).
- Approximately three-quarters (74%) of total respondents who received showerhead(s) indicated all of the showering in their home now is done under a new showerhead. More than one-quarter of total respondents indicated that most (2%) or about half (23%) of the showering in their home now is done under a new showerhead.

HHC—Low-income Initiative **Showerhead product installed in 2012** **(Total = 165 completions)**	A. Respondents: # Verified—Installed	B. Respondents: % Verified—Installed *(Base=165)*	**C. Respondents: # Verified—Still Installed**	**D. Respondents: % Verified—Still Installed** *(Base=# in A)*
Energy-efficient Showerhead	153	93%	151	99%
Of all the showering done in your home, how much is done under a New Showerhead? (# & % of total still installed—Col C)			All (100%) = 112 Most (75%+) = 3 Half (50%) =34 1/3 (30%) or less = 2 Don't know = 0	All (100%) = 74% Most (75%+) = 2% Half (50%) = 23% 1/3(30%) or less= 1% Don't know = 0%

Appendix L – Union Gas 2014 Low Income Project Verification Final Report

Union Gas
2014 Low Income Project Verification Final Report

12 June 2015

Union Gas

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Contents

Executive Summary

Union Gas delivers Demand Side Management (DSM) services to their low income market customers through a Custom program where incentives are based on claimed savings.

Incentives are based on energy savings and are capped at 50% of project costs. Depending on the project, eligible costs are based on the incremental cost relative to applicable codes, industry standard baselines, or on total project cost. Energy savings are calculated by Union Gas personnel using inputs provided by customers and other third parties.

Union Gas has retained Michaels Energy to verify the claimed savings, project costs, and effective useful lives on a representative sample of projects through the use of a customer or business partner interview, a desk review of the project documentation and savings calculations, and on-site verification. This is the final report of verification results for the Union Gas Low Income program in Ontario for projects completed in 2014.

A summary of the claimed gross savings for the projects selected for review is shown in the table below.

Project	Technology	First Year Natural Gas (m3)	EUL (Yrs)	Lifetime Natural Gas (m3)	Electrical (kWh)	Cost ($)
COM-0095	Roof Insulation	2,021	20	40,420	-	$15,270
COM-0282	VFD on MAU	6,002	10	60,020	-	$3,628
COM-0299	Windows	3,911	20	78,220	-	$157,635
COM-0179	VFD on MAU	15,121	10	151,210	18	$9,665
COM-0181	VFD on MAU	14,142	10	141,420	23	$5,109
COM-0300	Windows and Doors	7,567	20	151,340	-	$72,980
COM-0302	Windows	12,692	20	253,840	-	$226,765
COM-0312	HVAC Controls	7,033	15	105,495	-	$17,850
COM-0306	Solar Pre-Heater	28,706	30	861,180	-	$228,900
COM-0313	HVAC Controls	75,912	15	1,138,680	-	$200,160
Total Sample		173,107		2,981,825	41	$937,962

As indicated above, a total of ten projects were reviewed for the low income program. The projects were reviewed for both technical accuracy and consistency with operational characteristics, as determined from the project documentation, customer interviews, and on-site inspection. Based on the information collected, the calculations for each project were revised; the results for gross natural gas savings are shown in the table below.

Project	Technology	First Year Natural Gas (m3)		
		Ex Ante	Verified	RR
COM-0095	Roof Insulation	2,021	3,112	154.0%
COM-0282	VFD on MAU	6,002	5,764	96.0%
COM-0299	Windows	3,911	4,129	105.6%
COM-0179	VFD on MAU	15,121	3,941	26.1%
COM-0181	VFD on MAU	14,142	2,982	21.1%
COM-0300	Windows and Doors	7,567	1,396	18.5%
COM-0302	Windows	12,692	11,736	92.5%
COM-0312	HVAC Controls	7,033	-	0.0%
COM-0306	Solar Pre-Heater	28,706	21,722	75.7%
COM-0313	HVAC Controls	75,912	44,141	58.1%
Total Sample		173,107	98,924	57.1%

Two projects had electric savings claimed; however, five projects were verified to have electric savings associated. No project claimed any water savings and no water savings were found through the verification. The verified gross electrical savings are shown in the table below.

Project	Technology	Electrical (kWh)		
		Ex Ante	Verified	RR
COM-0095	Roof Insulation	-	-	N/A
COM-0282	VFD on MAU	-	6,146	N/A
COM-0299	Windows	-	110	N/A
COM-0179	VFD on MAU	18	6,885	38249.6%
COM-0181	VFD on MAU	23	1,162	5054.0%
COM-0300	Windows and Doors	-	57	N/A
COM-0302	Windows	-	-	N/A
COM-0312	HVAC Controls	-	-	N/A
COM-0306	Solar Pre-Heater	-	-	N/A
COM-0313	HVAC Controls	-	-	N/A
Total Sample		41	14,362	35028.2%

Similar to the annual savings values, the effective useful lives claimed, and the resulting lifetime natural gas savings, were reviewed. It should be noted that the lifetime natural gas savings values reflect both the adjustments to the annual natural gas savings presented earlier as well as any changes to the EUL. Overall, with the exception of the VFD projects, the claimed effective useful lives (EUL) of the installed equipment were found to be reasonable and appropriate.

Adjustments were made to the effective useful lives of all three VFD projects. The projects claimed an EUL of ten years, but the EUL for all three was increased to 15 years. This was increased to 15 years to be consistent with the EUL for similar measures, as finalized from prior year's verification efforts as well as to be consistent with other sources reviewed, such as:

- The California Database of Energy Efficient Resources (DEER)
- The Connecticut Program Savings Document (PSD)
- The Michigan Energy Measures Database (MEMD)

- Ohio Technical Reference Manual (TRM)

The individual project lifetimes and lifetime savings values are given in the table below.

EFFECTIVE USEFUL LIFE AND GROSS LIFETIME SAVINGS ADJUSTMENTS

Project	Technology	EUL (Yrs)		Lifetime Natural Gas (m3)		
		Ex Ante	Verified	Ex Ante	Verified	RR
COM-0095	Roof Insulation	20	20	40,420	62,240	154.0%
COM-0282	VFD on MAU	10	15	60,020	86,460	144.1%
COM-0299*	Windows	20	20	78,220	21,545	27.5%
COM-0179	VFD on MAU	10	15	151,210	59,115	39.1%
COM-0181	VFD on MAU	10	15	141,420	44,730	31.6%
COM-0300*	Windows and Doors	20	20	151,340	6,980	4.6%
COM-0302*	Windows	20	20	253,840	70,350	27.7%
COM-0312	HVAC Controls	15	15	105,495	-	0.0%
COM-0306	Solar Pre-Heater	30	30	861,180	651,660	75.7%
COM-0313	HVAC Controls	15	15	1,138,680	662,115	58.1%
Total Sample				2,981,825	1,665,195	55.8%

*** Verified lifetime savings reflect a dual baseline**

After conducting a review of the 2014 projects, the following observations and recommendations were made.

- **Continue Improving the Documentation Levels.** In general, documentation levels have improved from past years, but still were found to be insufficient for some projects. Specifically, window projects were found to lack information to support the performance of the installed or baseline windows.
- **Revise templates to preserve all inputs and assumptions.** The window replacement template used to determine the ex ante savings was complex and iterative in nature. The template required the user to overwrite inputs for much of the analysis, which increased the uncertainty level. Whenever possible, input parameters should be preserved within an analysis.
- **Continue Improving the Secondary Benefits Claims.** Only two of the reviewed projects claimed any electric savings. Both of those projects were found to significantly underestimate the electric savings.
- **Ensure Savings for Large Projects with High Uncertainty are Verified with Billed Data.** Large projects with high uncertainty can have significant impacts on program realization rates. An analysis of billing data to calculate the savings for these projects would ensure the reasonableness, if not the accuracy, of the savings estimates.
- **Ensure Savings and Costs are Based on Appropriate Baseline for Projects Replacing Equipment in Poor Condition.** All three windows and doors projects were revised to reflect the existing windows being in poor condition and near the end of useful life. The baseline changes significantly impact the lifetime savings for these projects as well as the incremental costs.
- **Ensure Projects are Completed Prior to Incenting.** At the time of the site inspection, the K3D controls for site COM-0313 were not fully commissioned. It is

recommended that projects only be incented after they are completely installed and fully operational.

Introduction

Union Gas delivers Demand Side Management (DSM) to their Ontario low income market customers through a custom program. Incentives are based on energy savings relative to a baseline that is determined by the type of measure. For retrofit projects, or early replacement, the baseline for first-year savings will be current actual use. In the case of new construction, or natural replacement at the EUL of the existing equipment, the baseline will be relative to applicable codes or industry standards. Energy savings are calculated by Union Gas personnel using inputs provided by customers and other third parties.

Michaels Energy was retained by Union Gas to perform technical project reviews for the low-income custom portion of their demand side management programs. The main objectives of the review are:

1) To provide an independent objective opinion on the reasonableness of the energy savings, effective useful lives, and equipment costs claimed by the custom projects through a review of a statistically representative sample of projects.

2) To provide information back to program staff to improve the effectiveness of the low-income custom program.

Verification Methodology

Sample Overview

A total of ten projects were reviewed for the low income program. The projects were reviewed for both technical accuracy and consistency with operational characteristics, as determined from the project documentation, customer interviews, and on-site inspection.

All ten projects were verified through on-site inspections, which were completed in February, 2015. A summary of the claimed savings for the projects selected for technical review are tabulated in Table 1.

TABLE 1: CLAIMED GROSS SAVINGS AND INCREMENTAL COSTS FOR PROJECTS REVIEWED

Project	Technology	First Year Natural Gas (m3)	EUL (Yrs)	Lifetime Natural Gas (m3)	Electrical (kWh)	Cost ($)
COM-0095	Roof Insulation	2,021	20	40,420	-	$15,270
COM-0282	VFD on MAU	6,002	10	60,020	-	$3,628
COM-0299	Windows	3,911	20	78,220	-	$157,635
COM-0179	VFD on MAU	15,121	10	151,210	18	$9,665
COM-0181	VFD on MAU	14,142	10	141,420	23	$5,109
COM-0300	Windows and Doors	7,567	20	151,340	-	$72,980
COM-0302	Windows	12,692	20	253,840	-	$226,765
COM-0312	HVAC Controls	7,033	15	105,495	-	$17,850
COM-0306	Solar Pre-Heater	28,706	30	861,180	-	$228,900
COM-0313	HVAC Controls	75,912	15	1,138,680	-	$200,160
Total Sample		173,107		2,981,825	41	$937,962

It should be noted that there were no water savings claimed for any of the reviewed projects.

Verification Process

The verification process has two stages of review. The first stage is the technical review. The calculations and documentation of all ten projects were reviewed in depth. The calculations were compared against information provided in the application and equipment data, as well as all other information available for consistency, calculation accuracy, and reasonableness of assumptions. If no calculations ARE provided, the savings were recalculated using any and all information available.

In order to comply with the 2014 Low-Income CPSV Terms of Reference, site visits were included in the verification process. An on-site inspection and customer interview was performed for all of the reviewed projects to verify the installation of equipment and to characterize the operation of the installed equipment to determine the savings. During the on-site visits, the installed equipment was visually verified to be installed, and its make and model and any operating characteristics or settings were recorded. The customer was interviewed regarding the operation of the baseline and proposed systems, and any occupancy records or trended data that was available was collected.

For projects where an on-site inspection would provide minimal additional confidence or information for the verification process, a phone interview of the project customer and/or business partner could have been completed in lieu of an on-site inspection; however, for this year no projects were verified through phone inspection.

For each project, a realization rate is calculated to show the impacts of any adjustments made to the savings during the technical reviews. The project realization rate is calculated by dividing the adjusted savings by the claimed savings. A project with no adjustments has a realization rate of 100%.

Verification Guidelines

The following guidelines were used during the course of the verification process.

- The claimed energy savings are determined based on the expected equipment operating conditions at the time of implementation. The verification, however, is based on the actual equipment operation at the time of the verification, after project completion. Adjustments are made if at the time of verification the system or equipment was not operating as described or portrayed in the original calculations. If the operation at the time of the verification is not considered to be "typical" operation by the customer, the verified savings are based instead on the customer described "typical" operation.
- The verification includes assessment of savings claimed, as well as savings not claimed. Therefore, measures were examined in depth to verify the existence or non-existence of electrical or water savings, regardless if they were claimed in the original analysis.
- The verification includes an assessment of costs associated with the projects. Costs were reviewed for reasonableness. In addition, the baseline and efficient system costs were reviewed to ensure they are consistent with the equipment used to determine the savings.
- The verification includes an assessment of the effective useful life of the equipment installed. The EUL is the effective useful life of the installed equipment unless the equipment is an "add-on" to an existing piece of equipment and is not likely to remain after the failure of the existing equipment. In this case, the EUL is the remaining useful life (RUL) of the existing equipment. The EUL is verified against approved values and/or EUL data from other sources.

Savings Adjustment Categories

Each calculation adjustment has been categorized into one of the following types.

Inappropriate Assumptions:	These are adjustments made because the assumptions used in the savings calculations resulted in unrealistically high or overly conservative energy savings. Unrealistic assumptions result in an

	incorrect energy use estimate before or after project implementation.
Baseline Change:	Calculations resulting in incorrect savings from using the wrong baseline equipment, system, or efficiency are included in this group.
Tracking Error:	These are adjustments made because the savings in the calculations do not match the savings ultimately used to determine the incentive for the project.
Calculation or Engineering Error:	These are adjustments made because of errors in applying engineering principles or general calculation errors not attributable to operation or installation.
Operated or Installed Differently:	These are adjustments made because based on the description of operation from the interview of the customer and/or business partner, the equipment was installed differently or is operated differently than what was assumed in the savings calculations.
Unknown:	The cause of these adjustments could not be determined. Often this is due to incomplete calculations or project descriptions being provided in the project file.

Project Verification Results

Natural Gas, Electric and Water Savings

As indicated above, a total of ten projects were reviewed for the low income program. The projects were reviewed for both technical accuracy and consistency with operational characteristics, as determined from the project documentation, customer interviews, and on-site inspection. Based on the information collected, the calculations for each project were revised.

As shown in Table 2 and Table 3 below, individual projects had gas savings realization rates ranging from 0% to 154% for annual natural gas savings. The two projects with electric savings claimed had electric realization rates of 5,054% and 38,250%. Three projects that did not claim electric savings were found to have electric savings in the verification. No projects claimed water savings, and none was found through the verification.

TABLE 2: GROSS NATURAL GAS PROJECT REALIZATION RATES

Project	Technology	First Year Natural Gas (m3)		
		Ex Ante	Verified	RR
COM-0095	Roof Insulation	2,021	3,112	154.0%
COM-0282	VFD on MAU	6,002	5,764	96.0%
COM-0299	Windows	3,911	4,129	105.6%
COM-0179	VFD on MAU	15,121	3,941	26.1%
COM-0181	VFD on MAU	14,142	2,982	21.1%
COM-0300	Windows and Doors	7,567	1,396	18.5%
COM-0302	Windows	12,692	11,736	92.5%
COM-0312	HVAC Controls	7,033	-	0.0%
COM-0306	Solar Pre-Heater	28,706	21,722	75.7%
COM-0313	HVAC Controls	75,912	44,141	58.1%
Total Sample		173,107	98,924	57.1%

TABLE 3: GROSS ELECTRICITY PROJECT REALIZATION RATES

Project	Technology	Electrical (kWh)		
		Ex Ante	Verified	RR
COM-0095	Roof Insulation	-	-	N/A
COM-0282	VFD on MAU	-	6,146	N/A
COM-0299	Windows	-	110	N/A
COM-0179	VFD on MAU	18	6,885	38249.6%
COM-0181	VFD on MAU	23	1,162	5054.0%
COM-0300	Windows and Doors	-	57	N/A
COM-0302	Windows	-	-	N/A
COM-0312	HVAC Controls	-	-	N/A
COM-0306	Solar Pre-Heater	-	-	N/A
COM-0313	HVAC Controls	-	-	N/A
Total Sample		41	14,362	35028.2%

In the tables above the total sample savings values and realization rates are presented. However, these values are only for the specific sample reviewed. These values are not weighted to the total program population and are not representative of the total program savings for realization rates.

Effective Useful Life and Lifetime Savings Assessment

Similar to the annual savings values, the effective useful lives claimed and the resulting lifetime natural gas savings were reviewed. The effective useful life (EUL) of each project was verified using documentation found from programs in other jurisdictions, research literature currently available, the customer interview, as well as the Union Gas custom project EUL guide. The claimed and verified EUL for each project, as well as the resulting lifetime natural gas savings is given in Table 4 below. It should be noted that the lifetime natural gas savings values reflect both the adjustments to the annual natural gas savings presented earlier, as well as any changes to the EUL.

TABLE 4: EFFECTIVE USEFUL LIFE AND LIFETIME GROSS SAVINGS ADJUSTMENTS

Project	Technology	EUL (Yrs)		Lifetime Natural Gas (m3)		
		Ex Ante	Verified	Ex Ante	Verified	RR
COM-0095	Roof Insulation	20	20	40,420	62,240	154.0%
COM-0282	VFD on MAU	10	15	60,020	86,460	144.1%
COM-0299*	Windows	20	20	78,220	21,545	27.5%
COM-0179	VFD on MAU	10	15	151,210	59,115	39.1%
COM-0181	VFD on MAU	10	15	141,420	44,730	31.6%
COM-0300*	Windows and Doors	20	20	151,340	6,980	4.6%
COM-0302*	Windows	20	20	253,840	70,350	27.7%
COM-0312	HVAC Controls	15	15	105,495	-	0.0%
COM-0306	Solar Pre-Heater	30	30	861,180	651,660	75.7%
COM-0313	HVAC Controls	15	15	1,138,680	662,115	58.1%
Total Sample				2,981,825	1,665,195	55.8%

*** Verified lifetime savings reflect a dual baseline**

As shown in Table 4 above, overall, effective useful lives (EUL) of the installed equipment were generally found to be reasonable and appropriate. However, adjustments were made to the effective useful lives of three projects.

All three of the projects adjusted (COM-0282, COM-0179, and COM-0181) involved the installation of VFDs on existing make-up air units. The ex ante EUL was 10 years for those projects. This was increased to 15 years to be consistent with the EUL for similar measures, as finalized from prior year's verification efforts as well as to be consistent with other sources reviewed, such as:

- The California Database of Energy Efficient Resources (DEER)
- The Connecticut Program Savings Document (PSD)
- The Michigan Energy Measures Database (MEMD)
- Ohio Technical Reference Manual (TRM)

For these projects, it was determined that the fans associated with the VFDs had sufficient RUL to match the VFD EUL, or the fans would be replaced in a like-for-like fashion and the VFDs would be retained.

Incremental Cost Assessment

Similar to the annual savings values, the incremental cost associated with each project was reviewed. The cost was verified using a combination of the customer interview as well as a literature review. The claimed and verified incremental cost for each project is given in Table 5 below.

TABLE 5: INCREMENTAL COST ADJUSTMENTS

Project	Technology	Incremental Cost		
		Ex Ante	Verified	RR
COM-0095	Roof Insulation	15,270	15,270	100.0%
COM-0282	VFD on MAU	3,628	3,628	100.0%
COM-0299	Windows	157,635	22,069	14.0%
COM-0179	VFD on MAU	9,665	9,665	100.0%
COM-0181	VFD on MAU	5,109	5,109	100.0%
COM-0300	Windows and Doors	72,980	10,217	14.0%
COM-0302	Windows	226,765	15,347	6.8%
COM-0312	HVAC Controls	17,850	17,850	100.0%
COM-0306	Solar Pre-Heater	228,900	228,900	100.0%
COM-0313	HVAC Controls	200,160	205,880	102.9%
Total Sample		937,962	533,935	56.9%

As shown in Table 5 above, overall, the incremental costs were found to be reasonable for all projects with the exception of the window projects.

All of the window projects had the incremental costs adjusted based on the determination that the existing equipment was near the end of useful life. Therefore, the incremental cost was adjusted to include the present value of the purchase of new windows after 5 years of use of the existing windows.

Only one other project had the incremental cost adjusted. Project COM-0313 had the incremental cost increased by 2.9%, based on the provided quotes and the customer interview.

Impact to Net TRC Benefits

Verification findings impacted the net TRC benefits for each verified project as shown in Table 6.

TABLE 6: NET TRC BENEFIT ADJUSTMENTS

Project ID	Description	Ex-Ante		Verified	
		Net TRC Benefits	TRC Ratio	Net TRC Benefits	TRC Ratio
COM-0095	Roof Insulation	-$10,481	0.28	-$8,309	0.43
COM-0282	VFD on MAU	$4,426	2.28	$12,865	4.73
COM-0299	Windows	-$141,964	0.05	-$17,569	0.16
COM-0179	VFD on MAU	$10,666	2.16	$4,802	1.52
COM-0181	VFD on MAU	$13,714	3.83	$1,457	1.30
COM-0300	Windows and Doors	-$54,260	0.22	-$8,558	0.12
COM-0302	Windows	-$190,149	0.12	-$4,570	0.69
COM-0312	HVAC Controls	-$4,967	0.71	$0	NA
COM-0306	Solar Pre-Heater	-$149,909	0.31	-$166,342	0.24
COM-0313	HVAC Controls	-$60,729	0.68	-$120,329	0.38
Total Sample		**-$583,653**	**0.34**	**-$306,553**	**0.37**

Observations on Specific Projects and Technologies

In order to better understand the trends within the program, the projects were divided and technology-specific realization rates were developed. It should be noted that these technology-specific realization rates represent only the projects selected for the sample, and cannot be readily extrapolated out to the program population. Table 6 includes the reported savings and the technology realization rate for each technology group for all ten projects reviewed. Specific adjustments by technology are described below.

TABLE 6: GROSS SAVINGS BY TECHNOLOGY GROUP

Technology	Qty	First Year Natural Gas (m3)		
		Ex Ante	Verified	RR
Windows	3	24,170	17,261	71.4%
VFDs on MAU	3	35,265	12,687	36.0%
HVAC Controls	2	82,945	44,141	53.2%
Other	2	30,727	24,835	80.8%
Total	10	173,107	98,924	57.1%

Windows

Three projects reviewed were window projects. One window project (COM-0299) had the verified gas savings increased slightly. However, the other two window projects (COM-0300 and COM-0302) had the verified savings decreased from the ex ante estimates, with one project (COM-0300) being decreased significantly.

There were various causes for adjustments to the three projects. While each project had its heating system efficiency changed from the ex ante analysis, the specific adjustment made was different for each project. For project COM-0299, the ex ante analysis assumed that the heating system efficiency was 103%. It was not clear what the rationale was for a heating system efficiency of greater than 100%. Based on the site inspection, the installed units were high efficiency, at 96% efficient. Conversely, for project COM-0300, the ex ante analysis assumed a 70% efficiency, lower than the 80% efficient units found to be installed. Project COM-0302, assumed a system efficiency of 80%, which was consistent with the as-found heating units. However, the ex ante analysis assumed that at high temperatures the efficiency of the units would degrade to 56% efficient. This was deemed excessive and was changed to 75% at the upper bins.

One project (COM-0302) was adjusted due to an apparent input error into the window template. The original calculation had described the leakage rate as 0.1 CFM per foot of crack for the installed windows. However, this value was input into the leakage per square foot of window area cell, which resulted in an equivalent leakage rate of 0.05 CFM per foot of crack area, which was determined to be excessively low.

It should be noted that the window template is somewhat complicated and does not automatically update with changes to values to many input parameters. Instead, heat load values must be calculated independently for conduction and for infiltration by orientation. The design heat load values are then input manually into the calculations for gas usage. Since the heat load calculation tab is used multiple times, the input values and output values are not always clearly recorded or tracked. The verification effort was able to recreate the savings predicted for each project from information in the calculation.

Additional changes to window projects were due to adjustments to input values. One project described the installed windows as Energy Star windows with low-E glass, however, a shading coefficient of 0.78 was assumed, which was inconsistent with the described windows. Another project had a leakage rate of 6 CFM per linear foot of crack area. This value is 15 times the leakage rate for new sliding glass doors as specified in ASHRAE 90.1-2004. Although a worn door will leak more than a new door, this leakage rate was determine to be excessive.

Additionally, all three window projects had the baseline modified from the ex ante analysis. Based on the information in the project file as well as from the customer interview, the windows replaced through all three projects were in poor condition and near the end of useful life. Therefore, the lifetime savings was adjusted based on the savings compared to the existing equipment only for the remaining useful life, and then the savings compared to new code-compliant equipment for the remaining portion of the EUL for the new windows. This change significantly reduces the lifetime savings as well as reducing the incremental cost.

VFDs on Make Up Air Units

Three projects (COM-0282, COM-0179, and COM-0181) reviewed were VFDs on make-up air units. All three projects had the verified savings decreased from the ex ante savings.

For two of the projects, the installed VFDs were found to not reduce the ventilation levels to the degree expected. Both projects claimed approximately a 50% reduction in ventilation levels. However, for both projects, the minimum speed for the VFD is set to 75% speed, with the units operating at 100% speed for more than 12 hours per day. The reduction in savings for project COM-0181 were partially offset due to an error resulting in the savings for only one of the two units being claimed in the ex ante analysis.

The calculations for the one remaining project (COM-0282) were found to be reasonable and consistent with the as-found system operation. However, the analysis assumed an 80% efficient heating efficiency while the site was found to have high efficiency condensing boilers installed.

HVAC Controls

Two projects included the installation of HVAC heating controls. The ex ante savings for COM-0312 were calculated based on a billed data analysis, while the savings for COM-0313 were calculated based on an assumed 20% reduction in gas usage. For both of these sites, the customer completed additional energy efficiency projects.

For project COM-0312, the facility savings were calculated using billed data analysis. While the savings were close to the results of the ex ante CuSum analysis, all of the savings could be attributed to the replacement of standard furnaces with high efficiency units immediately prior to the installation of the new controls.

For project COM-0313, the customer replaced non-condensing boilers and domestic water heaters with condensing units concurrently with the installation of the controls. When the ex post billing data analysis was adjusted for the efficiency in equipment improvement, the verified savings were significantly lower than the claimed savings.

Other

The last two projects reviewed were "other" projects. Due to the limited number and variety of these projects no conclusions could be made.

One of the "other" projects (COM-0095) was for the addition of roof insulation. The savings for this project were increased by 54%, as determined through a billing analysis. The ex ante calculations and inputs were found to be reasonable and appropriate. While the cause of the increased savings is uncertain, it is possible that the original insulation level was less than anticipated due to degradation or compression of the insulation since installation. This would result in higher than expected pre-installation heat loss and gas usage.

The second "other" project (COM-0306) included the installation of a solar wall to preheat the incoming make-up air. For this project, the savings were decreased by 24% from the original savings estimates. The specific cause for the reduction could not be identified due to the original analysis being completed with a building model. However, it appears that the savings are reduced due to the temperature rise not being as great as originally anticipated.

Specifically, the temperature rise is consistent with the claimed temperature rise, for some days, but less than anticipated on days with less sun. Additionally, the temperature rise is limited because the customer blends the warm air with outdoor air to limit the air temperature to between 70°F and 75°F.

Observations and Recommendations

After conducting a review of the 2014 projects, the following observations and recommendations were made.

Continue Improving the Documentation Levels. Although the documentation level of some projects has improved compared to past years, we would strongly recommend a continued focus on the improvement of documentation levels. Specifically, window projects were found to lack information to support the performance of the installed or baseline windows. No performance specifications or manufacturer's literature was included for the installed windows that specified U-values, shading coefficients, or leakage rates. Similarly, no description of the rationale for the specifications for the baseline windows was included.

Revise templates to preserve all inputs and assumptions. The window template used to determine the ex ante savings was complex and iterative in nature. Heat loads were calculated for conduction and for infiltration in each direction. The analysis itself appeared reasonable and appropriate; however, the template required an iterative approach where the inputs for each portion of the analysis were overwritten to calculate the next parameter. Although for most projects the inputs were tracked to some degree, the use of manual inputs increases the likelihood of errors due to typographical errors or values not being updated to reflect changes to installed equipment.

Continue Improving the Secondary Benefits Claims. Only two of the reviewed projects claimed any electric savings. Both of those projects were found to significantly underestimate the electric savings. Additionally, three additional projects did not claim electric savings when electric savings were expected. It is recommended that either the secondary benefits be calculated consistently or they be removed entirely.

Ensure Savings for Large Projects with High Uncertainty are Verified with Billed Data. Both HVAC controls projects were large projects with high uncertainty, one of which had the savings level set to zero, while the other had significantly reduced savings. These types of projects can have significant impacts on program realization rates. Therefore, it is recommended that whenever possible large projects with high uncertainty should be verified with a billed data analysis to ensure the savings estimates are accurate.

Ensure Projects are Completed Prior to Incenting. At the time of the site inspection, the K3D controls for site COM-0313 were not fully commissioned. While the K3D controller hardware was in place and the VFD was operating at a reduced speed, the vendor was still making adjustments to the controls and the pump VFD control wiring had not yet been connected. While the system was generally functioning as expected, this could be a contributing factor to the low savings on the billed data analysis. While it is recognized that resource-limited low-income customers rely upon receiving incentives up front to cover capital project costs, it is recommended that projects only be incented after they are completely installed and fully operational.

Ensure Savings and Costs are Based on Appropriate Baseline for Projects Replacing Equipment in Poor Condition. All three window projects had the lifetime savings levels adjusted due the existing equipment being in poor condition and near the end of useful life. These baseline changes have significant impacts on the lifetime savings. The savings for projects replacing equipment at or near the end of useful life should be based on the efficiency improvement to standard efficiency equipment. In cases where the equipment has some limited life remaining, a dual baseline approach can be used, where the annual savings are based on the existing equipment for the remaining life of the installed equipment, but then compared to standard efficiency equipment for the remaining portion of the useful life.

Appendix A—Project Reports

Reports are provided for each project verified. The CPSV Savings verification summary cover sheets are also included with each project. The cover sheets provide project summary information including information in the project basics, the baseline condition, the annual savings estimates, the measure life, and the project results.

A description of the information in each section in the report is provided below:

Measure Description — This section includes a high level description of the efficiency improvements involved in the project including the measure type, and a basic description of how the project was anticipated to reduce energy consumption.

Summary of Ex Ante Calculations — This section describes the methodology and key input assumptions used to determine the savings for the ex ante (original claimed) analysis supplied with the project files.

Description of Verification — This section describes the verification procedure that was used to evaluate the claimed savings. This section also contains the observations and discussion of information or data obtained during a site visit to the customer facility, or information obtained during a phone interview. Any immediate differences between observed or collected information and that found in the original project file may also be discussed.

Summary of Verification Calculations — The final section provides an in-depth discussion of the methodology, calculations, and any assumptions used to determine the verified savings. The discussion includes sources for assumptions, discussion of engineering equations, and key variable definitions, and the reasons for differences between the ex ante and verified savings numbers.

2014–COM-0095

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Roof Insulation
4	Date Measure(s) Operational	January 25, 2014
5	Site Visit	Yes, February 19, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case	Existing insulation
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	2,021 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	3,112 m3
15	Utility Claimed Gross Electricity Savings	None
16	Utility Claimed Gross Water Savings	None
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modelling Software	No
22	Were any Measures Add-ons?	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	The measure savings are not expected to be affected by the RUL of the existing insulation.
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	54.0 %
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	3,112 m3
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	62,240 m3
27	CPSV Firm Justification for Final Recommendation	Savings verified through billing analysis were greater

		than anticipated.
28	CPSV Firm IPMVP Option Identified	C
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	N/A
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014- COM-0095
Measure:	Roof Insulation
Gross Ex Ante Savings:	2,021 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	$-10,481
Gross Ex Ante Incremental Cost:	$15,270
Facility Usage:	Residential

Measure Description

The customer added blown-in insulation to 22,500 sf of under-roof area of an existing apartment complex. The R-value of the area was increased from the existing R-40 to R-60.

Summary of the Ex Ante Calculations

The savings were calculated using a bin method to determine the heating required to offset heat loss through the roof in the pre- and post-retrofit condition. A roof assembly U-value template was used to calculate the U-value of the roof assembly, which was reported to be "Wood Frame Construction (with vented attic)" for both pre- and post- cases. Those U-values were used to establish total heat loss at outdoor design conditions, -0.9° F, and the reported space temperature of 76° F as follows:

$$Peak\ heat\ loss\ BTUH = U\_value\ x\ 22{,}500\ sf\ x\ (76 - (-0.9))$$

The peak heat loss conditions was used with a standard bin calculation using local average temperatures and hours to determine annual gas usage for the pre- and post-retrofit conditions using equation:

$$Annual\ gas\ usage\ MBTU = \sum_{t=-13}^{64} (Hrs_i\ x(76 - Ti)/(76 - (-0.9)))/Eff_i$$

Where (Hrs_i) is the hours per year expected to occur within the temperature bin (i). The heating efficiency (Eff_i) is adjusted according to the bin temperature. At higher temperature bins, when the heating unit is less highly loaded, the efficiency is decreased somewhat. At the highest bins in the analysis (63°F), the efficiency is reduced to 70%. At bin temperatures of 45.5° F and below the heating efficiency is given as 80%. The resulting savings are given in the table below.

	Ex ante Gross Savings
m3 natural gas	2,021
kWh electric	0
L water	0
Incremental Cost	$15,270

The application states that the effective useful life of this measure is 20 years. Based on this EUL and the reported incremental costs and savings, the expected net TRC benefit for this project is -$10,916.

Description of Verification

A site visit to verify the installation of additional insulation was conducted on February 19, 2015. A walkthrough was performed and the site representative provided access to the attic space. The insulation was found to be installed as expected. Approximately 20" of blown in insulation were found in the attic, which is vented by soffit vents. The site contact did provide an onsite assessment report that was completed prior to the completion of the project, which indicated there was 14" of blown-in insulation at the facility. Heating is provided by 80% efficient Modine gas-fired furnaces.

The reported cost of the project is consistent with the invoices provided.

Summary of Verification Calculations

The results were verified using a billed data regression analysis relating the monthly gas usage to the heating degree days (HDD). The twelve months immediately prior to the completion of the project were used for the pre-case and the eight months of data since the completion of the project were used for the post-case. The pre- and post-case relationships are shown in Figure 1 below.

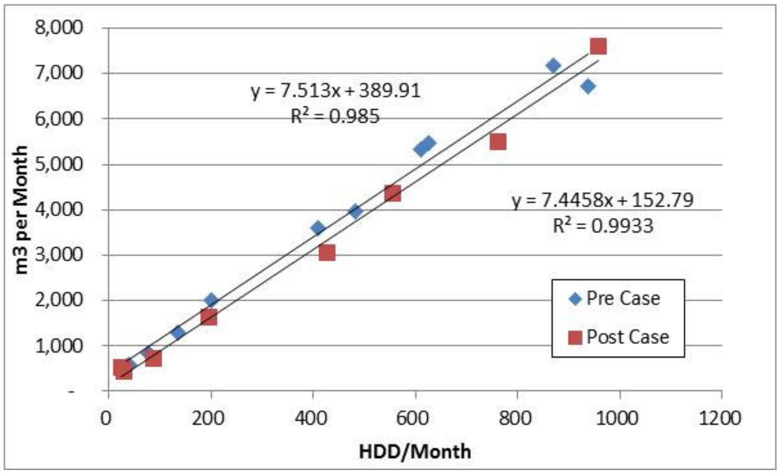


FIGURE 1 PRE AND POST GAS USAGES

No electrical savings are calculated for this measure. Although it is possible that there are electrical savings due to reductions in cooling load, these reductions are expected to be minor due to the high facility temperature setpoint. Therefore, the facility is rarely actively cooling.

The verified savings for this project are given in the table below. The savings are significantly higher than anticipated in the original analysis. The exact cause is not clear, however, the ex ante analysis conservatively assumes that no heating savings would occur above 64°F. Since the building is kept at high temperatures (75°F or higher, based on the preferences of the occupants) and has very low internal gains it is possible that the system would be heating at higher temperatures. Additionally, it is possible that the baseline heat transfer level was greater than anticipated due to the specific overall assembly R-value being less than anticipated or due to the R-value decreasing from the new construction value due to settling or degradation of the blown-in insulation.

EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas	2,021	3,112	154.0%
Lifetime m3	40,420	62,240	154%
kWh electric	0	0	N/A
L water	0	0	N/A
Incremental Cost	$15,270	$15,270	100%

Primary Cause for Adjustment: Operated or Installed Differently

2014–COM-0282

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Install VFD on makeup air unit
4	Date Measure(s) Operational	November 12, 2014
5	Site Visit	Yes, February 20, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case	MUA unit without VFD
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	6,002 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	5,764 m3
15	Utility Claimed Gross Electricity Savings	N/A
16	Utility Claimed Gross Water Savings	N/A
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	10 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	
Results		
21	Proprietary Modelling Software	No, Spreadsheet
22	Were any Measures Add-ons?	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	The existing MUA unit is in good condition and would likely be replaced in-kind at its EUL.
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-4.0 %
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	5,764 m3
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	86,460 m3
27	CPSV Firm Justification for Final Recommendation	The verified heating

		efficiency of 90% is higher than the ex ante value of 80%.
28	CPSV Firm IPMVP Option Identified	A. Used stipulated values for unit efficiencies and fan performance plus observed program settings. Validated savings using utility billed gas use.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	6,146 kWh
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0282
Measure:	HVAC VFD
Gross Ex Ante Savings:	6,002 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	$4,426
Gross Ex Ante Incremental Cost:	$3,628
Facility Usage:	Residential

Measure Description

The customer installed a variable frequency drive (VFD) to reduce the ventilation provided by a 1,800 CFM make-up air unit (MUA). The measure is expected to reduce total air flow through the MUA unit by 47%.

Summary of the Ex Ante Calculations

This measure consists of the installation of a VFD and controls on an existing MUA unit. The measure will allow for the reduction of ventilation air during hours of low activity, e.g. nights, and therefore the reduction of gas energy needed to temper the incoming air to a set point of 73^{o} F. The MUA unit is equipped with a hot water heating coil; heating hot water is supplied by (2) hot water boilers. The boilers also provide domestic hot water heating for the building.

The gas usage for the baseline case is calculated using an ASHRAE simplified bin analysis. The expected burner output at design conditions is calculated using the equation:

$$〚Baseline\ Coil\ Output\ MBH〛 = (1.08\ x\ CFM\ x\ (65-(-0.9)\ )$$

Where the make up air unit discharge and outdoor temperatures at design conditions are 65^{o} F and -0.9^{o} F, respectively.

The annual weather is broken down into 4.5°F (2.5^{o} C) outdoor air temperature bins. The total gas usage for each temperature bin (i) using the equation:

$$Baseline\ Gas\ Usage_i = \sum_{i=-13}^{64} \frac{Baseline\ Coil\ MBHx\ (73-T_i)/(73-(-0.9))\ x\ Hrs_i}{Eff_i}$$

Where (Hrs_i) is the hours per year expected to occur within the temperature bin (i). The heating efficiency (Eff) is adjusted according to the bin temperature. At higher temperature bins, and the heating unit is less highly loaded, the efficiency is decreased somewhat. At the highest bins in the analysis (63°F), the efficiency is reduced to 70%. At bin temperatures of 45.5° F and below the heating efficiency is given as 80%.

The air flow reduction was calculated using the customer-reported schedule of % fan capacity for hours of operation, where it was assumed that the air flow reduction and heating energy were proportional to the VFD % speed. The hourly weighted average fan capacity was calculated using the following equation:

$$Efficient\ Gas\ Usage\ \% \ = \sum_{\%speed=0}^{100} \left(\frac{Hours}{day} x\ \%fan\ capacity\right)$$

This resulted in post-retrofit gas usage being 53% of the baseline usage, for a reduction of 47%. The efficient annual gas usage was calculated as follows:

$$Annual\ Gas\ Savings\ m3 = Baseline\ Gas\ Usage\ x\ (1 - \ Efficient\ Gas\ Usage\ \%\ )$$

The efficient-case condition calculation did not account for the difference between day and night temperatures. This is likely to be a conservative approach because air flows are reduced more during night time hours, when outside air temperatures are expected to be lower and savings higher.

Electrical savings were calculated in a similar manner, but no savings were claimed. The result of the ex ante analysis was 9 kWh/year electrical savings. However, the savings were based on only 24 hours of operation, not a full year of operation.

The resulting savings are given in the table below.

	Ex ante Gross Savings
m3 natural gas	6,002
kWh electric	0
L water	0
Incremental Cost	$3,628

The application states that the effective useful life of this measure is 10 years. Based on this EUL, and the incremental costs and savings presented above, the expected net TRC benefit for this project is $4,426.

Description of Verification

A site visit to verify the installation of the VFD controls was conducted on February 20, 2015. The site representative was interviewed and a walkthrough of the building was performed. The customer provided access to the controller for the make up air unit VFD, the make up air unit itself, and the boiler systems.

The VFD was found to be installed as expected on the make up air unit for the building. The speed of the VFD is controlled based on a set schedule, which is programmed into the controls. The programmed schedule is shown in the table below. All days of the week have the same schedule.

Start Time	End Time	Hz
0:00	3:00	30
3:00	8:00	0
8:00	10:00	54
10:00	12:00	39
12:00	13:00	60
13:00	14:00	33
14:00	15:00	46.5
15:00	17:00	33
17:00	18:00	43.5
18:00	19:00	54
19:00	20:00	42
20:00	24:00	30

The 1,800 cfm for the unit, at full flow condition was found to be reasonable for the observed unit. Heating was provided by a condensing boiler system. The boiler system supplies 11 gpm of water at a constant 150°F throughout the year. The return water temperature is dictated by the load for the make up air units and the domestic hot water system, but based on the calculated loads and flow rates, is expected to vary between 148°F and 115°F, depending on the make up air unit load and the outdoor air temperature.

The reported cost of the project is consistent with the invoices provided. The invoice includes VFDs installed in an adjacent, similar building with identical equipment.

Summary of Verification Calculations

The verification calculated the pre- and post-retrofit gas usage using values collected during the site visit. The operating schedule was updated to reflect the observed set points described above. Additionally, the discharge air temperature setpoint was reduced slightly from 73°F to 72°F, based on the setting found in the control system.

Average hourly temperatures, by month, were obtained from the CWEC web site and used to estimate fresh air heating load for each hourly period from October 1 through May 15. The heating loads were determined using average temperature rise and the estimated CFM according to the VFD speed schedule. The average daily heating loads were multiplied by the days per month to determine total monthly loads.

The heating loads were divided by average boiler efficiencies to determine gas use for pre- and post-retrofit conditions. The boilers are condensing types, so it was assumed that the boiler efficiency would be affected by return water temperatures. Supply water temperature was constant, so the return water temperature would be affected by outdoor temperature. The return water temperatures were estimated for each outdoor bin temperature according to expected heat load. A generic relationship between boiler return water temperatures was used to determine overall boiler efficiency in the pre and post conditions. The savings were the difference between the two conditions.

The results were checked with the billed usage that was provided for the pre and post operating periods. Based on the billed data analysis, the expected savings for this project were lower than calculated using the approach described above, at approximately 4,500 m3 per year. However, it should be noted that this estimate was based on only three months of post operation. Additionally, this customer is active in monitoring the system and has revised the operating schedule and speeds at various points since the installation to determine the optimal operation. Therefore, it was assumed that the calculated approach was a more reasonable estimate of the savings and was supported as reasonable based on the review of the billed data.

Electrical savings were reported on the application and were also calculated by the verification. The electrical savings were based on the observed 1.5 hp motor, an assumed 80% motor load factor at full speed, and an assumed 85% efficiency. Based on these values, the motors were running at about 1.05 kW at full speed. The average reduction in motor kW was determined using the speed schedule and typical motor speed affinity relationship, derated slightly with a 2.5 exponent. The ex post electric savings are 6,146 kWh.

The verified savings for this project are given in the table below. The savings are lower than anticipated in the original analysis. This is primarily due to the ex ante analysis assuming an 80% efficient boiler, instead of the high efficiency boiler system in place.

The EUL was increased to 15 years to be consistent with the EUL for similar measures, as finalized from prior year's verification efforts as well as to be consistent with other sources reviewed, such as:

- The California Database of Energy Efficient Resources (DEER)
- The Connecticut Program Savings Document (PSD)
- The Michigan Energy Measures Database (MEMD)
- Ohio Technical Reference Manual (TRM)

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Ex ante Gross Savings	Verified Gross Savings	Project Realization Rate
m3 natural gas	6,002	5,764	96.0%
Lifetime m3	60,020	86,460	144.1%
kWh electric	0	6,146	N/A
L water	0	0	N/A
Incremental Cost	$3,628	$3,628	100%

Primary Cause for Adjustment: Operated or Installed Differently

2014–COM-0299

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Windows
4	Date Measure(s) Operational	November 14, 2014
5	Site Visit	Yes, February 18, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	Yes
8	Agreement with Advancement Designation?	Partial—Verified savings are compared to existing equipment for reduced RUL, then new equipment for remaining EUL
Baseline		
9	Utility Claimed Base Case	Existing windows
10	Agreement with Base Case	Partial
11	Where Item 10 is 'no': CPSV Recommended Base Case	Existing for RUL, then Standard Window Baseline
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	3,911 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	4,129 m3 (year 1-5) 60 m3 (year 6-20)
15	Utility Claimed Gross Electricity Savings	None
16	Utility Claimed Gross Water Savings	None
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modelling Software	No
22	Were any Measures Add-ons?	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	5.6 %
25	CPSV Firm Independently Recommended Annual Gross Natural	4,129 m3 (year 1-5)

	Gas Savings	60 m3 (year 6-20)
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	21,545 m3
27	CPSV Firm Justification for Final Recommendation	Ex ante analysis assumed heating efficiency greater than 100%. Heating efficiency revised based on as-found equipment. Lifetime savings reduced due to baseline change to new baseline windows for 15 years of 20 year EUL
28	CPSV Firm IPMVP Option Identified	A—Savings calculated based on window areas and as found heating efficiencies.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	110 kWh
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0299
Measure:	Windows
Gross Ex Ante Savings:	3,911 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	$-141,964
Gross Ex Ante Incremental Cost:	$157,635
Facility Usage:	Residential

Measure Description

The customer replaced 455 wood-frame, double-pane windows with efficient double-pane windows.

Summary of the Ex Ante Calculations

This project involved the installation of new windows. Based on the project description, a total of 455 windows in 56 residential townhouse units were replaced. The new windows include 327 operable, slider-type units and 128 fixed units. The installed window area and leakage area, by orientation, is given in the table below.

	N	S	E	W
Gross Window Area (ft^2)	565	1,594	1,054	1,876
Leakage Area (ft^2)	167	460	312	534

It should be noted that the leakage area is based on the area of the sliders and 1.8' of crack length per square foot of window area. The U-values (conduction coefficient), solar heat gain coefficients, and leakage rates were given for both the baseline and the efficient windows and are listed in the table below.

	Baseline Windows	Proposed Windows
U-Value	0.5	0.36
Leakage Rate (cfm/ft)	1.0	0.3
Leakage Rate (cfm/ft^2)	1.8	0.6

Shading Coefficient	0.80	0.74

The savings were calculated using a window replacement calculator template developed for Union Gas for window projects. The template calculates the savings due to the conduction, as well as the infiltration by orientation. The calculations also account for the solar gains transmitted into the space, due to the solar heat gain coefficient for each window. Overall project savings are then calculated using the equation:

$$Savings_{Total} = Savings_{Conduction} + Savings_{Infiltration} - Added\ Usage_{Solar\ Gains}$$

To determine the savings associated with the conduction a heat load is calculated using the window area and U-value (heat transfer coefficient), and the difference in temperature between the inside space and the temperature at the design conditions, based on the specific area, using the equation:

$$Design\ Heat\ Load = U_{window}\ x\ Area_{Window}\ x\ (T_{inside} - T_{design})$$

Where:

- U_{window} is the U-value of the window, as given in the tables above.
- $Area_{window}$ is the area of all orientations of windows, as given in the tables above.
- T_{inside} is the interior space temperature, or 72°F.
- T_{design} is the outdoor air temperature at the design conditions, based on the locations. For this project, the design outdoor air temperature is -0.9°F.

This design heat load is then applied to an ASHRAE simplified bin analysis method, where the expected gas usage for the baseline and efficient new window condition is calculated for each temperature bin, using the equation:

$$Gas\ Usage_{conduction} = Design\ Heat\ Load\ x\ \frac{(T_{inside} - T_{bin-i})}{(T_{inside} - T_{design})}\ x\ \frac{Hours_{Bin-i}}{Eff_{Bin-i}}$$

Where:

- *i* is the average temperature for each temperature bin for the ASHRAE simplified bin analysis, ranging from -13°F to 63.5°F, in 4.5°F increments.
- $Hours_{Bin-i}$ is the hours per year that occur within the temperature bin with an average temperature of i, based on typical meteorological year data.
- Eff_{Bin-i} is the heating efficiency at the bin temperature i. The heating efficiency ranges from a low of 98% at the lowest to a high of 103% at 36°F, then back to 100% at the highest temperature bins. No explanation or justification was given for the efficiency curve used.

For this project, the total gas usage due to conduction was 14,446 m3 and 10,401 m3 for the base and efficient case windows, respectively. This results in a total reduction in gas usage of 4,045 m3 due to reduced conduction.

A design heat load was also calculated for the baseline and the efficient installed windows for infiltration, similar to the approach used for conduction heat loads. The infiltration rate, without correcting for orientation, per square foot of door area was calculated:

$$\text{Infiltration}\,\frac{\text{CFM}}{\text{SF}} = \,Leakage\ Rate\ x\ Weather\ Stripping\ length\ \div SF$$

In the above equation, the leakage rate is defined as a cfm per linear foot of weather stripping.

The infiltration rate was used to estimate the total CFM of infiltration for each orientation:

$$Infiltration\ CFM = Infiltration\ Rate\left(\frac{CFM}{SF}\right) x\ Total\ window\ area\ x\ APD$$

APD is a pressure correction factor that is used to correct for the differences in observed pressure on the windows due to wind versus the leakage at the rated pressure for the windows, and is simply a ratio of the wind pressure expected by location based on the average wind speed and the rating pressure for window leakage (0.3 in W.C.). For this location, the expected wind velocity is 13 mph, resulting in a wind pressure of 0.09 in W.C.

The total infiltration rates were used to estimate the total BTUH heating load for each orientation at design conditions:

$$Design\ Heat\ Load\quad = \ Infiltration\ x\ 1.08\ x\ \left(T_{inside} - T_{design}\right)$$

Where 1.08 is a factor to account for units and for density and the resulting design heat load is in BTUs per hour.

This design heat load is then applied to an ASHRAE simplified bin analysis method, where the expected gas usage for the baseline and efficient new window condition is calculated for each temperature bin using the equation:

$$Gas\ Usage_{infiltration} = \sum_{i=-13}^{63.5} Design\ Heat\ Load\ x\ \frac{(T_{inside} - T_{bin-i})}{\left(T_{inside} - T_{design}\right)}\ x\ \frac{Hours_{Bin-i}}{Eff}$$

Where:

- *i* is the average temperature for each temperature bin for the ASHRAE simplified bin analysis, ranging from -13°F to 63.5°F, in 4.5°F increments.
- $Hours_{Bin-i}$ is the hours per year that occur within the temperature bin with an average temperature of i, based on typical meteorological year data.
- *Eff* is the heating efficiency at the bin temperature i. The heating efficiency ranges from a low of 83% at the highest temperature to 98% at the lowest bin. However, at most

temperatures in between, the efficiency given is 103%. No explanation or justification was given for the efficiency curve used.

The calculation is repeated for each orientation. The gas usage resulting from infiltration in each direction can then be calculated:

$$Gas\ Usage_{infiltration-j} = \sum_{j=1}^{4} Gas\ Usage_{infiltration}\ \ x\ \%Wind_{Direction-j}$$

In the equation above, the $\%Wind_{Direction\text{-}j}$ factor accounts for the percent of time that the wind is blowing from the direction j, that the window is facing. This value is determined based on location, from typical meteorological data. For this analysis, it is assumed that the average wind velocity is the same in all directions.

For this project, the total gas usage due to infiltration was 1,253 m3 and 418 m3 for the base and efficient case windows, respectively. This results in a total reduction in gas usage of 836 m3 due to reduced infiltration.

Radiation heat gains are calculated by month. To determine the heat gain due to radiation, the incident solar radiation (BTU/sf), by month, is multiplied by the area of the windows, by an orientation factor, and the area by orientation, as given in the equation below:

$$Solar\ Gain = Incident\ Solar\ x\ Area\ x\ Orientation\ Factor\ x\ Clearness\ Fraction\ x\ SC$$

Where:

- Incident solar specifies the incident solar radiation is based on the location, and is interpolated from 1997 ASHRAE Fundamentals Handbook.
- The area is the total window area, as given in the tables above.
- Clearness fraction is based on the location, and specifies the percent of incident solar radiation that is not blocked by the atmosphere and cloud cover. This data is taken from NASA surface meteorology and solar energy data.
- SC is the window shading coefficient. This is a property of the installed windows, and is essentially the percentage of incident solar radiation that is passed to the interior space. The shading coefficient is equal to the solar heat gain coefficient divided by 0.87.

The effect of reduced solar gains is expected to result in an overall gas usage increase of 970 m3.

The ex ante savings are presented in Table 1.

TABLE 1 EX-ANTE SAVINGS ESTIMATES

	Ex ante Gross Savings
m3 natural gas	3,911
kWh electric	0
L water	0
Total Cost	$157,635

The application states that the effective useful life of this measure is 20 years. Based on this EUL and the incremental costs and savings presented above, the expected net TRC benefit for this project is -$141,964.

Description of Verification

An initial site visit to verify the installation of the windows and doors was conducted on February 18, 2015. The site representative was interviewed and a walkthrough of the building was performed. The customer provided access to one rental unit for inspection of the windows as well as the heating equipment.

All of the windows were found to be installed as expected. The windows and doors are installed in residential units. They were found to be double-pane, insulated glass windows with vinyl frames. The operable windows were slider-style windows.

The removed windows were not available for inspection, however, per the site representative, the windows were approximately 20 years old. They were double-paned windows with wood frames. The windows were not broken and were still in adequate condition, but were drafty.

Heating for the units is met with 96% efficient high efficiency forced air furnaces. No central cooling is installed; however, the site representative estimated that approximately 40% of the units install window air conditioning units during the summer months. All of the air conditioning units are removed during the heating season.

Summary of Verification Calculations

The verification used a modified version of the Union Gas template to calculate the savings. Essentially, the same calculation methodology was used; however, the template was modified to eliminate the "iterative" approach that required the overwriting of the inputs to preserve the analysis in full.

No changes were made to the U-values, solar heat gain coefficient values, infiltration levels, or areas for the baseline or efficient windows. Per the customer, the removed windows were double-pane wood framed windows. Based on this, the 0.50 U-value and 0.70 shading coefficient were reasonable. Additionally, the leakage rate of 1.0 CFM per linear foot of crack length was reasonable for older windows.

No specifications for the installed windows were provided. Additionally, no U-value or solar heat gain coefficient values could be found from the manufacturer. However, based on a review of similar windows from the manufacturer, as well as a comparison of windows with similar energy rating (ER) values, the u-value and solar heat gain coefficient values appeared reasonable. Additionally, the 0.3 CFM per foot of crack area was reasonable for new windows.

However, the efficiency level was changed in the evaluation analysis. It was not clear why the original analysis assumed a heating efficiency of between 98% and 103%, depending on temperature, however, it is likely this is either a typo or the incorrect use of a heat input ratio (energy in/energy out) as opposed to a heating efficiency (energy out/energy in) value. The evaluation analysis assumes a 96% efficiency level for all temperature bins. This change increases the savings by approximately 5%. No other changes were made.

There were no electrical savings claimed on the application. During the site visit, it was learned that many of the units had window air conditioning units in place. It is expected that the improvement in window performance would result in reduced cooling loads. The average monthly savings for heat gain due to infiltration and solar heat gain cooling loads were calculated. The electrical savings were determined using that cooling load and assuming a total of 500 cooling hours in 40% of the units. It was also assumed that the average EER for the units was 6.

Based on the customer interview, the existing windows were in poor condition, but were still functional. Based on the customer description, the RUL of the existing windows was reduced to 5 years. This was determined to be a reasonable estimate of the time the existing windows could have been retained, if properly maintained.

To calculate the lifetime savings, the savings calculated compared to the existing windows were credited for the five years of remaining useful life. For the remaining 15 years of the effective useful life, the savings were based on the comparing the installed windows to standard efficiency new windows, based on the U-value compliance approach from SB-12. Based on this approach, the installed windows were only slightly better than the baseline windows, and were only expected to save 60 m3 per year.

Because the lifetime savings were based on the installation of new windows in five years, an incremental cost was calculated. The calculated incremental cost assumed that the baseline windows would cost similar to the installed windows (since they were only marginally better than the baseline). The present value of the cost in five years was then calculated based on a 5% discount rate, which resulted in an overall reduction in the incremental costs of 86%.

The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas, (Year 1-5)	3,911	4,129	105.6%
m3 natural gas, (Year 6-20)	3,911	60	1.5%
Lifetime m3	78,220	21,545	27.5%
kWh electric	0	110	N/A
L water	0	0	N/A
Incremental Cost	$157,635	$22,069	14%

Primary Cause for Adjustment: Baseline Change

2014–COM-0179

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Install VFD on makeup air unit
4	Date Measure(s) Operational	May 30, 2014
5	Site Visit	Yes, February 25, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case	MUA unit without VFD
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	15,121 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	3,941 m3
15	Utility Claimed Gross Electricity Savings	18 kWh
16	Utility Claimed Gross Water Savings	N/A
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	10 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	15 years is consistent with the EUL for similar measures, as finalized from prior year's verification efforts as well as other sources reviewed.
Results		
21	Proprietary Modelling Software	No, Spreadsheet
22	Were any Measures Add-ons?	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	The existing MUA unit is in good condition and would likely be replaced in-

		kind at the end of its life.
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-73.9%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	3,941 m3
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	59,115 m3
27	CPSV Firm Justification for Final Recommendation	Equipment was not operated as expected. Overall fan speed reduction due to VFD installation was not as great as predicted.
28	CPSV Firm IPMVP Option Identified	C. Whole building analysis using utility billed gas use.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	6,885 kWh
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0179
Measure:	HVAC VFD
Gross Ex Ante Savings:	15,121 m3 natural gas; 18 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	$10,666
Gross Ex Ante Incremental Cost:	$9,665
Facility Usage:	Residential

Measure Description

The customer installed a variable frequency drive (VFD) to reduce the ventilation provided by a 3,650 CFM make-up air unit (MUA). The measure is expected to reduce total air flow through the MUA unit by 48%.

Summary of the Ex Ante Calculations

This measure consists of the installation of a VFD and controls on an existing MUA unit. The measure will allow for the reduction of ventilation air during hours of low activity, e.g. nights, and therefore the reduction of gas energy needed to temper the incoming air to a set point of 72° F. The MUA unit is equipped with an indirect-fired gas burner.

The gas usage for the baseline case is calculated using an ASHRAE simplified bin analysis. The expected burner output at design conditions is calculated using the equation:

$$〚Baseline\ Burner\ Output\ MBH〛 = (1.08\ x\ CFM\ x\ (72-(-11.1)\ )$$

Where the MUA unit and outdoor temperatures at design conditions are 72° F and -11.1° F, respectively.

The annual weather is broken down into 4.5°F (2.5° C) outdoor air temperature bins. The total gas usage for each temperature bin (i) using the equation:

$$Baseline\ Gas\ Usage_i = \sum_{i=-22}^{64} \frac{Baseline\ Coil\ MBHx\ (72-T_i)/(72-(-11.1))\ x\ Hrs_i}{Eff_i}$$

Where (Hrs_i) is the hours per year expected to occur within the temperature bin (i). The heating efficiency (Eff) is adjusted according to the bin temperature. At higher temperature bins, and the heating unit is less highly loaded, the efficiency is decreased somewhat. At the highest bins in the analysis (63°F), the efficiency is reduced to 70%. At bin temperatures of 45.5° F and below the heating efficiency is given as 80%.

The air flow reduction was calculated using the customer-reported schedule of % fan capacity for hours of operation, where it was assumed that the air flow reduction and heating energy were proportional to the VFD % speed. The hourly weighted average fan capacity was calculated using the following equation:

$$Efficient\ Gas\ Usage\ \% \ = \sum_{\%speed=0}^{100} \left(\frac{Hours}{day} x\ \%fan\ capacity \right)$$

This resulted in post-retrofit gas usage being 51.7% of the baseline usage, for a reduction of 48.3%. The efficient annual gas usage was calculated as follows:

$$Annual\ Gas\ Savings\ m3 = Baseline\ Gas\ Usage\ x\ (1 -\ Efficient\ Gas\ Usage\ \%\ )$$

The efficient-case condition calculation did not account for the difference between day and night temperatures. This is likely to be a conservative approach because air flows are reduced more during night time hours, when outside air temperatures are expected to be lower and savings higher.

Electrical savings were calculated in a similar manner. The result of the ex ante analysis was 18 kWh/year electrical savings. However, the savings were based on only 24 hours of operation, not a full year of operation.

The resulting savings are given in the table below.

	Ex ante Savings
m3 natural gas	15,121
kWh electric	18
L water	0
Incremental Cost	$9,665

The application states that the effective useful life of this measure is 10years. Based on this EUL, and the incremental costs and savings presented above, the expected net TRC benefit for this project is $10,666.

Description of Verification

A site visit to verify the installation of the VFD controls was conducted on February 25, 2015. The site representative was interviewed and a walkthrough of the building was performed. The customer provided access to the controller for the make up air unit as well as to the make up air unit itself.

The application calculations only included one make up air unit to determine savings, but the building was found to have two identical units. VFDs were found to be installed as expected on each of the units. The speed of the VFD is controlled based on a set schedule, which is programmed into the controls. The programmed schedule is shown in the table below. All days of the week have the same schedule.

Hour	Hz	Hour	Hz	Hour	Hz	Hour	Hz
1	45	7	45	13	60	19	60
2	45	8	60	14	60	20	60
3	45	9	60	15	60	21	45
4	45	10	60	16	60	22	45
5	45	11	60	17	60	23	45
6	45	12	60	18	60	24	45

The 3,650 cfm for the unit at full flow condition appeared to be high, as determined during the verification calculations. It is estimated that the actual full flow rate was approximately 2,140 cfm per unit. Heating was provided by an indirect fired burner, which was reported to be 80% efficient. The units are limited to a nominal 60^{o} F temperature rise across the heat exchanger.

The customer reported that the minimum fans speed for each unit is about 42 HZ, according to the equipment vendor. Therefore, the minimum speed was set to 45 Hz to provide a small safety factor. In addition, because of the limited temperature rise of the units, a low-limit thermostat will shut the unit off at temperatures below -10^{o} C (14^{o} F)

The reported cost of the project is consistent with the invoices provided. The invoice includes VFDs installed in an adjacent, similar building with identical equipment.

Summary of Verification Calculations

The verification used a billing analysis to determine the final savings. The make up air units are the only gas load on the utility meter. The project was completed in May of 2014 so nearly a full year of post-retrofit operating data was available. Local HDD were matched with the billed periods and linear relationships with significant correlations were established for both pre- and post-case conditions. The correlations were used with average HDD for the area to determine baseline and efficient gas usage.

An alternate calculation using average hourly temperatures, by month, which were obtained from the CWEC web site and used to estimate fresh air heating load for each hourly period from October 1 through May 15. The heating loads were determined using average temperature rise and the estimated CFM according to the VFD speed schedule. The unit CFM was adjusted to ensure that the estimated baseline usage was in line with the billed usage. The result was a unit CFM that was somewhat lower than expected. The average daily heating loads were multiplied by the days per month to determine total monthly loads. This analysis resulted in slightly lower savings than determined through the billing analysis.

Electrical savings were reported on the application and were also calculated by the verification. The motor amps were collected from the VFD readout at 100% speed and used to estimate full load motor power. It was assumed that the motors operated with 208V, 3-phase power. Based on these values, the motors were running at about 1.9 kW at full speed. The average reduction in motor kW was determined using the speed schedule and typical motor speed affinity relationship, with a 2.5 exponent. The ex post electric savings are 6,885 kWh.

The EUL was increased to 15 years to be consistent with the EUL for similar measures, as finalized from prior year's verification efforts as well as to be consistent with other sources reviewed, such as:

- The California Database of Energy Efficient Resources (DEER)
- The Connecticut Program Savings Document (PSD)
- The Michigan Energy Measures Database (MEMD)
- Ohio Technical Reference Manual (TRM)

The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas	15,121	3,941	26.1%
Lifetime m3	151,210	59,115	39.1%
kWh electric	18	6,885	38,249%
L water	0	0	N/A
Incremental Cost	$9,665	$9,665	100%

Primary Cause for Adjustment: Operated or Installed Differently

2014–COM-0181

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Install VFD on makeup air unit
4	Date Measure(s) Operational	May 30, 2014
5	Site Visit	Yes, February 25, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case	MUA unit without VFD
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	14,142 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	2,982 m3
15	Utility Claimed Gross Electricity Savings	23 kWh
16	Utility Claimed Gross Water Savings	N/A
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	10 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	15 years is consistent with the EUL for similar measures, as finalized from prior year's verification efforts as well as other sources reviewed.
Results		
21	Proprietary Modelling Software	No, Spreadsheet
22	Were any Measures Add-ons?	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	The existing MUA unit is in good condition and would likely be replaced in-

		kind at its EUL.
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	- 78.9 %
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	2,982 m3
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	44,730 m3
27	CPSV Firm Justification for Final Recommendation	Equipment was not operated as expected. Overall fan speed reduction due to VFD installation was not as great as predicted.
28	CPSV Firm IPMVP Option Identified	A. Used stipulated values for unit efficiencies and fan performance plus observed program settings. Validated savings using utility billed gas use.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	1,162 kWh
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0181
Measure:	HVAC VFD
Gross Ex Ante Savings:	14,142 m3 natural gas; 23 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	$13,714
Gross Ex Ante Incremental Cost:	$5,109
Facility Usage:	Residential

Measure Description

The customer installed a variable frequency drive (VFD) to reduce the ventilation provided by a 3,300 CFM make-up air unit (MUA). The measure is expected to reduce total air flow through the MUA unit by 50%.

