
DNV·GL

ONTARIO GAS DSM EVALUATION CONTRACTOR

2016 Natural Gas Demand-Side Management Annual Verification

Ontario Energy Board

Date: October 30, 2018



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Table of Contents

1	EXECUTIVE SUMMARY	1
1.1	Results	1
1.2	2016 Annual Verification Recommendations	6
2	INTRODUCTION.....	10
2.1	Background	10
2.2	Method Summary	12
3	ENBRIDGE GAS DISTRIBUTION, INC.	16
3.1	Scorecard Achievements	16
3.2	Program Spending and Cost-Effectiveness	21
3.3	DSM Shareholder Incentive and Lost Revenue	22
4	UNION GAS LIMITED.....	24
4.1	Scorecard Achievements	24
4.2	Program Spending and Cost-Effectiveness	30
4.3	DSM Shareholder Incentive and Lost Revenue	31
5	FINDINGS AND RECOMMENDATIONS.....	32
5.1	2015 Annual Verification Recommendations	32
5.2	CPSV Recommendations	41
5.3	Measure Life Study Recommendations	58
6	APPENDICES	60
Appendix A	Glossary of Terms and Key Concepts	61
Appendix B	Summary of Verification Adjustments	64
Appendix C	Data and Documentation Requests	66
Appendix D	Description of Data Received	71
Appendix E	Resource Acquisition Scorecards	74
Appendix F	Low Income Scorecards	123
Appendix G	Large Volume Scorecards	146
Appendix H	Market Transformation Scorecards	153
Appendix I	Performance Based (Union) and Market Transformation (Enbridge) Scorecards	173
Appendix J	Review of lost revenue and DSM shareholder incentive calculations	186
Appendix K	Lost revenue and DSM shareholder incentive: detailed tables	193
Appendix L	Prescriptive Savings Verification	199
Appendix M	Program Spending Tables	236
Appendix N	Cost-Effectiveness Methodology	239
Appendix O	Final Annual Verification EM&V Plan	255
Appendix P	Report: Custom Measure Life Review	275
Appendix Q	Report: Custom Program Savings Verification	276

AUDIT OPINION

The Evaluation Contractor team¹ (DNV GL, Itron, and Dunsky) provides the following opinion on the utility-achieved energy savings, lost revenue, and shareholder incentive of the demand-side management (DSM) programs offered by Enbridge Gas Distribution, Inc. and Union Gas Limited for the calendar year ending December 31, 2016.

Our opinion stems from our review of the program documentation, utility shareholder incentive calculations, and lost revenue calculations as set forth in the report that follows. It is also based on the information available at the time that this report was published.

In our opinion, the following figures are reasonable, subject to the qualifications given above.

Definition	Enbridge Gas Distribution, Inc. Results	Union Gas Limited Results
Shareholder Incentive	\$4,480,052	\$3,886,112
Lost Revenue	\$14,656	\$181,682
Verified Net Cumulative Energy Savings (m ³)	837,114,041	959,435,289
Total Dollars Spent (not reviewed)	\$55,648,285	\$45,305,294
Cost Effectiveness (TRC-plus test)	2.6	2.9

¹ DNV GL leads the Evaluation Contractor team and led the evaluation of the 2016 DSM programs, with contributions from Itron and Dunsky.

1 Executive Summary

This document has been prepared for the Ontario Energy Board (OEB) and outlines the results of the annual verification of Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) programs² delivered in 2016. These verifications were conducted by the Evaluation Contractor (EC) team comprised of DNV GL, Itron, and Dunsky.

The annual verification assembles the results of all evaluation studies conducted on the 2016 programs and applies them to the gas energy savings and achieved scorecard metrics reported by the utilities. For programs or metrics where no recent studies have been performed, the EC team conducts a due diligence review to verify the savings or metrics reported by the utilities.

The overall objectives of the evaluations are to:

- Provide an independent opinion on whether lost revenue and DSM shareholder incentive have been calculated correctly using the most appropriate information.
- Recommend future evaluation research opportunities to enhance the future natural gas savings estimates and other assumptions used to calculate DSM shareholder incentive and lost revenue amounts.
- Recommend changes to improve input assumptions, verification procedures, and the overall verification process.

Lost revenue is the product of the verified natural gas energy savings (in annual cubic meters) by rate class and the cost (the delivery rate) of the natural gas by rate class for the program year.

DSM shareholder incentive is the actual program achievements compared to the scorecard metrics for that program, the weight placed on each metric within each scorecard, and the maximum incentive achievable for that scorecard.

1.1 Results

Table 1 through Table 5 show Enbridge verified savings, DSM shareholder incentive, lost revenue, and cost effectiveness results, respectively. Table 6 through Table 10 show the same for Union.

² Throughout this report, the word "program" is used to reflect the OEB's understanding of a program. The utilities define it differently. See Appendix N for additional detail.

1.1.1 Enbridge

Table 1. Enbridge verified savings results*

Program	Draft Utility-Reported Savings†		Verification Results		Verification Results	
	Gross Cumulative (m ³)	Net Cumulative (m ³)	Realization Rate	Net-to-Gross	Gross Cumulative (m ³)	Net Cumulative (m ³)
Resource Acquisition						
Home Energy Conservation	270,230,271	229,695,730	100%	85%	270,230,271	229,695,730
Residential Adaptive Thermostats	47,258,250	45,367,920	100%	96%	47,258,250	45,367,920
C&I Custom	50,514,695	34,434,566	105%	29%	53,195,827	15,456,573
C&I Direct	78,386,850	74,467,508	100%	95%	78,386,850	74,467,508
C&I Prescriptive	35,746,759	29,570,582	100%	83%	35,746,886	29,570,692
Energy Leaders Initiative	296,010	296,010	89%	100%	264,633	264,633
Small Volume Customers	482,432,834	413,832,315	101%	81%	485,082,717	394,823,056
C&I Custom	774,623,471	516,068,816	109%	35%	846,335,647	299,900,768
C&I Direct	4,943,250	4,696,088	100%	95%	4,943,250	4,696,088
C&I Prescriptive	24,844,439	21,806,899	100%	88%	24,844,440	21,806,900
Energy Leaders Initiative	429,760	429,760	95%	100%	406,553	406,553
Run-it-Right	3,870,040	3,870,040	100%	50%	3,870,040	1,937,342
Large Volume Customers	808,710,959	546,871,603	109%	37%	880,399,930	328,747,651
Resource Acquisition Total	1,291,143,794	960,703,918	106%	53%	1,365,482,647	723,570,706
Low Income						
Single Family (Part 9)	28,855,783	28,816,206	100%	100%	28,854,207	28,814,754
Multi-residential (Part 3)	82,368,350	82,345,391	103%	100%	84,751,540	84,728,581
Low Income Total	111,224,133	111,161,597	102%	100%	113,605,747	113,543,335
Grand Total	1,402,367,927	1,071,865,515	105%	57%	1,479,088,394	837,114,041

*Not all values may compute exactly due to rounding.

†Enbridge did not report small volume and large volume savings by program. These are the tracking savings. The net cumulative reported savings were 413,830,000 for small volume and 546,870,000 for large volume customers.

Table 2. Enbridge DSM shareholder incentive results*

Scorecard	Draft Utility-Reported DSM Shareholder Incentive	Verified DSM Shareholder Incentive
Resource Acquisition	\$4,036,376	\$2,773,187
Low Income	\$1,167,710	\$1,214,841
Market Transformation	\$515,001	\$492,023
Total	\$5,719,087	\$4,480,052

*Not all values may compute exactly due to rounding.

Table 3. Enbridge lost revenue results*

Rate Class	Utility-Reported Draft Lost Revenue†	Verified Lost Revenue
Rate 110	\$15,801	\$9,230
Rate 115	\$2,230	\$1,196
Rate 135	\$402	\$298
Rate 145	\$921	\$325
Rate 170	\$5,344	\$3,607
Total	\$24,699	\$14,656

*Not all values may compute exactly due to rounding.

†Enbridge-reported lost revenue values reflect those presented in Enbridge's draft 2016 report, 'Actual LR \$' values, not 'LR Allocation \$' values.

Table 4. Enbridge summary of cost-effectiveness ratio results*³

Scorecard	Draft using Utility-Tracking Savings†		Final Verified Ratio	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	2.6	3.8	2.7	2.9
Low Income	1.9	1.9	1.9	2.0
Total Portfolio	2.5	3.5	2.6	2.7

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification. TRC means Total Resource Cost. PAC means Program Administrator Cost.

Table 5. Enbridge summary of cost-effectiveness net present value results*

Scorecard	Draft Net Present Value (M\$) using Utility-Tracking Savings†		Final Verified Net Present Value (M\$)	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	123.8	109.4	95.5	72.9
Low Income	9.5	8.0	10.0	8.4
Total Portfolio	133.3	117.4	105.5	81.3

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

³ The TRC test includes the costs and benefits experienced by the utility system, plus costs and benefits to program participants, and is often considered to measure the net benefits to the region as a whole. The PAC test includes the costs and benefits experienced by the entity (in this case, the utilities) implementing the program, such as overhead and incentive costs.

1.1.2 Union

Table 6. Union verified energy savings results*

Program	Draft Utility-Reported Savings		Verification Results		Verification Results	
	Gross Cumulative (m ³)	Net Cumulative (m ³)	Realization Rate†	Net-to-Gross†	Gross Cumulative (m ³)	Net Cumulative (m ³)
Resource Acquisition						
Home Reno Rebate	125,749,150	119,461,693	92%	95%	116,116,765	110,310,927
Residential	125,749,150	119,461,693	92%	95%	116,116,765	110,310,927
C&I Custom	1,538,593,562	707,753,039	101%	35%	1,549,389,969	544,862,192
C&I Prescriptive	187,421,802	167,540,559	93%	92%	173,961,480	159,584,798
C&I Direct Install	0	0	-	-	0	0
Commercial & Industrial	1,726,015,364	875,293,598	100%	41%	1,723,351,449	704,446,990
Resource Acquisition Total	1,851,764,514	994,755,291	99%	44%	1,839,468,214	814,757,917
Large Volume						
Large Volume	845,977,484	346,931,144	101%	9%	853,595,980	79,848,302
Large Volume Total	845,977,484	346,931,144	101%	9%	853,595,980	79,848,302
Low Income						
Home Weatherization	46,352,827	46,352,465	99%	100%	45,754,573	45,754,203
Indigenous	0	0	-	-	0	0
Furnace End-of-Life	29,106	29,106	100%	100%	29,106	29,106
Multi-Family (Social and Assisted)	10,196,400	9,687,434	112%	95%	11,467,220	10,894,572
Multi-Family (Market Rate)	8,306,439	7,891,117	103%	95%	8,580,200	8,151,189
Low Income Total	64,884,772	63,960,122	101%	98%	65,831,099	64,829,070
Grand Total	2,762,626,770	1,405,646,557	100%	35%	2,758,895,293	959,435,289

*Not all values may compute exactly due to rounding.

Table 7. Union DSM shareholder incentive results*

Scorecard	Draft Utility-Reported DSM Shareholder Incentive	Verified DSM Shareholder Incentive
Resource Acquisition	\$3,437,543	\$2,583,320
Low Income	\$1,188,999	\$1,240,947
Large Volume	\$0	\$0
Market Transformation	\$0	\$0
Performance Based	\$61,844	\$61,844
Total	\$4,688,386	\$3,886,112

*Not all values may compute exactly due to rounding.

Table 8. Union lost revenue results*

Rate Class	Utility-Reported Draft Lost Revenue	Verified Lost Revenue
M4 South Industrial	\$62,461	\$44,781
M5 South Industrial	\$149,819	\$118,225
M7 South Industrial	\$17,222	\$13,830
T1 South Industrial	\$905	\$736
T2 South Industrial	\$1,025	\$219
20 North Industrial	\$5,006	\$3,691
100 North Industrial	\$715	\$199
Total	\$237,154	\$181,682

*Not all values may compute exactly due to rounding.

Table 9. Union summary of cost-effectiveness ratio results*

Scorecard	Draft using Utility-Tracking Savings†		Final Verified Ratio	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	3.2	6.5	3.0	5.4
Low Income	1.5	1.2	1.5	1.2
Large Volume	6.2	19.8	5.0	4.6
Total Portfolio	3.4	6.1	2.9	4.3

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

Table 10. Union summary of cost-effectiveness net present value results*

Scorecard	Draft Net Present Value (M\$) using Utility-Reported Savings†		Final Verified Net Present Value (M\$)	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	152.7	151.5	124.8	121.5
Low Income	4.9	1.6	5.3	1.9
Large Volume	57.7	56.3	12.7	10.6
Total Portfolio	215.3	209.4	142.7	134.1

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

1.2 2016 Annual Verification Recommendations

This section provides a summary of recommendations from the EC's 2016 annual verification efforts and the anticipated primary outcome of each recommendation, if implemented. The primary outcomes of the recommendation are based on three broad categories:

- Increase or reduce costs (evaluation or program or both)
- Improve savings accuracy
- Decrease risk (multiple types including risk of adjusted savings, risk to budgets or project schedules, and others)

The complete findings, recommendations, and outcomes of the 2016 annual verification efforts and other evaluations conducted on 2016 programs are found in section 5.

Table 11. Overall Annual Verification - summary of recommendations

#	Finding	Recommendation	Recommended in 2015	Applies to 2016			Primary Outcome		
				Union	Enbridge	Evaluation	Reduce Costs	Improve Accuracy	Decrease Risk
O1	The Enbridge tracking file does not currently include information that allows the evaluator to identify all the projects installed by a single customer.	A: Consider investing in a relational program tracking database.	✓	✓	✓		✓	✓	✓
		B: Enbridge should include site-level information for all measures installed through the program.	✓		✓			✓	✓
O2	The format of Enbridge's tracking data is not well suited to a combined evaluation with the Union data.	A: Enbridge should deliver tracking data in a single flat file.	✓		✓		✓	✓	✓
		B: Consider investing in a relational program tracking database.	✓	✓	✓		✓	✓	✓
O3	Neither Union nor Enbridge tracking databases currently use prescriptive measure descriptions that map directly to the approved energy savings spreadsheet (TRM).	A: Develop, maintain, and use an electronic summary spreadsheet of the TRM.	✓	✓	✓	✓	✓	✓	✓
		B: Once the electronic TRM spreadsheet is developed, track prescriptive savings using unique measure descriptions that map to electronic TRM.	✓	✓	✓	✓	✓	✓	✓

#	Finding	Recommendation	Recommended in 2015	Applies to 2016			Primary Outcome		
				Union	Enbridge	Evaluation	Reduce Costs	Improve Accuracy	Decrease Risk
		C: Once the electronic TRM spreadsheet is developed, utilize the same electronic TRM for both utilities		✓	✓	✓	✓	✓	✓
		D: OEB: develop means for consistent system				✓	✓	✓	✓
O4	Different TRMs were used by utilities for savings calculations.	A: Explicitly agree to the TRM version to utilize for measure-inputs		✓	✓	✓	✓	✓	✓
		B: Use the same TRM version for both utilities for each program year		✓	✓	✓	✓	✓	✓
O5	DNV GL and other EAC members were sometimes confused about appropriate sources and the definition of terms.	A: Evaluation Contractor: distribute to the EAC a list of the anticipated sources at the start of the verification process, possibly within the scope of work, for review and verification.				✓			✓
		B: Evaluation Contractor: distribute to the EAC a glossary of terms at the start of the verification process, possibly within the scope of work, for review and verification.				✓			✓
O6	Explicit documentation was not available for all program stages, specifically for non-savings metrics	A: Document each required element and stage for non-savings metrics.		✓	✓	✓	✓		✓

Table 12. Whole house simulation modelling - summary of recommendations

#	Finding	Recommendation	Recommended in 2015	Applies to			Primary Outcome		
				Union	Enbridge	Evaluation	Reduce Costs	Improve Accuracy	Decrease Risk
SM1	Both utilities use building simulation modeling to estimate energy savings	A: Provide both simulation file (HSE) and output file (TSV) to the evaluation team for every project.	✓		✓		✓		✓
SM2	Both utilities collect and deliver <i>some</i> photographs to support retrofit site improvements.	A: Provide more explicit support for major measure installations.	✓	✓	✓				✓
SM3	There were some inaccurate savings entries.	A: Consider reviewing and modifying program processes to avoid data entry or outdated simulation result errors.		✓			✓		✓
		B: Provide more explicit support for major measure installations.	✓	✓	✓		✓		✓
SM4	Air sealing as a savings measure is present in a high percentage of single-family home retro-fit projects.	A: Evaluation: distribute before and after equivalent leakage area and energy savings attributable to reduced air leakage (if possible).				✓		✓	✓
SM5	The energy savings from the home retrofit programs rely exclusively on the simulations provided by the delivery agents.	A: Consider funding a study to verify the models produced by the utility agents.	✓			✓		✓	

Table 13. Cost-effectiveness - summary of recommendations

#	Finding	Recommendation	Recommended in 2015	Applies to			Primary Outcome		
				Union	Enbridge	Evaluation	Reduce Costs	Improve Accuracy	Decrease Risk
CE1	All overhead is still applied at the sector level rather than the program level.	A: Allocate "sector"-level administrative cost and overhead to each individual program	✓	✓	✓		✓	✓	
CE2	Water avoided costs are still based on water rates.	A: Explore the possibility of better defining water costs	✓			✓	✓	✓	
CE3	The utilities used different discount rates.	A: Use a consistent real discount rate of 4% when using real streams of benefits and costs.	✓	✓	✓	✓		✓	
CE4	EUL is inconsistently applied for accelerated projects.	A: Include separate fields in the tracking data to explicitly communicate accelerated, annual and cumulative savings.			✓		✓		
CE5	A reduction factor accounting for removals and non-installs was applied to savings and resource costs.	A: Do not adjust resource costs if the costs are still incurred by the program, even if the equipment is removed.			✓		✓		

2 Introduction

This document has been prepared for the Ontario Energy Board (OEB) and outlines the results of the annual verification of Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) programs⁴ delivered in 2016. These verifications were conducted by the OEB's Evaluation Contractor (EC) team of DNV GL, Itron, and Dunskey.

The annual verification assembles the results of all evaluation studies conducted on the 2016 programs and applies them to the savings and scorecard metrics reported by the utilities. For programs or metrics where no recent studies have been performed, the EC team conducts a due diligence review to verify the savings or metrics reported by the utilities.

The overall objectives of the evaluations are to:

- Provide an independent opinion on whether the lost revenue and DSM shareholder incentive have been calculated correctly using the most appropriate information.
- Recommend future evaluation research opportunities to enhance the future natural gas savings estimates and other assumptions used to calculate DSM shareholder incentive and lost revenue amounts.
- Recommend changes to improve input assumptions, verification procedures, and the overall verification process.

The lost revenue and DSM shareholder incentive are based on the following metrics:

- Lost revenue: the verified natural gas energy savings (in annual cubic meters) by rate class and the cost (the delivery rate) of the natural gas by rate class for the program year
- DSM shareholder incentive: the verified program achievements compared to the scorecard metrics that are relevant for that program, the weight placed on each metric within each scorecard, and the maximum incentive achievable for that scorecard

Therefore, the information that was verified for 2016 includes the program natural gas savings and/or the program achievements compared to the scorecard metrics. The EC also reported the money spent by the programs but did not conduct a full financial audit of the reported amounts. The OEB may conduct financial audits of the gas utilities' DSM spending as it sees fit. The EC used verified savings and program achievements to confirm the lost revenue and DSM shareholder incentive amounts.

2.1 Background

Enbridge and Union deliver energy efficiency programs under the Demand Side Management Framework for Natural Gas Distributors (2015-2020)⁵ developed by the OEB. For the 2015 program year, both utilities "rolled-over" their 2014 plans into 2015 to allow them a smooth evolution into the new DSM framework. For the 2016 program year, the new framework was implemented, resulting in changes to the programs offered, as demonstrated in Table 14.

⁴ Throughout this report, the word "program" is used to reflect the OEB's understanding of a program. The utilities define it differently. See Appendix N for additional detail.

⁵ EB-2014-0134

Table 14. Energy efficiency programs offered in 2015 and 2016

Scorecard	Program Name	2015	2016
Enbridge			
Resource Acquisition	C&I Custom	✓	✓
	C&I Direct Install		✓
	C&I Prescriptive	✓	✓
	Comprehensive Energy Management		✓
	Energy Leaders Initiative		✓
	Home Energy Conservation	✓	✓
	Residential Adaptive Thermostats		✓
	Run it Right (CCM)	✓	✓
	Small Commercial New Construction		✓
Low Income	Low Income Multi-family	✓	✓
	Low Income Single Family	✓	✓
	Home Winterproofing		✓
Market Transformation	Commercial Savings by Design	✓	✓
	Residential Savings by Design	✓	✓
	School Energy Competition	✓	✓
	Run it Right (Participants)		✓
	Comprehensive Energy Management		✓
Home Labelling	Home Labelling	✓	
Union			
Resource Acquisition	C&I Custom	✓	✓
	C&I Prescriptive	✓	✓
	Energy Savings Kit	✓	
	Home Reno Rebate	✓	✓
Low Income	Home Weatherization	✓	✓
	Furnace End-of-Life		✓
	Multi-Family (Social and Assisted)		✓
	Multi-Family (Market Rate)		✓
	Affordable Housing Conservation	✓	
Large Volume	Large Volume	✓	✓
Market Transformation	Optimum Home	✓	✓
	Commercial New Construction		✓
Performance Based	RunSmart		✓
	Strategic Energy Management		✓

The OEB hired the EC team to develop an overall evaluation, measurement, and verification (EM&V) plan and lead an annual verification of the reported utility DSM savings and scorecard achievements. This report is a result of that annual verification.

Under the EM&V plan, a DNV GL-led team of DNV GL, Itron, and Dunsky completed:

- A spillover study of the 2013-2014 programs⁶
- A net-to-gross (NTG) study of the 2015 program year⁷
- A custom project savings verification (CPSV) study of the 2015 program year⁸
- A custom project savings verification (CPSV) study of the 2016 program year⁹

This report includes or applies the results of those studies. Michael's Energy conducted a separate study of custom measure lives. The study does not affect the lost revenue or DSM shareholder incentive for the 2016 program year, but it is attached to this document as one of the studies completed.

The OEB formed an evaluation advisory committee (EAC) to provide input and advice to the OEB and the EC on the evaluation and audit of DSM results. The EAC consists of representatives from OEB staff, the utilities, non-utility stakeholders, independent experts, staff from the Independent Electricity System Operator (IESO), and observers from the Environmental Commissioner of Ontario and the Ministry of Energy. The DNV GL team received feedback from the EAC throughout the CPSV/NTG/spillover studies and received comment, advice, and input on the results of this annual verification. The content included in this report integrates our responses to their input. We thank them for their involvement.

2.2 Method Summary

To verify the utility scorecard metrics discussed in the following sections, the EC conducted the activities outlined in Table 15 and Table 16. The methods used to evaluate the energy savings scorecard metrics fall into two basic categories – those applied to Technical Reference Manual (TRM) measures and those applied to Other measures. Tasks for verification of program metrics are defined as:

- **None:** For programs with no reported program activity or savings, no action was taken.
- **Confirm Tracking:** Confirmation of data within submitted tracking data contributing to savings values.
 - ◆ For prescriptive measures, the EC confirmed measure-level inputs where appropriate (such as free-ridership ratio and savings per unit), then recalculated net savings based on those inputs to verify the recorded net savings for a census of measures.
 - ◆ For metrics other than CCM, the EC confirmed that tracking records match reported metrics (for example, the number of participants in tracking data match utility reported values)
- **Non-TRM factors:** Application of relevant factor(s) that are not otherwise applied in the TRM, such as gross savings adjustments, attribution, and spillover ratios. Where this is the only activity performed by the annual verification (see Table 15 and Table 16), the EC applied the results of the CPSV, NTG, or other study which occurred separate from the annual verification.
- **Desk Review:** File review of relevant documentation to confirm it appropriately utilized non-prescriptive metrics. Unless specifically mentioned otherwise, desk review methods were similar to those used in the

⁶ 2013-2014 CPSV Participant Spillover Results, DNV GL for the Ontario Energy Board, May 23, 2018

⁷ 2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation, DNV GL for the Ontario Energy Board, August 15, 2017

⁸ Ibid

⁹ 2016 Natural Gas Demand Side Management Custom Savings Verification, DNV GL for the Ontario Energy Board, June 29, 2018



2015 verification. Desk review includes tasks such as review of energy software (HOT2000) modeling records and confirmation of customer participation and eligibility for participation metrics.