Summary of the Ex Ante Calculations

This measure consists of the installation of a VFD and controls on an existing MUA unit. The measure will allow for the reduction of ventilation air during hours of low activity, e.g. nights, and therefore the reduction of gas energy needed to temper the incoming air to a set point of 72° F. The MUA unit is equipped with an indirect-fired gas burner.

The gas usage for the baseline case is calculated using an ASHRAE simplified bin analysis. The expected burner output at design conditions is calculated using the equation:

$$〚Baseline\ Burner\ Output\ MBH〛 = (1.08\ x\ CFM\ x\ (72-(-11.1)\ )$$

Where the MUA unit and outdoor air temperatures at design conditions are 72° F and -11.1° F, respectively.

The annual weather is broken down into 4.5°F (2.5° C) outdoor air temperature bins. The total gas usage for each temperature bin (i) using the equation:

$$Baseline\ Gas\ Usage_i = \sum_{i=-22}^{64} \frac{Baseline\ Coil\ MBHx\ (72-T_i)/(72-(-11.1))\ x\ Hrs_i}{Eff_i}$$

Where (Hrs_i) is the hours per year expected to occur within the temperature bin (i). The heating efficiency (Eff) is adjusted according to the bin temperature. At higher temperature bins, when the heating unit is less highly loaded, the efficiency is decreased somewhat. At the highest bins in the analysis (63°F), the efficiency is reduced to 70%. At bin temperatures of 45.5° F and below the heating efficiency is given as 80%.

The air flow reduction was calculated using the customer-reported schedule of % fan capacity for hours of operation, where it was assumed that the air flow reduction and heating energy were proportional to the VFD % speed. The hourly weighted average fan capacity was calculated using the following equation:

$$Efficient\ Gas\ Usage\ \% \ = \sum_{\%speed=0}^{100} \left(\frac{Hours}{day} x\ \%fan\ capacity\right)$$

This resulted in post-retrofit gas usage being 50% of the baseline usage, for a reduction of 50%. The efficient annual gas usage was calculated as follows:

$$Annual\ Gas\ Savings\ m3 = Baseline\ Gas\ Usage\ x\ (1 - \ Efficient\ Gas\ Usage\ \%\ )$$

The efficient-case condition calculation did not account for the difference between day and night temperatures. This is likely to be a conservative approach because air flows are reduced more during night time hours, when outside air temperatures are expected to be lower and savings higher.

Electrical savings were calculated in a similar manner. The result of the ex ante analysis was 23 kWh/year electrical savings. However, the savings were based on only 24 hours of operation, not a full year.

The resulting savings are given in the table below.

	Ex ante Gross Savings
m3 natural gas	14,142
kWh electric	23
L water	0
Incremental Cost	$5,109

The application states that the effective useful life of this measure is 10 years. Based on this EUL, and the incremental costs and savings presented above, the expected TRC benefit for this project is $13,714.

Description of Verification

A site visit to verify the installation of the VFD controls was conducted on February 25, 2015. The site representative was interviewed and a walkthrough of the building was performed. The customer provided access to the controller for the make up air unit as well as to the make up air unit itself.

The VFD was found to be installed as expected on the make up air unit. The speed of the VFD is controlled based on a set schedule, which is programmed into the on-board VFD controls.

There is no remote connectivity to monitor or change the VFD speed. The programmed schedule is shown in the table below. All days of the week have the same schedule.

Hour	Hz	Hour	Hz	Hour	Hz	Hour	Hz
1	45	7	45	13	60	19	60
2	45	8	60	14	60	20	60
3	45	9	60	15	60	21	45
4	45	10	60	16	60	22	45
5	45	11	60	17	60	23	45
6	45	12	60	18	60	24	45

The 3,300 cfm assumed for the unit was consistent with the unit nameplate data. Heating is provided by an indirect fired burner, which was reported to be 80% efficient. The units are limited to a nominal 70^{o} F temperature rise across the heat exchanger.

The customer reported that the minimum fans speed for each unit is about 42 HZ, according to the equipment vendor. Therefore, the minimum speed was set to 45 Hz to provide a small safety factor. In addition, because of the limited temperature rise of the units, a low-limit thermostat will shut the unit off at temperatures below -10^{o} C (14^{o} F)

The reported cost of the project is consistent with the invoices provided with the application.

Summary of Verification Calculations

The verification calculated the pre- and post-retrofit gas usage using values collected during the site visit. The operating schedule was updated to reflect the observed set points described above. Operation below the low-temperature limit set point was assumed to be off in both the baseline and proposed conditions.

Average hourly temperatures, by month, were obtained from the CWEC web site and used to estimate fresh air heating load for each hourly period from October 1 through May 15. The heating loads were determined using average temperature rise and the estimated CFM according to the VFD speed schedule. The average daily heating loads were multiplied by the days per month to determine total monthly loads.

The heating loads were divided by the assumed make up air unit burner efficiency to determine gas use for pre- and post-retrofit conditions. The efficiency value accounted for the slight decrease in burner efficiency at higher OAT by using a value weighted for hours of operation at various bin temperatures. The savings were the difference between the two conditions.

The results were checked for reasonableness with the billed usage that was provided for the pre and post operating periods. The customer replaced the electrical pool heater with a gas boiler at some time during the billed history provided. The potential uncertainty introduced by this change was considered to reduce the accuracy of a billing analysis sufficiently to make it inappropriate for this project. However, the estimated heating gas usage of the building was in line with the usage predicted by the hourly calculations. Therefore, the results of the final calculations were considered reasonable.

The results were checked with the billed usage that was provided for the pre and post operating periods. The pre-retrofit data was used to validate the results of the baseline gas usage of the MUA unit. The estimated gas used for pre-retrofit heating based on billing data was nearly equal to the calculated baseline using the bin method. Therefore, it was assumed that the approach and values used to determine ex post results were reasonable.

Electrical savings were reported on the application and were also calculated by the verification. The motor amps were collected from the VFD readout at 100% speed and used to estimate full load motor power. It was assumed that the motors operated with 208V, 3-phase power. Based on these values, the motors were running at about 1.15 kW at full speed. The average reduction in motor kW was determined using the speed schedule and typical motor speed affinity relationship, with a 2.5 exponent.

The EUL was increased to 15 years to be consistent with the EUL for similar measures, as finalized from prior year's verification efforts as well as to be consistent with other sources reviewed, such as:

- The California Database of Energy Efficient Resources (DEER)
- The Connecticut Program Savings Document (PSD)
- The Michigan Energy Measures Database (MEMD)
- Ohio Technical Reference Manual (TRM)

The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas	14,142	2,982	21.1%
Lifetime m3	141,420	44,730	31.6%
kWh electric	23	1,162	5,054%
L water	0	0	N/A
Incremental Cost	$5,109	$5,109	100%

Primary Cause for Adjustment: Operated or Installed Differently

2014–COM-0300

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Windows and doors
4	Date Measure(s) Operational	September 15, 2014
5	Site Visit	Yes, February 19, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	Yes
8	Agreement with Advancement Designation?	Partial—Verified savings are compared to existing equipment for reduced RUL, then new equipment for remaining EUL
Baseline		
9	Utility Claimed Base Case	Existing patio doors
10	Agreement with Base Case	Partial
11	Where Item 10 is 'no': CPSV Recommended Base Case	Existing for RUL, then Standard Window Baseline
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	7,567 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	1,396 m3 (year 1-5) 0 m3 (year 6-20)
15	Utility Claimed Gross Electricity Savings	None
16	Utility Claimed Gross Water Savings	None
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modelling Software	No
22	Were any Measures Add-ons?	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-81.5 %

25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	1,396 m3 (year 1-5) 0 m3 (year 6-20)
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	6,980 m3
27	CPSV Firm Justification for Final Recommendation	Original savings used heating efficiencies lower than as found, the leakage rate was excessive for existing leaky patio door frames, and the installed windows shading coefficient was inconsistent with the description of Energy Star doors with low-E glass. Lifetime savings reduced due to baseline change to new baseline windows for 15 years of 20 year EUL
28	CPSV Firm IPMVP Option Identified	A—Savings calculated based on door areas and as found heating efficiencies.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	57
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0300
Measure:	Windows and doors
Gross Ex Ante Savings:	7,567 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	-$54,260
Gross Ex Ante Incremental Cost:	$72,980
Facility Usage:	Residential

Measure Description

The customer replaced 71 patio doors in a 61 unit townhouse complex with efficient ENERGY STAR windows and doors with low-E glass and argon fill. The project included the repair of framing problems, e.g. rotting jambs.

Summary of the Ex Ante Calculations

This project involved the installation of new patio doors and the repair of existing framing problems. Based on the project description, a total of 71 patio doors in 71 residential townhouse units were replaced. The installed door quantities and window areas are given in the table below.

	ENE	SSE	WSW	NNW
Patio Door Quantity	23	20	15	13
Door Area (ft^2)	743	646	485	420

The U-values (conduction coefficient) and leakage rates were given for both the baseline and the efficient patio doors. The U-values and leakage values given are listed in the table below.

	Baseline Patio doors	Proposed Windows
U-Value	0.49	0.29
Shading Coefficient	0.84	0.78
Leakage Rate (cfm/ft)	6.0	0.5

The savings were calculated using a template developed for Union Gas for window projects. The template calculates the savings due to the conduction, as well as the infiltration by orientation. The calculations also account for the solar gains transmitted into the space, due to the solar heat gain coefficient for each window. Overall project savings are then calculated using the equation:

$$Savings_{Total} = Savings_{Conduction} + Savings_{Infiltration} - Added\ Usage_{Solar\ Gains}$$

To determine the savings associated with the conduction a heat load is calculated using the window area and U-value (heat transfer coefficient), and the difference in temperature between the inside space and the temperature at the design conditions, based on the specific area, using the equation:

$$Design\ Heat\ Load = U_{window}\ x\ Area_{Window}\ x\ (T_{inside} - T_{design})$$

Where:

- U_{window} is the U-value of the window, as given in the tables above.
- $Area_{window}$ is the area of all orientations of windows, as given in the tables above.
- T_{inside} is the interior space temperature, or 72°F.
- T_{design} is the outdoor air temperature at the design conditions, based on the locations. For this project, the design outdoor air temperature is -0.9°F.

This design heat load is then applied to an ASHRAE simplified bin analysis method, where the expected gas usage for the baseline and efficient new window condition is calculated for each temperature bin, using the equation:

$$Gas\ Usage_{conduction} = Design\ Heat\ Load\ x\ \frac{(T_{inside} - T_{bin-i})}{(T_{inside} - T_{design})}\ x\ \frac{Hours_{Bin-i}}{Eff}$$

In the equation above, the heating efficiency was assumed to be constant at 70% at all outdoor air temperatures.

Similar to conduction, a design heat load was also calculated for the baseline and the efficient installed windows for infiltration. The infiltration rate, without correcting for orientation, per square foot of door area was calculated:

$$\mathrm{Infiltration}\frac{\mathrm{CFM}}{\mathrm{SF}} = Leakage\ Rate\ x\ Weather\ Stripping\ length\ \div SF$$

In the above equation, the leakage rate is defined as a cfm per linear foot of weather stripping.

The infiltration rate was used to estimate the total CFM of infiltration for each orientation:

$$Infiltration\ CFM = Infiltration\ Rate\left(\frac{CFM}{SF}\right) x\ Total\ window\ area\ x\ APD$$

APD is a pressure correction factor that is used to correct for the differences in observed pressure on the windows due to wind versus the leakage at the rating pressure for the windows, and is simply a ratio of the wind pressure expected by location based on the average wind speed and the rating pressure for window leakage (0.3 in W.C.). For this location, the expected wind velocity is 13 mph, resulting in a wind pressure of 0.09 in W.C.

The total infiltration rates were used to estimate the total BTUH heating load for each orientation at design conditions:

$$Design\ Heat\ Load \quad = Infiltration\ x\ 1.08\ x\ \left(T_{inside} - T_{design}\right)$$

Where 1.08 is a factor to account for units and for density and the resulting design heat load is in BTUs per hour.

This design heat load is then applied to an ASHRAE simplified bin analysis method, where the expected gas usage for the baseline and efficient new window condition is calculated for each temperature bin using the equation:

$$Gas\ Usage_{infiltration} = \sum_{i=-13}^{68} Design\ Heat\ Load\ x\ \frac{(T_{inside} - T_{bin-i})}{\left(T_{inside} - T_{design}\right)}\ x\ \frac{Hours_{Bin-i}}{Eff}$$

Where:

- *i* is the average temperature for each temperature bin for the ASHRAE simplified bin analysis, ranging from -13°F to 63.5°F, in 4.5°F increments.
- $Hours_{Bin-i}$ is the hours per year that occur within the temperature bin with an average temperature of i, based on typical meteorological year data.
- *Eff* is the heating efficiency, which is assumed to be 70% at all temperatures.

The calculation is repeated for each orientation. The gas usage resulting from infiltration in each direction can then be calculated:

$$Gas\ Usage_{infiltration-j} = \sum_{j=1}^{4} Gas\ Usage_{infiltration}\ \ x\ \%Wind_{Direction-j}$$

In the equation above, the $\%Wind_{Direction-j}$ factor accounts for the percent of time that the wind is blowing from the direction j, that the window is facing. This value is determined based on location, from typical meteorological data. For this analysis, it is assumed that the average wind velocity is the same in all directions.

For this project, the total gas usage due to infiltration was 20,634 m3 and 1,719 m3 for the base and efficient case windows, respectively. This results in a total reduction in gas usage of 4,343 m3 due to reduced infiltration.

Radiation heat gains are calculated by month. To determine the heat gain due to radiation, the incident solar radiation (BTU/sf), by month, is multiplied by the area of the windows, by an orientation factor, and the area by orientation, as given in the equation below:

$$Solar\ Gain = \ Incident\ Solar\ x\ Area\ x\ Orientation\ Factor\ x\ Clearness\ Fraction\ x\ SC$$

Where:

- *Incident solar* specifies the incident solar radiation is based on the location, and is interpolated from 1997 ASHRAE Fundamentals Handbook.
- The area is the total window area, as given in the tables above.
- *Clearness fraction* is based on the location, and specifies the percent of incident solar radiation that is not blocked by the atmosphere and cloud cover. This data is taken from NASA surface meteorology and solar energy data.
- *SC* is the window shading coefficient. This is a property of the installed windows, and is essentially the percentage of incident solar radiation that is passed to the interior space.

The effect of reduced solar gains is expected to result in an overall gas usage increase of 562 m3.

TABLE 1 EX-ANTE SAVINGS ESTIMATES

	Ex ante Gross Savings
m3 natural gas	7,567
kWh electric	0
L water	0
Incremental Cost	$72,980

The application states that the effective useful life of this measure is 20 years. Based on this EUL and the incremental costs and savings presented above, the expected net TRC benefit for this project is -$54,260.

Description of Verification

An initial site visit to verify the installation of the windows and doors was conducted on February 18, 2015. The site representative was interviewed and a walkthrough of the building was performed. The customer provided access to one rental unit for inspection of the windows as well as the heating equipment.

All of the windows and doors were found to be installed as expected. The windows and doors are installed in residential units. They were found to be double-pane, insulated glass windows with vinyl frames. The operable windows were slider-style windows.

The removed windows and doors were not available for inspection, however, per the site representative, they were approximately 20 years old. They were double-paned windows with wood frames. The windows were not broken and were still in adequate condition, but were drafty.

Heating for the units is met with 80% efficient furnaces. No central cooling is installed; however, the site representative estimated that approximately 10% of the units install window air conditioning units during the summer months. All of the air conditioning units are removed during the heating season.

Summary of Verification Calculations

The verification used a modified version of the Union Gas template to calculate the savings. Essentially, the same calculation methodology was used; however, the template was modified to eliminate the "iterative" approach that required the overwriting of the inputs to preserve the analysis in full.

No changes were made to the U-values or shading coefficient values for the baseline windows. Per the customer, the removed doors were wood framed double-pane patio doors from 1992. Based on this, the 0.49 U-value and 0.84 shading coefficient were reasonable. However, the leakage rate in the ex ante analysis of 6.0 CFM per linear foot of crack length was determined to be excessive. This level was set based on the customer description that the existing door frames were rotten and had significant leakage. Although it is likely that the leakage in this condition would have been excessive, it was determined that the rotten wood would need to be repaired in order to continue to use the existing doors. With the repairs, the doors could have continued to be used and is reasonable for comparison, at a leakage rate of 1.0 CFM per linear foot. The 1.0 CFM per linear foot is still 2.5 times the expected leakage rate of a code-compliant new door.

No specifications for the installed windows were provided. Additionally, no U-value or solar heat gain coefficient values could be found from the manufacturer. However, based on the project description, the installed doors were Energy Star doors with low-E glass and argon fill. Based on this, the U-value of 0.29 was reasonable, but the shading coefficient of 0.78 was not reasonable. Based on the description, the shading coefficient was changed to 0.55, based on a review of literature for window shading coefficients for windows with low-e glass.

Finally, the claimed savings calculations listed the heating efficiency at 70%. Based on the on-site inspection, the heating units are 80% efficient.

The reduction of the leakage and the increase in the heating efficiency reduced the infiltration savings from the 4,343 m3 expected from the ex ante savings to 480 m3, a reduction of nearly 90%. Additionally, the change to the shading coefficient and the increase in the heating efficiency increased the solar penalty for the project from 562 m3 to 2,367 m3. The change to the heating efficiency reduced the conduction savings from the ex ante savings of 3,786 m3 to 3,284 m3.

Based on the customer interview, the existing windows were in poor condition, but were still functional. Based on the customer description, the RUL of the existing windows was reduced to 5 years. This was determined to be a reasonable estimate of the time the existing windows could have been retained, in properly maintained.

To calculate the lifetime savings, the savings calculated compared to the existing windows were credited for the five years of remaining useful life. For the remaining 15 years of the effective useful life, the savings were based on the comparing the installed windows to standard efficiency new windows, based on the U-value compliance approach from SB-12. Based on this approach, the installed windows were no better than the baseline windows, and were not expected to save natural gas.

Because the lifetime savings were based on the installation of new windows in five years, an incremental cost was calculated. The calculated incremental cost assumed that the baseline windows would cost similar to the installed windows (since they were only marginally better than the baseline). The present value of the cost in five years was then calculated based on a 5% discount rate, which resulted in an overall reduction in the incremental costs of 86%

No additional changes were made to the analysis. The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas (Year 1-5)	7,567	1,396	18.5%
m3 natural gas (Year 6-20)	7,567	0	0%
Lifetime m3	151,340	6,980	4.6%
kWh electric	0	57	N/A
L water	0	0	N/A
Incremental Cost	$72,980	$10,217	14.0%

Primary Cause for Adjustment: Baseline Change

2014–COM-0302

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Windows and doors
4	Date Measure(s) Operational	November 17, 2014
5	Site Visit	Yes, February 19, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	Yes
8	Agreement with Advancement Designation?	Partial—Verified savings are compared to existing equipment for reduced RUL, then new equipment for remaining EUL
Baseline		
9	Utility Claimed Base Case	Existing windows and doors
10	Agreement with Base Case	Partial
11	Where Item 10 is 'no': CPSV Recommended Base Case	Existing for RUL, then Standard Window Baseline
Annual Savings Estimate		
12	Utility Claim ed Gross Natural Gas Savings (for each measure)	12,692 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	11,736 m3 (yr 1-5) 778 m3 (yr 6-20)
15	Utility Claimed Gross Electricity Savings	None
16	Utility Claimed Gross Water Savings	None
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modelling Software	No
22	Were any Measures Add-ons?	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-7.5 %

25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	11,736 m3 (yr 1-5) 778 m3 (yr 6-20)
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	70,350 m3
27	CPSV Firm Justification for Final Recommendation	Heating system efficiency was raised to match as-found equipment. The window leakage rate for the new windows was adjusted to equal typical leakage rates. Lifetime savings reduced due to baseline change to new baseline windows for 15 years of 20 year EUL
28	CPSV Firm IPMVP Option Identified	A—Savings calculated based on door areas and as found heating efficiencies.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	N/A
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0302
Measure:	Windows and Doors
Gross Ex Ante Savings:	12,692 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	-$190,149
Gross Ex Ante Incremental Cost:	$226,765
Facility Usage:	Residential

Measure Description

The customer replaced 174 windows in an 82 unit townhouse complex with efficient ENERGY STAR windows. In addition, doors in each of the units were replaced and fitted with new storm doors.

Summary of the Ex Ante Calculations

This project involved the replacement of 174 windows in a residential townhouse with 82 units. The typical replacement window is a slider type, where half of the area is fixed and the other half is able to slide. The installed window quantities, areas, and weather stripping perimeters are given in the table below.

	WSW	NNW	ESE
Window Quantity	98	5	71
Gross Window Area (ft^2)	1,164	54.4	873
Slider Perimeter (ft)	1,044	50	764

The U-values (conduction coefficient) and leakage rates were given for both the baseline and the efficient windows. The U-values and leakage values used in the calculations are listed in the table below.

	Baseline Windows	Proposed Windows
U-Value	1.18	0.5
Leakage Rate (cfm/ft)	1.0	0.05

The savings were calculated using a window replacement calculator template developed for Union Gas for window projects. The template calculates the savings due to the conduction, as well as the infiltration by orientation. The calculations also account for the solar gains transmitted into the space, due to the solar heat gain coefficient for each window. Overall project savings are then calculated using the equation:

$$Savings_{Total} = Savings_{Conduction} + Savings_{Infiltration} - Added\ Usage_{Solar\ Gains}$$

To determine the savings associated with the conduction a heat load is calculated using the window area and U-value (heat transfer coefficient), and the difference in temperature between the inside space and the temperature at the design conditions, based on the specific area, using the equation:

$$Design\ Heat\ Load = U_{window}\ x\ Area_{Window}\ x\ (T_{inside} - T_{design})$$

Where:

- U_{window} is the U-value of the window, as given in the tables above.
- $Area_{window}$ is the area of all orientations of windows, as given in the tables above.
- T_{inside} is the interior space temperature, or 72°F.
- T_{design} is the outdoor air temperature at the design conditions, based on the locations. For this project, the design outdoor air temperature is -0.9°F.

This design heat load is then applied to an ASHRAE simplified bin analysis method, where the expected gas usage for the baseline and efficient new window condition is calculated for each temperature bin, using the equation:

$$Gas\ Usage_{conduction} = Design\ Heat\ Load\ x\ \frac{(T_{inside} - T_{bin-i})}{(T_{inside} - T_{design})}\ x\ \frac{Hours_{Bin-i}}{Eff_{Bin-i}}$$

Where:

- i is the average temperature for each temperature bin for the ASHRAE simplified bin analysis, ranging from -13°F to 63.5°F, in 4.5°F increments.
- $Hours_{Bin-i}$ is the hours per year that occur within the temperature bin with an average temperature of i, based on typical meteorological year data.
- Eff_{Bin-i} is the heating efficiency at the bin temperature i. The heating efficiency is 80% for the lowest temperature, but decreases to 56% at the highest bin. No explanation or justification was given for the efficiency curve used.

Similar to conduction, a design heat load was also calculated for the baseline and the efficient installed windows for infiltration. The infiltration rate, without correcting for orientation, per square foot of door area was calculated:

$$\text{Infiltration}\frac{\text{CFM}}{\text{SF}} = Leakage\ Rate\ x\ Weather\ Stripping\ length\ \div SF$$

In the above equation, the leakage rate is defined as a cfm per linear foot of weather stripping.

The infiltration rate was used to estimate the total CFM of infiltration for each orientation:

$$Infiltration\ CFM = Infiltration\ Rate\left(\frac{CFM}{SF}\right) x\ Total\ window\ area\ x\ APD$$

APD is a pressure correction factor that is used to correct for the differences in observed pressure on the windows due to wind versus the leakage at the rating pressure for the windows, and is simply a ratio of the wind pressure expected by location based on the average wind speed and the rating pressure for window leakage (0.3 in W.C.). For this location, the expected wind velocity is 13 mph, resulting in a wind pressure of 0.09 in W.C.

The total infiltration rates were used to estimate the total BTUH heating load for each orientation at design conditions:

$$Design\ Heat\ Load \quad = \ Infiltration\ x\ 1.08\ x\ \left(T_{inside} - T_{design}\right)$$

Where 1.08 is a factor to account for units and for density and the resulting design heat load is in BTUs per hour.

This design heat load is then applied to an ASHRAE simplified bin analysis method, where the expected gas usage for the baseline and efficient new window condition is calculated for each temperature bin using the equation:

$$Gas\ Usage_{infiltration} = \sum_{i=-13}^{68} Design\ Heat\ Load\ x\ \frac{(T_{inside} - T_{bin-i})}{\left(T_{inside} - T_{design}\right)}\ x\ \frac{Hours_{Bin-i}}{Eff}$$

Where:

- *i* is the average temperature for each temperature bin for the ASHRAE simplified bin analysis, ranging from -13°F to 63.5°F, in 4.5°F increments.
- $Hours_{Bin-i}$ is the hours per year that occur within the temperature bin with an average temperature of i, based on typical meteorological year data.
- *Eff* is the heating efficiency at the bin temperature i. The heating efficiency is 80% for the lowest temperature, but decreases to 56% at the highest bin. No explanation or justification was given for the efficiency curve used.

The calculation is repeated for each orientation. The gas usage resulting from infiltration in each direction can then be calculated:

$$Gas\ Usage_{infiltration-j} = \sum_{j=1}^{4} Gas\ Usage_{infiltration}\ \ x\ \%Wind_{Direction-j}$$

In the equation above, the $\%Wind_{Direction-j}$ factor accounts for the percent of time that the wind is blowing from the direction j, that the window is facing. This value is determined based on location, from typical meteorological data. For this analysis, it is assumed that the average wind velocity is the same in all directions.

For this project, the total gas usage due to infiltration was 4,860 m3 and 251 m3 for the base and efficient case windows, respectively. This results in a total reduction in gas usage of 1,265 m3 due to reduced infiltration.

The ex ante analysis assumed that the new windows would not have an effect on solar radiation when compared to the baseline windows.

This project also involved the replacement of 82 doors in each of the residential units. The typical replacement door included a side panel that consisted of a fixed window above plus metal blanking panel below. A new storm door was installed with each of the unit doors. Four exit doors were replaced, but they do not have glazing or storm doors.

The energy savings calculations for the door replacements are also based on the window replacement calculator template. The calculations included with the documentation had many hard-coded values, so it was not possible to determine the source of some of the values or the continuity of calculations within the spreadsheet. It appears that only the effect of reduced infiltration was considered to contribute to energy savings. It could not be determined if the effects of a potential improvement in U-value or penalty for reduction in solar gain were considered.

The template and location-specific values used for the window calculations were also used for the door calculations. However, the verification could not with confidence determine what values were used to calculate the claimed savings estimates in all cases.

No additional changes were made to the analysis. The verified savings for this project are given in the table below.

The ex ante savings are presented in Table 1.

TABLE 1 EX-ANTE SAVINGS ESTIMATES

Ex ante Gross Savings	Windows	Doors	Total
m3 natural gas	11,823	869	12,692
kWh electric	0	0	0
L water	0	0	0
Total Cost			$226,765

The application states that the effective useful life of this measure is 20 years. Based on this EUL and the incremental costs and savings presented above, the expected TRC benefit for this project is -$190,149.

Description of Verification

An initial site visit to verify the installation of the windows and doors was conducted on February 18, 2015. The site representative was interviewed and a walkthrough of the building was performed. The customer provided access to one rental unit for inspection of the windows as well as the heating equipment.

All of the windows were found to be installed as expected. The windows and doors are installed in residential units. They were found to be double-pane, insulated glass windows with vinyl frames. The operable windows were slider-style windows.

The removed windows were not available for inspection, however, per the site representative, the windows were approximately 20 years old. They were double-paned windows with wood frames. The windows were not broken and were still in adequate condition, but were drafty.

Heating for the units is met with 80% efficient furnaces. No central cooling is installed; however, the site representative estimated that approximately 10% of the units install window air conditioning units during the summer months. All of the air conditioning units are removed during the heating season.

Summary of Verification Calculations

The verification used a modified version of the Union Gas template to calculate the savings. Essentially, the same calculation methodology was used; however, the template was modified to eliminate the "iterative" approach that required the overwriting of the inputs to preserve the analysis in full.

No changes were made to the U-values, shading coefficient, or leakage values for the baseline windows. Per the customer, the removed doors were single-pane aluminum framed windows. Based on this, the 1.18 U-value, 0.74 shading coefficient, and 1.0 CFM per linear foot of crack area were reasonable.

No specifications for the installed windows were provided. Additionally, no U-value or solar heat gain coefficient values could be found from the manufacturer. However, based on the supplied documentation, the installed windows were aluminum composite frame windows. Based on this, the U-value of 0.50 and the shading coefficient of 0.74 were reasonable. The leakage rate was adjusted, however. The original calculation had described the leakage rate as 0.1 CFM per foot of crack. However, this value was incorrectly input into the leakage per square foot cell instead of the leakage per linear foot of crack length, which gave an equivalent leakage rate of 0.05 CFM per linear foot of crack area. The revised analysis used 0.3 CFM per foot of crack length for the doors, which is consistent with the 0.3 CFM per foot of crack length described in the template for the leakage for new doors with tight weather stripping.

However, the heating efficiency was changed from the ex ante savings calculations. The original analysis listed the heating efficiency at 80%, however, this efficiency was decreased at the upper bins, to a minimum efficiency level of 56% at the 63.5°F bin. This was revised to retain the 80% efficiency at the lower temperatures, but only decrease the efficiency to a minimum efficiency level of 75% at the 63.5°F temperature bin.

The reduction of the leakage and the increase in the heating efficiency reduced savings by approximately 7%.

Based on the customer interview, the existing windows were in very poor condition with the jambs being rotting and letting in significant levels of infiltration. However, the windows jambs were repairable and if the jambs were repaired the windows would still have remained functional. Based on the customer description, the RUL of the existing windows was reduced to 5 years. This was determined to be a reasonable estimate of the time the existing windows could have been retained, in properly maintained.

To calculate the lifetime savings, the savings calculated compared to the existing windows were credited for the five years of remaining useful life. For the remaining 15 years of the effective useful life, the savings were based on the comparing the installed windows to standard efficiency new windows, based on the U-value compliance approach from SB-10, which referenced AHRAE 90.1-2010, as well as the window product standards. Based on this approach, the installed windows were only marginally better than the baseline windows, and are only expected to save 778 m3.

Because the lifetime savings were based on the installation of new windows in five years, an incremental cost was calculated. The calculated incremental cost assumed that the baseline windows would cost similar to the installed windows (since they were only marginally better than the baseline). The present value of the cost in five years was then calculated based on a 5% discount rate, which resulted in an overall reduction in the incremental costs of 86%. Additionally, the cost of the repair the jambs was added to the baseline cost. The cost was estimated to be $200 per unit for all 82 units, for the cost of supplies and internal labor costs. This reduces the incremental cost to by over 50% of the reduced cost after including the purchase of the new baseline windows after 5 years.

No additional changes were made to the analysis. The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas (Year 1-5)	12,692	11,736	92.5%
m3 natural gas (Year 6-20)	12,692	778	6.1%
Lifetime m3	253,840	70,350	27.7%
kWh electric	0	0	N/A
L water	0	0	N/A
Incremental Cost	$226,765	$15,347	6.8%

Primary Cause for Adjustment: Baseline Change

2014–COM-0312

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Building Controls (Demtroys)
4	Date Measure(s) Operational	November 26, 2013
5	Site Visit	Yes, February 26, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case	Furnaces without Demtroys controls
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	7,033 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	0 m3
15	Utility Claimed Gross Electricity Savings	None
16	Utility Claimed Gross Water Savings	None
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	15 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modelling Software	No, Spreadsheet
22	Were any Measures Add-ons?	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Existing units were new at the time of measure installation.
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	- 100.0 %
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	0 m3
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	0 m3
27	CPSV Firm Justification for Final Recommendation	All facility savings could be directly attributed to the

		replacement of older, standard efficiency (80%) furnaces with high-efficiency (96%) units.
28	CPSV Firm IPMVP Option Identified	C. Used stipulated values for furnace efficiencies to account for difference in gas usage due to furnace replacement.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	N/A
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

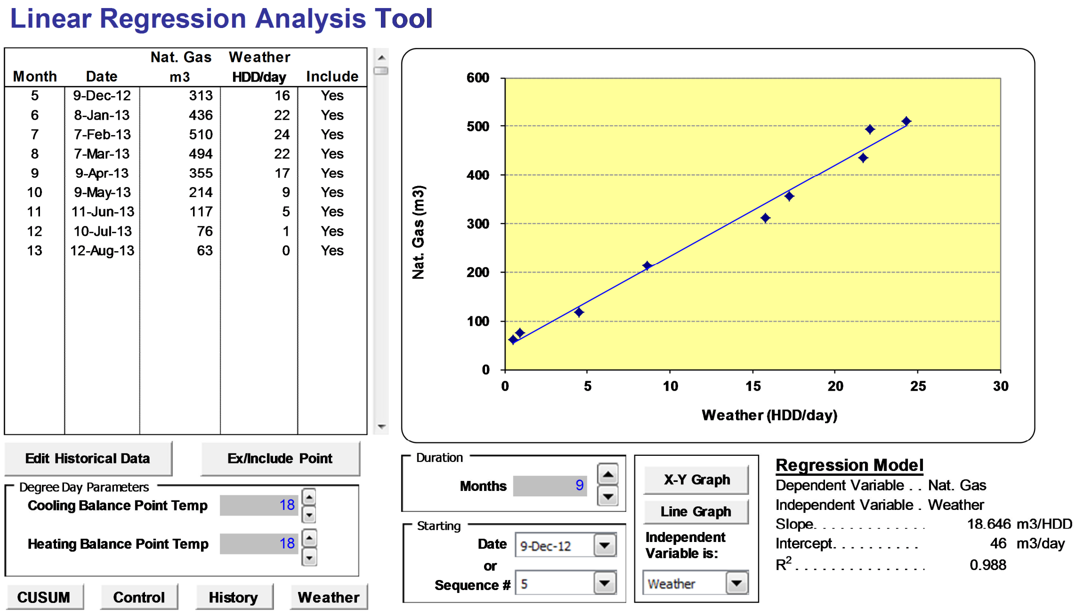
Project ID#:	2014-COM-0312
Measure:	Building Controls (Demtroys)
Gross Ex Ante Savings:	7,033 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	-$4,967
Gross Ex Ante Incremental Cost:	$17,850
Facility Usage:	Residential

Measure Description

The customer installed a Demtroys control system to improve the efficiency of the heating systems for a 57-unit residential townhouse complex consisting of nine buildings. The units are heated by individual forced-air gas furnaces. The Demtroys system limits the percent of time that furnaces can operate for each apartment based on outdoor air temperature. This limits the heat output of the furnaces and the potential for space overheating. Also, the system is intended to affect tenant behavior, e.g. discouraging them from opening windows when heating is needed.

Summary of the Ex Ante Calculations

The savings were calculated using a modified CUSUM analysis. For the CUSUM analysis, the expected operation for the building is based on the billed history from December 2013 through August of 2014, which was related linearly to heating degree days (HDD), as shown in the figure below.



Using this regression, a "baseline" usage was developed for the period from November 2013 to November of 2014. This baseline usage was then compared to the actual billed usage for those months to determine the reduction, due to the project, during those months. The baseline and actual billed usage data is given in the table below.

Date	Actual m3	HDD	Baseline m3	CUSUM m3
11-Nov-13	6,758	342	7,883	- 1,956
9-Dec-13	9,782	504	10,675	- 2,848
9-Jan-14	14,740	837	17,023	- 5,132
10-Feb-14	14,139	865	17,604	- 8,597
11-Mar-14	17,364	753	15,367	- 6,600
9-Apr-14	10,705	581	12,169	- 8,064
12-May-14	6,642	320	7,473	- 8,895
10-Jun-14	3,164	105	3,284	- 9,015
11-Jul-14	1,860	30	1,985	- 9,141
13-Aug-14	2,622	12	1,730	- 8,249
10-Sep-14	2,132	24	1,734	- 7,850
9-Oct-14	3,030	135	3,844	- 8,665
10-Nov-14	6,208	297	7,004	- 9,461

The annual savings were then determined by dividing out the savings for the comparison period by the heating degree days during that period and multiplying by the annual heating degree days, as shown in the formula below.

$$Annual\ Savings = \frac{Period\ Savings}{Period\ HDD} * Annual\ HDD$$

It should be noted that any heating degree days from the months of June, July, and August were not removed, even though the heating system is not expected to be in operation. The resulting savings are given in the table below.

TABLE 1 EX-ANTE SAVINGS ESTIMATES

	Ex ante Gross Savings
m3 natural gas	7,033
kWh electric	0
L water	0
Incremental Cost	$17,850

The application states that the effective useful life of this measure is 15 years. Based on this EUL, and the incremental costs and savings presented above, the expected net TRC for this project is -$4,967.

Description of Verification

A site visit to verify the installation and operation of the Demtroys controls was conducted on February 26, 2015. The site representative was interviewed and a walkthrough of several apartment units, including the one in which the main controller was installed, was performed.

The installation of the Demtroys system was verified and found to match the description provided in the application. The customer reported that this was the first installation by the vendor for a forced-air furnace system. While typical Demtroys installations involve hydronic systems with central heating plants, this system is used with individual, independent furnaces.

The operating principal for this system is similar to what would be used in a multi-unit facility with hydronic heating. In the case of hydronic heating, the Demtroys system would override the signal to the automatic control valve to limit the amount of time heating hot water would circulate through a unit's radiators. In the case of the furnaces at this facility, the Demtroys system will override the signal from the thermostat to limit the amount of time that the furnace's burner operates. The apartments are divided into zones to account for differences in primary building orientation and each zone has separate program settings.

The control sequence is based on a 900 second (15 minute) cycle; the amount of time the furnace is allowed to operate depends on outdoor air temperature (OAT) at a north-facing wall. When the OAT is 21^{o} C or higher, the Demtroys will not allow the furnaces to run. When OAT is approximately -18^{o} C, depending on the control zone, 100% operation is allowed. According to the vendor, the minimum on cycle is 300 seconds (5 minutes). Although the furnaces have two-stage heating capability, the system does not take advantage of this feature and the furnaces only operate at full capacity.

The customer also reported that the furnaces in all of the units were replaced just before the Demtroys system was installed. The new furnaces are high-efficiency units with ECMs and 2-stage heating capacity. The units have a rated efficiency of 96%; they replaced conventional furnaces with an estimated efficiency of 80%.

The customer also reported that the new furnaces have higher capacity than the old furnaces, 60,000 BTUH compared to 45,000 BTUH, because some of the end unit tenants reported difficulties with maintaining apartment temperatures when outdoor temperatures were very low.

The reported cost of the project is consistent with the invoices provided with the application.

Summary of Verification Calculations

The verification used a billed regression analysis to determine savings, which is similar to that used in the ex ante analysis. The final analysis was updated to reflect site observations, primarily the effect of the furnace replacement.

The analysis used one year of pre-case and one year of post case data to determine savings. Gas usage in the apartments includes domestic hot water heating; the total gas used for DHW heating was estimated by assuming that gas usage during the summer months represented typical DHW use throughout the year. The rest of the monthly gas use was assumed to be due to space heating. HDD data was provided with the gas bill information.

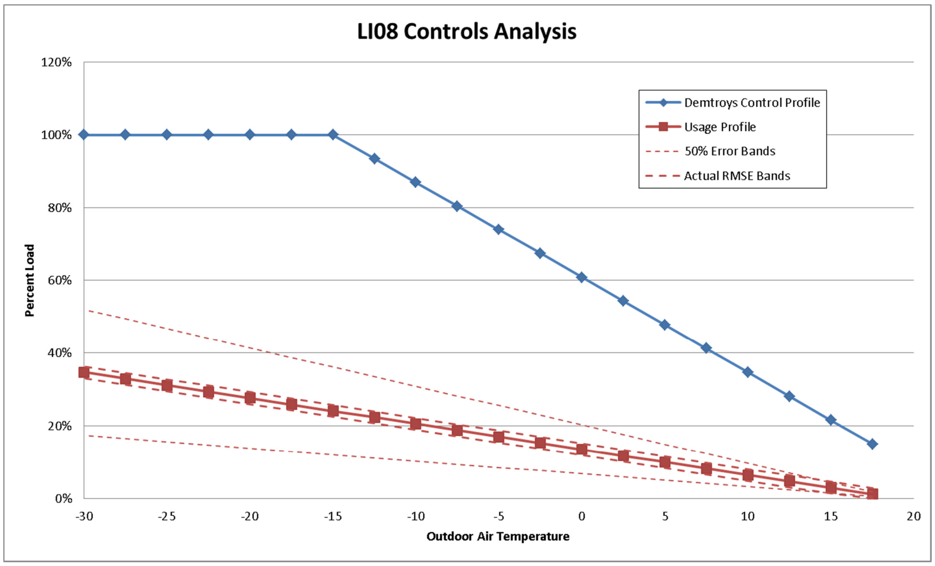
A regression analysis of M^3 gas per (HDD/day) was conducted for the pre and post conditions. For the pre-retrofit condition, an analysis was done using the as-operated condition with the old 80% efficient furnaces. The result was used with typical local HDD to normalize for weather to determine the expected gas usage without new furnaces or controls.

In addition, a regression analysis was done after accounting for the effect of the increase in furnace efficiency. The result was used with typical local HDD to normalize for weather to determine the effect of the installation of high-efficiency furnaces on the overall observed savings.

A similar regression analysis was conducted using post-retrofit billed usage and HDD. That result was used with typical local HDD to normalize for weather to determine the expected post-retrofit gas used for heating.

The total gas reduction from the pre- to post-retrofit periods was determined to be 9,629 M^3. However, all of the savings could be attributed to the furnace replacement; the results of the ex post analysis of the increase in furnace efficiency resulted in savings of 10,743 M^3. Therefore, there are no apparent savings that can be attributed to the installation of the Demtroys control system.

The effect of the larger furnaces was not considered to have a significant impact on the control savings. An analysis of the overall effect of the Demtroys indicates that, on average, the control point of the Demtroys will not have much impact on furnace operation. The graph below shows the estimated control point of the Demtroys as a function of OAT compared to the actual estimated profile as an estimate of per cent load. Both cases assume a furnace capacity of 60,000 BTUH. The picture shows that, on average, the Demtroys is not likely to have a significant impact on furnace operation at any outside air temperature.



The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas	7,033	0	0%
Lifetime m3	105,495	0	0%
kWh electric	0	0	N/A
L water	0	0	N/A
Incremental Cost	$17,850	$17,850	100%

Primary Cause for Adjustment: Incorrect Assumption

2014–COM-0306

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Solar Wall Pre-heater
4	Date Measure(s) Operational	November 14, 2014
5	Site Visit	Yes, February 18, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case	Standard siding and wall construction
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	28,706 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	21,722 m3
15	Utility Claimed Gross Electricity Savings	None
16	Utility Claimed Gross Water Savings	None
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	30 Years
18	Measure Life as per OEB Measure Life Guide	30 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	N/A—Not defined
20	Justification of CPSV Firm's Alternate Measure Life being Used	
Results		
21	Proprietary Modelling Software	No
22	Were any Measures Add-ons?	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-24.3%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	21,722 m3
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	651,660 m3
27	CPSV Firm Justification for Final Recommendation	Billed data and metered data suggest the savings are lower than anticipated.

28	CPSV Firm IPMVP Option Identified	Hybrid of IPMVP Option A and C. Review of calculations and billed data.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	N/A
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0306
Measure:	Solar Pre-heater
Gross Ex Ante Savings:	28,706 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	$-149,909
Gross Ex Ante Incremental Cost:	$228,900
Facility Usage:	Residential

Measure Description

The customer installed a solar wall to preheat ventilation air ahead of a makeup air (MAU) unit.

Summary of the Ex Ante Calculations

The savings were calculated using the Solar Air Heating Project Model in the RETScreen International Clean energy Project Analysis Software.

The model uses owner-provided information to estimate the amount of heating energy captured by the solar wall collector. The user-provided input includes:

- Space temperature (76^{o} F)
- Maximum MUA discharge temperature (120^{o} F)
- Heating system efficiency (95%)
- Design airflow rate (15,500 cfm)
- Hours of occupancy (24 hours/day, 7 days/week)
- Collector Area and properties (10,745 sf, absorptivity=0.95)
- Percent shading during season of use (0%)
- Nearest location for weather data (Windsor)

In addition to estimating the solar energy captured, the savings include building heat loss recaptured by the solar wall. It is assumed that the recaptured building heat loss would otherwise be lost to the environment.

A separate undocumented calculation by the solar wall vendor reported expected savings of 30,723 m3.

The resulting savings are given in the table below.

	Ex ante Savings
m3 natural gas	28,706
kWh electric	0
L water	0
Incremental Cost	$228,900

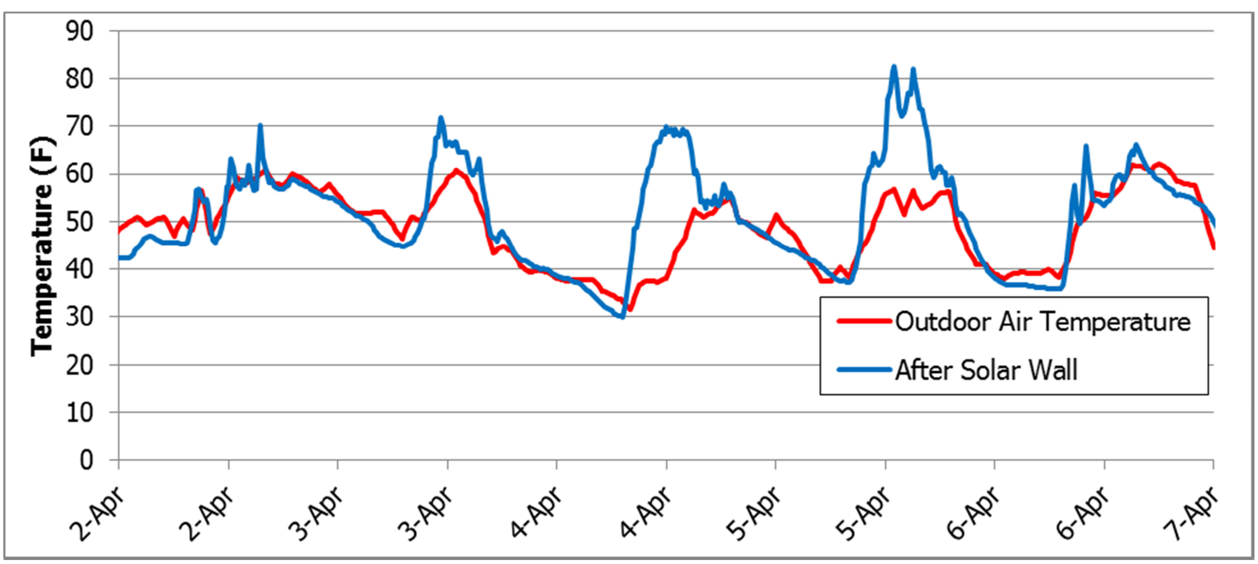
The application states that the effective useful life of this measure is 30 years. Based on this EUL and the reported incremental costs and savings, the expected net TRC benefit for this project is -$149,909

Description of Verification

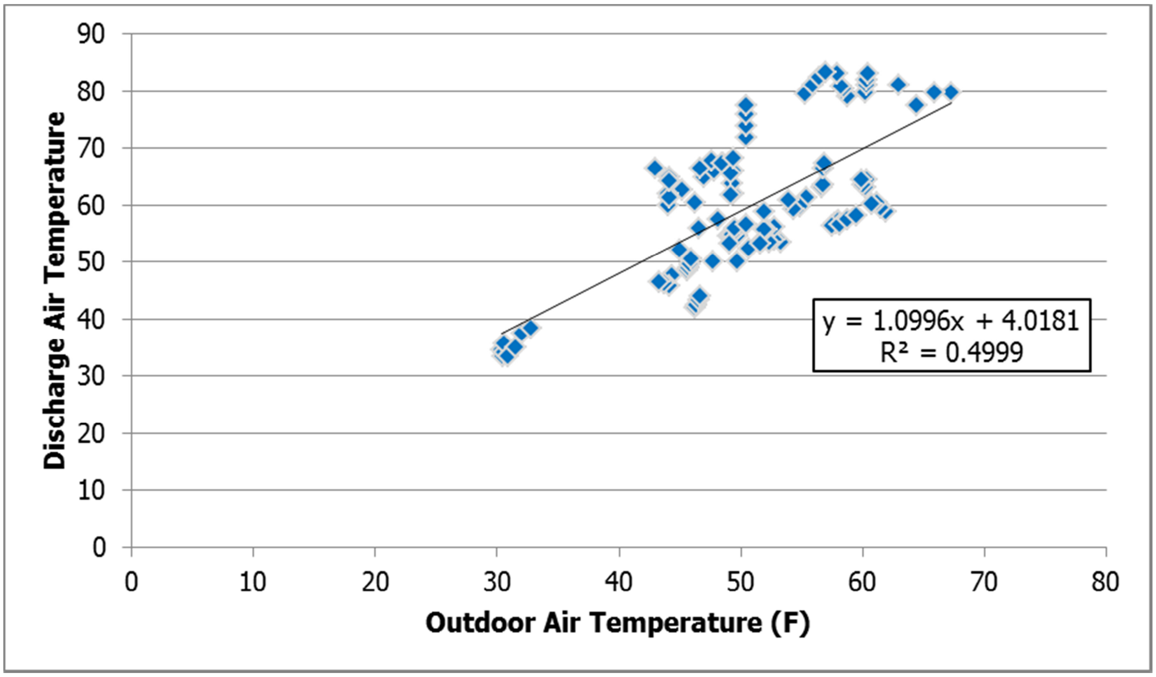
A site visit to verify the installation and operation of the solar wall was conducted on February 18, 2015. The site representative was interviewed and a walkthrough of the building was completed. The solar wall system preheats the air through the absorption of solar radiation on the black solar wall surface. During the moderate months and summer months, the incoming air from the solar wall system is blended with untreated air to maintain a temperature of approximately 68°F to the make-up air unit. If no heating is needed to maintain that temperature, the air from the solar wall is exhausted and untreated air is introduced into the make-up air unit instead.

Summary of Verification Calculations

The savings were calculated using two independent approaches. First, the savings were calculated based on metered temperature rise data collected from the customer's EMS system from March 7, 2015 to April 7, 2015. A sample of the collected data is shown below.



Using this data, temperature rise data was developed for each hour of the day, from 8:00 AM to 9:00 PM, where the discharge air temperature of the solar wall was calculated based on the air temperature. An example profile, for the 5:00 PM hour is shown below.

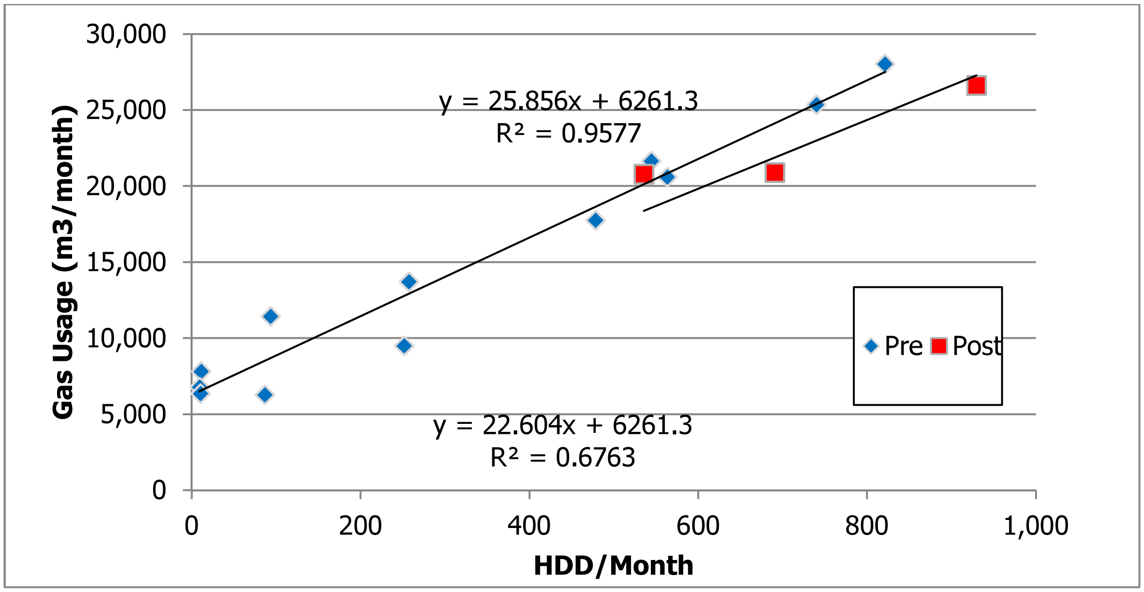


The hourly profiles were then used to calculate the savings in an ASHRAE bin analysis method where the savings for a temperature bin were calculated using the formula:

$$Savings = \frac{1.08\ x\ Temperature\ Rise\ x\ CFM\ x\ Hours}{Efficiency\ x\ 35{,}827}$$

Based on this analysis, the expected savings were 21,722 m3 per year.

To verify these savings levels a review was completed of the billed data since the project completion, shown in the figure below. It should be noted that only three months of billed data were available, therefore, to help ensure a reasonable slope, the intercept of the post-case was set to the same intercept as the pre-case. This was done because the installed equipment is only expected to save heating energy and not have any impact on the summer gas usage.



Based on this data, the expected savings were 22,621 mm3 per year, 4% greater than predicted in the prior analysis.

The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas	28,706	21,722	75.7%
Lifetime m3	861,180	651,671	75.7%
kWh electric	0	0	N/A
L water	0	0	N/A
Incremental Cost	$228,900	$228,900	100%

Primary Cause for Adjustment: Operated or Installed Differently

2014–COM-0313

Date: April 23, 2015

Project Basics		
1	Sector	Social Housing
2	Type of Building, Building Segment or Process	Residential
3	Efficiency Measure(s) Description	Building Controls (Demtroys and K3D)
4	Date Measure(s) Operational	November 11,2014
5	Site Visit	Yes, February 25, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case	Hydronic heating system without Demtroys or K3D controls.
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure)	75,912 m3
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure)	44,141 m3
15	Utility Claimed Gross Electricity Savings	None
16	Utility Claimed Gross Water Savings	None
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	15 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modelling Software	No, Spreadsheet
22	Were any Measures Add-ons?	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Existing boilers and pumps were new at the time of measure installation.
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-41.9%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings	44,141 m3
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM)	662,115 m3

27	CPSV Firm Justification for Final Recommendation	Based on the billed data, the savings are less than anticipated
28	CPSV Firm IPMVP Option Identified	C. Used stipulated values for boiler and domestic water heater efficiencies to account for difference in gas usage due to equipment replacement.
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	N/A
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	N/A

Project ID#:	2014-COM-0313
Measure:	Building Controls (Demtroys and K3D)
Gross Ex Ante Savings:	75,912 m3 natural gas; 0 kWh electric, 0 L water
Net Ex Ante TRC Benefits:	-$60,729
Gross Ex Ante Incremental Cost:	$200,160
Facility Usage:	Residential

Measure Description

The customer installed a Demtroys control system to improve the efficiency of the heating system for a 110-unit residential apartment building. The Demtroys system limits the percent of time that heating valves can be open for each apartment building based on outdoor air temperature thereby reducing the potential for overheating apartments while discouraging wasteful behavior, e.g. leaving windows open during the heating season.

The customer installed a K3D control system in a separate 110-unit building at the same site. The K3D system includes temperature monitoring, controls, valves, and variable frequency drives (VFDs) on the hot water supply pumps. The additional control provides the ability to reduce system flows and temperatures according to heating demands and outside air conditions.

Summary of the Ex Ante Calculations

The claimed savings were calculated assuming that the average effect of both systems would save 20% of the total estimated annual heating load. Based on the claimed savings for each system, this was considered to be a conservative estimate.

The savings for each building were calculated separately, although those results were not used for the final results. The average monthly summer gas use was used to estimate the total annual base gas load for domestic hot water and other year-round purposes. This was subtracted from the average annual gas use to determine heating gas usage for both buildings. The buildings are essentially identical, so it was assumed that the gas usage was divided evenly between the two.

According to the Demtroys vendor results for similar installations at other sites, the savings at this site were expected to be 22.5% of total heating gas usage. The K3D vendor stated that the system would be expected to save about 38% of total heating gas usage. Using the average of these values would have resulted in savings of about 30% of total heating gas usage.

The resulting savings are given in the table below.

TABLE 1 EX-ANTE SAVINGS ESTIMATES

	Ex ante Savings
m3 natural gas	75,912
kWh electric	0
L water	0
Incremental Cost	$200,160

The application states that the effective useful life of this measure is 15 years. Based on this EUL, and the incremental costs and savings presented above, the expected TRC benefit for this project is -$60,729.

Description of Verification

A site visit to verify the installation and operation of the Demtroys controls was conducted on February 25, 2015. The site representative was interviewed and a walkthrough of several apartment units plus the mechanical room of one building was performed. The two buildings at this site are identical, including the heating and domestic hot water equipment. The installation of the Demtroys and K3D systems were verified and found to match the description provided in the application.

The K3D system had not yet been fully commissioned at the time of the site visit. The vendor was still fine tuning the system and the automatic controls to the variable speed pumps had not yet been connected. It should be noted that the pumps were running at 50% speed and the automatic control valves were functional, so this may have had only a minor effect on the savings.

The customer also reported that the boilers and water heaters in both units were replaced at the same time as the control systems were installed. The new boilers are RBI Model CB2000 condensing units with nominal 97.5% efficiency. The old boilers were LAARS PH1200 boilers with atmospheric burners and nominal efficiency of 81.4%. The new domestic water heaters are RBI Infinite Energy2 IB/IW750 units with nominal rated efficiency of 94.8%. The old water heaters were LAARS PH250 w/atmospheric burner units with nominal efficiency of 81.4%.

The total quoted cost of the project was $205,880, compared to the application reported cost of $200,160. It appears that the application cost did not include the full installation and commissioning costs of the Demtroys system.

Summary of Verification Calculations

The verification used billed data to determine savings. In addition to space heating, the facility uses gas for domestic hot water heating. Average billed usage for the 3 months from June, July, and August was assumed to represent average monthly gas usage for domestic hot water. The average daily heating use was estimated by subtracting the estimated average daily use from total daily gas use for each billing period. Because of the replacement of heating equipment just prior to the installation of the controls, the heating gas use was further adjusted by the difference in efficiency between the old and new equipment.

A regression analysis of the adjusted pre-retrofit daily gas usage as a function of HDD data resulted in a linear correlation with an R2 value of 0.87. The regression was used with typical local HDD data to determine annual baseline gas usage for space heating.

Based on information collected during the verification, there was only one month of post retrofit billing data available between the project completion, including boiler start-up and the time of this analysis. Therefore, it was not possible to establish a correlation between post-installation energy usage and typical HDD.

The pre-retrofit correlation was used with average post-retrofit HDD data to estimate baseline heating gas usage for the one-month period for which post data was available. The total baseline use was compared to total actual post use to estimate the per cent savings due to the controls. The result was an estimated reduction in gas use of about 13%. This value was multiplied by the estimated baseline gas consumption to determine expected average annual savings.

Potential electrical savings were not included in the application analysis. While there may be some electrical savings due to the installation of VFDs for the hot water circulation pumps associated with the K3D system, the variable speed controls were not connected at the time of the site verification. Therefore, the verification analysis did not include any electrical savings.

The verified savings for this project are given in the table below.

TABLE 2 EX-POST ENERGY SAVINGS COMPARISON

	Gross Ex ante Savings	Gross Verified Savings	Project Realization Rate
m3 natural gas	75,912	44,141	58.1%
Lifetime m3	1,138,680	662,115	58.1%
kWh electric	0	0	N/A
L water	0	0	N/A
Incremental Cost	$200,160	$205,880	102.9%

Primary Cause for Adjustment: Incorrect Assumption

Appendix M – Engineering Review of 2014 Commercial/Industrial Custom Projects Review of Random Sample Files

Engineering Review of
2014 Commercial/Industrial Custom Projects
Review of Random Sample Files

Final Report – Version 2
(Supersedes June 1, 2015 report)

July 24, 2015

Prepared for:

Union Gas Limited
DSM Research and Evaluation Department
2901 - 777 Bay Street | Toronto, ON M5G 2C8

Prepared by:

Byron Landry, P. Eng., CEM, CEA

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APPENDICES

EXECUTIVE SUMMARY

Byron J. Landry & Associates Inc. was contracted by Union Gas Limited to complete a third party engineering review (CPSV) of the results of (24) Custom Applications Projects in the Industrial and Commercial sectors, applying to Year 2014. The review is aimed at developing an independent verification opinion as to the reasonableness of the annual and cumulative utility savings submitted by Union. Following receipt of the project files, the reviewer visited *all* project sites to observe the energy performance of the measures and gather supporting data. While the Terms of Reference for the CPSV assignment address the evaluations of remaining useful life and the concepts of "advancement" or "replacement", the determination of "free-ridership" is specifically excluded from the CPSV tasks.

In general, the quality of the supporting data that was presented in the project files was sufficient for the reviewer to make an informed evaluation. In all cases where the information was sufficient, the supporting calculations and analysis conformed to sound engineering practice. For (3) of the projects where the measures were implemented under either an ESCO or Design/Build/Operate framework, the brevity of information presented prompted the reviewer to insist on more supporting data being provided or that representatives from the third party be present for the site visit to elaborate on how the savings projections were arrived at. The outcome of these visits generally satisfied the reviewer but it is recommended that in future, more detail be outlined in the project file beyond the ultimate results summary derived from energy modeling efforts.

The following general instances triggered adjustments to either annual savings estimates or measure life (EUL) by the reviewer:

- Site observations of temperatures or other performance parameters differed from key inputs to the calculations.
- The estimated service life of the add-on measure exceeds that of the underlying base equipment.
- *Reviewer's opinion* that the EUL of Greenhouse structural materials (eg. Triple polycarbonate) should not exceed double the warranty period of that material
- Cases where the stated EUL is at odds with the OEB Measure Life Guideline or the support engineer's written confirmation included in the project file.

The results of the review and associated project measure adjustments are summarized on the following pages for reference.

Natural Gas Measure Summary for CPSV Review of Random Sample 2014 Custom Commercial & Industrial Projects (Union Gas)

Union Gas Project	Sector	Measure	Equipment Useful Life (yrs)		Gross Annual Savings Natural Gas (m3)			Gross Cumulative Savings Natural Gas (m3)		
			UG file	Reviewer Adjusted	UG file	Reviewer Adjusted	% variance	UG file	Reviewer Adjusted	% variance
CI04 - 2014-IND-0178	[redacted]	Steam leak repairs	10		2,787,038	1,684,467	-40%	27,870,380	16,844,670	-40%
CI01 - 2014-IND-0569	Manufacturing	Multi-measure process and energy intensity upgrades	20		2,754,000	2,754,000		55,080,000	55,080,000	
CI24 - 2014-COM-0087	Manufacturing	High Efficiency, Direct-fired H&V unit	20		12,964	13,974	8%	259,280	279,480	8%
CI21 - 2014-IND-0183	Manufacturing	Insulate dryer drum	20	15	73,092	47,291	-35%	1,461,840	709,365	-51%
CI14 - 2014-IND-0112	Manufacturing	Steam leak repairs	20		327,010	348,784	7%	6,540,200	6,975,680	7%
CI16 - 2014-IND-0166	Manufacturing	Process Oven burner upgrade and heat recovery	20		265,793	265,793		5,315,860	5,315,860	
CI11 - 2014-IND-0056	Manufacturing	Deaerator heat recovery	20	14	517,813	366,540	-29%	10,356,260	5,131,560	-50%
CI15 - 2014-COM-0079	Agriculture	Steam leak repairs	20		300,820	281,768	-6%	6,016,400	5,635,360	-6%
CI17 - 2014-COM-0051	Agriculture	Greenhouse expansion - multi-measure	14	16	319,540	514,195	61%	4,473,560	8,227,120	84%
CI05 - 2014-IND-0025	Agriculture	Greenhouse expansion - multi-measure	14	13	1,676,703	1,676,703		23,473,842	21,797,139	-7%
CI06 - 2014-IND-0024	Agriculture	Greenhouse expansion - multi-measure	15	14	1,158,947	1,158,947		17,384,205	16,225,258	-7%
CI07 - 2014-IND-0114	Agriculture	Greenhouse expansion - multi-measure	15		1,131,090	1,160,603	3%	16,966,350	17,409,045	3%
CI10 - 2014-IND-0172	Agriculture	Insulation of steam supply lines	20		594,534	604,538	2%	11,890,680	12,090,760	2%
CI13 - 2014-COM-0320	Agriculture	Greenhouse expansion - multi-measure	14		499,488	538,335	8%	6,992,832	7,536,690	8%
CI02 - 2014-IND-0021	Agriculture	Greenhouse expansion - multi-measure	16	15	2,727,061	2,727,061		43,632,976	40,905,915	-6%
CI03 - 2014-IND-0022	Agriculture	Greenhouse expansion - multi-measure	16	15	1,970,483	1,970,483		31,527,728	29,557,245	-6%
CI09 - 2014-IND-0570	Agriculture	Insulate steam, condensate, hot water piping	20		718,537	718,537		14,370,740	14,370,740	
CI12 - 2014-IND-0333	Agriculture	Heat exchanger upgrade	20	14	407,798	434,687	7%	8,155,960	6,085,618	-25%
CI18 - 2014-IND-0210	Agriculture	Heat exchanger upgrade	20	14	123,571	158,754	28%	2,471,420	2,222,556	-10%
CI08 - 2014-COM-0240	Healthcare	Upgrade building systems to LEED standards	20		822,929	747,828	-9%	16,458,580	14,956,560	-9%
CI19 - 2014-IND-0115	Healthcare	Steam leak repairs	20		104,655	100,630	-4%	2,093,100	2,012,600	-4%
CI23 - 2014-IND-0261	Healthcare	Insulate piping, valves and heat exchangers	20		17,281	21,221	23%	345,620	424,420	23%
CI20 - 2014-COM-0345	Education	Boiler control upgrades and adjustments	11	10	148,257	117,183	-21%	1,630,827	1,171,830	-28%
CI22 - 2014-COM-0239	Education	Upgrade building systems to LEED standards	20		33,358	45,299	36%	667,160	905,980	36%
				TOTAL	19,492,762	18,457,621	-5.3%	315,435,800	291,871,451	-7.5%

Variances -1,035,141 m^3 ***Variances*** -23,564,349 m^3

Electricity/Water Measure and Cost Observations Summary for CPSV Review of Random Sample 2014 Custom Commercial & Industrial Projects (Union Gas)

Union Gas Project Code	Sector	Measure	Installed Cost Applied in UG File			Gross Annual Electricity Savings (kWh)			Gross Annual Water Savings (L)		
			Incremental Cost	Reviewer Adjusted	% variance	UG file	Reviewer Adjusted	% variance	UG file	Reviewer Adjusted	% variance
CI04 - 2014-IND-0178	[redacted]	Steam leak repairs	$82,484	$80,283	-3%				34,139,808	20,032,448	-41%
CI01 - 2014-IND-0569	Manufacturing	Multi-measure process and energy intensity upgrades	2/3 measures	indeterminate	indeterminate	12,911,000	12,911,000	0%	289,000	289,000	0%
CI24 - 2014-COM-0087	Manufacturing	High Efficiency, Direct-fired H&V unit	$4,000								
CI21 - 2014-IND-0183	Manufacturing	Insulate dryer drum	$19,800								
CI14 - 2014-IND-0112	Manufacturing	Steam leak repairs	$5,040						3,160,153	3,158,710	-0.05%
CI16 - 2014-IND-0166	Manufacturing	Process Oven burner upgrade and heat recovery	$86,349	$49,680	-42%						
CI11 - 2014-IND-0056	Manufacturing	Deaerator heat recovery	$15,615						6,246,793	4,727,608	-24%
CI15 - 2014-COM-0079	Agriculture	Steam leak repairs	$4,600						3,114,708	2,917,443	-6%
CI17 - 2014-COM-0051	Agriculture	Greenhouse expansion - multi-measure	$237,660	$314,830	32%						
CI05 - 2014-IND-0025	Agriculture	Greenhouse expansion - multi-measure	$1,290,000								
CI06 - 2014-IND-0024	Agriculture	Greenhouse expansion - multi-measure	$849,847								
CI07 - 2014-IND-0114	Agriculture	Greenhouse expansion - multi-measure	$474,920	$655,675	38%						
CI10 - 2014-IND-0172	Agriculture	Insulation of steam supply lines	$15,500								
CI13 - 2014-COM-0320	Agriculture	Greenhouse expansion - multi-measure	$94,112	$151,448	61%						
CI02 - 2014-IND-0021	Agriculture	Greenhouse expansion - multi-measure	$1,647,500								
CI03 - 2014-IND-0022	Agriculture	Greenhouse expansion - multi-measure	$1,405,750								
CI09 - 2014-IND-0570	Agriculture	Insulate steam, condensate, hot water piping	$106,000								
CI12 - 2014-IND-0333	Agriculture	Heat exchanger upgrade	$115,003								
CI18 - 2014-IND-0210	Agriculture	Heat exchanger upgrade	$50,000								
CI08 - 2014-COM-0240	Healthcare	Upgrade building systems to LEED standards	$13,000,000			3,623,938	indeterminate	indeterminate			
CI19 - 2014-IND-0115	Healthcare	Steam leak repairs	$9,392						1,056,563	1,056,563	0%
CI23 - 2014-IND-0261	Healthcare	Insulate piping, valves and heat exchangers	$51,191								
CI20 - 2014-COM-0345	Education	Boiler control upgrades and adjustments	$12,480								
CI22 - 2014-COM-0239	Education	Upgrade building systems to LEED standards	$445,000								
		TOTAL				16,534,938	12,911,000	-22%	48,007,025	32,181,772	-33%
			Variances				-3,623,938 kWh			-15,825,253 L	

1. Introduction and Scope of Review

Union Gas Limited encourages its customers to efficiently utilize natural gas. Demand Side Management (DSM) energy efficiency programs of Union Gas include educational materials, technical assistance and financial incentives. These programs offer energy efficiency audits/studies and financial support in implementing an energy management project. Commercial/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 Union Gas Limited to complete a third party engineering review (CPSV) of the results of (24) Custom Applications Projects in the Industrial and Commercial sectors, applying to Year 2014.

This report provides an independent review of an independent 3rd party consultant 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 original claim.

The general approach used for the evaluation consisted of:

- review of the original claim 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;
- review available information to estimate the actual gas savings and EUL; and
- provide an assessment of the reasonableness of non-gas savings (water, electricity, incremental cost) estimates found to be noteworthy.

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 CPSV Reviewer does not warranty or guarantee the energy or water savings estimates.

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

- (10) files (February 9, 2015)
- (8) files (February 10, 2015)
- (6) files (February 11, 2015)

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 Union Gas and review by its Audit Committee and external auditor for the DSM Program.

2. Opinion of Equipment Useful Life (EUL)

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 that have not yet occurred. (An example would include retroactive rulings by regulatory agencies that would require immediate upgrade or replacement of equipment). The evaluation that was conducted as part of this assignment represents a *technical* judgment based on accepted industry published data, the visually observed condition of the system and previous experience with similar systems in similar applications. This assessment is contingent on the assumption that regular preventive maintenance of the system will be carried out for the duration of its estimated life.

The Project Summary Table, included in the Executive Summary of this report, identifies which projects incurred reviewer's adjustments on EUL values originally stated in Union's project file. Reasons for the adjustments are presented in each outline of the reviewer's observations, included in Section 4 of this report. Since some of the adjustments repeat themselves for similar measures, the following projects that incurred EUL adjustments are grouped according to the reviewer's rationale for making those adjustments:

CI21 - 2014-IND-0183

The reviewer adjusts the EUL (noted in the project file at 20 years) to 15 years, given that due to the robust operation of the plant, the remaining service life of the drum (to which the insulation is attached) was expected by plant personnel to be 15 years.

CI11 - 2014-IND-0056

While the EUL that is stated in the project file at 20 years conforms to Union's Guidelines under the category of "Steam Piping Leaks", an EUL of 14 years is also listed for Heat Exchangers. The EUL is adjusted to reflect the OEB Guide reference to Heat Exchangers (14 years); the equipment which had the tube replacement.

CI05 - 2014-IND-0025; CI06 - 2014-IND-0024; CI02 - 2014-IND-0021; CI03 - 2014-IND-0022

The composite, multi-measure EUL for these projects include a 25 year spreadsheet input for the Polycarbonate Triple Wall and 10 years for the Energy Curtain measure. This wall material typically has a manufacturer's warranty period of 10 years (excluding hail damage) but most published sources state a useful life that ranges from 10 – 20 years. Union's EUL Custom Offering guideline of 5 years for energy curtains equals the typical warranty life specified by manufacturers. Some published sources claim an actual replacement interval of every 7 – 12 years, depending on use, installation quality, etc. Factoring these elements into consideration, it is the reviewer's opinion that in both cases the component EUL should not exceed double the warranty life. This yields a component EUL of 20 years for Polycarbonate Triple Wall and remains at 10 years for the Energy Curtain measure. This adjustment has been reflected in the multi-measure savings-weighted EUL for each project.

CI12 - 2014-IND-0333; CI18 - 2014-IND-0210;

The EUL that is stated in the project file at 20 years for Plate & Frame Heat Exchangers is adjusted to conform to Union's Guidelines of 14 years and the service provider's engineer's written confirmation that is included in the project file.

CI20 - 2014-COM-0345

Reviewer's analysis revealed a lower operating time for one of the two boilers impacted by the measures and reduced fuel consumption for the other boiler. These adjustments triggered a revised, weighted composite EUL.

The assignment's terms of reference also request comment on the "reasonableness of the designation of *advancement* where applicable". In this context, the reviewer interprets the term "advancement" to apply to situations where Union's Programs caused an early replacement of systems or equipment for the customer to realize energy savings from increased efficiencies sooner, rather than later. This infers that "advancement" measures should not be claimed over the full measure life of the new equipment. According to this determination, the CPSV reviewer must count the savings from the time of installation *minus* the time that the installation would have been scheduled for without the incentive. *During the review of all projects and information gathering on site, no projects were deemed to be "advancements".* In some projects, the Customer stated that the availability of Union's incentives prompted the inclusion of more energy efficient features than otherwise would have been constructed, but there was no hard evidence to suggest *which* measures would have been excluded and *when* this may otherwise have occurred. (The lack of compelling evidence in this regard makes it impossible to subtract the time that the installation would have been scheduled for without the incentive).

3. Opinion of Installed or Incremental Cost

The opinions of how reasonable were the installed or incremental costs stated in the project files are developed by the reviewer in the absence of detailed engineering design and quantity survey (*beyond the scope of this assignment*). Due to the susceptibility of pricing to variable market conditions, the nature of the review is focused on a "high level" assessment as to whether the stated costs appear to fall within a reasonable order-of-magnitude, based on the reviewer's experience with similar projects and published data such as Means or Hanscomb.

The extent of supporting cost information in the files varied. In some cases, the project costs were very well supported in the files by the inclusion of line item breakdowns of labour and material from the vendor or installer. In other project files, total costs were simply stated as a single line item. Usually, this may have been due to circumstances where the project measure was but one component of several other site works, where this would have been difficult to split out shared piping, valving, etc. Otherwise, the plant or facility may have expressed strong sensitivities or concerns on not having this key information potentially leaked to their competitors and would then view the pursuit of any further detail by an outsider to be intrusive.

The reviewer did not discover any objectionable issues with regard to the magnitude or reasonableness of the costs that were outlined in the project files. In the cases of insulation measures on pipework, some of the costs appeared lower than what would be calculated on a unit basis from published cost data but this is likely due to the installations being completed by internal labour. For the project measures reviewed, most costs were appropriately applied on an *incremental* basis. Specific exceptions include the following projects:

<u>CI04 - 2014-IND-0178</u>

The removal of two major steam leaks that appear to have a high likelihood of warranting immediate attention (and being repaired outside of Union's incentive programs in any case) triggered a corresponding incremental cost adjustment from $82,484 to $80,283.

<u>CI01 - 2014-IND-0569</u>

Full costs were identified for (1) of the (3) component projects; namely, the [redacted]. The inter-relational aspects and magnitude of this project preclude the development of an incremental cost in the absence of detailed design engineering.

<u>CI16 - 2014-IND-0166</u>

A Labour & Material cost breakdown for recuperators plus burners, ($86,349 *total*) according to each process oven and commissioning date, is itemized. The CPSV review adjusts this to the incremental cost of the recuperators (*the equipment which drive the savings*) at $49,680.

CI17 - 2014-COM-0051; CI-07-2014-IND-0114; CI-13-2014-COM-0320

Given that the IR AC Poly structures (that are included in the greenhouse multi-measure projects) cost roughly double that of regular double poly, an incremental cost adjustment to $38,585 was made for that component measure in project CI17 - 2014-COM-0051. For all (3) projects the reviewer concedes that the effect of the envelope on infiltration is likely to equal the 20 year stimated life of the new climate control systems, (*assuming envelope replacement about every 5 years is a reasonable expectation*). On this basis, the incremental cost of structural envelope replacement for (4) five year cycles was then included as an adjustment to the incremental cost, to avoid exaggerating the cost effectiveness of the measure. (*No attempt was made by the reviewer to forecast discount rate, in the interests of not over-complicating this issue*).

4. Commercial/Industrial Custom Project Review Summaries

A custom project savings verification summary along with CPSV review observations and applicable adjustments are presented below for each Industrial Custom Application project.

In each case the review evaluated the reported energy savings according to four (4) measurement and verification options as follows:

- Option 'A' – retrofit isolation with measured performance and stipulated operation
- Option 'B' - retrofit isolation with measured performance and measured operation
- Option 'C' – whole facility or utility bill comparison
- Option 'D' – calibrated computer simulation.

4.1 CI - 04 (2014-IND-0178)

Union Gas Project Number:	**CI - 04 (2014-IND-0178)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	[redacted]
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Steam Leak Repairs
4	Date Measure(s) Operational	Nov 24, 2013
5	Site Visit	Mar 10, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Measure isolation. Steam leakage rates were estimated according to the Darcy formula for flange leaks and Sarco derived formula for orifice type leaks and summed.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	2,787,038
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	1,684,467
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	34,139,808
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	10 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	Most leakage at flanges
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	1,684,467
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	16,844,670
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A

29	CPSV Firm Final Assessed Electricity Savings (if noteworthy) (kWh)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy) (L)	20,032,448

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 04 (2014-IND-0178)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	Each steam leak line item is well supported by a Work Order #, which includes associated Labour hours and cost and actual material cost. ($82,484 representing sum of *incremental* measure items). This value was adjusted to $80,283 by the reviewer, in accordance with the removal of (2) sources of leakage from the savings claim, as discussed in the following Observations.
Project Measure:	SHW - Leaks - Repairs 2013
Project Description:	Steam leaks were repaired throughout the [redacted] as cross-referenced to work order documentation in the project file.

Prioritization/Maintenance Practice/Union Gas Role:

<u>Prioritization/Customer Practice:</u> Severe steam leaks that represent an immediate safety issue warrant immediate priority. Next, simple leaks which can be easily isolated are repaired ASAP. *Leaks that are not readily accessible or do not warrant rapid attention are recorded in the work order system for repair at an unspecified future date. These leak types represent the incremental DSM measures that are listed in the project calculation files and cross-referenced to the Work Order line items.*

<u>Documented Practice:</u> Entered into the Work Order system when spotted.

<u>Union's Role:</u> Some leakage repair could be deferred indefinitely without the plant's access to the incentive program. Incentive funds received from Union are directed into the site utility group's cost centre, and allocated in the maintenance budget planning process for further leakage repair.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

A plant walk-through to representative repair locations with the site's designated Mechanical Maintenance Engineer confirmed the stoppage of steam leaks as outlined in their respective work order summaries. (A representative photo is included in Appendix 'A' for reference).

Baseline calculations factor 8,600 hr/yr operation of the steam system. This is an appropriate annual average, given the close to 3 week planned maintenance outage that occurs every 18 months. The calculation methodology for the individual steam leakage rates from the project file was reviewed and appropriately applies the Darcy formula for pipe flange leaks and Sarco derived formula for "orifice" type leaks. As a "first screening reality check" against total steam flows, the total estimated steam leakage *claim* of 9,136 pph was compared to the average (non-weather sensitive) summer total load of 24,821 pph, minus process rated demand of 18,480 pph. Given the latter represents a total coincidental peak which is not likely to occur, it is conceivable that the actual steam leakage is within the estimated order-of-magnitude. Also, the nominal steam/fuel efficiency factor used in the calculations appears to be reasonable, given the reviewer's observation of combustion parameters and expected allowances for blowdown losses, etc. (A boiler control screen capture is included in Appendix 'A' for reference).

Notwithstanding the foregoing, it was noted that out of the repaired leaks list, leakage items quantified at 2759 lbs/hr and 854 lbs/hr were designated in the maintenance logs for repair "as soon as possible" due to potential flange damage and one was roped off while awaiting repair, presumably due to safety issues. Due to the need for immediate repair recognized by the maintenance staff, these repairs should not have been included and the claimed gas and water savings for this project should be reduced accordingly. The final adjustment by the reviewer is calculated on the basis that the sum of the two major leaks (2,759 + 854) pph = 3,613 pph removed out of the original 9,136 pph savings claim estimate.

While the EUL that is stated in Union's Guidelines under the category of "Steam Piping Leaks" is 20 years, the reviewer believes this is unrealistic, given that the majority of leakage repair relates to flange gaskets, which are not as durable as a pipe or fitting replacement. This must also be viewed within the context that much of the pipework and valve sections pre-date the 1970's. Accordingly, an energy based weighted average adjustment is applied as follows:

$(1{,}485{,}939_{\text{flangework}}/1{,}684{,}467_{\text{total}})\ m^3$ x 10 years = 8.8 years
$(198{,}528_{\text{pipework}}/1{,}684{,}467_{\text{total}})\ m^3$ x 20 years = 1.2 years
10.0 years

On the basis of the foregoing, the reviewer concurs with the 10 year EUL applied by Union for this specific case.

The project file's spreadsheet calculations appropriately estimate the annual water makeup (L) savings associated with each steam leakage reduction line item but the adjustment on total steam leakage from 9,136 pph to 5,523 pph (*that should be claimed*) triggered a corresponding adjustment in water makeup savings estimates.

4.2 CI - 01 (2014-IND-0569)

Union Gas Project Number:	**CI - 01 (2014-IND-0569)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	[redacted]
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Multi-measure process and energy intensity upgrades
4	Date Measure(s) Operational	Nov 1, 2013
5	Site Visit	Mar 20, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Continue direct steam injection, operation of one additional curing oven, maintain lower production rate at higher energy intensity.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	2,754,000
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	Yes
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	n/a
15	Utility Claimed Gross Electricity Savings (kWh)	12,911,000
16	Utility Claimed Gross Water Savings (L)	289,000
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		

21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Reasonable; refer to Observations
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	2,754,000
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (m^3)	55,080,000
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	C
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	12,911,000 kWh
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	289,000 L

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 01 (2014-IND-0569)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	The costs for the multi-measures that comprise this overall project are supported by line item breakdowns for assembly labour and materials as well as a copy of the Purchase Order (PO) that was processed through the plant's vendor contract administration system. (Incremental costs of $2,270,988 for [redacted] and $36,587,380 for [redacted]; full costs of Capacity Increase project at $50,740,000). Incremental costs of the Capacity Increase component project are difficult to establish in the absence of detailed engineering by the reviewer.
Project Measure:	Energy Intensity Improvements
Project Description:	The site underwent three significant and distinct initiatives related to energy efficiency and production energy intensity/efficiency at the site. Many of the changes began in January 2013 and all were completed and operational by November 2013. Due to the interrelated nature of the initiatives a CUSUM style analysis was used to estimate the savings observed on the customer's gas meter. The savings were then normalized for weather impacts to reduce the impact of the cold weather of 2013/2014 winter. Past impacting energy savings claims at the site were also summarized and removed from this savings claim. The three initiatives included: (1) [redacted] (2) [redacted], and 3) A new [redacted]. (Refer to more details in EUL Observations which follow).

Prioritization/Maintenance Practice/Union Gas Role:

Prioritization/Customer Practice: Facing competitive pressures in the industry, the plant has adopted aggressive targets for Energy Efficiency. While Electricity represents approximately 65% of the energy cost, Natural Gas represents the same percentage on a total energy basis, thus raising the profile of DSM opportunities for Natural Gas.

Documented Practice: Compared to other sites visited during the CPSV reviews, the level of documentation support is above average.

Union's Role: The availability of Union's incentives appears to have increased the priority level for a portion of the projects, but there is no hard evidence to suggest when this may otherwise have occurred. The incentives assisted the site's "Energy champion" to achieve his energy efficiency targets by rededicating the rebate funds towards further improvements (an "Energy dividend" approach). Beyond the incentives, the Customer perceives Union's role as being of even more value with their technical validation of the parameters used by the plant in their "first screening" energy analysis.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The projected savings for the process improvements were calculated on the basis of an Energy Intensity analysis of before/after conditions surrounding the production changes. The project file includes a rigorous CUSUM and Regression analysis. The supporting analysis correctly factors out any previously incented projects out of the Baseline Period. Both weather and production influencing variables were factored in the analysis. (While there is no universally accepted standard for a minimum acceptable regression analysis R^2 value, 0.75 is often considered a reasonable indicator of a good correlation between Energy and independent variables). Given the analysis yields R^2 values of 0.72 (water), 0.81 (electricity) and 0.96 (multi-measures), the inferred correlation ranges from acceptable to strong. These considerations and an overall review of the analysis suggest that the functional form of the model is deemed to be sound. The on-site meeting with the Customer's technical and managerial resource enabled viewing of the relevant documentation and production enhancements to fully support the measure. (Specific details are highly confidential and cannot be included in this report).

The savings period identified in the original project file analysis ended at October 2014 and more data was requested during the March 2015 site visit to enable the reviewer to gage how the post-implementation energy performance is tracking. Toward that end, extended data from November 2014 to February 2015 was used to populate the original spreadsheet analysis. A comparison of monthly average energy data between (Nov 2013 – Feb 2014) and (Nov 2014 – Feb 2015) indicated that, on balance, the energy improvements continue to track. 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.

The EUL that is stated in the project file at 20 years must be evaluated on the basis of the (3) broad measures that comprise the overall project. The [redacted] project's major equipment includes installation of a new direct fired burner and high pressure piping/nozzles. According to published ASHRAE data, these could be expected to realize a 20 year service life. The longevity of the [redacted] project is more difficult to evaluate, given the line extensions, conveyor modifications, robot programming and new equipment additions that comprise this measure. Given that most entail new equipment and that the re-use of any original equipment would not pre-date Year 2008, an expected service life of 20 years is possible. Even if components such as robots or programming controls become obsolete due to rapid technology advancements, line capacity will not likely decrease (due to the "survival motive") and Energy Intensity will not likely change appreciably. Factoring these perspectives into consideration, there is no hard evidence to suggest that a 20 year EUL for this project component is unattainable. The 3rd component measure ([redacted]) entails the building of a new system to replace the previous system that was in operation since Year 2008. While the original system was generally functional, it was prone to capacity bottlenecks and higher maintenance that was at odds with the [redacted] project. Various aspects of this measure distill down to the energy perspective that it enabled the elimination of one curing oven and its associated natural gas consumption. The remaining oven, originally installed in Year 2008 is of industrial grade construction and could be reasonably expected to have a 30 year service life. Accordingly, a 20 year EUL for this measure component should be achievable. (During the site survey, the eliminated oven was viewed and it became apparent that the level of construction demolition that was occurring would make this oven inoperable towards any unforeseen future attempts to reinstate it back into service).

The project file's CUSUM and regression analysis calculations appropriately estimate the annual electricity and water makeup (L) savings associated with the multi-measure projects and no further adjustment is warranted.

4.3 CI - 24 (2014-COM-0087)

Union Gas Project Number:	**CI - 24 (2014-COM-0087)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Manufacturing
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	High Efficiency, Direct-fired H&V unit
4	Date Measure(s) Operational	Dec 15, 2013
5	Site Visit	Feb 24, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Hourly BIN temperature analysis based on a burner input rating of 735 MBH for an indirect fired space heater.	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case Amend burner input rating to 718 MBH, per site gathered data.	
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	12,964
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	13,974
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	15 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	BOMA & ASHRAE compatibility
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+8%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	13,974

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	279,480
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 24 (2014-COM-0087)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	Total installed cost ($24,000) is identified by Union Gas in an e-mail communication. Given the installed cost of the Base case is $20,000, a $4,000 *incremental* cost was appropriately applied by the utility.
Project Measure:	HVAC - Cambridge Heater
Project Description:	Following fire damage, a direct-fired H&V unit with full modulation was selected over the previous indirect fired unit.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Fire damage to (and subsequent reconstruction of) the shop area served by the makeup air unit prompted the plant to reconsider design options.

Documented Practice: N/A. Upgrade action seems driven by need and value judgment of cost effectiveness.

Union's Role: Plant's initial view was to reselect a less efficient and lower cost indirect fired makeup air heater. They also expressed preliminary doubts about a single unit's capability to serve a (100 ft x 80 ft) shop area. Union suggested the high temperature/high flow direct fired unit alternative and worked with the vendor/contractor supply chains directly to acquire the appropriate supporting data. They also facilitated the use of a third party consultant to demonstrate the energy savings potential through an energy engineering spreadsheet analysis. This process lent credibility for the plant management to change their view and adopt the direct fired option.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The direct fired heating and ventilating unit was viewed in relation to its dual space heating and makeup air heating functions and its contribution to overall building air balance with the operation of exhaust fans and wall intake louvres in the adjacent shop area. While the unit primarily heats the shop assembly area, access to the adjacent welding area only separates both spaces with plastic strip curtains. These strip curtains move inward toward the welding shop area during exhaust fan operation. According to CSA B149 code requirements, the direct fired unit can operate by using an interlocked exhaust fan, relief openings, infiltration or a combination of all three. (Site staff reported that the infiltration rate has been factored in the design and that the wall exhaust fans only operate during normal daytime operations). The file's supporting spreadsheet calculations (which are deemed to be sound) separate the space heating and makeup air aspects of the direct fired heater but only claim the space heating aspect. (Discussion with Union's Customer representatives revealed this was done to defer to the most conservative savings estimate). The reviewer believes that the additional makeup air heating component should be applied to the overall savings and has made an adjustment in the spreadsheet calculations to factor this component for 8 hours per day.

The original Bin Temperature based spreadsheet calculations note a burner input rating of 735 MBH for the direct fired industrial air heater. Shop drawing data (included in Appendix 'C' for reference) for this unit identifies an input heating capacity of 718 MBH. The reviewer has amended the spreadsheet calculations accordingly.

The spreadsheet calculations are also based on a maximum space heating temperature setpoint of 65 °F. (This has been confirmed on site with related photo, included in Appendix 'C').

While the EUL that is stated in the project file at 20 years is at odds with Union's Guidelines, stated at 15 years under the category of "Make-Up Air", the BOMA Preventive Maintenance Guidebook suggests a 20 year life for makeup air units. ASHRAE data is limited for this type of equipment, but identifies a life of at least 20 years for burners and centrifugal fans. In this context, the EUL of 20 years is maintained for this measure.

4.4 CI - 21 (2014-IND-0183)

Union Gas Project Number:	**CI - 21 (2014-IND-0183)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Manufacturing
2	Type of Building, Building Segment or Process	Paving aggregate dryer
3	Efficiency Measure(s) Description	Insulate dryer drum
4	Date Measure(s) Operational	May 14, 2013
5	Site Visit	Mar 17, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case: Heat loss calculations based on 9.4 °C *annual* average and 16 km/hr wind speed from weather data; bare surface drum temperature of 450 °F.	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case Adjustments toward 16 °C average and 14 km/hr wind speed to reflect actual ambient conditions experienced during the operating period; bare surface drum temperature of 360 °F, within actual operational setpoints.	
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	73,092
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No. Process temperature and seasonal aspects.
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	47,291
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	Drum EUL < insulation
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Drum EUL < insulation
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-35%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	47,291

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	709,365
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 21 (2014-IND-0183)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	The cost for this measure ($19,800) is supported by a written confirmation from the industrial insulation contractor's detailed scope of work and total installed cost. This applies to the total *incremental* measure; hence, no CPSV adjustment.
Project Measure:	IN - Tank (Aggregate Dryer Drum Insulation)
Project Description:	Insulation of Aggregate Dryer (Drum Insulation). 2" thick ceramic insulation was used. Drum size approx. 10' dia X 30' long.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Customer demand for their product has shifted beyond the traditional [redacted] to now include operation into late November, where ambient temperatures are lower and heat loss is greater. This, and changes in production mode to include pauses where the product remains dormant in the drum (while waiting for truck loading) have warranted more attention towards reducing heat loss in the uninsulated vessel.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of priority (reactive).

Union's Role: The availability of Union's incentives appears to have increased the priority level for insulation upgrades, but there is no hard evidence to suggest *when* this may otherwise have occurred. Corporate maintenance staff intuitively knew that the measure made sense but were unsure as to the cost/energy savings benefit. Union supported the site with the energy analysis and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The installed insulation and jacket covering were viewed on site and the quality of the installation was considered to be excellent. Reported installed lengths were paced off and dimensions are in agreement with the project file. The energy savings calculations in the file are modeled on a reputable insulation software package (3E Plus) and all parameters check out.

The nominal efficiency factor of 75% in the file calculations cannot be independently verified through combustion analyzer analysis as the nature of the direct fired heating (with high excess air quantities) would skew the efficiency calculations. On the basis of this value being sourced from Corporate internal data and the reviewer's experience factor, this value is accepted as being reasonable.

Annual operation of the system, noted at 1,600 hours, is compatible with winter/summer historical fuel consumption data and factoring the shutdown periods that were reported by the site contacts.

Information gathered by the verifier during the site visit interview process has prompted adjustments on two levels; seasonality and actual operating parameters. The project file calculations assume a 9.4 °C annual average and 16 km/hr wind speed from weather data; however, the May-Nov seasonal operation suggests that 16 °C average and 14 km/hr wind speed should be used to reflect actual ambient conditions experienced during the operating period. On a second level, a bare surface drum temperature of 450 °F is used in the file calculations. Site personnel stated that the mixed product temperature in the drum ranges from 270 – 320 °F and that the high limit air temperature setpoint from the drum is 190 °C (374 °F). This sets the bounds of what the drum surface temperatures could be expected to be. Since the plant was in seasonal shutdown mode during the site visit, it was not possible to view related operating data. The reviewer's experience in observing other similar plants in this industry suggests a 360 °F drum surface temperature to be more appropriate. This value falls within the expected operating temperature bounds that were communicated on site.

On the basis of the foregoing, this CPSV review adjusts the stated savings claim with revised 3E+ calculations to reflect lower expected drum surface temperatures and ambient temperature/wind speed that is more applicable to the actual operating months of the equipment, rather than the annual averages used in the project file.

The reviewer also adjusts the EUL (noted in the project file at 20 years) to 15 years, given that due to the robust operation of the plant, the remaining service life of the drum (to which the insulation is attached) was expected by plant personnel to be 15 years.

All related adjustment calculations are included in Appendix 'D' for reference.

4.5 CI - 14 (2014-IND-0112)

Union Gas Project Number:	**CI - 14 (2014-IND-0112)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Manufacturing
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Steam Leak Repairs
4	Date Measure(s) Operational	Sept 22, 2013
5	Site Visit	Feb 20, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Total annual natural gas consumption for Year 2013.	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case Last of multiple repairs was not completed until Sept. 22/13 so Year 2013 reflects a transition year. Boiler fuel (impacted by the steam leakage repairs) is not sub-metered and site's natural gas meter also includes HVAC equipment and unit heater loads. Subsequent historical natural gas billing is not normalized to either weather or production variations. Due to these considerations, simple measure isolation based on the steam leakage calculations is recommended.	
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	327,010
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	348,784
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	3,160,153
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+7%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	348,784

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	6,975,680
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified (see Footnote)	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	3,158,710 L

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 14 (2014-IND-0112)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	Each steam leak line item identifies a corresponding labour and material cost, which all appear to be within a reasonable range. ($5,040 representing sum of *incremental* measure items). No CPSV adjustment.
Project Measure:	SWH - Leaks
Project Description:	Replacement of process heating coils, since continuous steam leakage repairs in these were unsuccessful.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Steam leaks that affect production and safety issue warrant immediate priority. Leakage that is allowed to continue out of control can adversely affect the size and density of the baked product, which can also incur more scrap wastage.

Documented Practice: No formal documented procedure is in place. Maintenance action seems driven by need and value judgment of priority.

Union's Role: The availability of Union's incentives appears to have increased the priority level for repairing these, but there is no hard evidence to suggest when this may otherwise have occurred. Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

A plant walk-through to all repair locations with the site's designated contact confirmed the stoppage of steam leaks as outlined in the Union Gas project file.

Baseline calculations factor 8,760 hr/yr operation of the steam system as the boiler must operate to the maximum extent possible to meet continuous production loads. It was reported that the boiler typically shuts down for a maximum 4 hour period to enable the annual insurance inspection. Accordingly, a minor adjustment to 8,756 annual operating hours was made. It was also confirmed that the boiler is operating at 13 psig, as stated in the project file and illustrated in the pressure gage photo capture in Appendix 'E'. The calculation methodology for the individual steam leakage rates from the project file was reviewed and appropriately applies the Napier equation (with 0.7 coefficient factor) for "orifice"type leaks. The nominal steam/fuel efficiency factor of 70% , on which the natural gas savings estimates are based, prompted the reviewer to request a sample combustion analyzer reading. (A copy is included in Appendix 'E' for reference). The combustion chart data reveals a *gross* combustion efficiency of 70%, largely due to elevated O_2 levels (15.2%) and the detection of CO (137 ppm). A cursory calculation by the reviewer (refer to Appendix 'E') estimates that the expected lower steam/fuel efficiency would *presently* be in the 66% range. This efficiency factor triggered an upward revision in the savings calculations. (*The CPSV reviewer draws attention to the relatively poor boiler performance and suggests that a yearly boiler tune-up, with encouragement from Union Gas, is in order. A well-tuned boiler should incur lower O_2 to maintain CO in check to only trace levels, with an expected increase in steam/fuel efficiency to 76% as a target value outlined in Appendix 'E').*

The EUL that is stated in the project file at 20 years conforms to Union's Guidelines under the category of "Steam Piping Leaks", and appears to be reasonable, given the expected longevity of the process rad coils to which they apply.

The project file's original spreadsheet calculations appropriately estimate the annual water makeup (L) savings associated with each steam leakage reduction line item and the only CPSV water savings adjustment made was in line with the 8,756 annual operating hour adjustment, referenced in the above.

4.6 CI - 16 (2014-IND-0166)

Union Gas Project Number:	**CI - 16 (2014-IND-0166)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Manufacturing
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Process furnace heat recovery
4	Date Measure(s) Operational	April 22, 2014
5	Site Visit	Feb 20, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case: Calculated retrofit isolation, with higher efficiency usage grossed up by annual % fuel savings improvement.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	265,793
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	Yes
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	n/a
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	14 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	OEB EUL is commercial grade; not industrial
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Installation of new burners paired with recuperators.
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	265,793

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (m^3)	5,315,860
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 16 (2014-IND-0166)**
Site Measurements:	IR temperature gun readings and site's data trends.
Installed/Incremental Cost:	A Labour & Material cost breakdown for recuperators and burners, ($86,349 total) is itemized according to each process oven and commissioning date, by the plant's Process Engineer that managed the project. Incremental cost of the recuperators (*the equipment which drive the savings*) is [4 x ($7,200+50% x 2 x 3 x 8 x $\$65_{labour}$) + ($11,520 + 2 x 3 x 8 x $\$65_{labour}$) = $49,680. CPSV review adjusts to this incremental cost.
Project Measure:	HR - Recuperator
Project Description:	Installation of 32 new burners with [redacted] vertical recuperators resulting in an approximate 19% natural gas savings based on 750 ° F preheated combustion oven.

Prioritization/Maintenance Practice/ Union Gas Role:

<u>Prioritization/Customer Practice:</u> This opportunity was initially raised by the Plant Production group for process improvement (reduced preheat times for more throughput). To move up in priority, the project must clear a 1 year payback hurdle. (This is a necessary but not sufficient condition as explained under Union's Role).

<u>Documented Practice:</u> N/A as this measure was perceived to be outside the realm of the company's core business.

<u>Union's Role:</u> In addition to Program incentives, Union added value with guidance on the supporting calculations, preliminary analysis and data on available related products. Their credibility factor was perceived as the "missing link" for securing senior management's approval with confidence.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The installed recuperators were viewed on site and the quality of the installation was considered to be industrial grade. The supporting spreadsheet calculations were reviewed and the methodology used is sound. The performance curves that formed the basis of the energy saving estimates are sourced from the manufacturer's lab test results, using field data collected from actual furnace installations. As a cross-check, the results were compared to the heat recovery calculations outlined in the North American Combustion Handbook (Vol II, p125), which came to within 6% agreement in comparison to the manufacturer's curves. This is a reasonably close correlation, given the influencing variables that affect each calculation approach (e.g., O_2, incoming air temperature, etc.). Having established the validity of the calculation methodology used to support the savings estimates, attention was given to the input parameters, with the following observations:

- Burner rated input was confirmed with nameplate data (copy in Appendix 'F').
- A useful indicator of the recuperator performance is that preheat times for each production cycle were typically reduced from 131 min to 75 min, as illustrated graphically in Appendix 'F' from site logged data. Also noteworthy is that although the oven temperature setpoint is 1,700 °F, trended temperatures for steady state conditions in the cycle are at the 1,600 °F level, the same input parameter used in the supporting calculations.

- The use of 8,400 annual operating hours is a reflection of the fact that only unplanned forced outages would halt production as the heat treating process is scheduled to operate as continuously as possible, due to high demand. As such, this value is deemed appropriate.
- The term "Percent Firing Rate" being input to the calculations is a misnomer in the sense that the burners are of "on/off" control; not staged or modulated. The 60% factor associated with this input parameter is appropriately used in the calculations but is actually an indicator of the open/close operation of the oven doors, with associated loss of temperature.
- A preheated air temperature of 760 °F, is predicted from the manufacturer's curve data and used in the calculations. Snapshot readings with the IR temperature gun during the site visit typically displayed bare pipe temperatures in the 729 °F range, taken at a point close to the oven (illustrated in Appendix 'F'). This would suggest an internal preheated air temperature in the 735 °F range. Given the 3% variance between measured and predicted values and the impact of using the lower number only leads to a 2% variance in the final fuel savings estimate, an adjustment to the file estimates is not warranted as contingencies for operating variables appear to be already amply covered by the 60% diversity factor used in Union's calculations.

On the basis of the foregoing, this review supports the stated savings claim without adjustment.

The EUL that is stated in the project file at 20 years would initially appear to be at odds with Union's Guidelines under the category of "Air-Air Heat Exchangers", however, it must be emphasized that Union's Guidelines stipulate a *Commercial* installation, while these heat reclaim units are *Industrial* grade and would have a 20 year service life expectation. The burners, which are paired with the operation of the recuperators, were installed at the same time and could also be expected to have at least a 20 year service life. The ovens, to which both pieces of equipment are connected to, are of 1980's vintage. Despite their advanced age, they have no moving parts and would be more subject to a routine, periodic refractory replacement. Their external structural integrity observed at the time of the site visit and the plant's stated objective of extending the service life of major equipment leads the reviewer to support the 20 year EUL for this measure.

4.7 CI - 11 (2014-IND-0056)

Union Gas Project Number:	**CI - 11 (2014-IND-0056)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Manufacturing
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Deaerator heat recovery
4	Date Measure(s) Operational	Feb 1, 2014
5	Site Visit	Mar 12, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	N/A
Baseline		
9	Utility Claimed Base Case: Total annual natural gas consumption for Year 2013.	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case Subsequent historical natural gas billing is not normalized to either weather or production variations. Due to these considerations, simple measure isolation based on the heat recovery calculations is recommended.	
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	517,813
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	366,540
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	6,246,793
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	14 Years
18	Measure Life *as per OEB Measure Life Guide*	14 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	Project file adopted 20 year EUL; at odds with OEB's EUL
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Deaerator vessel appears to have > 14 year EUL

24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-29%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	366,540
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	5,131,560
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	4,727,608 L

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 11 (2014-IND-0056)**
Site Measurements:	IR temperature gun on pipework.
Installed/Incremental Cost:	The costs for the completed work ($15,615 total) is supported by actual contractor invoices for "Supply and Install" according to progress payments and documented in the project file. Since this is strictly for the SS tube bundle, this represents an incremental cost and no CPSV adjustment needed.
Project Measure:	Deaerator heat recovery
Project Description:	The plant has a heat exchanger to pre-heat reclaim water used for the CIP process. The heat exchanger in the vent line of the deaerator was severely porous and experienced a high amount of steam leakage. Heating steam efficiency was lost as well as water usage, salt and chemical usage. To correct this, the plant replaced the damaged copper pipe at the heat exchanger with stainless steel tubing. The savings are primarily generated from the prevention of lost heat related to CIP #1 and CIP #2 preheating, which would otherwise have to be made up by direct steam heating. (The project reflects a Base Case of allowing an unrepaired heat exchanger to continue operation in that mode indefinitely due to the availability of the primary steam heating capacity at the CIP).

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Steam leaks that affect production equipment and safety warrant immediate priority. While the plant has the installed steam heater capacity to fully heat the CIP reclaim water during the outage of the heat exchanger, this heat exchanger captures waste heat and energy projects are regarded with high priority. (ie. Not simply regarded as part of overhead but it forms a discrete component of the overall budget planning and plant performance metric).

Documented Practice: No formal documented procedure is in place. Maintenance action seems driven by need and value judgment of priority through the corporate maintenance budget planning process.

Union's Role: The availability of Union's incentives have helped the plant to overcome maintenance budget constraints that are determined at the corporate level and dedicate efforts to energy projects which may not be implemented otherwise. Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

Prior to viewing the heat reclaim unit, a meeting with the Engineering & Maintenance Manager revealed that the heat recovery calculations that are outlined in the Union Gas project file are outdated. (The updated calculations, as completed by the plant's external Energy Engineers and provided by the plant during the CPSV visit, are included in Appendix 'G' for reference). The most major change relates to the reclaim water heat gain, originally filed as 152 °F and now amended to 85 °F, as advised by the plant engineer who is familiar with this process. The amended value appears to be more plausible and is generally more compatible with spot readings of pipe surface temperature taken by the reviewer (illustrated in Appendix 'G'), yielding a ΔT of 47 °F (a lower value but likely affected by low flow demands on the process side affecting the ΔT during the observation period).

Original Baseline calculations also factor 80 hr/week operation of the pumped reclaim system but has been amended to 100 hrs/week, as correlated to current production levels.

Other than the amendments referenced in the foregoing and a revision by the reviewer for (gross) steam heat capacity to net enthalpy added by the boilers, a review of combustion test data provided by the plant and cursory calculations prompted the adjustment of steam/fuel efficiency factor to 79%. (Related calculations are also included in Appendix 'G'). All factors mentioned have contributed to the net downward adjustment to the claimed energy savings.

While the EUL that is stated in the project file at 20 years conforms to Union's Guidelines under the category of "Steam Piping Leaks", an EUL of 14 years is also listed for Heat Exchangers. On the basis of a strict interpretation of the OEB Measure Life Guide, the EUL is adjusted to 14 years.

The steam consumption adjustments referenced in the foregoing triggered a corresponding adjustment in projected water savings to 4,727,608 L/yr, as highlighted in the Appendix 'G' calculation revisions.

4.8 CI - 15 (2014-COM-0079)

Union Gas Project Number:	**CI - 15 (2014-COM-0079)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Steam Leak Repairs
4	Date Measure(s) Operational	Nov 28, 2013
5	Site Visit	Mar 18, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Total annual natural gas consumption for Year 2013.	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case Subsequent historical natural gas billing is not normalized to weather variations. Simple measure isolation based on the steam leakage calculations is recommended.	
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	300,820
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	281,768
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	3,114,708
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-6%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	281,768
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	5,635,360
27	CPSV Firm Justification for Final Recommendation	Refer to Observations

28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	2,917,443 L

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 15 (2014-COM-0079)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	Each steam leak line item identifies a corresponding labour and material cost, which all appear to be within a reasonable range. (Sub-Total cost of $4,600 in project file correctly sums net incremental cost of all repairs listed; ie. Steam trap repairs or replacements were factored out of the sub-total indicated cost of this project.)
Project Measure:	SWH - Leaks
Project Description:	Repair of steam leaks for calendar year 2013.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Steam leaks are regarded as a source of waste and are red tagged for repair as soon as a shutdown of the related pipework is possible. Easy and rapid repairs (eg. pinhole leaks) are considered part of routine maintenance and are addressed as soon as possible. (These are not factored in this project claim). Higher capital cost items (eg. replacements on leaking 4" valve, expansion joint, and sections of larger pipework) are considered incremental.

Documented Practice: No formal documented procedure is in place. Maintenance action seems driven by need and value judgment of priority.

Union's Role: The availability of Union's incentives appears to have increased the priority level for repairing these, but there is no hard evidence to suggest when this may otherwise have occurred. Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

A plant walk-through to all repair locations with the site's designated contact confirmed the stoppage of steam leaks as outlined in the Union Gas project file. (Sample photos of pipework replacement and tagging practice on shut down sections of steam leakage are included in Appendix 'H').

Baseline calculations factor a 7,200 hr/yr operation of the steam system and is based on the boiler operation of 24 hrs/day for (8) months of the year, with 12 hr/day operation for the remaining (4) months. A cursory analysis of the fuel consumption suggests that for the months of (July, August/September), the 12 hour per day operation estimate in the file appears overstated and that 6 hour per day operation is more likely. (Related calculations are outlined in Appendix 'H'). This would yield an adjustment from 7,200 hr/yr to 6,744 hrs/yr. (The file revision calculations are also included in Appendix 'H' for reference).

It was also confirmed that the boiler is operating at 10 psig, as stated in the project file and illustrated in the pressure gage photo capture in Appendix 'H'. The calculation methodology for the individual steam leakage rates from the project file was reviewed and appropriately applies the Napier equation (with 0.7 coefficient factor) for "orifice" type leaks. No data was available on site to substantiate the nominal steam/fuel efficiency factor of 75% in the project file but this value appears to be reasonable for a seasonal efficiency on the boiler operation.

The EUL that is stated in the project file at 20 years conforms to Union's Guidelines under the category of "Steam Piping Leaks", and appears to be reasonable, given the replacement of leaking pipes and fittings with new sections.

The steam consumption adjustments referenced in the foregoing triggered a corresponding adjustment in projected water savings to 2,917,443 L/yr, as highlighted in the Appendix 'H' calculation revisions.

4.9 CI - 17 (2014-COM-0051)

Union Gas Project Number:	**CI - 17 (2014-COM-0051)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Greenhouse expansion - multi-measure
4	Date Measure(s) Operational	Feb 25, 2013
5	Site Visit	Mar 18, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Derived from Virtual Grower energy modeling software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	319,540
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	514,195
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	16 Years
18	Measure Life as per OEB Measure Life Guide	16 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes; multi-measure weighted EUL
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	No, VG 3
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+61%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	514,195
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	8,227,120
27	CPSV Firm Justification for Final Recommendation	Lower T setpoints

28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 17 (2014-COM-0051)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	A cost data summary identifies a cost breakdown for component measures, supported by Invoice and Contractor Progress Payment documentation. (Full cost of climate control system $160,490 plus IR AC Poly structure $77,170 was identified in the project file. No incremental cost over Base Case materials used. While the Base Case includes no climate control system and therefore defaults to an incremental cost for this component, the IR AC Poly structure cost is roughly double that of regular double poly, warranting an incremental cost adjustment to $38,585 for that component measure). The reviewer concedes that the effect of the envelope on infiltration is likely to equal the 20 year estimated life of the new climate control systems, (*assuming envelope replacement about every 5 years is a reasonable expectation*). On this basis, the incremental cost of structural envelope replacement for (4) five year cycles was then included as an adjustment to the incremental cost, to avoid exaggerating the cost effectiveness of the measure. (*No attempt was made by the reviewer to forecast discount rate, in the interests of not over-complicating this issue*). Accordingly, the incremental cost is adjusted to {$160,490+ (4 x 38,585)}=$314,830.
Project Measure:	GH - New Expansion ([redacted])
Project Description:	[redacted], new expansion included [redacted] climate control system and double IR Poly roof and sidewalls.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Land adjacent to the original [redacted] site was purchased with the view toward expansion. Owner was unsure of what the most cost-effective opportunities were to build a facility that would yield the lowest energy operating costs within his budgetary constraints. Selection of the [redacted] climate control system was strictly price based.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of rapid return on investment (reactive).

Union's Role: Union offered technical/energy economics guidance on energy efficient design opportunities. The owner stated that the availability of Union's incentives prompted the inclusion of more energy efficient features than otherwise would have been constructed; however, there is no hard evidence to suggest which measures would have been excluded and when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The analysis is based on energy modeling derived from a reputable software package (Virtual Grower 3) which factors fuel input to boilers and solar energy input. The database for VG also includes historic solar data for various cities (Windsor ON data was used). The project file illustrates the key inputs and calculated outputs in very comprehensive detail. Site observations were made to cross-check key input values to the calculations and the reviewer noted that the observed space temperature settings were in the 19 °C range, lower than the stated 21 °C setpoint temperature used in the High Efficiency Case. (A screen capture of temperature control setpoints is included in Appendix 'I' for reference). These site observations prompted the reviewer to increase the *annual* energy savings claim by the 194,655 m^3 projected impact from the revised 3 °C temperature change over the Base Case. This adjustment has also been reflected in the multi-measure savings-weighted EUL for each project and yielded an increase in composite EUL from Union's originally stated 14 years to a new weighted value of 16 years.

4.10 CI - 05 (2014-IND-0025)

Union Gas Project Number:	**CI - 05 (2014-IND-0025)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Greenhouse expansion - multi-measure
4	Date Measure(s) Operational	Feb 3, 2014
5	Site Visit	Mar 5, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Derived from Virtual Grower energy modeling software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	1,676,703
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	Yes
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	n/a
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	13 Years
18	Measure Life as per OEB Measure Life Guide	14 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes; partially
20	Justification of CPSV Firm's Alternate Measure Life being Used	Limit to double warranty life
Results		
21	Proprietary Modeling Software	No; VG3
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%

25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	1,676,703
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	21,797,139
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 05 (2014-IND-0025)**
Site Measurements:	(Site instrumentation and [redacted] archived data)
Installed/Incremental Cost:	A cost data summary identifies a cost breakdown for component measures, based on information supplied by fabricating consultant. Total incremental cost differential of $1,290,000 for all measures is correctly applied.
Project Measure:	GH-New Expansion
Project Description:	New Greenhouse Build with Multiple energy efficiency measures added. Project modeled using Virtual Grower. Greenhouse growing acreage: [redacted]. - Glass Roof (Tripe Polycarbonate side walls, Double Poly End walls to enable future expansion) - Energy Curtains - Climate Control System - HE Boiler with Condenser

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Competitive pressures within the industry prompted the owner to construct a new expansion to offer improved economies of scale.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of rapid return on investment (reactive).

Union's Role: Union offered technical/energy economics guidance on energy efficient design opportunities. The owner stated that the availability of Union's incentives prompted the inclusion of more energy efficient features than otherwise would have been constructed; however, there is no hard evidence to suggest which measures would have been excluded and when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The analysis is based on energy modeling derived from a reputable software package (Virtual Grower 3) which factors fuel input to boilers and solar energy input. The database for VG also includes historic solar data for various cities (Windsor ON data was used). The project file summarizes the key inputs and calculated outputs.

A comparison of the predicted VG natural gas consumption vs metered actual consumption for Year 2014 was done. (A single natural gas meter serves the new [redacted] expansion). Using a continuous 12 month summation starting in Feb. 2014 and factoring out the forward months where natural gas supply interruptions occurred, the predicted and actual consumptions yielded a 23% variance. This can be explained by actual weather being much colder than normal (as reflected in the VG weather database). Since baseline and installed case calculations need to reflect the same weather data, the review re-focused on the modeling methodology instead of the utility metering comparison.

A review of the energy model with observed site operating parameters revealed that key input values corresponded to those outlined in the project file summary and that space temperature setpoints were in accordance to the model's input parameters. (A print screen capture is included in Appendix 'J' for reference). On this basis, the modeling analysis was accepted by the reviewer without adjustment to the projected energy savings.

The composite, multi-measure EUL for this project includes a 25 year spreadsheet input for the Polycarbonate Triple Wall (per installer's opinion noted in project file) and 10 years for the Energy Curtain measure. This wall material typically has a manufacturer's warranty period of 10 years (excluding hail damage) but most published sources state a useful life that ranges from 10 – 20 years. Union's EUL Custom Offering *guideline* of 5 years for energy curtains equals the typical warranty life specified by manufacturers. Some published sources claim an actual replacement interval of every 7 – 12 years, depending on use, installation quality, etc. Factoring these elements into consideration, it is the reviewer's opinion that in both cases the component EUL should not exceed double the warranty life. This yields a component EUL of 20 years for Polycarbonate Triple Wall and remains at 10 years for the Energy Curtain measure. (A component of the calculations that allows for Double Poly end walls has appropriately been factored with a 5 year EUL factor and this remains unadjusted). The impact of the adjustments are factored in the multi-measure savings-weighted EUL for this project, as illustrated in Appendix 'J'.

4.11 CI - 06 (2014-IND-0024)

Union Gas Project Number:	**CI - 06 (2014-IND-0024)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Greenhouse expansion - multi-measure
4	Date Measure(s) Operational	Jan 15, 2014
5	Site Visit	Mar 5, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Derived from Virtual Grower energy modeling software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	1,158,947
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	Yes
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	n/a
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	14 Years
18	Measure Life as per OEB Measure Life Guide	15 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes; partially
20	Justification of CPSV Firm's Alternate Measure Life being Used	Limit to double warranty life
Results		
21	Proprietary Modeling Software	No; VG 3
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings ($m^{3)}$	1,158,947
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) ($m^{3)}$	16,225,258
27	CPSV Firm Justification for Final Recommendation	Refer to Observations

28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS **CPSV Review/Observations for 2014 Custom Projects**	
Union Gas Project Code:	**CI - 06 (2014-IND-0024)**
Site Measurements:	(Site instrumentation and [redacted] archived data)
Installed/Incremental Cost:	A cost data summary identifies a cost breakdown for component measures, supported in writing by related vendor/installer confirmations. A total incremental cost of $849,847 was correctly applied for all measures.
Project Measure:	GH - New Expansion ([redacted])
Project Description:	This site had an existing [redacted] range [redacted] that was built in [redacted]. They have now expanded (to the West wall) another [redacted] Acres of Greenhouse with the same crop ([redacted]). This GH consists of the following energy efficient components: • Roof Glass • Triple Poly Carbonate Side-walls • 2 Layers of Energy Curtain -- [redacted] - on entire 8.1 acres • [redacted] Climate Control System *software update*

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Competitive pressures within the industry prompted the owner to construct a new expansion to offer improved economies of scale. The owner was open to include energy cost reduction features (within his financial constraints).

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of rapid return on investment (reactive).

Union's Role: The expansion required at least 200 more control sensors and added software capability in areas such as CO_2 monitoring and strategic use of Hot Water Storage during natural gas curtailments, humidity and venting control. Union played a significant role in bringing the owner up on the learning curve on the application and cost-benefit of the energy efficiency options. (This was mutually beneficial as Union learned as well). The owner stated that the availability of Union's incentives prompted the inclusion of more energy efficient features than otherwise would have been constructed; however, there is no hard evidence to suggest which measures would have been excluded and when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The analysis is based on energy modeling derived from a reputable software package (Virtual Grower 3) which factors fuel input to boilers and solar energy input. The database for VG also includes historic solar data for various cities (Windsor ON data was used). The project file illustrates the key inputs and calculated outputs in very comprehensive detail. Site observations were made to cross-check key input values to the calculations and these were in general accordance with the energy model. (As an example, a screen capture of temperature and energy curtain performance is included in Appendix 'K' for reference). The referenced Appendix also includes a comparison of the predicted VG natural gas consumption vs metered actual consumption for Year 2014. (A single natural gas meter serves both the original [redacted] site plus the new [redacted] expansion). Factoring a proportional sharing of the metered natural gas load between the two adjacent sites based on area, the predicted and actual consumptions are within 1% agreement (yielding a high degree of confidence in the modeling methodology). The site observations suggest that the energy systems are operating as intended. These site observations and a review of the file calculations lead the reviewer to support the *annual* energy savings claim without adjustment.

The composite, multi-measure EUL for this project includes a 25 year spreadsheet input for the Polycarbonate Triple Wall (per installer's opinion noted in project file) and 10 years for the Energy Curtain measure. This wall material typically has a manufacturer's warranty period of 10 years (excluding hail damage) but most published sources state a useful life that ranges from 10 – 20 years. Union's EUL Custom Offering *guideline* of 5 years for energy curtains equals the typical warranty life specified by manufacturers. Some published sources claim an actual replacement interval of every 7 – 12 years, depending on use, installation quality, etc. Factoring these elements into consideration, it is the reviewer's opinion that in both cases the component EUL should not exceed double the warranty life. This yields a component EUL of 20 years for Polycarbonate Triple Wall and remains at 10 years for the Energy Curtain measure. The impact of the adjustments are factored in the multi-measure savings-weighted EUL for this project, as illustrated in Appendix 'K'.

4.12 CI - 07 (2014-IND-0114)

Union Gas Project Number:	**CI - 07 (2014-IND-0114)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Greenhouse expansion - multi-measure
4	Date Measure(s) Operational	June 10, 2014
5	Site Visit	Mar 5, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Derived from Virtual Grower energy modeling software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	1,131,090
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	1,160,603
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	15 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes; multi-measure weighted EUL
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	No; VG 3
22	Were any Measures Add-ons	Yes; linkageless controls
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Boilers to which they are applied are only about 2 yrs old
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+2%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	1,160,603

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	17,409,045
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 07 (2014-IND-0114)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	A cost data summary identifies a cost breakdown for component measures, supported by detailed vendor Invoices for Labour & Materials. A total incremental cost of $474,920 was applied in Union's file for all measures. The reviewer concedes that the effect of the envelope on infiltration is likely to equal the 20 year estimated life of the new climate control systems, (*assuming envelope replacement about every 5 years is a reasonable expectation*). On this basis, the incremental cost of structural envelope replacement for (4) five year cycles was then included as an adjustment to the incremental cost, to avoid exaggerating the cost effectiveness of the measure. (*No attempt was made by the reviewer to forecast discount rate, in the interests of not over-complicating this issue*). Accordingly, the incremental cost is adjusted to $\{\$474{,}920_{original} + (3_{additional\ IR\ Poly\ replacement\ cycles} \times \$60{,}252)\} = \$655{,}676$.
Project Measure:	GH - New Expansion ([redacted])
Project Description:	This enterprise had an existing [redacted] acres of Greenhouse and now expanded another [redacted] acres as of [redacted] [redacted]. The [redacted] acre expansion consists of the following energy efficient components: • Double IR Poly Roof and Side-walls • One 800 BHP CB (steam) Boiler with Linkageless Controls and high-efficiency Burner • [redacted] Climate Control System • Energy Curtain - [redacted] - on entire [redacted] acres

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Owner was unsure of what the most cost-effective opportunities were to build a facility that would yield the lowest energy operating costs within his budgetary constraints. Selection of the [redacted] climate control system was based on desire for more zone-friendly control.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of rapid return on investment (reactive).

Union's Role: Union offered technical/energy economics guidance on energy efficient design opportunities. The owner stated that the availability of Union's incentives prompted the inclusion of more energy efficient features than otherwise would have been constructed; however, there is no hard evidence to suggest which measures would have been excluded and when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The analysis is based on energy modeling derived from a reputable software package (Virtual Grower 3) which factors fuel input to boilers and solar energy input. The database for VG also includes historic solar data for various cities (Windsor ON data was used). The project file illustrates the key inputs and calculated outputs in very comprehensive detail. Site observations were made to cross-check key input values to the calculations and the reviewer noted that the observed space temperature settings were in accordance with the stated 21 °C setpoint temperature used in the High Efficiency Case. (A screen capture of temperature control setpoints is included in Appendix 'L' for reference).

The nominal steam/fuel efficiency factor of 80% in the file calculations prompted the reviewer to request a recent combustion analyzer reading. (A copy is included in Appendix 'L' for reference, along with related calculations). Given that the measured combustion efficiency is at the 85% to 86% level, subtraction of a few percentage points for steam/fuel efficiency would suggest the 80% value is understated. The combustion data, cursory calculations by the reviewer and on-site observations reveal the steam/fuel efficiency is more in line with an 81.6% value, averaged over the tested load range. This has also been factored into the adjustments outlined in Appendix 'L' yielding an overall positive net variance.

This adjustment has also been reflected in the multi-measure savings-weighted EUL for each project.

4.13 CI - 10 (2014-IND-0172)

Union Gas Project Number:	**CI - 10 (2014-IND-0172)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse steam distribution lines
3	Efficiency Measure(s) Description	Insulation of steam supply lines
4	Date Measure(s) Operational	May 1, 2014
5	Site Visit	Mar 5, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Simple measure isolation, supported by heat loss calculations based on bare pipe loss from 3E Plus software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	594,534
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	604,538
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	OK; new insulation on new piping
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+2%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	604,538
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	12,090,760

27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 10 (2014-IND-0172)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	The installed cost ($15,500) is supported by a copy of the vendor's invoice. This cost, at less than $10/LF appears very low but must reflect the fact that the work was performed by site forces. As this insulation was applied on bare pipe, it reflects the incremental cost.
Project Measure:	Insulation of steam supply lines
Project Description:	Insulated 1600 feet of supply (steam) lines in the [redacted] Greenhouse.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Project was driven by owner's realization that considerable lengths of uninsulated steam pipe represent significant sources of Energy waste.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of priority (reactive).

Union's Role: The availability of Union's incentives appears to have increased the priority level for insulation upgrades, but there is no hard evidence to suggest when this may otherwise have occurred. Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The installed insulation and jacket covering were viewed on site and the quality of the installation was considered to be excellent. Installed lengths were paced off during the site visit and a check of pipe lengths against sketched building dimensions showed these to be in general accordance with the calculations.

The energy savings calculations in the file are modeled on a reputable insulation software package (3E Plus). (Ambient temperatures of 70 deg. F were input; hence, losses were not treated as losses to the outdoors. Parasitic heat loss from bare pipe to offset indoor heating does not enter into consideration since the pipework is distributed within unconditioned service corridors, where heat gain to this space would not offer as effective a contribution as that directed to intended end use heating locations). It was noted that the bare pipe surface temperature (239 °F) is based on a nominal steam pressure of 10 psig. The observed steam pressure on site was 12.5 psig (photo in Appendix 'M') which would elevate the bare pipe surface temperature to 244 °F. A positive adjustment was made to the original calculations to reflect actual site conditions.

The nominal steam/fuel efficiency factor of 80% in the file calculations prompted the reviewer to request a recent combustion analyzer reading. (A copy is included in Appendix 'M' for reference, along with related calculations). Given that the measured combustion efficiency is at the 85% to 86% level, subtraction of a few percentage points for steam/fuel efficiency would suggest the 80% value is understated. The combustion data, cursory calculations by the reviewer and on-site observations reveal the steam/fuel efficiency is more in line with an 81.6% value, averaged over the tested load range. This has also been factored into the adjustments outlined in Appendix 'M', yielding an overall positive net variance.

The EUL that is stated in the project file at 20 years conforms to Union's Guidelines and appears to be reasonable, given the high quality aluminum jacketing used and indoor location throughout the facility. The piping to which the insulation is applied is a new installation and would be expected to have a service life that exceeds the 20 year EUL.

4.14 CI - 13 (2014-COM-0320)

Union Gas Project Number:	**CI - 13 (2014-COM-0320)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Greenhouse expansion - multi-measure
4	Date Measure(s) Operational	Sept 20, 2014
5	Site Visit	Mar 18, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Derived from Virtual Grower energy modeling software. (Based on 21 °C space setpoint temperature).	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case	22 °C space setpoint temperature
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	499,488
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	538,335
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	14 Years
18	Measure Life as per OEB Measure Life Guide	14 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes; multi-measure weighted EUL
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	No; VG 3
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+8%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	538,335
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) ($m^{3)}$	7,536,690

27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS
CPSV Review/Observations for 2014 Custom Projects

Union Gas Project Code:	**CI - 13 (2014-COM-0320)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	Installed cost summary with component measure breakdown, supported by copies of vendor invoices. A total incremental cost of $94,112 is stated. The reviewer concedes that the effect of the envelope on infiltration is likely to equal the 20 year estimated life of the new climate control systems, (*assuming envelope replacement about every 5 years is a reasonable expectation*). On this basis, the incremental cost of structural envelope replacement for (4) five year cycles was then included as an adjustment to the incremental cost, to avoid exaggerating the cost effectiveness of the measure. (*No attempt was made by the reviewer to forecast discount rate, in the interests of not over-complicating this issue*). Accordingly, the incremental cost is adjusted to $\{\$94{,}112_{original} + (3_{additional\ IR\ Poly\ replacement\ cycles}\ x\ \$19{,}112)\}=\$151{,}448$.
Project Measure:	Greenhouse – Expansion ([redacted])
Project Description:	The [redacted] expansion consists of the following energy efficient components: • Double IR Poly Roof and Side-walls • [redacted] Climate Control System

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Competitive pressures within the industry prompted the owner to construct a new expansion to offer improved economies of scale. Original boilers were constrained in performance due to natural gas volume and pressure limitations. This triggered an additional discussion on energy load reduction measures; some of which are not included in this project measure submission (eg. Boiler controls upgrade, pipe insulation, etc.)

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of rapid return on investment (reactive).

Union's Role: The owner was previously unaware of Union's incentives when operating the original [redacted] site, or the cost-benefit implications of energy efficiency measures. As the owner approached Union to discuss the natural gas supply constraints, Union offered technical/energy economics guidance on energy efficient design opportunities. The owner stated that the availability of Union's incentives prompted the inclusion of more energy efficient features than otherwise would have been constructed; however, there is no hard evidence to suggest which measures would have been excluded and when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The analysis is based on energy modeling derived from a reputable software package (Virtual Grower 3) which factors fuel input to boilers and solar energy input. The database for VG also includes historic solar data for various cities (Windsor ON data was used). The project file illustrates the key inputs and calculated outputs in very comprehensive detail. Site observations were made to cross-check key input values to the calculations and the reviewer noted that the observed space temperature settings were in the 21 °C range, the same as the Base Case that was originally stated in the Union Gas project file. (A screen capture of temperature control setpoints is included in Appendix 'N' for reference).