- **Additional Detailed Sample (non-tracking, non-prescriptive):** For most programs, the EC utilized only tracking data for the evaluation. For some programs, the EC required information for desk review *in addition to* data provided in tracking documents. For example, the EC requested HOT2000 records or documentation to confirm participation and eligibility for a sample of relevant participants in the Home Energy Conservation, Home Reno Rebate, Winterproofing, and Home Weatherization programs. Table 15 and Table 16 show the number of records for which the EC requested the additional information. This additional information is related to that requested by the annual verification only, and not related to other projects (i.e., CPSV, NTG, and spillover).

To prepare for the program-specific evaluation activities, the EC requested tracking data and, where necessary, documentation for a sample of projects or participants from the utilities. For all programs, the EC first reviewed the reported savings and metrics from the gas utilities' tracking data and compared them to the summarized information in the gas utilities' draft annual report to ensure consistency.

After completing the program-specific verifications, the EC assembled the verified scorecard results and calculated the verified lost revenue, DSM shareholder incentive, and cost-effectiveness results. We also documented recommendations that may improve the annual verification process going forward. The full annual verification EM&V plan is in Appendix O. The results presented in this report are based on data collected from:

- Enbridge and Union tracking databases (Round 1 of data requests)
- Enbridge and Union project documentation (Round 2 of data requests)

The data and documentation requests are explained in detail in Appendix C. A description of the data received is provided in detail in Appendix D.

Table 15. Enbridge 2016 annual verification activities, by scorecard

Program		None	Confirm Tracking	Non-TRM Factors	Desk Review	Additional Detailed Sample
Resource Acquisition	C&I Custom			✓		
	C&I Direct Install		✓	✓		
	C&I Prescriptive		✓	✓		
	Comprehensive Energy Management*	✓				
	Energy Leaders Initiative		✓	✓	✓	Census
	Home Energy Conservation		✓	✓	✓	25
	Residential Adaptive Thermostats		✓	✓		
	Run it Right		✓	✓	✓	10
	Small Commercial New Construction	✓				
Low Income	Low Income – Part 9		✓	✓	✓	25
	Multi-Residential (Prescriptive)		✓	✓		
	Multi-Residential (Custom)			✓		
	New Construction		✓		✓	Census
Market Transformation	Commercial Savings by Design		✓		✓	1 Builder 1 Development
	Comprehensive Energy Management*		✓		✓	Census
	Residential Savings by Design		✓		✓	1 Builder 1 Home
	Run it Right		✓		✓	10
	School's Energy Competition		✓		✓	Census

*The Comprehensive Energy Management Program reported new participants in 2016 who enrolled in the program but did not yet realize energy savings, thus claiming participation for the Market Transformation Scorecard but not for the Resource Acquisition Scorecard. As a result, the Market Transformation activity was verified but there was no verification activity for the Resource Acquisition Scorecard for the program.

Table 16. Union 2016 annual verification activities, by scorecard

Program		None	Confirm Tracking	Non-TRM Factors	Desk Review	Additional Sample
Resource Acquisition	C&I Custom			✓		
	C&I Direct Install	✓				
	C&I Prescriptive		✓	✓		
	Home Reno Rebate		✓	✓	✓	25
Large Volume	Large Volume (Custom)			✓		
	Large Volume (Prescriptive)		✓	✓		
Low Income	Indigenous	✓				
	Furnace End-of-Life		✓	✓		
	Home Weatherization		✓	✓	✓	25
	Multi-Family (Market Rate, Prescriptive)		✓	✓		
	Multi-Family (Market Rate, Custom)			✓		
	Multi-Family (Social & Assisted, Prescriptive)		✓	✓		
	Multi-Family (Social & Assisted, Custom)			✓		
Market Transformation	Commercial New Construction	✓				
	Optimum Home		✓		✓	1 Builder 1 Home
Performance-Based	RunSmart		✓		✓	10
	Strategic Energy Management		✓		✓	Census

3 Enbridge Gas Distribution, Inc.

This section reports on the results of the annual verification and scorecard achievements of Enbridge’s 2016 DSM programs.

3.1 Scorecard Achievements

Enbridge has three scorecards: Resource Acquisition, Low Income, and Market Transformation. Table 17 shows the programs included in each scorecard and the appendix that contains a detailed explanation of the verification of each program. For a discussion of the calculations behind the DSM shareholder incentive and lost revenue, see Appendix J.

Table 17. Overview of Enbridge 2016 programs by scorecard

Scorecard	Program	Detailed Appendix
Resource Acquisition	Home Energy Conservation Residential Adaptive Thermostats C&I Custom C&I Direct Install C&I Prescriptive Comprehensive Energy Management Energy Leaders Initiative Run it Right Small Commercial New Construction	Appendix E
Low Income	Home Winterproofing Low Income Multi Residential Low Income New Construction	Appendix F
Market Transformation	Residential Savings by Design Commercial Savings by Design School Energy Competition	Appendix H
Market Transformation (similar to Union Performance Based)	Run it Right Comprehensive Energy Management	Appendix I

Table 18 shows the Enbridge scorecard for 2016, including the target metrics, reported achievement, weight, and maximum shareholder incentive. These were the metrics reviewed as part of the annual verification. The recommendations related to these activities are listed in section 5.

Table 18. Enbridge's unverified, tracked 2016 achievement, target, weight, and shareholder incentive by scorecard

Program	Metric	2016 Target	2016 Tracking Data Achievement* (Reported)	Weight	Utility Draft Incentive†
Resource Acquisition					
Home Energy Conservation Residential Adaptive Thermostats C&I Custom C&I Direct Install C&I Prescriptive Energy Leaders Initiative Run it Right Comprehensive Energy Management Small Commercial New Construction	Small Volume Customers – CCM	319,171,212	413,832,315	40%	\$4,036,376
	Large Volume Customers‡ – CCM	664,619,473	546,871,603	40%	
Home Energy Conservation	Deep Savings Participants (homes)	8,259	12,986	20%	
Low Income					
Single Family (Part 9)	CCM	31,790,000	28,816,206	45%	\$1,167,710
Multi-family (Part 3)	CCM	64,900,000	82,345,391	45%	
Low Income New Construction	Project Applications	6	6	10%	
Market Transformation					
Residential Savings by Design	Builders	33	31	10%	\$515,001
	Homes Built	2,751	2,206	15%	
Commercial Savings by Design	New Developments	33	43	25%	
School Energy Competition	Schools	55	25	10%	
Run it Right	Participants	83	88	20%	
Comprehensive Energy Management	Participants	7	7	20%	
Total Utility Draft Incentive					\$5,719,087

*Values from tracking file submitted to EC by Enbridge, 2016 Annual Report Tracker DNV_2017.09.26.xlsx

†2016 Demand Side Management Draft Annual Report, Enbridge Gas. While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

‡Large volume consumers include commercial customers with a 3-year average annual consumption of greater than 75,000m³/year or industrial customers with a 3-year average consumption of greater than 340,000m³/year

3.1.1 Resource Acquisition

This section summarizes the results of the EC's review of the Enbridge Resource Acquisition scorecard. The metrics for the Resource Acquisition scorecard include:

- Total cumulative large volume customer natural gas savings
- Total cumulative small volume customer natural gas savings
- Number of residential deep savings participants

To verify natural gas savings, the EC team reviewed each program independently. A detailed explanation of the verification activities for all Resource Allocation programs can be found in Appendix E. Verified program achievements are listed in Table 19 with DSM shareholder incentive results in Table 20.

Table 19. Enbridge 2016 Resource Acquisition verified achievements*

Programs	Metrics	Verified Achievement	
		Program	Scorecard Metric Total
Home Energy Conservation	Small Volume Customers CCM	229,695,730	394,823,056
Residential Adaptive Thermostats		45,367,920	
C&I Custom		15,456,573	
C&I Direct		74,467,508	
C&I Prescriptive		29,570,692	
Energy Leaders Initiative		264,633	
Run-it-Right		0	
Comprehensive Energy Management		0	
Small Commercial New Construction		0	
Home Energy Conservation		0	
Residential Adaptive Thermostats	0		
C&I Custom	299,900,768		
C&I Direct	4,696,088		
C&I Prescriptive	21,806,900		
Energy Leaders Initiative	406,553		
Run-it-Right	1,937,342		
Comprehensive Energy Management	0		
Small Commercial New Construction	0		
Home Energy Conservation	Participants	12,986	12,986

*Not all values may compute exactly due to rounding.

Table 20. Enbridge's 2016 Resource Acquisition targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Small Volume Customers CCM Savings	319,171,212	394,823,056	40%	124%	49%
Large Volume Customers CCM Savings	664,619,473	328,747,651	40%	49%	20%
Residential Deep Savings Participants	8,259	12,986	20%	157%	31%
Verified Total Weighted Scorecard Achieved					101%
Verified Scorecard Incentive Achieved					\$2,773,187

*Not all values may compute exactly due to rounding.

Table 21 shows the gross and net cumulative natural gas savings (CCM), as reported by the utility and verified by the EC. The table also shows the realization rates (RR) of the savings, both in terms of gross

savings (reported vs. verified gross) and net savings, which are savings that have been adjusted to exclude free riders and include spillover.

Table 21. Enbridge's verified 2016 Resource Acquisition savings*

Program	Draft Utility-Reported Savings		Verification Results		Verified Savings	
	Gross Cumulative (m ³)	Net Cumulative (m ³)	Realization Rate	Net-to-Gross	Gross Cumulative (m ³)	Net Cumulative (m ³)
Home Energy Conservation	270,230,271	229,695,730	100%	85%	270,230,271	229,695,730
Residential Adaptive Thermostats	47,258,250	45,367,920	100%	96%	47,258,250	45,367,920
C&I Custom	825,138,165	550,503,382	109%	35%	899,531,474	315,357,341
C&I Direct	83,330,100	79,163,595	100%	95%	83,330,100	79,163,595
C&I Prescriptive	60,591,197	51,377,481	100%	85%	60,591,326	51,377,592
Energy Leaders Initiative	725,770	725,770	92%	100%	671,186	671,186
Run-it-Right	3,870,040	3,870,040	100%	50%	3,870,040	1,937,342
Resource Acquisition Total	1,291,143,793	960,703,918	106%	53%	1,365,482,647	723,570,706

*Not all values may compute exactly due to rounding.

3.1.2 Low Income

This section summarizes the results of the EC's review of the Enbridge Low Income scorecard. The metrics for the Low Income scorecard include:

- Total cumulative natural gas savings for single family homes
- Total cumulative natural gas savings for multi-residential homes
- Total applications for Low Income New Construction

To verify natural gas savings, the EC team reviewed each program independently. A detailed explanation of the verification activities for all Low Income programs can be found in Appendix F. Verified program achievements are listed in Table 22 with DSM shareholder incentive results in Table 23.

Table 22. Enbridge 2016 Low Income verified achievements

Programs	Metrics	Verified Achievement	
		Program	Scorecard Metric Total
Single Family (Part 9)	CCM	28,814,754	28,814,754
Multi-residential (Part 3)	CCM	84,728,581	84,728,581
New Construction	Participants	6	6

Table 23. Enbridge's 2016 Low Income scorecard targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Single Family (Part 9) CCM Savings	31,790,000	28,814,754	45%	91%	41%
Multi-residential (Part 3) CCM Savings	64,900,000	84,728,581	45%	131%	59%
New Construction Participants	6	6	10%	100%	10%
Verified Total Weighted Scorecard Achieved					110%
Verified Scorecard Incentive Achieved					\$1,214,841

*Not all values may compute exactly due to rounding.

Table 24 shows the gross and net cumulative natural gas savings (CCM), as reported by the utility and verified by the EC. The tables also show the realization rates (RR) of the savings, both in terms of gross savings (reported vs. verified gross) and net savings, which are those savings that have been adjusted to exclude free riders and include spillover.

Table 24. Enbridge’s verified 2016 Low Income savings*

Program	Draft Utility-Reported Savings		Verification Results		Verified Savings	
	Gross Cumulative (m ³)	Net Cumulative (m ³)	Realization Rate	Net-to-Gross	Gross Cumulative (m ³)	Net Cumulative (m ³)
Single Family (Part 9)	28,855,783	28,816,206	100%	100%	28,854,207	28,814,754
Multi-residential (Part 3)	82,368,350	82,345,391	103%	100%	84,751,540	84,728,581
Low Income Total	111,224,133	111,161,597	102%	100%	113,605,747	113,543,335

*Not all values may compute exactly due to rounding.

3.1.3 Market Transformation

This section summarizes the results of the EC’s review of the Enbridge Market Transformation scorecard. The metrics for the Market Transformation scorecard include the number of:

- Builders for Residential Savings by Design
- Sites (individual homes) built for Residential Savings by Design
- New developments for Commercial Savings by Design
- Participating schools for School Energy Competition
- Participants for Run it Right
- Participants for Comprehensive Energy Management

As some programs are similar to Union Market Transformation programs, and others similar to Union Performance Based programs, the programs are divided between Appendix H (Market Transformation Scorecards) and Appendix I (Performance Based (Union) and Market Transformation (Enbridge) Scorecards), as listed in Table 25.

Table 25. Enbridge Market Transformation program detailed evaluation, by appendix

Enbridge Program	Appendix
Commercial Savings by Design	Appendix H
Residential Savings by Design	
School Energy Competition	
Run it Right	Appendix I
Comprehensive Energy Management	

To verify these achievement metrics, the EC team reviewed each program independently. Verified program achievements are listed in Table 26 with DSM shareholder incentive results in Table 27.

Table 26. Enbridge 2016 Market Transformation verified achievements

Program	Metric	Verified Achievement	
		Program	Scorecard Metric Total
Residential Savings by Design	Builders	31	31
	Homes Built	2,206	2,206
Commercial Savings by Design	New Developments	43	43
School Energy Competition	Participating Schools	25	25
Run-it-Right	Participants	84	84
Comprehensive Energy Management	Participants	7	7

Table 27. Enbridge's 2016 Market Transformation scorecard targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Residential Savings by Design Builders	33	31	10%	94%	9%
Residential Savings by Design Homes Built	2,751	2,206	15%	80%	12%
Commercial Savings by Design New Developments	33	43	25%	130%	32%
School Energy Competition Schools	55	25	10%	45%	5%
Run it Right Participants	83	84	20%	101%	20%
Comprehensive Energy Management Participants	7	7	20%	100%	20%
Verified Total Weighted Scorecard Achieved					99%
Verified Scorecard Incentive Achieved					\$492,023

*Not all values may compute exactly due to rounding.

Table 28 shows the Market Transformation metric achievements, as reported by the utility and verified by the EC. The table also shows the achievement ratio for each program and metric.

Table 28. Enbridge's 2016 Market Transformation reported and verified achievements*

Program	Metric	Reported	Ratio	Verified
Residential Savings by Design	Builders	31	100%	31
	Homes Built	2,206	100%	2,206
Commercial Savings by Design	New Developments	43	100%	43
School Energy Competition	Participating Schools	25	100%	25
Run-it-Right	Participants	88	95%	84
Comprehensive Energy Management	Participants	7	100%	7

*Not all values may compute exactly due to rounding.

3.2 Program Spending and Cost-Effectiveness

This section reports on Enbridge's program spending and cost-effectiveness.

3.2.1 Program Spending

The Enbridge tracking database included reported program spending information. The EC has reported on what was provided by Enbridge and has not verified spending figures or conducted a financial audit. Table 29 summarizes the spending across the portfolio. Additional spending detail is in Appendix M.

Table 29. Enbridge program cost summary*

Spending Area	OEB-Approved Budget	Actual Spending	Difference (\$)	Difference (%)
Programs Sub-total	\$52,861,117	\$ 53,977,669	\$1,116,552	2%
Research	\$ 1,000,000	\$ 248,279	-\$ 751,721	-75%
Evaluation	\$ 1,500,000	\$1,327,235	- \$ 172,765	-12%
Administration	\$ 1,000,000	\$ 95,101	- \$ 904,899	-90%
Total DSM Budget	\$ 56,361,117	\$ 55,648,285	- \$ 712,832	-1%

*Not all values may compute exactly due to rounding.

3.2.2 Cost-Effectiveness

Table 30 and Table 31 show summary results for the TRC-Plus and PAC tests, including the cost-benefit ratio and the net present value. Additional detail is provided in Appendix N.

Table 30. Enbridge summary of cost-effectiveness ratio results*

Scorecard	Draft using Utility-Tracking Savings†		Final Verified Ratio	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	2.6	3.8	2.7	2.9
Low Income	1.9	1.9	1.9	2.0
Total Portfolio	2.5	3.5	2.6	2.7

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

Table 31. Enbridge summary of cost-effectiveness net present value results*

Scorecard	Draft Net Present Value (M\$) using Utility-Tracking Savings†		Final Verified Net Present Value (M\$)	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	123.8	109.4	95.5	72.9
Low Income	9.5	8.0	10.0	8.4
Total Portfolio	133.3	117.4	105.5	81.3

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

3.3 DSM Shareholder Incentive and Lost Revenue

This section reports on the results of the DSM shareholder incentive and lost revenue calculations. The recommendations related to these activities are listed in section 5. See Appendix J for a description of the DSM shareholder incentive and lost revenue calculations and Appendix K for detailed tables.

3.3.1 DSM shareholder incentive

The EC gathered the verified scorecard achievements from section 3.1 to produce the DSM shareholder incentive by scorecard and overall, shown in Table 32. Detailed calculations with targets, weights, achievements and incentives are included in Appendix K.

Table 32. Enbridge DSM shareholder incentive results*

Scorecard	Draft Utility-Reported DSM Shareholder Incentive	Verified DSM Shareholder Incentive
Resource Acquisition	\$4,036,376	\$2,773,187
Low Income	\$1,167,710	\$1,214,841
Market Transformation	\$515,001	\$492,023
Total	\$5,719,087	\$4,480,052

*Not all values may compute exactly due to rounding.

3.3.2 Lost revenue

The EC summed the verified net annual savings (prorated by installation month) by rate class and estimated lost revenues. Table 33 shows the results for each rate class.

Table 33. Enbridge lost revenue results*

Rate Class	Utility-Reported Draft Lost Revenue†	Verified Lost Revenue
Rate 110	\$15,801	\$9,230
Rate 115	\$2,230	\$1,196
Rate 135	\$402	\$298
Rate 145	\$921	\$325
Rate 170	\$5,344	\$3,607
Total	\$24,699	\$14,656

*Not all values may compute exactly due to rounding.

†Enbridge-reported lost revenue values reflect those presented in Enbridge's draft 2016 report, 'Actual LR \$' values, not 'LR Allocation \$' values.

4 Union Gas Limited

This section reports the results of the annual verification and scorecard achievements of Union's 2016 DSM programs.

4.1 Scorecard Achievements

Union has five scorecards: Resource Acquisition, Large Volume, Low Income, Market Transformation, and Performance Based. Table 34 shows the programs included in each scorecard and the appendix that contains a detailed explanation of the verification of each program. For a discussion of the calculations behind the DSM shareholder incentive and lost revenue, see Appendix J.

Table 34. Overview of Union 2016 programs by scorecard

Scorecard	Program	Detailed Appendix
Resource Acquisition	C&I Custom C&I Direct Install C&I Prescriptive Home Reno Rebate	Appendix E
Low Income	Furnace End-of-Life Home Weatherization Indigenous Multi-Family (Social and Assisted) Multi-Family (Market Rate)	Appendix F
Large Volume	Large Volume Program	Appendix G
Market Transformation	Commercial New Construction Optimum Home	Appendix H
Performance Based	RunSmart Strategic Energy Management	Appendix I

Table 35 shows the Union scorecard for 2016, including the target metrics, reported achievement, weight, and maximum shareholder incentive. These were the metrics reviewed as part of the annual verification. The recommendations related to these activities are listed in section 5.

Table 35. Union's reported, unverified 2016 achievement, target, weight, and maximum shareholder incentive by scorecard*

Program	Metric	2016 Target	2016 Tracking Data Achievement† (Reported)	Weight	Utility Draft Incentive†
Resource Acquisition					
C&I Custom C&I Direct Install C&I Prescriptive Home Reno Rebate	CCM	1,214,104,360	994,755,290	75%	\$3,437,543
Home Reno Rebate	Participants	3,300	6,595	25%	
Low Income					
Indigenous Furnace End-of-Life Low Income – Part 9	CCM	37,786,348	46,381,571	60%	\$1,188,999
Multi-Family (Social and Assisted)	CCM	16,216,022	9,687,434	35%	
Multi-Family (Market Rate)	CCM	2,639,817	7,891,117	5%	
Large Volume					
Large Volume	CCM	890,890,721	346,931,144	100%	\$0
Market Transformation					
Commercial New Construction	New enrolled developments	8	0	50%	\$0
Optimum Home	% of homes	70.30%	70.09%	50%	
Performance Based					
RunSmart	Participants	28	32	50%	\$61,844
Strategic Energy Management	Participants	3	3	50%	
Total Utility Draft Incentive					\$4,688,386

*Not all values may compute exactly due to rounding.

†Values from tracking file submitted to EC by Union Gas, 2016 Data Request for Auditor - SHI tracking database.xlsx

4.1.1 Resource Acquisition

This section summarizes the results of the EC's review of the Union Resource Acquisition scorecard. The metrics for the Resource Acquisition scorecard include:

- Total cumulative natural gas savings
- Number of residential deep savings participants

To verify natural gas savings, the EC team reviewed each program independently. A detailed explanation of the verification activities for all Resource Allocation programs can be found in Appendix E. Verified program achievements are listed in Table 36 with DSM shareholder incentive results in Table 37.

Table 36. Union 2016 Resource Acquisition verified achievements*

Programs	Metrics	Verified Achievement	
		Program	Scorecard Metric Total
Home Reno Rebate	CCM	110,310,927	814,757,917
C&I Custom		544,862,192	
C&I Prescriptive		159,584,798	
C&I Direct Install		-	
Home Reno Rebate	Participants (Homes)	6,595	6,595

*Not all values may compute exactly due to rounding.

Table 37. Union's 2016 Resource Acquisition targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
CCM Savings	1,214,104,360	814,757,917	75%	67%	50%
Participants	3,300	6,595	25%	200%	50%
Verified Total Weighted Scorecard Achieved					100%
Verified Scorecard Incentive Achieved					\$2,583,320

*Not all values may compute exactly due to rounding.

Table 38 shows the gross and net cumulative natural gas savings (CCM), as reported by the utility and verified by the EC. The tables also show the realization rates (RR) of the savings, both in terms of gross savings (reported vs verified gross) and net savings (those savings which have been adjusted to exclude free riders and include spillover).

Table 38. Union's verified 2016 Resource Acquisition savings*

Program	Draft Utility-Reported Savings		Verification Results		Verified Savings	
	Gross Cumulative (m ³)	Net Cumulative (m ³)	Realization Rate	Net-to-Gross	Gross Cumulative (m ³)	Net Cumulative (m ³)
Home Reno Rebate	125,749,150	119,468,288	92%	95%	116,116,765	110,310,927
C&I Custom	1,538,593,562	707,753,039	101%	35%	1,549,389,969	544,862,192
C&I Prescriptive	187,421,802	167,540,559	93%	92%	173,961,480	159,584,798
C&I Direct Install	0	0	-	-	0	0
Resource Acquisition Total	1,851,764,514	994,761,886	99%	44%	1,839,468,214	814,757,917

*Not all values may compute exactly due to rounding.

4.1.2 Low Income

This section summarizes the results of the EC's review of the Union Low Income scorecard. The metrics for the Low Income scorecard include:

- Total cumulative natural gas savings for single-family programs
- Total cumulative natural gas savings for "social & assisted" multi-family projects

- Total cumulative natural gas savings for “market rate” multi-family projects

To verify natural gas savings, the EC team reviewed each program independently. A detailed explanation of the verification activities for all Low Income programs can be found in Appendix F. Verified program achievements are listed in Table 39 with DSM shareholder incentive results in Table 40.

Table 39. Union 2016 Low Income verified achievements*

Programs	Metrics	Verified Achievement	
		Program	Scorecard Metric Total
Home Weatherization	CCM	45,754,203	45,783,309
Indigenous		0	
Furnace End-of-Life		29,106	
Multi-Family (Social and Assisted)	CCM	10,894,572	10,894,572
Multi Family MR CCM	CCM	8,151,189	8,151,189

*Not all values may compute exactly due to rounding.

Table 40. Union’s 2016 Low Income targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Single Family (Part 3) CCM	37,786,348	45,783,309	60%	121%	73%
Multi Family S&A CCM	16,216,022	10,894,572	35%	67%	24%
Multi Family MR CCM	2,639,817	8,151,189	5%	309%†	10%
Verified Total Weighted Scorecard Achieved					106%
Verified Scorecard Incentive Achieved					\$1,240,947

*Not all values may compute exactly due to rounding.