The original project file calculations estimate a 1 °C temperature control improvement from the new greenhouse climate control system but base this on a Base Case 21 °C temperature control setpoint and temperature control improvement to 20 °C from the High Efficiency Case. The reviewer concurs with the 1 °C temperature control improvement as reflecting a conservative estimate (given the old system had very limited zone control) but has adjusted the calculations to a Base Case 22 °C temperature control setpoint and temperature control to 21 °C from the High Efficiency Case, which was observed during the site visit. The revised Base Case is also more compatible with (5) out of the (7) greenhouse multi-measure Custom Projects (under review in this assignment) that stipulated a Base Case 22 °C temperature control setpoint.

This adjustment has also been reflected in the multi-measure savings-weighted EUL for each project.

4.15 CI - 02 (2014-IND-0021)

Union Gas Project Number:	**CI - 02 (2014-IND-0021)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Greenhouse expansion - multi-measure
4	Date Measure(s) Operational	Dec 26, 2013
5	Site Visit	Mar 16, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Derived from Virtual Grower energy modeling software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	2,727,061
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	Yes
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	n/a
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	16 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes; partially
20	Justification of CPSV Firm's Alternate Measure Life being Used	Limit to double warranty life
Results		
21	Proprietary Modeling Software	No; VG 3
22	Were any Measures Add-ons	No

23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	2,727,061
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	40,905,915
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 02 (2014-IND-0021)**
Site Measurements:	(Site instrumentation and [redacted] archived data)
Installed/Incremental Cost:	A cost data summary identifies a cost breakdown for component measures, supported in writing by related vendor/installer confirmations. Total incremental cost of $1,647,500 has been appropriately applied.
Project Measure:	Greenhouse - New Expansion ([redacted])
Project Description:	This new GH consists of the following energy efficient components: • Roof Glass and Triple Poly Carbonate Side-wall • [redacted] Energy Curtains - on entire [redacted] acres • 2 [redacted] Boilers equipped with [redacted] Burners and Autoflame Linkageless Control Units • 1 Flue Gas Condenser • 1 Heat Storage tank - 1.5 million liters • [redacted] Climate Control System

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Competitive pressures within the industry prompted the owner to construct a new expansion to offer improved economies of scale.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of rapid return on investment (reactive).

Union's Role: As the owner approached Union to confirm if natural gas was available for the new site, Union offered technical/energy economics guidance on energy efficient design opportunities. The owner stated that the availability of Union's incentives prompted the inclusion of more energy efficient features than otherwise would have been constructed; however, there is no hard evidence to suggest which measures would have been excluded and when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The analysis is based on energy modeling derived from a reputable software package (Virtual Grower 3) which factors fuel input to boilers and solar energy input. The database for VG also includes historic solar data for various cities (Windsor ON data was used). The project file illustrates the key inputs and calculated outputs in very comprehensive detail. Site observations were made to cross-check key input values to the calculations and these were in general accordance with the energy model. (As an example, a screen capture of temperature control setpoints is included in Appendix 'O' for reference). The referenced Appendix also includes a comparison of the predicted VG natural gas consumption versus metered actual consumption for Year 2014. (A single natural gas meter serves the new expansion). The predicted and actual consumptions are within 1.4% agreement (yielding a high degree of confidence in the modeling methodology) and the site observations suggest that the energy systems are operating as intended.

These site observations and a review of the file calculations lead the reviewer to support the *annual* energy savings claim without adjustment.

The composite, multi-measure EUL for this project includes a 25 year spreadsheet input for the Polycarbonate Triple Wall (per installer's opinion noted in project file) and 10 years for the Energy Curtain measure. This wall material typically has a manufacturer's warranty period of 10 years (excluding hail damage) but most published sources state a useful life that ranges from 10 – 20 years. Union's EUL Custom Offering *guideline* of 5 years for energy curtains equals the typical warranty life specified by manufacturers. Some published sources claim an actual replacement interval of every 7 – 12 years, depending on use, installation quality, etc. Factoring these elements into consideration, it is the reviewer's opinion that in both cases the component EUL should not exceed double the warranty life. This yields a component EUL of 20 years for Polycarbonate Triple Wall and remains at 10 years for the Energy Curtain measure. The impact of the adjustments are factored in the multi-measure savings-weighted EUL for this project, as illustrated in Appendix 'O'.

4.16 CI - 03 (2014-IND-0022)

Union Gas Project Number:	**CI - 03 (2014-IND-0022)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Greenhouse expansion - multi-measure
4	Date Measure(s) Operational	Dec 19, 2013
5	Site Visit	Mar 19, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Derived from Virtual Grower energy modeling software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	1,970,483
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	Yes
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	n/a
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	15 Years
18	Measure Life as per OEB Measure Life Guide	16 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	Limit to double warranty life
Results		
21	Proprietary Modeling Software	No; VG 3
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings ($m^{3)}$	1,970,483
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	29,557,245
27	CPSV Firm Justification for Final Recommendation	Refer to Observations

28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 03 (2014-IND-0022)**
Site Measurements:	(Site instrumentation and [redacted] archived data)
Installed/Incremental Cost:	A cost data summary identifies a cost breakdown for component measures, supported in writing by related vendor/installer confirmations. Total incremental cost of $1,405,750 has been appropriately applied.
Project Measure:	Greenhouse - New Expansion ([redacted])
Project Description:	This new GH consists of the following energy efficient components: • Roof Glass • Triple Poly Carbonate Side-walls • [redacted] Energy Curtains - on entire [redacted] acres • 2 [redacted] Boilers equipped with [redacted] Burners and Autoflame Linkageless Control Units • 1 Flue Gas Condensers • 1 Heat Storage tank - 1.5 million liters • [redacted] Climate Control System

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Vendor confirmation of wall material cost (base case glass at approx. 50% of triple polycarbonate) and prior experience with older farm originally influenced the owner to maintain status quo, based on first cost. Energy efficiency initially did not appear to have as high a priority.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of rapid return on investment (reactive).

Union's Role: The availability of Union's incentives appears to have increased the priority level for energy efficient features (CO_2 generation and system heat storage in particular) to be included in any contemplated move towards new greenhouse construction. While Union encouraged the on-site generation of CO_2 instead of purchasing it in liquid form, and offered technical/energy economics guidance on energy efficient design opportunities, there is no hard evidence to suggest when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The analysis is based on energy modeling derived from a reputable software package (Virtual Grower 3) which factors fuel input to boilers and solar energy input. The database for VG also includes historic solar data for various cities (Windsor ON data was used). The project file illustrates the key inputs and calculated outputs in very comprehensive detail. Site observations were made to cross-check key input values to the calculations and these were in general accordance with the energy model. (As an example, a screen capture of temperature control setpoints is included in Appendix 'P' for reference). The referenced Appendix also includes a comparison of the predicted VG natural gas consumption versus metered actual consumption for Year 2014. (A single natural gas meter serves the new expansion). The predicted and actual consumptions are within 1% agreement (yielding a high degree of confidence in the modeling methodology) and the site observations suggest that the energy systems are operating as intended.

These site observations and a review of the file calculations lead the reviewer to support the *annual* energy savings claim without adjustment.

The composite, multi-measure EUL for this project includes a 25 year spreadsheet input for the Polycarbonate Triple Wall (per installer's opinion noted in project file) and 10 years for the Energy Curtain measure. This wall material typically has a manufacturer's warranty period of 10 years (excluding hail damage) but most published sources state a useful life that ranges from 10 – 20 years. Union's EUL Custom Offering *guideline* of 5 years for energy curtains equals the typical warranty life specified by manufacturers. Some published sources claim an actual replacement interval of every 7 – 12 years, depending on use, installation quality, etc. Factoring these elements into consideration, it is the reviewer's opinion that in both cases the component EUL should not exceed double the warranty life. This yields a component EUL of 20 years for Polycarbonate Triple Wall and remains at 10 years for the Energy Curtain measure. The impact of the adjustments are factored in the multi-measure savings-weighted EUL for this project, as illustrated in Appendix 'P'.

4.17 CI - 09 (2014-IND-0570)

Union Gas Project Number:	**CI - 09 (2014-IND-0570)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Insulate steam, condensate, hot water piping
4	Date Measure(s) Operational	Feb 21, 2013
5	Site Visit	Mar 19, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Simple measure isolation, supported by heat loss calculations based on bare pipe loss from 3E Plus software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	718,537
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	Yes
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	n/a
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Piping in excellent condition
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	0%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	718,537
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	14,370,740

27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 09 (2014-IND-0570)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	The cost ($106,000) for this measure is supported by a written confirmation from the site's General Manager for the Labour & Material components of total installed cost. As this insulation was applied on bare pipe, it reflects the incremental cost.
Project Measure:	Insulate steam, condensate, hot water piping
Project Description:	• Insulated 2,064 feet of supply (steam) lines (16 inches) • Insulated 2,064 feet of condensate (hot water) lines (4 inches) • Insulated 4,400 feet of grow pipes (hot water) - (6 inches and 8 inches). • Type of insulation used = 2" Glass Fibre for pipe greater than or equal to 8 inch diameter. Remainder -1 inch insulation.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: The Customer realizes that considerable lengths of uninsulated steam/condensate/Hot water pipe represent significant sources of Energy waste.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of priority (reactive).

Union's Role: The availability of Union's incentives appears to have increased the priority level for insulation upgrades, but there is no hard evidence to suggest when this may otherwise have occurred. Union supports Energy Efficiency on site through awareness raising and related information transfer. Site contacts stated that energy improvement projects can be kept going with the confidence that Union's programs are still in place.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The installed insulation and jacket covering were viewed on site and the quality of the installation was considered to be excellent. Reported installed lengths were measured by the site with a rolling distance measuring wheel and related dimensions are sketched in the project file. The energy savings calculations in the file are modeled on a reputable insulation software package (3E Plus) and all parameters check out. (Ambient temperatures of 72 deg. F were input; hence, losses were not treated as losses to the outdoors. For the *majority* of the calculations outlined in the project file, parasitic heat loss to offset indoor heating does not enter into consideration since the main pipework is distributed within unconditioned service corridors which are not directed to intended end use heating locations. For the remaining areas where there are sidewall pipes that are not located in the bulk of the growing area, a geometry based calculation factors a 50% fraction coefficient on useful energy saved as an acknowledgement of the heat component that bare pipe would have contributed in these minor (heated) areas. As such, site layout considerations have been properly accounted for in the file calculations).

The nominal steam/fuel efficiency factor of 80% in the file calculations prompted the reviewer to request a recent combustion analyzer reading. (A copy is included in Appendix 'Q' for reference, along with related calculations). The combustion data, cursory calculations by the reviewer and on-site observations reveal the steam/fuel efficiency is compatible with the stated 80% value, averaged over the tested load range.

Annual operation of the steam system, noted at 7,200 hours, is compatible with winter/summer historical fuel consumption data and appropriately factors the shutdown periods that were reported by the site contacts.

On the basis of the foregoing, this CPSV review supports the stated savings claim without adjustment.

The EUL that is stated in the project file at 20 years conforms to Union's Guidelines and appears to be reasonable, given the high quality aluminum jacketing used and indoor location throughout the facility.

4.18 CI - 12 (2014-IND-0333)

Union Gas Project Number:	CI - 12 (2014-IND-0333)	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Heat Exchanger Upgrade
4	Date Measure(s) Operational	July 21, 2014
5	Site Visit	Mar 19, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Isolated retrofit measure with thermodynamics calculations based on increased steam requirements to sterilize leachate water and return it at higher temperature than the retrofit case.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	n/a
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	407,798
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	434,687
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	14 Years
18	Measure Life as per OEB Measure Life Guide **(*project file stated 20 years but OEB Guide stipulates 14 years*)**	14 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	Conform to OEB Guide and independent technical opinion
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+7%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	434,687

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	6,085,618
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 12 (2014-IND-0333)**
Site Measurements:	(Observations of flows and temperatures from site instrumentation.)
Installed/Incremental Cost:	The cost ($115,003) for this measure is supported by a detailed breakdown of Labour & Material cost components, with each line item keyed to Invoice Number. This represents the full cost of the higher capacity heat exchanger, (but incremental over the existing Base Case), installed to address changed operating parameters from site expansion.
Project Measure:	HR - Heat Exchanger (Pasteurizer Upgrade)
Project Description:	This project involved the installation of a higher capacity water to water heat exchanger on the existing leachate sterilization system. It is expected that the higher capacity heat exchanger will recover a larger amount of process heat which is currently being lost to the surroundings and reduce "cleaned leachate" water temperature by nearly 5°C.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Changes in the irrigation patterns due to site expansion rendered the original heat exchanger limited in capacity and temperature control flexibility.

Documented Practice: No formal documented procedure or policy is in place. Upgrade action seems driven by need and value judgment of priority (reactive).

Union's Role: Union supports Energy Efficiency on site through awareness raising and related information transfer. They encouraged the site to pursue a professionally engineered study to demonstrate the energy savings resulting from the changes (not only the process benefits).

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The (2) heat exchangers (steam/water & water/water) form part of a single *system* for sterilizing unclean leachate water. Increasing the capacity of the water/water heat exchanger enabled higher heat transfer and steam reduction in the second heat exchanger. (Had the higher capacity heat exchanger not been installed, the lack of heat recovery would have required a much larger capacity cooling tower system (with heat relieved to the outdoors and no associated heat recovery) to be installed in lieu of this equipment).

Appendix "R" includes the basic LMTD calculations that illustrate the temperature performance of the Heat Exchanger *system*. The equation for heat transfer in a heat exchanger is Q = U x A x LMTD. The Log Mean Temperature Difference is an accurate representation of the actual conditions in an exchanger. These LMTD calculations should be viewed in conjunction with the spreadsheet calculation revisions (adjusted for observed flows) outlined below . (Observed temperatures on site were in close agreement to those outlined in the original project file). The 68 ° C Improved Case LMTD (vs the 63 °C Base Case LMTD) suggests that the increased capacity of the water-water HX1 is performing as intended and the nominal 8% increase is commensurate with the running capacity increase of HX1 (6,284 kW Base vs 6,782 kW improved) as outlined in the revised spreadsheet calculations.

The installed heat exchangers (2 acting as 1 system) were viewed on site and the quality of the installation was considered to be excellent. The energy savings evaluation is well supported by a professionally stamped Engineering report that is based on sound engineering principles and was developed with input data that reflected the best available information at the time of report preparation (prior to full operation of the system). Based on the reviewer's observations made during the site visit, adjustments were made to the following key input parameters:

- Volume flow of 500 gpm is amended to reflect (370 -387) gpm flow range actually observed (photo in Appendix 'R')
- System annual operating hours, originally estimated during a shutdown period and noted at 6,400 appears understated. It has been adjusted to 7,200 hours, in line with another CPSV project at this site.
- The energy savings calculations omit the steam/fuel efficiency factor. This has been factored in the adjustments at 80%, in line with the other CPSV project at this site.

All other temperatures used in the calculations are in close agreement with those viewed on the system's temperature gages. A copy of the revised calculations spreadsheet is included in Appendix 'R' for reference.

The EUL that is stated in the project file at 20 years is adjusted to conform to Union's Guidelines of 14 years and the service provider's engineer's written confirmation that is included in the project file.

4.19 CI - 18 (2014-IND-0210)

Union Gas Project Number:	**CI - 18 (2014-IND-0210)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Agriculture
2	Type of Building, Building Segment or Process	Greenhouse
3	Efficiency Measure(s) Description	Heat Exchanger Upgrade
4	Date Measure(s) Operational	Dec 15, 2013
5	Site Visit	Mar 16, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Isolated retrofit measure with thermodynamics calculations based on faulty (steam leaking) heat exchanger. (Unavailability of spare parts precluded repair; improved performance is from the new heat exchanger offering a "drop-in" replacement with approximately the same capacity as the old heat exchanger).	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	n/a
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	123,571
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	158,754
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	14 Years
18	Measure Life as per OEB Measure Life Guide **(*project file stated 20 years but OEB Guide stipulates 14 years*)**	14 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No
20	Justification of CPSV Firm's Alternate Measure Life being Used	Conform to OEB Guide and independent technical opinion
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of EUL.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+28%
25	CPSV Firm Independently Recommended Annual Gross NG Savings (m^3)	158,754

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	2,222,556
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 18 (2014-IND-0210)**
Site Measurements:	(Observations of pump operating profiles and temperatures from site instrumentation.)
Installed/Incremental Cost:	The cost ($50,000) for this measure is supported by a written confirmation of total Labour & Material cost components from the site's General Manager. This represents the full cost of the near equal (design) performance (non-faulty) heat exchanger, installed in lieu of ineffective repair attempts and the unavailability of spare parts for the existing equipment. This represents an incremental condition over the existing Base Case.
Project Measure:	Heat Exchanger Upgrade
Project Description:	Two of the existing plate and frame heat exchangers were replaced with two new, non-faulty heat exchangers of approximately equal capacity. (Original Union file calculations are based on nominal 3,400 kW capacity but site visit confirms 3,484 kW actual capacity of the new heat exchanger. The modest 2.4% capacity variance is accounted for by the addition of (6) more plates in the new heat exchanger equipment). It was observed that the condensate temperature following the replacement of the leaky heat exchangers was much lower, with reduced steam load on the boiler.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Steam to hot water leakage in both original heat exchangers, coupled with the fact that repeated repair attempts failed and spare parts were unavailable from the sourcing company being no longer in business, moved up the level of priority for replacement.

Documented Practice: A maintenance schedule is documented for routine items but continuous site observations on the heat exchanger performance degradation led the site to engage outside expertise, knowledgeable in heat exchanger technology.

Union's Role: Union supports Energy Efficiency on site through awareness raising and related information transfer. They encouraged the site to pursue a professionally engineered study to demonstrate the energy savings resulting from the changes (not only the process benefits).

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The reviewer draws attention to the photo illustration in Appendix 'S' (taken by the reviewer during the site visit) of the dismantled heat exchanger. The heat exchanger plates appear to be in good condition (suggesting that this equipment was not at the end of its service life) but the gasket seals and their commercial unavailability represented the constraint on the optimum energy performance of this equipment. The Customer could have operationally continued to live with the higher condensate return temperatures associated with the Base Case, but would have incurred poorer energy performance in doing so. Union's incentive drove outright replacement of the equipment. (The $50k full cost represents the incremental cost over living with a still functioning but poor energy performing unit that becomes an ongoing maintenance concern). The fact that there is no documentary evidence as to suggest *if*, or *when* the equipment could have been scheduled for replacement does not offer a firm basis for designation of this measure as an "advancement".

The installed heat exchangers (2 acting in parallel) were viewed on site and the quality of the installation was considered to be excellent. The energy savings calculations are extracted from an Engineering report that is based on sound engineering principles. Based on the reviewer's observations made during the site visit, adjustments were made to the following key input parameters:

- Observed steam generated pressures were 7.3 psig vs the nominal 10 psig value used.
- The nominal 3,400 kW heat exchanger capacity value is embedded in some of the calculations and is amended according to the design capacity, specified at 3,484 kW.
- The energy savings calculations omit the steam/fuel efficiency factor. This has been factored in the adjustments at 80%, on the basis of combustion test data yielding a combustion efficiency of 84% for the main duty boilers (referenced in Appendix 'S').

Rationalization of heat exchanger load factors and operating hours through cursory calculations based on observed heat exchanger inlet/outlet water temperatures and circulation pump operating profile suggest the assumed values of 50% load factor and 5,000 operating hours per year to be appropriate. A copy of the revised calculations spreadsheet and supporting observations is included in Appendix 'S' for reference.

The EUL that is stated in the project file at 20 years is adjusted to conform to Union's Guidelines of 14 years.

4.20 CI - 08 (2014-COM-0240)

Union Gas Project Number:	**CI - 08 (2014-COM-0240)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Healthcare
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Upgrade building systems to LEED standards
4	Date Measure(s) Operational	July 31, 2014
5	Site Visit	Mar 11, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Construct new facility to minimum energy cost budget regulated by MNECB 1997 reference case.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	N/A
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	822,929
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	747,828
15	Utility Claimed Gross Electricity Savings (kWh)	3,623,938
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		

17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	No; DOE 2.2, eQuest 3.64
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-9%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	747,828
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	14,956,560
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	(Indeterminate)
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 08 (2014-COM-0240)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	Project file outlines a basic calculation of 4% (of total estimated building costs/sq. ft.) incremental costs ($13,000,000) over a known similar building at another site without the high efficiency measures. [redacted].
Project Measure:	HE Building - Energy Simulation vs OBC Standard
Project Description:	Construction of a new building to LEED Gold compliance using energy efficient equipment such as heat recovery chillers, instantaneous domestic water heating, variable speed drives on fans and pumps, heat reclaim coils on exhaust air, remotely sourced steam from cogeneration plant.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Given the current cost constraints in the Health Care sector, a new facility was built [redacted], with high efficiency energy measures built into the structures under an off-balance savings financing ([redacted]) approach.

Documented Practice: All performance monitoring documentation falls within the domain of the ESCO project. Documented to demonstrate compliance with LEED Gold Rating. Reference Building is according to minimum OBC standards.

Union's Role: As part of a long-standing working relationship, Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The energy savings outlined in Union's project file are based on the results of a building energy simulation model (eQuest 3.64). The reviewer visited the building to view the related mechanical systems and confirmed that nameplate data and temperature setpoints for major equipment were found to be in accordance with information illustrated in the Mechanical drawings viewed on site.

The contractual arrangement (read by the reviewer) for the operation of the building's energy consuming equipment and systems offers a number of compelling reasons to ensure that the simulated results are achieved. (Foremost is a "Painshare" penalty clause that is applied if actual energy use exceeds the energy model by more than 5%). Other noteworthy M&V requirements stipulate the appointment of an "Independent Certifier" for oversight, plus monthly and annual Energy Analysis reports with precise consumption data and breakdown by [redacted]

Notwithstanding the strong drivers for compliance (as outlined in the foregoing) the challenge for verification of this project revolves around limited data to date and the commercial confidentiality that leads to a restrained response in obtaining comprehensive energy performance data. ([redacted]). While the reviewer was forwarded print screen data for various building systems observed on site, these represented snapshots in time with no defined time spans for any integrated readings. The 1st Quarterly utility review occurred prior to the site visit but the site contacts were not at liberty to discuss whether the energy consumption met expectations. (The reviewer's request for an *indication* of this following the site visit have yet to be communicated to either Union or the reviewer; probably restrained by the commercial confidentiality aspect).

Given the constraints mentioned in the above, the reviewer had to adopt a high level approach toward verification with limited data. Appendix 'T' illustrates a redacted e-mail message that lists the monthly purchased steam consumption for October/14 – January/15, inclusive. The 4-month steam consumption is extrapolated to annualized consumption as follows:

- *7,187,000 $lbs_{125\ psig\ steam}$ x 1,193 BTU/lb ~ 85,741 therms (or 257,233 therms on straight-line annualization)*

The rough annualization of very limited steam consumption data suggests that present purchased steam consumption appears to be trending under the 285,051 therm proposed building consumption that is subtracted from the reference building consumption in the project file (to determine the natural gas energy savings estimate). As such, the proposed thermal consumption that forms a key component of the energy model is accepted in principle.

Upon closer review of the Energy Modeling Report Summary (excerpt included in Appendix 'T'), a discrepancy is noted between the inferred natural gas savings in the model and those identified in Union's project file. The "Calculations" tab in the project file outlines a savings claim of 822,929 m^3, based on 294,946 therms. The "Summary of Results" section in the Modeling Report states a net difference in NG as (53,781,052-25,501,988 = 28,279,064 MJ). Based on the project file's stated conversion of 2.7901 m3/therm, this is equivalent to 268,029 therms or 747,828 m^3. This can be explained by the fact that the project file estimates were originally based on use of the Modeler's original simulation using DOE 2.2 software in Year 2010. The updated model is based on eQuest 3.64 software in Year 2014. Using the most recent results, the reviewer adjusts the natural gas savings claim accordingly.

The project file also identifies electrical energy savings. Due to the context surrounding the contractual aspects of the project, no electricity consumption data was made available (at the time of writing this report) for the reviewer to support or reject the associated electricity savings claim. For this reason, the electricity savings are considered to be "indeterminate" at this time. (*Intuitively, electricity savings would be realized with the application of variable speed drives and other control measures*).

The 20 year EUL that is stated in the project file appears reasonable and is accepted without adjustment, given the newly installed equipment and the fact that the performance contract life exceeds the EUL time frame.

4.21 CI - 19 (2014-IND-0115)

Union Gas Project Number:	**CI - 19 (2014-IND-0115)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Healthcare
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Steam Leak Repairs
4	Date Measure(s) Operational	May 1, 2014
5	Site Visit	Mar 17, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Historical natural gas consumption for Year 2013.	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case Historical natural gas billing is not normalized to weather variations. Simple measure isolation based on the steam leakage calculations is recommended.	
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	104,655
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	100,630
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	1,056,563
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-4%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	100,630
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	2,012,600
27	CPSV Firm Justification for Final Recommendation	Refer to Observations

28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	N/A
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	1,056,563 L

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 19 (2014-IND-0115)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	Each steam leak line item identifies a corresponding labour and material cost, which all appear to be within a reasonable range. All items are keyed to Work Order #s, samples of which were made available for viewing on site for consistency. Summed Labour & Material cost of $9,392 appears to represent discretionary, incremental repairs in areas that would not have likely received as high a priority without the incentive.
Project Measure:	Steam Leak Repairs (March 2013 to May 2014)
Project Description:	Steam leak repairs, completed by facility's own maintenance Dept.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: A large capital expansion on site initially drew main attention, with little change to the steam pipework system. With increased steam loads leaving little or no redundancy, the repair of steam leaks drew increased attention as one of several efforts toward reducing energy waste and regaining some boiler redundancy capacity. (While the potential shortfall in steam capacity could suggest that the repairs may have been repaired regardless of the incentive, there is no hard evidence to suggest if this would have occurred and when).

Documented Practice: No formal documented procedure or policy is in place. Maintenance action seems driven by need and value judgment of priority (reactive).

Union's Role: The availability of Union's incentives appears to have increased the priority level for repairing these, but there is no hard evidence to suggest when this may otherwise have occurred. Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

A plant walk-through to all repair locations with the site's designated contact confirmed the stoppage of steam leaks as outlined in the Union Gas project file.

Baseline calculations factor 8,760 hr/yr operation of the steam system as the boilers must fire to meet year-round autoclave and sterilizer loads. It was also confirmed that the boilers are operating at 100 psig, as stated in the project file and illustrated in the pressure gage photo capture in Appendix 'U'. The calculation methodology for the individual steam leakage rates from the project file was reviewed and appropriately applies the Napier equation (with 0.7 coefficient factor) for "orifice" type leaks. The nominal steam/fuel efficiency factor of 75% in the original calculations prompted the reviewer to request a recent combustion analyzer reading. (A copy is included in Appendix 'U' for reference). The combustion data and on-site observations reveal the steam/fuel efficiency is likely in the 80% range for Boiler #2 (equipped with stack economizer) and 76% for the remaining boilers, averaged over the tested load range. The higher values would be consistent with blowdown losses being negligible, given that the boiler plant is also equipped with an RO water treatment system. Based on the reviewer's observations, a slight adjustment is made to the calculations to also reflect an *average* steam/fuel efficiency of 78% vs the 75% nominal value used in the file calculations. (Refer to Appendix 'U').

The EUL that is stated in the project file at 20 years conforms to Union's Guidelines under the category of "Steam Piping Leaks", and appears to be reasonable, given the replacement of leaking pipes and fittings with new sections.

4.22 CI - 23 (2014-IND-0261)

Union Gas Project Number:	**CI - 23 (2014-IND-0261)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Healthcare
2	Type of Building, Building Segment or Process	[redacted]
3	Efficiency Measure(s) Description	Insulate piping, valves and heat exchangers
4	Date Measure(s) Operational	April 1, 2014
5	Site Visit	Feb 27, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Simple measure isolation, supported by heat loss calculations based on bare pipe loss from 3E Plus software.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	n/a
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	17,281
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	21,221
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	Yes
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	Piping and valves in good condition
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+23%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	21,221
26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	424,420
27	CPSV Firm Justification for Final Recommendation	Refer to Observations

28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 23 (2014-IND-0261)**
Site Measurements:	(IR Temperature Gun or Site Gauges)
Installed/Incremental Cost:	The cost for this measure ($51,191) is supported by a confirmation progress payment and savings summary that forms part of the ESCO contract reporting obligations, with a specific line item identified for the Piping Insulation measure. The addition of insulation to bare pipe represents an incremental cost.
Project Measure:	Insulate piping, valves and heat exchangers
Project Description:	Insulate piping, valves and steam to HW converters with upgraded 1.5" mineral fibre insulation with PVC jacketing, canvas covering or temp-matt removable covers.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Given the current cost constraints in the Health Care sector, this project would not likely have happened without the off-balance savings financing (ESCO project) approach that was adopted by the organization.

Documented Practice: All performance monitoring documentation falls within the domain of the ESCO project.

Union's Role: Realizing the constrained capital and operating cost environment under which the facility must operate, Union facilitated the savings financing approach for the project. The availability of Union's incentives appears to have increased the priority level for insulation upgrades, but there is no hard evidence to suggest when this may otherwise have occurred.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The installed insulation and jacket covering were viewed on site and the quality of the installation was considered to be excellent. The energy savings calculations in the file are modeled on a reputable insulation software package (3E Plus) and all parameters check out, with respect to the calculation methodology. (Ambient temperatures of 70 – 80 deg. F were input; hence, losses were not treated as losses to the outdoors. Parasitic heat loss to offset indoor heating does not enter into consideration since the pipework is distributed within unconditioned interior service corridors and Mechanical Rooms which are not directed to intended end use heating locations).

Upon review of the calculation summaries, two items of note drew the attention of the reviewer. The first item relates to the stated pipe temperature for steam at the 100 psig pressure to be 350 °F, whereas steam table data would suggest this should be 338 °F. Corresponding adjustments were made to pipe heat loss calculations by the reviewer. The second item relates to the fact that no steam/fuel efficiency factor was applied to the heat loss savings in the calculations. Since no combustion test data was readily available (or easily available through the ESCO framework), the reviewer has adopted an 80% factor, based on prior test experience with the type of boiler in use ([redacted] (Related photos of representative pressure and temperature observations plus adjustment calculations made by the reviewer are included in Appendix 'V' for reference).

Annual operation of the steam system, noted at 8,760 hours for the service tunnel and 5,040 hours for the Mechanical Room items is compatible with the year round steam demands (space heating plus process sterilizer/autoclave loads) in the former case and reduced hours during the summer/shoulder season operation for the latter case.

The EUL that is stated in the project file at 20 years conforms to Union's Guidelines and appears to be reasonable, given the high quality PVC or all-service jacketing used and indoor location throughout the facility. The piping to which the insulation was applied has varying ages in different sections but is no older than 1985 vintage and not only appears to be in good condition but all leaking valves, pipes and fittings were replaced by the hospital, prior to application of the insulation. This context, coupled with the fact that removable insulation was used to cover valves and fittings, leads the reviewer to conclude that the installation has a high likelihood of remaining serviceable beyond the ESCO guarantee period.

4.23 CI - 20 (2014-COM-0345)

Union Gas Project Number:	**CI - 20 (2014-COM-0345)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Education
2	Type of Building, Building Segment or Process	University Physical Plant
3	Efficiency Measure(s) Description	Boiler control upgrades and adjustments
4	Date Measure(s) Operational	Oct 9, 2014
5	Site Visit	Feb 25, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Retrofit isolation based on *assumed* boiler efficiency improvement.	
10	Agreement with Base Case	No
11	Where Item 10 is 'no': CPSV Recommended Base Case Retrofit isolation based on operator log data to proportion the operation of each boiler and calculated steam/fuel efficiency based on before/after combustion test data.	
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	148,257
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	117,183
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	10 Years
18	Measure Life as per OEB Measure Life Guide	11 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	No *specific* guidance
20	Justification of CPSV Firm's Alternate Measure Life being Used	Weighted average adjustment
Results		
21	Proprietary Modeling Software	N/A
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of EUL.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	-21%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	117,183

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	1,171,830
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	A
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 20 (2014-COM-0345)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	The central utility plant's Chief Engineer confirmed in writing the Labour cost for Boiler #5 plus Labour & Material cost breakdown for Boiler #4. Summed cost of $12,480 appropriately reflects incremental cost over Base Case.
Project Measure:	SWH - Boiler - (Boiler 4 and 5 Upgrade)
Project Description:	#4 Boiler: A new O_2 analyzer was installed and calibrated to offer accurate excess air measurements and associated excess O_2 control. #5 Boiler: The boiler gas valve and air flow damper were hunting, using more air, then correcting and cutting back. (The automatic gas control valve performed likewise because the fuel flow follows the air flow on the combustion curve). Service technician troubleshooting identified that the sensing arm on the fan damper had worked itself loose and was giving inaccurate feed back to the positioner. This caused higher air flow than was needed, followed by boiler control hunting. Subsequent tightening of the feed back arm stopped boiler surging operation and over-feed of excess air.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: Capital budgeting constraints initially relegated the purchase of a new O_2 analyzer for Boiler #4 to deferred maintenance budget. The plant uses the opportunity offered by downtime from the scheduled annual maintenance inspection to prioritize potential upgrades. Boiler #5, due to its young age (approx. 5 years) did not draw attention to corrective maintenance (with the main focus being state of refractory, etc.) The audible indicators of the boiler controls "hunting" during resumptions in operation prompted the site to increase the priority of these measures, seek guidance from Union and follow up with an outside service agency.

Documented Practice: No formal documented procedure is in place. Maintenance action seems driven by need and value judgment of priority.

Union's Role: The availability of Union's incentives appears to have increased the priority level for repairing these, but there is no hard evidence to suggest when this may otherwise have occurred. Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The savings estimates in the project file are developed on expectations that the measures for Boiler #4 would yield a 0.75% efficiency gain for a stated fuel consumption of 6,600,000 m^3. For Boiler #5 measures, an expectation of a 0.5% efficiency gain for a stated fuel consumption of 14,000,000 m^3 is claimed.

Following the initial file overview and site visit, the reviewer requested (and received) natural gas and steam data from the monthly boiler plant operating summaries. First attempts to draw a meaningful correlation between the natural gas consumed and steam generated for each boiler were unsuccessful, and it was concluded that the raw data embedded a number of meter multiplication factors. It was then decided that relating the individual boiler data on a proportional basis to the granular, utility grade metered data from Union Gas (with Temperature/Pressure corrections) offered a more reliable approach. (The reviewer's related analysis is included in Appendix 'W' for reference).

Regardless of how the data is analyzed, the site's monthly data summaries did clearly indicate that Boiler #4 operates for a limited period of time throughout the year and likely at low load. This is illustrated in Appendix 'W' where "0" natural gas consumption and steam generation is outlined for Boiler #4 from Sept 2014 – Feb 2015 summaries received. As such, the reported 6,600,000 m3 annual consumption estimate by the site appears overstated and the reviewer has rationalized a lower adjusted fuel consumption for this boiler (1,849,191 m^3 per Appendix 'W').

A second aspect of the Union metered data led the reviewer to question the reported natural gas consumption of Boiler #5, as communicated by the site. The sum total reported loads for Boilers (#4+#5) yield 20,600,000 m^3. Union's total metered consumption for the boiler plant in 2014 is 21,009,346 m^3, and this includes Boilers #2/3/4/5, which all operate at some time according to the operator log sheets. Using the same proportional correlation methodology as for Boiler #4, the reviewer has rationalized a lower adjusted fuel consumption for this boiler (8,806,086 m^3 per Appendix 'W').

Having established the adjusted annual fuel consumptions dedicated to each boiler, the next step was to independently calculate the fuel efficiency savings estimates for each boiler measure. The results of a before/after combustion test for Boilers #4 and #5 were requested and received following the site visit. Only Boiler #4 had a documented before/after combustion performance test and the site took the initiative to have a combustion test on Boiler #5 following the site visit. Unfortunately, no "before" test data is available for this boiler and the reviewer then had to use a "Predicted Performance Summary" data to estimate the "before" condition for comparative purposes. Combustion data was extracted for 40% fire on each boiler, as this was most compatible with observations of the site visit (Boiler #4 was off-line; Boiler #5 was indicating 64,715 CFH fuel consumption) and the monthly operations monthly summaries. Combined with steam plant operation observations (feedwater, deaerator, blowdown conditions, etc) a steam/fuel efficiency was calculated for each boiler. This yielded fuel improvements of 0.56% for Boiler #4 measures and 1.21% for Boiler #5 measures. (Related calculations are also included in Appendix 'W' for reference).

Boiler #5 was manufactured in 2010 while Boiler #4 is 1967 vintage. A condition assessment by B&W in 2010 was reviewed and it concluded the unit to be in good condition, requiring only routine refractory replacement at regular service intervals. These observations have established the ability of the boilers to at least survive the EULs associated with the energy measures. The stated EUL for the Boiler #4 O_2 analyzer at 12 years and the Gas Valve and Air Flow Damper tightening at 10 years appears aggressive but not unachievable. Given the reviewer's adjustments to savings, a revised weighted EUL is outlined as follows:

Boiler #4(10,357 m^3) ~ 8.8% of 117,183 m^3 total savings sum cost with 12 year EUL ; Boiler #5 (106,826 m^3) ~ 91.2% of total savings with (10) year EUL.

Weighted Avg: *0.088 x 12 yrs = 1.06 yrs*

0.912 x 10 yrs = 9.12 yrs

10 yrs (rounding reduced from 11 years)

4.24 CI - 22 (2014-COM-0239)

Union Gas Project Number:	**CI - 22 (2014-COM-0239)**	
#	**Required Information**	**Value**
Project Basics		
1	Sector	Education
2	Type of Building, Building Segment or Process	Classroom & Office space
3	Efficiency Measure(s) Description	Upgrade building systems to LEED standards
4	Date Measure(s) Operational	Sept 1, 2013
5	Site Visit	Mar 11, 2015
6	Justification of why Site Visit not Required	N/A
7	Advancement Project?	No
8	Agreement with Advancement Designation?	No advancement
Baseline		
9	Utility Claimed Base Case: Retrofit isolation on space heating and domestic water heating. Construction to minimum OBC standard with conventional natural gas fired boilers and ASHRAE 90.1-2007.	
10	Agreement with Base Case	Yes
11	Where Item 10 is 'no': CPSV Recommended Base Case	n/a
Annual Savings Estimate		
12	Utility Claimed Gross Natural Gas Savings (for each measure) (m^3)	33,358
13	Agreement with Utility Claimed Gross Natural Gas Savings (for each measure)	No
14	Where Item 13 is 'no': CPSV Calculated Gross Natural Gas Savings (for each measure) (m^3)	45,299
15	Utility Claimed Gross Electricity Savings (kWh)	0
16	Utility Claimed Gross Water Savings (L)	0
Measure Life		
17	CPSV Recommended Measure Life (for each measure)	20 Years
18	Measure Life as per OEB Measure Life Guide	20 Years
19	Measure Life Conforms with Filed OEB Measure Life Guide?	Yes
20	Justification of CPSV Firm's Alternate Measure Life being Used	N/A
Results		
21	Proprietary Modeling Software	No. (EnergyPro)
22	Were any Measures Add-ons	No
23	Where Item 22 applies, Provide Commentary of Reasonableness of Remaining Useful Life.	N/A
24	% Difference Between CPSV Independently Calculated Gross Natural Gas Savings vs. Utility Gross Natural Gas Savings	+36%
25	CPSV Firm Independently Recommended Annual Gross Natural Gas Savings (m^3)	45,299

26	CPSV Firm Final Recommended Gross Cumulative Cubic Meters (CCM) (m^3)	905,980
27	CPSV Firm Justification for Final Recommendation	Refer to Observations
28	CPSV Firm IPMVP Option Identified	D
29	CPSV Firm Final Assessed Electricity Savings (if noteworthy)	0
30	CPSV Firm Final Assessed Water Savings (if noteworthy)	0

UNION GAS CPSV Review/Observations for 2014 Custom Projects	
Union Gas Project Code:	**CI - 22 (2014-COM-0239)**
Site Measurements:	(Not applicable)
Installed/Incremental Cost:	The construction cost of the total building is confirmed in writing by the Mechanical Engineering consultant along with installed cost estimate for the VRF system, developed from Hanscomb cost data. Incremental energy efficiency enhancements include not only VRF technology but enthalpy wheel air-air heat recovery, high levels of wall and roof insulation and passive solar orientation features. Consistent with a LEED costing report included in the project file, an incremental cost of $445,000 was estimated on the basis of an expected 3% total building cost premium applied over a minimum OBC standard building.
Project Measure:	Upgrade building systems to LEED standards with VRF technology
Project Description:	Construction of a new building to LEED compliance using VRF air-source heat pump technology, controlled with variable refrigerant flow and no intermediate fluid loop, in conjunction with energy efficient building envelope assemblies. Domestic water heating is accomplished by high efficiency, natural gas fired condensing boilers. Base case is construction to minimum OBC standard with conventional natural gas fired boilers.

Prioritization/Maintenance Practice/ Union Gas Role:

Prioritization/Customer Practice: The site, in its ongoing efforts to demonstrate the application of innovative technologies, approved the inclusion of VRF technology in the design. The success to date has prompted the consideration of this technology in the current conceptual design of other building expansions on campus.

Documented Practice: Documented to demonstrate compliance with LEED prerequisite EAp2 and credit EAc1. Reference Building is according to ASHRAE 90.1-2007.

Union's Role: As part of a long-standing working relationship, Union supports Energy Efficiency on site through awareness raising and related information transfer.

OBSERVATIONS & REASON FOR AGREEMENT/ADJUSTMENT:

The energy savings outlined in union's project file are based on the results of a building energy simulation model (EnergyPro 5.1). The reviewer visited the building to view the related mechanical systems and observe the operating performance and setpoints of the VRF based HVAC system through the centralized controller's display screens. (Nameplate data and temperature setpoints were found to be in accordance with information illustrated in the Mechanical drawings viewed on site). Following the reviewer's site visit, an updated report (to prove LEED compliance) was forwarded at the reviewer's request, in conjunction with metered electricity data.

The presentation of the energy simulation report is comprehensive (63 pages), with the energy simulator's analysis verified by a third party engineering company and a professional who is included in the CaGBC Experienced Modeler list.

As a cross-check to the simulation's propose building model consumption, a regression analysis of utility metered electricity data was subsequently prepared by Union and it agrees with the simulation model to within a 6% variance. The R^2 value for the regression is 0.873, showing a good correlation. Given the 6%

variance with actual metered consumption included an abnormally cold winter period for the time span (March 27, 2014 – Feb 27, 2015) in comparison to normalized HDD and the reasonably good regression correlation, the reviewer is prepared to accept the energy model as presented to reflect long term operation of the building. The data outlined in the excerpts from the compliance modeling report, included in Appendix 'X' for reference, yield an adjusted energy savings as follows:

Natural gas equivalent displacement for space heating (assuming 80% conventional boiler efficiency factor): *(1,820,318 – 485,831) MJ x (1 m^3/38.14 MJ) x (1/0.8) = 43,736 m^3*

Domestic Hot Water (natural gas): (328,633 – 269,025) MJ x (1 m^3/38.14 MJ) = 1,563 m^3

Total natural gas avoidance = 45,299 m^3

The 20 year EUL that is stated in the project file appears reasonable and is accepted without adjustment.

5. New Construction Baseline for Greenhouse Expansions

The reviewer emphasizes that a new construction baseline was used in the model assumptions for greenhouse expansions and not the baseline of the previous property. The external review process during the development of this report prompted the question as to what constitutes "standard" technologies in a new construction baseline. This issue should be considered within the context that all of the greenhouse facilities visited are family owned businesses with varying levels of knowledge in the application of energy efficient technologies or practices and perceptions of cost/benefit. As such, a *site-specific customized* approach has to be adopted in determining what aspects would be factored into a new construction baseline.

While some sites would appear to have a very similar construction and boiler equipment to the existing (pre-expansion or demolished) site, not all factors were identical between existing and new construction baseline when input to the Virtual Grower energy modeling software. For example, even if the owner expressed a pre-disposition toward using glass construction in the new facility due to cost constraints, the existing site's glass construction would have been framed with wood or galvanized material that would have experienced higher air infiltration levels (probably 1.5 air changes per hour). In these cases, the assumption adopted was that even if glass would likely have been used in the new construction, an improved sealed frame would have warranted a lower infiltration rate in the Base Case energy model (0.95 air changes per hour).

Given that the Base Case assumptions are aligned with the feedback received during the site visits and that no Ontario Building Code regulations specifically apply to greenhouse construction, a request was made during the external review process to develop an opinion as to what "average" baseline conditions would entail. (The aim here is not to re-model all of the greenhouse projects in this CPSV review, but to offer guidance to Union Gas on a go-forward basis).

It is recommended that a more in-depth Market Research project be commissioned by Union Gas to examine "average" market practices on a larger sample size than the (7) greenhouse construction projects reviewed in this assignment. *(This is beyond the scope of this CPSV review assignment)*. A *preliminary opinion* is developed by the CPSV reviewer on the basis of site observations made during this current assignment:

<u>Wall Construction</u>: While (4) out of the (7) visited greenhouses noted glass construction as the baseline, Union's increasing efforts to educate this sector's customer base on promoting energy efficient alternatives through direct contact and related workshop events seems to be promoting a shift in awareness towards at least using (inflated) *double polyethylene film as wall construction.*

<u>Energy Curtains</u>: None of the sites visited had an energy baseline that would include energy curtains. While this technology is gaining increasing acceptance (only (2) sites maintained the "no curtain" option in the new construction), most owners stated a low awareness level

of the cost/benefit of this technology while considering the new construction. It appears that acceptance of this technology is gaining traction but that its implementation has not reached full maturity yet. For this reason, the reviewer suggests that the *"no curtain"* option be maintained in baseline parameters, subject to re-evaluation every (3) years.

Boiler Equipment: (6) out of (7) boilers modeled in the new construction baseline were conventional, non-condensing gravity ventilated boilers. In all cases, the owner was initially pre-disposed to adopt the path of least cost and simply operate the existing boilers for the new site. Given the aged condition of some of these boilers, the controls of these boilers would likely be upgraded to achieve at least a basic (seasonal) efficiency of 75% instead of the 51% default value, which could have been used in the modeling software. While some controls upgrades included the addition of linkage-free controls, most retained boilers simply were retuned with basic combustion control adjustments. Given the relatively higher capital cost alternative for condensing boilers, the *conventional gravity vented boiler, tuned to 75% (seasonal) efficiency* could be maintained until the majority of existing boiler stock has approached rated service life in years to come.

Climate Control System: While existing, older greenhouse facilities relied on simple local temperature/humidity/ventilation controls, all facility expansions viewed have adopted a central climate control system, with control software that is specific to the greenhouse industry. This would suggest that the industry has now generally accepted this technology as the new norm. Moving forward, retrofit measures should be based on energy savings resulting on enhancements to the basic climate control system platform such as software updates that demonstrate *improved* temperature and zone control; addition of more sensors that enable scheduling of open/close energy curtain operations; CO_2 monitoring of plants and strategizing hot water storage tank use.

Appendix A: CI - 04 (2014-IND-0178)

Darcy formula for steam leaks at flanges :
$1891 \times d^2_{orifice} \times Y\, [(P_{in}-P_{out})/\, k\, V_1]^{1/2}$ where Y is a coefficient found in Appendix A22 in Crane Technical Paper No. 410-C,

Valve leakage using critical flow:
w in pph = 1.65 x Cv x Pin

Sarco derived formula for full leakage (orifice type leak):
$24.24 \times P_{INa} \times d^2_{orifice}$

Here is the Darcy formula reference to which steam leakage <u>at flanges</u> was applied.

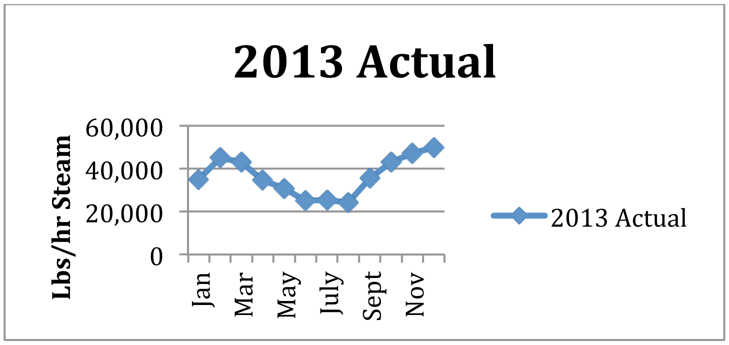
Darcy formula for steam leaks at flanges :
$1891 \times d^2_{orifice} \times Y\, [(P_{in}-P_{out})/\, k\, V_1]^{1/2}$ where Y is a coefficient found in Appendix A22 in Crane Technical Paper No. 410-C,

Valve leakage using critical flow:
w in pph = 1.65 x Cv x Pin

Sarco derived formula for full leakage (orifice type leak):
$24.24 \times P_{INa} \times d^2_{orifice}$

Here is the Sarco formula reference to which steam "hole" leakage was applied. (This is a variant of the Napier formula).

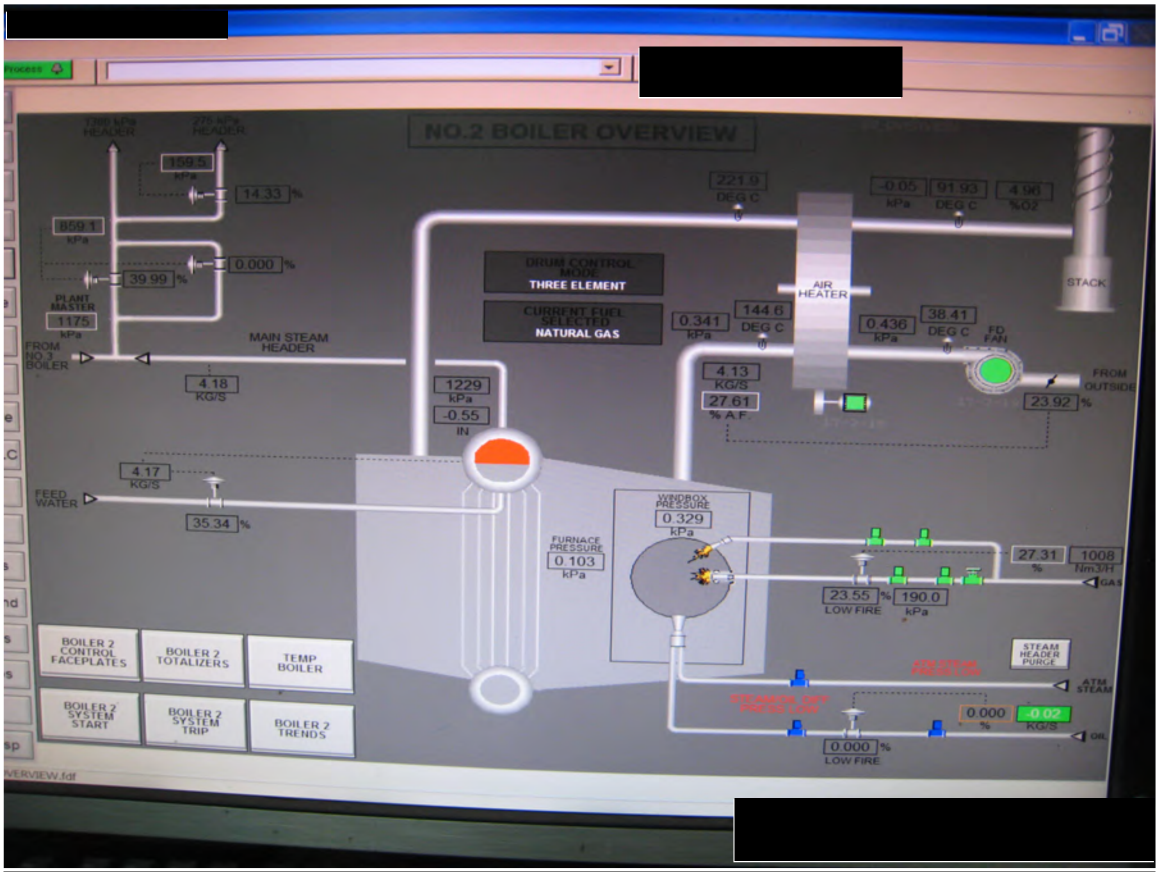
Comparison to total steam production



Example of steam valve flange repair

[redacted]

Boiler and Main Steam Operating Parameters



Appendix B: CI - 01 (2014-IND-0569)

Project CUSUM energy intensity spreadsheet analysis accepted as filed and related data will not be repeated in this Appendix. Site gathered data, and that which was received following the site visit, have been forwarded to the external Auditor on a confidential basis to enable completion of his review. (The CPSV Reviewer, being sensitive to the competitive nature of this site's industry, will not include this data in this Appendix).

Appendix C: CI - 24 (2014-COM-0087)

Capacity data from shop drawings for the site

[redacted]

JOB NAME: None
LINE #: 1
DATE: 07/16/13

Equipment Description

Direct gas-fired heater CSA certified to meet ANSI Z83.4/CSA3.7

Unit

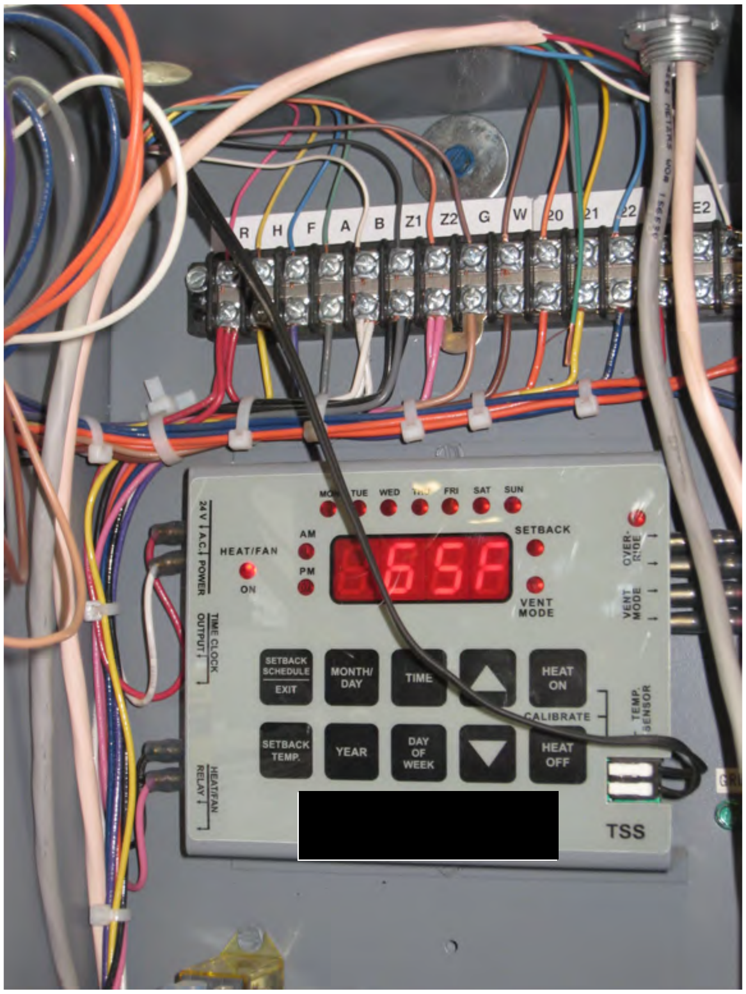
Qty	Model	Configuration	Weight (ea.)
1	[redacted]	Vertical Outdoor Up Blast	625 lbs.

ASHRAE 90.1 COMPLIANT

Ratings

Airflow		Heating Capacity		Temperature	
Design	TESP	Input	Output	Rise	Inlet
3,400 CFM	0.43"WC	718 MBH	661 MBH	160°F	-3°F

Observed space heating setpoint



(BJL revisions highlighted in red and orange colors)

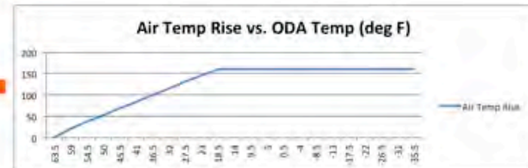
Cambridge S-series Heater Gas Savings

London

Hit ENTER after inputting data

	BASE CASE	**HIGHER EFFICIENCY**	
Burner Input Rating		[illegible]	BTUH
Design Day Temperature		-0.9	deg F
Space Setpoint Temperature		65	deg F
Assumed Balance Point Temp		65	deg F
Full Fire Air Temperature Rise		160	deg F
Burner Turndown Ratio		15	:1
Indoor/Outdoor Inverse Reset Ratio		3.5	:1
Indirect-Fired Makeup Air Unit Efficiency		0.8	range 0-1

[illegible]



Base Case Temperature Bin Analysis (Space Heating)

Avg. Bin Temp	Annual Hours	Annual Energy Output	Part Load Efficiency	Annual Energy Input	
°F	Oct 1 - May 31	MBTU	%	MBTU	
63.5	172.1	#DIV/0!	[illegible]	#DIV/0!	
59.0	278.5	[illegible]	[illegible]	[illegible]	←omitted in orig. sum
54.5	359.6	[illegible]	[illegible]	[illegible]	
50.0	417.8	[illegible]	[illegible]	[illegible]	
45.5	487.7	[illegible]	0.70	140,224	
41.0	573.7	142,411	0.71	200,197	
36.5	671.2	[illegible]	0.72	[illegible]	
32.0	819	[illegible]	0.73	[illegible]	
27.5	579.7	[illegible]	0.74	[illegible]	
23.0	415.3	[illegible]	0.74	[illegible]	
18.5	311.4	[illegible]	0.75	[illegible]	
14.0	226.1	102,740	0.76	[illegible]	
9.5	141.0	61,720	0.76	[illegible]	
5.0	68.4	[illegible]	0.77	[illegible]	
0.5	48	[illegible]	0.78	[illegible]	
-4.0	18.5	[illegible]	0.78	[illegible]	
-8.5	7.2	2,571	0.79	[illegible]	
-13.0	3	[illegible]	0.80	[illegible]	
-17.5		0		0	
-22.0		0		0	
-26.5		0		0	
-31.0		0		0	
-35.5		0		0	
TOTAL	* 5,019			2,221,095	MBTU

Higher Efficiency Temperature Bin Analysis

Avg. Bin Temp	Annual Hours	Part Load Efficiency	Air Temp Rise	ATR w/ Reset	ATR w/ Reset	S-series Output	Space Heating Output Avail	Space Heating Input Req'd	
°F	Oct 1 - May 31	%	°F	°F	°F	BTUH	MBTU	MBTU	
63.5	172.1	0.92	5.3	5.3	0.0	0	#DIV/0!	#DIV/0!	
59.0	278.5	0.92	21.0	21.0	21.0	[illegible]	17234.42	18733	←omitted in orig. sum
54.5	359.6	0.92	36.8	36.8	36.8	[illegible]	38971	42380	
50.0	417.8	0.92	52.5	52.5	52.5	[illegible]	64683	70306	
45.5	487.7	0.92	68.3	68.3	68.3	[illegible]	98157	106692	
41.0	573.7	0.92	84.0	84.0	84.0	[illegible]	142111	154469	
36.5	671.2	0.92	99.8	99.8	99.8	[illegible]	197437	214606	
32.0	819	0.92	115.5	115.5	115.5	[illegible]	278952	303299	
27.5	579.7	0.92	131.3	131.3	131.3	[illegible]	224371	243882	
23.0	415.3	0.92	147.0	147.0	147.0	[illegible]	180029	195684	
18.5	311.4	0.92	162.8	160.0	160.0	[illegible]	145917	158606	
14.0	226.1	0.92	178.5	160.0	160.0	[illegible]	101746	110594	
9.5	141.0	0.92	194.3	160.0	160.0	[illegible]	61220	66543	
5.0	68.4	0.92	210.0	160.0	160.0	[illegible]	36496	39670	
0.5	48	0.92	225.8	160.0	160.0	[illegible]	18925	20571	
-4.0	19.5	0.92	241.5	160.0	160.0	[illegible]	6950	7555	
-8.5	7.2	0.92	257.3	160.0	160.0	[illegible]	2571	2795	
-13.0	3	0.92	273.0	160.0	160.0	[illegible]	1018	1104	
-17.5		0.92	288.8	160.0	160.0	660560	0	0	
-22.0		0.92	304.5	160.0	160.0	660560	0	0	
-26.5		0.92	320.3	160.0	160.0	660560	0	0	
-31.0		0.92	336.0	160.0	160.0	660560	0	0	
-35.5		0.92	351.8	160.0	160.0	660560	0	0	
								1757370	MBTU

Additional Savings when Indirect-Fired Makeup Air Unit is being Replaced

S-series Output	Makeup Air Output	Direct-Fired Makeup Air Input	Indirect-Fired Makeup Air Input	
MBTU	MBTU	MBTU	MBTU	
0	#DIV/0!	#DIV/0!	#DIV/0!	
24128	6894	7493	8617	←omitted in orig. sum
54559	15588	16944	19485	
90557	25873	28123	32342	
137419	39263	42677	49078	
198956	56844	61787	71056	
276412	78975	85842	98719	
390633	111581	121284	139476	
314120	89748	97553	112186	
252041	72012	78274	90015	
205698	59781	64979	74726	
149353	47606	51746	59508	
93733	32514	35341	40642	
58394	21898	23802	27372	
31707	12782	13893	15977	
12220	5270	5728	6588	
4756	2185	2375	2731	
1982	966	1050	1208	
		738,891	849,725	

Direct-Fired Makeup Air Unit Replacement

ANNUAL ENERGY SAVINGS	463,717	MBTU
ANNUAL GAS SAVINGS	12943	m3

Indirect- Fired Makeup Air Unit Replacement

ANNUAL ENERGY SAVINGS	[illegible]	MBTU	adjusted for assumed [illegible] exhaust fan operation in conjunction with welding and painting operations
ANNUAL GAS SAVINGS	13974	m3	← final adjusted savings estimate

Appendix D: CI - 21 (2014-IND-0183)

Revised BJL calculations

Tank Insulation - Energy Savings Calculation

System Efficiencyt: 0.75 % *provided by customer*

Tank Insulation Log - Siding

#	Component	Dimensions of Component				Surface Temperature	Content Pressure	Ambient Temperature in Location	Location	Layout or System App	Operating Hours	Thickness of Insulation Installed	Type of Insulation Installed	Jacket Material
		length	width	height	diameter									
		(feet)			(feet)	(F)	(psig)	(F)			(hours)	(in)		Type / Thickness (in)
1	Aggregate Dryer Insulation - Siding	30	-	-	10	360		60	Outdoors	Tank Shell - Horizontal	1600	2"	650F Min Fiber Tank Insulation	Aluminum Jacket

See "Weather Data" Tab.

Calculations

#	Component	Length ft	Base Case: Energy Loss Bare Tank (from 3E Plus) Btu/ft²/yr	Base Case: Net Base Case Energy Loss m³/yr	High Eff. Case: Energy Loss Insulated Tank (from 3E Plus) Btu/ft²/yr	High Eff. Case: Net High Eff. Case Energy Loss m³/yr	Natural Gas Energy Saved m³/yr
1	Aggregate Dryer Insulation - Siding	30	1,435,000	50,305	86,000	3,015	47,291
	TOTAL			50,305		3,015	47,291

BJL revised calculations to 360 °F process temperature

NAIMA 3EPlus V4.1

BJL Assoc

[redacted]

Item ID = 1
Item Description =
System Application = Tank Shell - Horizontal
Dimensional Standard = ASTM C 585 Rigid
Calculation Type = Heat Loss Per Year Report
Process Temperature = 360
Ambient Temperature = 60
Wind Speed = 8.8

Hours Per Year = 1600

Bare Metal = Steel
Bare Surface Emittance = 0.8
Insulation Layer 1 = 650F Min.Fiber Pipe and Tank, Type II, C1393-11

Outer Jacket Material = Aluminum, oxidized, in service
Outer Surface Emittance = 0.1

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (kBTU/ft^2/yr)	Efficiency (%)
Bare	359.4	1435	
0.5	171.5	266	81.44
1.0	124.9	157	89.03
1.5	105.5	111	92.25
2.0	95.0	86	94.02
2.5	88.4	70	95.13
3.0	83.9	59	95.89
3.5	80.6	51	96.45
4.0	78.1	45	96.88
4.5	76.2	40	97.21
5.0	74.6	36	97.48
5.5	73.3	33	97.70
6.0	72.2	30	97.89
6.5	71.3	28	98.04
7.0	70.5	26	[illegible]

Appendix E: CI - 14 (2014-IND-0112)

TPI716N

OFB Flue Gas Repor

Date : 24/02/15
Time : 09:12
Address No. : 02
Fuel : Natural Gas

-------- Report --------

CO(ppm):	137
O2(%):	15.2
CO2(%):	3.2
Ratio(CO/CO2):	0.0042
Excess Air(%):	266
Gross Effi(%):	70.3
T1_ST(C):	201.6
T2_AT(C):	Open
Diff(T1-T2):	----
NO(ppm):	12
NOx(ppm):	12
Pressure(mbar):	-0.02
Pump(cc/min):	983

Customer :

Reading Accepted by :

09:19 24/02/15

Combustion test data

Boiler Steam Pressure

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964
GENERAL DATA:

FUEL HHV =	1000	BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	22,723	BTU/LB	Combustible HHV	1000	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.59	CU FT/LB			

CUSTOMER/PROJECT: General Description — Hurst Fire Tube Boiler - NO Economizer; Model: 150 hp Series 500
Rated Input: 6,300 MBH on natural gas/ 5,175 pph steam output

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

	UNITS	As-tested	BJL calc.
SECTION A ENTER TEST DATA IN THIS SECTION			
FIRING RATE =			
STEAM DRUM PRESSURE =	PSIG	13	13
COMBUSTION AIR TEMP =	DEG. F	80	80
STACK TEMP	DEG. F	475	475
NET STACK TEMP =	DEG.F	395	395
OXYGEN=	% by vol	15.20	5.00
CARBON MONOXIDE =	PPM	137	10
	% by vol.	0.01	0.00
COMBUSTIBLES =	% by vol.	0.000	0.000
SECTION B TOTAL LOSS CALCULATION			
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	18.38%	8.08%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	11.60%	11.60%
PERCENT CARBON MONOXIDE LOSS	%	0.04%	0.00%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	30.02%	19.68%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE			
COMBUSTION EFFICIENCY (100-LOSSES)	%	69.98%	80.32%

SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49		TEST #1	TEST #2
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	234.20	27.95
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		365.80	386.20
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	9.889	10.274
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	10.133	9.753
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	23.244	9.485
VOL N2 per VOL DFG	CU FT/CU FT	235.054	92.323
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F. ASME EQ. 25	44.05	19.36
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F. ASME SEC. 7.3.2.07	9.79	0.74
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

Boiler Ratings:			Losses:		
Full Load Fuel Input	6,300	MBTU/HR	Radiation	1.0%	of full load fuel input
Min. Fuel Input	NA	BTU/HR	Blow-Down	3.0%	of steam output
Rated Steam Output	5,175	LB/HR	Unmeasured Loss	0.5%	of fuel input
Fuel HHV	1000	BTU/CU FT			

Test #	Units	As-Tested	BJL calc
Fuel Input	percent of F.L.	100%	100%
Fuel Input	MBTU/HR	6,300	6,300
Combustion Loss	percent	30.02%	19.68%
Combustion Loss	**BTU/HR**	**1,891**	**1,240**
Radiation Loss	MBTU/HR	63	63
Blow-Down Loss	MBTU/HR	180	180
Unmeasured Loss	MBTU/HR	31.5	31.5
TOTAL LOSS	**MBTU/HR**	**2,166**	**1,514**
Fuel Input, MBTU/H		6,300	6,300
Combustion Efficiency	**Comb. Eff.**	**70.0%**	**80.3%**
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**65.6%**	**76.0%**

BJL revised Input Parameters

PROJECT ASSUMPTIONS

Small Leaks

Big Leaks

LIST OF ASSUMPTION / ESTIMATIONS					SUPPORT	
DEFINITION BELOW FOR CATEGORY 1 LEAK						
1.0	Low Plant Pressure =	10	psig		1.0	Provided by Customer
2.0	Leak Orifice Diameter Category 1 =	1/32"	@	10 psig	2.0	Provided by Customer
3.0	Leak Orifice Diameter Category 1 =	1/16"	@	10 psig	3.0	Provided by Customer
4.0	Leak Rate @ 1/32"	0.70	lb/hr		4.0	Steam Discharge Rate & Linear Interpolation.pdf
5.0	Leak Rate @ 1/16"	2.80	lb/hr		5.0	Steam Discharge Rate & Linear Interpolation.pdf
6.0	Use Average From Above =	1.8	lb/hr		6.0	Category 1 Estimate
DEFINITION BELOW FOR CATEGORY 2 LEAK						
7.0	Low Plant Pressure =	10	psig		1.0	Provided by Customer
8.0	Leak Orifice Diameter Category 1 =	1/8"	@	10 psig	2.0	Provided by Customer
9.0	Leak Orifice Diameter Category 1 =	5/16"	@	10 psig	3.0	Provided by Customer
10.0	Leak Rate @ 1/8"	11.20	lb/hr		4.0	Steam Discharge Rate & Linear Interpolation.pdf
11.0	Leak Rate @ 5/16"	44.60	lb/hr		5.0	Steam Discharge Rate & Linear Interpolation.pdf
12.0	Use Average From Above =	27.9	lb/hr		6.0	Category 1 Estimate
OTHER ASSUMPTIONS						
1.0	Condensate Return Pressure [psig] =	5	psig		1.0	Provided by Customer
2.0	Enthaply of 10 psig Steam =	1160.3	Btu/lb		2.0	From Steam Tables
3.0	Steam Pressure Raised =	13	psig		3.0	Provided by Customer
4.0	Estimated Boiler Efficiency =	76%			4.0	Provided by Customer
5.0	Hours Per Year =	8756			5.0	Provided by Customer
6.0	Nat Gas HHV =	1000	Btu/ft^3		6.0	Standard Assumption
7.0	$1 m^3$ =	35.314	ft^3		7.0	Standard Conversion

NATURAL GAS STEAM LOSS CALCULATION

Total Number of Steam Leaks	51	#
Total 10 psig Steam Leaks	795	lb/hour
	-	lb/hour
	-	lb/hour
	-	lb/hour
Energy Lost at 10 psig	8,079,919,382	Btu/year - heat loss
	-	Btu/year - heat loss
	-	Btu/year - heat loss
	-	Btu/year - heat loss
Heat Input to Make-up Loss	12,316,950,278	Btu/year - heat input lost
m3 Gas Savings - Annual	348,784	m^3/year
EUL	20	years
m3 Gas Savings - Lifetime	3,208,811	m^3

WATER LOSS CALCULATIONS

$$\text{Water Savings} = \frac{L}{yr} = 795.3\ \frac{\cancel{lbs}}{hr} \times 0.4536\ \frac{L}{\cancel{lbs}}$$

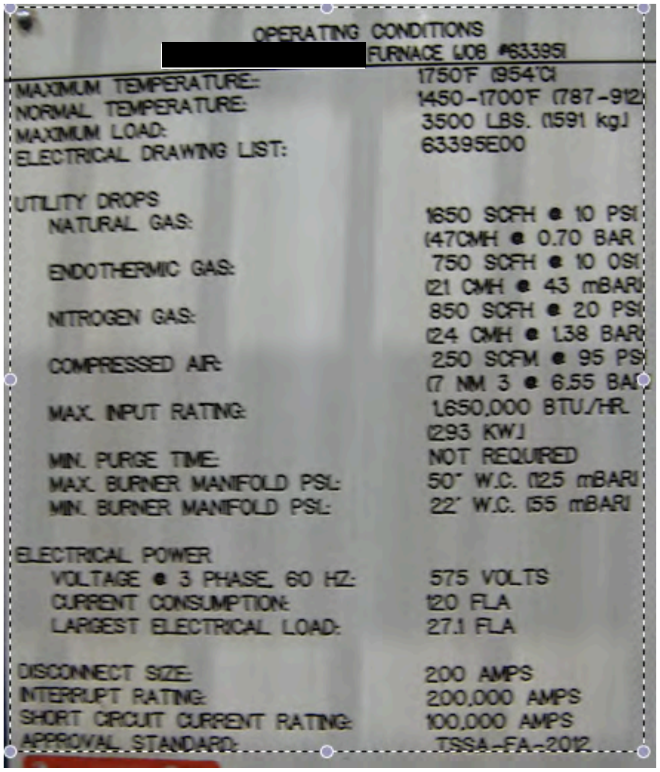
$$\text{Water Savings} = \frac{L}{yr} = 360.75\ \frac{L}{hr} \times \text{Operating Hours}$$

$$\text{Water Savings} = \frac{L}{yr} = 360.75\ \frac{L}{\cancel{hr}} \times 8756\ \frac{\cancel{hr}}{yr}$$

$$\text{Water Savings} = \frac{L}{yr} = 3,158,710\ \frac{L}{yr}$$

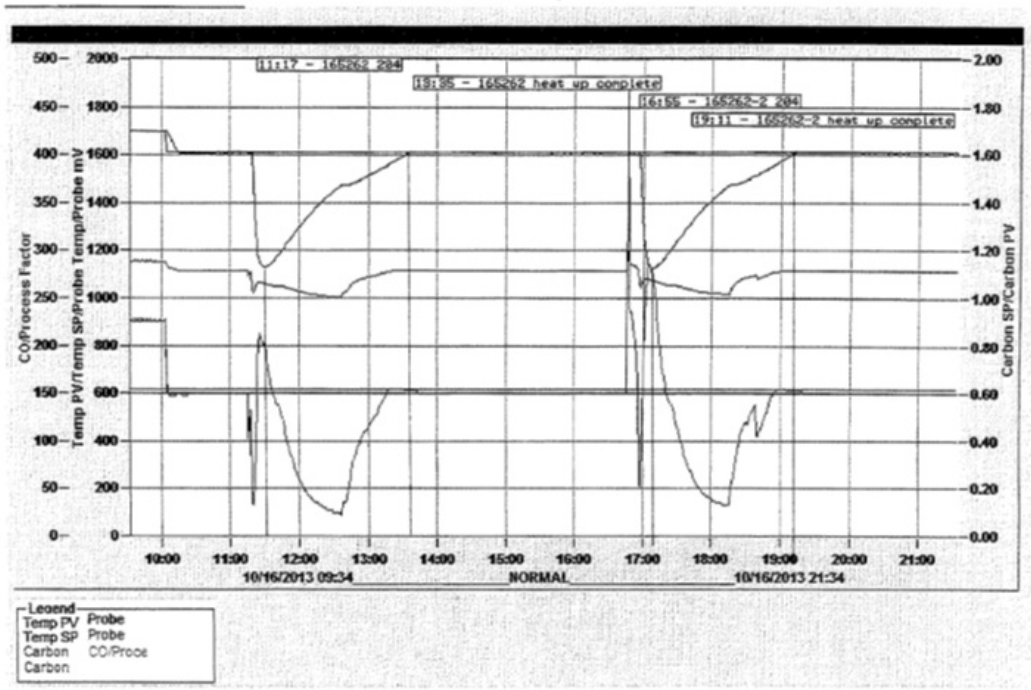
Appendix F: CI - 16 (2014-IND-0166)

Burner nameplate data



Pre Burner Replacement Temperature vs Time Profiles

Preburner Replacement - Preheat Times.

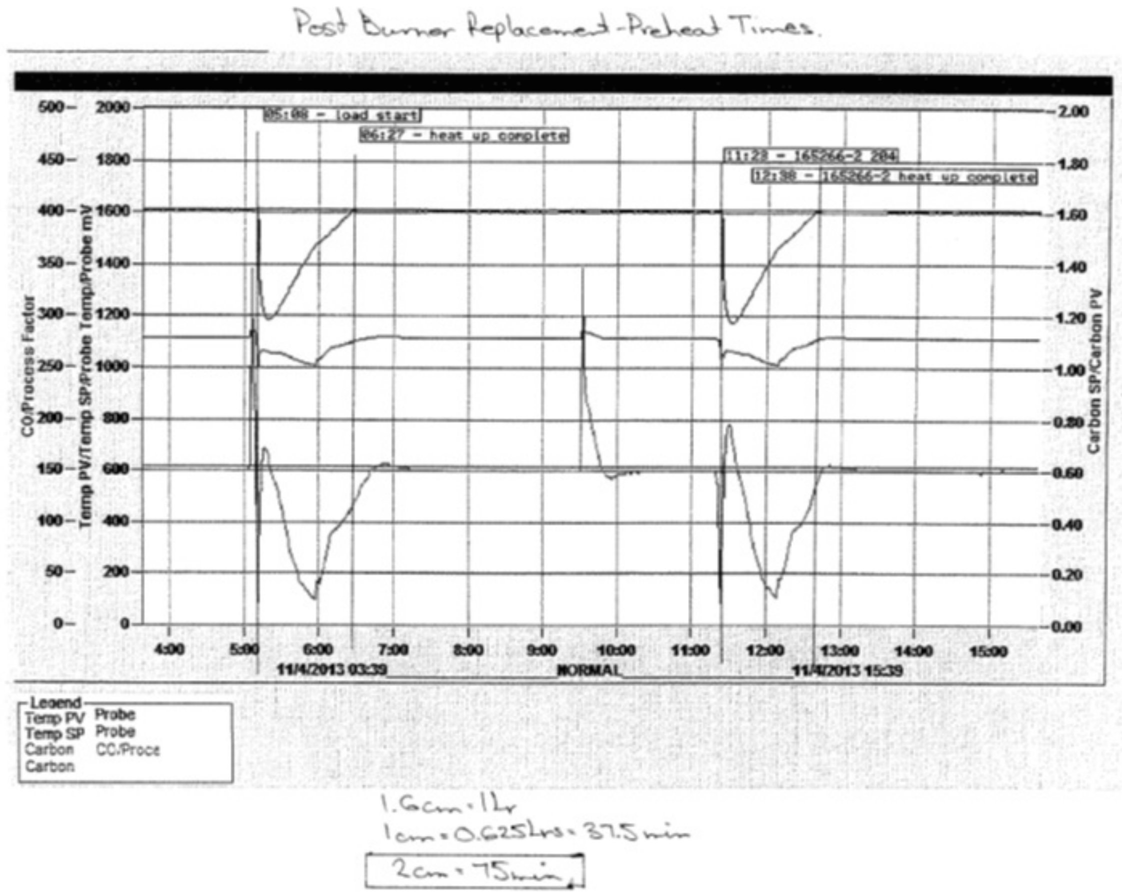


1.6cm = 1hr

1cm = 0.625hrs = 37.5min.

3.5cm = 131.25min = 2.2hrs

Post Burner Replacement Temperature vs Time Profiles



Preheated Air Pipe Temperature Measurement

Appendix G: CI - 11 (2014-IND-0056)

Revised Site data – communicated during site visit by Customer

updated March 12/15
(From Site Visit)

DEAERATOR TANK FLASH HEAT RECOVERY

Basis

Installation of a recirc pump from Reclaim Catch Tank through Deaerator Flash heat exchanger to pre-heat reclaim water used in CIP 1,2 process.

Deareator Project

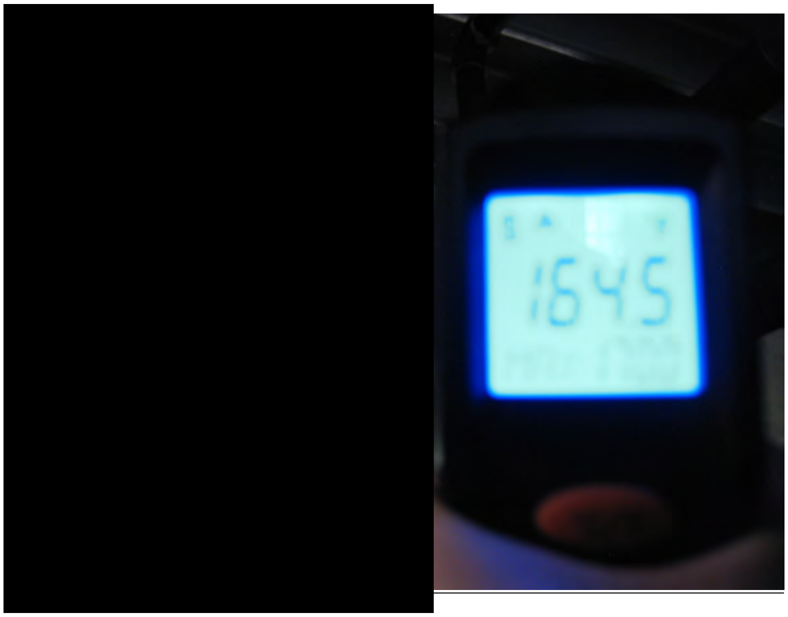
Operating Hours per week	100	hours/week
Pump Flow Rate	50	gpm
	50	weeks/year
Operating Hours	5,000	hours/year
Annual Flow	15,000,000	gallons/yr
Total Mass of Water Used	124,500,000	lb/yr
Water Delta T	85	Deg F.
Total BTUs	10,582,500,000	BTUs
Steam Heat Capacity	1,100	BTU/lb
Total Steam	9,620,455	lb/yr
Gas Rate	0.22	$/m3
Water Rate	0.46	$/m3
Net Boiler Efficiency	0.85	
Project Cost	17,177	

Calculations

Net Steam Saved	9,620,455	lb/yr
Q (Steam) Saved	10,582,500,000	BTU/yr
Net Water Saved for Steam	1,153,532	gallons/yr
Gas Heating Value	36,546	BTU/m3
Gas Flow	289,567	m3/yr
Net Gas Flow	340,667	m3/yr
Gas Savings - CAD	76,173	per year
Gas Savings - EURO	60,938	per year

Results

Simple Payback	**0.23**	**years**
Daily Savings	**254**	**per day**
Gas Reduction	**340,667**	**m3/yr**
Gas Reduction Change	**0.09**	**(% of 2012 Consumption)**
Steam Reduction	**9,620,455**	**lb/yr**
NOx Emission Rate	**0.57**	**Tonnes/yr**
SOx Emission Rate	**0.003**	**Tonnes/yr**
CO2 Emission Rate	**625**	**Tonnes/yr**



Measured outlet pipe temperature

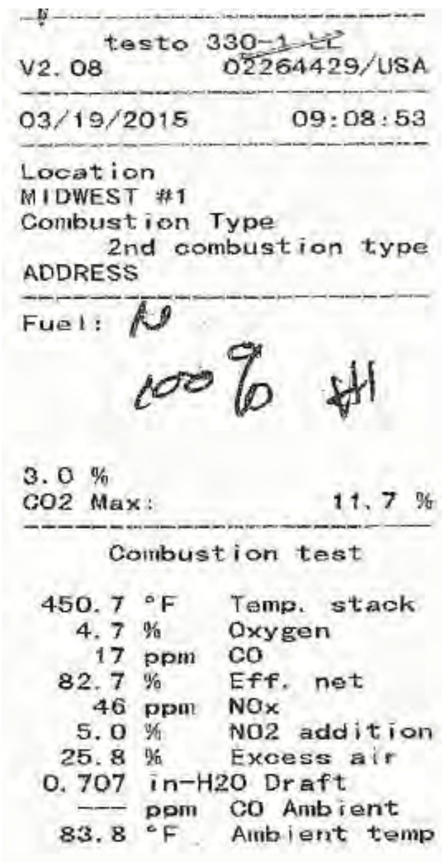
Measured inlet pipe temperature

Weighting of Calculated steam/fuel efficiencies

As-Found Boiler Firing

Boiler	Rating BTUH	% Firing Rate	I/P BTUH		Stm/fuel Eff.	Weighted Avg.
B1	12,246,951	67%	8,205,457		79.8%	29.5%
B2	12,246,951	25%	3,061,738		79.4%	11.0%
B3	12,246,951	21%	2,571,860		78.4%	9.1%
B4	12,246,951	43%	5,266,189		79.1%	18.8%
B5	12,246,951	25%	3,061,738		78.2%	10.8%
			22,166,981	Total		79.2%
			3.01666667	equiv # of boilers @ 60%		
Total NG Mar '14 to Feb '15			4,299,551	m3		
			491	avg m3/hr		
			17,672,714			

Boiler #1 Combustion test data example


testo 330-1 LL
V2.08 02264429/USA

03/19/2015 09:08:53

Location
MIDWEST #1
Combustion Type
2nd combustion type
ADDRESS

Fuel: N
100% #1

3.0 %
CO2 Max: 11.7 %

Combustion test

450.7	°F	Temp. stack
4.7	%	Oxygen
17	ppm	CO
82.7	%	Eff. net
46	ppm	NOx
5.0	%	NO2 addition
25.8	%	Excess air
0.707	in-H2O	Draft
---	ppm	CO Ambient
83.8	°F	Ambient temp

Boiler #1 combustion test data example

50%

testo 330-1 LL
V2.08 02264429/USA

03/19/2015 09:12:37

Location
MIDWEST #1
Combustion Type
2nd combustion type
ADDRESS

Fuel: Natural Gas
O2ref. 3.0 %
CO2 Max: 11.7 %

Combustion test

382.1	°F	Temp. stack
4.0	%	Oxygen
58	ppm	CO
84.4	%	Eff. net
71	ppm	NOx
5.0	%	NO2 addition
21.0	%	Excess air
0.245	in-H2O	Draft
---	ppm	CO Ambient
84.6	°F	Ambient temp

25% Lo

testo 330-1 LL
V2.08 02264429/USA

03/19/2015 09:17:49

Location
MIDWEST #1
Combustion Type
2nd combustion type
ADDRESS

Fuel: Natural Gas
O2ref. 3.0 %
CO2 Max: 11.7 %

Combustion test

289.9	°F	Temp. stack
6.6	%	Oxygen
18	ppm	CO
85.5	%	Eff. net
46	ppm	NOx
5.0	%	NO2 addition
41.0	%	Excess air
0.036	in-H2O	Draft
---	ppm	CO Ambient
85.5	°F	Ambient temp

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964

GENERAL DATA:

FUEL HHV =	1000	BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	22,723	BTU/LB	Combustible HHV	1000	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.59	CU FT/LB			

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

BOILER #1 NO Economizer

	UNITS	TEST #1	TEST #2	TEST #3
SECTION A ENTER TEST DATA IN THIS SECTION				
FIRING RATE =	Fuel Input MBTU/HR	3,062	6,123	12,247
STEAM DRUM PRESSURE =	PSIG	150	150	150
COMBUSTION AIR TEMP =	DEG. F	86	85	84
STACK TEMP Before Economizer	DEG. F	290	382	451
STACK TEMP After Economizer	DEG. F	290	382	451
NET STACK TEMP =	DEG.F	204	297	367
OXYGEN=	% by vol	6.60	4.00	4.70
CARBON MONOXIDE =	PPM	18	58	17
	% by vol.	0.00	0.01	0.00
COMBUSTIBLES =	% by vol.	0.000	0.000	0.000
SECTION B TOTAL LOSS CALCULATION				
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	4.55%	5.77%	7.39%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	10.72%	11.14%	11.45%
PERCENT CARBON MONOXIDE LOSS	%	0.01%	0.02%	0.01%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	15.27%	16.93%	18.85%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE				
COMBUSTION EFFICIENCY (100-LOSSES)	%	84.73%	83.07%	81.15%

SECTION D- SUB-SECTION FOR CALCULATION OF DRY FLUE GAS CO2, N2 AND O2 RELATIONSHIPS

		TEST #1	TEST #1	TEST #3
SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49				
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	40.99	21.05	25.79
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		383.00	388.20	386.80
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	10.214	10.312	10.286
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	9.810	9.717	9.742
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	10.351	9.028	9.342
VOL N2 per VOL DFG	CU FT/CU FT	101.344	87.548	90.829
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F ASME EQ. 25	21.10	18.40	19.06
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F ASME SEC. 7.3.2.07	1.33	4.33	1.27
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

Natural Gas Fuel No Econ

Boiler Ratings:			**Losses:**	Radiation	1.0%	of full load fuel input
Full Load Fuel Input	**12,247**	MBTU/HR		Blow-Down	3.0%	of steam output
Min. Fuel Input	1,400	BTU/HR		Unmeasured	0.5%	of fuel input
Rated Steam Output	**N/A**	LB/HR		Loss		
Fuel HHV	**1000**	BTU/CU FT				

Test #	Units	TEST #1	TEST #2	TEST #3		
Fuel Input	percent of F.L.	25%	50%	100%		
Fuel Input	MBTU/HR	3,062	6,123	12,247		
Combustion Loss	percent	**15.27%**	**16.93%**	**18.85%**		
Combustion Loss	**BTU/HR**	**467**	**1,036**	**2,308**		
Radiation Loss	MBTU/HR	122	122	122		
Blow-Down Loss	MBTU/HR	24	46	91		
Unmeasured Loss	MBTU/HR	15.3	30.6	61.2		
Cycling Loss	MBTU/HR	0	0	0		
TOTAL LOSS	**MBTU/HR**	**629**	**1,236**	**2,583**		
Fuel Input, MBTU/H		3,062	6,123	12,247		
Combustion Efficiency	**Comb. Eff.**	**84.7%**	**83.1%**	**81.2%**		
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**79.5%**	**79.8%**	**78.9%**	Average:	79.4%
Total Steam Production	**LB/HR**	**2,395**	**4,811**	**9,512**		
Steam to Condensate Tank	**LB/HR**	**261**	**467**	**867**		
Net Steam to Process	**LB/HR**	**2,133**	**4,344**	**8,645**		

Final calculation revisions by BJL

DEAERATOR TANK FLASH HEAT RECOVERY				
Assumptions				
Operating Hours per week	100	hours/week		
Pump Flow Rate	50	gpm		
	50	weeks/year		
Operating Hours	5,000	hours/year		
Annual Flow	15,000,000	gallons/yr		
Total Mass of Water Used	124,500,000	lb/yr		
Water Delta T	85	Deg F.		
Total BTUs	10,582,500,000	BTUs		
Steam Heat Capacity	1,016	BTU/lb	net added by boiler	
Total Steam	10,415,846	lb/yr		
Gas Rate	0.35	$/m3		
Water Rate	0.23	$/m3		
Net Boiler Efficiency	0.79			
Project Cost	15,615			
Calculations				
Net Steam Saved	10,415,846	lb/yr		
Q (Steam) Saved	10,582,500,000	BTU/yr		
Net Water Saved for Steam	1,248,902	gallons/yr	4,727,608	liters/year
Gas Heating Value	36,546	BTU/m3		
Gas Flow	289,567	m3/yr		
Net Gas Flow	366,540	m3/yr		
Gas Savings	$ 129,791.80	per year		
Results				
Simple Payback	**0.1**	**years**		
Daily Savings	**433**	**per day**		
Gas Reduction	**366,540**	**m3/yr**		
Steam Reduction	**10,415,846**	**lb/yr**		
NOx Emission Rate	**0.57**	**Tonnes/yr**		
SOx Emission Rate	**0.003**	**Tonnes/yr**		
CO2 Emission Rate	**626**	**Tonnes/yr**		

Appendix H: CI - 15 (2014-COM-0079

New pipe replacement, example for leakage avoidance

Shut down and tagging of line leakage

Boiler pressure confirmation

BJL revised input parameters

PROJECT ASSUMPTIONS

	LIST OF ASSUMPTION / ESTIMATIONS				SUPPORT	
	DEFINITION BELOW FOR CATEGORY 1 LEAK					
1.0	Low Plant Pressure =	10	psig		1.0	Provided by Customer
2.0	Leak Orifice Diameter Category 1 =	1/16"	@	10 psig	2.0	Provided by Customer
3.0	Leak Orifice Diameter Category 1 =	3/16"	@	10 psig	3.0	Provided by Customer
4.0	Leak Rate @ 1/16"	2.80	lb/hr		4.0	Steam Discharge Rate & Linear Interpolation.pdf
5.0	Leak Rate @ 3/16"	25.10	lb/hr		5.0	Steam Discharge Rate & Linear Interpolation.pdf
6.0	Use Average From Above =	**14.0**	lb/hr		6.0	Category 1 Estimate
	DEFINITION BELOW FOR CATEGORY 2 LEAK					
7.0	Low Plant Pressure =	10	psig		1.0	Provided by Customer
8.0	Leak Orifice Diameter Category 1 =	3/16"	@	10 psig	2.0	Provided by Customer
9.0	Leak Orifice Diameter Category 1 =	5/16"	@	10 psig	3.0	Provided by Customer
10.0	Leak Rate @ 3/16"	25.10	lb/hr		4.0	Steam Discharge Rate & Linear Interpolation.pdf
11.0	Leak Rate @ 5/16"	69.70	lb/hr		5.0	Steam Discharge Rate & Linear Interpolation.pdf
12.0	Use Average From Above =	**47.4**	lb/hr		6.0	Category 1 Estimate
	OTHER ASSUMPTIONS					
1.0	Condensate Return Pressure [psig] =	5	psig		1.0	Provided by Customer
2.0	Enthaply of 10 psig Steam =	1160.3	Btu/lb		2.0	From Steam Tables
3.0	Steam Pressure Raised =	12	psig		3.0	Provided by Customer
4.0	Estimated Boiler Efficiency =	75%			4.0	Provided by Customer
5.0	Hours Per Year =	6744			5.0	Provided by Customer
6.0	Nat Gas HHV =	1000	Btu/ft^3		6.0	Standard Assumption
7.0	$1 m^3$ =	35.314	ft^3		7.0	Standard Conversion

Small Leaks

Big Leaks

	2013		2014		2015	
	Consumption M3	# of Billing Days	Consumption M3	# of Billing Days	Consumption M3	# of Billing Days
January	73,759.506	30	164,226.188	34	105,398.897	33
February	290,671.055	30	363,867.081	29	352,400.267	29
March	299,630.384	31	335,974.831	29	329,579.335	28
April	229,871.584	29	248,494.592	29		
May	173,326.386	30	182,088.497	32		
June	97,482.005	33	79,140.738	30		
July	38,006.713	30	37,894.017	33		
August	29,836.255	32	31,667.565	30		
September	30,174.343	30	31,836.609	29		
October	69,308.015	29	99,538.707	32		
November	110,188.475	32	92,297.991	30		
December	76,971.341	28	57,249.548	29		
Corr. Totals	1,519,226.062	364	1,724,276.364	366	787,378.499	90

* Estimated Value

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Capacity of smallest boilers		Old Farm (steam leaks)	New farm
		350 hp	150 hp
% weighting of fuel consumption:		0.7	0.3
Input rating (BTUH):	14,645,000		
m3/hr	406.729		

Full fire hrs →	65.21741	(say) 7.1 Vd →	195.65 hr/day	5.9289	data suggests summer operation is more like 6 hrs/day instead of the estimated 12
	54.50138		163.5	5.4501	
	54.79232		164.38	5.6682	

Revised hrs estimate:

8 months X 24/day hrs =	5832
1 months X 12/day hrs =	360
3 months X 6/day hrs =	552
sum	6744 hrs

BJL revised calculations

NATURAL GAS STEAM LOSS CALCULATION		
Total Number of Steam Leaks	30	#
Total 10 psig Steam Leaks	954	lb/hour
	-	lb/hour
	-	lb/hour
	-	lb/hour
Energy Lost at 10 psig	7,462,762,774	Btu/year - heat loss
	-	Btu/year - heat loss
	-	Btu/year - heat loss
	-	Btu/year - heat loss
Heat Input to Make-up Loss	9,950,350,365	Btu/year - heat input lost
m3 Gas Savings - Annual	281,768	m^3/year
EUL	20	years
m3 Gas Savings - Lifetime	2,592,264	m^3

WATER LOSS CALCULATIONS

$$\text{Water Savings} = \frac{L}{yr} = 953.7\ \frac{\cancel{lbs}}{hr} \times 0.4536\ \frac{L}{\cancel{lbs}}$$

$$\text{Water Savings} = \frac{L}{yr} = 432.60\ \frac{L}{hr} \times \text{Operating Hours}$$

$$\text{Water Savings} = \frac{L}{yr} = 432.60\ \frac{L}{\cancel{hr}} \times 6744\ \frac{\cancel{hr}}{yr}$$

$$\text{Water Savings} = \frac{L}{yr} = 2,917,443\ \frac{L}{yr}$$

Appendix I: CI - 17 (2014-COM-0051)

Temperature setpoint profile (note Avg. 19.1 ° C in tabular data)

BJL calculation revisions

CI-17-(2014-COM-0051)

New Expansion Project Savings Estimates

Total Acreage of New Expansion 6.8

	Base Case Measures	High Efficient Measures	Savings	
January	320,942	265,190	55,752	
February	255,503	211,452	44,051	
March	210,121	173,200	36,921	
April	121,626	97,544	24,082	
May	79,709	62,851	16,858	
June	29,661	20,691	8,970	
July	13,993	8,245	5,748	
August	23,946	15,964	7,981	
September	48,013	35,094	12,920	
October	104,894	83,214	21,680	
November	188,043	153,688	34,355	
December	287,204	236,981	50,223	
	1,683,653	1,364,113	514,195	m^3 Annual
			16.0	EUL
	247,596 m^3/acre	200,605 m^3/acre	8,227,118	m^3 Lifetime

temperature setpoint impact from VG model reset: 194,655 m^3 Annual

Savings per Acrage: 75,617 m^3 Annual

Air Infiltration Calculator:	
	0.095
0.95	0.855

Virtual Grower Inputs

EUL Analysis

	Base Case Measures	High Efficient Measures	Input order in VG	m^3 Consumption as a result of High Efficent option	Individual Measure Saviggs	EUL	Weighted EUL
Greenhouse Design - Structure				VIRTUAL Grower Inputs			
Greenhouse Size =	Same	Same					
Greenhouse Design - Materials			4	1,364,113	118,996	5	1.1
Roof =	Polyethylene Double Layer	IR Film Double Layer					
End Wall 1 =	Polyethylene Double Layer	IR Film Double Layer					
End Wall 2 =	Polyethylene Double Layer	IR Film Double Layer					
Side Wall 1 =	Polyethylene Double Layer	IR Film Double Layer					
Side Wall 2 =	Polyethylene Double Layer	IR Film Double Layer					
End Kneewal 1 =	Concrete Block	Concrete Block					
End Kneewal 2 =	Concrete Block	Concrete Block					
Side Kneewal 1 =	Concrete Block	Concrete Block					
Side Kneewal 2 =	Concrete Block	Concrete Block					
Greenhouse Design - Air Infiltration			3	1,483,109	84,612	20	3.2
Current Air Exchange Rate =	0.95	0.855					
Greenhouse Design - Energy Curtain			5	1,364,113	-	10	-
Is energy curtain installed =	No	No					
Material =	n/a	n/a					
Heating - Heating Schedules			2	1,567,721	110,587	20	12
Temperature Setting =	22°C	[illegible]					
Heating - Heating System Set-up			1	1,683,653	-	20	-
Heater Type =	Steam Boiler	Steam Boiler					
Ventilation =	Gravity Ventilation	Gravity Ventilation					
Heat Delivery - Method =	Steam Pipes	Steam Pipes					
Heat Delivery - Variations =	Below Bench	Below Bench					
Maintenance - Heater's Age =	Old (6+ years)	Old (6+ years)					
Maintenance - Schedule =	Annually	Annually					
Heating System Efficiency Override =	0.7	0.7					16.5
					514,195		16.0

CI-17-(2014-COM-0051)

Cost Summary

	Base Cost $	Source	High Eff. Cost $	Source		
[redacted] Climate Control System						
	$ -	No basecase cost.	$ 160,490		Information supplied by customer - refer to PDF document.	Invoice Summary - Climate Control.PD
Double IR AC Poly Roof & Side Walls						
	$ 38,585	No basecase cost.	$ 77,170	$ 154,340	Information supplied by customer - refer to PDF document.	Invoice Summary - Roof and Sidewalls.
TOTAL	$ 38,585		$ 237,660	over 20 years		
			total	$ 314,830		
Difference	$ 199,075					

Appendix J: CI - 05 (2014-IND-0025)

Comparison of predicted vs metered consumption

Usage from March 1 to Feb 28th

Note the impact of Interuptions in March .

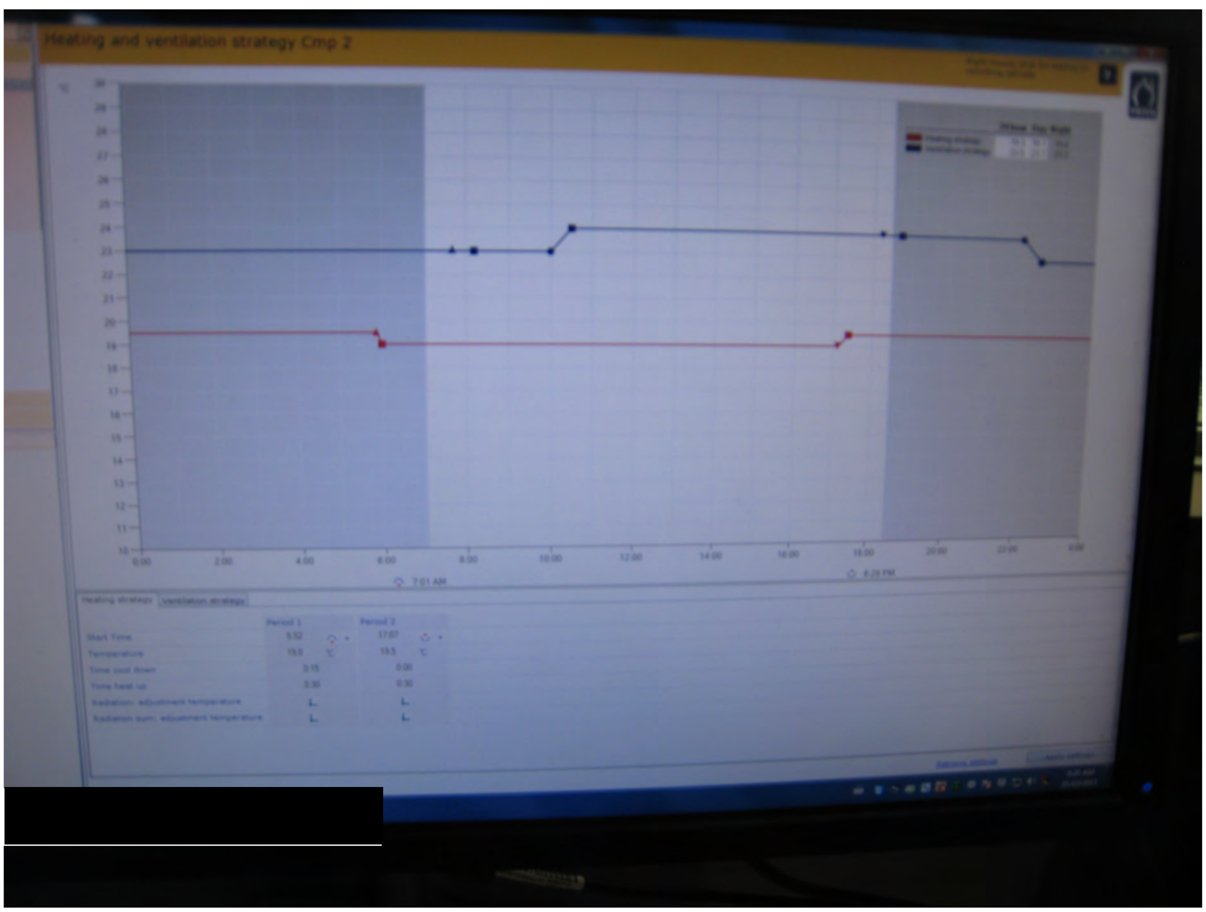
			Volume in m3	
2014	Jan		0	Dec 2013 was also zero m3. Meter was in place and measurement available Dec 1 2013.
	Feb		269230.8	First gas used Feb 3 2014) The commissioning date.
	Mar		270751.8	
	Apr		201303.2	
	May		152731.1	
	Jun		96496.1	
	Jul		110583.2	
	Aug		88889.1	
	Sep		83113.3	
	Oct		126303.9	
	Nov		235056	
	Dec		238126.5	
2015	Jan		199246.6	
	Feb		167720	Interruptions for several weeks not representative data
	Mar		36738.9	only 4 days
Total			2,071,831.6	Feb 1 2014 to Jan 31,2015
			1,970,320.8	Mar 1 2014 to Feb 29th 2015
Acres		11.07	187,157.3	m3 /yr
	acres		177,987.4	

EXTREMELY COLD YEAR - What is Normalized data.
on a degree day basis ??

VG estimate	% variance
1681195	23%

HDD sum
3002.92

Temperature setpoints (red line) match VG model



BJL revised calculations

New Expansion Project Savings Estimates

Total Acreage of New Expansion 11.07

	Base Case Measures	High Efficient Measures	Savings	
January	672,100	352,820	319,280.4	
February	545,467	282,749	262,717.6	
March	440,131	223,652	216,478.3	
April	235,460	111,720	123,739.3	
May	145,514	66,783	78,731.1	
June	41,008	15,287	25,721.8	
July	12,816	3,532	9,283.4	
August	29,938	10,275	19,662.4	
September	73,010	29,313	43,697.4	
October	195,646	88,673	106,973.3	
November	376,785	188,420	188,365.0	
December	590,024	307,971	282,052.8	
	3,357,898.0	**1,681,195.1**	**1,676,702.8**	m^3 Annual
			13.0	EUL
			21,797,136.7	m^3 Lifetime
		Savings per Acreage	[illegible]	m^3 Annual

Virtual Grower Inputs

EUL Analysis

	Base Case Measures	High Efficient Measures		Individual Measure Savings from Virtual Grower	EUL	Weighted EUL
Greenhouse Design - Structure						
Greenhouse Size 11.07 acres =	Same	Same				
Greenhouse Design - Materials				202,430	11	1.4
Roof =	Glass	Glass				
End Wall 1 =	Glass	Polycarbonate Triple-Wall				
End Wall 2 =	Glass	Polycarbonate Triple-Wall				
Side Wall 1 =	Glass	Double Polyethylene				
Side Wall 2 =	Glass	Double Polyethylene				
End Kneewal 1 =	Concrete Block	Concrete Block				
End Kneewal 2 =	Concrete Block	Concrete Block				
Side Kneewal 1 =	Concrete Block	Concrete Block				
Side Kneewal 2 =	Concrete Block	Concrete Block				
Greenhouse Design - Air Infiltration				146,331	20	1.7
Current Air Exchange Rate =	0.95	0.855				
Greenhouse Design - Energy Curtain				948,486	10	5.7
Is energy curtain installed =	No	Yes				
Material =	n/a	Aluminum Fabric				
Heating - Heating Schedules				155,295	20	1.9
Temperature Setting =	20°C	19°C				
Heating - Heating System Set-up				224,159	20	2.7
Heater Type =	Hot Water Boiler	Hot Water Boiler				
Ventilation =	Gravity Ventilation	Condensing				
Heat Delivery - Method =	Hot Water Pipes	Hot Water Pipes				
Heat Delivery - Variations =	Below Bench	Below Bench				
Maintenance - Heater's Age =	New (1-2 Years)	New (1-2 Years)				
Maintenance - Schedule =	Monthly	Monthly				
Heating System Efficiency Override =	0.75	0.85				13.30
				1,676,703		13

Some rounding effects in Virtual Grower Model

Appendix K: CI - 06 (2014-IND-0024)

Typical Temperature and Energy Curtain Position profiles

Colou		Settings	Unit	Group	Factor	Axis	Min	Max	Avg	Cursor
	☑	greenhouse temperature climate: measurement	°C	Gr 1	1	<-	16.8	27.9	21.0	26.8
	☑	heating temperature: ViP	°C	Gr 1	1	<-	17.5	24.0	20.7	24.0
	☑	circuit pipe: computed	°C	Gr 1 Pri.Ht	10	->	20	76	51	20
	☑	circuit pipe: measurement	°C	Gr 1+3+5 Sec Gu	10	->	25	79	40	39
	☑	lee side vent position: computed	%	Gr 1	10	->	0	8	1	5
	☑	wind side vent position: computed	%	Gr 1	1	->	0	0	0	0
	☑	uni-measurement		Top Cur Temp Z3	1	<-	2.4	27.7	12.6	26.8
	☑	curtain: position	%	Energy Gr 1	10	->	0.0	100.0	77.9	0.0
	☑	radiation: measurement	W/m^2	Gr 1	1	->	0	804	125	768
	☑	CO2 measurement	ppm	Gr 1-6	0.1	->	974	2362	1261	1368

Predicted vs Actual Proportional Natural gas Consumption

Historical Data

Retrieve Data from ConTrax

Note: ONLY 5 years of Data used in Charts
Recommend earliest Starting Date as Jan 2009

Seq	Month / Year	Consumption m^3	Customer:	#VALUE!		SA
26	December 2013	265,822	8.1vs13 ratio			
27	January 2014	471,041	180,826			
28	February 2014	589,034	226,122			
29	March 2014	519,782	199,537			
30	April 2014	370,178	142,106			
31	May 2014	251,481	96,540			
32	June 2014	129,375	49,665			
33	July 2014	66,829	25,655			
34	August 2014	95,228	36,557			
35	September 2014	203,078	77,959			
36	October 2014	327,720	125,807			
37	November 2014	509,583	195,622			
38	December 2014	242,437	93,068	VG projection	variance	
39	January 2015	349,442	1,449,465	1,463,890	1.00%	
40	February 2015	650,453				

BJL EUL calculation revisions

8.1 Acre Expansion

New Expansion Project Savings Estimates **AIMS#:** **42328**

Total Acreage of New Expansion **8.1**

	Base Case Measures	High Efficient Measures	Savings	
January	500,354	293,232	207,122	
February	405,436	235,069	170,367	
March	332,586	189,518	143,069	
April	189,753	101,111	88,642	
May	123,135	63,985	59,150	
June	45,452	20,113	25,339	
July	20,987	7,684	13,303	
August	36,019	14,358	21,661	
September	72,795	33,640	39,156	
October	161,998	83,535	78,463	
November	290,540	162,732	127,809	
December	443,781	258,915	184,866	
	2,622,837	**1,463,890**	**1,158,947**	m^3 Annual
			14.0	EUL
	323,807 m^3/acre	180,727 m^3/acre	7,463,619	m^3 Lifetime
		Savings per Acrage	143,080	m^3 Annual

Air Infiltration Calculator:

	0.095
0.95	0.855

Virtual Grower Inputs

EUL Analysis

	Base Case Measures	High Efficient Measures	Input order in VG	m^3 Consumption as a result of High Efficent option	Individual Measure Saviggs	EUL	Weighted EUL
Greenhouse Design - Structure				VIRTUAL Grower Inputs			
Greenhouse Size =	Same	Same					
Greenhouse Design - Materials			4	2,157,376	183,433	20	3.17
Roof =	Glass	Glass					
End Wall 1 =	Glass	Polycarbonate Triple-Wall					
End Wall 2 =	Glass	Polycarbonate Triple-Wall					
Side Wall 1 =	Glass	Polycarbonate Triple-Wall					
Side Wall 2 =	Glass	Polycarbonate Triple-Wall					
End Kneewal 1 =	Concrete Block	Concrete Block					
End Kneewal 2 =	Concrete Block	Concrete Block					
Side Kneewal 1 =	Concrete Block	Concrete Block					
Side Kneewal 2 =	Concrete Block	Concrete Block					
Greenhouse Design - Air Infiltration			3	2,340,809	101,731	20	1.76
Current Air Exchange Rate =	0.95	0.855					
Greenhouse Design - Energy Curtain			5	1,463,890	693,486	10	6
Is energy curtain installed =	No	Yes					
Material =	n/a	Double Layer Spun Bonded Polyster					
Heating - Heating Schedules			2	2,442,539	180,297	20	3
Temperature Setting =	22°C	21°C					
Heating - Heating System Set-up			1	2,622,837	-	20	-
Heater Type =	Hot Water Boiler	Hot Water Boiler					
Ventilation =	Condensing	Condensing					
Heat Delivery - Method =	Hot Water Pipes	Hot Water Pipes					
Heat Delivery - Variations =	Below Bench	Below Bench					
Maintenance - Heater's Age =	New (1-2 years)	New (1-2 years)					
Maintenance - Schedule =	Annually	Annually					
Heating System Efficiency Override =	0.85	0.85					14.02
					1,158,947		14.0

Virtual Grower Screen Prints

For Details - please open Virtual Grower File "Base Case - Entire GH.gsf"

Appendix L: CI - 07 (2014-IND-0114)

CI-07_(2014-IND-0114)

New Expansion Project Savings Estimates **AIMS#:** 46568

Total Acreage of New Expansion 9.9

	Base Case Measures	High Efficient Measures	Savings	
January	502,981	296,622	206,359	
February	401,150	235,270	165,881	
March	329,583	191,541	138,042	
April	190,361	105,902	84,460	
May	124,508	68,036	56,472	
June	46,302	21,952	24,349	
July	21,783	8,649	13,134	
August	37,285	16,488	20,797	
September	74,842	37,222	37,620	
October	163,934	89,310	74,624	
November	294,084	169,326	124,758	
December	449,435	264,841	184,594	
	2,636,248	**1,505,158**	**1,160,603**	m^3 Annual
			15.0	EUL
	266,288 m^3/acre	152,036 m^3/acre	17,409,046	m^3 Lifetime
		Savings per Acrage	117,233	m^3 Annual

Air Infiltration Calculator:

	0.095
0.95	0.855

Virtual Grower Screen Prints

For Details - please open Virtual Grower File "Base Case - Entire GH.gs"

Virtual Grower Inputs EUL Analysis

	Base Case Measures	High Efficient Measures	Input order in VG	m^3 Consumption as a result of High Efficent option	Individual Measure Saviggs	EUL	Weighted EUL
Greenhouse Design - Structure				**VIRTUAL Grower Inputs**			
Greenhouse Size =	Same	Same					
Greenhouse Design - Materials			4	1,834,[illegible]	148,963	5	0.64
Roof =	Polyethylene Double Layer	IR Film Double Layer					
End Wall 1 =	Polyethylene Double Layer	IR Film Double Layer					
End Wall 2 =	Polyethylene Double Layer	IR Film Double Layer					
Side Wall 1 =	Polyethylene Double Layer	IR Film Double Layer					
Side Wall 2 =	Polyethylene Double Layer	IR Film Double Layer					
End Kneewal 1 =	Concrete Block	Concrete Block					
End Kneewal 2 =	Concrete Block	Concrete Block					
Side Kneewal 1 =	Concrete Block	Concrete Block					
Side Kneewal 2 =	Concrete Block	Concrete Block					
Greenhouse Design - Air Infiltration			3	1,983,461	122,483	20	2.11
Current Air Exchange Rate =	0.95	0.855					
Greenhouse Design - Energy Curtain			5	1,475,6[illegible]	358,855	10	3
Is energy curtain installed =	No	Yes					
Material =	n/a	Aluminum Fabric					
Heating - Heating Schedules			2	2,105,[illegible]	155,541	20	3
Temperature Setting =	22°C	21°C					
Heating - Heating System Set-up			1	2,261,488	374,761	20	6
Heater Type =	Steam Boiler	Steam Boiler					
Ventilation =	Gravity	Gravity					
Heat Delivery - Method =	Steam Pipes	Steam Pipes					
Heat Delivery - Variations =	Below Bench	Below Bench					
Maintenance - Heater's Age =	Old (6+ years)	New (1-2 years)					
Maintenance - Schedule =	Annually	Annually					
Heating System Efficiency Override =	0.7	0.80					14.98
					1,160,603		15.0
				Efficiency adjustment to 0.818	17,409,046 m^3 Lifetime		

CI-07-(2014-IND-0114)

Cost Summary

	Base Cost $	Source	High Eff. Cost $	Source		
Heating System				**Estimated Price by Measure**		
CB -800 HP - 1 unit =	$ 65,000	Estimate based on previous projects.	$ 142,889	$	127,430	Information supplied by Customer - refer to email.
Siemens Linkageless Controls Unit - 1 unit =	$ -	No basecase cost.		$	15,459	Invoice - Linkageless Control
[redacted] **Climate Control System**						
	$ -	No basecase cost.	$ 85,000			Invoice - Climate Control System . PD
IR Poly Roof and Side Walls						
	$ 241,006	Information supplied by ThermoEnergy Systems Inc. (GH Builder) - refer to email below.	$ 482,013			Invoice - IR Poly (Roof and Sidewalls
Energy Curtain						
	$ -	No basecase cost.	$ 251,779			Invoice - Energy Curtain. PDF
TOTAL	**$ 306,006**		**$ 961,681**			
Difference	**$ 655,675**					

12.5 psig operating steam pressure

After Siemens conversion

Powerhouse Boiler & Combustion September 15, 2014
Combustion analysis
Boiler 700 hp [redacted]

Low Fire

Fuel	Natural Gas
O2%	7.2
CO2%	7.65
Co ppm	0
Flue F	250.0
Inlet F	85
Eff (G)	85.5
Xair%	48.0

Half Fire

Fuel	Natural Gas
O2%	5.3
CO2%	8.75
Co ppm	0
Flue F	281.3
Inlet F	85.2
Eff (G)	85.9
Xair%	30.0

High Fire

Fuel	Natural Gas
O2%	4.1
CO2%	9.39
Co ppm	1
Flue F	312.4
Inlet F	85.2
Eff (G)	86.3
Xair%	20.4

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964

GENERAL DATA:

FUEL HHV =	1000	BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	22,723	BTU/LB	Combustible HHV	1000	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.59	CU FT/LB			

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

BOILER #1 NO Economizer

	UNITS	TEST #1	TEST #2	TEST #3
SECTION A ENTER TEST DATA IN THIS SECTION				
FIRING RATE =	Fuel Input MBTU/HR	8,369	16,738	33,476
STEAM DRUM PRESSURE =	PSIG	12	12	12
COMBUSTION AIR TEMP =	DEG. F	85	85	85
STACK TEMP Before Economizer	DEG. F	250	281	312
STACK TEMP After Economizer	DEG. F	250	281	312
NET STACK TEMP =	DEG.F	165	196	227
OXYGEN=	% by vol	7.20	5.30	4.10
CARBON MONOXIDE =	PPM	0	0	1
	% by vol.	0.00	0.00	0.00
COMBUSTIBLES =	% by vol.	0.000	0.000	0.000
SECTION B TOTAL LOSS CALCULATION				
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	3.81%	4.07%	4.44%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	10.55%	10.68%	10.82%
PERCENT CARBON MONOXIDE LOSS	%	0.00%	0.00%	0.00%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	14.35%	14.76%	15.26%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE				
COMBUSTION EFFICIENCY (100-LOSSES)	%	85.65%	85.24%	84.74%

SECTION D- SUB-SECTION FOR CALCULATION OF DRY FLUE GAS CO2, N2 AND O2 RELATIONSHIPS

SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49		TEST #1	TEST #1	TEST #3
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	46.67	30.20	21.70
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		381.80	385.60	388.00
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	10.191	10.263	10.308
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	9.832	9.763	9.720
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	10.728	9.634	9.071
VOL N2 per VOL DFG	CU FT/CU FT	105.266	93.875	88.000
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F. ASME EQ. 25	21.84	19.66	18.50
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F. ASME SEC. 7.3.2.07	0.00	0.00	0.07
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

Natural Gas Fuel

No Econ

Boiler Ratings:			**Losses:**	**Radiation**	**1.0%**	of full load fuel input
Full Load Fuel Input	**33,476**	MBTU/HR		**Blow-Down**	**3.0%**	of steam output
Min. Fuel Input	8,369	BTU/HR		**Unmeasured**	**0.5%**	of fuel input
Rated Steam Output	**N/A**	LB/HR		**Loss**		
Fuel HHV	**1000**	BTU/CU FT				

Test #	Units	TEST #1	TEST #2	TEST #3		
Fuel Input	percent of F.L.	25%	50%	100%		
Fuel Input	MBTU/HR	8,369	16,738	33,476		
Combustion Loss	percent	**14.35%**	**14.76%**	**15.26%**		
Combustion Loss	**BTU/HR**	**1,201**	**2,470**	**5,108**		
Radiation Loss	MBTU/HR	335	335	335		
Blow-Down Loss	MBTU/HR	65	129	257		
Unmeasured Loss	MBTU/HR	41.8	83.7	167.4		
Cycling Loss	MBTU/HR	0	0	0		
TOTAL LOSS	**MBTU/HR**	**1,643**	**3,017**	**5,867**		
Fuel Input, MBTU/H		8,369	16,738	33,476		
Combustion Efficiency	**Comb. Eff.**	**85.6%**	**85.2%**	**84.7%**		
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**80.4%**	**82.0%**	**82.5%**	Average:	81.6%
Total Steam Production	**LB/HR**	**6,569**	**13,399**	**26,962**		
Steam to Condensate Tank	**LB/HR**	**141**	**226**	**394**		
Net Steam to Process	**LB/HR**	**6,428**	**13,173**	**26,568**		

Appendix M: CI - 10 (2014-IND-0172)

12.5 psig operating steam pressure

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

Natural Gas Fuel No Econ

Boiler Ratings:			**Losses:**	**Radiation**	**1.0%**	of full load fuel input
Full Load Fuel Input	**33,476**	MBTU/HR		**Blow-Down**	**3.0%**	of steam output
Min. Fuel Input	8,369	BTU/HR		**Unmeasured**	**0.5%**	of fuel input
Rated Steam Output	**N/A**	LB/HR		**Loss**		
Fuel HHV	**1000**	BTU/CU FT				

Test #		TEST #1	TEST #2	TEST #3		
	Units					
Fuel Input	percent of F.L.	25%	50%	100%		
Fuel Input	MBTU/HR	8,369	16,738	33,476		
Combustion Loss	percent	**14.35%**	**14.76%**	**15.26%**		
Combustion Loss	**BTU/HR**	**1,201**	**2,470**	**5,108**		
Radiation Loss	MBTU/HR	335	335	335		
Blow-Down Loss	MBTU/HR	65	129	257		
Unmeasured Loss	MBTU/HR	41.8	83.7	167.4		
Cycling Loss	MBTU/HR	0	0	0		
TOTAL LOSS	**MBTU/HR**	**1,643**	**3,017**	**5,867**		
Fuel Input, MBTU/H		8,369	16,738	33,476		
Combustion Efficiency	**Comb. Eff.**	**85.6%**	**85.2%**	**84.7%**		
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**80.4%**	**82.0%**	**82.5%**	Average:	81.6%
Total Steam Production	**LB/HR**	**6,569**	**13,399**	**26,962**		
Steam to Condensate Tank	**LB/HR**	**141**	**226**	**394**		
Net Steam to Process	**LB/HR**	**6,428**	**13,173**	**26,568**		

BJL calculation revisions

Pipe Insulation - Energy Savings Calculation

Facility Name: [redacted]
Facility Location: [redacted]
System Efficiencyt: 0.816 % → based on combustion test data

Insulation Log

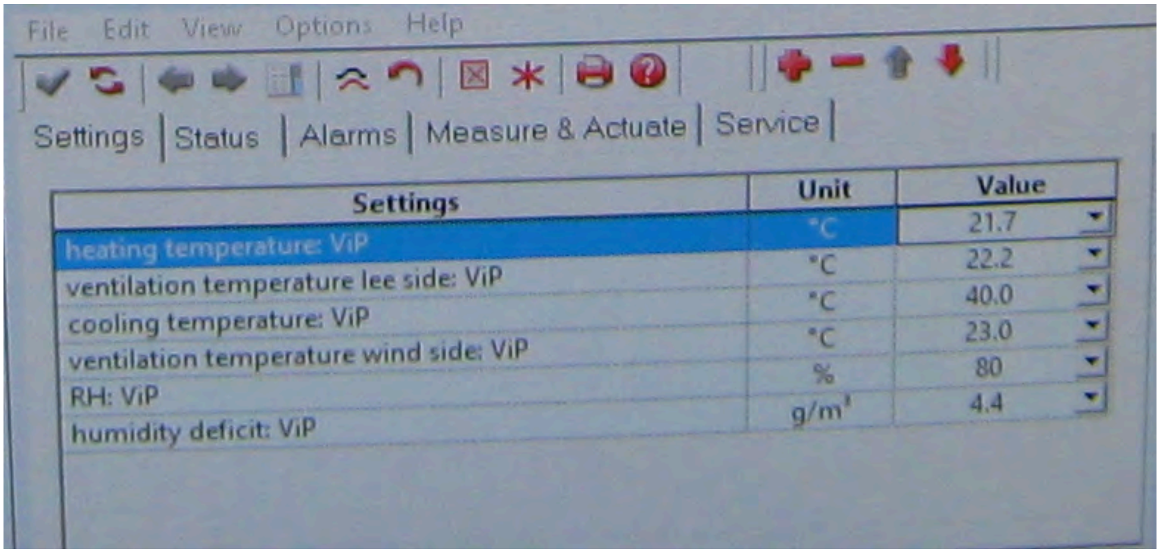
#	Component	Dimensions of Component: length (feet)	width (feet)	height (feet)	diameter (inches)	Surface Temperature (°F)	Content Pressure (psig)	Ambient Temperature in Location (F)	Location	Layout	Operating Hours per year (hours)	Thickness of Insulation Installed (in)	Type of Insulation Installed	Jacket Material Type / Thickness (in)
1	Steam Pipe - Main Supply Line	1,600	-	-	14"	244	-	70	Indoor	Horizontal	8,000	2"	Glass Fibre	Aluminum (0.1)

Calculations

#	Component	Length ft	Base Case: Energy Loss Bare Pipe (from 3E Plus) Btu/ft/yr	Base Case: Net Base Case Energy Loss m^3/yr	High Eff. Case: Energy Loss Insulated Pipe (from 3E Plus) Btu/ft/yr	High Eff. Case: Net High Eff. Case Energy Loss m^3/yr	Natural Gas Energy Saved m^3/yr
1	Steam Pipe - Main Supply Line	1,600	12,030,000	658,034	978,000	53,496	604,538
	TOTAL	1,600		658,034		53,496	604,538 m^3/yr

Appendix N: CI - 13 (2014-COM-0320)

Temperature setpoints in climate control system



BJL revisions to spreadsheet calculations

CI-13-(2014-COM-0320)

Virtual Grower Inputs

EUL Analysis

	Base Case Measures	High Efficient Measures	Input order	m3 Consumption as a result of High Efficent option	Individual Measure Saviggs	EUL	Weighted EUL
Greenhouse Design - Structure				**VIRTUAL Grower Inputs**			
Greenhouse Size =	Same	Same					
Greenhouse Design - Materials			4	**2,267,109**	203,564	5	1.89
Roof =	Polyethylene Double Layer	IR Film Double Layer					
End Wall 1 =	Polyethylene Double Layer	IR Film Double Layer					
End Wall 2 =	Polyethylene Double Layer	IR Film Double Layer					
Side Wall 1 =	Polyethylene Double Layer	IR Film Double Layer					
Side Wall 2 =	Polyethylene Double Layer	IR Film Double Layer					
End Kneewal 1 =	Concrete Block	Concrete Block					
End Kneewal 2 =	Concrete Block	Concrete Block					
Side Kneewal 1 =	Concrete Block	Concrete Block					
Side Kneewal 2 =	Concrete Block	Concrete Block					
Greenhouse Design - Air Infiltration			3	**2,470,673**	137,084	20	5.09
Current Air Exchange Rate =	0.95	0.855					
Greenhouse Design - Energy Curtain			5				
Is energy curtain installed =	No	No					
Material =	n/a	n/a					
Heating - Heating Schedules			2	**2,607,757**	197,687	20	7.34
Temperature Setting =	22°C	21°C					
Heating - Heating System Set-up			1	**2,805,444**		20	
Heater Type =	Steam Boiler	Steam Boiler					
Ventilation =	Gravity Ventilation	Gravity Ventilation					
Heat Delivery - Method =	Steam Pipes	Steam Pipes					
Heat Delivery - Variations =	Below Bench	Below Bench					
Maintenance - Heater's Age =	Old (6+ years)	Old (6+ years)					
Maintenance - Schedule =	Annually	Annually					
Heating System Efficiency Override =	0.51	0.51					**14.32796**
					538,335		**14.0**

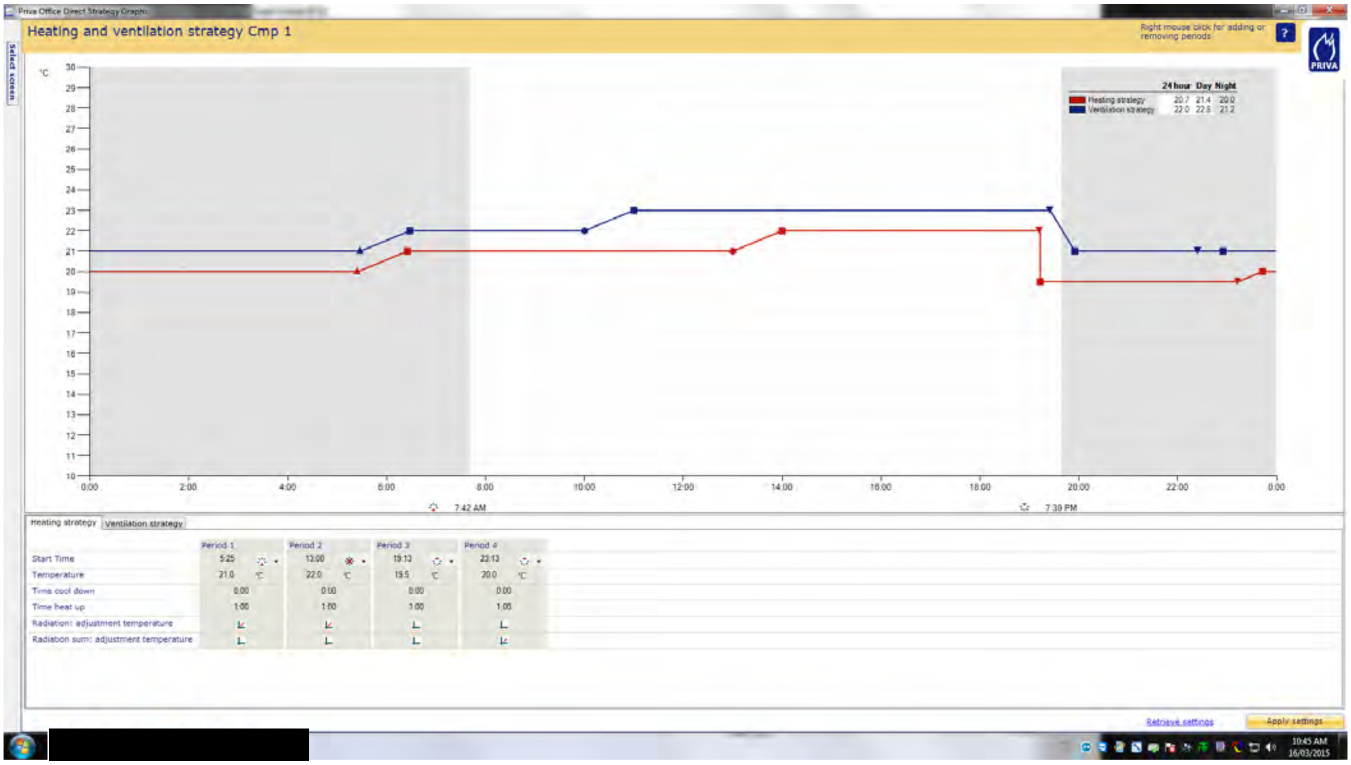
CI-13-(2014-COM 0320)