†As the metric has exceeded the maximum 200%, the weighted scorecard achievement for this metric is calculated using 200%. However, the full value is displayed here.

Table 41 shows the gross and net cumulative natural gas savings (CCM), as reported by the utility and verified by the EC. The tables also show the realization rates (RR) of the savings, both in terms of gross savings (reported vs. verified gross) and net savings, which are those that have been adjusted to exclude free riders and include spillover.

Table 41. Union’s verified 2016 Low Income savings*

Program	Draft Utility-Reported Savings		Verification Results		Verified Savings	
	Gross Cumulative (m ³)	Net Cumulative (m ³)	Realization Rate	Net-to-Gross	Gross Cumulative (m ³)	Net Cumulative (m ³)
Home Weatherization	46,352,827	46,352,465	99%	100%	45,754,573	45,754,203
Indigenous	0	0	-	-	0	0
Furnace End-of-Life	29,106	29,106	100%	100%	29,106	29,106
Multi-Family (Social and Assisted, Custom)	3,546,430	3,369,109	121%	95%	4,291,181	4,076,621
Multi-Family (Social and Assisted, Prescriptive)	6,649,970	6,318,325	108%	95%	7,176,039	6,817,951
Multi-Family Social and Assisted Total	10,196,400	9,687,434	112%	95%	11,467,220	10,894,572
Multi-Family (Market Rate, Custom)	45,112	42,856	121%	95%	54,586	51,857
Multi-Family (Market Rate, Prescriptive)	8,261,327	7,848,261	103%	95%	8,525,614	8,099,332
Multi-Family Market Rate Total	8,306,439	7,891,117	103%	95%	8,580,200	8,151,189
Low Income Total	64,884,772	63,960,122	101%	98%	65,831,099	64,829,070

*Not all values may compute exactly due to rounding.

†The utility did not report savings at this level of detail. These values were taken from the tracking data.

4.1.3 Large Volume

This section summarizes the results of the EC's review of the Union Large Volume scorecard. The metric for the Large Volume scorecard is total cumulative natural gas savings. A detailed explanation of the verification activities for the Large Volume program, broken out by prescriptive and custom savings, can be found in Appendix G. Verified program achievements are listed in Table 42 with DSM shareholder incentive results in Table 43.

Table 42. Union Gas 2016 Large Volume verified achievements*

Programs	Metrics	Verified Achievement	
		Program	Scorecard Metric Total
Large Volume	CCM	79,848,302	79,848,302

*Not all values may compute exactly due to rounding.

Table 43. Union's 2016 Large Volume targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric
CCM Savings	890,890,721	79,848,302	100%	9%	9%
Verified Total Weighted Scorecard Achieved					9%
Verified Scorecard Incentive Achieved					\$0

*Not all values may compute exactly due to rounding.

Table 44 shows the gross and net cumulative natural gas savings (CCM), as reported by the utility and verified by the EC. The tables also show the realization rates (RR) of the savings, both in terms of gross savings (reported vs. verified gross) and net savings, which are those have been adjusted to exclude free riders and include spillover.

Table 44. Union's verified 2016 Large Volume savings*

Segment	Draft Utility-Reported Savings		Verification Results		Verified Savings	
	Gross Cumulative (m ³)	Net Cumulative (m ³)	Realization Rate	Net-to-Gross	Gross Cumulative (m ³)	Net Cumulative (m ³)
Custom	752,383,093	346,096,223	113%	9%	853,013,950	79,455,523
Prescriptive	1,241,945	834,921	47%	67%	582,030	392,779
Large Volume Total	753,625,038	346,931,144	113%	9%	853,595,980	79,848,302

*Not all values may compute exactly due to rounding.

4.1.4 Market Transformation

This section summarizes the results of the EC's review of the Union Market Transformation scorecard. The metrics for the Market Transformation scorecard include:

- Percentage of total homes built by participating builders that are at least 20% above OBC 2012 for Optimum Home
- Number of new developments enrolled by participating builders for Commercial New Construction

To verify these metrics, the EC team reviewed each program independently. A detailed explanation of the verification activities for all Market Transformation programs can be found in Appendix H. Verified program achievements are listed in Table 45 with DSM shareholder incentive results in Table 46.

Table 45. Union 2016 Market Transformation verified achievements*

Programs	Metrics	Verified Achievement	
		Program	Scorecard Metric Total
Optimum Home	% Homes Built	70.09%	70.09%
Commercial New Construction	Participants	0	0

*Not all values may compute exactly due to rounding.

Table 46. Union's 2016 Market Transformation targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Optimum Home % Homes Built	70.00%	70.09%	50%	100%	50%
Commercial New Construction Participants	8	0	50%	0%	0%
Verified Total Weighted Scorecard Achieved					50%
Verified Scorecard Incentive Achieved					\$0

*Not all values may compute exactly due to rounding.

Table 47 shows the Market Transformation metric achievements, as reported by the utility and verified by the EC. The table also shows the achievement ratio for each program and metric.

Table 47. Union's 2016 Market Transformation reported and verified achievements*

Program	Metric	Reported	Ratio	Verified
Optimum Home	% Homes Built	70.00%	100%	70.09%
Commercial New Construction	Participants	-	-	-

*Not all values may compute exactly due to rounding.

4.1.5 Performance Based

This section summarizes the results of the EC's review of the Union Performance Based scorecard. The metric for the Performance Based scorecard is the number of participants in the RunSmart and Strategic Energy Management programs respectively. To verify participants, the EC team reviewed each program independently. A detailed explanation of the verification activities for all Performance programs can be found in Appendix I. Verified program achievements are listed in Table 48 with DSM shareholder incentive results in Table 49.

Table 48. Union 2016 Performance Based verified achievements*

Programs	Metrics	Verified Achievement	
		Program	Scorecard Metric Total
RunSmart	Participants	32	32
Strategic Energy Management (SEM)	Participants	3	3

*Not all values may compute exactly due to rounding.

Table 49. Union's 2016 Performance Based targets, achievements, weights, and incentive*

Metric	Target	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
RunSmart Participants	28	32	50%	114%	58%
SEM Participants	3	3	50%	100%	50%
Verified Total Weighted Scorecard Achieved					108%
Verified Scorecard Incentive Achieved					\$61,844

*Not all values may compute exactly due to rounding.

To verify these achievement metrics, the EC team reviewed each program independently, with results presented in Table 50.

Table 50. Union’s 2016 Performance Based reported and verified achievements*

Program	Metric	Reported	Ratio	Verified
RunSmart	Participants	32	100%	32
Strategic Energy Management (SEM)	Participants	3	100%	3

*Not all values may compute exactly due to rounding.

4.2 Program Spending and Cost-Effectiveness

This section reports on Union’s program spending and cost-effectiveness.

4.2.1 Program Spending

The Union tracking database included a sheet that reported program spending by scorecard. The EC has reported on what was provided by Union and has not verified spending figures or conducted a financial audit. Table 51 shows the Union budget for the portfolio overall. Additional spending detail is in Appendix M.

Table 51. Union portfolio budget overall*

Spending Area	OEB-Approved Budget	Actual Spending	Difference (\$)	Difference (%)
Programs Sub-total	\$45,586,373	\$42,255,026	-\$3,331,347	-7%
Research	\$1,500,000	\$517,567	-\$982,433	-65%
Evaluation	\$1,300,000	\$168,121	-\$1,131,879	-87%
Administration	\$2,935,000	\$2,364,580	-\$570,420	-19%
Total DSM Budget	\$51,321,373	\$45,305,294	-\$6,016,079	-12%

*Not all values may compute exactly due to rounding.

4.2.2 Cost-Effectiveness

Table 52 and Table 53 show summary results for the TRC-Plus and PAC tests, including the cost-benefit ratio and the net present value. Additional detail is shown in Appendix N.

Table 52. Union summary of cost-effectiveness ratio results*

Scorecard	Draft using Utility-Reported Savings†		Final Verified Ratio	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	3.2	6.5	3.0	5.4
Low Income	1.5	1.2	1.5	1.2
Large Volume	6.2	19.8	5.0	4.6
Total Portfolio	3.4	6.1	2.9	4.3

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

Table 53. Union summary of cost-effectiveness net present value results

Scorecard	Draft Net Present Value (M\$) using Utility-Reported Savings †		Final Verified Net Present Value (M\$)	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	152.7	151.5	124.8	121.5
Low Income	4.9	1.6	5.3	1.9
Large Volume	57.7	56.3	12.7	10.6
Total Portfolio	215.3	209.4	142.7	134.1

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

4.3 DSM Shareholder Incentive and Lost Revenue

This section reports on the results of the DSM shareholder incentive and lost revenue calculations. The recommendations related to these activities are listed in section 5. See Appendix J for a description of the DSM shareholder incentive and lost revenue calculations and Appendix K for detailed tables.

4.3.1 DSM shareholder incentive

The EC gathered the verified scorecard achievements from section 4.1 to produce the DSM shareholder incentive by scorecard and overall, shown in Table 54. Detailed calculations with targets, weights, achievements, and incentives are included in Appendix K.

Table 54. Union DSM shareholder incentive results*

Scorecard	Draft Utility-Reported DSM Shareholder Incentive	Verified DSM Shareholder Incentive
Resource Acquisition	\$3,437,543	\$2,583,320
Low Income	\$1,188,999	\$1,240,947
Large Volume	\$0	\$0
Market Transformation	\$0	\$0
Performance Based	\$61,844	\$61,844
Total	\$4,688,386	\$3,886,112

*Not all values may compute exactly due to rounding.

4.3.2 Lost revenue

The EC summed the verified net annual savings (prorated by installation month) by rate class and estimated lost revenues. Table 55 shows the results.

Table 55. Union lost revenue results*

Rate Class	Utility-Reported Draft Lost Revenue	Verified Lost Revenue
M4 South Industrial	\$62,461	\$44,781
M5 South Industrial	\$149,819	\$118,225
M7 South Industrial	\$17,222	\$13,830
T1 South Industrial	\$905	\$736
T2 South Industrial	\$1,025	\$219
20 North Industrial	\$5,006	\$3,691
100 North Industrial	\$715	\$199
Total	\$237,154	\$181,682

*Not all values may compute exactly due to rounding.

5 Findings and Recommendations

This section contains the recommendations from the 2016 annual verification efforts and all other evaluations conducted on the 2016 programs or completed before releasing this report. The annual verification recommendations are in the first section. CPSV recommendations are in the second section. Measure life study recommendations are in the third section. Some recommendations overlap the various studies and are provided in all sections.

5.1 2015 Annual Verification Recommendations

The 2016 annual verification identified numerous recommendations. Many of these recommendations were previously identified in the 2015 annual verification process. While the EC appreciates that insufficient time elapsed between evaluations for implementation of the 2015 recommendations, they are nonetheless included here. In the tables below, the primary outcomes of the findings and recommendation are classified into three categories: reduce costs (evaluation or program or both), improve savings accuracy, and decrease risk (multiple types of risk are in this category including risk of adjusted savings, risk to budgets or project schedules, and others). Details of the findings, recommendations and outcomes follow the tables.

Table 56. Overall annual verification - summary of recommendations

#	Finding	Recommendation	Recommended in 2015	Applies to 2016			Primary Outcome		
				Union	Enbridge	Evaluation	Reduce Costs	Improve Accuracy	Decrease Risk
O1	The Enbridge tracking file does not currently include information that allows the evaluator to identify all the projects installed by a single customer.	A: Consider investing in a relational program tracking database.	✓	✓	✓		✓	✓	✓
		B: Enbridge should include site-level information for all measures installed through the program.	✓		✓			✓	✓
O2	The format of Enbridge's tracking data is not well suited to a combined evaluation with the Union data.	A: Enbridge should deliver tracking data in a single flat file.	✓		✓		✓	✓	✓
		B: Consider investing in a relational program tracking database.	✓	✓	✓		✓	✓	✓
O3	Neither Union nor Enbridge tracking databases currently use prescriptive measure descriptions that map directly to the approved energy savings spreadsheet (TRM).	A: Develop, maintain, and use an electronic summary spreadsheet of the TRM.	✓	✓	✓	✓	✓	✓	✓
		B: Once the electronic TRM spreadsheet is developed, track prescriptive savings using unique	✓	✓	✓	✓	✓	✓	✓

		measure descriptions that map to electronic TRM.							
		C: Once the electronic TRM spreadsheet is developed, utilize the same electronic TRM for both utilities		✓	✓	✓	✓	✓	✓
		D: OEB: develop means for consistent system				✓	✓	✓	✓
O4	Different TRMs were used by utilities for savings calculations.	A: Explicitly agree to the TRM version to utilize for measure-inputs		✓	✓	✓	✓	✓	✓
		B: Use the same TRM version for both utilities for each program year		✓	✓	✓	✓	✓	✓
O5	DNV GL and other EAC members were sometimes confused about appropriate sources and the definition of terms.	A: Evaluation Contractor: distribute to the EAC a list of the anticipated sources at the start of the verification process, possibly within the scope of work, for review and verification.				✓	✓		✓
		B: Evaluation Contractor: distribute to the EAC a glossary of terms at the start of the verification process, possibly within the scope of work, for review and verification.				✓	✓		✓
O6	Explicit documentation was not available for all program stages, specifically for non-savings metrics	A: Document each required element and stage for non-savings metrics.		✓	✓	✓	✓		✓

Table 57. Whole home simulation modelling - summary of recommendations

#	Finding	Recommendation	Recommended in 2015	Applies to			Primary Outcome		
				Union	Enbridge	Evaluation	Reduce Costs	Improve Accuracy	Decrease Risk
SM1	Both utilities use building simulation modeling to estimate energy savings	A: Provide both simulation file (HSE) and output file (TSV) to the evaluation team for every project.	✓		✓		✓		✓
SM2	Both utilities collect and deliver <i>some</i> photographs to support retrofit site improvements.	A: Provide more explicit support for major measure installations.	✓	✓	✓				✓
SM3	There were some inaccurate savings entries.	A: Consider reviewing and modifying program processes to avoid data entry or outdated simulation result errors.		✓			✓		✓
		B: Provide more explicit support for major measure installations.	✓	✓	✓		✓		✓
SM4	Air sealing as a savings measure is present in a high percentage of single-family home retro-fit projects.	A: Evaluation: distribute before and after equivalent leakage area and energy savings attributable to reduced air leakage (if possible).				✓		✓	✓
SM5	The energy savings from the home retrofit programs rely exclusively on the simulations provided by the delivery agents.	A: Consider funding a study to verify the models produced by the utility agents.	✓			✓		✓	

Table 58. Cost-effectiveness - summary of recommendations

#	Finding	Recommendation	Recommended in 2015	Applies to			Primary Outcome		
				Union	Enbridge	Evaluation	Reduce Costs	Improve Accuracy	Decrease Risk
CE1	All overhead is still applied at the sector level rather than the program level.	A: Allocate "sector"-level administrative cost and overhead to each individual program	✓	✓	✓		✓	✓	
CE2	Water avoided costs are still based on water rates.	A: Explore the possibility of better defining water costs	✓			✓	✓	✓	
CE3	The utilities used different discount rates.	A: Use a consistent real discount rate of 4% when using real streams of benefits and costs.	✓	✓	✓	✓		✓	
CE4	EUL is inconsistently applied for accelerated projects.	A: Include separate fields in the tracking data to explicitly communicate accelerated, annual and cumulative savings.			✓		✓		
CE5	A reduction factor accounting for removals and non-installs was applied to savings and resource costs.	A: Do not adjust resource costs if the costs are still incurred by the program, even if the equipment is removed.			✓		✓		

5.1.1 Overall Annual Verification Recommendations

O1.Finding: The Enbridge tracking file does not currently include information that allows the evaluator to identify all the projects installed by a single customer.

Recommendation A: Both utilities should strongly consider investing in relational program tracking databases. Relational program tracking databases and customer relationship management (CRM) systems allow for multiple measures and projects to be associated with a single customer and/or customer site. The incremental cost of implementation is low if it is part of the initial database design, populated as projects are started, and updated once they are complete.

Outcome: Reduced burden on utility staff and reduced evaluation costs. A relational database would streamline aggregation of program data for scorecards and make providing data simpler for annual savings evaluation and verification.

Recommendation B: Enbridge should include a unique site-level or customer-level identifier for every measure installed in the program to allow the evaluator to identify all projects installed at a single customer, regardless of program.

Outcome: Confirmation that each installation is unique and assessment of interactive effects.

O2.Finding: The format of Enbridge's tracking data is not well suited to a combined evaluation with the Union data, meaning that the format requires a significant investment of time to extract the necessary data for verifying each program's savings. In addition to increased time and thus verification cost, the need for manual extraction of data introduces many opportunities for error, which potentially decreases savings accuracy and increases risk.

Recommendation A: Deliver to evaluators a single, flat file of tracking data.¹⁰ Each record should have measure-level information which includes the information listed below:

- Program identification information, such as scorecard, and program name
- Customer identification information, such as a unique customer ID, rate class, and location
- Measure identification information, such as measure description, unique measure identification, measure group, measure life, free rider rate, and savings per unit for prescriptive measures
- Savings information, such as annual gross and net savings, cumulative gross and net savings, and non-gas savings
- Additional information as needed to allow the evaluator to verify lost revenue and cost-effectiveness

A "verification ready" flat file would not require summary rows, hidden rows or columns, links or formulas but would include all necessary variables in a single tab or table for all projects and measures, regardless of type.

Outcome: Reduced burden on program staff, more flexibility for evaluators.

¹⁰ In this context, a flat file is a table with one record per line and no summary information.

Recommendation B: See recommendation O1A. The utilities should consider investing in a new database.

Outcome: Reduced burden on utility staff and reduced evaluation costs.

O3.Finding: Neither Union nor Enbridge tracking databases currently use prescriptive measure descriptions that map directly to the approved energy savings spreadsheet (TRM). The EC does note that Enbridge did provide a tab within the excel Tracking File that provided a summary of their prescriptive offers and the savings values associated with these and that Union provided a mapping of Union names to TRM terms. However, these offer names do not consistently match the values described within the TRMs. The EC often struggled to align tracking measures to the correct TRM measure, resulting in increased effort and time in identifying intended TRM measures and repeated back-and-forth between evaluation and the utilities for clarification.

Recommendation A: Develop, maintain, and use an electronic summary of the TRM, such as an Excel file. Each measure (identified as a unique savings value) should have an assigned measure ID number, and new ID numbers should be assigned when a measure is updated with a new savings value. This allows for a historical record of the changes in the TRM and allows the evaluation to identify outdated values. Once developed or agreed to, both utilities should utilize this system for simplification and transparency.

Recommendation B: Once the electronic TRM is developed, track prescriptive savings using unique measure descriptions that clearly map to the electronic TRM.

Recommendation C: Once the electronic TRM is developed, utilize the same electronic summary file for both utilities.

Recommendation D: As the entity with primary ownership of the TRM, the OEB should develop the references for parties to directly refer to specific measures in a consistent way which accounts for variations in energy savings due to capacity or other characteristics.

Outcome: Reduced burden on utility staff and reduced evaluation costs. Fewer errors in the tracking data.

O4.Finding: Mid-way through the evaluation and verification process, it was noted that utilities were using different TRMs for reference for savings values. The general rule for use of the best available information, while generally good, does allow for ambiguity. In this instance, the ambiguity created a need for additional verification processes, with new savings values for Union Gas.

Recommendation A: Explicitly state which TRM version applies to the annual savings calculations for savings calculations for both Scorecard/DSM shareholder incentive calculations as well as lost revenue calculations. This explicit agreement on the appropriate TRM should be made prior to the start of the verification cycle, at the very latest.

Recommendation B: Use the same TRM version for both utilities for each program year.

Outcome: Reduced evaluation costs. Decreased risk to utilities that savings estimates are incorrect due to use of "incorrect" TRM, improved savings accuracy.

O5.Finding: Throughout the verification process, DNV GL and other EAC members had questions about the appropriate source to use for items such as TRM savings (March or December), program eligibility requirements, and other information necessary to complete the evaluation. The EAC and EC also had a

number of discussions about terminology and the meaning of different terms. These conversations often resulted in small delays in the evaluation work.

Recommendation A: The evaluation team should distribute to the EAC a list of the anticipated sources at the start of the verification process, possibly within the scope of work, for review and verification.

Recommendation B: The evaluation team should distribute a glossary of terms to the EAC at the start of the verification process, possibly within the scope of work, for review and verification.

Outcome: Clearly defined and agreed upon sources, definitions and documentation should reduce the risk for confusion and re-analysis of scorecard metrics and reduce costs.

O6.Finding: Explicit documentation was not available for all program stages for programs such as Enbridge's Market Transformation Run It Right program. In that program, there was no documentation for participants moving to step 4 of the program (see Appendix H), only documentation that the participants had completed step 3 and utility confirmation that this is equivalent to engagement in step 4. Similar recommendations are included in section 5.1.2 for whole home simulation modeling programs.

Recommendation A: Documentation for each required element and stage for non-savings metrics should be recorded. The majority of these elements for future years have been identified in this evaluation, in the scorecard and program-relevant appendix sections.

Outcome: Reduced burden on utility staff and reduced evaluation costs.

5.1.2 Whole Home Simulation Modeling Recommendations

SM1. Finding: Both utilities use building simulation modeling to estimate energy savings for their home retrofit programs, including Home Energy Conservation, Home Reno Rebate, Winterproofing, and the Home Weatherization Program. HOT2000 is the most common program used for those simulations, which is a program developed and released by NRCan for certified energy advisors. Because of the restrictions on the program, the evaluator could not consistently run the simulation files and produce the same result reported by the program. While Union provided TSV files for all sampled locations, Enbridge did not.

Recommendation A: Provide the building simulation file (HSE), the program output file (TSV), and full supporting documentation for *all* claimed project measures for every sampled project.

Outcome: Reduced burden on utility staff and reduced evaluation costs.

SM2. Finding: Both utilities collect and deliver *some* photographs to support many of the changes made at a home retrofit site as well as additional documentation for installed equipment and performed measures. However, the evaluator could not consistently confirm the number or type of major measures installed based on the photographs or other documentation provided.

Recommendation A: Consider providing more explicit support for each measure to eliminate uncertainty around project savings and participation. Full project documentation (pre/post photos, documentation of all installations or actions such as invoices and/or photos of each measure, data collection reports, pre-and post blower door tests for all sites) to the evaluation team. By delivering all documentation, the evaluation team would not have to follow up with the utility to obtain output for models that could not be run but could still verify the output for models that can be run.

Outcome: Greater certainty around scorecard achievements.

SM3. Finding: The evaluator identified a number of inaccurate savings entries due to data entry errors or outdated Union home retrofit simulation results. Many of these errors could be avoided through changes in program processes.

Recommendation A: Consider reviewing and modifying program processes to avoid similar errors in the future.

Recommendation B: Consider providing more explicit support for each measure to eliminate uncertainty around project savings and participation. Full project documentation (pre/post photos, documentation of all installations or actions such as invoices and/or photos of each measure, data collection reports, pre-and post blower door tests for all sites) to the evaluation team. By delivering all documentation, the evaluation team would not have to follow up with the utility to obtain output for models that could not be run but could still verify the output for models that can be run.

Outcome: Reduced burden on utility staff and reduced evaluation costs.

SM4. Finding: Air sealing as a savings measure is present in a high percentage of single-family home retro-fit projects, over 90% of projects in some programs. With such a high percentage of projects relying on a single measure, it is more important to ensure the savings validity of that measure.

Recommendation A: If possible, the evaluation team should evaluate the before and after leakage area and attributable energy savings.

Outcome: Greater certainty around savings estimates.

SM5. Finding: The energy savings from the home retrofit programs rely exclusively on the simulations provided by the delivery agents. Those simulations likely rely on a number of assumptions or standard modeling practices which may or may not follow industry standards. A detailed review of the models was outside the scope of the annual audit.

Recommendation A: Consider funding a study to verify the models produced by the utility agents to ensure they conform to standard industry practice.

Outcome: Greater certainty around savings estimates.

SM6. Finding: Site-level documentation confirmed that an auditor was involved, it does not signal that the auditor was an approved Certified Energy Evaluator.

Recommendation A: Tracking certifications for all energy evaluators and/or auditors submitting records.

Outcome: Ensuring proper credentials for all auditors decreases risk to program.

SM7. Finding: Number of projects for residential retrofit programs was very large.

Recommendation A: Increase sample to include more project files in following verification cycles.

Outcome: Increased sample, along with improved documentation recommended earlier, increases the accuracy of savings estimates for the applicable programs.