Cost Summary

	Base Cost $	Source	High Eff. Cost $	Source
[redacted] Climate Control System				
	$ -		$ 75,000.00	From customer- see attached invoices.
IR Poly				
	$ 76,448		$ 152,895.00	From customer - see attached invoices.
TOTAL	$ 76,448		$ 227,895.00	

Difference	$ 151,448

Appendix O: CI - 02 (2014-IND-0021)



Year	VG High Eff Case Consumption
Jan	520,690
Feb	416,403
Mar	335,421
Apr	178,658
May	113,079
Jun	35,452
Jul	13,538
Aug	25,201
Sep	59,331
Oct	147,303
Nov	288,406
Dec	459,993
Total	**2,593,476**

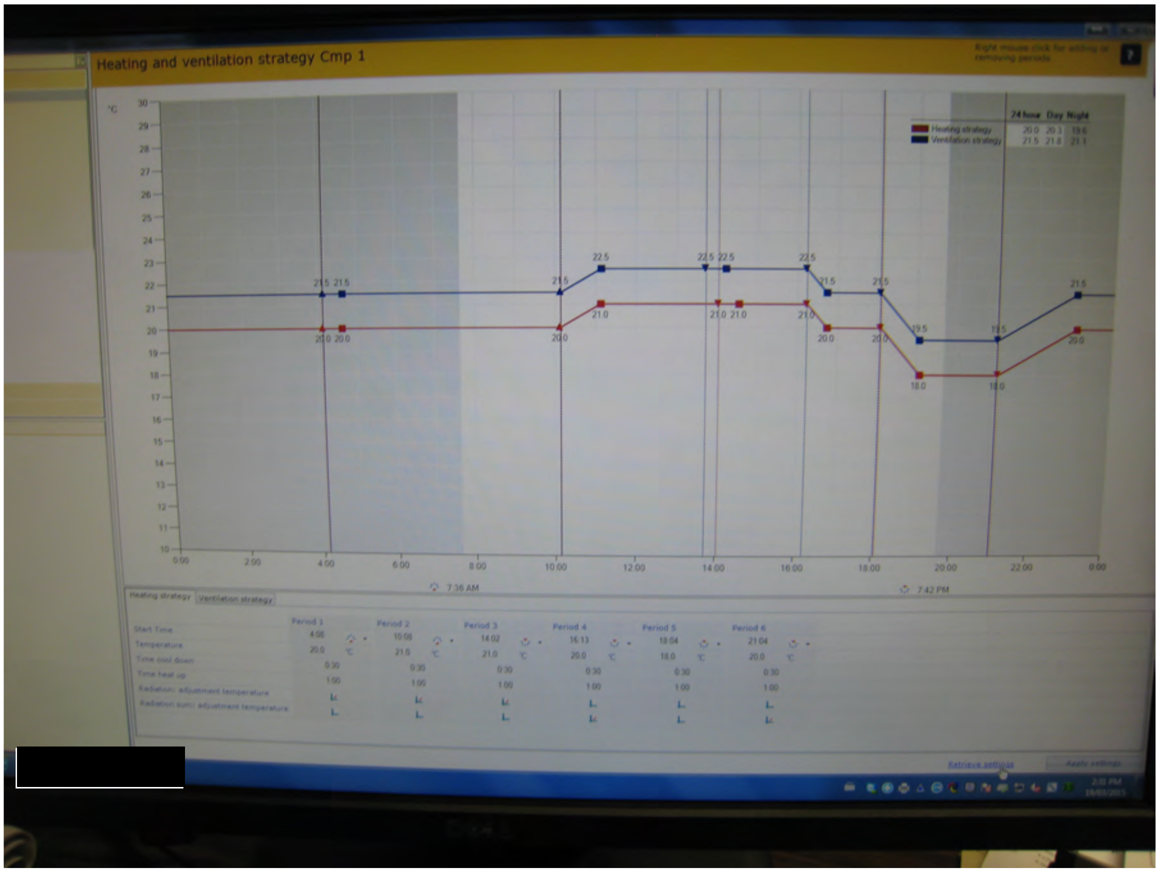
Year	Actual Consumption
Jan	473,436
Feb	377,391
Mar	333,665
Apr	211,446
May	170,481
Jun	111,936
Jul	98,130
Aug	85,424
Sep	142,927
Oct	214,038
Nov	192,937
Dec	217,842
Total	2,629,651

BJL revisions to EUL

	Base Case Measures	High Efficient Measures	Input order in VG	m^3 Consumption as a result of High Efficent option	Individual Measure Saviggs	EUL	Weighted EUL
Greenhouse Design - Structure				VIRTUAL Grower Inputs			
Greenhouse Size =	Same	Same					
Greenhouse Design - Materials			4	3,934,579	247,954	20	1.82
Roof =	Glass	Glass					
End Wall 1 =	Glass	Polycarbonate Triple-Wall					
End Wall 2 =	Glass	Polycarbonate Triple-Wall					
Side Wall 1 =	Glass	Polycarbonate Triple-Wall					
Side Wall 2 =	Glass	Polycarbonate Triple-Wall					
End Kneewal 1 =	Concrete Block	Concrete Block					
End Kneewal 2 =	Concrete Block	Concrete Block					
Side Kneewal 1 =	Concrete Block	Concrete Block					
Side Kneewal 2 =	Concrete Block	Concrete Block					
Greenhouse Design - Air Infiltration			3	4,182,533	189,446	20	1.39
Current Air Exchange Rate =	0.95	0.855					
Greenhouse Design - Energy Curtain			5	2,593,476	1,341,103	10	5
Is energy curtain installed =	No	Yes					
Material =	n/a	Aluminum Fabric					
Heating - Heating Schedules			2	4,371,979	322,612	20	2
Temperature Setting =	22°C	21°C					
Heating - Heating System Set-up			1	4,694,591	625,946	20	5
Heater Type =	Hot Water Boiler	Hot Water Boiler					
Ventilation =	Gravity	Condensing					
Heat Delivery - Method =	Hot Water Pipes	Hot Water Pipes					
Heat Delivery - Variations =	Below Bench	Below Bench					
Maintenance - Heater's Age =	Old (6+ years)	New (1-2 years)					
Maintenance - Schedule =	Annually	Annually					
Heating System Efficiency Override =	0.75	0.85					15.08
					2,727,061		15.0

Appendix P: CI - 03 (2014-IND-0022)

Climate control system setpoints (Temperature – red line)



Year	VG High Eff Case Consumption
Jan	375,427
Feb	300,565
Mar	242,164
Apr	128,982
May	81,624
Jun	25,603
Jul	9,775
Aug	18,213
Sep	42,827
Oct	106,387
Nov	208,002
Dec	331,557
Total	**1,871,126**

Year	Actual Consumption
Jan	325,099
Feb	249,058
Mar	198,317
Apr	121,092
May	103,709
Jun	56,940
Jul	39,979
Aug	56,264
Sep	86,578
Oct	142,223
Nov	119,965
Dec	353,527
Total	**1,852,749**

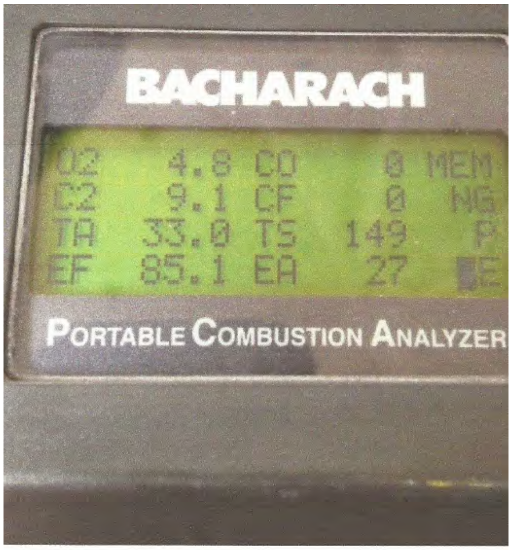
BJL revisions to EUL in calculations

Virtual Grower Inputs

EUL Analysis

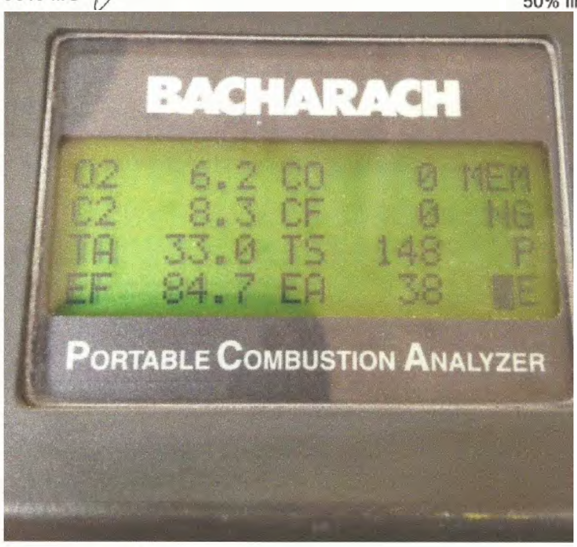
	Base Case Measures	High Efficient Measures	Input order in VG	m^3 Consumption as a result of High Efficent option	Individual Measure Saviggs	EUL	Weighted EUL
Greenhouse Design - Structure				**VIRTUAL Grower Inputs**			
Greenhouse Size =	Same	Same					
Greenhouse Design - Materials			4	2,816,745	205,883	20	2.09
Roof =	Glass	Glass					
End Wall 1 =	Glass	Polycarbonate Triple-Wall					
End Wall 2 =	Glass	Polycarbonate Triple-Wall					
Side Wall 1 =	Glass	IR Film Double Layer					
Side Wall 2 =	Glass	Polycarbonate Triple-Wall					
End Kneewal 1 =	Concrete Block	Concrete Block					
End Kneewal 2 =	Concrete Block	Concrete Block					
Side Kneewal 1 =	Concrete Block	Concrete Block					
Side Kneewal 2 =	Concrete Block	Concrete Block					
Greenhouse Design - Air Infiltration			3	3,022,628	134,020	20	1.36
Current Air Exchange Rate =	0.95	0.855					
Greenhouse Design - Energy Curtain			5	1,871,126	945,619	10	5
Is energy curtain installed =	No	Yes					
Material =	n/a	Aluminum Fabric					
Heating - Heating Schedules			2	3,156,647	233,007	20	2
Temperature Setting =	22°C	21°C					
Heating - Heating System Set-up			1	3,389,655	451,954	20	5
Heater Type =	Hot Water Boiler	Hot Water Boiler					
Ventilation =	Gravity	Condensing					
Heat Delivery - Method =	Hot Water Pipes	Hot Water Pipes					
Heat Delivery - Variations =	Below Bench	Below Bench					
Maintenance - Heater's Age =	Old (6+ years)	New (1-2 years)					
Maintenance - Schedule =	Annually	Annually					
Heating System Efficiency Override =	0.75	0.85					**15.20**
					1,970,483		**15.0**

Appendix Q: CI - 09 (2014-IND-0570)



100% fire

50% fire



Low Fire

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964

GENERAL DATA:

FUEL HHV =	1000	BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	22,723	BTU/LB	Combustible HHV	1000	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.59	CU FT/LB			

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

BOILER #1 NO Economizer

	UNITS	TEST #1	TEST #2	TEST #3
SECTION A ENTER TEST DATA IN THIS SECTION				
FIRING RATE =	Fuel Input MBTU/HR	8,369	16,738	33,476
STEAM DRUM PRESSURE =	PSIG	15	15	15
COMBUSTION AIR TEMP =	DEG. F	91	91	91
STACK TEMP Before Economizer	DEG. F	298	263	300
STACK TEMP After Economizer	DEG. F	298	263	300
NET STACK TEMP =	DEG.F	207	172	209
OXYGEN=	% by vol	6.20	16.20	4.80
CARBON MONOXIDE =	PPM	0	0	0
	% by vol.	0.00	0.00	0.00
COMBUSTIBLES =	% by vol.	0.000	0.000	0.000
SECTION B TOTAL LOSS CALCULATION				
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	4.51%	9.40%	4.23%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	10.70%	10.55%	10.71%
PERCENT CARBON MONOXIDE LOSS	%	0.00%	0.00%	0.00%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	15.22%	19.95%	14.94%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE				
COMBUSTION EFFICIENCY (100-LOSSES)	%	84.78%	80.05%	85.06%

SECTION D- SUB-SECTION FOR CALCULATION OF DRY FLUE GAS CO2, N2 AND O2 RELATIONSHIPS

SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49		TEST #1	TEST #1	TEST #3
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	37.47	301.52	26.50
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		383.80	363.80	386.60
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	10.229	9.851	10.282
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	9.796	10.172	9.745
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	10.117	27.745	9.389
VOL N2 per VOL DFG	CU FT/CU FT	98.906	281.655	91.321
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F. ASME EQ. 25	20.64	51.77	19.16
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F. ASME SEC. 7.3.2.07	0.00	0.00	0.00
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

Natural Gas Fuel

No Econ

Boiler Ratings:			**Losses:**	**Radiation**	**1.0%**	of full load fuel input
Full Load Fuel Input	**33,476**	MBTU/HR		**Blow-Down**	**2.0%**	of steam output
Min. Fuel Input	8,369	BTU/HR		**Unmeasured**	**0.5%**	of fuel input
Rated Steam Output	**N/A**	LB/HR		**Loss**		
Fuel HHV	**1000**	BTU/CU FT				

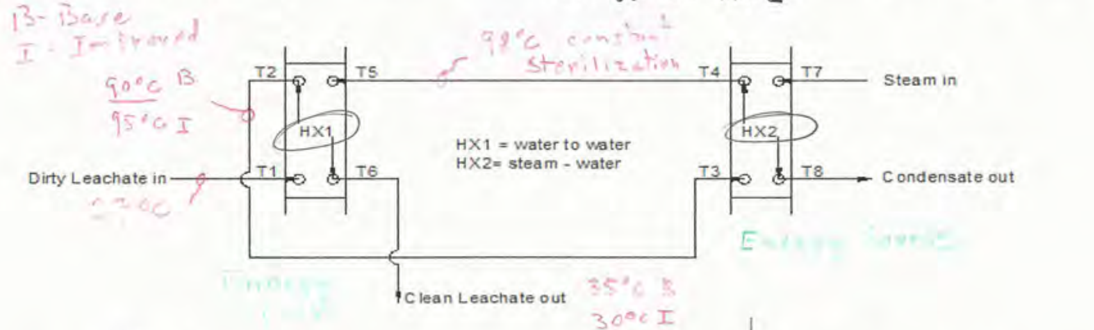
Test #	Units	TEST #1	TEST #2	TEST #3		
Fuel Input	percent of F.L.	25%	50%	100%		
Fuel Input	MBTU/HR	8,369	16,738	33,476		
Combustion Loss	percent	**15.22%**	**19.95%**	**14.94%**		
Combustion Loss	**BTU/HR**	**1,273**	**3,340**	**5,002**		
Radiation Loss	MBTU/HR	335	335	335		
Blow-Down Loss	MBTU/HR	43	81	172		
Unmeasured Loss	MBTU/HR	41.8	83.7	167.4		
Cycling Loss	MBTU/HR	0	0	0		
TOTAL LOSS	**MBTU/HR**	**1,693**	**3,839**	**5,676**		
Fuel Input, MBTU/H		8,369	16,738	33,476		
Combustion Efficiency	**Comb. Eff.**	**84.8%**	**80.0%**	**85.1%**		
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**79.8%**	**77.1%**	**83.0%**	Average:	80.0%
Total Steam Production	**LB/HR**	**6,507**	**12,572**	**27,096**		

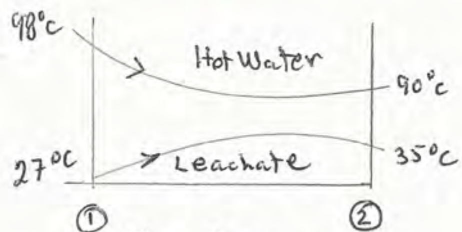
Appendix R: CI - 12 (2014-IND-0333)

PROJECT CI12-IND-0333-48

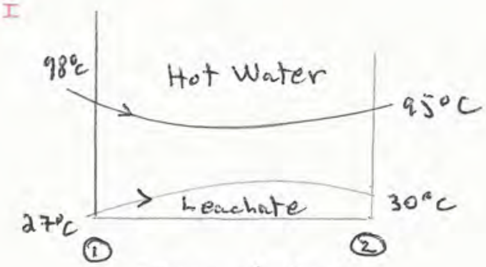
Project Aim: Increase capacity of HX_1 to reduce energy at HX_2.

B - Base
I - Improved





Base Case



Improved Case

$$LMTD_1 = \frac{\Delta T_1 - \Delta T_2}{\ln\left[\frac{\Delta T_1}{\Delta T_2}\right]}$$

$$= \frac{\left[(90-35) - (98-27)\right]}{\ln\left[\frac{(98-27)}{(90-35)}\right]}$$

$$\cong 63°C$$

$$LMTD_2 = \frac{(71-65)}{\ln\left(\frac{71}{65}\right)}$$

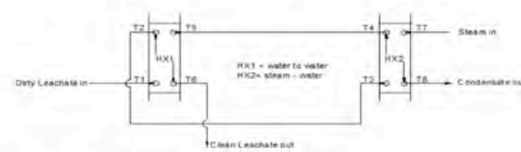
$$= 68°C$$

Circulation pump flow range observed under normal operating conditions

BJL calculation revisions (highlighted in red colour)

Greenhouse Heat Pasteurizer Retro fit Project

Data			
cp water	4.18	kJ/kg-K	
Calorific value natural gas - kJ/m³	37200	kJ/m³	
Natural gas cost - $/GJ	6.5	$/GJ	
Base Case Condition			
Volume Flow Q - GPM	379	GPM	flow through the heat exchanger - average from Reviewer's observations
HX_1 Inlet Temperature (T_1) °C	[illegible]	°C	inlet temperature of water coming from GH (temperature of dirty leachate in)
Specific Volume Leachate - SV	998.00	kg/m³	
Mass Flow M - kg/s	23.86	kg/s	
Step 1 Calculate the running capacity based on known information			
HX_1 Inlet Temperature (T_5) °C	98	°C	this is the sterilization temperature that GLG uses within the system - temperature of steam
HX_1 Outlet Temperature (T_6) °C	35.00	°C	this temperature was given by GLG based as a measured value, they said they were more than than 8.0 °C rise in temperature of water leaving the system
Running Capacity HX_1 -kW	6,284.20	kW	using m*cp*dt
Step 2 Calculate the outlet temperature of HX 1 based on HX1 capacity			
Capacity HX_1 - kW	6,284.20	kW	from above
HX_1 Outlet Temperature (T_2) °C	90.00	°C	using q/(mcp)+tin
Step 3 Calculate the required steam input capacity for the base case			
HX_2 Inlet Temperature (T_3) °C	90.00	°C	from above
HX_2 Outlet Temperature (T_4) °C	98	°C	given by GLG as the sterilization temperature
Running Capacity HX_2 -kW	**797.99**	**kW**	using m*cp*dt
Start-up Capacity HX_2 -kW	7,082.20	kW	this has no effect on the project, it interesting to see how large the heat exchanger would need to be if no heat recovery were present
Improved Case Condition			
Volume Flow Q - GPM	379	GPM	from above
HX_1 Inlet Temperature (T_1) °C	37	°C	from above
Specific Volume Leachate - SV	998.00	kg/m³	from above
Mass Flow M - kg/s	23.86	kg/s	from above
Step 4 Calculate the running capacity based on known information			
HX_1 Inlet Temperature (T_5) °C	98	°C	this is the sterilization temperature that GLG uses within the system
HX_1 Outlet Temperature (T_6) °C	30	°C	this temperature was given by GLG based as a measured value, they said they were getting less than 3.0 °C rise in temperature of water leaving the system
Running Capacity HX_1 -kW	6,782.95	kW	using m*cp*dt
Step 5 Calculate the outlet temperature of HX 1 based on HX1 capacity			
Capacity HX_1 - kW	6,782.95	kW	from above
HX_1 Outlet Temperature (T_2) °C	95	°C	using q/(mcp)+tin
Step 6 Calculate the required steam input capacity for the improved case			
HX_2 Inlet Temperature (T_3) °C	95	°C	from above
HX_2 Outlet Temperature (T_4) °C	98	°C	given by GLG as the sterilization temperature
Running Capacity HX_2 -kW	**299.25**	**kW**	using m*cp*dt
Start-up Capacity HX_2 -kW	7,082.20	kW	this has no effect on the project, it interesting to see how large the heat exchanger would need to be if no heat recovery were present
Estimated Savings			Note: the estimated savings is realized in a decrease in steam input at point 7
Running Capacity HX_2 -kW Base Case	797.99	kW	
Running Capacity HX_2 -kW Improved Case	299.25	kW	
Average daily operating hours - hr.	17.53	hrs. per day	
Average annual usage - Days per year	365	days per year	
Average annual operating hours	7200	hours per year	estimated operating hours updated to [illegible] information
Estimated annual savings - GJ	12,927.50	GJ/year	
Estimated annual savings - m³	347,749.85	m³/year	net of efficiency on steam/fuel
Estimated annual savings - $	84,028.78	$/year	
factoring steam/fuel efficiency factor of 80%	434,687	m³/year	



Appendix S: CI - 18 (2014-IND-0210)

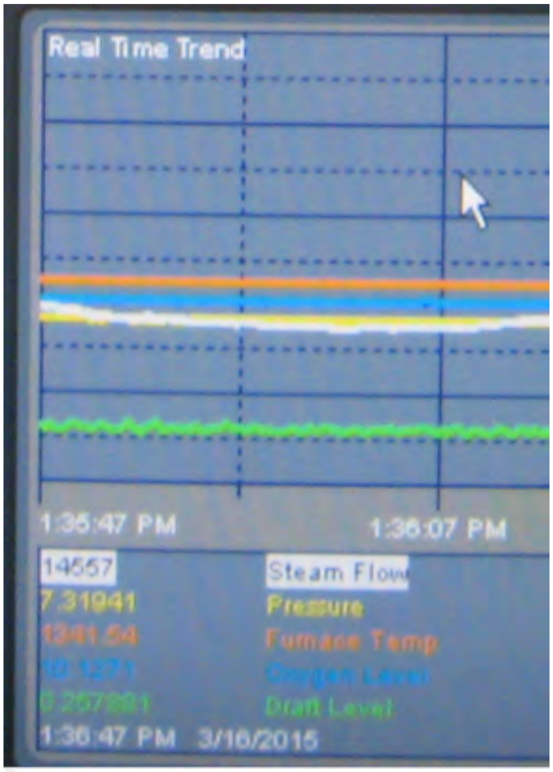


Plate Heat Exchanger

Technical Specification

Customer : [redacted]
Model :
Project: :
Item : **3480 KW for** [redacted]

Date: 02/04/2013

Fluid		**Steam 8 psig**	**Water**
Mass flow rate	kg/h	5540	149700 (660 GPM)
Fluid Condensed	kg/h	5540	0.000
Inlet temperature	°C	110.0	75.0
Outlet temperature	°C	108.4	95.0
Operating pressure	bara	1.43	
Pressure drop	kPa	7.39	24.6
Heat Exchanged	kW	3484	

Powerhouse Boiler & Combustion August 13 2014

Combustion analysis

Boiler #1

Low Fire

Fuel	Natural Gas
O2%	10.6
CO2%	5.9
Co ppm	2.5
Flue F	256.0
Inlet F	80.7
Eff (G)	83.4
Losses	16.6
Xair%	79.1

Half Fire

Fuel	Natural Gas
O2%	5.3
CO2%	8.9
Co ppm	2.1
Flue F	290.0
Inlet F	80.7
Eff (G)	84.4
Losses	15.6
Xair%	38.1

High Fire

Fuel	Natural Gas
O2%	4.9
CO2%	8.9
Co ppm	2.0
Flue F	297.0
Inlet F	80.7
Eff (G)	84.4
Losses	15.6
Xair%	30.1

Boiler #2

Low Fire

Fuel	Natural Gas
O2%	9.6
CO2%	5.5
Co ppm	2.8
Flue F	246.0
Inlet F	80.6
Eff (G)	83.7
Losses	16.9
Xair%	77.1

Half Fire

Fuel	Natural Gas
O2%	5.6
CO2%	8.5
Co ppm	2.0
Flue F	295.0
Inlet F	80.6
Eff (G)	84.5
Losses	15.4
Xair%	38.0

High Fire

Fuel	Natural Gas
O2%	4.8
CO2%	8.8
Co ppm	1.8
Flue F	299.0
Inlet F	80.6
Eff (G)	84.8
Losses	15.6
Xair%	30.0

Boiler #3

Low Fire

Fuel	Natural Gas
O2%	9.4
CO2%	5.4
Co ppm	3.5
Flue F	240.0
Inlet F	80.7
Eff (G)	83.1
Losses	16.7
Xair%	77.3

Half Fire

Fuel	Natural Gas
O2%	5.7
CO2%	8.2
Co ppm	2.8
Flue F	294.0
Inlet F	80.7
Eff (G)	84.1
Losses	15.8
Xair%	39.0

High Fire

Fuel	Natural Gas
O2%	5.2
CO2%	8.0
Co ppm	5.6
Flue F	321.0
Inlet F	80.7
Eff (G)	84.0
Losses	15.7
Xair%	38.0

Boiler #4

Low Fire

Fuel	Natural Gas
O2%	9.1
CO2%	6.7
Co ppm	3.9
Flue F	258.5
Inlet F	80.7
Eff (G)	84.1
Losses	16.0
Xair%	77.1

Half Fire

Fuel	Natural Gas
O2%	5.4
CO2%	8.0
Co ppm	4.5
Flue F	291.0
Inlet F	80.7
Eff (G)	84.3
Losses	15.5
Xair%	37.5

High Fire

Fuel	Natural Gas
O2%	4.7
CO2%	9.2
Co ppm	5.5
Flue F	296.7
Inlet F	80.7
Eff (G)	84.4
Losses	15.6
Xair%	29.0

Boiler #5

Low Fire

Fuel	Natural Gas
O2%	10.6
CO2%	5.9
Co ppm	9.5
Flue F	256.5
Inlet F	80.7
Eff (G)	83.4
Losses	16.6
Xair%	80.3

Half Fire

Fuel	Natural Gas
O2%	5.9
CO2%	8.5
Co ppm	12.5
Flue F	308.7
Inlet F	80.7
Eff (G)	83.7
Losses	16.5
Xair%	39.3

High Fire

Fuel	Natural Gas
O2%	4.7
CO2%	9.0
Co ppm	19.5
Flue F	310.7
Inlet F	80.7
Eff (G)	83.4
Losses	15.9
Xair%	30.0

BJL revisions to calculations (highlighted in red colour)

Project Description

Two of the existing plate and frame heat exchangers were replaced with two new higher efficiency heat exchangers. It was observed that the condensate temperature following the retro fit was much lower and consequently steam load on the boiler was reduced.

Greenhouse Heat Exchanger Retro fit Project

General Data					
cp water	1.00	Btu/lbm-R	4.18	kJ/kg-K	
Calorific value natural gas			37200	kJ/m³	
Natural gas cost			6.5	$/GJ	
Original Design Conditions					
Heat exchanger design capacity	11,890,892.00	Btu/hr	3,484.00	kW	the new heat exchanger was a drop in replacement with the same capacity as the old heat exchanger
Steam Pressure	7.3	PSIg	151.00	kpa	
Steam temperature	233.00	°F	111.67	°C	
Sensible heat (hf)	210.00	Btu/lb	487.41	kJ/kg	from Spirax Sarco steam table
Latent heat (hg)	956.00	Btu/lb	2,218.88	kJ/kg	from Spirax Sarco steam table
Total heat (hfg)	1,158.00	Btu/lb	2,706.29	kJ/kg	from Spirax Sarco steam table
Base Case Data					
Condensate outlet temperature	185.00	°F	85.00	°C	observed from actual performance
total heat extracted from steam	1,004.03	Btu/lb	2,330.34	kJ/kg	total heat removed from the steam, latent heat + sensible heat from steam temperature to condensate temperature
Estimated steam flow	11,843.22	lb/hr	5,382.21	kg/hr	steam flow required to produce 3400 kW at the specified design conditions (heat exchanger capacity *3600) / total heat extracted from steam
Improved Case Data					
Condensate outlet temperature	110.00	°F	43.33	°C	observed from actual performance; pipe temperature measurement yielded 41 deg. C - a close indication.
total heat extracted from steam	1,079.06	Btu/lb	2,504.51	kJ/kg	total heat removed from the steam, latent heat + sensible heat from steam temperature to condensate temperature (sensible heat = m*cp*dt)
Estimated steam flow	11,017.44	lb/hr	5,007.93	kg/hr	(heat exchanger capacity *3600) / total heat extracted from steam
Savings Calculation					
Condensate tank temperature	122.00	°F	50.00	°C	assumed and constant for both base case and improved case
Cost of producing steam	5,448.61	lb/hr	2,476.64	kJ/kg	sensible heat to raise temperature from condensate tank temp to steam temp + latent heat (sensible heat = m*cp*dt)
Base case cost of operation	12,637,407.75	Btu/hr	3,702.73	kW	assumes full load operation (the cost of sensible heat to go from tank temperature to condensate outlet temperature should be the difference between this value and the heat exchanger capacity
Improved case cost of operation	11,758,586.83	Btu/hr	3,445.23	kW	assumes full load operation (the cost of sensible heat to go from tank temperature to condensate outlet temperature should be the difference between this value and the heat exchanger capacity
Improved case cost to reheat condensate	- 132,305.17	Btu/hr	- 38.77	kW	improved case condensate temperature is below that of the assumed condensate tank temperature and needs to be deducted from the savings
Savings	746,515.75	Btu/hr	218.73	kW	
Operating hours			5,000.00	hrs / year	assumed hours the heat exchangers are in service based on information provided; correlates to PRIVA system archived data
Load intensity	80%	of the hours	50%	load	based on rule of thumb data and information provided
Estimated annual savings			2,362.25	GJ per year saved	savings per heat exchanger assuming that the performance of the heat exchanger consistent for 100% steam flow and 50% steam flow
Total QTY of heat exchangers	2.00	pcs			
Total Savings			4,724.51	GJ per year saved	
Total Savings			127,003	m3	total estimated savings for the project converted to m3 natural gas
factoring steam/fuel efficiency factor of 80%:	158,754	m³/year			

Dismantled Original Heat Exchanger

Appendix T: CI - 08 (2014-COM-0240)

Excerpt from e-mail message confirming metered, purchased steam consumption from Oct 2013 – January 2014

"What I have is this (in 1000 lbs):

October	1,258
November	1,431
December	1,882
January	2,616

Excerpt from LEED documentation, compatible with most recent Modeling Report

EA Credit 1.1-1.10: Optimize Energy Performance

(Mechanical or Energy Engineer or Responsible Party)
I, [redacted], declare the following reduction in design energy cost compared to the energy cost budget for energy systems regulated by MNECB 1997 for New Construction.

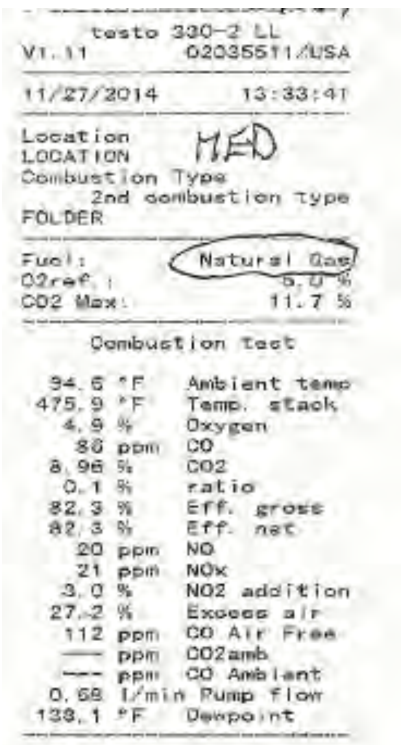
☑ This project has been reviewed and approved by an independent third party reviewer (ie. Natural Resources Canada)

Energy Summary by End Use		Energy Type	Proposed Building [MJ]	Proposed Building Intensity [kWh/m²]	Reference Building [MJ]	Reference Building Intensity [kWh/m²]	Energy Savings [%]
Regulated Energy							
Lighting		Electric	4,575,324	34.7	8,256,747	62.5	45%
Space Heating		Natural gas	25,501,988	193.2	53,781,052	407.4	53%
Space Cooling		Electric	4,542,303	34.4	6,657,789	50.4	32%
Pumps		Electric	1,037,171	7.9	7,394,284	56.0	86%
Fans		Electric	5,433,145	41.2	9,062,345	68.6	40%
Service Water Heating		Electric	230,201	1.7	864,678	6.5	73%
Other:		Select a fuel		0.0		0.0	0%
Other:		Select a fuel		0.0		0.0	0%
Subtotal Regulated Energy			**41,320,130**	**313.0**	**86,016,893**	**651.6**	**52%**
Non-Regulated Energy							
Plug Loads		Electric	2,270,993	17.2	2,270,993	17.2	0%
Other:	Enter End Use	Select a fuel	0	0.0	0	0.0	0%
Other:	Enter End Use	Select a fuel	0	0.0	0	0.0	0%
Subtotal Non-Regulated Energy			**2,270,993**	**17.2**	**2,270,993**	**17.2**	**0%**

Appendix U: CI - 19 (2014-IND-0115)

Representative steam operating pressure

Most recent combustion test data



testo 330-2 LL
V1.11 02035511/USA

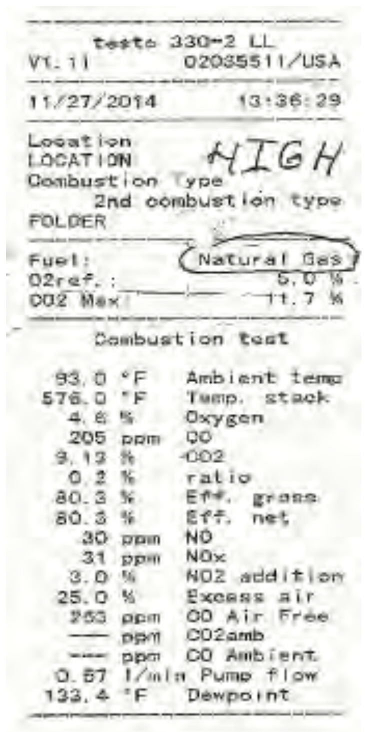
11/27/2014 13:33:41

Location
LOCATION MED
Combustion Type
2nd combustion type
FOLDER

Fuel: Natural Gas
O2ref.: 5.0 %
CO2 Max: 11.7 %

Combustion test

94.6	°F	Ambient temp
475.9	°F	Temp. stack
4.9	%	Oxygen
86	ppm	CO
8.96	%	CO2
0.1	%	ratio
82.3	%	Eff. gross
82.3	%	Eff. net
20	ppm	NO
21	ppm	NOx
3.0	%	NO2 addition
27.2	%	Excess air
112	ppm	CO Air Free
----	ppm	CO2amb
----	ppm	CO Ambient
0.68	l/min	Pump flow
138.1	°F	Dewpoint



testo 330-2 LL
V1.11 02035511/USA

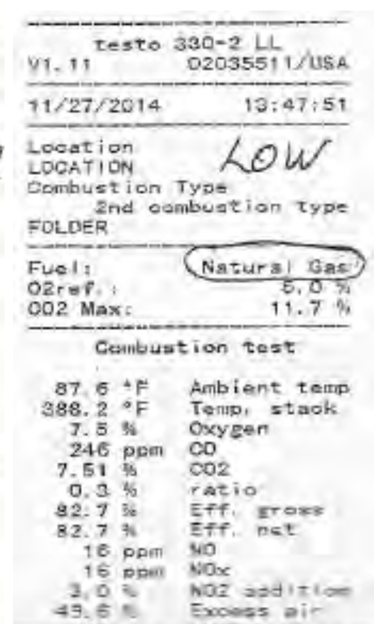
11/27/2014 13:36:29

Location
LOCATION HIGH
Combustion Type
2nd combustion type
FOLDER

Fuel: Natural Gas
O2ref.: 5.0 %
CO2 Max: 11.7 %

Combustion test

93.0	°F	Ambient temp
576.0	°F	Temp. stack
4.6	%	Oxygen
205	ppm	CO
9.13	%	CO2
0.2	%	ratio
80.3	%	Eff. gross
80.3	%	Eff. net
30	ppm	NO
31	ppm	NOx
3.0	%	NO2 addition
25.0	%	Excess air
253	ppm	CO Air Free
----	ppm	CO2amb
----	ppm	CO Ambient
0.57	l/min	Pump flow
133.4	°F	Dewpoint



testo 330-2 LL
V1.11 02035511/USA

11/27/2014 13:47:51

Location
LOCATION LOW
Combustion Type
2nd combustion type
FOLDER

Fuel: Natural Gas
O2ref.: 5.0 %
CO2 Max: 11.7 %

Combustion test

87.6	°F	Ambient temp
388.2	°F	Temp. stack
7.5	%	Oxygen
246	ppm	CO
7.51	%	CO2
0.3	%	ratio
82.7	%	Eff. gross
82.7	%	Eff. net
16	ppm	NO
16	ppm	NOx
3.0	%	NO2 addition
43.6	%	Excess air

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964

GENERAL DATA:

FUEL HHV =	1000 BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	22,723 BTU/LB	Combustible HHV	1000	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.59 CU FT/LB			

CUSTOMER/PROJECT: General Description

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

est Economizer

	UNITS	TEST #1	TEST #2	TEST #3
SECTION A ENTER TEST DATA IN THIS SECTION				
FIRING RATE =	Fuel Input MBTU/HR	1,400	6,150	9,900
STEAM DRUM PRESSURE =	PSIG	100	100	100
COMBUSTION AIR TEMP =	DEG. F	74	74	74
STACK TEMP Before Economizer	DEG. F	388	476	576
STACK TEMP After Economizer	DEG. F	282	310	329
NET STACK TEMP =	DEG.F	208	236	255
OXYGEN=	% by vol	7.50	4.90	4.60
CARBON MONOXIDE =	PPM	246	86	205
	% by vol.	0.02	0.01	0.02
COMBUSTIBLES =	% by vol.	0.000	0.000	0.000
SECTION B TOTAL LOSS CALCULATION				
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	4.87%	4.80%	5.10%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	10.79%	10.92%	11.00%
PERCENT CARBON MONOXIDE LOSS	%	0.08%	0.03%	0.07%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	15.74%	15.74%	16.17%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE				
COMBUSTION EFFICIENCY (100-LOSSES)	%	84.26%	84.26%	83.83%

SECTION D- SUB-SECTION FOR CALCULATION OF DRY FLUE GAS CO2, N2 AND O2 RELATIONSHIPS

		TEST #1	TEST #2	TEST #3
SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49				
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	49.69	27.22	25.09
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		381.20	386.40	387.00
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	10.180	10.278	10.289
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	9.843	9.749	9.738
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	10.929	9.437	9.296
VOL N2 per VOL DFG	CU FT/CU FT	107.358	91.819	90.343
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F. ASME EQ. 25	22.18	19.24	18.93
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F. ASME SEC. 7.3.2.07	18.08	6.39	15.23
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

Natural Gas Fuel Economizer

Boiler Ratings:			**Losses:**	**Radiation**	**1.0%**	of full load fuel input
Full Load Fuel Input	**9,900**	MBTU/HR	RO system	**Blow-Down**	**0.1%**	of steam output
Min. Fuel Input	1,400	BTU/HR		**Unmeasured Loss**	**0.5%**	of fuel input
Rated Steam Output	**N/A**	LB/HR				
Fuel HHV	**1000**	BTU/CU FT				

Test #	Units	TEST #1	TEST #2	TEST #3
Fuel Input	percent of F.L.	14%	62%	100%
Fuel Input	MBTU/HR	1,400	6,150	9,900
Combustion Loss	percent	**15.74%**	**15.74%**	**16.17%**
Combustion Loss	**BTU/HR**	**220**	**968**	**1,601**
Radiation Loss	MBTU/HR	99	99	99
Blow-Down Loss	MBTU/HR	0	1	2
Unmeasured Loss	MBTU/HR	7.0	30.8	49.5
Cycling Loss	MBTU/HR	0	0	0
TOTAL LOSS	**MBTU/HR**	**327**	**1,099**	**1,751**
Fuel Input, MBTU/H		1,400	6,150	9,900
Combustion Efficiency	**Comb. Eff.**	**84.3%**	**84.3%**	**83.8%**
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**76.7%**	**82.1%**	**82.3%**

Average: 80.4%

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964

GENERAL DATA:

FUEL HHV =	1000	BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	22,723	BTU/LB	Combustible HHV	1000	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.59	CU FT/LB			

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

BOILER #1 NO Economizer

	UNITS	TEST #1	TEST #2	TEST #3
SECTION A ENTER TEST DATA IN THIS SECTION				
FIRING RATE =	Fuel Input MBTU/HR	1,400	6,150	9,900
STEAM DRUM PRESSURE =	PSIG	100	100	100
COMBUSTION AIR TEMP =	DEG. F	74	74	74
STACK TEMP Before Economizer	DEG. F	388	476	576
STACK TEMP After Economizer	DEG. F	388	476	576
NET STACK TEMP =	DEG.F	314	402	502
OXYGEN=	% by vol	7.50	4.90	4.60
CARBON MONOXIDE =	PPM	246	86	205
	% by vol.	0.02	0.01	0.02
COMBUSTIBLES =	% by vol.	0.000	0.000	0.000
SECTION B TOTAL LOSS CALCULATION				
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	7.36%	8.17%	10.04%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	11.27%	11.66%	12.11%
PERCENT CARBON MONOXIDE LOSS	%	0.08%	0.03%	0.07%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	18.70%	19.86%	22.21%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE				
COMBUSTION EFFICIENCY (100-LOSSES)	%	81.30%	80.14%	77.79%

SECTION D- SUB-SECTION FOR CALCULATION OF DRY FLUE GAS CO2, N2 AND O2 RELATIONSHIPS

		TEST #1	TEST #2	TEST #3
SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49				
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	49.69	27.22	25.09
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		381.20	386.40	387.00
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	10.180	10.278	10.289
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	9.843	9.749	9.738
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	10.929	9.437	9.296
VOL N2 per VOL DFG	CU FT/CU FT	107.358	91.819	90.343
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F. ASME EQ. 25	22.18	19.24	18.93
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F. ASME SEC. 7.3.2.07	18.08	6.39	15.23
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

Natural Gas Fuel No Econ

Boiler Ratings:			**Losses:**	**Radiation**	**1.0%**	of full load fuel
Full Load Fuel Input	**9,900**	MBTU/HR	RO system	**Blow-Down**	**0.1%**	of steam outpu
Min. Fuel Input	1,400	BTU/HR		**Unmeasured Loss**	**0.5%**	of fuel input
Rated Steam Output	**N/A**	LB/HR				
Fuel HHV	**1000**	BTU/CU FT				

Test #	Units	TEST #1	TEST #2	TEST #3		
Fuel Input	percent of F.L.	14%	62%	100%		
Fuel Input	MBTU/HR	1,400	6,150	9,900		
Combustion Loss	percent	**18.70%**	**19.86%**	**22.21%**		
Combustion Loss	**BTU/HR**	**262**	**1,221**	**2,199**		
Radiation Loss	MBTU/HR	99	99	99		
Blow-Down Loss	MBTU/HR	0	1	2		
Unmeasured Loss	MBTU/HR	7.0	30.8	49.5		
Cycling Loss	MBTU/HR	0	0	0		
TOTAL LOSS	**MBTU/HR**	**368**	**1,352**	**2,349**		
Fuel Input, MBTU/H		1,400	6,150	9,900		
Combustion Efficiency	**Comb. Eff.**	**81.3%**	**80.1%**	**77.8%**		
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**73.7%**	**78.0%**	**76.3%**	Average:	76.0%
Total Steam Production	**LB/HR**	**1,045**	**4,858**	**7,645**		

BJL revised efficiency input

PROJECT ASSUMPTIONS

Small Leaks

LIST OF ASSUMPTION / ESTIMATIONS					SUPPORT	
	DEFINITION BELOW FOR CATEGORY 1 LEAK					
1.0	Low Plant Pressure =	15	psig		1.0	Provided by Customer
2.0	Leak Orifice Diameter Category 1 =	1/16"	@	15 psig	2.0	Estimated by H.Ahmadzai, P.Eng.
3.0	Leak Orifice Diameter Category 1 =	3/32"	@	15 psig	3.0	Estimated by H.Ahmadzai, P.Eng.
4.0	Leak Rate @ 1/16"	3.40	lb/hr		4.0	Steam Discharge Rate & Linear Interpolation.pdf
5.0	Leak Rate @ 3/32"	7.70	lb/hr		5.0	Steam Discharge Rate & Linear Interpolation.pdf
6.0	Use Average From Above =	**5.6**	lb/hr		6.0	Category 1 Estimate
	DEFINITION BELOW FOR CATEGORY 2 LEAK					
7.0	Mid Plant Pressure =	75	psig		7.0	Provided by Customer
8.0	Leak Orifice Diameter Category 2 =	3/32"	@	75 psig	8.0	Estimated by H.Ahmadzai, P.Eng.
9.0	Leak Orifice Diameter Category 2 =	1/8"	@	75 psig	9.0	Estimated by H.Ahmadzai, P.Eng.
10.0	Leak Rate @ 3/32"	25.40	lb/hr		10.0	Steam Discharge Rate & Linear Interpolation.pdf
11.0	Leak Rate @ 1/8"	41.30	lb/hr		11.0	Steam Discharge Rate & Linear Interpolation.pdf
12.0	Use Average From Above =	**33.4**	lb/hr		12.0	Category 2 Estimate
	DEFINITION BELOW FOR CATEGORY 3 LEAK					
13.0	High Plant Pressure =	100	psig		13.0	Provided by Customer
14.0	Leak Orifice Diameter Category 2 =	1/16"	@	100 psig	14.0	Estimated by H.Ahmadzai, P.Eng.
15.0	Leak Orifice Diameter Category 2 =	3/32"	@	100 psig	15.0	Estimated by H.Ahmadzai, P.Eng.
16.0	Leak Rate @ 1/16"	13.20	lb/hr		16.0	Steam Discharge Rate & Linear Interpolation.pdf
17.0	Leak Rate @ 3/32"	29.70	lb/hr		17.0	Steam Discharge Rate & Linear Interpolation.pdf
18.0	Use Average From Above =	**21.5**	lb/hr		18.0	Category 3 Estimate
	DEFINITION BELOW FOR CATEGORY 4 LEAK					
13.0	High Plant Pressure =	100	psig		13.0	Provided by Customer
14.0	Leak Orifice Diameter Category 2 =	3/32"	@	100 psig	14.0	Estimated by H.Ahmadzai, P.Eng.
15.0	Leak Orifice Diameter Category 2 =	1/8"	@	100 psig	15.0	Estimated by H.Ahmadzai, P.Eng.
16.0	Leak Rate @ 3/32"	29.7	lb/hr		16.0	Steam Discharge Rate & Linear Interpolation.pdf
17.0	Leak Rate @ 1/8"	52.8	lb/hr		17.0	Steam Discharge Rate & Linear Interpolation.pdf
18.0	Use Average From Above =	**41.3**	lb/hr		18.0	Category 4 Estimate
	OTHER ASSUMPTIONS					
22.0	Condensate Return Pressure [psig] =	10	psig		22.0	Provided by Customer
23.0	Enthaply of 100 psig Steam =	1190	Btu/lb		23.0	From Steam Tables
24.0	Steam Pressure Raised =	100	psig		24.0	Provided by Customer
25.0	Estimated Boiler Efficiency =	[illegible]			25.0	Provided by Customer
26.0	Hours Per Year =	8760			26.0	Steam System Operates All Year
27.0	Nat Gas HHV =	1000	Btu/ft^3		27.0	Standard Assumption
28.0	$1\ m^3$ =	35.314	ft^3		28.0	Standard Conversion

BJL calculation revisions (highlighted in red colour)

WATER LOSS CALCULATIONS

$$\text{Water Savings} = \frac{L}{yr} = 265.9\,\frac{\cancel{lbs}}{hr} \times 0.4536\,\frac{L}{\cancel{lbs}}$$

$$\text{Water Savings} = \frac{L}{yr} = 120.61\,\frac{L}{hr} \times \text{Operating Hours}$$

$$\text{Water Savings} = \frac{L}{yr} = 120.61\,\frac{L}{\cancel{hr}} \times 8760\,\frac{\cancel{hr}}{yr}$$

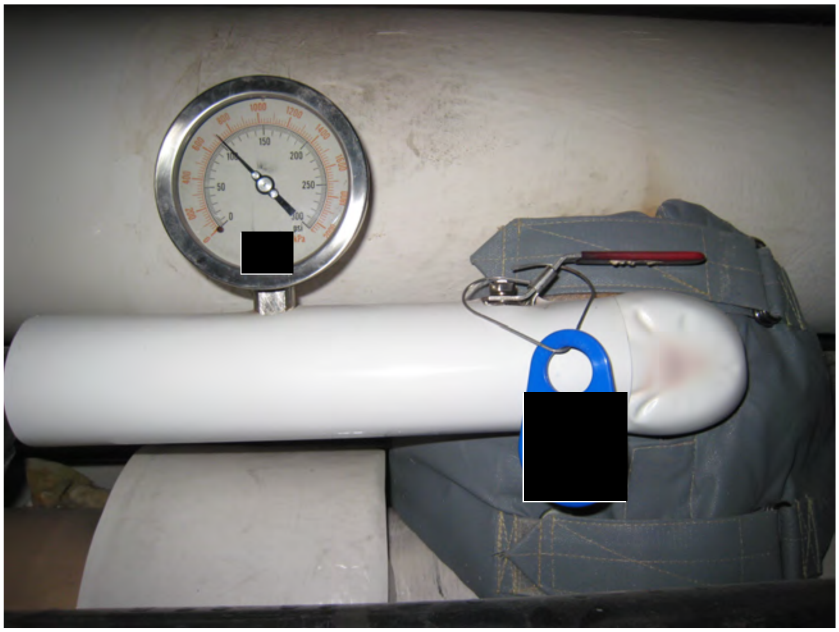
$$\text{Water Savings} = \frac{L}{yr} = 1{,}056{,}563\,\frac{L}{yr}$$

NATURAL GAS STEAM LOSS CALCULATION

Total Number of Steam Leaks	10	#
Total 15 psig Steam Leaks	11.1	lb/hour
Total 75 psig Steam Leaks	66.7	lb/hour
Total 100 psig Steam Leaks	188.1	lb/hour
	-	lb/hour
Energy Lost at 15 psig	115,710,840	Btu/year - heat loss
Energy Lost at 75 psig	695,307,480	Btu/year - heat loss
Energy Lost at 100 psig	1,960,829,640	Btu/year - heat loss
	-	Btu/year - heat loss
Heat Input to Make-up Loss	3,553,651,231	Btu/year - heat input lost
m3 Gas Savings - Annual	100,630	m^3/year
EUL	20	years
m3 Gas Savings - Lifetime	2,012,601.93	m^3

Appendix V: CI - 23 (2014-IND-0261)

Main steam pressure in distribution system piping



Low pressure steam pipe at converter **Hot Water pipe surface temperature**

Revised Tunnel Savings to Reflect 100 psig steam (338 deg F vs 350 deg F)

dia (in)	Length (ft)	Bare Pipe BTUH/ft	Insul Pipe BTUH/ft	Operating Hours	MBTU savings
14	1.5	2672	215	8760	32,285
6	12	1299	112	8760	124,777
4	4	898	79	8760	28,698
1	5	286	34	8760	11,038
0.75	5	234	32	8760	8,848
					205,645
				m3 @ 80% steam/fuel	7,282

Revised Mechanical Room Savings to Reflect 100 psig steam (338 deg F vs 350 deg F)

dia (in)	Length (ft)	Bare Pipe BTUH/ft	Insul Pipe BTUH/ft	Operating Hours	MBTU savings
3	7	708	65	5040	22,685
2	5	493	50	5040	11,164

Total Listed MBTU savings:	395,917
less Steam at 100 psi (3")	-23,986
less Steam at 100 psi (2")	-12,139
plus 3" item above	22,685
plus 2" item above	11,164
net	393,641
m3 @ 80% steam/fuel	13,939
Total m3:	21,221

Appendix W: CI - 20 (2014-COM-0345)

Boiler fuel consumption rationalization

Year 2014 and YTD 2015 Monthly Plant Metered Totals

Month_Yr	Boiler #4		Month Avg	Boiler #5		Month Avg	Oil		seems factors embedded plant NG	
	NG (ft3)	UG m3 share	MBH	NG (ft3)	UG m3 share	MBH	B4	B5	boilers sum	Plant UG historical data
Jan_14	8,463,800	331,332	16,102	24,613,000	963,523	46,825		69,909	log data CF	m3
Feb_14	3,676,100	142,962	6,948	21,792,720	847,512	41,187			75,472,720	2,935,110
Mar_14	2,368,800	89,493	4,349	23,802,000	899,234	43,701			74,304,300	2,807,200
Apr_14	241,300	12,637	614	19,773,400	1,035,541	50,325			33,939,800	1,777,441
May_14	5,697,700	182,470	8,868	0	0	0			34,456,940	1,103,491
June_14	2,245,300	73,879	3,590	0	0	0			23,374,800	769,122
July_14	15,456,120	737,478	35,840	64,200	3,063	149			16,255,720	775,630
Aug_14	4,105,800	278,941	13,556	7,051,712	479,080	23,282			11,157,512	758,021
Sept_14	0	0	0	12,657,130	856,637	41,631			13,552,030	917,204
Oct_14	0	0	0	25,936,250	1,412,081	68,624			25,936,250	1,412,081
Nov_14	0	0	0	29,738,660	1,278,598	62,137			50,713,790	2,180,413
Dec_14	0	0	0	24,180,000	1,030,816	50,095			54,333,700	2,316,297
Jan_15	0			25,182,700	1,019,960	49,568	After-		76,983,500	3,118,016
Feb_15	0			25,138,880			measure		92,030,780	no data
Total 2014	42,254,920	1,849,191		##########	8,806,086				Total 2014	21,009,346 NG
Total YTD2015	0	0		50,321,580	1,019,960					

Ratings:	Boiler #4	Boiler #5	observed 64,715 CFH firing @ time of visit Feb. 25/15 (B4 off)
MBH Input	132,000	179,000	
Steam Output (pph)	110,000	150,000	
t/d	3:1	10:1	

Boiler Efficiency

Combustion Efficiency Measurements

Instrument Type/Model: Nova O2 and CO analyzer

	Boiler #	Four	Four	Four	Four	Four	Four
1	Boiler Type/Model	B & W. FM					
2	Test Conditions	Before tune-up, running of 15 min.	Before tune-up, running of 15 min.	Before tune-up, running of 15 min.	After tune-up, running of 15 min.	After tune-up, running of 15 min.	After tune-up, running of 15 min.
3	Estimated Firing Rate (% or Lo/Mid/Hi)	20%	40%	67%	20%	40%	67%
4	Outside Air Temperature F	52	52	52	52	52	52
5	Combustion Air Temperature	88	88	88	88	88	88
6	Flue/Stack Temperature	315	340	375	310	337	371
7	Net Stack Temperature (Row #6 - Row #5)	227	252	287	222	249	283
8	Inlet Water Temperature	225	225	225	225	225	225
9	Outlet Water Temperature or	X	X	X	X	X	X
	Steam Pressure PSIG	120	120	120	120	120	120
10	Draft Observations in W.C.	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
11	CO2 %	6.47	7.83	8.76	7.65	8.76	9.26
12	O2 %	7.8	5.5	4	5.8	4	3.2
13	CO ppm	0	0	0	0	0	0
14	NOx	x	x	x	x	x	x
15	Excess Air	63.22	38.17	25.36	41.03	25.36	19.39
16	Combustion Efficiency	79.39	80.99	81.2	80.52	81.69	81.62

PREDICTED PERFORMANCE SUMMARY - Natural Gas

150,0

Load Rating	100	75	50	25
FLOW RATES : (Lbs/Hr)				
Steam	150,000	112,500	75,000	37,500
Feed Water	153,061	114,796	76,531	38,265
Fuel	8,223	6,178	4,138	2,093
Combustion Air	150,995	113,443	77,631	40,107
Flue Gas	159,223	119,625	81,771	42,202
Flue Gas Recirculation	23,883	17,944	12,266	6,330
Flue Gas Leaving Furnace	183,107	137,569	94,037	48,533
PRESSURES : (Psig)				
Steam @ NRV	150	150	150	150
Drum Operating Pressure	150	150	150	150
Boiler Design Pressure	250	250	250	250
TEMPERATURES : (Deg F)				
Steam Temp. @ NRV	366	366	366	366
Feed Water Entering Econ	228	228	228	228
Combustion Air Temp	90	90	90	90
Fl.Gas Temp. Leaving Blr	543	506	469	408
Fl.Gas Temp. Leaving Econ	300	300	300	300
DRAFT LOSSES : (Inwc)				
Silencer	00.00	00.00	00.00	00.00
Combustion Air Duct	00.00	00.00	00.00	00.00
Burner	00.00	00.00	00.00	00.00
Furnace & Boiler	13.56	07.82	03.83	01.22
Economizer	01.50	00.84	00.38	00.09
Flue Gas Duct & Stack	00.00	00.00	00.00	00.00
Total Draft Loss	15.06	08.66	04.20	01.31
BOILER EFFICIENCY : (%)				
Dry Gas Loss	03.96	03.96	04.05	04.14
Fuel Moisture Loss	10.58	10.58	10.58	10.58
Air Moisture Loss	00.11	00.11	00.11	00.11
Radiation Loss	00.44	00.58	00.87	01.75
Unburned Loss	00.00	00.00	00.00	00.00
Manufacturer's Margin	01.00	01.00	01.00	01.00
Total Heat Loss	16.09	16.23	16.62	17.59
Boiler Efficiency	83.91	83.77	83.38	82.41
HEAT INPUT & RELEASE RATES :				
Boiler Heat Input	179.068	134.535	90.105	45.582
Vol. Heat Release Rate	75,673	56,854	38,078	19,263
Furn. Surf. Ht Rel. Rate	146,903	110,369	73,920	37,395

BOILER DATA

Boiler#	Five	Capacity:	150,000 Lb/Hr.
Make:	[redacted]	Stm press	120 psig
Type:	Package. # [redacted]	Air flow	Pitot tube at air intake
Econ	Yes	# Burners	One. Coen
Air heater	No		
Controls	DeltaV		
O2 trim	Yes		
Analyzer	Delta.		