5.1.3 Cost-effectiveness Recommendations

- CE1. Finding:** In 2015, the EC recommended that “sector”-level administrative costs and overhead be allocated to each individual program and the utilities report program-level cost-effectiveness results. In 2016, there are still inconsistencies in how administrative and overhead costs are allocated. For example, Union identifies administration and evaluation costs at the scorecard level whereas Enbridge details spending as direct and indirect at the OEB-defined program level and then has an explicit ‘overhead’ spend at the scorecard level. To facilitate the analysis, the EC recommends that the utilities report spending in a consistent format and apportion the overhead costs to individual programs.
- Recommendation A:** Allocate “sector”-level administrative cost and overhead to each individual program and report program-level cost-effectiveness results. Explicit allocation of general administration and evaluation costs will allow for easier cost-effectiveness calculations at the program level.
- CE2. Finding:** Water avoided costs are still based on water rates. The utilities followed the EC’s 2015 approach and reduced the water avoided costs by 75% to simulate the removal of the fixed-cost portion of the rate. As is the case for gas and electricity, water avoided costs should only include the marginal impact from reduced consumption. Fixed costs (which, in our experience, can represent about 75% to 80% of water costs) must be excluded. On the other hand, water rates are often predominantly or exclusively variable, notably to promote conservation, and are thus a bad proxy of avoided costs.
- Recommendation A:** Explore the possibility of better defining water avoided costs.
- Outcome:** Better defined water avoided costs will result in more accurate cost effectiveness values, reducing the risk of less accurate values.
- CE3. Finding:** While the discount rate appears to be aligned there was a methodological inconsistency between utilities. Union calculated their discount rate using 4% as their real discount rate and an inflation rate of 1.68% to get a combined discount rate of 5.7472%. Enbridge did not show how their discount rate was calculated and simply applied a discount rate of 5.75%.
- Recommendation A:** Both utilities should use identical discount rates.
- CE4. Finding:** EUL and cumulative gross savings were not provided in a consistent manner in the Enbridge program tracking database extract. The EUL inconsistency is the result of a work-around for advanced (Accelerated) projects used by Enbridge to report accurate dual baseline savings estimates and first year savings. Communicating the work-around consistently with the evaluation team led to some rework.
- Recommendation A:** Include separate fields in the program tracking database for EUL, RUL, gross first year annual savings, gross post-RUL annual savings, NTG, gross cumulative savings, net cumulative savings, and net first year savings.
- Outcome:** Improved data integrity results in less evaluation risk and more accurate savings totals. Proving each of the key savings types and their components allows evaluation to confirm that the savings provided are internally consistent.
- CE5. Finding:** Enbridge applied a reduction factor to both the resource savings and costs for some measures to account for the percent of non-installs and removals. The adjustment factor is correctly applied to the savings; however, it should not be applied to the costs as costs are still incurred.
- Recommendation A:** Do not adjust resource costs to account for non-installations or removals.

Outcome: A more accurate representation of the costs incurred by the program.

5.2 CPSV Recommendations

A number of recommendations were identified as part of the CPSV evaluation. In the tables below, the primary outcomes of the recommendation are classified into four categories: reduce costs, increase savings, increase (or maintain) customer satisfaction and decrease risk (multiple types of risk are in this category including risk of adjusted savings, risk to budgets or project schedules, and others). Details of the findings, recommendations and outcomes follow the tables.

Table 59. Energy savings and program performance recommendations

#	Energy Savings and Program Performance		Applies to			Primary Beneficial Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
1	Both utilities exhibit a strong commitment to accurate energy savings estimate	The utilities should continue in their commitment to accuracy.	✓	✓				✓	✓
2	The CPSV effort found realization rates near 100% and identified adjustments for most projects.	Continue performing custom savings verification on a regular basis.			✓				✓
3	Relative precision targets were met or surpassed for all programs	Use error ratio assumptions from the results provided in this report in future evaluation years, but with more conservative bounding than performed this year.			✓	✓			✓
4	Some measures have difficult-to-define baseline technologies.	Establish a policy to define rules around energy savings calculation for fuel switching and district heating/cooling measures.	✓	✓	✓				✓
5	Review of documentation for gross evaluation showed that several projects were high free rider risks.	Review projects with large incentives for free ridership risk. Develop clear program rules that allow the utility to reject free rider projects.	✓	✓			✓		✓

#	Energy Savings and Program Performance		Applies to			Primary Beneficial Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
6	Influence adjustments were made to projects that adjusted the gross savings for "net" or program influence reasons.	Increase transparency of "influence adjustments" and do not include in gross savings	✓				✓	✓	✓
7	There is not a clear policy to determine "standard" baselines.	Establish a clear policy to determine and define "standard" baselines	✓	✓	✓	✓			✓
8	Some measures in each utility program are routine maintenance or periodic repairs that are considered standard care in other jurisdictions.	Establish a clear policy regarding eligibility of maintenance and repair measures for the programs.	✓	✓	✓	✓			✓
9	The programs did not consistently account for interactivity among measures.	Add an interactivity check to the programs' internal QC process for savings estimates.	✓	✓	✓	✓			✓

Table 60. Verification process recommendations

#	Verification Process		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
10	DNV GL was unable to obtain access to all the equipment at all the sites selected for verification.	Modify contracts to require participants to agree to comply with EM&V as part of the requirements for participation in the program.	✓	✓		✓			✓
11	Future evaluations should consider large HVAC to be high rigour rather than standard rigour.	Consider large HVAC measures for higher rigour verification.			✓				✓

Table 61. Documentation and support recommendations

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
12	Incremental improvement in project documentation by both utilities was observed in the 2016 CPSV. Project documentation for some projects lacked sufficient details to allow evaluators to reproduce the calculations made by program staff or third-party vendors.	<p>Take steps to improve documentation:</p> <ul style="list-style-type: none"> • Implement an electronic tracking system that archives all materials • Include explicit sources for all inputs and assumptions in the project documentation. • Store background studies and information sources with the project files and make them available to evaluators. • Provide evaluators full access to customer data. • Provide pre- and post-installation photos, where available. • Document and provide internal M&V documents where available. • Institute a checklist as part of project closeout to ensure all relevant project documentation is assembled as ready for verification 	✓	✓			✓		✓
13	Explanations of complex projects were not consistently clear making it hard to understand what process is producing energy savings.	Improve clarity and details of documentation explaining the source of energy savings for complex projects.	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
14	Ex ante savings estimates based on annual energy consumption for industrial sites did not always include sufficient information documenting production.	Include site production totals in relevant years in the savings estimates based on annual energy consumption for industrial sites	✓	✓					✓
15	Enbridge Boilers use a 73% assumed thermal efficiency for in situ boilers that have been in place for more than 10 years.	Estimate boiler degradation from name plate efficiency to determine the baseline boiler efficiency rather than a flat number	✓	✓					✓
16	Pipe insulation is a significant source of savings for the Union Gas programs. Documentation for the source of factors used in calculations and of in situ conditions was not consistently provided.	Document baseline conditions of pipe insulation (and other measures) using photos and text descriptions to provide context. Explicitly tie the documentation of baseline condition to the heat loss rate used for the savings calculation.	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
17	Enbridge documentation did not always include a prose explanation and supporting documentation for baseline types (ROB, ER) and remaining useful life (RUL).	Always complete the “Base Case Overview” in the form with a prose description of the base case. The description should reference included emails and photos to document in situ conditions and features that are carried over into the baseline system.		✓					✓
18	The utilities should use longer duration data in ex ante savings estimates when possible.	Use longer duration data in ex ante savings estimates. When time periods less than a year are used, documentation should be provided to indicate why the period used is applicable to a full year and why a full year was not able to be used.	✓	✓		✓			✓
19	In situ boiler name plate information, age and operating condition are all helpful for determining the designed performance and reasonable range of actual efficiency for the system as well as providing context to better determine remaining useful life (RUL)	Document in situ boiler name plate information, age and operating condition for all projects where boiler efficiency affects savings	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
20	Items that may be obvious to the ex ante team can be non-obvious to an outside party.	Review ex ante documentation from an outside perspective to help identify gaps	✓	✓					✓
21	At large sites with multiple spaces containing similar equipment, ex ante documentation did not always identify which space or piece of equipment was affected by the project.	Include additional descriptions of spaces and equipment affected to differentiate among similar spaces and equipment at the site.	✓	✓					✓
22	Invoices were not always included with documentation, and sources for incremental costs were not always clear.	Ensure that incremental costs are supported by invoices or other documentation, especially for add-on and optimization measures where the total cost and incremental cost are likely to be the same.	✓	✓				✓	✓
23	Larger projects appeared to fall under the same documentation standards as smaller projects.	Increase the amount of documentation and source material for projects that have greater energy savings.	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
24	Union's custom project summary workbook is a good approach to documentation. The workbook is not used in a consistent manner across all projects.	Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner. Identify a common approach for common measures and, if necessary, document deviations and the reasons for the deviations in a clearly labelled field on the summary sheet.	✓			✓			✓
25	Enbridge Etools does not sufficiently document sources of inputs and assumptions.	Use a consistent summary workbook.		✓		✓			✓

Table 62. Data management recommendations

#	Data Management		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
26 A	Neither Union nor Enbridge currently track participating customer or participating vendor contact information in their program tracking	Track contacts associated with projects in the program tracking database.	✓	✓		✓		✓	✓
26 B		Strongly consider investing in relational program tracking databases.	✓	✓		✓	✓	✓	✓

#	Data Management		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
26 C	database. Providing the information to the evaluation puts significant burden on utility staff. In 2016, the data provided by utility staff was much more consistent and clear relative to 2015.	Continue to use improved structure for data integrity in the evaluator request for contact information for the 2017 savings verification and evaluation.			✓	✓		✓	
27	The extracts from the utility program tracking database do not include dates for key project milestones.	Track and provide to evaluators dates for key milestones in the project.	✓	✓		✓			✓
29	EUL and cumulative gross savings were not provided in a consistent manner in the Enbridge program tracking database extract	Include separate fields in the program tracking database for all components of gross and net cumulative and first year savings.	✓	✓			✓		✓

5.2.1 Energy savings and program performance

Finding: Both utilities exhibit a strong commitment to accurate energy savings estimates. Both utilities have made significant investments in developing calculation tools which model savings accurately. For example, Union’s dock door seal calculator is well considered and designed, and Enbridge’s Etools calculator is very thorough in attempting to model savings for key measures.

Both utilities chose to retain engineers with strong understanding of their customers’ building and process systems and showed a commitment to finding accurate savings estimates. On several occasions, both on the phone and in writing, the evaluation team suggested a value that would have increased savings in a way that the utility program engineer did not think was valid. When this happened, neither utility was shy in suggesting that we may want to make a more conservative choice.

Recommendation: The utilities should continue in their commitment to accuracy.

Outcome: Accurate energy savings.

Finding: The CPSV effort this year found realization rates near 100% and identified adjustments for most projects. Across the programs a near equal number of adjustments increased and decreased savings and one third of projects had a large adjustment (verified savings more than 20% different from tracked).

Recommendation: Continue performing custom savings verification on a regular basis. Even a study that results in an adjustment of near 100% is still valuable because the programs know that their savings estimates will be reviewed. Knowing a review will be conducted improves the quality of ex ante estimates. The review itself also results in information that improves future program savings estimates.

Outcome: Accurate energy savings.

Finding: Relative precision targets were met or surpassed for all programs. The sample design incorporated the previous year's error ratios (ERs) and averaged them with the assumption used in 2015. ERs were further bounded (minimum ER was 0.25, maximum 0.60) to limit the risk of over- or under- collecting data. There was one segment (Union Commercial) where precision was not as good as expected.

Recommendation: The process used to develop error ratios assumptions from the results provided in this report should be continued in future evaluation years, possibly with more conservative bounding (potentially increasing the maximum ER) to avoid under-collection of data for any segments.

Outcome: Realistic estimates of error ratios result in an appropriate amount of data collected to meet targets.

Finding: Some measures (e.g., geothermal heat pumps, combined heat and power, and those that save district heating energy) have difficult-to-define baseline technologies. Multiple different baselines are possible for these projects depending on how one looks at the scope of the project: how non-gas energy changes and offsite gas use are considered in savings estimates are two of the challenging aspects.

Recommendation: Consider establishing a policy to define rules around energy savings calculations and baselines for fuel switching and district heating/cooling measures.

Outcome: Less risk of adjustment and a better alignment between province energy efficiency goals and program implementation.

Finding: Through the gross verification process, we reviewed project documentation and had conversations with customers about their installed measures. While the focus of this report is not on net savings, we did observe a handful of projects (out of the 122 evaluated) that appeared to be clearly at high risk for free ridership. These projects included maintenance type measures, projects that were far along in planning prior to utility involvement, projects with very short paybacks, and projects that included significant non-energy benefits.

Recommendation: Review projects with large incentives for free ridership risk. Develop clear program rules that allow the utility to reject free rider projects.

Outcome: Increased savings, reduced risk of free ridership, more efficient use of program funds.

Finding: Union made influence adjustments to projects that adjusted the gross savings for "net" or program influence reasons. Accounting of which projects had these adjustments was not maintained by Union and

the adjustments were included in different places in project calculation workbooks, making their identification and validation challenging. In addition, the program NTG was also applied to these projects, effectively double discounting savings in scorecards.

Recommendation: If Union chooses to continue making influence adjustments to the savings upon which it calculates savings, it should make these adjustments more transparent and exclude them from the reported gross savings for the program in scorecards. Instead the specific project influence adjustment should be included in the scorecard in place of the general program or domain level NTG factor.

Outcome: Reduced risk of double adjustments.

Finding: There is not a clear policy to determine what standard to use for replace on burnout or new construction baselines. The 2016 verification used a code or minimum available baseline where required, in alignment with the 2015 net-to-gross study. Without a clear policy there is uncertainty for all stakeholders as to what the appropriate baseline should be. This uncertainty affects all aspects of the programs, including what measures are offered, what incentives are paid and how measures are evaluated.

Recommendation: Establish a clear policy to determine and define baseline standards where an “industry standard” baseline would be applicable.

Outcome: Consistency of approach across utilities, evaluators and studies will reduce risk of adjustment and evaluation cost.

Finding: Some measures in each utility program are routine maintenance or periodic repairs that are considered standard care in other jurisdictions.

Recommendation: Establish a clear policy regarding eligibility of maintenance and repair measures for the programs.

Outcome: Reduced free ridership risk.

Finding: The programs did not consistently account for interactivity among measures. In several cases, we saw an overestimation of the combined boiler efficiency improvement yielded by the addition of linkageless controls and condensate heat recovery measures and an overestimation of savings for subsequent measures that interact with earlier measures within the same program year.

Recommendation: Add an interactivity check to the programs’ internal QC process for savings estimates.

Outcome: More accurate savings estimates and a reduced evaluation risk.

5.2.2 Verification processes

Finding: DNV GL was unable to obtain access to all the equipment at all the sites selected for verification. Both Enbridge and Union have several large projects with industrial companies, including food processing, refineries, and other industries. In many cases, the customer refused to provide SCADA (Supervisory Control and Data Acquisition) system data or similar trend data to allow a reasonable verification of the project. This means we were unable to do more than a reasonableness check on the savings.

A review of the Enbridge contract shows that the customer is not required to provide the information that is necessary for EM&V. The most relevant sections are:

- Item 6: Payment of the Incentive Payment is subject to the completion of a satisfactory site inspection of the improvements, including the installed equipment by an authorized representative of Enbridge.
- Item 9: Upon request within eighteen months of the commissioning date of the Project, and with reasonable notice, the Customer agrees to provide authorized representatives of Enbridge with access to the Project, and with required information or data relating to the project for the purposes of the Application and these General Terms and Conditions.

Neither of these are sufficient for EM&V.

Recommendation: Modify contracts to require participants to agree to comply with EM&V as well as utility representatives as part of the requirements for participation in the program.

Outcome: Reduced evaluation costs and risks. Participant non-compliance requires evaluators to request documentation for a large backup sample, and to survey and/or visit additional sites to obtain sufficient data for the evaluation. The process of contacting a site and getting a refusal costs time and money, as does the substitution of an additional site to make up for the unobtained data. In some cases, there might not be additional sites to sample, in which case the evaluation estimates will have lower precision than they would with full compliance.

Finding: Large HVAC and HVAC controls projects proved more complex to evaluate than planned.

Recommendation: Future evaluations should consider large HVAC to be high rigour rather than standard rigour.

Outcome: Better alignment of rigour with uncertainty will improve accuracy of savings estimates and provide more cost-effective evaluation.

5.2.3 Documentation and support

Finding: Incremental improvement in project documentation by both utilities was observed in the 2016 CPSV. Project documentation for some projects lacked sufficient details to allow evaluators to reproduce the calculations made by program staff or third-party vendors. Specific issues included:

- Project data or details missing
- Insufficient measure-level details to fully describe what was installed
- Descriptions that were difficult to understand
- Use of black box tools
- Hardcoded information in calculation spreadsheets
- Undocumented assumptions
- Sources referenced but not included or available, such as feasibility studies and historical analysis of energy use that was left out of the project documentation
- Input adjustments that approximate other effects, but are not explained
- Insufficient access to customer data (by customers).
- Modelling files that could not be opened
- Adjustments to savings estimates for safety or influence that were not clearly marked, sourced, or carried out in a consistent fashion

Recommendation: Improve data quality. Possible steps include:

- Implement an electronic tracking system that archives all materials
- Include explicit sources for all inputs and assumptions in the project documentation.
- Store background studies and information sources with the project files and make them available to evaluators.
- Provide evaluators full access to customer data.
- Provide pre- and post-installation photos, where available.
- Document and provide internal M&V documents where available.
- Institute a checklist as part of project closeout to ensure all relevant project documentation is assembled as ready for verification

Outcome: Properly explaining and sourcing the savings calculation method and assumptions allows the evaluating engineer to more easily identify what needs to be verified. It also makes it easier to determine whether the methods and assumptions are reasonable and use ex ante assumptions rather than seek documented values elsewhere.

Finding: Explanations of complex projects were not consistently clear making it hard to understand what process is producing energy savings. This was seen with large HVAC control projects with MUAs, AHUs, heat recovery projects, and custom process projects, and others.

Recommendation: Improve the documentation/explanation of the source of energy savings for complex projects that are related to complex systems. Use figures, diagrams, and equations as needed, especially for cascading or multi-staged measures. Parameters such as the heating source, and the efficient case peak and off-peak period flowrates and schedules should be recorded and sourced. If there are additional units not included in the measure, these should be documented and considered in savings estimates (even if the effect is zero).

Outcome: Increased accuracy of savings estimates. Reduced evaluation risk.

Finding: Ex ante savings estimates based on annual energy consumption for industrial sites did not always include sufficient information documenting production. The change in energy use pre- and post-measure is sensitive to changes in production.

Recommendation: Savings estimates based on annual energy consumption for industrial sites should include information from the site on amount of production in the years used. It's not enough to say, "not much is changed, they run 24/7". If detailed production data are not available, the utilities should get percentage differences year to year (e.g.: if year 1=100%; is year 2 exactly the same, or is it 95% or 110% of production the previous year).

Outcome: Documenting production changes and using them in savings estimates will improve accuracy and reduce evaluation risk.

Finding: Enbridge Boilers use a 73% assumed thermal efficiency for in situ boilers that have been in place for more than 10 years. This is based on a 2% de-rate of a 2007 combustion efficiency study that found an average combustion efficiency of 74.6% for 39 boilers aged 12-38 years (average 24.5). The study, which EGD provided to the evaluation team, did not attempt to tie the degraded combustion efficiency to the original rated efficiency of the boilers. The study is also now more than 10 years old, so its findings are likely out of date and should only at most apply to 20-year-old or more boilers. For 2016, the evaluation used the 73% value since a better option was unavailable at the time.

Recommendation: Use a degradation from name plate efficiency to determine the baseline boiler efficiency rather than a flat number. The 2017 CPSV effort should include in the scope secondary research to determine a degradation factor or curve to be used for the 2017 and 2018 CPSV and could be incorporated by the utilities for the 2019 program year until primary research is completed or a better approach is developed.

Outcome: Improving this key assumption will improve savings estimates for a significant portion of savings in the Enbridge portfolio and the process would also be applicable to Union sites where baseline boiler efficiencies are required and not based on site tests of boiler performance.

Finding: Pipe insulation is a significant source of savings for the Union Gas programs. Union estimates heat loss rate for damaged baseline insulation less than that from a simple bare pipe assumption, which is reasonable and appropriate. Documentation for the source of the factors used in the calculation and documentation (via photos and/or a description of the pipe insulation condition) was not consistently provided.

Recommendation: Document baseline conditions using photos and text descriptions to provide context. Tie the documentation of baseline condition to the heat loss rate used in a clear way.

Outcome: Improving documentation of baseline conditions and clarity in calculations will reduce evaluation risk improve consistency of approach among the Union engineering team.

Finding: Enbridge documentation did not always include a prose explanation and supporting documentation for baseline types (ROB, ER) and remaining useful life (RUL). "See Etools for base case" is not sufficient: Etools is not designed to provide context and sources to support the values included.

Recommendation: Always complete the "Base Case Overview" with a prose description of the base case. The description should reference included emails and photos to document in situ conditions and features that are carried over into the baseline system.

Outcome: Improved descriptions and documentation will reduce evaluation risk and help Enbridge ensure that accurate information has been entered into Etools.

Finding: Duration of pre- post- data (energy consumption, production output, raw material consumption, etc.) used for savings estimates were too brief in several instances.

Recommendation: The utilities should use longer duration data in ex ante savings estimates when possible. When time periods less than a year are used, the utilities should document why the period used is applicable to a full year and why a full year was not able to be used.

Outcome: Increased accuracy of savings estimates.

Finding: The utilities did not always gather boiler nameplate data for in situ systems. The age and operating condition was also not always recorded or described. This was a concern on boiler projects, but also for projects where boiler efficiency has an effect on savings, such as greenhouses, pipe insulation and heat recovery.

Recommendation: In situ boiler name plate information, age and operating condition are all helpful for determining the designed performance and reasonable range of actual efficiency for the system as well as providing context to better determine remaining useful life (RUL)

Outcome: Improving documentation of the in situ boiler will reduce uncertainty in savings estimates and reduce evaluation risk.

Finding: Items that may be obvious to the ex ante team can be non-obvious to an outside party. Examples from sites this year included in situ burners that could not be turned off and whether heating needs were equal to or greater than the amount of heat recovered.

Recommendation: Review ex ante documentation from an outside perspective to identify where documentation or explanation could be added.

Outcome: Reduced evaluation risk.

Finding: At large sites with multiple spaces containing similar equipment, ex ante documentation did not always identify which space or piece of equipment was affected by the project.

Recommendation: Include additional descriptions of spaces and equipment affected to differentiate among similar spaces and equipment at the site.

Outcome: Reduced evaluation risk.

Finding: Invoices were not always included with documentation, and sources for incremental costs were not always clear.

Recommendation: Ensure that incremental costs are supported by invoices or other documentation, especially for add-on and optimization measures where the total cost and incremental cost are likely to be the same. Equipment replacement measures may require an additional standard efficiency quote to produce incremental cost.

Outcome: Incremental cost is an important component of simple payback, which is often used to judge the economic benefit of energy efficiency projects. It is also an input to some benefit-cost tests.

Finding: Larger projects appeared to fall under the same documentation standards as smaller projects.

Recommendation: Increase the amount of documentation and source material for projects that have greater energy savings.

Outcome: Projects that are better documented tend to have more accurate savings estimates and receive fewer evaluation adjustments than those that are less documented. Large projects have a greater effect on overall savings adjustment factors. Therefore, large projects with better documentation are more likely to result in adjustment factors closer to 100%.

Finding: Union custom projects utilized a project application summary workbook that summarizes the key project inputs, calculations, and most details. In general, this is a good approach that facilitates internal review and evaluation. We also found that the workbooks had improved source documentation relative to the 2015 projects. One challenge was that different projects used the workbook in different ways:

- The notes section was sometimes used to identify and highlight specific unique approaches and features in projects, but not always.
- Calculations internal to the summary page were consistent for most projects, but not all (additional factors were sometimes added).
- Sub-methods critical to the calculation were contained in hidden sheets.
- Safety and influence adjustments were inserted in different locations and not always explained.

Recommendation: Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner. Identify a common approach for common measures and, if necessary, document deviations and the reasons for the deviations in a clearly labelled field on the summary sheet.

Outcome: A consistent summary workbook aids both internal and external quality assurance, quality control, and measurement and verification.