TEST RESULTS

Test #	1	2	3	4	5	6	7		
Steam Flow x 1000 =lbs/hr	10.7	28	50.7	65	80	95	98		
Drum Press. psig	123	124	124	123	125	126	126		
Header press. psig	121	120	121	121	120	121	122		
F.W. Press. psig	187	187	187	187	187	187	187		
Steam temp. Deg F	sat	sat	sat	sat	sat	sat	sat		
Feedwater temp. Deg F	229	229	229	229	229	229	229		
Drum level. 0=Normal	0	0.2	0	0.1	-0.1	0	0		
Fuel supply press. psig	20	20	20	20	20	20	20		
Fuel press @ burner. psig	0	0	0.1	0.5	8	12	12.5		
Flue gas econ in Deg F	366	368	396	419	428	458	463		
Flue Gas econ out Deg F	226	244	249	254	260	264	265		
F.W. econ in Deg F	229	229	229	229	229	229	229		
F.W. econ out Deg F	269	276	278	280	282	284	285		
Windbox press. "W.C.	20	19.6	19.3	19.4	19.4	19.5	19.6		
Furnace press. "W.C.	0.2	1.3	2	2.9	3.7	5.8	6		
Uptake press "W.C.	0	0	0	0	0	0	0		
# Burners	1	1	1	1	1	1	1		
Air temperature Deg F	85	85	85	85	85	85	85		
Air flow%	11	23	30	37	44	53	55		
Gas flow%	11	23	30	37	44	53	55		
As found Excess O2%	5.8	4.8	4.1	3.1	2.9	2.9	2.9		
CO2 %	8.66	9.3	9.6	10.2	10.3	10.3	10.3		
CO ppm	0	0	0	0	0	0	0		
Air drive loading %	7.2	20	25	28	34	43	47		
Fuel v/v loading %	4	12	17	20	25	44	47		
F.W. Valve loading %	11	14	20	25	27	34	35		
As found. Boiler Efficiency %	79.3	82.5	83.6	83.9	84.1	84.1	84.1		
Final Boiler Efficiency %	79.8	83	84.1	84.5	84.6	84.6	84.6		

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964

BOILER #4

GENERAL DATA:

FUEL HHV =	1020	BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	23,018	BTU/LB	Combustible HHV	1020	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.567	CU FT/LB			

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

BOILER # 4 NO (external) Economizer

	UNITS	TEST #1	TEST #2
SECTION A ENTER TEST DATA IN THIS SECTION			
FIRING RATE =	Fuel Input MBTU/HR	52,800	52,800
STEAM DRUM PRESSURE =	PSIG	125	125
COMBUSTION AIR TEMP =	DEG. F	88	88
STACK TEMP Before Economizer	DEG. F	340	337
STACK TEMP After Economizer	DEG. F	340	337
NET STACK TEMP =	DEG.F	252	249
OXYGEN=	% by vol	5.50	4.00
CARBON MONOXIDE =	PPM	0	0
	% by vol	0.00	0.00
COMBUSTIBLES =	% by vol	0.000	0.000
SECTION B TOTAL LOSS CALCULATION			
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	5.22%	4.78%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	10.78%	10.77%
PERCENT CARBON MONOXIDE LOSS	%	0.00%	0.00%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	16.00%	15.55%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE			
COMBUSTION EFFICIENCY (100-LOSSES)	%	84.00%	84.45%

SECTION D- SUB-SECTION FOR CALCULATION OF DRY FLUE GAS CO2, N2 AND O2 RELATIONSHIPS

		TEST #1	TEST #2
SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49			
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	31.74	21.05
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		385.20	388.20
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	10.255	10.312
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	9.771	9.717
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	9.737	9.028
VOL N2 per VOL DFG	CU FT/CU FT	94.942	87.548
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F. ASME EQ. 25	19.87	18.41
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F. ASME SEC. 7.3.2.07	0.00	0.00
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

BOILER #4: Natural Gas Fuel

Boiler Ratings:			
Full Load Fuel Input	**132,000**	MBTU/HR	
Min. Fuel Input	44,000	BTU/HR	
Rated Steam Output	**110,000**	LB/HR	
Fuel HHV	**1020**	BTU/CU FT	

Losses:		
Radiation	**1.0%**	of full load fuel input
Blow-Down	**5.0%**	of steam output
Unmeasured Loss	**0.5%**	of fuel input

Test #	Units	TEST #1	TEST #2
Fuel Input	percent of F.L.	40%	40%
Fuel Input	MBTU/HR	52,800	52,800
Combustion Loss	percent	**16.00%**	**15.55%**
Combustion Loss	**BTU/HR**	**8,449**	**8,208**
Radiation Loss	MBTU/HR	1,320	1,320
Blow-Down Loss	MBTU/HR	724	728
Unmeasured Loss	MBTU/HR	264.0	264.0
TOTAL LOSS	**MBTU/HR**	**10,757**	**10,520**
Fuel Input, MBTU/H		52,800	52,800
Combustion Efficiency	**Comb. Eff.**	**84.0%**	**84.5%**
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**79.6%**	**80.1%**
Total Steam Production	**LB/HR**	**42,254**	**42,492**
	kg/hr	***19,172***	***19,280***
Steam to De-aerator	**LB/HR**	**2,817**	**2,833**
Net Steam to Process	**LB/HR**	**39,437**	**39,660**
	kg/hr	***17893***	***17994***

Fuel savings:	
	0.56%
	10,357 m3

COMBUSTION EFFICIENCY CALCULATION
BASED ON A.S.M.E.TEST STANDARD PTC 4.1, 1964

BOILER #5

GENERAL DATA:

FUEL HHV =	1020	BTU/CU FT	CO HHV	4347	BTU/LB
FUEL HHV =	23,018	BTU/LB	Combustible HHV	1020	BTU/CU FT
SPECIFIC VOL. OF FUEL=	22.567	CU FT/LB			

= DATA INPUT MANDATORY-Values are used in calcs.
=DATA INPUT FOR INFORMATION ONLY
= CALCULATED VALUED, DO NOT INPUT DATA

	UNITS	BOILER # 5 TEST #1	TEST #2
SECTION A ENTER TEST DATA IN THIS SECTION		projected data	
FIRING RATE =	Fuel Input MBTU/HR	75,000	75,000
STEAM DRUM PRESSURE =	PSIG	125	125
COMBUSTION AIR TEMP =	DEG. F	90	85
STACK TEMP Before Economizer	DEG. F	469	419
STACK TEMP After Economizer	DEG. F	300	254
NET STACK TEMP =	DEG.F	210	169
OXYGEN= *iterated to dry flue gas loss spec on test 1*	% by vol	3.65	3.10
CARBON MONOXIDE =	PPM	0	0
	% by vol.	0.00	0.00
COMBUSTIBLES =	% by vol.	0.000	0.000
SECTION B TOTAL LOSS CALCULATION			
PERCENT LOSS DUE TO DRY GAS PER LB. OF AS FIRED FUEL	%	3.96%	3.11%
PERCENT LOSS DUE TO H2O FORMATION FROM HYDROGEN IN FUEL	%	10.58%	10.43%
PERCENT CARBON MONOXIDE LOSS	%	0.00%	0.00%
PERCENT COMBUSTIBLE LOSS	%	0.00%	0.00%
TOTAL COMBUSTION LOSSES	%	14.55%	13.53%
SECTION C - COMBUSTION EFFICIENCY VS. FIRING RATE			
COMBUSTION EFFICIENCY (100-LOSSES)	%	85.45%	86.47%

SECTION D- SUB-SECTION FOR CALCULATION OF DRY FLUE GAS CO2, N2 AND O2 RELATIONSHIPS

		TEST #1	TEST #2
SOURCE: NORTH AMERICAN COMBUSTION HANDBOOK 1986 PP 49			
EXCESS AIR BY VOLUME AS A FUNCTION OF O2 MEASURED IN DFG	PERCENT	18.82	15.49
THETA AS DEFINED IN NA COMBUSTION HANDBOOK 1986-PP49 Note: Theta is a function of the fuel analysis.		388.90	390.00
VOL DFG per VOL AFF- NA Handbook p 49 eq 3/12	CU FT/CU FT	10.325	10.346
VOL CO2 per VOL AFF- NA Handbook p 49 eq 3/13	CU FT/CU FT	1.002	1.002
VOL CO2 PER VOL DFG	CU FT/CU FT	9.704	9.685
VOL N2 per VOL AFF-NA Handbook p 49 eq 3/16a	CU FT/CU FT	8.880	8.660
VOL N2 per VOL DFG	CU FT/CU FT	86.007	83.707
LB OF DRY FLUE GAS per LB OF AS FIRED FUEL	LB per LB of A.F.F. ASME EQ. 25	18.09	17.62
ENERGY LOSS DUE TO CO IN DRY FLUE GAS	BTU/LB of A.F.F. ASME SEC. 7.3.2.07	0.00	0.00
ENERGY LOSS DUE TO HYDROCARBONS IN DRY FLUE GAS	BTU per LB of A.F.F. ASME SEC. 7.3.2.09	0.00	0.00

BOILER EFFICIENCY CALCULATION AND GRAPH SHOWING COMBUSTION VS FUEL TO STEAM EFFICIENCY
FUEL INPUT IS KNOWN, STEAM OUTPUT IS CALCULATED

BOILER #5: Natural Gas Fuel

Boiler Ratings:			
Full Load Fuel Input	179,000	MBTU/HR	
Min. Fuel Input	17,900	BTU/HR	
Rated Steam Output	150,000	LB/HR	
Fuel HHV	1020	BTU/CU FT	

Losses:		
Radiation	1.0%	of full load fuel input
Blow-Down	5.0%	of steam output
Unmeasured Loss	0.5%	of fuel input

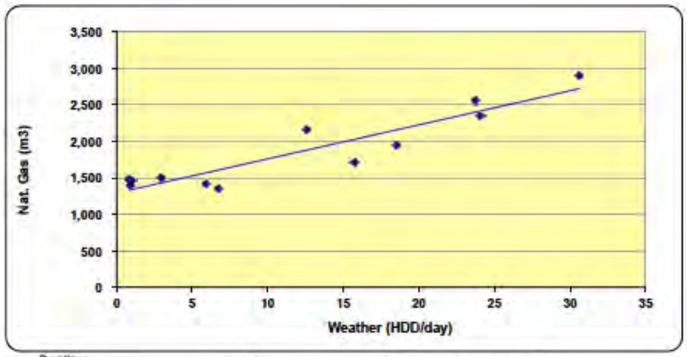
Fuel savings: 1.21%
106,826 m3

Test #	Units	TEST #1	TEST #2
Fuel Input	percent of F.L.	42%	42%
Fuel Input	MBTU/HR	75,000	75,000
Combustion Loss	percent	**14.55%**	**13.53%**
Combustion Loss	**BTU/HR**	**10,910**	**10,150**
Radiation Loss	MBTU/HR	1,790	1,790
Blow-Down Loss	MBTU/HR	1,047	1,059
Unmeasured Loss	MBTU/HR	375.0	375.0
TOTAL LOSS	**MBTU/HR**	**14,122**	**13,374**
Fuel Input, MBTU/H		75,000	75,000
Combustion Efficiency	**Comb. Eff.**	**85.5%**	**86.5%**
Fuel to Steam Efficiency	**Fuel/Stm Eff.**	**81.2%**	**82.2%**
Total Steam Production	**LB/HR**	**61,184**	**61,936**
	kg/hr	***27,761***	***28,101***
Steam to De-aerator	**LB/HR**	**4,036**	**4,085**
Net Steam to Process	**LB/HR**	**57,148**	**57,851**
	kg/hr	***25929***	***26248***

Appendix X: CI - 22 (2014-COM-0239)

Linear Regression Analysis Tool

Month	Date	Nat. Gas m3	Weather HDD/day	Include
7	27-Mar-14	2,554	24	Yes
8	24-Apr-14	2,160	13	Yes
9	28-May-14	1,412	6	Yes
10	24-Jun-14	1,458	1	Yes
11	25-Jul-14	1,486	1	Yes
12	25-Aug-14	1,394	1	Yes
13	25-Sep-14	1,502	3	Yes
14	27-Oct-14	1,350	7	Yes
15	25-Nov-14	1,721	16	Yes
16	19-Dec-14	1,940	19	Yes
17	23-Jan-15	2,345	24	Yes
18	27-Feb-15	2,907	31	Yes



Edit Historical Data | Ex/Include Point

Degree Day Parameters
Cooling Balance Point Temp 18
Heating Balance Point Temp 18

Duration
Months 12

Starting
Date 27-Mar-14
or
Sequence # 7

X-Y Graph
Line Graph
Independent Variable is: Weather

Regression Model

Dependent Variable . . .	Nat. Gas	
Independent Variable . .	Weather	
Slope.		47.367 m3/HDD
Intercept.		1,286 m3/day
R^2.		0.873

PATH 2: ASHRAE 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings

Complete the following tables to support the selected option:

Table: Energy Cost and Consumption by Energy Type

Energy Summary by End Use		Energy Type	Proposed Building [MJ]	Proposed Building Intensity [kWh/m²]	Reference Building [MJ]	Reference Building Intensity [kWh/m²]	Energy Savings [%]
Lighting		Electric	367,852	16.4	574,286	25.6	36%
Space Heating		Electric	485,831	21.7	1,820,318	81.2	73%
Space Cooling		Electric	215,968	9.6	397,739	17.8	46%
Pumps		Electric	5,944	0.3	0	0.0	0%
Fans		Electric	598,345	26.7	238,961	10.7	-150%
Service Water Heating		Natural gas	269,025	12.0	328,633	14.7	18%
Plug Loads		Electric	471,161	21.0	471,161	21.0	0%
Other:	Process	Electric	140,951	6.3	140,951	6.3	0%
Other:	Enter End Use	Select a fuel	0	0.0	0	0.0	0%
Other:	Enter End Use	Select a fuel	0	0.0	0	0.0	0%
Other:	Enter End Use	Select a fuel	0	0.0	0	0.0	0%
Subtotal			**2,555,077**	**114.0**	**3,972,049**	**177.3**	**36%**

Total Energy Summary		Proposed Building Energy [MJ]	Proposed Building Cost [$]	Reference Building Energy [MJ]	Reference Building Cost [$]	Percent Savings Energy [%]	Percent Savings Cost [%]
Electricity		2,286,050	$88,946	3,643,416	$137,875	37%	35%
Natural Gas		269,025	$1,493	328,633	$1,822	18%	18%
Oil / Other Fuels		0	$0	0	$0	0%	0%
Total		**2,555,075**	**$90,439**	**3,972,049**	**$139,697**	**36%**	**35%**
Subtotal Energy Costs		**2,555,077**	**$90,439**	(DEC')	**$139,697 (ECB')**		
Renewable	Select a fuel	0	$0	(REC$_1$)	Enter REC System 1		(REC')
Energy Credit	Select a fuel	0	$0	(REC$_2$)	Enter REC System 2		$0
Net Total		**2,555,077**	**$90,439**				

Percent Savings = 100 x (ECB' $ - DEC' $ + REC' $)/ECB' $ – **35%**
Points Awarded (ASHRAE 90.1-2007) **12**

Space htg $(1,820,318 - 485,831)\,MJ \times \frac{1\,m^3}{38.14\,MJ} \times \frac{1}{0.8} = 43,736\,m^3$

DHW $(328,633 - 269,025)\,MJ / 38.14 = 1,563$

$45,299\,m^3$

Appendix N – 2014 Verification of Large Custom Projects

2014 Verification of Large Custom Projects

For

Union Gas
50 Keil Drive North
PO Box 2001
Chatham, Ontario, Canada
N7M 5M1

July 31, 2015

Performed By

Diamond Engineering Company
3723 W. Hamilton Road S
Fort Wayne, IN 46814

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Introduction

Union Gas has been undertaking Demand Side Management initiatives to encourage the efficient use of natural gas. In the industrial markets, custom projects represent a significant portion of the DSM savings. A sampling plan randomly selects an appropriate number of sites that are to be verified by an independent third party. The primary objectives of the report on this verification are:

- To review the original customer application and supporting documentation with respect to savings estimates.
- To conduct site visits (if instructive) and verify the system was installed and operational. To verify equipment costs with the customers.
- To discuss the project with service representatives and customers, and determine operating practices.
- To collect operating data and design information.
- To review the information and make an estimate of the rate of annual gas volume savings, and where appropriate, make an estimate of the rate of water and electrical savings. Savings estimates are Diamond Engineering's best attempt to determine, with the information provided, what the actual savings rate is, without any factors of safety.
- Project Costs are solely the representations of the customers interviewed. This review does not constitute a financial audit.

Summary

Twenty-two projects were reviewed. Customers invested $ 7,202,475 in these projects. These projects resulted in an annual natural gas savings of 54,118,400 m^3. Using a 0.00188 metric ton CO_2 / m^3 gas consumed conversion factor, CO_2 emission reduction from these twenty-two projects was 101,700 metric tons per year.

While this verification process consists of both a Boolean and numeric analysis of project applications and results, there are other factors that, when considered with the supporting information and data, either add to or detract from the verifier's confidence in the conclusions presented. It must be reported that during every site visit, the customers welcomed the verifier and willingly took the time necessary to explain the project and its results. In several instances, a customer was not initially able to provide sufficient information to verify critical savings elements but provided the information at a later date.

Union Gas Representatives and Project Managers were always welcomed by the customers, viewed as partners and considered valuable resources.

It would be desirable to encourage all Customers to provide internal verification procedures to estimate the exact savings achieved from their projects, however, it is important to note most end users perform only enough analysis to justify a course of action. In other words, if the companies required payback period is one year, the investment of additional resources to accurately calculate whether the project pays back in six or three months is a an academic exercise and has no commercial value to the customer.

As with any such body of work, the quality of the supporting material for each project varies significantly. Diamond Engineering personnel have used what is in their judgment the best available information to arrive at the savings estimates.

Summary (continued)

Other Considerations

Energy Intensity – Whenever possible, this analysis will describe energy efficiency improvement(s) in light of *Energy Intensity* reductions. If no such conclusion is provided, in general, there was insufficient data provided or the it required analysis falls outside the describe scope of the analysis. For the purposes of this analysis, Energy Intensity is defined as *Gross Energy Consumed* per consistent unit produced or processed.

Gross Energy Consumed – Unless otherwise noted, *Gross Energy Consumed* is assumed to be the energy value at the facilities boundary. Generation and Distribution losses are not accounted for in the analysis.

HHV – Unless otherwise noted, All values are expressed in terms of the *Higher Heating Value* of any given fuel. The quantity of fuel saved is expressed in terms of a volume under standard pressure and temperature. The Higher Heating Value (HHV) for a standard cubic foot of natural gas is assumed to be 1020 British Thermal Units (BTU).

Period of Savings – Unless otherwise stated, When describing the impact of a project or action on energy consumption, it is assumed the benefit has accrued for a period of one year.

Rational Process Operator – Unless evidence is uncovered to the contrary, it is assume the person / people responsible for various decisions as to the operation, maintenance, and investment in the process or apparatus follow sound business principles. Unless otherwise noted, this analysis does not seek to understand why decision(s) are made, only the decision(s) impact on energy consumption.

Honest Process Operator – Unless evidence is uncovered to the contrary, it is assume the person / people disclosing information do so without any intentional misrepresentation, however, it is not assumed the information is accurate.

While the execution of each project was verified, this was not a financial audit – project costs are as represented by the customers interviewed.

Summary (continued)

Natural Gas Savings	Estimated Annual Natural Gas Saved (Normal Cubic Meters) from Application	Estimated Annual Natural Gas Savings Rate (Normal Cubic Meters) Verifier's Calculations
1. 2014-IND-0649	1,747,225	1,954,000
2. 2014-IND-0670	1,856,905	976,000
3. 2014-IND-0487	1,292,155	855,200
4. 2014-IND-0664	316,149	309,500
5. 2014-IND-0356	1,045,885	1,174,000
6. 2014-IND-0522	2,217,522	3,353,000
7. 2014-IND-0452	1,446,878	1,612,000
8. 2014-IND-0675	557,154	615,200
9. 2014-IND-0371	99,301	172,800
10. 2014-IND-0620	2,745,230	2,943,000
11. 2014-IND-0612	7,226,580	7,259,000
12. 2014-IND-0615	3,902,000	3,980,000
13. 2014-IND-0608	3,063,761	2,895,000
14. 2014-IND-0622	1,277,774	2,569,000
15. 2014-IND-0431	589,960	36,870
16. 2014-IND-0299	248,696	92,830
17. 2014-IND-0287	103,192	152,000
18. 2014-IND-0543	3,964,367	4,630,000
19. 2014-IND-0609	5,340,742	5,984,000
20. 2014-IND-0630	5,353,144	4,908,000
21. 2014-IND-0632	1,775,872	1,631,000
22. 2014-IND-0667	4,354,483	6,016,000
Totals	**50,524,975**	**54,118,400**

Summary (continued)

Water Savings	Estimated Annual Water (liters) from Application	Estimated Annual Water (liters) Verifier's Calculations
1. 2014-IND-0649	179,164,043	204,300,000
2. 2014-IND-0670	19,938,817	10,450,000
3. 2014-IND-0487	13,813,074	8,672,000
4. 2014-IND-0664	1,622,972	3,837,000
5. 2014-IND-0356	0	0
6. 2014-IND-0522	21,948,919	34,490,000
7. 2014-IND-0452	16,592,640	16,550,000
8. 2014-IND-0675	6,389,383	6,514,000
9. 2014-IND-0371	1,229,903	0
10. 2014-IND-0620	0	0
11. 2014-IND-0612	215,699,459	221,000,000
12. 2014-IND-0615	0	0
13. 2014-IND-0608	0	0
14. 2014-IND-0622	0	0
15. 2014-IND-0431	0	0
16. 2014-IND-0299	0	0
17. 2014-IND-0287	0	0
18. 2014-IND-0543	51,677,231	51,300,000
19. 2014-IND-0609	0	0
20. 2014-IND-0630	42,286,006	45,940,000
21. 2014-IND-0632	8,736,914	16,330,000
22. 2014-IND-0667	12,141,372	60,160,000
Totals	**591,240,733**	**679,543,000**

Summary (continued)

Project Costs	Estimated Project Costs from Application	Estimated Project Costs confirmed during site visits
1. 2014-IND-0649	$ 15,890	$ 15,890
2. 2014-IND-0670	526,227	526,227
3. 2014-IND-0487	530,045	530,045
4. 2014-IND-0664	8,019	8,019
5. 2014-IND-0356	25,149	25,149
6. 2014-IND-0522	218,337	218,337
7. 2014-IND-0452	1,352,455	1,352,455
8. 2014-IND-0675	16,000	16,000
9. 2014-IND-0371	920	920
10. 2014-IND-0620	264,391	264,391
11. 2014-IND-0612	397,465	362,465
12. 2014-IND-0615	348,212	348,212
13. 2014-IND-0608	261,272	261,272
14. 2014-IND-0622	62,300	62,300
15. 2014-IND-0431	300,000	300,000
16. 2014-IND-0299	800,000	800,000
17. 2014-IND-0287	134,657	134,657
18. 2014-IND-0543	205,467	205,467
19. 2014-IND-0609	765,327	956,000
20. 2014-IND-0630	337,691	337,691
21. 2014-IND-0632	109,244	109,244
22. 2014-IND-0667	367,734	367,734
Totals	$ 7,046,802	$ 7,202,475

Summary (continued)

Equipment Life	**Estimated Project Life in Years from Application**	**Estimated Project Life in Years confirmed during site visits**
1. 2014-IND-0649	20	20
2. 2014-IND-0670	20	19.54
3. 2014-IND-0487	20	20
4. 2014-IND-0664	7	7
5. 2014-IND-0356	7	7
6. 2014-IND-0522	7	7
7. 2014-IND-0452	20	30
8. 2014-IND-0675	20	20
9. 2014-IND-0371	20	20
10. 2014-IND-0620	2	1.5
11. 2014-IND-0612	20	20
12. 2014-IND-0615	20	20
13. 2014-IND-0608	30	30
14. 2014-IND-0622	10	10
15. 2014-IND-0431	20	20
16. 2014-IND-0299	20	20
17. 2014-IND-0287	20	20
18. 2014-IND-0543	7	7
19. 2014-IND-0609	30	30
20. 2014-IND-0630	20	20
21. 2014-IND-0632	20	20
22. 2014-IND-0667	20	20

Project: 2014-IND-0649 Custom Project Savings Verification Coversheet

[redacted]

Project: 2014-IND-0649

[redacted]

Project: 2014-IND-0649

[redacted]

Project: 2014-IND-0649

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Project: 2014-IND-0649

[redacted]

Project: 2014-IND-0670 Custom Project Savings Verification Coversheet

[redacted]

Project: 2014-IND-0670

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Project: 2014-IND-0670

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Project: 2014-IND-0670

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Project: 2014-IND-0670

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Project: 2014-IND-0670

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Project: 2014-IND-0670

[redacted]

Project: 2014-IND-0487 Custom Project Savings Verification Coversheet

[redacted]

Project: 2014-IND-0487

[redacted]

Site Visit

[redacted]

Project: 2014-IND-0487

[redacted]

Project: 2014-IND-0487

[redacted]

Project: 2014-IND-0487

[redacted]

Project: 2014-IND-0664 Custom Project Savings Verification Coversheet

[redacted]

Project: 2014-IND-0664

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Site Visit

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Project: 2014-IND-0664

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Project: 2014-IND-0664

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Project: 2014-IND-0664

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Project: 2014-IND-0664

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Project: 2014-IND-0356 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0356

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Site Visit

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Project: 2014-IND-0356

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Project: 2014-IND-0356

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Project: 2014-IND-0356

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Project: 2014-IND-0522 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0522

Project Savings Estimates (Water)

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Project: 2014-IND-0522

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Project: 2014-IND-0452 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0452

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Project: 2014-IND-0675 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0675

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Project: 2014-IND-0675

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Project: 2014-IND-0675

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Project: 2014-IND-0371 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0371

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Site Visit

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Project: 2014-IND-0371

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Project: 2014-IND-0371

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Project: 2014-IND-0620 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0620

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Site Visit

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Project: 2014-IND-0612 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0622 Custom Project Savings Verification Coversheet

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Site Visit

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Project: 2014-IND-0622

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Project: 2014-IND-0431 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0431

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Site Visit

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Project: 2014-IND-0299 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0299

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Site Visit

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Project: 2014-IND-0299

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Project: 2014-IND-0287 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0287

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Project: 2014-IND-0287

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Project: 2014-IND-0287

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Project: 2014-IND-0543 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0543

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Project: 2014-IND-0543

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Project: 2014-IND-0609 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0609

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Project: 2014-IND-0609

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Project: 2014-IND-0630 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0632 Custom Project Savings Verification Coversheet

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Project: 2014-IND-0632

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Project: 2014-IND-0632

[redacted]

Project: 2014-IND-0667 Custom Project Savings Verification Coversheet

[redacted]

Project: 2014-IND-0667

[redacted]

Site Visit

[redacted]

Project: 2014-IND-0667

[redacted]

Project: 2014-IND-0667

[redacted]

Project: 2014-IND-0667

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Independent Audit of 2014 DSM Program Results

Final Report

Submitted by Evergreen Economics

October 29, 2015

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Executive Summary

We have audited the Annual Report, DSM Shareholder Incentive, Lost Revenue Adjustment Mechanism (LRAM) and Demand Side Management Variance Account (DSMVA) of Union Gas Limited for the calendar year ended December 31, 2014. The Annual Report and the calculations of DSM Shareholder Incentive, LRAM, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts based on our audit.

We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in the DSM Guidelines for Natural Gas Utilities (EB-2008-0346). Details of the steps taken in this audit process are set forth in the Audit Report that follows, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that have been gathered and recorded using reasonable methods and accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2014 DSM programs of Union Gas Limited:

DSM Shareholder Incentive Amount Recoverable - $8,987,690

LRAM Amount Recoverable - $309,964

DSMVA Amount Recoverable - $1,664,354

Audit Overview

Evergreen Economics was contracted by Union Gas Limited (Union Gas) to conduct an audit of the Union Gas 2014 DSM Annual Report. Engineering firm SBW Consulting was also engaged by Evergreen to be part of the audit team. The primary objective of the audit is to provide DSM stakeholders (i.e., the Ontario Energy Board, intervener consultative members, and Union Gas) with an independent opinion on whether the DSMVA, LRAM, and utility DSM Shareholder Incentive calculations are appropriate and have been calculated correctly.

The following programs were included in the Union Gas 2014 Annual Report and reviewed as part of this audit:

- Residential Program
  - Energy Savings Kit Offering
  - Home Reno Rebate Offering
- Commercial/Industrial Program
  - Prescriptive and Quasi-Prescriptive Offering
  - Custom Offering
- Low-Income Program
  - Home Weatherization Program Offering
  - Affordable Housing Conservation Offering
- Large Volume Program

Table 1 and Table 2 show the 2014 claimed savings values for each of the Union Gas programs.

A separate contractor selected the sample of custom projects used in the verification process. Based on the final audited savings numbers, the relative precision levels achieved for the various custom project sample groups are as follows:

Large Volume T2/R100:	90/16.1
Large Volume T1:	90/28.7
Commercial/Industrial:	90/8.1
Low Income:	90/18.5

Additional detail on the precision levels achieved is available in the sampling memo included in the final version of the Union Gas Annual Report.

Table 1: 2014 Union Gas Net Annual Program Savings

Program	Offering	Units	Net Original Annual Gas Savings (m^3)	Audited Net Annual Gas Savings (m^3)	Percent Change[1]
Residential	Energy Savings Kit	45,967	2,788,541	2,788,541	0%
Residential	Home Reno Rebate	1,000	1,342,361	1,342,361	0%
Com/Ind	Prescriptive	3,326	11,275,675	11,275,675	0%
Com/Ind	Custom	588	48,228,800	42,923,632	-11%
Low-Income	Helping Homes Conserve	1,805	1,446,863	1,446,863	0%
Low-Income	Affordable Housing Conservation	142	1,382,596	1,277,353	-8%
Large Volume	Rate T1	53	5,893,002	4,194,776	-29%
Large Volume	Rate T2	98	47,045,453	40,465,390	-14%
Large Volume	Rate 100	56	30,360,967	26,110,432	-14%
Total		**53,035**	**149,764,259**	**131,825,022**	**-12%**

Table 2: 2014 Union Gas Net Cumulative Program Savings

Program	Offering	Units	Net Original Cumulative Gas Savings (m^3)	Audited Net Cumulative Gas Savings (m^3)	Percent Change[2]
Residential	Energy Savings Kit	45,967	35,141,167	35,141,167	0%
Residential	Home Reno Rebate	1,000	26,518,351	26,518,351	0%
Com/Ind	Prescriptive	3,326	216,057,244	216,057,244	0%
Com/Ind	Custom	588	814,113,151	683,855,047	-16%
Low-Income	Helping Homes Conserve	1,805	36,105,327	36,105,327	0%
Low-Income	Affordable Housing Conservation	142	23,549,797	21,586,843	-8%
Large Volume	Rate T1	53	94,788,072	81,607,775	-14%
Large Volume	Rate T2	98	643,936,401	502,418,896	-22%
Large Volume	Rate 100	56	366,883,053	286,168,782	-22%
Total		**53,035**	**2,257,092,563**	**1,889,459,431**	**-16%**

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[1] Auditor adjustments to savings for Commercial/Industrial, Low-Income, and Large Volume projects are discussed in detail in Section 2 of this report.

[2] Auditor adjustments to savings for Commercial/Industrial, Low-Income, and Large Volume projects are discussed in detail in Section 2 of this report.

Audit Process and Overarching Activities

Note that the nature of the audit process is by definition somewhat negative, as the process is designed to identify areas where the program implementation and evaluation went *wrong* and not to focus on areas where things went *right*. Despite the comments and recommendations presented in this report, in general it appears that Union Gas has robust DSM programs that are being implemented effectively. Given the nature of the audit process, the discussion in this report necessarily focuses on those areas where we believe there is room for improvement and (in some cases) where savings should be adjusted for program year 2014.

The audit included a number of overarching audit activities as well as a more specific focus on custom project reviews. Overarching audit activities included a review of:

- Evaluation resources;
- Audit process; and
- Free ridership, including:
    - Age of free ridership report
    - Behavioral and maintenance projects.

The majority of the audit was dedicated to reviewing the savings estimates for the various custom programs. To audit the custom savings, we first reviewed the draft Custom Project Savings Verification (CPSV) reports for each custom program, which are discussed in more detail below. Along with reviewing the CPSV reports, we also reviewed the individual project files for each project included in the custom verification sample. After this review, we had several conference calls with the verifiers, Union staff, and Audit Committee members to discuss the individual project calculations and to ask detailed technical questions about the customer site and impact analysis. Based on these conversations, the verifiers made modifications to the savings calculations prior to finalizing their CPSV reports. Once the CPSV reports were finalized, we conducted a second review of the reports to ensure that all edits discussed during conference calls were incorporated into the final versions. A table listing the various calls and participants is included as Attachment 1 of this report.

Based on the results of all these conference calls, along with our review of secondary sources and our team's experience with similar projects, the audit team has made adjustments to the custom savings estimates where appropriate. The audited savings estimates reflect both the audit team's adjustments and the adjustments made by the verifiers. Brief descriptions of the adjustments and our rationale for making these changes are included in the sections below.

Residential Programs

The Audit Team reviewed the Audit Tool provided by Union Gas and found that all savings values and calculations were implemented properly. The audit activities completed included:

- Reviewing the summary tables in the Audit Tool to ensure consistency with the values reported in the Draft DSM 2014 Annual Report;
- Reviewing the data and formulas in the Audit Tool to ensure no computational errors; and
- Reviewing the per-unit savings values noted in the Audit Tool to ensure consistency with the values presented in the Draft DSM 2014 Annual Report.

Low-Income Custom Project Findings

No recommendations or adjustments to verified gas savings or EULs were necessary for low-income custom projects this year. It is recommended that the realization rates for electricity and water savings be capped at 100 percent in situations where the verification process results in extremely high realization rates.

Commercial/Industrial Custom Project Findings

The rationales for adjustments made to savings based on our review are described below by project. No adjustments were made to EULs for Commercial/Industrial Custom Projects. Savings for steam leak projects were reduced by 50 percent due to the lack of required documentation on customer standard maintenance practices. Projects where this reduction was applied include:

- **2014-IND-0178**
- **2014-IND-0112**
- **2014-COM-0079**
- **2014-IND-0115**

Large Volume Custom Project Findings

Specific project savings were adjusted based on the audit review of project files. Those projects involving steam leaks had savings reduced by 50 percent due to a lack of required documentation on the customer standard maintenance practices. The rationales for adjustments made to savings and EULs based on the auditor’s review are described below by project.

- **2014-IND-0649.** Savings were reduced by 50 percent due to a lack of documentation on maintenance practices.

- **2014-IND-0670.** See rationale above for 2014-IND-0649. Reduction in the verified value for EUL is due to a small percentage of leaks due to trap repair; EUL was adjusted back to rounded value (20 years).
- **2014-IND-0487.** See rationale above for 2014-IND-0649.
- **2014-IND-0664.** See rationale above for 2014-IND-0649.
- **2014-IND-0356.** See rationale above for 2014-IND-0649.
- **2014-IND-0522.** See rationale above for 2014-IND-0649.
- **2014-IND-0608.** The verified savings assume a 0.75 adjustment factor; however, the auditor assumes that at the end of EUL the condition of the pipe is the same as when it was replaced. At this point, the annual savings would be zero relative to the baseline condition. Assuming a linear fouling rate, the average savings over the life of the projects should be 50 percent of the first-year savings.
- **2014-IND-0543.** See rationale above for 2014-IND-0649.
- **2014-IND-0609.** See rationale above for 2014-IND-0608.

Overarching Recommendations

Recommendation #1: Increase annual evaluation spending to 3-5 percent of the program implementation budget. This will allow for (at a minimum) additional baseline research, an annual free ridership study for custom projects, and process evaluations for all programs.

Recommendation #2: The expected timing of the audit must be clearly communicated at the RFP stage, when project staff and budgets are determined, not during the project initiation meeting. This will enable the audit team to ensure that appropriate resources are available throughout the project.

Recommendation #3: Conduct a new custom free ridership study every year (beginning in 2015) using a sample from the current year's custom participants.

Recommendation #4: The annual custom free ridership study should have separate and robust samples for behavioral and maintenance-related projects.

Recommendation #5: For maintenance and behavioral projects, the customer's standard maintenance and operations practices must be formally documented, as has been agreed to by Union in prior years. This can be accomplished by developing a standard form that each customer fills out with their project application that is sufficiently flexible to accommodate differences across customers. If documentation is not completed, these projects should be disallowed and the savings set to zero.

Recommendation #6: Savings from projects that result from addressing obvious safety hazards (e.g., gas leaks or very large steam leaks) or are otherwise obviously free riders should not be eligible for Union Gas incentives. To identify obvious free riders, a possible criterion is to have projects with a simple payback of less than one year be ineligible for the program.

Low Income Custom Program Recommendation

Recommendation #7: Set a maximum value of 100 percent for electricity and water realization rates in situations where extremely high realization rates occur during the verification process.

Commercial & Industrial Program Recommendations

Recommendation #8: Some customers' work orders for steam leaks showed very high leak rates, and notes indicated that repairs were urgent; however, the savings for the repairs were included in the claimed savings. These repairs likely would have been made for safety or severity reasons regardless of program availability. O&M measures of specific types should be considered for exclusion from program incentives. In particular, steam leaks, steam trap repairs, and condensate leaks fall into this category, each often resulting in paybacks of less than one year. In addition, any condition that results in a safety or ecological hazard or has the capability of causing significant damage to equipment should need no incentive to induce its repair in a timely manner and therefore should not be attributed to the program.

Recommendation #9: A number of greenhouse expansion and new construction projects had no previously existing building referenced as a baseline condition. Each of these projects incorporated a unique set of baseline conditions against which to compare efficient case energy consumption. This allowed for the possibility of customizing the baseline to improve savings estimations. Union should specify standard practice for establishing baselines in terms of a level of performance that can be expected of each of the components installed in new construction greenhouses when no program incentives are included.

Recommendation #10: Savings calculations for insulation measures assume first-year savings will recur throughout the EUL; however, insulation effectiveness generally degrades over time, thereby reducing savings. Union should take into account degradation of insulation over time in calculating EULs and lifetime savings in cases where insulation is installed in unprotected areas. This is less of a concern when insulation is installed in protected areas and/or aluminum cladding is installed with the insulation.

Recommendation #11: In a couple of instances, one verifier indicated in the CPSV report that electric savings and incremental costs were "indeterminate". Future evaluator responsibilities should include developing estimates of project costs and savings for those cases where initial values are not provided in the project documentation.

Large Volume Custom Program Recommendation

Recommendation #12: Projects that replaced coke oven gas pipelines and pipe insulation often assumed that the measure condition at the end of the measure EUL is the same as when it was replaced; however, at that point the annual savings would be zero relative to the baseline condition. Assuming a linear fouling rate, the average savings over the life of the projects should be 50 percent of the first-year savings.

1 Introduction

Evergreen Economics was contracted by Union Gas Limited (Union Gas) to conduct an audit of the Union Gas 2014 DSM Annual Report. Engineering firm SBW Consulting was also engaged by Evergreen to be on the audit team. The primary objective of the audit is to provide DSM stakeholders (i.e., the Ontario Energy Board, intervener consultative members, and Union Gas) with an independent opinion on whether the DSMVA, LRAM, and utility DSM Shareholder Incentive calculations are appropriate and have been calculated correctly.

The following programs were included in the Union Gas 2014 Annual Report and reviewed as part of this audit:

- Residential Program
  - Energy Savings Kit Offering
  - Home Reno Rebate Offering
- Commercial/Industrial Program
  - Prescriptive and Quasi-Prescriptive Offering
  - Custom Offering
- Low-Income Program
  - Home Weatherization Program Offering
  - Affordable Housing Conservation Offering
- Large Volume Program

Table 3 and Table 4 show the 2014 claimed savings values for each of the Union Gas programs.

A separate contractor selected the sample of custom projects used in the verification process. Based on the final audited savings numbers, the relative precision levels achieved for the various custom project sample groups are as follows:

Large Volume T2/R100:	90/16.1
Large Volume T1:	90/28.7
Commercial/Industrial:	90/8.1
Low Income:	90/18.5

Additional detail on the precision levels achieved is available in the sampling memo included in the final version of the Union Gas Annual Report.

Table 3: 2014 Union Gas Net Annual Program Savings

Program	Offering	Units	Net Original Annual Gas Savings (m^3)	Audited Net Annual Gas Savings (m^3)	Percent Change[3]
Residential	Energy Savings Kit	45,967	2,788,541	2,788,541	0%
Residential	Home Reno Rebate	1,000	1,342,361	1,342,361	0%
Com/Ind	Prescriptive	3,326	11,275,675	11,275,675	0%
Com/Ind	Custom	588	48,228,800	42,923,632	-11%
Low-Income	Helping Homes Conserve	1,805	1,446,863	1,446,863	0%
Low-Income	Affordable Housing Conservation	142	1,382,596	1,277,353	-8%
Large Volume	Rate T1	53	5,893,002	4,194,776	-29%
Large Volume	Rate T2	98	47,045,453	40,465,390	-14%
Large Volume	Rate 100	56	30,360,967	26,110,432	-14%
Total		**53,035**	**149,764,259**	**131,825,022**	**-12%**

Table 4: 2014 Union Gas Net Cumulative Program Savings

Program	Offering	Units	Net Original Cumulative Gas Savings (m^3)	Audited Net Cumulative Gas Savings (m^3)	Percent Change[4]
Residential	Energy Savings Kit	45,967	35,141,167	35,141,167	0%
Residential	Home Reno Rebate	1,000	26,518,351	26,518,351	0%
Com/Ind	Prescriptive	3,326	216,057,244	216,057,244	0%
Com/Ind	Custom	588	814,113,151	683,855,047	-16%
Low-Income	Helping Homes Conserve	1,805	36,105,327	36,105,327	0%
Low-Income	Affordable Housing Conservation	142	23,549,797	21,586,843	-8%
Large Volume	Rate T1	53	94,788,072	81,607,775	-14%
Large Volume	Rate T2	98	643,936,401	502,418,896	-22%
Large Volume	Rate 100	56	366,883,053	286,168,782	-22%
Total		**53,035**	**2,257,092,563**	**1,889,459,431**	**-16%**

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[3] Auditor adjustments to savings for Commercial/Industrial, Low-Income, and Large Volume projects are discussed in detail in Section 2 of this report.

[4] Auditor adjustments to savings for Commercial/Industrial, Low-Income, and Large Volume projects are discussed in detail in Section 2 of this report.

The remainder of this report details the audit methods used, the results of our audit, and the recommendations for adjustments to the 2014 savings numbers along with recommendations for future evaluations.

Audit Principles

A detailed list of tasks required for the audit were included in the original project RFP, and are repeated here verbatim for reference:

- The auditor will review the accuracy and reasonableness of Union Gas Limited's claims regarding achievement relative to Resource Acquisition, Large Volume, Low Income and Market Transformation performance metrics.
- Consider and respond to stakeholder comments on Union Gas Limited's Draft Evaluation DSM Report for 2014, including those of the Audit Committee (AC).
- Review Union Gas Limited's 2014 procedures for tracking program participants and determine whether they lead to accurate counts, particularly for programs that do not provide customer rebates.
- Determine whether Union Gas Limited's reported values for participation and measure input assumptions are appropriate for calculation of LRAM and DSM Shareholder Incentive. This shall include assessing:
    - Whether values are adequately documented by program records, evaluation studies and other relevant data; and
    - The reasonableness of prescriptive measure input assumptions – measure lives, annual gas savings and free rider rates – for the calculation of LRAM and DSM Shareholder Incentives. The auditor will be provided with the most recent set of prescriptive measure input assumptions upon which Union Gas Limited relies in estimating savings.[5] Note that only some of those prescriptive assumptions were reviewed and approved by the Technical Evaluation Committee (TEC). Only the TEC-approved assumptions will be rebuttably presumed to be correct unless the auditor has compelling information to the contrary. Recommendations to change input assumption must be explained and, to the extent practical, documented with appropriate references and/or other forms of substantiation.
- Review measures that are considered advancements (sometimes called "early retirement" measures) rather than purchases at times of natural equipment replacement to ensure measure lives and gas savings are treated appropriately.
- Review and verify the accuracy of all calculations leading up to the proposed DSMVA, LRAM, and DSM Shareholder Incentive amounts and verify that the

[5] "If the input assumptions used by the natural gas utilities vary from those on the Board's approved list, the variation(s) should be identified, and additional information supporting the variation(s) should be filed." EB-2008- 0346, the DSM Guidelines for Natural Gas Utilities, page 40.

calculations are consistent with the Board-approved prescribed methodology.

- In accordance with OEB direction, Union Gas Limited, in consultation with their AC, have retained independent third party engineering consultants to undertake a detailed evaluation of gross savings estimates for custom projects under what is commonly called their Custom Project Savings Verification (CPSV) process. The CPSV Terms of Reference will be provided to the auditor. These Terms of Reference include a detailing of the types of information the CPSV firms are expected to provide for each project they review in their CPSV evaluation reports. The AC has made provision for the auditor to work with the selected CPSV firm to enable the review of both the draft and final reports and an opportunity to discuss individual projects, any findings and adjustment factors recommended throughout the CPSV firm's evaluation. The Auditor will be expected to provide its independent opinion on all claimed results, including those that come out of the CPSV process. This will include its opinion on the reliability and reasonableness of the error ratio (and/or realization rate) from the CPSV reports when applied to a larger population of custom projects. Recommendations to change findings from those recommended by the CPSV firm must be explained and, to the extent practical, documented with appropriate references and/or other forms of substantiation. If the auditor cannot identify a reference, the auditor must provide a reasonable rationale for its assumption.
- The auditor will also review all verification studies conducted in support of the DSM Evaluation Report and ensure the conclusions are sound and that the results have been appropriately incorporated into the calculation of the DSM Shareholder Incentive.
- Identify any assumptions underlying Union Gas Limited's DSM program design that should be modified prospectively, based on the auditor's experience, the results of the audit, and knowledge of other studies or data.
- Identify future evaluation research opportunities to enhance the assumptions used to calculate the DSM Shareholder Incentive and LRAM.
- Work with the AC and Union Gas Limited to resolve any relevant issues prior to completion of the audit.
- Identify any other matters considered by the auditor to be relevant to an assessment of Union Gas Limited's DSMVA, LRAM and DSM Shareholder Incentive claims.

The principles guiding Evergreen's audit methods focused on several different layers of review of the DSM results. These principles are the same ones that the Evergreen team has applied successfully to previous audits of the Union Gas programs, and can be summarized as follows:

1. **Reviewed savings calculations for accuracy.** This preliminary review was completed to make sure that there were not any simple errors applied in the basic savings calculations (e.g., incorrect cell references and/or application of free ridership adjustments) in the savings values presented in the final 2014 savings

claims. In addition, we reviewed the calculations of the DSMVA, LRAM, and DSM Shareholder Incentive to ensure that they are error-free.

2. **Reviewed calculations for consistency with stated objectives.** The next level of review was making sure that any factors that have been determined through earlier consultation with the OEB, such as OEB orders, Decisions, and Board-approved guidelines, have been applied correctly. This may include fixed values for free ridership, per unit savings values, or the types of measures that are eligible to be included in the final savings calculations. We reviewed the appropriate filings and decisions from the OEB that apply to the 2014 Union Gas savings claim at the start of the audit.
3. **Reviewed savings claims and related savings components for appropriate documentation.** This level of review involved reviewing supporting evaluation and research used for the 2014 DSM Annual Report. Even though the values may have been approved at a general level with the OEB and applied correctly in the calculations, there may be better information available that would support revising the values used. The analysis methods and results were compared to best practices in other regions to make sure that the Union Gas evaluation methods are conforming to standard practice observed elsewhere.
4. **Reviewed overall processes used to determine annual savings.** This included a review of participation tracking and other over-arching decisions made by Union Gas regarding the amount of evaluation research, requirements for documentation required of contractors, the timing of evaluation research in relation to publication of the Annual Report, and similar management decisions.

To follow our audit principles and cover the various requirements listed in the RFP, we conducted the following activities during the course of the audit:

- Reviewed Union's Audit Tool to verify program participant counts were accurate.
- Reviewed third party surveys instruments and survey results that examined the installation and retention of measures in the Energy Saving Kit (ESK) and Home Weatherization Program (HWP) programs.
- Reviewed Union's Audit Tool and supporting documentation for Prescriptive and Quasi-Prescriptive Measures to ensure that all algorithms and prescriptive values were used correctly to calculate the savings and were consistent with program documentation filed with the OEB.
- Reviewed deep savings measure savings values and calculations for accuracy.
- Reviewed Scorecard values and calculations for accuracy.
- Reviewed third party verification studies that examined a sample of custom projects for Large Volume, Commercial/Industrial, and Low Income customers.
- Reviewed and verified that the LRAM claimed savings values are accurate, consistent with the Settlement agreement, and based on the best available information at the time of the audit.
- Considered and addressed issues raised by the stakeholders during the audit process, including those of the Audit Committee.

The majority of the audit was dedicated to reviewing the savings estimates for the various custom programs. To audit the custom savings, we first reviewed the draft Custom Project Savings Verification (CPSV) reports for each custom program, which are discussed in more detail below. Along with reviewing the CPSV reports, we also reviewed the individual project files for each project included in the custom verification sample. After this review, we had several conference calls with the verifiers, Union staff, and Audit Committee members to discuss the individual project calculations and to ask detailed technical questions about the customer site and impact analysis. Based on these conversations, the verifiers made modifications to the savings calculations prior to finalizing their CPSV reports. Once the CPSV reports were finalized, we conducted a second review of the reports to ensure that all edits discussed during conference calls were incorporated into the final versions. A table listing the various calls and participants is included as Attachment 1 of this report.

Based on the results of all these conference calls, along with our review of secondary sources and our team's experience with similar projects, the audit team has made adjustments to the custom savings estimates where appropriate. These adjustments and our rationale for making these changes are included in this audit report.

2 Audit Findings

This section presents the findings of the Independent Auditor regarding the Union Gas 2014 DSM Report.

Note that the nature of the audit process is by definition somewhat negative, as the process is designed to identify areas where the program implementation and evaluation went *wrong* and not to focus on areas where things went *right*. Despite the comments and recommendations presented in this report, in general it appears that Union Gas has robust DSM programs that are being implemented effectively. Given the nature of the audit process, the discussion below necessarily focuses on those areas where we believe there is room for improvement and (in some cases) where savings should be adjusted for program year 2014.

Overarching Findings

The following are general observations and recommendations that apply to multiple programs.

Evaluation Resources

The audit team worked with Union Gas to determine how much was spent annually on program evaluation, and the approximate spending amounts for 2014 are shown in Table 5. Additional evaluation funds were spent as part of Union's portfolio budget that addressed issues such as reviewing savings input assumptions and developing savings values for the Technical Reference Manual. Union reports that they spent $398,782 on these portfolio-level evaluation activities in 2014.

As shown in Table 5, Union Gas spends approximately 2 percent of the total implementation budget to fund an annual independent third-party program evaluation (excluding the portfolio-level evaluation costs). When the portfolio evaluation spending is added to the total, the overall evaluation spending increases to 3.5 percent of overall spending. For the Commercial/Industrial and Large Volume Custom Programs, spending on program evaluation ranged from approximately 1-3 percent of implementation budgets, even though these two programs accounted for the vast majority of savings. Given the size of these programs and the issues listed below, more resources should be devoted to evaluation specifically for these programs.

A typical rule of thumb for evaluating DSM programs is that evaluation spending should equal 3-5 percent of the program implementation budgets. Although Union's total evaluation spending hits the low end of that range, we believe that additional funds should be allocated to program-specific evaluation. An increase in evaluation research would help address the specific issues we list below, including conducting an annual free ridership study for custom projects, documenting baseline conditions (including maintenance policies), developing program logic and metrics of progress for the market transformation program, and conducting process evaluations for all programs.

Table 5: 2014 Calendar Year Union Gas Program-Specific Evaluation Spending

Program	Total Spending (excluding EM&V)	EM&V Spending	% of total
Residential	$3,514,450	$173,300	4.9%
Com/Ind	$12,637,706	$103,687	0.8%
Low-Income	$8,285,766	$243,580	2.9%
Large Volume	$3,993,130	$108,595	2.7%
Optimum Home	$1,262,958	$-	0.0%
Portfolio		$398,782	N/A
Total	**$29,694,010**	**$1,027,944**	**3.5%**

Audit Process

The audit process was originally scheduled to begin in April, following the completion of the CPSV reports and Union's draft Annual Report. A draft audit report was then supposed to be completed on June 1 and a final report produced by June 8. This timeline was included in the Audit RFP that Evergreen Economics responded to, which also included a requirement that "the auditor will be contractually bound to meet the deadlines outlined in their proposal. If due to the auditor's negligence, the auditor has not provided the AC with the deliverables, 10% of the amount payable to the auditor may be deducted for each week beyond the deliverable dates specified herein that the auditor has not provided the AC with the deliverables."[6]

Union communicated the uncertainty in the timelines for the availability of CPSV reports and their Annual Report during the audit kickoff meeting, acknowledging the delayed release of CPSV reports. This meant that the audit process would be drawn out over several months again, similar to what was done the prior year. However, the audit staff assignments and project budget had already been established prior to the kickoff meeting. While we have managed to stay on budget, it is difficult to assign staff for a project that is originally scheduled for two months and then have the project timeline extended an additional five months. For future audits, the timeline and process need to be clearly communicated at the RFP stage, not at the project kickoff meeting, so that the appropriate staff and budget can be allocated at the start of the project. If it is known that the project timeline will be extended, we urge that the entire process be reviewed so that additional

[6] Request for Proposal Independent Audit of 2014 DSM Program Results, page 5.

time and resources can be devoted to evaluation (rather than audit) activities—the audit can be completed in the time originally allocated provided that the evaluations and Draft Annual Report are already completed. This would provide enough time for the other recommended evaluation activities (e.g., free ridership study, documentation of maintenance practices, process evaluation) to be completed.

The actual audit process involved several rounds of review of the three custom program verifications. In the first stage of the audit, the auditor reviewed draft CPSV reports and compiled a list of questions for clarification and requested any additional information needed for the audit from the verifiers. Once all questions were resolved and supplemental information was received, we conducted secondary in-depth reviews of the draft CPSV reports for each project.

A number of questions and recommendations were compiled based on this in-depth review, and a series of calls was held with Union, Audit Committee members, and the verifiers to discuss these issues. Based on the feedback from these calls, we developed a set of recommendations and specific adjustments to project savings and EULs where necessary. These calls were also used to provide input to the verifiers to inform the finalization of the CPSV reports. Once the verifiers submitted final reports, the auditor and Union Gas completed a second review of the CPSV reports to ensure that all changes were incorporated into the final versions. The audited savings values noted throughout this report reflect both the audit team's adjustments and the adjustments made by the verifiers. A schedule of the audit meetings is included as Attachment 1 of this report.

Free Ridership

As in the previous year, the free ridership issue was subject to a significant amount of discussion with the Audit Committee during the verification process. Key issues relating to free ridership in this audit include:

1. Age of the free ridership report; and
2. Treatment of behavioral and O&M projects.

The following discussion of free ridership issues is repeated from the prior audit report, as they were found to be still relevant in 2014.

Age of Free Ridership Report

As discussed in prior audits, the age of the free ridership report remains an issue with the current evaluations. The free ridership adjustments used by Union Gas for 2014 come from a Summit Blue study published in 2008 that relies on survey responses from participants from 2006 and 2007.[7] This report uses a small sample of Union Gas custom program

[7] See *Custom Projects Attribution Study* prepared by Summit Blue for Union Gas and Enbridge (October 31, 2008).

participants (n=52) to conduct a self-reported free ridership analysis. Union Gas uses the free ridership rate of 54 percent from this study to calculate net savings for its 2014 custom projects (Large Volume and Commercial/Industrial). While this sample was large enough to achieve a 90/10 relative precision for all custom projects, it was not large enough to achieve 90/10 precision for the individual custom programs, or for individual measure types within programs.

The current free ridership report is undoubtedly outdated, as markets, participant characteristics, technologies, and eligible custom technologies have all evolved since the original study was completed. We strongly recommend that an updated custom free ridership study be completed immediately for use in the evaluation of the 2015 custom programs. As has been discussed in past audits, we believe that free ridership values should be updated annually to reflect changes that occur year-to-year in market conditions, technology, program design, and participant makeup.

We understand that the Ontario Technical Evaluation Committee (TEC) initiated a custom program free ridership study that Union plans to use in the future, but at this point it is unclear if the results of this study will be available in time for the 2015 evaluation. We also understand that both Union's programs and evaluation process are under review by the Board and will likely change in 2015. Despite these potential future changes, we still believe it would be beneficial for Union Gas to conduct a new free ridership study for use in the 2015 program evaluation. At a minimum, such a study would improve the net impact estimates for the 2015 program year by providing updated information and more information on free ridership rates for behavioral and maintenance projects. It would also provide useful information to inform any broader free ridership studies that the Board may undertake in the future. At the time of this audit report, it appears that Union is in a better position than the Board to complete a study in time for use in the 2015 program evaluation, and we urge Union to begin this process immediately.

Behavioral and Maintenance Projects

A significant amount of the verification discussions centered on participants that installed measures that may be considered as routine maintenance or measures that involve changes in behavior. These include measures such as steam trap tests, steam leak repairs, thermostat setbacks, and pipe insulation.

Union Gas asserted that examples of maintenance and behavioral projects were included in the original Summit Blue free ridership study, and therefore, the current free ridership is valid for these projects in 2014. Upon review of the Summit Blue study, it is not clear that these types of projects were included in the sample (this level of detail is not provided in the report). Regardless of whether or not they are included, the overall sample size of 52 respondents (covering 77 projects) is so small that any subsets of O&M or behavioral measures are unlikely to be statistically significant.

In discussions with Union Gas on individual projects, Union staff also asserted that their Account Managers and Project Managers had been actively involved with the participants and had a significant amount of influence in getting these projects completed (i.e., these projects should not be considered free riders). In order to support the energy savings claims, however, these interactions between Union and its customers for specific projects need to be documented. Copies of emails and notes from customer meetings that document Union's work with these customers on a specific project should be kept in the project file. Union should also document the customer's standard maintenance practices, and these should be confirmed through an independent verification.

Including appropriate documentation of customer baseline conditions was a recommendation from the previous two audits (covering program years 2012 and 2013) and was something that Union agreed to begin doing for future program years. This is particularly important for maintenance measures like steam leak repairs that have a greater potential for high free ridership, and this measure was specifically listed as an example in the agreement language.

In conversations with Union during the audit process, it is clear that there still has been no significant progress to date on documenting standard maintenance practices at these sites. During meetings with the verifiers, it was also apparent that the verifiers were unaware that maintenance practices needed to be documented and that Union was only allowed to claim savings above what would normally be achieved from each customer's standard maintenance practices. While some language was included in the verifiers' terms of references to cover this, it was clear from our meetings and the CPSV reports that the verifiers had not considered this as part of their job requirements. In future years, Union needs to emphasize these requirements more to its verifiers and follow up with the verifiers throughout the course of the project to ensure that it is being done.

While there may be a high level of variation across customers and sites within the custom program, developing a standard form that documents each customer's standard maintenance and operations practices is a relatively straightforward task. To document standard operations and maintenance practices, things that should be documented (at a minimum) include:

- Equipment/system type (e.g., Steam Generation, Turbine, Process, Annealing Oven)
- Responsible party (department, position, reporting structure)
- Components inspected
- Inspection method
    - Visual Observations
    - Readings from existing gauges/meters
    - Measurements with portable meters (e.g. temperature, pressure, O2, CO2)
    - Other
- Recordkeeping (e.g. log sheets, digitally stored)

- Tracking (e.g. data plots, analysis)
- Inspection Schedules
    - Frequency (e.g. hourly, daily, weekly, etc.)

For specific maintenance events, items that should be recorded include:

- Equipment/system and components involved
- Date/Time reported
- Identified by whom
- Type of issue (e.g. equipment failure, out of adjustment, calibration, etc.)
- Threat (e.g. health/safety, environmental, equipment damage, economic)
- Severity (e.g. leak rate, excess temperature, excess pressure, etc.)
- Urgency (e.g. immediate attention, within week, at next shutdown, etc.)
- Date/Time rectified
- Cost

In future years, we recommend that maintenance-related and behavioral measures that are not sufficiently documented be disallowed and given a savings value of zero. As discussed more below, we have adjusted savings for steam leak projects in response to the lack of appropriate documentation on maintenance practices.

Overarching Recommendations

The following are recommendations based on the overarching issues discussed above. A number of recommendations are repeated from the "Independent Audit of 2013 DSM Program Results" where still relevant.

Recommendation #1: Increase annual evaluation spending to 3-5 percent of the program implementation budget. This will allow for (at a minimum) additional baseline research, an annual free ridership study for custom projects, and process evaluations for all programs.

Recommendation #2: The expected timing of the audit must be clearly communicated at the RFP stage, when project staff and budgets are determined, not during the project initiation meeting. This will enable the audit team to ensure that appropriate resources are available throughout the project.

Recommendation #3: Conduct a new custom free ridership study every year (beginning in 2015) using a sample from the current year's custom participants.

Recommendation #4: The annual custom free ridership study should have separate and robust samples for behavioral and maintenance-related projects.

Recommendation #5: For maintenance and behavioral projects, the customer's standard maintenance and operations practices must be formally documented, as has been agreed to by Union in prior years. This can be accomplished by developing a standard form that each customer fills out with their project application that is sufficiently flexible to accommodate differences across customers. If documentation is not completed, these projects should be disallowed and the savings set to zero.

Recommendation #6: Savings from projects that result from addressing obvious safety hazards (e.g., gas leaks or very large steam leaks) or are otherwise obviously free riders should not be eligible for Union Gas incentives. To identify obvious free riders, a possible criterion is to have projects with a simple payback of less than one year be ineligible for the program.

Additional issues and recommendations by specific program area are presented below.

Residential Programs

The Audit Team reviewed the Audit Tool provided by Union Gas and found that all savings values and calculations were implemented properly. The audit activities completed included:

- Reviewing the summary tables in the Audit Tool to ensure consistency with the values reported in the Draft DSM 2014 Annual Report;
- Reviewing the data and formulas in the Audit Tool to ensure no computational errors; and
- Reviewing the per-unit savings values noted in the Audit Tool to ensure consistency with the values presented in the Draft DSM 2014 Annual Report.

Low Income Custom Projects

To conduct our review of the Low Income Custom Projects, we reviewed the Custom Project Savings Verification (CPSV) reports prepared by Michaels Energy for the evaluation sample of low income projects. We first conducted an initial review of the draft CPSV reports, compiled a list of questions for clarification and requested any additional information needed for the audit. A call was held with Union, the Audit Committee, and Michaels Energy staff to review and resolve these initial questions based on the draft CPSV reports.

Once all questions were resolved and supplemental information was received, we conducted secondary in-depth reviews of the draft CPSV reports for each project. The CPSV reports were reviewed for baseline assumptions, operating hours, savings calculations, and EUL for each measure. A number of questions and recommendations were compiled based on this in-depth review, and a series of calls was held with Union and Audit Committee members to discuss these issues. These calls were also used to provide input to Michaels Energy to inform the finalization of the CPSV reports. Based on our review and feedback from these calls, we determined that no adjustments to verified project gas savings or EULs were necessary this year.

Michaels Energy also reviewed electricity and water savings estimates for the Low Income Custom Projects and found that Union significantly underestimated savings for the projects included in the sample. The verified electric savings resulted in an overall verification rate of nearly 35,000 percent for program electricity savings. As the analysis sample was drawn based on gas savings (rather than electric or water savings), however, it is unclear if electric and water savings are adequately represented in the sample.

In addition to questions regarding the representativeness of the sample for water and electric savings, from conversations with both Union Gas and Michaels Energy, it is also apparent that developing rigorous estimates of electric and water savings is a lower priority than developing estimates of the gas savings. More rigorous estimates of electricity and water savings by Union would help eliminate extreme realization rates calculated in the verification phase. If resources cannot be devoted to developing reliable estimates of electricity and water savings, we recommend that the realization rates for electricity and water savings be capped at 100 percent in situations where extremely high realization rates occur.

Table 6 below summarizes the application, verified, and audited gross gas savings and EUL values by project for the Low Income Custom program. Table 7 summarizes net gas savings and EUL values; Table 8 summarizes cumulative net gas savings; and Table 9 summarizes annual electricity and water savings.

Recommendation #7: Set a maximum value of 100 percent for electricity and water realization rates in situations where extremely high realization rates occur during the verification process.

Table 6: Summary of Adjustments to Gross Gas Savings and EUL - Low Income Custom Projects

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL		
		Application	Verified	Audit	Application	Verified	Audit
COM-0095	Roof Insulation	2,021	3,112	3,112	20	20	20
COM-0282	VFD on MAU	6,002	5,764	5,764	10	15	15
COM-0299	Windows	3,911	4,129	4,129	20	20	20
COM-0179	VFD on MAU	15,121	3,941	3,941	10	15	15
COM-0181	VFD on MAU	14,142	2,982	2,982	10	15	15
COM-0300	Windows and Doors	7,567	1,396	1,396	20	20	20
COM-0302	Windows	12,692	11,736	11,736	20	20	20
COM-0312	HVAC Controls	7,033	0	0	15	15	15
COM-0306	Solar Pre-Heater	28,706	21,722	21,722	30	30	30
COM-0313	HVAC Controls	75,912	44,141	44,141	15	15	15
Totals		**173,107**	**98,923**	**98,923**			
Percent of Application Savings			**57%**	**57%**			

Table 7: Summary of Adjustments to Net Gas Savings and EUL - Low Income Custom Projects

Project ID	Project Description	Net Gas Savings (Cubic Meters/year)			EUL		
		Application	Verified	Audit	Application	Verified	Audit
COM-0095	Roof Insulation	1,920	2,956	2,956	20	20	20
COM-0282	VFD on MAU	5,702	5,476	5,476	10	15	15
COM-0299	Windows	3,715	3,923	3,923	20	20	20
COM-0179	VFD on MAU	14,365	3,744	3,744	10	15	15
COM-0181	VFD on MAU	13,435	2,833	2,833	10	15	15
COM-0300	Windows and Doors	7,189	1,326	1,326	20	20	20
COM-0302	Windows	12,057	11,149	11,149	20	20	20
COM-0312	HVAC Controls	6,681	0	0	15	15	15
COM-0306	Solar Pre-Heater	27,271	20,636	20,636	30	30	30
COM-0313	HVAC Controls	72,116	41,934	41,934	15	15	15
Totals		**164,452**	**93,977**	**93,977**			
Percent of Application Savings			**57%**	**57%**			

Table 8: Summary of Adjustments to Cumulative Net Gas Savings and Incremental Cost - Low Income Custom Projects

Project ID	Project Description	Cumulative Net Gas Savings (Cubic Meters)			Net Incremental Cost		
		Application	Verified	Audit	Application	Verified	Audit
COM-0095	Roof Insulation	38,399	59,128	59,128	$14,507	$14,507	$14,507
COM-0282	VFD on MAU	57,019	82,137	82,137	$3,447	$3,447	$3,447
COM-0299	Windows	74,309	20,468	20,468	$149,753	$20,966	$20,966
COM-0179	VFD on MAU	143,650	56,159	56,159	$9,181	$9,181	$9,181
COM-0181	VFD on MAU	134,349	42,494	42,494	$4,854	$4,854	$4,854
COM-0300	Windows and Doors	143,773	6,631	6,631	$69,331	$9,706	$9,706
COM-0302	Windows	241,148	66,833	66,833	$215,427	$14,580	$14,580
COM-0312	HVAC Controls	100,220	0	0	$16,958	$16,958	$16,958
COM-0306	Solar Pre-Heater	818,121	619,077	619,077	$217,455	$217,455	$217,455
COM-0313	HVAC Controls	1,081,746	629,009	629,009	$190,152	$195,586	$195,586
Totals		**2,832,734**	**1,581,935**	**1,581,936**	**$891,063**	**$507,238**	**$507,238**
Percent of Application Savings			**56%**	**56%**		**57%**	**57%**

Table 9: Summary of Adjustments to Net Electricity and Water Savings - Low Income Custom Projects

Project ID	Project Description	Annual Net Electricity Savings (kWh)			Annual Net Water Savings (L)		
		Application	Verified	Audit	Application	Verified	Audit
COM-0095	Roof Insulation	0	0	0	0	0	0
COM-0282	VFD on MAU	0	5,839	5,839	0	0	0
COM-0299	Windows	0	105	105	0	0	0
COM-0179	VFD on MAU	17	6,541	6,541	0	0	0
COM-0181	VFD on MAU	22	1,104	1,104	0	0	0
COM-0300	Windows and Doors	0	54	54	0	0	0
COM-0302	Windows	0	0	0	0	0	0
COM-0312	HVAC Controls	0	0	0	0	0	0
COM-0306	Solar Pre-Heater	0	0	0	0	0	0
COM-0313	HVAC Controls	0	0	0	0	0	0
Totals		**39**	**13,642**	**13,642**	**0**	**0**	**0**
Audit Recommended Realization Rate			**100%**	**100%**		**N/A**	**N/A**

Commercial/Industrial Custom Projects

A similar process was used for our review of the Commercial/Industrial Custom Projects. For this program, we reviewed CPSV reports prepared by Byron Landry & Associates in two phases. We first conducted an initial review of the draft CPSV reports, compiled a list of questions for clarification, and requested any additional information needed for the audit. A call was held with Union and Byron Landry to review and resolve these initial questions based on the draft CPSV reports.

Once all questions were resolved and supplemental information was received, we conducted secondary in-depth reviews of the draft CPSV reports for each project. The CPSV reports were reviewed for baseline assumptions, operating hours, savings calculations, and EUL for each measure. A number of questions and recommendations were compiled based on this in-depth review, and a series of calls was held with Union and Audit Committee members to discuss these issues. These calls were also used to provide input to Byron Landry as he produced the final CPSV reports for this program. Based on the feedback from these calls, we developed a set of recommendations and specific adjustments to project savings and EULs where necessary.

As discussed above, Union has made no significant attempt to document standard operations and maintenance practices when maintenance-related measures are installed. We therefore do not have an estimate of how much the current values overstate savings for these measures. To correct for this, we are applying an additional adjustment of 50 percent to all projects involving steam leak repairs, which is the most common measure where the lack of documentation occurs. The 50 percent adjustment is based on professional judgment, as it was beyond the scope of the audit to attempt to quantify actual savings above baseline for these measures. We believe that 50 percent is a fair adjustment, as a 100 percent adjustment is likely too extreme and a 0 percent adjustment too low.

The projects that were subjected to savings adjustments are listed below. No adjustments were made to EULs for Commercial/Industrial Custom Projects. Adjustments were made to specific projects involving steam leak repairs that did not have the required documentation of maintenance practices. These projects included:

- **2014-IND-0178**
- **2014-IND-0112**
- **2014-COM-0079**
- **2014-IND-0115**

One additional issue was brought up by the Audit Committee during the review and was investigated by the audit team. This issue involved the greenhouse expansion projects, where concern was raised as to whether an appropriate new construction baseline was assumed. We reviewed these projects and are satisfied that a new construction baseline was used in the model assumptions, and not an existing baseline. This applies to the greenhouse expansion projects in the Commercial/Industrial program as well as the greenhouse expansion project in the Large Volume custom program.

Finally, we note that there were a few instances in the CPSV report where the evaluator indicated that the electric savings or costs were "indeterminate". Part of a comprehensive impact evaluation includes developing estimates for these parameters if they are not documented in the project file. An estimate can be created by interviewing those involved with the project to obtain project-specific information, or else one can be developed from secondary sources. We recommend that this responsibility be clearly assigned in future evaluations.

Table 10 below summarizes the application, verified, and audited gross gas savings and EUL values by project for the Commercial/Industrial program. Table 11 summarizes net gas savings and EUL values.

Additionally Table 12 summarizes cumulative net gas savings, and Table 13 summarizes annual electricity and water savings.