Finding: Enbridge Etools is used as both a calculation tool and as a communication tool with customers. While it appears to serve the needs of the program, this form of communication is difficult for the evaluation efforts.

- Etools does not easily allow for assumptions to be sourced within the record.
- Some Etools selections may be site-specific and some may be defaults; the calculator does not distinguish.
- Energy savings that are calculated outside of Etools are hard-entered in Etools but not always sourced.

Recommendation: Use a consistent summary workbook.

Outcome: A consistent summary workbook aids both internal and external quality assurance, quality control, and measurement and verification.

5.2.4 Data management

27. Finding: Neither Union nor Enbridge currently track participating customer or participating vendor contact information in their program tracking database. Providing the information to the evaluation puts significant burden on utility staff. In 2016, the data provided by utility staff was much more consistent and clear relative to 2015.

Recommendation A: Track contacts associated with projects in the program tracking database. At a minimum, the program tracking database should include:

- Project site address
- Customer mailing address
- Primary customer contact name
- Primary customer contact phone
- Primary customer contact email
- Primary customer contact mailing address
- Addresses are best tracked as multiple fields including:
 - ◆ Street address line 1
 - ◆ Street address line 2
 - ◆ City
 - ◆ Province
 - ◆ Postal code

Phone number fields should include data validation to enforce a consistent format and avoid missing or extra digit errors. Phone extensions should be tracked in a field separate from the ten-digit phone number and be restricted to numeric data only.

The best practice is to maintain contacts in a table separate from specific project or customer data. This allows for a single contact to be connected to multiple accounts and/or projects as necessary without creating duplication. This structure also makes it easier to associate multiple contacts with a single project, and decreases quality control costs.

Vendor contact information should also be tracked in the database, in the same table as the participating customer contact information. With a relational database, the contact ID from the table can be added to a project record in the role consistent with the contact's participation (such as vendor, decision maker, or technical expert) with a separate table that allows a single vendor contact to be associated with multiple projects.

Outcome A: Reduced burden on utility staff to seek contact information for projects, whether for internal or evaluation use. Reduced evaluation costs and improved sample design expectations.

Recommendation B: The utilities should strongly consider investing in relational program tracking databases. Relational program tracking databases and customer relationship management (CRM) systems allow for multiple contacts to be associated with a single account and/or project. The incremental cost of implementation is low if it is part of the initial database design, populated as projects are started, and updated once they are complete.

For the implementation team, a query-able one-stop shop for information provides a wealth of information that can improve delivery. For example, these databases can help programs understand how contractors work across projects, identify when projects have hit snags and need attention, and give the program team access to key customer context such as historical participation, and different contacts that have worked with the program.

For evaluation, this allows programs to easily clarify aspects of projects during implementation and to provide accurate, timely, and usable contact information to evaluators and verifiers.

Outcome B: Improved customer satisfaction from better delivery, and a reduced burden on utility staff for tracking information. A relational database would also streamline aggregation of program data for scorecards and make providing data simpler for annual savings evaluation and verification.

Recommendation C: When the evaluation requests contact information for savings verification and evaluation, the contact request spreadsheet will continue to provide additional fields to enforce data integrity (e.g., specific fields for a parsed address and company name for the technical and decision-making contacts). If the program tracking databases are able to report contact information, this spreadsheet should be modified to reduce burden on utility staff while maintaining high levels of data integrity.

Outcome C: Reduced evaluation costs due to less data cleaning and research to fill missing information. Improved data collection with less returned advance letters and more accurate connection between projects and contacts.

28. Finding: The extracts from the utility program tracking database do not include dates for key project milestones. Enbridge's data did not include any dates and Union's included only the "install date."

Recommendation: Track and provide to evaluators dates for key milestones in the project. Dates for project start, installation, and those that define the program year provide useful context for interviewers that is not always easy to find in project documentation

Outcome: Improved data collection through more informed interviewers and reduced evaluation costs through less need to search for dates in documentation.

29. Finding: EUL and cumulative gross savings were not provided in a consistent manner in the Enbridge program tracking database extract. The EUL inconsistency is the result of a work around for advanced (accelerated) projects used by Enbridge to report accurate dual baseline saving estimates and first year savings. Communicating the workaround consistently within the evaluation team led to some re-work.

Recommendation: Include separate fields in the program tracking database for:

- EUL
- RUL
- gross first year annual savings
- gross post-RUL annual savings
- NTG,
- gross cumulative gross
- net cumulative savings
- net first year savings.

Outcome: Improved data integrity results in less evaluation risk and more accurate savings totals. Providing each of the key savings types and their components allows evaluation to confirm that the savings provided are internally consistent.

5.3 Measure Life Study Recommendations

The following recommendations are summarized from the measure life study finalized in May of 2018. The entire report is included in Appendix P.

Updates to Measure Lives:

- Use a 15-year measure life for boiler controls. This does not include burner modifications, which are currently assigned a separate measure life by Union. Enbridge could consider adding a separate category for burner modifications, which would use a 20-year life similar to Union.
- Increase the measure life for variable frequency drives for make-up air units to 15 years.
- Reduce the measure life for loading dock door and ramp seals to 10 years to be consistent with what is used in other cold-weather jurisdictions.
- Reduce the measure life for pipe insulation to 14 years, which is consistent with the industry average, and accounts for a portion of the insulation being installed outdoors or in hazardous environments where it is unlikely to last 20 years.
- Use a measure life of 15 years for building automation systems, also known as energy management systems.

Future Research:

- As the top priority, conduct primary research on the type of pipe insulation projects installed in Ontario to determine the appropriate measure life.
- As the second priority, conduct primary research on recently installed building automation systems to determine how current system measure lives deviate from the primary research conducted approximately 20 years ago.

- Consider also studying dock door seals, either through vendor interviews or program participant interviews, to determine the appropriate measure life.
- Collect on-going data, similar to the ASHRAE database referenced in the study, to confirm or deny the assumed measure lives for energy curtains, exhaust fan controls, boiler controls, heat exchangers, and “other” industrial equipment.

Michaels Energy recommends the measure lives in Table 63 be adopted as the “default” values for custom programs.

Table 63. Recommended measure lives

Measure	Recommended Measure Life
All other industrial equipment	20
Boiler – Industrial Process	20
Boiler – Space heating	25
Pipe Insulation	14
Boiler – Domestic Hot Water	25
Boiler Controls	15
Energy Curtains	10
Heat Recovery – Commercial	15
Heat Recovery – Industrial	20
Exhaust Fan Controls	15
Heat Reflector Panels	15
Economizers – Conventional and condensing	20
Steam Trap	6
Infiltration Controls – Air Doors	15
Infiltration Controls – Dock Seals	10
IR Poly	5
VFD retrofit on MUA	15
Heat Exchanger	17
Building Automation System	15
Ovens and Thermal Oxidizers	20
Reverse Osmosis Water Conditioner	20
Building Envelope	25



6 APPENDICES

Appendix A Glossary of Terms and Key Concepts

Adjustment factor	The adjustment factors are ratios of savings that allow evaluation findings from a sample of projects to be applied to and “adjust” the population of program savings. Realization rates, and ratios are other common terms.
Baseline, base case	Energy use / equipment in place if the program measure had not been done
Building envelope	Exterior surfaces (e.g., walls, windows, roof, and floor) of a building that separate the conditioned space from the outdoors.
Capacity expansion (CE)	Measure that allows customer to increase production/productivity
CCM	Cumulative Cubic meters (cumulative m ³)
Code	Measure required by regulations for safety, environmental, or other reasons
C&I	Commercial and Industrial
Custom Program Savings Verification (CPSV)	Activities related to the collection, analysis, and reporting of data for purposes of measuring gross custom program impacts.
Customer - Enbridge	Unique customers can be identified based on the Con_acc_num and the contact information provided by Enbridge. A customer may have multiple site addresses, decision makers, Con_acc_nums, and utilities. Customers can only be identified for records for which we received contact information (ie records associated with con_acc_num that have measures in the sample or backup sample).
Customer - Union	Unique customers can be identified based on the AIMS ID and the contact information provided by Union. A customer may have multiple site addresses, decision makers, AIMS IDs, and utilities. Customers can only be identified for records for which we received contact information (ie records associated with AIMS ID that have measures in the sample or backup sample).
Demand side management (DSM)	Modification of perceived customer demand for a product through various methods such as financial incentives, education, and other programs
Early replacement (ER)	Measure that replaces a piece of equipment that is not past EUL and in good operating condition
Domain	Grouping of like projects. A domain may be defined as projects within a specific sector or a category of measure types, end uses or other.
Dual Baseline	Savings calculation approach which addresses or combines the savings associated with early replacement and the savings after the early replacement period.
Early replacement Period (ER Period)	Years that the existing equipment would have continued to be in use. This is the same as RUL.
Energy Advisors	Energy Advisors are utility and/or program staff who provide information to customers about energy saving opportunities and program participation, this term includes, but is not limited to, Enbridge’s Energy Solutions Consultants and Union’s Account Managers
Estimated useful life (EUL)	Typically, the median number of years that the measure will remain in service
Ex ante	Program claimed or reported inputs, assumptions, savings, etc.
Ex post	Program inputs, assumptions, savings, etc. which are verified after the claimed savings are finalized. Does not include assessment of program influence. Synonym for verified gross savings.
Gross savings	Gross savings are changes in energy consumption and/or demand directly caused by program-related actions by participants regardless of reasons for participation (savings relative to baseline, defined above)
In situ	Existing measure, conditions, and settings
Incentive	An incentive is a transfer payment from the utility to participants of a DSM program. Incentives can be paid to customers, vendors or other parties as part of a DSM program.
Incremental cost	The difference in purchase price (and any differences in related installation, implementation costs), at the time of purchase, between the efficient measure and the base case measure. In some early retirements and retrofits, the full cost of the efficient technology is the incremental cost.



Industry standard practice (ISP)	Common measure implemented within the industry
Input assumptions	Assumptions such as operating characteristics and associated units of resource savings for DSM technologies and measures
Lifetime cumulative savings	Total natural gas savings (CCM) over the life of a DSM measure. Can be claimed, gross, or net. Sometimes referred to as just “cumulative” or “lifetime.”
Maintenance (Maint.)	Repair or maintain, restore to prior efficiency
Measure – Enbridge	Measures are identified in the tracking data as a unique combination of project code, project sub code, and DSM project ID. Multiple measures may belong to the same project.
Measure – Union	Measure refers to a project # in the tracking data. When referring to Union programs, measure and project are used interchangeably as there is one level provided in the tracking data.
Measurement and Verification (M&V)	Verification of savings using methods not including attribution/free-ridership assessment.
Metric	Metrics used within OEB Order and Decision to describe program achievement units.
MF	Multifamily (multi-residential).
New construction (NC)	New buildings or spaces
Non-early replacement period (non-ER period)	Years after the ER period up to the EUL
Normal replacement (NR)	Measure that replaces a piece of equipment that has reached or is past its EUL and in good operating condition
Persistence	The extent to which a DSM measure remains installed, and performing as originally predicted, in relation to its EUL
Program	Programs as listed within the OEB Decision and Order. Generally sub-units of Scorecards; for example, Commercial and Industrial Prescriptive Program within the Resource Acquisition Scorecard.
Program evaluation	Activities related to the collection, analysis, and reporting of data for purposes of measuring program impacts from past, existing, or potential program impacts
Project - Enbridge	Projects are identified in the tracking data based on the project code. A project may have multiple measures as indicated by sub-codes in the current data tracking system.
Project – Union	Projects are identified in the tracking data based on project # or project ID. When referring to Union programs, measure and project may be used interchangeably as there is one level provided in the tracking data.
Remaining useful life (RUL)	The number of years that the existing equipment would have remained in service and in good operating condition. This is the same as ER Period.
Realization Rate	A combination of adjustment factors, which represents ratios between two savings values. For example, the final realization rate is the ratio between evaluated savings and program claimed savings.
Replace on burnout (ROB)	Measure that replaces a failed or failing piece of equipment
Retrofit add-on (REA)	Measure reduces energy use through modification of an existing piece of equipment
Scorecard	Approach used to allow the gas utilities to be rewarded for undertaking important activities other than strictly reducing natural gas consumption, such as increasing customer participation in programs or installing energy efficiency measures with a long life. A scorecard approach allows for taking multiple metrics into consideration.
Site	Sites are identified based on unique site addresses provided by Union and Enbridge through the contact information data request. A site may have multiple units of analysis, measures, and projects. Sites can be identified by the evaluation only for records for which we receive contact information – ie records associated with con_acc_num (EGD) or AIMS ID (Union) that have projects in the sample or backup sample.
System optimization (OPT)	Improve system or system settings to exceed prior efficiency
TRM	“Technical Reference Manual” – Generally accepted acronym and term for document that identify standard methodologies and inputs for calculating energy savings.
TSER	Telephone Supported Engineering Review

Unit of Analysis – Enbridge	The level at which the data are analyzed, which in 2016 is a “measure” or sub-project level for Enbridge
Union Influence Factor	Factor applied by Union to a small number of projects in 2016. The factor reduced ex ante (claimed) savings to account for anticipated partial free ridership. In this report, the savings reported have the factor removed.
Unit of Analysis - Union	The level at which the data are analyzed, which in 2016 is a project for Union. A project is equivalent to a measure for Union as the database did not have a sub-project level.
Vendors	Program trade allies, business partners, contractors and suppliers who work with program participants to implement energy saving measures

Appendix B Summary of Verification Adjustments

Table 64 and Table 65 provide a combined summary of metrics for Enbridge and Union, respectively. These tables show where the EC made adjustments of greater than 1% from the utility reported values.

Table 64: Enbridge Metrics with Verified Value Greater than 1% Different from Reported

Scorecard	Program Name	Metric	Component	>1% Difference?
Resource Acquisition	C&I Direct	CCM	Small Volume Customers	
	C&I Prescriptive			
	Custom			✓
	Energy Leaders Initiative			
	Run-it-Right			
	C&I Direct			Large Volume Customers
	C&I Prescriptive			
	Custom		✓	
	Energy Leaders Initiative			
	Home Energy Conservation			
	Residential			
	Home Energy Conservation		Participants	
Low Income	Low Income Multi-family	CCM		✓
	Low Income Single Family	CCM		
	Home Winterproofing	Participants		
Market Transformation	Commercial Savings by Design	New Developments		
	Residential Savings by Design	Builders		
		Homes Built		
	Comprehensive Energy Management	Participants		
	School Energy Competition	Participants		
Run it Right	Participating Schools			

Table 65: Union Metrics with Verified Value Greater than 1% Different from Reported

Scorecard	Program Name	Metric	Component	>1% Difference?
Resource Acquisition	C&I Custom	CCM		✓
	C&I Direct			
	C&I Prescriptive			✓
	Home Reno Rebate			✓
Large Volume	Direct Access – Custom	CCM		✓
	Direct Access - Prescriptive			✓
Low Income	Furnace End-of-Life Upgrade	Single Family CCM		
	Home Weatherization			✓
	Multi-Family – Market Rate – Custom	Market Rate Multi-Family CCM		✓
	Multi-Family – Market Rate – Prescriptive			✓



Scorecard	Program Name	Metric	Component	>1% Difference?
	Multi-Family – Social & Assisted – Custom	Social and Assisted Multi-Family CCM		✓
	Multi-Family – Social & Assisted - Prescriptive			✓
Market Transformation	Commercial New Construction	Participants		
	Optimum Home	Participants		
Performance Based	RunSmart	Participants		
	Strategic Energy Management	Participants		

Appendix C Data and Documentation Requests

First Documentation Request

There were officially two data and documentation requests during the 2016 annual verification; a third formal request was planned for but was not necessary as a formal request. In practice, there was repeated back-and-forth between the EC and the utility teams with questions and follow-up information which functioned as a third request. Any back-and-forth is described in the individual program verification sections later in these appendices. This appendix shows the two formal documentation requests. The first is a copy of the memo sent on August 4, 2017, and the second is a copy of the emails sent November 28, 2017.

Memo to: Utility staff
Date: August 4, 2017

Copied to: DNV GL and OEB staff
Prep. By: DNV GL employee

Ontario Gas Portfolio Data Request

This memo formally requests anonymized program tracking data for all Enbridge¹¹ and Union¹² projects submitted as part of the program filings¹³ for the 2016 program year. It also requests additional reports, data, and other documentation to support the Evaluation Contractor's (EC's) verification of the 2016 program year impacts and scorecard achievements. The deadline for this request is August 30, 2017.

Non-tracking data requested

The EC team is requesting additional (non-tracking) data to support our verification of the 2016 program year impacts and scorecard achievements. In addition to the tracking data requested in the rest of this memo, we ask that Enbridge and Union send:

- A copy of Year 2016 verification and evaluation studies
- A copy of any previous verification and evaluation studies that apply to Year 2016 savings calculations
- A copy of operational and quality assurance documentation associated with the tracking database
- A copy of the spreadsheets or other documentation that confirms the reported market transformation achievements for Year 2016, if they are not already included in the tracking data
- Year 2016 data or documentation that that may not be included in tracking data and confirms any non-energy metrics including
- Union Optimum Home total homes built

¹¹ Reporting of Enbridge Gas Distribution Inc.'s 2015 DSM Program Results (EB-2015-0245): 2015 Demand Side Management Draft Annual Report. April 22, 2016.

¹² Union Gas Limited ("Union") – Demand Side Management ("DSM") Program Evaluations – Draft 2015 Annual Report: 2015 Demand Side Management Draft Annual Report. April 22, 2016.

¹³ From what DNV GL understands, the programs may not have submitted 2016 programs; however, please send whatever projects would be included as part of a 2016 submittal, even if it has not yet been delivered.

- Union Commercial New Construction New Development Builders enrollments
- Union Strategic Energy Management participants
- Union RunSmart participants
- Union Home Reno Rebate deep savings homes
- Enbridge Market Transformation & Energy Management records
- Enbridge Low Income New Construction project applications
- Enbridge Home Energy Conservation deep savings participant records

Tracking data requested

The additional programs/projects for which we are requesting 2016 tracking data are shown in Table 66. Please provide all **anonymized** records associated with the measures installed through these programs as part of the 2016 program year.

Table 66. 2016 programs requested

Union Programs	Enbridge Programs
Resource Acquisition Requested	
Home Reno Rebate	Residential Home Energy Conservation
Commercial & Industrial Prescriptive	Residential Adaptive Thermostats
Commercial & Industrial Direct Install	Commercial & Industrial Prescriptive
Commercial & Industrial Custom	Commercial & Industrial Direct Install
	Commercial & Industrial Custom
	Run it Right
	Comprehensive Energy Management
	Small Commercial New Construction
Large Volume Requested	
Large Volume	
Low Income Requested	
Home Weatherization	Low Income Home Winterproofing
Low Income Multi-Residential Housing	Low Income Multi-Residential Housing
Furnace End-of-Life	Low Income New Construction
Indigenous	
Market Transformation Requested	
Optimum Home	Residential Savings by Design
Commercial New Construction	Commercial Savings by Design
	School Energy Competition
	Comprehensive Energy Management (CEM)
	Run it Right
Performance-Based Requested	
Run Smart	
Strategic Energy Management	

The first step in the verification is to confirm that the provided tracking data matches the participant/measure counts and savings reported in the 2016 filings. DNV GL understands that programs may not have submitted 2016 programs; however, please send whatever projects would be included as part of a 2016 submittal, even if not yet delivered. In addition, DNV GL requests overall totals of participant/measure counts and savings that will be submitted, if available. To perform step one, the evaluation requires the database fields shown in Table 67. The names of the fields are indicative of the content and do not reflect the names that the utilities use in their tracking systems.

Table 67. Minimum Database Fields Required for Matching Database to Utility Filings

Required Database Field	Field Description
Measure ID	Unique Identifier – smallest grain of analysis, a measure is a unique calculation within a project. For example, 2 identical boilers would be one measure, while 2 different boilers would be two separate measures
Project ID	Unique Identifier - project can include multiple measures at one site and at one time; typically projects affect a single account
Account ID	Unique Identifier - billing account
Site ID	Unique Identifier - unique to a facility or group of facilities at a location
Customer ID	Unique Identifier - customer may have multiple sites, multiple accounts
Annual gross gas savings	Gross per year
Annual net gas savings	Net per year
Cumulative gross gas savings	Gross over lifetime of measure
Cumulative net gas savings	Net over lifetime of measure
Estimated useful life	Lifetime of the measure
Incentive amount	Amount of financial incentive paid (may be multiple fields if more than one party received a financial incentive)
Incentive type	Participant Rebate, Grant, Vendor Rebate/Spiff, participant loan
Program Year	The program year in which the measure impacts are claimed
Program	The program under which the measure impacts are claimed
Offering	The offering under which the measure impacts are claimed
Market segment	Business type or rate class for C&I (both in separate fields are best) 4-way single/multi-family by low income/market rate for residential
Net-to-gross factor	The net-to-gross (NTG)rate used for the program/offering/measure in calculating net savings for the filing

For prescriptive measures, the next step is to confirm the inputs and assumptions used in the savings estimates versus those required by the Technical Reference Manual (TRM) or agreed-on prescriptive savings documentation applicable to the 2016 program year. This step is best completed on a measure level dataset, where each row in the tracking data conforms to a single measure defined in the TRM. The information

required for this task depends on the measures covered by the TRM and implemented by the programs. For the verification, the EC needs a tracking database which includes all of the site specific inputs required to estimate savings using the TRM. An example of the type of information required in the database for this process is shown in Table 68. This list is not comprehensive; please provide all necessary fields for calculating the prescriptive measure savings.

Table 68. Example of the type of information required to verify prescriptive savings

Example Database Field	Verification Purpose
Measure description	Connects the tracking measure to the TRM measure to determine the per-unit savings.
Quantity	Identifies the number of units installed to produce the total measure savings.
New or existing installation	Connects the tracking measure to the appropriate savings value in the TRM.
Measure TRM	TRM descriptor used as basis for gross and net savings calculations
Measure Capacity	Capacity value necessary for determining savings (e.g. MBH for high efficiency boilers)
Details of efficient equipment	Connects the tracking measure to the appropriate savings value in the TRM.
Base equipment	Connects the tracking measure to the appropriate savings value in the TRM.

Please provide tracking data for the programs identified in Table 66 which includes the fields listed in Table 67 and Table 68, in addition to any similar or relevant fields that will aid in the verification. The deadline for this request is August 30, 2017.

Please contact me with any questions or concerns related to this contact information request at <phone number and email address>.

Thank you in advance for your assistance.

Data Recommendations

In the 2015 Natural Gas Demand Side Management Annual Verification Report, the EC provided summary and program specific recommendations. These recommendations are summarized in section 1.3 of that report, Table 11 through Table 15. Most relevant to this request in general are those regarding data including:

- Deliver tracking data in a single flat file.
- Develop and maintain an electronic summary of the TRM.
- Track prescriptive savings using unique measure descriptions that map to electronic TRM.
- Include site-level information for all measures installed through the program.

In addition, the EC again emphasizes the importance for **anonymized** records.



Notice for future requests

After receiving and reviewing the data and documentation requested in this memo, the EC will follow up with a second round of documentation request for a sample of program participants in some programs. The final details will be established after the EC reviews the tracking data requested in this memo. In the 2015 evaluation, the second request followed approximately 8 business days after the due date of the first; the EC anticipates a similar timeline for the 2016 evaluation.

Second Documentation Request - Enbridge

(Email sent November 28, 2017)

Good afternoon –

Attached, please find the second data request of detailed information for the 2016 Annual Verification.

Please note – at this time, we do not have sufficient information to select a home for evaluation of the Residential Savings by Design program. This is also noted in the attached request. We request that the full list of homes be sent along with the response to this request. In that list, please include a unique identifier that can be matched between the list of homes and in subsequent home's documentation.

Please let me know when the requested records are ready for transmission. I will have a secure file transfer request link sent to you at that time.

Please provide the requested documentation by Friday, December 8, 2017.

Second Documentation Request – Union

(Email sent November 28, 2017)

Good afternoon –

Attached, please find the second data request of detailed information for the 2016 Annual Verification.

Please note – at this time, we do not have sufficient information to select a home for evaluation of the Optimal Home program. This is also noted in the attached request. We request that the full list of homes be sent along with the response to this request. In that list, please include a unique identifier that can be matched between the list of homes and in subsequent home's documentation.

Please let me know when the requested records are ready for transmission. I will have a secure file transfer request link sent to you at that time.

Please provide the requested documentation by Friday, December 8, 2017.

Appendix D Description of Data Received

This appendix describes the initial data received from the utilities in response to the data requests shown in Appendix C. The appendix also describes the EC process for verifying that the correct data was received. As discussed in Appendix C, there was repeated back-and-forth between the EC and the utilities after the initial data submissions. Those will be discussed in the individual program verification sections.

Enbridge: first submission

Enbridge's first data submission included the following:

- An Excel file with:
 - ♦ The tracking data for 2016, including custom and prescriptive programs, contained in multiple sheets within the workbook
 - A sheet with the prescriptive, quasi-prescriptive, and custom measures, with each measure listed individually and summed to the overall measure category.
 - A sheet similar to the previous, with lost revenue values included
 - A sheet providing an abbreviated table of Enbridge measures with TRM values
 - A sheet summarizing Home Energy Conservation measures by residence and energy savings
 - A sheet summarizing Adaptive Thermostats measures by project
 - A sheet summarizing Prescriptive and Direct Install Measures¹⁴
 - A sheet summarizing showerhead installations in multi-family residences
 - A sheet summarizing C&I Custom program projects¹⁴
 - A sheet summarizing Run it Right savings estimates for the Resource Acquisition Scorecard
 - A sheet summarizing CEM program savings (empty for 2016 program year)
 - A sheet summarizing Small New Construction program savings (empty for 2016 program year)
 - A sheet summarizing Energy Leaders program projects¹⁴
 - A sheet summarizing the Winterproofing energy savings by residence
 - A sheet summarizing the TAPS installations by residence
 - A sheet summarizing Low Income custom projects¹⁴
 - A sheet summarizing Low Income prescriptive projects¹⁴
 - A sheet summarizing Low Income prescriptive showerhead projects
 - A sheet summarizing Low Income New Construction projects
 - A sheet summarizing SBD Residential Builders
 - A sheet summarizing SBD homes built

¹⁴ The primary workbook sheets (first two listed) contain "hard-coded" formula links/references to this sheet. This adds unnecessary complexity and risk to the tracking document.

- A sheet summarizing SBD Commercial Builders
 - A sheet summarizing School Energy Competition projects
 - A sheet summarizing CEM projects for the Market Transformation Scorecard
 - A sheet summarizing Run it Right projects for the Market Transformation Scorecard
 - A sheet summarizing Avoided Cost inputs
 - A sheet summarizing Avoided Costs 2016-2025
- Despite some difficulties, the Enbridge data largely satisfied the initial data request. Some notes on the tracking data:
 - The Enbridge tracking data (the first Excel file listed above) is contained in multiple sheets within the workbook. Some have multiple levels of data in them, including those listed in the bullets below. The interim summary rows made it impossible to import the data directly into our own analysis tool for manipulation and verification, which made the verification process much more difficult to complete.
 - ◆ Site-level savings for custom projects, summarized to the building type (such as accommodation or retail), the segment (such as large commercial or multi-family) and program (such as commercial or industrial) within the same sheet.
 - ◆ Measure-level savings for prescriptive and quasi-prescriptive projects, summarized to the measure type.
 - The Enbridge tracking data was very “manual” in its summary approach. Formulas are clearly directed to individual cells, making it very easy to follow the calculation throughout the workbook.
 - The data was not always presented at the site level. For example, showerhead measures were simply presented in terms of the number of addresses that received the measure, not the site-level information (such as company name and address) of the facility that received the measures. This was partially remedied by separate showerhead sheets.

To verify that we received the correct data, the EC compared the summarized energy savings values with those reported by Enbridge in their annual report.

Union: first submission

Union’s first data submission included the following:

- An Excel file with:
 - ◆ The tracking data for 2015, including custom and prescriptive programs
 - ◆ 2016 avoided costs
 - ◆ A list of the RunSmart projects
 - ◆ A list of SEM program participants
 - ◆ A summary of the Optimum Homes built in 2016 by builder
 - ◆ A summary of the 2016 budget spend

The Union tracking data (the first Excel sheet listed above) is contained in a single table within the Excel workbook. There was one row per record with no interim rows containing summary information. It was very easy for the EC team to import the data into our own analysis tool for manipulation and verification.

Enbridge: second submission

Enbridge's second data submission included the following:

- Twenty-five folders with HOT2000 files, pre-post installation photos, and invoices for Home Energy Conservation projects
- Twenty-five folders with consent forms, HOT2000 files, field audits, pre-post installation photos, and invoices for Winterproofing projects
- PDF copies of applications for seven CEM participants
- Six folders with Low Income New Construction participation applications and invoices
- Ten folders with applications and audit reports for Run it Right (Market Transformation) participants
- PDF copies of applications, invoices, and other documentation for ten Run it Right (Resource Acquisition) participants
- PDF copy of commitment form and application summary for one Commercial Savings by Design development
- PDF copy of application and report for one Residential Savings by Design builder
- Six PDF scans and two JPG images of school application hardcopies for School's Energy Competition participants
- Updated tracking file with individual listings for all Residential Savings by Design participating builders and SBD-compliant homes built by the participating Residential Savings by Design builders

Union: second submission

Union's second data submission included the following:

- Twenty-five folders with HOT2000 files and photos for Home Weatherization projects
- Pre-post installation photos and invoices for twenty five Home Reno Rebate program projects
- PDF copy of ten Checklists for the RunSmart program
- PDF copy of three Memoranda of Understanding for the Strategic Energy Management program
- Documentation for one Optimum Home Builder
- Documentation for one Optimum Home customer (home)



Appendix E Resource Acquisition Scorecards

This appendix describes the detailed process used to verify the metrics for the Resource Acquisition Scorecard programs for Enbridge (Table 69) and Union Gas (Table 70). The programs addressed in this appendix are:

- Home Energy Conservation – Enbridge
- Home Reno Rebate – Union
- Residential Adaptive Thermostats – Enbridge
- Commercial & Industrial – Prescriptive – Enbridge
- Commercial & Industrial – Prescriptive – Union
- Commercial & Industrial – Direct Install – Enbridge
- Commercial & Industrial – Direct Install – Union
- Commercial & Industrial – Custom – Enbridge
- Commercial & Industrial – Custom – Union
- Energy Leaders Initiative – Enbridge
- Comprehensive Energy Management – Enbridge
- Run it Right – Enbridge

Table 69. Enbridge 2016 Resource Acquisition scorecard*¹⁵

Programs	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
Home Energy Conservation	Small Volume Customers CCM	229,695,730	394,823,056	239,378,409	319,171,212	478,756,818	40%
Residential Adaptive Thermostats		45,367,920					
C&I Custom		15,456,573					
C&I Direct		74,467,508					
C&I Prescriptive		29,570,692					
Energy Leaders Initiative		264,633					
Comprehensive Energy Management		0					
Run it Right		0					
Small Commercial New Construction		0					
Home Energy Conservation		Large Volume Customers CCM					
Residential Adaptive Thermostats	0						
C&I Custom	299,900,768						
C&I Direct	4,696,088						
C&I Prescriptive	21,806,900						
Energy Leaders Initiative	406,553						
Run it Right	1,937,342						
Comprehensive Energy Management	0						
Small Commercial New Construction	0						
Home Energy Conservation	Deep Savings Participants	12,986	12,986	6,194	8,259	12,389	20%

*Not all values may compute exactly due to rounding.

¹⁵ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Schedule C

Table 70. Union Gas 2016 Resource Acquisition scorecard*¹⁶

Programs	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
Home Reno Rebate	CCM	110,310,927	814,757,917	910,578,270	1,214,104,360	1,821,156,541	75%
C&I Custom		544,862,192					
C&I Prescriptive		159,584,798					
C&I Direct Install		0					
Home Reno Rebate	Participants (Homes)	6,595	6,595	2,475	3,300	4,950	25%

*Not all values may compute exactly due to rounding.

¹⁶ Ibid.

Residential Home Retrofit - Home Energy Conservation – Enbridge

Overview

Table 71 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Home Energy Conservation Program, with the metrics of CCM savings for small volume customers and the number of deep savings participants. As a result of this review, the EC verifies 229,695,730 CCM for small volume customers (100.0% of tracked savings) and 12,986 participants (100%). Each metric is discussed separately in this section, starting with the participant metric. Table 71 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 71. Enbridge Resource Acquisition scorecard achievement: Home Energy Conservation metrics*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Small Volume Customers CCM	N/A	229,695,730	229,695,730	100.00%
Homes (Deep Savings Participants)	12,986	12,986	12,986	100.00%

*Not all values may compute exactly due to rounding.

†Enbridge’s draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Documentation

The EC used the documentation shown in Table 72 to verify the metrics for the Home Energy Conservation (HEC) program.

Table 72. Documentation used to verify the Home Energy Conservation program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Project Files	Various documents for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ¹⁷

¹⁷ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Participant Selection

Enbridge provided the Tracking File listing 12,986 individual participants in the HEC program. To certify the scorecard metrics, the EC randomly selected 25 participants for review, requested additional documentation, confirmed receipt of the correct files, and reviewed documents to verify participation and eligibility.

Received Files

The typical file folder had the following information:

- Photographs of pre- and post-installation conditions
- Participation form with personally identifiable information redacted
- Invoice information (PDF scans or photo of receipts)
- HOT2000 Model input or "Simulation" Files (.HSE)
- HOT2000 Model Output Files (.TSV)

Participants Metric

Table 73 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge HEC program with the metric of participant homes.

Table 73. Enbridge Resource Acquisition achievement: HEC Program participants metric*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Homes (Deep Savings Participants)	12,986	12,986	12,986	100.00%

*Not all values may compute exactly due to rounding.

Verify Participation and Eligibility

The Resource Acquisition Scorecard identifies one metric for the program as "Residential Deep Savings Participants (Homes)". To determine the definition of "participants," the EC looked first to the OEB Decision, which identified approval of the Enbridge Home Energy Conservation program.¹⁸ The EC next looked to Enbridge's plan, which identified the following criteria:^{19 20}

1. Be a residential homeowner in the EGD franchise area
2. Have a valid Enbridge Gas account in good standing
3. Use an approved Certified Energy Evaluator ("CEE")
4. Install at least two measures
5. Complete a pre- and post-energy audit
6. Achieve an average of at least 15% gas savings across all participants²¹

The EC evaluated the sampled participant files against the criteria above and determined:

- **Criterion 1:** Enbridge appropriately redacted Personally Identifiable Information (PII) in all of the project files, including customer name and address. However, each file contained an Enbridge account

¹⁸ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Page 13

¹⁹ Enbridge's Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 2, Schedule 2, Page 19 of 55

²⁰ Enbridge's Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 2, Schedule 1, Page 25 of 100

²¹ Enbridge's plan is internally inconsistent on this point. In some areas, each house must achieve at least 15% savings. In others, the program must achieve 15% average across all homes. After deliberation, the EAC chose to use the second (average) criteria for evaluation.

number, providing confirmation that the records were for Enbridge customers and thus within the service territory.

- **Criterion 2:** Each file contained an Enbridge account number, providing confirmation that the records were for Enbridge customers in good standing at the time of the project.
- **Criterion 3:** Each of the sampled 25 files contained a participant form. Each form was signed by the owner/participant (redacted) and the Energy Auditor, confirming customer enrollment in the program and involvement of an auditor. However, while the documentation confirmed that an auditor was involved, it does not signal that the auditor was an approved Certified Energy Evaluator.²² Therefore, we did not use this requirement as a qualification for project eligibility for this round of evaluation.
- **Criterion 4:** The tracking data for all 12,986 records (including the 25 sampled) indicated that at least two measure types were installed at each location, with some homes receiving as many as eight. According to the tracking data, all of the 25 sampled participants received “Air Sealing” as a measure, although the EC found direct evidence confirming specific insulation or air sealing installations for only 5 of the sampled customers in photos or measure invoices.²³ Table 74 shows the breakdown of the types and number of measures installed through the program, according to the tracking data.
- **Criterion 5:** Each project contained *some* pre- and post- project photos. As mentioned for criterion #4, photo documentation was not comprehensive for all measures, but did partially exist for each sampled project, confirming inspections did occur. In combination with submitted modelling files, the EC found that all projects satisfied this requirement.
- **Criterion 6:** In reviewing and confirming CCM savings, the EC identified that all 25 records recorded savings greater than 15% of the original whole-house energy use. Tracking data, corroborated by HOT2000 model files, showed savings of no less than 16.9%, with an average of 29.1% for the 25 sample projects reviewed. The EC observed that while all *sampled* records demonstrated savings greater than 15%, 96 projects listed in the Tracking File (out of 12,986) did not show savings greater than 15%.²⁴ Gas savings for these 96 projects ranged from 6.3% to 15% of baseline usage. Upon deliberation and review, the EAC determined that the EC would not use this criterion for individual sites but use the same criterion of a 15% *average* as applied to the Union program. Since on average, the program saved 30.9% natural gas across all participants, the EC verified all 12,986 as eligible participants.

In addition to these six criteria, the EAC identified one additional criterion for homes that installed air sealing.

- **Criterion 7:** For air sealing to qualify as a measure, the EAC determined that a reduction of at least 10% of cubic feet per minute of air leakage (as measured by a documented blower-door test) must occur. Tracking data for all projects with air sealing identified a reduction of 10% or more.

²² In future evaluation cycles, the EC recommends tracking certifications for all energy evaluators and/or auditors submitting records. NRCAN requires certification for all auditors permitted to use EnerGuide mode, however the EC is unable to verify this without supporting documentation or records.

²³ Numerous records included photos of blower door tests, but without photos or invoices for specific air sealing measures. For future verifications, the EC recommends improving and standardizing verification records to include direct evidence of all claimed measures, but as Enbridge had little time since the previous evaluation to update requirements and procedures, the EC identifies this requirement as satisfied.

²⁴ Enbridge's tracking spreadsheet included a separate tab for detailed HEC records, including variables for Base Case (m3), Upgraded Case (M3), Actual Gas Savings, and Actual Gas Savings %. To determine project qualification, the EC utilized the Actual Gas Savings % to identify projects with savings less than 15.0%

Table 74 shows the measure types installed by the program, broken out by the number of total measure types installed per customer. The most common measure type was air sealing, with 12,794 total installations. Air sealing was most common in homes with only two measures; of the 10,275 homes with two measures, 10,109 (98%) installed air sealing.

Table 74. Count of individual measure types among verified projects and types per home*

Measure Type	Number of Measure Types by Customer							Total	% of Total Homes
	Two	Three	Four	Five	Six	Seven	Eight		
Air Sealing upgraded	10,109	2,174	376	91	33	10	1	12,794	99%
Furnace upgraded	10,096	2,046	326	77	31	10	1	12,587	97%
Water Heater upgraded	129	1,283	233	62	20	10	1	1,738	13%
Attic Insulation upgraded	149	595	229	63	30	10	1	1,077	8%
Windows	18	241	152	66	31	10	1	519	4%
Basement Insulation upgraded	16	153	145	60	29	10	1	414	3%
Wall Insulation upgraded	33	74	61	30	21	10	1	230	2%
Exposed Floor Insulation upgraded	-	7	13	11	3	-	1	35	<1%
Drain Water Heat Recovery System	-	-	1	-	-	-	-	1	<1%
Total Measure Types	20,550	6,573	1,536	460	198	70	8	29,395	N/A
Total Homes	10,275	2,191	384	92	33	10	1	12,986	N/A

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC verifies that 12,986 homes satisfy the requirements deep savings participants.

CCM Savings Metric

Table 75 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge HEC program with the metric of CCM savings.

- Reported: Metric value reported in Enbridge's draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File.
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified in the Documents section.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates verified values match tracked values.

Table 75. Enbridge Resource Acquisition scorecard achievements: HEC Program CCM metric*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Small Volume Customers CCM	N/A	229,695,730	229,695,730	100.00%

*Not all values may compute exactly due to rounding.

†Enbridge's draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Verify Tracked Savings

In calculating Net Cumulative Cubic Meters (CCM) savings, the EC first utilized Enbridge tracking data to identify the savings for each of the tracked projects. The EC confirmed that the measure life and free ridership multipliers were correctly applied and reviewed the documentation for the sample of 25 program participants to identify whether the gross energy savings in the project files matched the gross energy savings in the tracking data. If any of the 25 projects did not match, an average savings-weighted realization rate was calculated and applied to the tracking savings to produce verified savings.

Table 76. Enbridge Home Energy Conservation projects and savings: verified net savings*

Project Type	Gross Savings	# of Projects	Measure Life	Free Ridership Rate	Verified Tracked Net Savings (CCM)
Retrofit Without Furnace	566,597	399	25	15%	12,179,559
Retrofit With Furnace	17,022,255	12,587	15	15%	217,516,172
Total	17,588,852	12,986			229,695,730

*Not all values may compute exactly due to rounding.

Calculate Realization Rate

The EC used a multi-step process to verify tracked energy savings for the 25 sampled homes, shown in Figure 1 for the 2016 HEC verification. The process was necessary because the simulation mode (EnerGuide or Expert²⁵) used by program delivery agents is not available to non-certified professionals. While the EC can attempt to run the Expert simulations in General mode, the runs may produce error warnings or result in a savings differential between the Expert result and General result. Therefore, this multi-step process was developed to verify savings:

- EC requested simulation (HSE) and output (TSV) files from the program
- Where possible, the simulation file was re-run and the results used to verify the tracking savings. If different simulation versions or modes were used, the savings could be slightly different; therefore, simulation savings were considered “verified” if they were within 2% of the tracking savings; in this case, the tracked savings value was accepted as the verified savings.
- If a simulation file was not provided, the file inputs were incompatible with General mode and would not run, the file ran but produced an error due to version or mode differences, or the file produced a difference in savings greater than 2%, the output file was used to verify the tracking savings. As with the simulation file, the EC accepted tracking savings values within 2% of the output file value as the verified savings.
- If the EC was unable to verify the tracking savings against the output file, the EC would have requested additional documentation from the program (utility) to explain the discrepancy. This verification step was not necessary for this program in this round of evaluation.
- If no additional documentation or explanation was available, the EC would have compared the output file values to the project documentation to determine whether they were consistent. This verification step was not necessary for this program in this round of evaluation.

²⁵ “Expert” is the mode listed in the output files. This mode is also labelled as “EnerGuide” in simulation files. The EC uses both terms.

Figure 1. Overview of Gross Savings Verification for 2016 HEC Verification

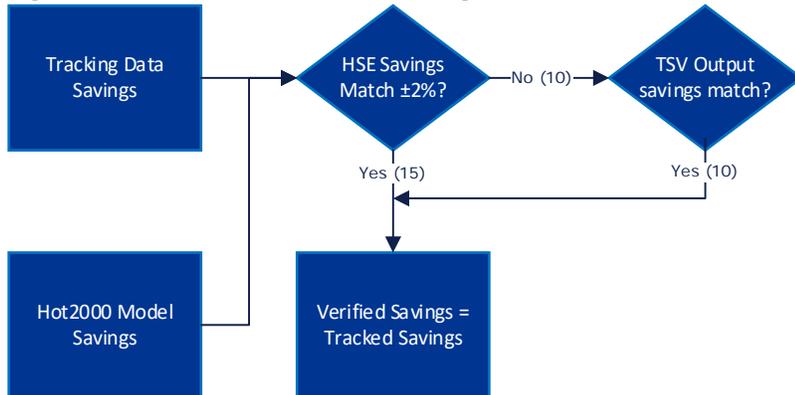


Table 77 shows how many customers were verified against the simulation (HSE) and output (TSV) file.

Table 77. Overview of gross savings verification

Evaluation Step	# Verified
Simulation re-run (HSE) and compared to tracking, verified if $\pm 2\%$	15
Output files (TSV) compared to tracking, verified if $\pm 2\%$	10
Additional explanation requested	-
Comparison to output file values	-
Total Verified	25

The EC produced verified savings for all 25 homes in the sample, shown in Table 78. The table shows the tracking and verified annual savings for each home. The EC used these values to calculate the savings ratio and standard deviation.

Table 78. Tracked and verified savings with savings ratio and standard deviation*

Home	Tracked Savings	Verified Savings	Savings Ratio
A	2,236	2,236	100%
B	1,299	1,299	100%
C	1,539	1,539	100%
D	885	885	100%
E	2,212	2,212	100%
F	1,271	1,271	100%
G	1,603	1,603	100%
H	709	709	100%
I	473	473	100%
J	1,291	1,291	100%
K	1,077	1,077	100%
L	1,025	1,025	100%
M	834	834	100%
N	1,810	1,810	100%
O	797	797	100%
P	1,556	1,556	100%
Q	1,466	1,466	100%
R	925	925	100%
S	560	560	100%
T	1,297	1,297	100%
U	1,246	1,246	100%
V	1,749	1,749	100%
W	1,147	1,147	100%
X	1,009	1,009	100%
Y	1,407	1,407	100%
Total	31,422	31,422	100.00%
Standard Deviation			0.00

*Not all values may compute exactly due to rounding.

The gross savings realization rate (RR) is 100%, shown in Table 79. As there was no variation between Tracked and Verified Savings (all ratios equal 100%), the standard deviation was 0.

Table 79. Enbridge HEC Realization Rate*

Number of Houses	Realization Rate	90% Confidence Interval			
		Absolute Precision	Lower Bound	Upper Bound	Relative Precision
25	100.00%	0.00%	100%	100%	0.00%

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC confirms the total savings of 229,695,730 CCM for Enbridge's Home Energy Conservation small volume customer CCM savings metric (100% of tracked savings).

Residential Home Retrofit - Home Reno Rebate – Union

Overview

Table 80 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Gas Home Reno Rebate (HRR) program, with the metrics of CCM savings and the number of deep savings participants. As a result of this review, the EC verifies 110,310,927 CCM savings (92.3% of tracked savings) and 6,595 program participants (100%). Each metric is discussed separately in this section, starting with the participant metric. Table 80 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 80. Union Resource Acquisition scorecard achievement: Home Reno Rebate metrics*

Metric	Achievement			Savings Ratio
	Reported	Tracked	Verified	
CCM	119,461,693	119,461,693	110,310,927	92.34%
Participants (Homes)	6,595	6,595	6,595	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 81 to verify the metrics for the Home Reno Rebate program.

Table 81. Documentation used to verify the Home Reno Rebate program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	Various documents for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union’s 2015-2020 DSM Plan, EB-2015-0029
Union’s Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ²⁶

Participant Selection

Union provided the Tracking File listing 6,595 individual participants in the HRR program. To certify the scorecard metric, the EC randomly selected 25 participants for review, requested additional documentation, confirmed receipt of the correct files, and reviewed documents to verify participation and eligibility.

²⁶ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Received Files

The typical file folder had the following information:

- Photographs of pre- and post-installation conditions
- Invoice information (PDF scans or photo of receipts)
- HOT2000 Model simulation or “Simulation” Files (.HSE)
- HOT2000 Model Output Files (.TSV)

Participants Metric

Table 82 shows the reported, tracked, and verified scorecard achievements for the 2016 Union HRR program with the metric of participant homes.

Table 82. Union Gas Resource Acquisition achievement: HRR Program participants metric*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Deep Savings Participant Homes	6,595	6,595	6,595	100.00%

*Not all values may compute exactly due to rounding.

Verify Participation and Eligibility

The Resource Acquisition Scorecard identifies one metric for the program as “Home Reno Rebate Participants (Homes)”. To determine the definition of “participants,” the EC looked first to the OEB Decision, which identified approval of the Union HRR program²⁷. The EC looked next to Union’s plan, which identified the following criteria:²⁸

Homes that count as a participant towards the Home Reno Rebate (“HRR”) Participant (Homes) metric must meet the following two requirements:

- 1. A homeowner must complete at least two eligible renovations as outlined at Exhibit A, Tab 3, Appendix A, Section 1.0, Table 1.*
- 2. The aggregate of all of the homes counted towards the metric must achieve, on average, at least a 15% reduction in annual natural gas use as determined through comparing a pre and post energy assessment.*

The EC evaluated the sampled participant files against the criteria above and determined:

- **Criterion 1:** The EC confirmed that the project files documented at least two eligible measures for all 25 sampled homes.
- **Criterion 2:** Of the 25 homes randomly sampled, tracking files reported pre-improvement total annual consumption of 72,829 m³. The EC verified gross savings of 11,661 m³ for an average of 16.0%.

Table 83 shows the measure types installed by the program, broken out by the number of total measure types installed per customer. The most common measure type was air sealing, with 6,140 total installations. Air sealing was most common in homes with only two measures; of the 4,576 homes with two measures, 4,229 (98%) installed air sealing.