Table 10: Summary of Adjustments to Gross Gas Savings and EUL - Commercial/Industrial Custom Projects

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL			Rationale for Audit Adjustment
		Application	Verified	Audit	Application	Verified	Audit	
2014-IND-0178	Steam leak repairs	2,787,038	1,684,467	842,234	10	10	10	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0569	Multi-measure process and energy intensity upgrades	2,754,000	2,754,000	2,754,000	20	20	20	
2014-COM-0087	High efficiency, direct fired H&V unit	12,964	13,974	13,974	20	20	20	
2014-IND-0183	Insulate dryer drum	73,092	47,291	47,291	20	15	15	
2014-IND-0112	Steam leak repairs & 2 process heating coil replacements	327,010	348,784	174,392	20	20	20	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0166	Process oven burner upgrade and heat recovery	265,793	265,793	265,793	20	20	20	
2014-IND-0056	Deaerator heat recovery	517,813	366,540	366,540	20	14	14	
2014-COM-0079	Steam leak repairs	300,820	281,768	140,884	20	20	20	Savings reduced by 50% for lack of maintenance practices documentation

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL			Rationale for Audit Adjustment
		Application	Verified	Audit	Application	Verified	Audit	
2014-COM-0051	Greenhouse expansion - multi-measure	319,540	514,195	514,195	14	16	16	
2014-IND-0025	Greenhouse expansion - multi-measure	1,676,703	1,676,703	1,676,703	14	13	13	
2014-IND-0024	Greenhouse expansion - multi-measure	1,158,947	1,158,947	1,158,947	15	14	14	
2014-IND-0114	Greenhouse expansion - multi-measure	1,131,090	1,160,603	1,160,603	15	15	15	
2014-IND-0172	Insulation of steam supply lines	594,534	604,538	604,538	20	20	20	
2014-COM-0320	Greenhouse expansion - multi-measure	499,488	538,335	538,335	14	14	14	
2014-IND-0021	Greenhouse expansion - multi-measure	2,727,061	2,727,061	2,727,061	16	15	15	
2014-IND-0022	Greenhouse expansion - multi-measure	1,970,483	1,970,483	1,970,483	16	15	15	
2014-IND-0570	Insulate steam, condensate, hot water piping	718,537	718,537	718,537	20	20	20	
2014-IND-0333	Heat exchanger upgrade	407,798	434,687	434,687	20	14	14	
2014-IND-0210	Heat exchanger upgrade	123,571	158,754	158,754	20	14	14	

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL			Rationale for Audit Adjustment
		Application	Verified	Audit	Application	Verified	Audit	
2014-COM-0240	Upgrade building systems to LEED standards	822,929	747,828	747,828	20	20	20	
2014-IND-0115	Steam leak repairs	104,655	100,630	50,315	20	20	20	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0261	Insulate piping, valves and heat exchangers	17,281	21,221	21,221	20	20	20	
2014-IND-0345	Boiler control upgrades and adjustments	148,257	117,183	117,183	11	10	10	
2014-COM-0239	Upgrade building systems to LEED standards	33,358	45,299	45,299	20	20	20	
Totals **Percent of Application Savings**		**19,492,762**	**18,457,621** **95%**	**17,249,797** **88%**				

Table 11: Summary of Adjustments to Net Gas Savings and EUL - Commercial/Industrial Custom Projects

Project ID	Project Description	Net Gas Savings (Cubic Meters/year)			EUL		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0178	Steam leak repairs	1,282,037	774,855	387,427	10	10	10
2014-IND-0569	Multi-measure process and energy intensity upgrades	1,266,840	1,266,840	1,266,840	20	20	20
2014-COM-0087	High efficiency, direct fired H&V unit	5,963	6,428	6,428	20	20	20
2014-IND-0183	Insulate dryer drum	33,622	21,754	21,754	20	15	15
2014-IND-0112	Steam leak repairs & 2 process heating coil replacements	150,425	160,441	80,220	20	20	20
2014-IND-0166	Process oven burner upgrade and heat recovery	122,265	122,265	122,265	20	20	20
2014-IND-0056	Deaerator heat recovery	238,194	168,608	168,608	20	14	14
2014-COM-0079	Steam leak repairs	138,377	129,613	64,807	20	20	20
2014-COM-0051	Greenhouse expansion - multi-measure	146,988	236,530	236,530	14	16	16
2014-IND-0025	Greenhouse expansion - multi-measure	771,283	771,283	771,283	14	13	13
2014-IND-0024	Greenhouse expansion - multi-measure	533,116	533,116	533,116	15	14	14
2014-IND-0114	Greenhouse expansion - multi-measure	520,301	533,877	533,877	15	15	15
2014-IND-0172	Insulation of steam supply lines	273,486	278,087	278,087	20	20	20
2014-COM-0320	Greenhouse expansion - multi-measure	229,764	247,634	247,634	14	14	14

Project ID	Project Description	Net Gas Savings (Cubic Meters/year)			EUL		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0021	Greenhouse expansion - multi-measure	1,254,448	1,254,448	1,254,448	16	15	15
2014-IND-0022	Greenhouse expansion - multi-measure	906,422	906,422	906,422	16	15	15
2014-IND-0570	Insulate steam, condensate, hot water piping	330,527	330,527	330,527	20	20	20
2014-IND-0333	Heat exchanger upgrade	187,587	199,956	199,956	20	14	14
2014-IND-0210	Heat exchanger upgrade	56,843	73,027	73,027	20	14	14
2014-COM-0240	Upgrade building systems to LEED standards	378,547	344,001	344,001	20	20	20
2014-IND-0115	Steam leak repairs	48,141	46,290	23,145	20	20	20
2014-IND-0261	Insulate piping, valves and heat exchangers	7,949	9,762	9,762	20	20	20
2014-IND-0345	Boiler control upgrades and adjustments	68,198	53,904	53,904	11	10	10
2014-COM-0239	Upgrade building systems to LEED standards	15,345	20,838	20,838	20	20	20
Totals		**8,966,671**	**8,490,506**	**7,934,906**			
Percent of Application Savings			**95%**	**88%**			

Table 12: Summary of Adjustments to Cumulative Net Gas Savings and Incremental Cost - Commercial/Industrial Custom Projects

Project ID	Project Description	Cumulative Net Gas Savings (Cubic Meters)			Net Incremental Cost		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0178	Steam leak repairs	12,820,375	7,748,548	3,874,274	$37,943	$36,930	$36,930
2014-IND-0569	Multi-measure process and energy intensity upgrades	25,336,800	25,336,800	25,336,800	$41,215,250	$41,215,250	$41,215,250
2014-COM-0087	High efficiency, direct fired H&V unit	119,269	128,561	128,561	$1,840	$1,840	$1,840
2014-IND-0183	Insulate dryer drum	672,446	326,308	326,308	$9,108	$9,108	$9,108
2014-IND-0112	Steam leak repairs & 2 process heating coil replacements	3,008,492	3,208,813	1,604,406	$2,318	$2,318	$2,318
2014-IND-0166	Process oven burner upgrade and heat recovery	2,445,296	2,445,296	2,445,296	$39,720	$22,853	$22,853
2014-IND-0056	Deaerator heat recovery	4,763,880	2,360,518	2,360,518	$7,183	$7,183	$7,183
2014-COM-0079	Steam leak repairs	2,767,544	2,592,266	1,296,133	$2,116	$2,116	$2,116
2014-COM-0051	Greenhouse expansion - multi-measure	2,057,838	3,784,475	3,784,475	$109,324	$144,822	$144,822
2014-IND-0025	Greenhouse expansion - multi-measure	10,797,967	10,026,684	10,026,684	$593,400	$593,400	$593,400
2014-IND-0024	Greenhouse expansion - multi-measure	7,996,734	7,463,619	7,463,619	$390,930	$390,930	$390,930
2014-IND-0114	Greenhouse expansion - multi-measure	7,804,521	8,008,161	8,008,161	$218,463	$301,611	$301,611
2014-IND-0172	Insulation of steam supply lines	5,469,713	5,561,750	5,561,750	$7,130	$7,130	$7,130
2014-COM-0320	Greenhouse expansion - multi-measure	3,216,703	3,466,877	3,466,877	$43,291	$69,666	$69,666

Project ID	Project Description	Cumulative Net Gas Savings (Cubic Meters)			Net Incremental Cost		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0021	Greenhouse expansion - multi-measure	20,071,169	18,816,721	18,816,721	$757,850	$757,850	$757,850
2014-IND-0022	Greenhouse expansion - multi-measure	14,502,755	13,596,333	13,596,333	$646,645	$646,645	$646,645
2014-IND-0570	Insulate steam, condensate, hot water piping	6,610,540	6,610,540	6,610,540	$48,760	$48,760	$48,760
2014-IND-0333	Heat exchanger upgrade	3,751,742	2,799,384	2,799,384	$52,900	$52,900	$52,900
2014-IND-0210	Heat exchanger upgrade	1,136,853	1,022,376	1,022,376	$23,000	$23,000	$23,000
2014-COM-0240	Upgrade building systems to LEED standards	7,570,947	6,880,018	6,880,018	$5,980,000	$5,980,000	$5,980,000
2014-IND-0115	Steam leak repairs	962,826	925,796	462,898	$4,320	$4,320	$4,320
2014-IND-0261	Insulate piping, valves and heat exchangers	158,985	195,233	195,233	$23,548	$23,548	$23,548
2014-COM-0345	Boiler control upgrades and adjustments	750,180	539,042	539,042	$5,741	$5,741	$5,741
2014-COM-0239	Upgrade building systems to LEED standards	306,894	416,751	416,751	$204,700	$204,700	$204,700
Totals		**145,100,468**	**134,260,867**	**127,023,156**	**$50,425,480**	**$50,552,620**	**$50,552,620**
Percent of Application Savings			**93%**	**88%**		**100%**	**100%**

Table 13: Summary of Adjustments to Electricity and Water Savings - Commercial/Industrial Custom Projects

Project ID	Project Description	Annual Net Electricity Savings (kWh)			Annual Net Water Savings (L)		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0178	Steam leak repairs	0	0	0	15,704,312	9,214,926	9,214,926
2014-IND-0569	Multi-measure process and energy intensity upgrades	5,939,060	5,939,060	5,939,060	132,940	132,940	132,940
2014-COM-0087	High efficiency, direct fired H&V unit	0	0	0	0	0	0
2014-IND-0183	Insulate dryer drum	0	0	0	0	0	0
2014-IND-0112	Steam leak repairs & 2 process heating coil replacements	0	0	0	1,453,670	1,453,007	1,453,007
2014-IND-0166	Process oven burner upgrade and heat recovery	0	0	0	0	0	0
2014-IND-0056	Deaerator heat recovery	0	0	0	2,873,525	2,174,700	2,174,700
2014-COM-0079	Steam leak repairs	0	0	0	1,432,766	1,342,024	1,342,024
2014-COM-0051	Greenhouse expansion - multi-measure	0	0	0	0	0	0
2014-IND-0025	Greenhouse expansion - multi-measure	0	0	0	0	0	0
2014-IND-0024	Greenhouse expansion - multi-measure	0	0	0	0	0	0
2014-IND-0114	Greenhouse expansion - multi-measure	0	0	0	0	0	0

Project ID	Project Description	Annual Net Electricity Savings (kWh)			Annual Net Water Savings (L)		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0172	Insulation of steam supply lines	0	0	0	0	0	0
2014-COM-0320	Greenhouse expansion - multi-measure	0	0	0	0	0	0
2014-IND-0021	Greenhouse expansion - multi-measure	0	0	0	0	0	0
2014-IND-0022	Greenhouse expansion - multi-measure	0	0	0	0	0	0
2014-IND-0570	Insulate steam, condensate, hot water piping	0	0	0	0	0	0
2014-IND-0333	Heat exchanger upgrade	0	0	0	0	0	0
2014-IND-0210	Heat exchanger upgrade	0	0	0	0	0	0
2014-COM-0240	Upgrade building systems to LEED standards	1,667,011	1,667,011	1,667,011	0	0	0
2014-IND-0115	Steam leak repairs	0	0	0	486,019	486,019	486,019
2014-IND-0261	Insulate piping, valves and heat exchangers	0	0	0	0	0	0
2014-IND-0345	Boiler control upgrades and adjustments	0	0	0	0	0	0
2014-COM-0239	Upgrade building systems to LEED standards	0	0	0	0	0	0
Totals		**7,606,071**	**7,606,071**	**7,606,071**	**22,083,232**	**14,803,615**	**14,803,615**
Percent of Application Savings			**100%**	**100%**		**67%**	**67%**

Commercial & Industrial Program Recommendations

Recommendation #8: Some customers' work orders for steam leaks showed very high leak rates, and notes indicated that repairs were urgent; however, the savings for the repairs were included in the claimed savings. These repairs likely would have been made for safety or severity reasons regardless of program availability. O&M measures of specific types should be considered for exclusion from program incentives. In particular, steam leaks, steam trap repairs, and condensate leaks fall into this category, each often resulting in paybacks of less than one year. In addition, any condition that results in a safety or ecological hazard or has the capability of causing significant damage to equipment should need no incentive to induce its repair in a timely manner and therefore should not be attributed to the program.

Recommendation #9: A number of greenhouse expansion and new construction projects had no previously existing building referenced as a baseline condition. Each of these projects incorporated a unique set of baseline conditions against which to compare efficient case energy consumption. This allowed for the possibility of customizing the baseline to improve savings estimations. Union should specify standard practice for establishing baselines in terms of a level of performance that can be expected of each of the components installed in new construction greenhouses when no program incentives are included.

Recommendation #10: Savings calculations for insulation measures assume first-year savings will recur throughout the EUL; however, insulation effectiveness generally degrades over time, thereby reducing savings. Union should take into account degradation of insulation over time in calculating EULs and lifetime savings in cases where insulation is installed in unprotected areas. This is less of a concern when insulation is installed in protected areas and/or aluminum cladding is installed with the insulation.

Recommendation #11: In a couple of instances, one verifier indicated in the CPSV report that electric savings and incremental costs were "indeterminate". Future evaluation responsibilities should include developing estimates of project costs and savings in cases where initial estimates are not provided in the project documentation.

Large Volume Custom Projects

The Large Volume Custom Projects provided the vast majority of Union's 2014 savings (see Table 3) and therefore received the most attention from the audit team. Our review process followed the same process used for the other custom programs. First, we reviewed CPSV reports prepared by Diamond Engineering in two phases. We first conducted an initial review of the draft CPSV reports, compiled a list of questions for clarification and requested any additional information needed for the audit. A call was held with Union and Diamond Engineering staff to review and resolve these initial questions based on the draft CPSV reports.

Once all the initial questions were resolved, we conducted secondary in-depth reviews of the draft CPSV reports for each project. The CPSV reports were reviewed for baseline assumptions, operating hours, savings calculations, and EUL for each measure. A number of questions and recommendations were compiled based on this in-depth review, and a series of calls was held with Union and Audit Committee members to discuss these issues. These calls were also used to provide input to Diamond Engineering so they could finalize the CPSV reports. Based on the feedback from these calls, we developed a set of recommendations and specific adjustments to project savings and EULs where necessary.

The documentation issue is also present in the Large Volume Program, with no documentation of standard operations and maintenance procedures for customers conducting steam leak repairs or other maintenance-related measures through the program. As before, we are reducing savings for these projects by 50 percent due to the lack of required documentation.

The rationales for adjustments made to savings and EULs based on the auditor's review are described below by project.

- **2014-IND-0649.** Savings were reduced by 50 percent due to a lack of documentation of customer standard maintenance procedures.
- **2014-IND-0670.** See rationale above for 2014-IND-0649. Reduction in the verified value for EUL is due to a small percentage of leaks due to trap repair; EUL was adjusted back to rounded value (20 years).
- **2014-IND-0487.** See rationale above for 2014-IND-0649.
- **2014-IND-0664.** See rationale above for 2014-IND-0649.
- **2014-IND-0356.** See rationale above for 2014-IND-0649.
- **2014-IND-0522.** See rationale above for 2014-IND-0649.
- **2014-IND-0608.** The verified savings assume a 0.75 adjustment factor; however, the audit assumes that at the end of EUL, the condition of the pipe is the same as when it was replaced. At this point, the annual savings would be zero relative to the baseline condition. Assuming a linear fouling rate, the average savings over the life of the projects should be 50 percent of the first-year savings.
- **2014-IND-0543.** See rationale above for 2014-IND-0649.
- **2014-IND-0609.** See rationale above for 2014-IND-0608.

Table 14 below summarizes the application, verified, and audited gross gas savings and EUL values by project for the Large Volume program. Table 15 summarizes net gas savings and EUL values; Table 16 summarizes cumulative net savings; and Table 17 summarizes annual electricity and water savings.

Table 14: Summary of Adjustments to Gross Gas Savings and EUL - Large Volume Projects

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL			Rationale for Audit Adjustment
		Application	Verified	Audit	Application	Verified	Audit	
2014-IND-0649	Steam leak repairs	1,747,225	1,954,000	977,000	20	20	20	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0670	Steam leak repairs	1,856,905	976,000	488,000	20	19.54	20	See rationale for 2014-IND-0649; EUL adjusted back to rounded value
2014-IND-0487	Steam leak repairs	1,292,155	855,200	427,600	20	20	20	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0664	Steam trap replacements	316,149	309,500	154,750	7	7	7	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0356	Steam trap replacements	1,045,885	1,174,000	587,000	7	7	7	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0522	Steam trap replacements	2,217,522	3,353,000	1,676,500	7	7	7	Savings reduced by 50% for lack of maintenance practices documentation

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL			Rationale for Audit Adjustment
		Application	Verified	Audit	Application	Verified	Audit	
2014-IND-0452	Process improvement to allow productive use of steam generated on weekends	1,446,878	1,612,000	1,612,000	20	30	30	
2014-IND-0675	Evaporator steam injector repair	557,154	615,200	615,200	20	20	20	
2014-IND-0371	Control programming to close dampers when OA not needed for process	99,301	172,800	172,800	20	20	20	
2014-IND-0620	Repair of boiler preheater	2,745,230	2,943,000	2,943,000	2	1.5	1.5	
2014-IND-0612	Re-route condensate from condensing turbine back to boiler	7,226,580	7,259,000	7,259,000	20	20	20	
2014-IND-0615	Burner upgrade on process furnace	3,902,000	3,980,000	3,980,000	20	20	20	

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL			Rationale for Audit Adjustment
		Application	Verified	Audit	Application	Verified	Audit	
2014-IND-0608	COG pipeline replacement/ cleaning	3,063,761	2,895,000	1,931,000	30	30	30	Assuming a linear fouling rate, savings adjusted to 50% of the first-year savings
2014-IND-0622	COG pipeline replacement	1,277,774	2,569,000	2,569,000	10	10	10	
2014-IND-0431	Feedwater economizer on backup boiler	589,960	36,870	36,870	20	20	20	
2014-IND-0299	High-efficiency turbine generator	248,696	92,830	92,830	20	20	20	
2014-IND-0287	Kiln insulation replacement	103,192	152,000	152,000	20	20	20	
2014-IND-0543	Steam trap repairs	3,964,367	4,630,000	2,315,000	7	7	7	Savings reduced by 50% for lack of maintenance practices documentation
2014-IND-0609	COG pipeline replacement/ cleaning	5,340,742	5,984,000	3,989,000	30	30	30	Assuming a linear fouling rate, savings adjusted to 50% of the first-year savings
2014-IND-0630	Pipe insulation repairs	5,353,144	4,908,000	4,908,000	20	20	20	
2014-IND-0632	Pipe insulation repairs	1,775,872	1,631,000	1,631,000	20	20	20	

Project ID	Project Description	Gross Gas Savings (Cubic Meters/year)			EUL			Rationale for Audit Adjustment
		Application	Verified	Audit	Application	Verified	Audit	
2014-IND-0667	Pipe insulation repairs	4,354,483	6,016,000	6,016,000	20	20	20	
Totals		**50,524,975**	**54,118,400**	**44,533,550**				
Percent of Application Savings			**107%**	**88%**				

Table 15: Summary of Adjustments to Net Gas Savings and EUL - Large Volume Projects

Project ID	Project Description	Net Gas Savings (Cubic Meters/year)			EUL		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0649	Steam leak repairs	803,724	898,840	449,420	20	20	20
2014-IND-0670	Steam leak repairs	854,176	448,960	224,480	20	19.54	20
2014-IND-0487	Steam leak repairs	594,391	393,392	196,696	20	20	20
2014-IND-0664	Steam trap replacements	145,429	142,370	71,185	7	7	7
2014-IND-0356	Steam trap replacements	481,107	540,040	270,020	7	7	7
2014-IND-0522	Steam trap replacements	1,020,060	1,542,380	771,190	7	7	7
2014-IND-0452	Process improvement to allow productive use of steam generated on weekends	665,564	741,520	741,520	20	30	30
2014-IND-0675	Evaporator steam injector repair	256,291	282,992	282,992	20	20	20
2014-IND-0371	Control programming to close dampers when OA not needed for process	45,678	79,488	79,488	20	20	20
2014-IND-0620	Repair of boiler preheater	1,262,806	1,353,780	1,353,780	2	1.5	1.5
2014-IND-0612	Re-route condensate from condensing turbine back to boiler	3,324,227	3,339,140	3,339,140	20	20	20
2014-IND-0615	Burner upgrade on process furnace	1,794,920	1,830,800	1,830,800	20	20	20

Project ID	Project Description	Net Gas Savings (Cubic Meters/year)			EUL		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0608	COG pipeline replacement/cleaning	1,409,330	1,331,700	888,260	30	30	30
2014-IND-0622	COG pipeline replacement	587,776	1,181,740	1,181,740	10	10	10
2014-IND-0431	Feedwater economizer on backup boiler	271,382	16,960	16,960	20	20	20
2014-IND-0299	High-efficiency turbine generator	114,400	42,702	42,702	20	20	20
2014-IND-0287	Kiln insulation replacement	47,468	69,920	69,920	20	20	20
2014-IND-0543	Steam trap repairs	1,823,609	2,129,800	1,064,900	7	7	7
2014-IND-0609	COG pipeline replacement/cleaning	2,456,741	2,752,640	1,834,940	30	30	30
2014-IND-0630	Pipe insulation repairs	2,462,446	2,257,680	2,257,680	20	20	20
2014-IND-0632	Pipe insulation repairs	816,901	750,260	750,260	20	20	20
2014-IND-0667	Pipe insulation repairs	2,003,062	2,767,360	2,767,360	20	20	20
Totals		**23,241,489**	**24,894,464**	**20,485,433**			
Percent of Application Savings			**107%**	**88%**			

Table 16: Summary of Adjustments to Cumulative Net Gas Savings and Incremental Cost - Large Volume Projects

Project ID	Project Description	Cumulative Net Gas Savings (Cubic Meters)			Net Incremental Cost		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0649	Steam leak repairs	16,074,470	17,976,800	8,988,400	$7,309	$7,309	$7,309
2014-IND-0670	Steam leak repairs	17,083,526	8,772,678	4,489,600	$242,064	$242,064	$242,064
2014-IND-0487	Steam leak repairs	11,887,826	7,867,840	3,933,920	$243,821	$243,821	$243,821
2014-IND-0664	Steam trap replacements	1,018,000	996,590	498,295	$3,689	$3,689	$3,689
2014-IND-0356	Steam trap replacements	3,367,750	3,780,280	1,890,140	$11,568	$11,568	$11,568
2014-IND-0522	Steam trap replacements	7,140,421	10,796,660	5,398,330	$100,435	$100,435	$100,435
2014-IND-0452	Process improvement to allow productive use of steam generated on weekends	13,311,278	22,245,600	22,245,600	$622,125	$622,125	$622,125
2014-IND-0675	Evaporator steam injector repair	5,125,817	5,659,840	5,659,840	$7,360	$7,360	$7,360
2014-IND-0371	Control programming to close dampers when OA not needed for process	913,569	1,589,760	1,589,760	$423	$423	$423
2014-IND-0620	Repair of boiler preheater	2,525,612	2,030,670	2,030,670	$121,620	$121,620	$121,620
2014-IND-0612	Re-route condensate from condensing turbine back to boiler	66,484,536	66,782,800	66,782,800	$182,834	$166,734	$166,734
2014-IND-0615	Burner upgrade on process furnace	35,898,400	36,616,000	36,616,000	$160,177	$160,177	$160,177
2014-IND-0608	COG pipeline replacement/cleaning	42,279,902	39,951,000	26,647,800	$120,185	$120,185	$120,185
2014-IND-0622	COG pipeline replacement	5,877,760	11,817,400	11,817,400	$28,658	$28,658	$28,658

Project ID	Project Description	Cumulative Net Gas Savings (Cubic Meters)			Net Incremental Cost		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0431	Feedwater economizer on backup boiler	5,427,632	339,204	339,204	$138,000	$138,000	$138,000
2014-IND-0299	High-efficiency turbine generator	2,288,003	854,036	854,036	$368,000	$368,000	$368,000
2014-IND-0287	Kiln insulation replacement	949,366	1,398,400	1,398,400	$61,942	$61,942	$61,942
2014-IND-0543	Steam trap repairs	12,765,262	14,908,600	7,454,300	$94,515	$94,515	$94,515
2014-IND-0609	COG pipeline replacement/cleaning	73,702,240	82,579,200	55,048,200	$352,050	$439,760	$439,760
2014-IND-0630	Pipe insulation repairs	49,248,925	45,153,600	45,153,600	$155,338	$155,338	$155,338
2014-IND-0632	Pipe insulation repairs	16,338,022	15,005,200	15,005,200	$50,252	$50,252	$50,252
2014-IND-0667	Pipe insulation repairs	40,061,244	55,347,200	55,347,200	$169,157	$169,157	$169,157
Totals		**429,769,559**	**452,469,358**	**379,188,695**	**$3,241,524**	**$3,313,133**	**$3,313,133**
Percent of Application Savings			**105%**	**88%**		**102%**	**102%**

Table 17: Summary of Adjustments to Net Electricity and Water Savings - Large Volume Projects

Project ID	Project Description	Annual Net Electricity Savings (kWh)			Annual Net Water Savings (L)		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0649	Steam leak repairs	0	0	0	82,415,460	93,978,000	93,978,000
2014-IND-0670	Steam leak repairs	0	0	0	9,171,856	4,807,000	4,807,000
2014-IND-0487	Steam leak repairs	0	0	0	6,354,014	3,989,120	3,989,120
2014-IND-0664	Steam trap replacements	0	0	0	746,567	1,765,020	1,765,020
2014-IND-0356	Steam trap replacements	0	0	0	0	0	0
2014-IND-0522	Steam trap replacements	0	0	0	10,096,503	15,865,400	15,865,400
2014-IND-0452	Process improvement to allow productive use of steam generated on weekends	0	0	0	7,632,614	7,613,000	7,613,000
2014-IND-0675	Evaporator steam injector repair	0	0	0	2,939,116	2,996,440	2,996,440
2014-IND-0371	Control programming to close dampers when OA not needed for process	0	0	0	565,755	0	0
2014-IND-0620	Repair of boiler preheater	0	0	0	0	0	0
2014-IND-0612	Re-route condensate from condensing turbine back to boiler	0	0	0	99,221,751	101,660,000	101,660,000
2014-IND-0615	Burner upgrade on process furnace	0	0	0	0	0	0
2014-IND-0608	COG pipeline replacement/cleaning	0	0	0	0	0	0
2014-IND-0622	COG pipeline replacement	0	0	0	0	0	0
2014-IND-0431	Feedwater economizer on backup boiler	0	0	0	0	0	0
2014-IND-0299	High-efficiency turbine generator	0	0	0	0	0	0
2014-IND-0287	Kiln insulation replacement	0	0	0	0	0	0

Project ID	Project Description	Annual Net Electricity Savings (kWh)			Annual Net Water Savings (L)		
		Application	Verified	Audit	Application	Verified	Audit
2014-IND-0543	Steam trap repairs	0	0	0	23,771,526	23,598,000	23,598,000
2014-IND-0609	COG pipeline replacement/cleaning	0	0	0	0	0	0
2014-IND-0630	Pipe insulation repairs	0	0	0	19,451,563	21,132,400	21,132,400
2014-IND-0632	Pipe insulation repairs	0	0	0	4,018,980	7,511,800	7,511,800
2014-IND-0667	Pipe insulation repairs	0	0	0	5,585,031	27,673,600	27,673,600
Totals		**0**	**0**	**0**	**271,970,737**	**312,589,780**	**312,589,780**
Percent of Application Savings			**N/A**	**N/A**		**115%**	**115%**

Large Volume Custom Program Recommendation

Recommendation #12: Projects that replaced coke oven gas pipelines and pipe insulation often assumed that the measure condition at the end of the measure EUL is the same as when it was replaced; however, at that point the annual savings would be zero relative to the baseline condition. Assuming a linear fouling rate, the average savings over the life of the projects should be 50 percent of the first-year savings.

3 Summary of Recommendations

This chapter presents a summary of the audit recommendations for the 2014 Union Gas Annual Report.

Overarching Recommendations

Recommendation #1: Increase annual evaluation spending to 3-5 percent of the program implementation budget. This will allow for (at a minimum) additional baseline research, an annual free ridership study for custom projects, and process evaluations for all programs.

Recommendation #2: The expected timing of the audit must be clearly communicated at the RFP stage, when project staff and budgets are determined, not during the project initiation meeting. This will enable the audit team to ensure that appropriate resources are available throughout the project.

Recommendation #3: Conduct a new custom free ridership study every year (beginning in 2015) using a sample from the current year's custom participants.

Recommendation #4: The annual custom free ridership study should have separate and robust samples for behavioral and maintenance-related projects.

Recommendation #5: For maintenance and behavioral projects, the customer's standard maintenance and operations practices must be formally documented, as has been agreed to by Union in prior years. This can be accomplished by developing a standard form that each customer fills out with their project application that is sufficiently flexible to accommodate differences across customers. If documentation is not completed, these projects should be disallowed and the savings set to zero.

Recommendation #6: Savings from projects that result from addressing obvious safety hazards (e.g., gas leaks or very large steam leaks) or are otherwise obviously free riders should not be eligible for Union Gas incentives. To identify obvious free riders, a possible criterion is to have projects with a simple payback of less than one year be ineligible for the program.

Low Income Custom Projects Recommendation

Recommendation #7: Set a maximum value of 100 percent for electricity and water realization rates in situations where extremely high realization rates occur during the verification process

Commercial & Industrial Program Recommendations

Recommendation #8: Some customers' work orders for steam leaks showed very high leak rates, and notes indicated that repairs were urgent; however, the savings for the repairs were included in the claimed savings. These repairs likely would have been made for safety or severity reasons regardless of program availability. O&M measures of specific types should be considered for exclusion from program incentives. In particular, steam leaks, steam trap repairs, and condensate leaks fall into this category, each often resulting in paybacks of less than one year. In addition, any condition that results in a safety or ecological hazard or has the capability of causing significant damage to equipment should need no incentive to induce its repair in a timely manner and therefore should not be attributed to the program.

Recommendation #9: A number of greenhouse expansion and new construction projects had no previously existing building referenced as a baseline condition. Each of these projects incorporated a unique set of baseline conditions against which to compare efficient case energy consumption. This allowed for the possibility of customizing the baseline to improve savings estimations. Union should specify standard practice for establishing baselines in terms of a level of performance that can be expected of each of the components installed in new construction greenhouses when no program incentives are included.

Recommendation #10: Savings calculations for insulation measures assume first-year savings will recur throughout the EUL; however, insulation effectiveness generally degrades over time, thereby reducing savings. Union should take into account degradation of insulation over time in calculating EULs and lifetime savings in cases where insulation is installed in unprotected areas. This is less of a concern when insulation is installed in protected areas and/or aluminum cladding is installed with the insulation.

Recommendation #11: In a couple of instances, one verifier indicated in the CPSV report that electric savings and incremental costs were “indeterminate”. Future evaluation responsibilities should include developing estimates of project costs and savings in cases where initial estimates are not provided in the project documentation.

Large Volume Custom Program Recommendation

Recommendation #12: Projects that replaced coke oven gas pipelines and pipe insulation often assumed that the measure condition at the end of the measure EUL is the same as when it was replaced; however, at that point the annual savings would be zero relative to the baseline condition. Assuming a linear fouling rate, the average savings over the life of the projects should be 50 percent of the first-year savings.

4 Audit LRAM, DSMVA, and DSM Shareholder Incentive Amount Recoverable

We have audited the Annual Report, DSM Shareholder Incentive, Lost Revenue Adjustment Mechanism (LRAM) and Demand Side Management Variance Account (DSMVA) of Union Gas Limited for the calendar year ended December 31, 2014. The Annual Report and the calculations of DSM Shareholder Incentive, LRAM, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts based on our audit.

We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in the DSM Guidelines for Natural Gas Utilities (EB-2008-0346). Details of the steps taken in this audit process are set forth in the Audit Report that follows, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that have been gathered and recorded using reasonable methods and accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2014 DSM programs of Union Gas Limited:

DSM Shareholder Incentive Amount Recoverable: $8,987,690
LRAM Amount Recoverable: $309,964
DSMVA Amount Recoverable: $1,664,354

Attachment 1

The table below shows the dates and attendees of the meetings held during the 2014 audit process.

Table 18: Meetings During the 2014 DSM Audit

Date	Meeting Topic	Attendees			
		Audit Committee	Auditor	Verifier	Union
2/3/15	Audit Kickoff Meeting	●	●		●
4/8/15	CPSV: Low Income Report	●	●	●	●
4/15/15	CPSV: Low Income Report	●	●	●	●
4/22/15	CPSV: Commercial/Industrial Report	●	●	●	●
4/29/15	CPSV: Low Income Report	●	●	●	●
5/6/15	CPSV: Commercial/Industrial Report	●	●	●	●
5/13/15	CPSV: Commercial/Industrial Report	●	●	●	●
5/27/15	Questions on Annual Report	●	●	●	●
6/17/15	CPSV: Large Volume Projects	●	●	●	●
7/15/15	CPSV: Large Volume Projects	●	●	●	●
7/24/15	CPSV: Large Volume Projects	●	●	●	●
9/23/15	Draft Audit Report Comments	●	●	●	●
10/14/15	Draft Audit Report Comments	●	●	●	●

FINAL
Audit Committee

Summary Results and Responses to the Audit of Union's 2014 DSM Annual Report

December 4, 2015

The purpose of this document is to outline the process followed for the Audit of the 2014 DSM Annual Report, summarize the Audit Committee (AC) resolutions to Audit recommendations, and recalculate the corresponding impacts to the 2014 DSM savings claims.

Selection of AC members

The AC was comprised of three Consultative representatives and one Union Gas representative (Tina Nicholson).

The Consultative elected three AC members by electronic voting concluding September 15, 2014, to represent the group through the Audit process. These representatives are:

- Kai Millyard – Green Energy Coalition
- Judy Simon – Low-Income Energy Network
- Vince DeRose – Canadian Manufacturers and Exporters

Selection of Auditor and Terms of Reference

Union and the AC retained Evergreen Economics ("Evergreen") – who was also retained as Auditor in 2013 – to complete a thorough audit of Union's 2014 DSM results. While the AC strives for consensus, the ToR appoints the intervenor members of the AC to ultimately select the successful proponent in the absence of consensus. In 2014, the AC achieved consensus on retaining the same auditor as in 2013.

Union issued a Request for Proposal (RFP) to Evergreen Economics for the purpose of conducting the Annual DSM Audit. The RFP was developed in conjunction with Union and Enbridge's ACs to standardize the audit process between the two utilities. For the 2014 audit, the standardized RFP scope of work was extended to state that any auditor recommendations to change findings from those recommended by the CPSV firm (for custom project findings) or prescriptive input assumptions must be explained and, to the extent practical, documented with appropriate references and/or other forms of substantiation. If the auditor cannot identify a reference, the auditor must provide a reasonable rationale for its assumption. The 2014 RFP included the provision that allowed the Auditor to work with the Custom Project Savings Verification firm to enable the review of both the draft and final verification reports and an opportunity to discuss individual projects, any findings and adjustment factors recommended throughout the firm's review. The RFP is attached as Appendix A.

Information Exchange

The Consultative, including the members of the AC and Evergreen, reviewed the Draft 2014 DSM Annual Report circulated by Union Gas on April 1, 2015. Other than comments from members of the AC, no additional comments were received from members of the Consultative.

The draft annual report was circulated prior to the incorporation of CPSV results (i.e. before factoring in custom project realization rates). This approach allowed for the timely release of the draft annual report.

Evergreen presented the AC with the 2014 Draft Auditor report on September 11, 2015 for review. Thirteen joint meetings with the AC, Evergreen, and Union were held between February 3, 2015 and October 14, 2015 to initiate the audit process, review the Draft 2014 Annual DSM Report, the Draft Audit Report, and the Draft Final Audit Report. The 2014 Audit of Union's DSM Annual Report was completed following Evergreen's submission of its Final Auditor's Report dated October 29, 2015.

Auditor's Recommended Changes to Cumulative Gas Savings, Utility DSM Incentive and LRAM Claim

Evergreen Economics conducted the audit in accordance with the rules and principles set down by the Ontario Energy Board in the DSM Guidelines for Natural Gas Utilities (EB-2008-0346) and in accordance to the contents of the 2012-2014 Union Gas Settlement Agreement (EB-2011-0327) and the 2013-2014 DSM Plan for Large Volume (EB-2012-0337). The Auditor's Final Report presents their opinion subject to the qualifications set forth above, that "the following figures are calculated correctly using reasonable assumptions, based on data that has been gathered and recorded using reasonable methods and accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2014 DSM programs of Union Gas Ltd:

DSM Shareholder Incentive Amount Recoverable: $8,987,690

LRAM Amount Recoverable: $309,964

DSMVA Amount Recoverable: $1,664,354

Audit findings and recommendations led to a decrease of 368 million net cumulative m3 and $0.040M in LRAM claim from what was reported in Union's Pre-Audit Annual Report.

Overarching Recommendations

Recommendation #1

Increase annual evaluation spending to 3-5 percent of the program implementation budget. This will allow for (at a minimum) additional baseline research, an annual free ridership study for custom projects, and process evaluations for all programs.

Resolution:

The AC agrees with the Auditor that a spend in the range of 3-5% of the program implementation budget is appropriate for Union's future Evaluation activities. Union's total evaluation spend in 2014 was 3.5% of its total program spend and Union is proposing evaluation spends of between 3.5% and 4.5% of total budget over the 2015-2020 period. However, the parameters of future evaluation work including budgets, is currently before the Board as part of the new 2015-2020 DSM framework.

Recommendation #2

The expected timing of the audit must be clearly communicated at the RFP stage, when project staff and budgets are determined, not during the project initiation meeting. This will enable the audit team to ensure that appropriate resources are available throughout the project.

Resolution:

The AC accepts the Auditor's recommendation; the AC suggests that expected timing of the audit be outlined at the RFP stage while noting that this a best estimate only. A more firm project schedule can be made available at project kickoff. Union will refer this recommendation to the Evaluation Advisory Committee (EAC). As noted in the Board letter dated August 21, 2015

(EB-2015-0245)[1], the EAC will provide input and advice to the OEB and the Evaluation Contractor (EC). The EC is ultimately charged with carrying out the evaluation and audit process, including auditor RFP.

Recommendation #3

Conduct a new custom free ridership study every year (beginning in 2015) using a sample from the current year's custom participants.

Resolution:

The AC agrees that monitoring and adjusting Net-to-Gross (NTG) ratios, including free ridership and spillover, for custom projects is an important input to estimating savings for custom projects. A number of the details about how this should be done may be resolved by the parties following the study currently underway by the TEC. Subject to the outcome of that study, and a review of the cost-effectiveness of regular NTG studies, the AC agrees that annual studies are preferable due to the large contribution of custom projects to total savings.

The AC agrees that it is not reasonable to conduct a separate Net-to-Gross (NTG) study for the purposes of 2015 audit given the current work underway.

Recommendation #4

The annual custom free ridership study should have separate and robust samples for behavioral and maintenance-related projects

Resolution:

The AC agrees that when sampling for free ridership surveys, customized questions dealing with the difference between baseline and free ridership issues should be posed for behavioural and maintenance projects. As noted in the Board's letter dated August 21, 2015, completion of the NTG study is a current responsibility of the TEC until such time that the EC is retained by the OEB and an appropriate plan to transition to the new framework on a go-forward basis is determined by OEB Staff and the TEC. As such, this recommendation will be referred to the TEC for the purposes of the current NTG study.

Recommendation #5

For maintenance and behavioral projects, the customer's standard maintenance and operations practices must be formally documented, as has been agreed to by Union in prior years. This can be accomplished by developing a standard form that each customer fills out with their project application that is sufficiently flexible to accommodate differences across customers. If documentation is not completed, these projects should be disallowed and the savings set to zero.

[1] 2015-2020 Demand Side Management Evaluation Process of Program Results, EB-2015-0245, August 21, 2015

Resolution:

The AC agrees that the customer's standard maintenance and operations practices must be documented and that if the documented evidence is not sufficient to support the basecase, then savings for that project should be set to zero.

The AC also agrees that capturing a customer's standard maintenance and operations practices can be accomplished with a standard form that is filled out as part of the project application. For 2015 O&M custom projects, Union has developed a formalized approach to capture customer's standard maintenance and operations practices via a standard form. Union will use this form to support the basecase and demonstrate incremental savings from the customer's standard practices.

Recommendation #6

Savings from projects that result from addressing obvious safety hazards (e.g., gas leaks or very large steam leaks) or are otherwise obviously free riders should not be eligible for Union Gas incentives. To identify obvious free riders, a possible criterion is to have projects with a simple payback of less than one year be ineligible for the program.

Resolution:

The AC agrees with the Auditor's recommendation that savings from projects that are obvious safety hazards should not be eligible for incentives. The AC also agrees that if classes of projects – including projects below a certain payback threshold – are to be made ineligible that this policy should be established in advance.

Starting in 2014, Union no longer provided incentives for gas leak projects. As of 2016, it will no longer be incenting projects classified as O&M Repair. O&M repair projects are those in which a customer has completed a repair (i.e. maintenance) to improve energy performance, as opposed to continuing to operate less efficiently. The most common types of projects would be steam leak and steam trap repairs. It would also encompass descaling and heat exchanger cleaning projects.

Low Income Custom Program Recommendation

Recommendation #7

Set a maximum value of 100 percent for electricity and water realization rates in situations where extremely high realization rates occur during the verification process.

Resolution:

This recommendation arose from two custom projects (2014-COM-0179 and 2014-COM-0181) for which the verifier identified additional sources of electricity savings not considered in the original claim. Resulting project-level electricity realization rates were 38,249% and 5,054% respectively, which if applied to all projects would have skewed portfolio-level electricity realization rates. The AC accepts the Auditor's recommendation to set these two project-level realization rates to 100%.

The AC also agrees that in this type of situation, the extremely high incremental savings found during verification should be added to the individual project claims only; this ensures that the savings are fully captured without skewing realization rates and program level savings.

Commercial & Industrial Program Recommendations

Recommendation #8

Some customers' work orders for steam leaks showed very high leak rates, and notes indicated that repairs were urgent; however, the savings for the repairs were included in the claimed savings. These repairs likely would have been made for safety or severity reasons regardless of program availability. O&M measures of specific types should be considered for exclusion from program incentives. In particular, steam leaks, steam trap repairs, and condensate leaks fall into this category, each often resulting in paybacks of less than one year. In addition, any condition that results in a safety or ecological hazard or has the capability of causing significant damage to equipment should need no incentive to induce its repair in a timely manner and therefore should not be attributed to the program.

Resolution:

The AC agrees with the Auditor's recommendation that savings from projects that are obvious safety hazards should not be eligible for incentives. The AC also agrees that if classes of projects – including projects below a certain payback threshold – are to be made ineligible that this policy should be established in advance.

Starting in 2014, Union no longer provided incentives for gas leak projects. As of 2016, it will no longer be incenting projects classified as O&M Repair. O&M repair projects are those in which a customer has completed a repair (i.e. maintenance) to improve energy performance, as opposed to continuing to operate less efficiently. The most common types of projects would be steam leak and steam trap repairs. It would also encompass descaling and heat exchanger cleaning projects.

Recommendation #9

A number of greenhouse expansion and new construction projects had no previously existing building referenced as a baseline condition. Each of these projects incorporated a unique set of baseline conditions against which to compare efficient case energy consumption. This allowed for the possibility of customizing the baseline to improve savings estimations. Union should specify standard practice for establishing baselines in terms of a level of performance that can be expected of each of the components installed in new construction greenhouses when no program incentives are included.

Resolution:

As with all custom projects, Union has been customizing greenhouse baselines based on what a customer would commonly and reasonably have chosen to do as an alternative to the higher energy efficiency option. Given the unique business processes and requirements associated with custom projects, the approach must consider customer-specific circumstances.

The CI verifier provided findings related to greenhouse project baselines. It noted that "a site-specific customized approach has to be developed in determining what aspects would be factored into a new construction baseline." The verifier also provided a preliminary opinion on average greenhouse market practices. This opinion was based only on observations made during site visits to 2014 greenhouse projects selected for CPSV sampling.

Union notes that the verifier's preliminary opinions are consistent with the types of equipment that it currently considers when establishing greenhouse baselines. Going forward, in order to respond to the Auditor's concern, and simplify the evaluation and auditing of these types of projects, the AC agrees that Union will specify the preliminary opinion provided by the 2014 CI verifier as standard practice for its new greenhouse baseline determination.

Recommendation #10

Savings calculations for insulation measures assume first-year savings will recur throughout the EUL; however, insulation effectiveness generally degrades over time, thereby reducing savings. Union should take into account degradation of insulation over time in calculating EULs and lifetime savings in cases where insulation is installed in unprotected areas. This is less of a concern when insulation is installed in protected areas and/or aluminum cladding is installed with the insulation.

Resolution:

The AC agrees that Union will take degradation into account for insulation projects installed in unprotected areas bearing in mind that the level of degradation – if any – is dependent on the specific circumstances of the installation. Installing insulation in protected areas and/or adding aluminum cladding are two examples of circumstances that could reduce or potentially eliminate insulation degradation.

Recommendation #11

In a couple of instances, one verifier indicated in the CPSV report that electric savings and incremental costs were "indeterminate". Future evaluator responsibilities should include developing estimates of project costs and savings for those cases where initial values are not provided in the project documentation

Resolution:

The AC accepts the Auditor's recommendation and notes that the "evaluator" in this case will be interpreted as the CPSV verifier. Following the roles defined in the 2015-2020 OEB DSM Evaluation Governance Structure (Board letter dated August 21, 2015), Union will refer this recommendation to the Evaluation Advisory Committee (EAC).

Large Volume Custom Program Recommendation

Recommendation #12

Projects that replaced coke oven gas pipelines and pipe insulation often assumed that the measure condition at the end of the measure EUL is the same as when it was replaced; however, at that point the annual savings would be zero relative to the baseline condition. Assuming a linear fouling rate, the average savings over the life of the projects should be 50 percent of the first-year savings.

Resolution:

The AC accepts the Auditor's recommendation that the net cumulative natural gas savings for two projects (2014-IND-0608, 2014-IND-0609) should be decreased by a total of 40,834,200 m^3 from their verified values.

Commercial/Industrial Custom Projects

Specific Project Recommended Adjustments

Recommendation #13

2014-IND-0178, 2014-IND-0112, 2014-COM-0079, 2014-IND-0115. Savings were reduced by 50 percent due to a lack of documentation of customer standard maintenance procedures.

Resolution:

The AC agrees that the customer's standard maintenance and operations practices must be documented and that if the documented evidence is not sufficient to support the basecase, then savings for that project should be set to zero.

The AC also agrees that capturing a customer's standard maintenance and operations practices can be accomplished with a standard form that is filled out as part of the project application. For 2015 O&M custom projects, Union has developed a formalized approach to capture customer's standard maintenance and operations practices via a standard form. Union will use this form to support the basecase and demonstrate incremental savings from the customer's standard practices.

The AC accepts the Auditor's recommendation that the net cumulative natural gas savings for four CI projects should be decreased by a total of 7,237,712 m^3 from their verified values.

Large Volume Custom Projects

Specific Project Recommended Adjustments

Recommendation #14

2014-IND-0649, 2014-IND-0487, 2014-IND-0664, 2014-IND-0356, 2014-IND-0522, 2014-IND-0543. Savings were reduced by 50 percent due to a lack of documentation of customer standard maintenance procedures.

Resolution:

The AC agrees that the customer's standard maintenance and operations practices must be documented and that if the documented evidence is not sufficient to support the basecase, then savings for that project should be set to zero.

The AC also agrees that capturing a customer's standard maintenance and operations practices can be accomplished with a standard form that is filled out as part of the project application. For 2015 O&M custom projects, Union has developed a formalized approach to capture customer's standard maintenance and operations practices via a standard form. Union will use this form to support the basecase and demonstrate incremental savings from the customer's standard practices.

The AC accepts the Auditor's recommendation that the net cumulative natural gas savings for six Large Volume projects should be decreased by a total of 28,163,385 m^3 from their verified values.

Recommendation #15

2014-IND-0670. See rationale above for 2014-IND-0649. Reduction in the verified value for EUL is due to a small percentage of leaks due to trap repair; EUL was adjusted back to rounded value (20 years).

Resolution:

The AC accepts the Auditor's recommendation that the net cumulative natural gas savings for this Large Volume project should be decreased by a total of 4,283,078 m^3 from its verified value.

Recommendation #16

2014-IND-0608, 2014-IND-0609. The verified savings assume a 0.75 adjustment factor; however, the audit assumes that at the end of EUL, the condition of the pipe is the same as when it was replaced. At this point, the annual savings would be zero relative to the baseline condition. Assuming a linear fouling rate, the average savings over the life of the projects should be 50 percent of the first-year savings

Resolution:

The AC accepts the Auditor's recommendation that the net cumulative natural gas savings for these two Large Volume projects should be decreased by a total of 40,834,200 m^3 from their verified values.

Impacts of Audit Recommendations

Claimed Cumulative m3 savings

Recommendations that adjusted cumulative m^3 savings had the following impact to values claimed in Union's pre-audit Annual Report.

Table 1 – Impact of Audit Recommendations on 2014 Cumulative Gas Savings (m^3)

Scorecard	Union Pre-Audit Annual Report	Audit Findings	Difference
Resource Acquisition	1,091,829,914	961,571,810	-130,258,104
Large Volume (Rate T1, Rate T2, Rate 100	1,105,607,526	870,195,452	-235,412,074
Low Income	59,655,123	57,692,170	-1,962,953
Market Transformation	NA	NA	NA
Total	**2,257,092,563**	**1,889,459,432**	**-367,633,131**

Claimed DSM Incentive Amounts

Recommendations that resulted in adjustments to cumulative m^3 savings had the following impact on the Utility DSM incentive values claimed in Union's pre-audit Annual Report.

Table 2– Impact of Audit Recommendations on 2014 DSM Utility Incentives

Scorecard	Union Pre-Audit Annual Report	Audit Findings	Difference
Resource Acquisition	$5,666,634	$5,666,634	$0
Large Volume (Rate T1, Rate T2, Rate 100	$0	$0	$0
Low Income	$2,763,699	$2,763,699	$0
Market Transformation	$557,358	$557,358	$0
Total	**$8,987,690**	**$8,987,690**	**$0**

Claimed LRAM Amounts

Recommendations that adjusted annual m^3 savings had the following impact on the Utility LRAM values claimed in Union's pre-audit Annual Report.

Table 3 – Impact of Audit Recommendations on 2014 LRAM Claim

Rate Class	**Union Pre-Audit Annual Report**	**Audit Findings**	**Difference**
South			
M4 Industrial	$88,139	$78,521	$ -9,618
M5 Industrial	$164,486	$146,491	$ -17,995
M7 Industrial	$24,345	$21,691	$ -2,654
T1 Industrial	$2,765	$1,968	$ -797
T2 Industrial	$2,635	$2,266	$ -369
South Total	**$282,369**	**$250,937**	**$ -31,432**
North			
20 Industrial	$24,263	$21,606	$ -2,657
100 Industrial	$43,513	$37,421	$ -6,092
North Total	**$67,776**	**$59,027**	**$ -8,749**
Total	**$350,145**	**$309,964**	**$ -40,181**

Union Gas Limited

Request for Proposal
Independent Audit of 2014 DSM Program Results

BACKGROUND

Union Gas Limited has been delivering Demand Side Management (DSM) initiatives since 1997 to its broad customer base. DSM activities include planning, developing, implementing and evaluating energy efficiency initiatives for residential, commercial, industrial and low income markets. Union Gas Limited's DSM activities are regulated by the Ontario Energy Board (OEB/Board) and adhere to the requirements as laid out in EB-2008-0346, the DSM Guidelines for Natural Gas Utilities (Guidelines).

The Guidelines include two financial mechanisms: the Demand Side Management Variance Account (DSMVA) and the Lost Revenue Adjustment Mechanism (LRAM), with a provision for a DSM Shareholder Incentive. For 2014, the Guidelines establish an annual cap for the 2014 DSM Shareholder Incentive at $10.82M.

Program results are presented in a detailed Draft Evaluation Report which is then subject to a third party audit. The 2014 DSM Draft Evaluation Report contains a review of DSM program results across Resource Acquisition, Large Volume, Low Income and Market Transformation program types and will be provided to the auditor.

As part of the current framework, the utilities worked with intervenor (active participants before the OEB) stakeholder groups to develop a "Joint Terms of Reference on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution Inc. and Union Gas Limited" (ToR) for the 2012-2014 Plan period.[2]

In accordance with the ToR, each utility will have an Audit Committee (AC). Comprised of three intervenor representatives and a utility representative, the goal of the AC is to ensure that there is, each year, an effective and thorough audit of Union Gas Limited's DSM results.

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[2] Joint Terms of Reference on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution Inc. and Union Gas Limited, November 4, 2012.

OBJECTIVE

The primary objective of the audit is to provide an independent opinion to DSM stakeholders (i.e. the OEB, Intervenor consultative members, and the utility), that serves to determine if the DSMVA, LRAM and utility DSM Shareholder Incentive calculations are appropriate.
The auditor should include in their final report or subsequent memo an independent professional opinion in the following form, with or without qualifications:

We have audited the Evaluation Report, DSM Shareholder Incentive, Lost Revenue Adjustment Mechanism (LRAM) and Demand Side Management Variance Account (DSMVA) of Union Gas Limited for the calendar year ended December 31, 2014. The Evaluation Report and the calculations of DSM Shareholder Incentive, LRAM, and DSMVA are the responsibility of the company's management. Our responsibility is to express an opinion on these amounts based on our audit.

We conducted our audit in accordance with the rules and principles set down by the Ontario Energy Board in the DSM Guidelines for Natural Gas Utilities (EB-2008-0346). Details of the steps taken in this audit process are set forth in the Audit Report that follows, and this opinion is subject to the details and explanations therein described.

In our opinion, and subject to the qualifications set forth above, the following figures are calculated correctly using reasonable assumptions, based on data that has been gathered and recorded using reasonable methods and accurate in all material respects, and following the rules and principles set down by the Ontario Energy Board that are applicable to the 2014 DSM programs of Union Gas Limited:

DSM Shareholder Incentive Amount Recoverable	-	*$ x,xxx,xxx*
LRAM Amount Recoverable	-	*$ x,xxx,xxx*
DSMVA Amount Recoverable	-	*$ x,xxx,xxx*

REPORTING STRUCTURE

The 2014 Union Gas AC members are:
- Vince DeRose representing Canadian Manufacturers & Exporters;
- Kai Millyard representing Green Energy Coalition;
- Judy Simon representing Low Income Energy Network; and,
- Tina Nicholson, Union Gas.

The AC members, together with the utility representative, endeavor to reach consensus on both a bidders list for the auditor RFP and selection of the winning bid. In the event consensus is not possible, the utility has responsibility for final selection of the firms on the bidders list and the non-utility AC members make the final decision on the selection of the auditor from among those submitting bids. In practice, consensus on both has been the norm.

The following excerpts from the ToR outline the primary function of the AC with respect to the Audit itself:

- "The auditor will receive guidance and direction from the AC (e.g., on the scope of work, draft work plans, and draft work products). However, the auditor's report and effort will be independent of utility or intervenor control or influence."[3]
- The AC will make recommendations based on the Audit Report regarding the utility's claims regarding DSM results and DSMVA, LRAM, and utility DSM Shareholder incentives through the AC Report submitted to the Board.

The AC will also help to ensure that the process enables the utility to file the Final Audit Report and recommended DSMVA, LRAM and DSM Shareholder Incentive claims by June 30th as required by the Board's Directive and in keeping with the Guidelines.

While the AC will provide guidance and direction throughout the audit process, "The utility will administer the audit contract and hold the auditor accountable to the terms of the contract."[4]

The initial start-up meeting with the auditor will be held with all members of the AC to ensure a consistent understanding among all parties of the scope and expectations of the independent audit. Regular additional meetings between all Committee members and the auditor will be arranged for group discussion and progress reporting. Meetings will be held at Company offices or through conference calls as appropriate.

SCOPE AND REQUIREMENTS

The auditor shall, at a minimum:

- provide an audit opinion on the DSMVA, LRAM and DSM Shareholder Incentive amounts proposed by the natural gas utility and any amendment thereto;
- identify any input assumptions that either warrant further research or that should be updated with new best available information;
- audit the reasonableness of Custom Project Savings Verification (CPSV) reports produced by independent 3rd-party engineering firms and, if necessary and appropriate, propose modifications to custom C&I project savings realization rates;

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[3] Joint ToR on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution Inc. and Union Gas Limited, November 4, 2012, page 15 of 21.

[4] Ibid, page 15 of 21.

- audit the reasonableness of any other evaluation work (examples include but are not limited to - studies of installation rates and/or persistence of installation of measures) that has been undertaken to inform utility savings estimates; and,
- recommend any forward-looking evaluation work to be considered.

The auditor selected for this task will be expected to exercise his/her expert judgment to determine the elements of the audit, and to set the approach and process that will be followed in the audit in order to meet the regulatory requirements as stated above.

The deliverable will be a written report outlining the principles of the audit, the methodology followed, and the findings and recommendations of the audit, including an opinion in the form set forth above.

The following list outlines activities that are expected to be carried out for the purpose of this audit. In their review of the DSM program results from Resource Acquisition, Large Volume, Low Income and Market Transformation program types, the auditor is encouraged to propose other tasks that they believe would be helpful in reaching the study objective.

Audit Activities

1. The auditor will review the accuracy and reasonableness of Union Gas Limited's claims regarding achievement relative to Resource Acquisition, Large Volume, Low Income and Market Transformation performance metrics.
2. Consider and respond to stakeholder comments on Union Gas Limited's Draft Evaluation DSM Report for 2014, including those of the AC.
3. Review Union Gas Limited's 2014 procedures for tracking program participants and determine whether they lead to accurate counts, particularly for programs that do not provide customer rebates.
4. Determine whether Union Gas Limited's reported values for participation and measure input assumptions are appropriate for calculation of LRAM and DSM Shareholder Incentive. This shall include assessing:
   (i) whether values are adequately documented by program records, evaluation studies and other relevant data; and
   (ii) the reasonableness of prescriptive measure input assumptions – measure lives, annual gas savings and free rider rates – for the calculation of LRAM and DSM Shareholder Incentives. The auditor will be provided with the most recent set of prescriptive measure input assumptions upon which Union Gas

Limited relies in estimating savings.[5] Note that only some of those prescriptive assumptions were reviewed and approved by the Technical Evaluation Committee (TEC). Only the TEC-approved assumptions will be rebuttably presumed to be correct unless the auditor has compelling information to the contrary. Recommendations to change input assumption must be explained and, to the extent practical, documented with appropriate references and/or other forms of substantiation.

5. Review measures that are considered advancements (sometimes called "early retirement" measures) rather than purchases at times of natural equipment replacement to ensure measure lives and gas savings are treated appropriately.
6. Review and verify the accuracy of all calculations leading up to the proposed DSMVA, LRAM, and DSM Shareholder Incentive amounts and verify that the calculations are consistent with the Board-approved prescribed methodology.
7. In accordance with OEB direction, Union Gas Limited, in consultation with their AC have retained independent third party engineering consultants to undertake a detailed evaluation of gross savings estimates for custom projects under what is commonly called their Custom Project Savings Verification (CPSV) process. The CPSV Terms of Reference will be provided to the auditor. These Terms of Reference include a detailing of the types of information the CPSV firms are expected to provide for each project they review in their CPSV evaluation reports. The AC has made provision for the auditor to work with the selected CPSV firm to enable the review of both the draft and final reports and an opportunity to discuss individual projects, any findings and adjustment factors recommended throughout the CPSV firm's evaluation. The Auditor will be expected to provide its independent opinion on all claimed results, including those that come out of the CPSV process. This will include its opinion on the reliability and reasonableness of the error ratio (and/or realization rate) from the CPSV reports when applied to a larger population of custom projects. Recommendations to change findings from those recommended by the CPSV firm must be explained and, to the extent practical, documented with appropriate references and/or other forms of substantiation. If the auditor cannot identify a reference, the auditor must provide a reasonable rationale for its assumption.
8. The auditor will also review all verification studies conducted in support of the DSM Evaluation Report and ensure the conclusions are sound and that the results have been appropriately incorporated into the calculation of the DSM Shareholder Incentive.

[5] "If the input assumptions used by the natural gas utilities vary from those on the Board's approved list, the variation(s) should be identified, and additional information supporting the variation(s) should be filed." EB-2008-0346, the DSM Guidelines for Natural Gas Utilities, page 40.

9. Identify any assumptions underlying Union Gas Limited's DSM program design that should be modified prospectively, based on the auditor's experience, the results of the audit, and knowledge of other studies or data.
10. Identify future evaluation research opportunities to enhance the assumptions used to calculate the DSM Shareholder Incentive and LRAM.
11. Work with the AC and Union Gas Limited to resolve any relevant issues prior to completion of the audit.
12. Identify any other matters considered by the auditor to be relevant to an assessment of Union Gas Limited's DSMVA, LRAM and DSM Shareholder Incentive claims.

Audit Resources

To assist the auditor in conducting the audit, all relevant Union Gas Limited documentation will be made available to the auditor for review. Union Gas Limited is committed to providing the necessary data and tools the auditor deems reasonably necessary in order to meet the ultimate goal of the audit.

SCHEDULE

Following the Board Directive of December 2004, the independent audit of DSM results is to be completed and a recommendation filed with the Board by the last day of the sixth month after the financial year end.

Due to the importance to meet these Board imposed deadlines, the auditor will be contractually bound to meet the deadlines outlined in their proposal. If due to the auditor's negligence, the auditor has not provided the AC with the deliverables, 10% of the amount payable to the auditor may be deducted for each week beyond the deliverable dates specified herein that the auditor has not provided the AC with the deliverables.

Audit Schedule	
Activity	**Due**
RFP Dissemination	December 16, 2014
Questions of Clarification	December 19, 2014
Proposal Due	January 9, 2015
Contract Awarded	January 16, 2015
Auditor Work Plan	Week of January 19, 2015
Launch Meeting	Week of January 19, 2015
Draft DSM Annual Report sent to Auditor*	April 1, 2015
AC & Consultative Comments on Annual Report	April 15, 2015
CPSV Draft Reports	Week of April 6, 2015
CPSV Final Reports	Week of April 27, 2015
Draft Audit Report	On or before May 18, 2015
Response from AC	On or before May 25, 2015
Final Draft Audit Report	On or before June 1, 2015
Final Audit Report	On or before June 8, 2015

*Draft DSM Annual Report will be prepared with pre-CPSV results, unless CPSV results are available

SELECTION CRITERIA

Proposals will be evaluated on the following criteria listed in approximate order of importance:

Qualifications & Experience of Project Team

- Qualification and experience of key project personnel in evaluation of natural gas utility DSM programs;
- Relevant engineering experience (preference for a PEng), particularly in understanding Commercial and Industrial Custom Projects;
- Demonstrated ability to work with (and be viewed as credible and objective by) a variety of different types of stakeholders, including utilities, environmental groups, consumer groups and industry;
- Experience in Ontario and knowledge of the DSM regulatory framework for natural gas utilities;

- Experience to include both market transformation and resource acquisition programs for all market sectors (residential, commercial, industrial, and low-income).

Approach

- Logical presentation of a reasonable, clear, and comprehensive approach and method; and supporting rationale for approach including description of quantitative and qualitative assessments that will be conducted;
- Quality, depth and clarity of writing in the proposal and work plan.

Cost and Administration

- Reasonableness of cost proposal including allocation of dollars per task and team member;
- Ability to work in Eastern Standard Time (E.S.T.) regular business hours.

MANDATORY PROPOSAL REQUIREMENTS

The proposal must include the following elements:

- A clear disclosure of any potential conflict of interest;
- A description of the methodology and approach to be used in the audit;
- A list of proposed tasks;
- Suitable information for the AC to determine the qualifications of individuals and their roles in the project:
  - Breadth of expertise in impact evaluations of gas DSM
  - Experience in developing deemed savings and/or review of year end savings calculations
  - Identify exact nature of historic experience with DSM in Ontario
  - Identify and describe technical expertise that the firm would bring to the role for the review of the CPSV
  - Focus on examples of experience in the past 5 years;
- Confirmation that the proponent will be able to meet Union Gas Limited's contractor insurance and WSIB requirements; and,
- Confirmation of ability to meet timelines or specific reasons why a deviation from the schedule is required.

The cost proposal must include:

- Breakout of costs by task and roles;
- Assumptions regarding the number of meetings at Union Gas Limited offices and the associated costs; and,

- Hourly rates for additional related work such as appearing as an expert witness at the OEB.

Proposals are due no later than 4:00pm EST January 9, 2015. Proposals must be submitted in electronic format via email.

Questions of clarification should be directed to Union Gas Limited representatives at the coordinates indicated below. Responses to questions of clarification will be circulated to all respondents.

Proposals must be sent to the attention of all stakeholders listed in Appendix A.

APPENDIX A – AUDIT CONTACTS

Union Gas Representatives
Eric Buan - ebuan@uniongas.com
Tina Nicholson - tnicholson@uniongas.com

Intervenor Representatives:
Vince DeRose - vderose@blg.com;
Kai Millyard - kai@web.ca;
Judy Simon - judysimon@jsimon.net