²⁷ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Page 13

²⁸ Union’s Proposed 2015-2020 DSM Plan, EB-2015-0029, Exhibit A, Tab 3, Page 24 of 73

Table 83. Count of individual measure types among verified projects and types per home*

Measure Type	Number of Measure Types by Customer					Total	% of Total Homes
	Two	Three	Four	Five	Six		
Air Sealing	4,229	1,331	412	143	25	6,140	93%
Furnace	4,264	1,012	268	93	22	5,659	86%
Window	185	520	278	114	24	1,121	17%
Attic Insulation	139	510	284	124	22	1,079	16%
Basement Insulation	118	301	232	117	25	793	12%
Wall Insulation	85	228	160	84	23	580	9%
Water Heater	108	329	87	45	9	578	9%
Boiler	24	20	7	5	0	56	<1%
Total Measure Types	9,152	4,251	1,728	725	150	16,006	N/A
Total Homes	4,576	1,417	432	145	25	6,595	N/A

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC verifies that 6,595 Homes satisfy the requirement for participant.

CCM Savings Metric

Table 84 shows the reported, tracked, and verified scorecard achievements for the 2016 Union HRR program with the metric of CCM.

- Reported: Metric value reported in Union’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File.
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified in the Documents section.
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates verified values match tracked values.

Table 84. Union Gas Resource Acquisition scorecard achievements: HRR Program savings metric*

Metric	Achievement			Savings Ratio
	Reported	Tracked	Verified	
CCM	119,461,693	119,461,693	110,310,927	92.34%

*Not all values may compute exactly due to rounding.

Verify Tracked Savings

In calculating Net Cumulative Cubic Meters (CCM) savings, the EC first utilized Union Tracking Data to identify the savings for each of the tracked projects, confirming that the measure life and free ridership multipliers were correctly applied. Union Tracking data includes all projects as individual records within tracking data, allowing for a simple summing of tracked savings. The EC reviewed the documentation for the sample of 25 program participants to identify whether the gross energy savings in the project files matched the gross energy savings in the tracking data. If any of the 25 projects did not match, an average savings-

weighted realization rate was calculated and applied to the tracking savings to produce verified savings. Tracking Files savings values are shown Table 85.

Table 85. Union Home Reno Rebate projects and savings: verified net savings*

Gross Savings	# of Projects	Measure Life	Free Ridership Rate	Verified Tracked Net Savings (CCM)
5,029,966	6,595	25	5%	110,310,927

*Not all values may compute exactly due to rounding.

Calculate Realization Rate

The EC used a multi-step process to verify tracked energy savings for the 25 sampled homes, shown in Figure 2 for the 2016 HRR verification. The process was necessary because the simulation mode (EnerGuide or Expert²⁹) used by program delivery agents is not available to non-certified professionals. While the EC can attempt to run the Expert simulations in General mode, the runs may produce error warnings or result in a savings differential between the Expert result and General result. Therefore, this multi-step process was developed to verify savings:

- EC requested simulation (HSE) and output (TSV) files from the program
- Where possible, the simulation file was re-run and the results used to verify the tracking savings. If different simulation versions or modes were used, the savings could be slightly different; therefore, simulation savings were considered “verified” if they were within 2% of the tracking savings; in this case, the tracked savings value was accepted as the verified savings.
- If a simulation file was not provided, the file inputs were incompatible with General mode and would not run, the file ran but produced an error due to version or mode differences, or the file produced a difference in savings greater than 2%, the output file was used to verify the tracking savings. As with the simulation file, the EC accepted tracking savings values within 2% of the output file value as the verified savings.
- If the EC was unable to verify the tracking savings against the output file, the EC requested additional documentation from the program (utility) to explain the discrepancy.
- If no additional documentation or explanation was available, the EC would have compared the output file values to the project documentation to determine whether they were consistent. This verification step was not necessary for this program in this round of evaluation.

²⁹ “Expert” is the mode listed in the output files. This mode is also labelled as “EnerGuide” in simulation files. The EC uses both terms.

Figure 2. Overview of gross savings verification for 2016 HRR verification

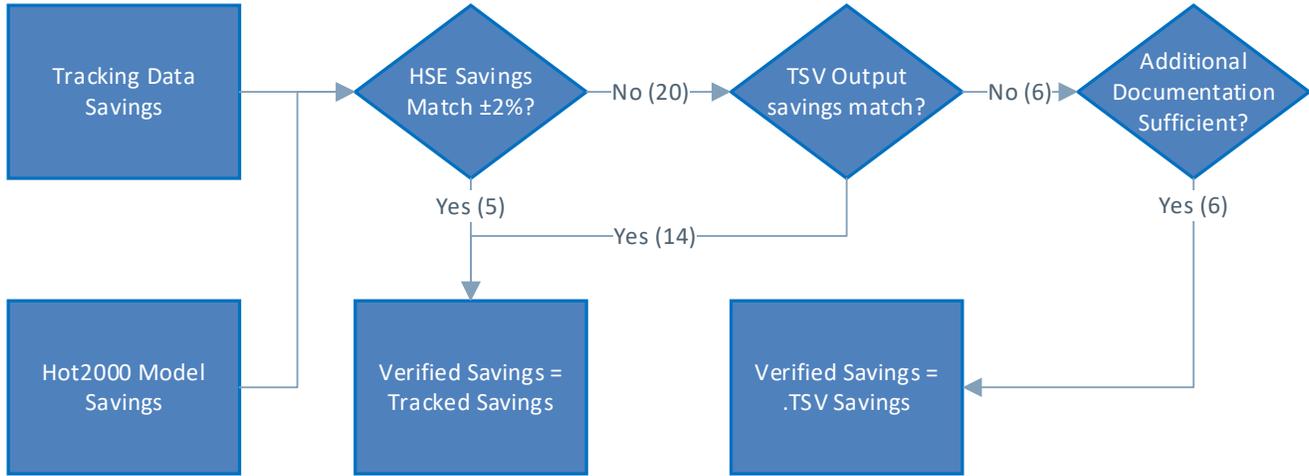


Table 86 shows how many customers were verified in each evaluation step. Savings for 19 homes were verified with comparison of tracking data against either simulation (HSE) or output (TSV) files.

Table 86: Overview of gross savings verification

Evaluation Step	# Verified
Simulation re-run (HSE) and compared to tracking, verified if $\pm 2\%$	5
Output files (TSV) compared to tracking, verified if $\pm 2\%$	14
Additional explanation requested	6
Comparison to output file values	-
Total Verified	25

The EC asked Union for explanation for differences with the six homes that could not be verified through the review of the HSE and TSV files. Union provided the statement below, as well as more individualized responses for each home, which are summarized in Table 87.

Union relies upon its service providers to run HOT2000 in accordance with the requirements of Union's program and are responsible for data entering the HOT2000 output used by Union for program results. This sometimes involves running models that are different than what is required by NRCAN.

Service providers do their best to ensure data entered captures all modelling amendments and to retain all appropriate model scenarios/ corrections/ amendments but sometimes not all get saved or re-submitted.

Table 87: Union: Description of Home Reno Rebate discrepancies and how addressed

Discrepancy	# Projects Affected	How Addressed for Verified Savings
Something was initially modeled incorrectly; new model uploaded but tracking not changed	4	The verified savings were set equal to those calculated from the simulation output (TSV).
Data entry error	2	The verified savings were set equal to those calculated from the simulation output (TSV). Data entry error in tracking data was removed with modelled value accepted.

The EC produced verified savings for all 25 homes in the sample, shown in Table 88. The table shows the tracking and verified annual savings for each home. The EC used these values to calculate the savings ratio and standard deviation.

Table 88: Tracked and verified savings with savings ratio and standard deviation*

Home	Tracked Savings	Verified Savings	Savings Ratio
A	358	358	100%
B	133	133	100%
C	274	274	100%
D	347	347	100%
E	133	133	100%
F	648	648	100%
G	816	756	93%
H	567	567	100%
I	1,231	1,268	103%
J	332	332	100%
K	566	566	100%
L	392	142	36%
M	275	275	100%
N	723	122	17%
O	1,503	1,503	100%
P	514	514	100%
Q	323	380	118%
R	76	76	100%
S	1,935	1,935	100%
T	286	286	100%
U	126	126	100%
V	237	237	100%
W	427	276	65%
X	305	305	100%
Y	102	102	100%
Total	12,629	11,661	92.34%
Standard Deviation			0.218

*Not all values may compute exactly due to rounding.

The gross savings realization rate (RR) is 92.3%, shown in Table 89.

Table 89: Union HRR realization rate*

Number of Houses	Realization Rate	90% Confidence Interval			
		Absolute Precision	Lower Bound	Upper Bound	Relative Precision
25	92.34%	7.19%	85.15%	99.53%	7.78%

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC confirms the total savings of 110,310,927 CCM for Union's Home Reno Rebate CCM savings metric (92.3% of tracked savings).

Residential Adaptive Thermostats - Enbridge

Overview

Table 90 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Residential Adaptive Thermostat Program, with the metric of CCM savings for small volume customers. As a result of this review, the EC verifies 45,367,920 CCM for small volume customers (100% of tracked savings). Table 90 contains the following variables:

- Reported: Metric value reported in Enbridge's draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File.
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified in the Documents section.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates verified values match tracked values.

Table 90: Enbridge Resource Acquisition Achievements: Residential Adaptive Thermostats CCM metric*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Small Volume Customers CCM	N/A	45,367,920	45,367,920	100.00%

*Not all values may compute exactly due to rounding.

†Enbridge's draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Documentation

The EC used the documentation shown in Table 91 to verify the metrics for the Residential Adaptive Thermostat program.

Table 91: Documentation used to verify the Residential Adaptive Thermostat program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge's Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ³⁰
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

³⁰ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.



Verify Cumulative Natural Gas Savings

The EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L.

In calculating gas savings, the EC used:

- Tracking File data, which reported 17,030 units
- December 2015 TRM, which included an entry for Residential Adaptive Thermostats - Retail Purchase

The EC certified the tracked savings, for a savings ratio of 100% of tracked savings, as shown in Table .

Verification Result

As a result of this review, the EC confirms the savings of 45,367,920 CCM for Enbridge's Residential Adaptive Thermostat small volume customer CCM metric (100% of tracked savings).

Commercial & Industrial - Prescriptive – Enbridge

This program section has two sub-sections. The first section addresses the methods for calculating the C&I Prescriptive contributions toward the DSM shareholder incentive metrics. The second addresses the changes necessary for calculating lost revenue.

Shareholder Incentive Metric

Overview

Table 92 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Commercial & Industrial Prescriptive program, with the metric of CCM savings. As a result of this review, the EC verifies total savings of 51,377,592 CCM for large and small volume customers (100% of tracked savings). Table 92 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 92. Enbridge Resource Acquisition achievement: C&I Prescriptive CCM metric*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Small Volume Customers CCM	N/A	29,570,582	29,570,692	100.00%
Large Volume Customers CCM	N/A	21,806,899	21,806,900	100.00%
Total	51,377,481	51,377,481	51,377,592	100.00%

*Not all values may compute exactly due to rounding.

†Enbridge’s draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Documentation

The EC used the documentation shown in Table 93 to verify the metrics for the C&I Prescriptive program.

Table 93: Documentation used to verify the C&I Prescriptive program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ³¹

³¹ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Report Language	Description or Citation
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution
December 2012 TRM	EB-2012-0441 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution ³²
Showerhead Verification Among Rental Buildings	Showerhead Verification Among Rental Buildings, Ipsos Research, 2012 ³³

Verify Cumulative Natural Gas Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC made some minor changes to the tracked savings which resulted in a (rounded) savings ratio of 100%, as shown in Table 94 and Table 95.

Table 94. Enbridge Resource Acquisition achievement by measure group: small volume customers*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement (CCM)	Savings Ratio
Air Curtains	37	3,434,649	3,434,649	100%
Demand Control Ventilation	105	8,325,596	8,325,596	100%
Destratification Fans	33	772,497	772,497	100%
Energy Star Dishwashers	19	89,470	89,470	100%
Energy Star Fryers	127	1,716,634	1,716,634	100%
Boilers - School Offering	12	3,225,198	3,225,288	>100%
Showerheads	3,460	805,187	805,187	100%
Condensing Boilers - Water Heat	12	578,571	578,571	100%
Condensing Boilers - Space Heat	16	765,244	765,244	100%
H.E. Boilers - Water Heat	1	61,520	61,520	100%
H.E. Boilers - Space Heat	2	265,300	265,320	>100%
Heat Recovery Ventilation	1	6,544	6,544	100%
Infrared Heaters	477	7,889,961	7,889,961	100%
Ozone Washer Extractors	4	1,310,643	1,310,643	100%
H.E. Condensing Furnace	12	85,788	85,788	100%
Energy Recovery Ventilation	8	237,783	237,783	100%
Total	4,326	29,570,582	29,570,692	>100%

*Not all values may compute exactly due to rounding.

³² 2012 TRM is the original source for Prescriptive High Efficiency Boiler savings, with greater detail than provided in later TRM summary sheets. For example, December 2015 TRM describes Free Ridership as "10/12/20%" whereas 2012 document describes when to apply these values.

³³ Showerhead Verification Among Rental Buildings, Ipsos Research for Enbridge Gas, March 29, 2012

Table 95. Enbridge Resource Acquisition achievement by measure group: large volume customers*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement (CCM)	Savings Ratio
Air Curtains	9	1,061,255	1,061,255	100%
Demand Control Ventilation	30	2,238,297	2,238,297	100%
Destratification Fans	33	772,497	772,497	100%
Energy Star Dishwashers	9	76,070	76,070	100%
Energy Star Fryers	4	54,067	54,067	100%
Boilers - School Offering	5	2,983,265	2,983,266	100%
Showerheads	2,325	541,058	541,058	100%
Condensing Boilers - Water Heat	6	248,691	248,691	100%
Condensing Boilers - Space Heat	4	40,423	40,423	100%
H.E. Boilers - Water Heat	11	968,338	968,338	100%
H.E. Boilers - Space Heat	8	1,989,502	1,989,502	100%
Heat Recovery Ventilation	3	181,040	181,040	100%
Infrared Heaters	101	1,713,939	1,713,939	100%
Ozone Washer Extractors	24	8,128,572	8,128,572	100%
H.E. Condensing Furnace	1	3,695	3,695	100%
Energy Recovery Ventilation	5	455,711	455,711	100%
Make Up Air Unit	5	350,481	350,481	100%
Total	2,583	21,806,899	21,806,900	100%

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC confirms the savings of 29,570,692 CCM for small volume customers (100% savings ratio) and 21,806,900 CCM for large volume customers (100% savings ratio) for Enbridge's C&I Prescriptive Program.

Lost revenue Savings

Overview

This section describes the detailed process used to verify the results for the 2016 C&I Prescriptive Program's lost revenue accounting for applicable rate classes. For an explanation of lost revenue calculations, please refer to Appendix J.

Verified Annual Net Savings – Prescriptive

The EC adjusted the annual savings from the DSM shareholder incentive calculation to the best available information at the time of the evaluation, which is the December 2016 TRM. However, the measure-level inputs were unchanged from the DSM shareholder incentive source calculation to the December 2016 TRM, so the annual savings are the same. Table 96 demonstrates the savings and measures applicable to the C&I Prescriptive program under lost revenue applicable rate classes.

Table 96: Enbridge – Prescriptive Measures – tracked gross and verified net annual savings (m3) by measure group*

Measure Group	Gross Tracking Savings (Annual m3)	FR	Prescriptive Adjustment	Net Verified Savings (Annual m3)
Air Door	20,796	5.00%	0.00%	19,756
Infrared	4,025	33.00%	0.00%	2,697
Total	24,821	10%	0%	22,453

*Not all values may compute exactly due to rounding.

The prescriptive savings adjustment factor, used to calculate net savings, is also unchanged between the planning period (DSM shareholder incentive value) to the evaluation.

Total Verified Net Savings

Verified Annual Net Savings for the Enbridge C&I Prescriptive Program are shown in Table 97 and Table 98.

Table 97: Enbridge Gas C&I Prescriptive Program verified annual net saving by measure type*

Measure Type	Net Verified Savings (Annual m3)	Net Verified Savings (1,000 Annual m3)
Prescriptive	22,453	22
Total	22,453	22

*Not all values may compute exactly due to rounding.

Table 98: Enbridge Gas C&I Prescriptive Program verified annual net saving by customer type*

Customer Type	Net Verified Savings (Annual m3)	Net Verified Savings (1,000 Annual m3)
Large Volume Customers CCM	22,453	22
Total	22,453	22

*Not all values may compute exactly due to rounding.

Lost revenue calculation

In Table 99 the total savings have been distributed by installation month (see Appendix J). The first row shows the savings without the proration.

Table 99: C&I Prescriptive annual savings by installation month*

Savings Type	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Without Monthly Proration					20						1	2
Total With Monthly Proration					13						<1	<1

*Not all values may compute exactly due to rounding.

Delivery Rates are listed in Table 100. The EC did not verify these values.

Table 100: Enbridge C&I Prescriptive rate classes and delivery costs

Rate Class	Delivery Rate (\$/1,000 m3)
Rate 110	\$18.53

In Table 101, the rate classes have been applied to the annual savings prorated in Table 99.

Table 101: C&I Prescriptive annual savings by installation month – with monthly proration*

Rate Class	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rate 110					13						<1	<1
Total					13						<1	<1

*Not all values may compute exactly due to rounding.

Lost revenue

Savings for each rate class, with monthly proration factors applied, were summed, delivery rates applied, and revenue impact calculated.

Table 102: Enbridge C&I Prescriptive lost revenue*

Rate Class	Savings Volume (1,000 m3)	Delivery Rate (\$/1,000 m3)	Revenue Impact (\$)
Rate 110	13	\$18.53	\$249
Total	13		\$249

*Not all values may compute exactly due to rounding.

As a result of this review, the EC confirms lost revenue of \$249 for Enbridge's C&I Prescriptive program.

Commercial & Industrial - Prescriptive – Union

This program section has two sub-sections. The first section addresses the methods for calculating the C&I Prescriptive contributions toward the DSM shareholder incentive metrics. The second addresses the changes necessary for calculating lost revenue.

Shareholder Incentive Metric

Overview

Table 103 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Commercial & Industrial Prescriptive program, with the metric of CCM savings. As a result of this review, the EC has verified 159,584,798 CCM savings (95.3% of tracked). Table 103 contains the following variables:

- Reported: Metric value reported in Union's draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 103. Union Resource Acquisition scorecard achievement: Commercial & Industrial Prescriptive CCM metric*

Metric	Achievement			Savings Ratio
	Reported	Tracked	Verified	
CCM	167,540,559	167,540,559	159,584,798	95.25%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 104 to verify the metrics for the C&I Prescriptive program.

Table 104: Documentation used to verify the C&I Prescriptive program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union's 2015-2020 DSM Plan, EB-2015-0029
Union's Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ³⁴
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution
December 2016 TRM	EB-2016-0246 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution (used for measures expanded beyond the December 2015 TRM)

³⁴ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Report Language	Description or Citation
MUA Substantiation Document	MUA Substantiation Document - 2015 SHI CORRECT.pdf
December 2012 TRM	EB-2012-0441 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution ³⁵ "Boiler Cycling Controls Document": Boiler Cycling Controls subdocs used in 2016.pdf

Verify Cumulative Natural Gas Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC made some minor changes to the tracked savings which resulted in a (rounded) savings ratio of 95.3%, as shown in Table 105.

Table 105. Union Resource Acquisition Achievement by measure group*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement (CCM)	Savings Ratio
Air Curtains	65	5,602,715	6,051,298	108%
Boiler Cycling Controls	5	819,666	819,666	100%
Clothes Washer	16	18,533	18,533	100%
Condensing Boilers - Space Heat	583	90,785,555	90,785,555	100%
Condensing Boilers - Water Heat†	197	8,469,924	7,971,264	94%
Condensing Furnaces/Unit Heater	135	374,127	575,065	154%
Demand Control Ventilation‡	91	4,530,262	4,267,777	94%
Dishwashers	57	1,189,240	1,189,240	100%
Ovens/Fryers	35	467,875	467,875	100%
Energy Recovery Ventilation	1,357	20,443,578	22,769,893	111%
Heat Recovery Ventilation	105	2,478,709	2,830,161	114%
Infrared Heaters	870	23,321,411	11,688,350	50%
Make Up Air Units	21	3,342,171	4,453,337	133%
Ozone Washer Extractors	49	5,696,791	5,696,790	100%
Total	3,586	167,540,559	159,584,798	95.25%

*Not all values may compute exactly due to rounding.

† Includes condensing DHW, condensing storage, and condensing tankless water heaters.

‡ Includes DCV w/CO2 sensor and DCKV.

Verification Result

As a result of this review, the EC confirms the savings of 159,584,798 CCM (95.3% savings ratio) for Union's C&I Prescriptive Program.

Lost revenue savings

Overview

This section describes the detailed process used to verify the results for the 2016 C&I Prescriptive Program's lost revenue accounting for applicable rate classes. For an explanation of lost revenue calculations, please refer to Appendix J.

³⁵ 2012 TRM is the original source for Prescriptive High Efficiency Boiler savings, with greater detail than provided in later TRM summary sheets. For example, December 2015 TRM describes Free Ridership as "10/12/20%" whereas 2012 document describes when to apply these values.

Verified Annual Net Savings – Prescriptive

The EC adjusted the annual savings from the DSM shareholder incentive calculation to the best available information at the time of the evaluation, which is the December 2016 TRM. However, the measure-level inputs were unchanged from the DSM shareholder incentive source calculation to the December 2016 TRM, so the annual savings are the same, as shown in Table 106.

Table 106: Union – Prescriptive Measures – tracked gross and verified net annual savings (m3) by measure group*

Measure Group	Gross Tracking Savings (Annual m3)	FR	Prescriptive Adjustment	Net Verified Savings (Annual m3)
1-Stage & H.I. Infrared Heaters	1,553	33.00%	0.00%	1,040
2-Stage Infrared Heaters	6,272	33.00%	0.00%	4,202
Air Curtains	49,255	5.00%	0.00%	46,792
Condensing Boilers - Water Heating	12,893	5.00%	0.00%	12,248
Condensing Boilers - Space Heating	205,899	5.00%	0.00%	195,604
Condensing Storage Water Heater	3,195	5.00%	0.00%	3,035
Low Use ERV (OWS)	29,736	5.00%	0.00%	28,249
Total	308,802	5.71%	0.00%	291,170

*Not all values may compute exactly due to rounding.

The prescriptive savings adjustment factor, used to calculate net savings, is also unchanged between the planning period (DSM shareholder incentive value) to the evaluation.

Total Verified Net Savings

Verified Annual Net Savings for the Union C&I Prescriptive Program are shown in Table 107.

Table 107: Union Gas C&I Prescriptive Program verified annual net saving by measure type*

Measure Type	Net Verified Savings (Annual m3)	Net Verified Savings (1,000 Annual m3)
Prescriptive	291,170	291
Total	291,170	291

*Not all values may compute exactly due to rounding.

Lost revenue calculation

In Table 108 the total savings has been distributed by installation month (see Appendix J). The first row shows the savings without the proration.

Table 108: C&I Prescriptive annual savings by installation month*

Savings Type	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Without Monthly Proration	11	0	4	41	2	0	62	2	40	129	<1	0
Total With Monthly Proration	11	0	4	31	1	0	31	1	13	32	0	0

*Not all values may compute exactly due to rounding.

Delivery Rates for Union C&I Prescriptive customers are listed in Table 109. The EC did not verify these values.

Table 109: Union C&I Prescriptive rate classes and delivery costs

Rate Class	Delivery Rate (\$/1,000 m3)
20 North	\$5.55
M4 South	\$11.57
M5 South	\$25.64
M7 South	\$3.53

In Table 110, the rate classes have been applied to the annual savings prorated in Table 108.

Table 110: C&I Prescriptive annual savings by installation month – with monthly proration*

Rate Class	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20 North	8	0	0	0	0	0	0	0	13	0	0	0
M4 South	3	0	4	0	1	0	30	1	0	25	0	0
M5 South	0	0	0	0	0	0	1	0	0	0	0	0
M7 South	0	0	0	31	0	0	0	0	0	7	0	0
Total	11	0	4	31	1	0	31	1	13	32	0	0

*Not all values may compute exactly due to rounding.

Lost revenue

Savings for each rate class, with monthly proration factors applied, were summed, delivery rates applied, and revenue impact calculated.

Table 111: Union C&I Prescriptive lost revenue*

Rate Class	Savings Volume (1,000 m3)	Delivery Rate (\$/1,000 m3)	Revenue Impact (\$)
20 North	22	\$5.55	\$121
M4 South	63	\$11.57	\$728
M5 South	1	\$25.64	\$35
M7 South	64	\$3.53	\$762
Total	150		\$1,645

*Not all values may compute exactly due to rounding.

As a result of this review, the EC confirms lost revenue of \$1,645 for Union's C&I Prescriptive program.

Commercial & Industrial – Direct Install – Enbridge

Overview

Table 112 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Commercial & Industrial Direct Install Program. As a result of this review, the EC verifies total savings of 79,163,595 CCM for large and small volume customers (100% of tracked savings). Table 112 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 112. Enbridge Resource Acquisition scorecard achievement: C&I Direct Install CCM metric*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Small Volume Customers CCM	N/A	74,467,508	74,467,508	100.00%
Large Volume Customers CCM	N/A	4,696,088	4,696,088	100.00%
Total	79,163,595	79,163,595	79,163,595	100.00%

*Not all values may compute exactly due to rounding.

†Enbridge’s draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Documentation

The EC used the documentation shown in Table 113 to verify the metrics for the C&I Direct Install program.

Table 113: Documentation used to verify the C&I Direct Install program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ³⁶
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

Verify Cumulative Natural Gas Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. Only one measure group (air curtains) was installed, with

³⁶ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.



22 installed at large volume customers and 323 at small volume customers. The EC verified the tracked savings which resulted in a savings ratio of 100%.

Verification Result

As a result of this review, the EC confirms the savings of 4,696,088 CCM for large volume customers (100% savings ratio) and 74,467,508 CCM for small volume customers (100% savings ratio) of Enbridge's C&I Direct Install Program.



Commercial & Industrial – Direct Install – Union

No savings were reported for this program in 2016.

Commercial & Industrial - Custom – Enbridge

This program section has two sub-sections. The first section addresses the methods for calculating the C&I Custom contributions toward the DSM shareholder incentive metrics. The second addresses the changes necessary for calculating lost revenue.

Shareholder Incentive Metric

Overview

Table 114 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Commercial & Industrial Custom program. As a result of this review, the EC verifies total savings of 315,357,341 CCM (57.3% of tracked savings). Table 114 contains the following variables:

- Reported: Metric value reported in Enbridge's draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 114 Enbridge Resource Acquisition scorecard achievement: C&I Custom CCM metric*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Small Volume Customers CCM	N/A	34,434,566	15,456,573	44.89%
Large Volume Customers CCM	N/A	516,068,816	299,900,768	58.11%
Total	550,503,382	550,503,382	315,357,341	57.29%

*Not all values may compute exactly due to rounding.

†Enbridge's draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Table 115 includes these variables:

- Cumulative Gross Savings – Tracking: Gross cumulative tracking savings for all customers in the Enbridge C&I Custom program.
- RR: Gross realization rate from the 2016 CSPV report.
- Att: Attribution ratio (the complement of free ridership) from the 2015 CPSV report.
- Spillover: Spillover ratio from 2013-2014 Spillover Study.
- Adj: Adjustment Ratio, the product of the RR and the sum of the Att ratio and Spillover ratio

Equation 1: Adjustment Ratio

$$\text{Adjustment Ratio} = RR * (\text{Att} + \text{Spillover})$$

- Verified Net Savings: Cumulative gross savings multiplied by the Adjustment Ratio

Equation 2: Verified Net Savings

$$\text{Verified Net Savings} = \text{Adjustment Ratio} * (\text{Cumulative Gross})$$

Table 115: Adjustment factors applied to Enbridge C&I Custom Program cumulative gross savings* †

Measure Type	Tracking Gross Savings (CCM)	RR (%)	Att (%)	Spillover (%)	Adj* (%)	Verified Net Savings (CCM)
Custom	825,138,165	109.02%	32.03%	3.03%	38.22%	315,357,341

*Not all values may compute exactly due to rounding.

†Adjustment value displayed is truncated (2 digit) average based on sum of all individual adjustments using ratios found in this appendix section.

Documentation

The EC used the documentation shown in Table 116 to verify the metrics for the C&I Custom program.

Table 116: Documentation used to verify the C&I Custom program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge Draft 2016 Report	2016 Demand Side Management Draft Annual Report, Enbridge Gas ³⁷
2016 CPSV Report	2016 Natural Gas Demand Side Management Custom Savings Verification ³⁸
2015 CPSV Report	2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation ³⁹
2013-2014 Spillover Study	CPSV Participant Spillover Results ⁴⁰

Verify Savings

Adjustment Values – RR

The 2016 CPSV Report conveyed gross realization rate by sector, as shown in Table 117. The EC used the same sectors to apply the relevant rates at the measure level.

Table 117: Verified gross savings rates for the Enbridge Custom C&I program

Sector	RR
Multi Family	112.10%
Commercial	96.80%
Industrial	113.47%

Adjustment Values – Att Ratios

The 2015 CPSV Report conveyed attribution ratios using a combination of sector and measure group, as shown in Table 118. Because the ratios are being applied to a population outside of the one that was sampled, the EC recalculated the relative precision of the ratios without the finite population correction

³⁷ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

³⁸ 2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation, DNV GL for the Ontario Energy Board, August 15, 2017

³⁹ 2016 Natural Gas Demand Side Management Custom Savings Verification, DNV GL for the Ontario Energy Board, June 31, 2018

⁴⁰ DNV GL for the Ontario Energy Board, CPSV Participant Spillover Results, May 23, 2018

factor. Where the original sector/measure group precision did not meet the application criteria of +/- 20% or less, the EC combined groups, improving the precision, until the application criteria was met. Then the EC individually mapped the measures in the Enbridge tracking data to these sector/measure group combinations and applied the relevant rates at the measure level.

Table 118: Attribution ratios for the Enbridge Custom C&I program

Sector and Measure Group Combination	Att Ratio	Relative Precision (+/-) *
Enbridge - Multi-Residential - All	44.02%	16%
Enbridge - Custom Commercial - Etool Boiler and Boiler Add-ons	24.09%	15%
Enbridge - Custom Commercial - Etool Ventilation	4.93%	5%
Enbridge - Custom Commercial - Other	18.22%	18%
Enbridge - Custom Commercial - Steam Trap	27.42%	14%
Enbridge - Custom Industrial - All	32.10%	17%

*Relative precision is reported at the 90% confidence interval with the finite population correction factor "off".

Adjustment Values – Spillover Ratios

The 2013-2014 Spillover Study conveyed spillover ratios at the sector level, as shown in Table 119. The EC used the same sectors to apply the relevant rates at the measure level.

Table 119: Spillover ratios for the Enbridge Custom C&I program

Sector	Spillover Ratio
ENBRIDGE - Multi-Residential	8.24%
ENBRIDGE - Custom Commercial	1.36%
ENBRIDGE - Custom Industrial	1.45%

Verify Cumulative Natural Gas Savings

The program-level adjustment factors shown in Table 115 were built up from a measure-level application of the RR, Att, and Spillover ratios. Each measure was assigned a RR or Spillover ratio based on its sector, and a Att ratio based on the combination of sector and measure group. The EC calculated the measure-level net savings using Equation 1 and Equation 2, then summed the measure-level savings to produce program-level savings. The EC calculated the program-level adjustment ratio by dividing the program-level net savings by the program-level gross savings.

Verification Result

As a result of this review, the EC confirms the savings of 315,357,341 CCM (57.3% of tracked savings) for Enbridge's C&I Custom Program.

Lost revenue savings

Overview

This section describes the detailed process used to verify the results for the 2016 C&I Custom Program's lost revenue accounting for applicable rate classes. For an explanation of lost revenue calculations, please refer to Appendix J.

Verified Annual Net Savings - Custom

For custom projects, an lost revenue-specific gross savings realization rate and Att factor are applied to the tracking savings. The lost revenue-specific gross savings realization rate does not include the effect of measure life adjustments. The lost revenue-specific Att factor accounts for dual baselines at the beginning of the installed measure life.

Total Verified Net Savings

Specific calculation inputs are shown with sources in Table 120.

Table 120: Custom measures lost revenue inputs and sources

Input	Source
Gross Annual Savings	Enbridge Tracking File
Adjustment Ratio	RR* (ATT+Spillover)
Realization Rate (RR)	2016 CPSV Evaluation (First Year Rate)
Attribution Ratio	2015 CPSV Evaluation
Spillover	2013-2014 Spillover Study

Total Verified Annual Net Savings

Verified Annual Net Savings for the Enbridge C&I Custom Program are shown in Table 121 and Table 122.

Table 121: Enbridge Gas C&I Custom Program verified annual net saving by measure type*

Measure Type	Net Verified Savings (Annual m3)	Net Verified Savings (1,000 Annual m3)
Custom	7,724,751	7,725

*Not all values may compute exactly due to rounding.

Table 122: Enbridge Gas C&I Custom Program verified annual net saving by customer type*

Customer Type	Net Verified Savings (Annual m3)	Net Verified Savings (1,000 Annual m3)
Small Volume Customers CCM	106,646	107
Large Volume Customers CCM	7,618,105	7,618
Total	7,724,751	7,725

*Not all values may compute exactly due to rounding.

Lost revenue calculation

In Table 123 the total savings have been distributed by installation month (see Appendix J). The first row shows the savings without the proration.

Table 123: C&I Custom annual savings by installation month*

Savings Type	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Without Monthly Proration	0	0	26	318	44	135	58	24	65	480	544	6,033
Total With Monthly Proration	0	0	21	238	29	79	29	10	22	120	91	503

*Not all values may compute exactly due to rounding.

Delivery rates are shown in Table 124. The EC did not verify these values.

Table 124: Enbridge C&I Custom rate classes and delivery costs

Rate Class	Delivery Rate (\$/1,000 m3)
Rate 110	\$18.53

In Table 125, the rates have been applied to the annual savings prorated in Table .

Table 125: C&I Custom annual savings by installation month – with monthly proration*

Rate Class	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rate 110	-	-	21	11	11	79	-	3	22	90	45	203
Rate 115	-	-	-	-	-	-	3	7	-	14	16	82
Rate 135	-	-	-	-	-	-	-	-	-	-	11	7
Rate 145	-	-	-	-	-	-	-	-	-	13	3	-
Rate 170	-	-	-	227	18	-	26	-	-	2	16	211
Total	-	-	21	238	29	79	29	10	22	120	91	503

*Not all values may compute exactly due to rounding.

Lost revenue

Savings for each rate class, with monthly proration factors applied, were summed, delivery rates applied, and revenue impact calculated.

Table 126: Enbridge C&I Custom lost revenue*

Rate Class	Savings Volume (1,000 m3)	Delivery Rate (\$/1,000 m3)	Revenue Impact (\$)
Rate 110	485	\$18.53	\$8,981
Rate 115	122	\$9.78	\$1,196
Rate 135	18	\$16.70	\$298
Rate 145	17	\$19.65	\$325
Rate 170	500	\$7.22	\$3,607
Total	1,141		\$14,407

*Not all values may compute exactly due to rounding.

As a result of this review, the EC confirms lost revenue of \$14,407 for Enbridge's C&I Custom program.

Commercial & Industrial - Custom – Union

This program section has two sub-sections. The first section addresses the methods for calculating the C&I Custom contributions toward the DSM shareholder incentive metrics. The second addresses the changes necessary for calculating lost revenue.

Shareholder Incentive Metric

Overview

Table 127 shows the reported, tracked, and verified scorecard achievements for the 2016 Union C&I Custom program. As a result of this review, the EC verifies total savings of 544,862,192 CCM (77.0% of tracked savings). Table 127 contains the following variables:

- Reported: Metric value reported in Union's draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 127 Union Resource Acquisition scorecard achievement: Custom C&I CCM metric*

Metric	Achievement			Savings Ratio
	Reported	Tracked	Verified	
CCM	707,753,039	707,753,039	544,862,192	76.98%

*Not all values may compute exactly due to rounding.

Table 128 includes these variables:

- Cumulative Gross Savings – Tracking: Gross cumulative tracking savings for all customers in the Enbridge C&I Custom program
- RR: Gross realization rate from the 2016 CSPV report (savings weighted)
- Att: Attribution ratio (the complement of free ridership) from the 2015 CPSV report (savings weighted)
- Spillover: Spillover ratio from 2013-2014 Spillover Study (savings weighted)
- Adj: Adjustment Ratio, the product of the RR and the sum of the Att ratio and Spillover ratio

Equation 3: Adjustment Ratio

$$\text{Adjustment Ratio} = RR * (\text{Att} + \text{Spillover})$$

- Verified Net Savings: Cumulative gross savings multiplied by the Adjustment Ratio

Equation 4: Verified Net Savings

$$\text{Verified Net Savings} = \text{Adjustment Ratio} * (\text{Cumulative Gross})$$

Table 128: Adjustment factors applied to Union C&I Custom Program cumulative gross savings *

Measure Type	Tracking Gross Savings (CCM)	RR (%)	Att (%)	Spillover (%)	Adj† (%)	Verified Net Savings (CCM)
Custom	1,538,593,562	100.70%	34.43%	0.74%	35.41%	544,862,192

*Not all values may compute exactly due to rounding.

†Adjustment value displayed is truncated (2 digit) average based on sum of all individual adjustments using ratios found in this appendix section. Due to rounding, results do not sum when calculated.

Documentation

The EC used the documentation shown in Table 129 to verify the metrics for the C&I Custom program.

Table 129: Documentation used to verify the C&I Custom program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union's 2015-2020 DSM Plan, EB-2015-0029
Union's Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ⁴¹
2016 CPSV Report	2016 Natural Gas Demand Side Management Custom Savings Verification ⁴²
2015 CPSV Report	2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation ⁴³
2013-2014 Spillover Study	CPSV Participant Spillover Results ⁴⁴

Verify Savings

Adjustment Values – RR

The 2016 CPSV Report conveyed gross realization rate by sector, as shown in Table 130. The EC used the same sectors to apply the relevant rates at the measure level.

Table 130: Verified gross savings rates for the Union Custom C&I program

Program	RR
Agricultural	100.10%
Commercial	112.45%
Industrial	99.20%

Adjustment Values – Att Ratios

The 2015 CPSV Report conveyed attribution ratios using a combination of sector and measure group, as shown in Table 131. Because the ratios are being applied to a population outside of the one that was sampled, the EC recalculated the relative precision of the ratios without the finite population correction factor. Where the original sector/measure group precision did not meet the application criteria of +/- 20% or

⁴¹ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

⁴² 2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation, DNV GL for the Ontario Energy Board, August 15, 2017

⁴³ 2016 Natural Gas Demand Side Management Custom Savings Verification, DNV GL for the Ontario Energy Board, June 31, 2018

⁴⁴ DNV GL for the Ontario Energy Board, CPSV Participant Spillover Results, May 23, 2018

less, the EC combined groups, improving the precision, until the application criteria was met. Then the EC individually mapped the measures in the Union tracking data to these sector/measure group combinations and applied the relevant rates at the measure level.

Table 131: Attribution ratios for the Union Custom C&I program*

Sector and Measure Group Combination	Att Ratio	Relative Precision (+/-)*
Union - Custom Commercial and Industrial - Other	35.97%	15%
Union - Custom Industrial - Controls	18.21%	8%
Union - Custom Industrial - Heat Recovery	59.14%	15%
Union - Custom Industrial - Leak Repair and Hydronic Insulation	39.71%	17%
Union - Custom Industrial - Operational Improvements	10.15%	14%

*Relative precision is reported at the 90% confidence interval with the finite population correction factor "off".

Adjustment Values – Spillover Ratios

The 2013-2014 Spillover Study conveyed spillover ratios at the sector level, as shown in Table 132. The EC used the same sectors to apply the relevant rates at the measure level.

Table 132: Spillover ratios for the Union Custom C&I program

Sector	Spillover Ratio
UNION - Custom Commercial and Multi-family	0.00%
UNION - Custom Industrial	0.89%

Verify Cumulative Natural Gas Savings

The program-level adjustment factors shown in Table 128 were built up from a measure-level application of the RR, Att, and Spillover ratios. Each measure was assigned a RR or Spillover ratio based on its sector, and a Att ratio based on the combination of sector and measure group. The EC calculated the measure-level net savings using Equation 3 and Equation 4, then summed the measure-level savings to produce program-level savings. The EC calculated the program-level adjustment ratio by dividing the program-level net savings by the program-level gross savings.

Verification Result

As a result of this review, the EC verifies the total savings of 544,862,192 CCM for Union's C&I Custom Program, an overall savings ratio of 77.0%.

Lost revenue savings

Overview

This section describes the detailed process used to verify the results for the 2016 C&I Custom Program's lost revenue accounting for applicable rate classes. For an explanation of lost revenue calculations, please refer to Appendix J.

Verified Annual Net Savings – Custom

For custom projects, an lost revenue-specific gross savings realization rate and Att factor are applied to the tracking savings. The lost revenue-specific gross savings realization rate does not include the effect of

measure life adjustments. The lost revenue-specific Att factor accounts for dual baselines at the beginning of the installed measure life.

Total Verified Net Savings

Specific calculation inputs are shown with sources in Table 133.

Table 133: Custom measures lost revenue inputs and sources

Input	Source
Gross Annual Savings	Union Tracking File
Adjustment Ratio	RR* (ATT+ Spillover)
Realization Rate (RR)	2016 CPSV Evaluation (First Year Rate)
Attribution Ratio	2015 CPSV Evaluation
Spillover	2013-2014 Spillover Study

Total Verified Annual Net Savings

Verified Annual Net Saving for the Union C&I Custom Program are shown in Table 134.

Table 134: Union Gas C&I Custom Program verified annual net saving by measure type*

Measure Type	Net Verified Savings (Annual m3)	Net Verified Savings (1,000 Annual m3)
Custom	26,293,658	26,294
Total	26,293,658	26,294

*Not all values may compute exactly due to rounding.

Lost revenue calculation

In Table 135 the total savings has been distributed by installation month (see Appendix J). The first row shows the savings without the proration.

Table 135: C&I Custom annual savings by installation month*

Savings Type	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Without Monthly Proration	3,442	1,191	3,575	2,749	385	695	1,328	1,058	3,226	2,420	2,299	5,673
Total With Monthly Proration	3,442	1,092	2,979	2,061	257	406	664	441	1,075	605	383	473

*Not all values may compute exactly due to rounding.

Delivery Rates are listed in Table 136. The EC did not verify these values.

Table 136: Union C&I Custom rate classes and delivery costs

Rate Class	Delivery Rate (\$/1,000 m3)
20 North	\$5.55
M4 South	\$11.57
M5 South	\$25.64
M7 South	\$3.53
T1 South	\$0.76

In Table 137, the rates have been applied to the annual savings prorated in Table 135.

Table 137: C&I Custom annual savings by installation month – with monthly proration*

Rate Class	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20 North	546	0	15	0	0	0	0	18	5	52	6	0
M4 South	1,540	104	643	601	16	46	284	69	75	194	129	97
M5 South	1,009	337	1,422	1,265	78	79	184	0	20	0	184	17
M7 South	294	651	835	53	2	281	196	354	738	183	7	281
T1 South	53	0	64	142	161	0	0	0	237	176	57	77
Total	3,442	1,092	2,979	2,061	257	406	664	441	1,075	605	383	473

*Not all values may compute exactly due to rounding.

Lost revenue

Savings for each rate class, with monthly proration factors applied, were summed, delivery rates applied, and revenue impact calculated.

Table 138: Union C&I Custom lost revenue*

Rate Class	Savings Volume (1,000 m3)	Delivery Rate (\$/1,000 m3)	Revenue Impact (\$)
20 North	642	\$5.55	\$3,563
M4 South	3,799	\$11.57	\$43,959
M5 South	4,596	\$25.64	\$117,820
M7 South	3,874	\$3.53	\$13,658
T1 South	967	\$0.76	\$735
Total	13,878		\$179,735

*Not all values may compute exactly due to rounding.

As a result of this review, the EC confirms lost revenue of \$179,735 for Union's C&I Custom program.



Small Commercial New Construction – Enbridge

No savings or activity were reported for this program in 2016.

Energy Leaders Initiative – Enbridge

Overview

Table 139 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Energy Leaders Initiative, with the metric of CCM savings. As a result of this review, the EC verifies total savings of 671,186 CCM for large and small volume customers (92.5% of tracked savings). Table 139 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 139: Enbridge Resource Acquisition scorecard achievement: Energy Leaders Initiative CCM metric*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Small Volume Customers CCM	N/A	296,010	264,633	89.40%
Large Volume Customers CCM	N/A	429,760	406,553	94.60%
Total	725,770	725,770	671,186	92.48%

*Not all values may compute exactly due to rounding.

†Enbridge’s draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Table 140 includes these variables:

- Cumulative Gross Savings – Tracking: Gross cumulative tracking savings for all customers in the Enbridge Energy Leaders Initiative.
- RR: Gross realization rate based on engineering reviews.
- Att: Attribution ratio (the complement of free ridership), deemed based on EAC consensus.
- Spillover: Spillover ratio, deemed based on EAC consensus.
- Adj: Adjustment Ratio, the product of the RR and the sum of the Att ratio and Spillover ratio

Equation 5: Adjustment Ratio

$$\text{Adjustment Ratio} = RR * (\text{Att} + \text{Spillover})$$

- Verified Net Savings: Cumulative gross savings multiplied by the Adjustment Ratio

Equation 6: Verified Net Savings

$$\text{Verified Net Savings} = \text{Adjustment Ratio} * (\text{Cumulative Gross})$$

Table 140: Adjustment factors applied to Enbridge Energy Leaders Initiative cumulative gross savings*

Measure Type	Tracking Gross Savings (CCM)	RR (%)	Att (%)	Spillover (%)	Adj* (%)	Verified Net Savings (CCM)
Small Volume Customers	296,010	89.40%	100.00%	0.00%	89.40%	264,633
Large Volume Customers	429,760	94.60%	100.00%	0.00%	94.60%	406,553

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 141 to verify the metrics for the Energy Leaders Initiative.

Table 141: Documentation used to verify the Energy Leaders Initiative

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	PDF document for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge Draft 2016 Report	2016 Demand Side Management Draft Annual Report, Enbridge Gas ⁴⁵

Participant Selection

Enbridge first provided the Tracking File listing the Enbridge Account (number) and Project Code (unique ID). The spreadsheet identified four participants. The EC requested full documentation for all participants.

Received Files

The EC received four individual pdf files, one for each project listed in the Tracking File. PDF files generally included:

- Project summary
- Customer invoice for project incentive
- Custom Project Documentation Review Checklist
- 2016-2017 Ice Resurfacing Application Form
- Custom project documentation (ETools)
- Site evaluation/audit documentation
- Manufacturer invoice
- Installation invoice

Verify Gross Savings

This program consists of five vortex ice resurfacing projects implemented at four ice rinks.

⁴⁵ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Calculate Savings Adjustment Factor

The EC reviewed the calculations to determine whether the savings estimates were reasonable. The program calculated savings using the following equation, which the EC deems appropriate.

$$\text{energy savings} = \left(\frac{\text{gallons of water}}{\text{year}} \right) (\text{specific heat of water})(\text{change in water temperature})$$

The Etools custom project documentation shows the inputs used in the equation. In all cases except the change in water temperature, or Delta T, the Etools inputs match the information on the customer application. For two projects, the Etools input for Delta T was inconsistent with the documentation, as shown in Table 142. The EC adjusted the inputs to match the application, ran the calculation, and determined the verified savings shown in Table 143 and Table 144.

Table 142: Calculated savings using application form inputs vs Etools claimed savings (m3)*

Site ID	Customer Type	Claimed (Etools)		Application Form		Calculated		Savings Difference
		Delta-T	Savings (m3)	Input Temp	Output Temp	Delta-T	Savings (m3)	
7	Small Volume	115	14,366	140	50	90	11,243	-3,123
23	Large Volume	115	10,105	140	55	85	7,779	-2,326

*Not all values may compute exactly due to rounding.

Table 143: Energy Leaders Initiative gross annual savings – small volume customers – RR*

Site ID	Claimed Savings (m3)	Verified Savings (m3)	Difference (m3)	Realization Rate
23	10,105	7,779	-2,326	77%
19 (1)	20,349	20,349	0	100%
19 (2)	12,513	12,513	0	100%
Total	42,967	40,641	-2,326	94.6%

*Not all values may compute exactly due to rounding.

Table 144: Energy Leaders Initiative gross annual savings – large volume customers – RR*

Site ID	Claimed Savings (m3)	Verified Savings (m3)	Difference (m3)	Realization Rate
7	14,366	11,243	-3,123	78.3%
8	15,235	15,235	0	100%
Total	29,601	26,478	-3,123	89.4%

*Not all values may compute exactly due to rounding.

Adjustment Values

By consensus, the EAC agreed to deem the Att and Spillover ratios at 100% and 0%, respectively. Therefore, the adjustment factor is equal to the realization rate.

Verification Result

As a result of this review, the EC confirms the savings of 264,633 CCM (89.4% of tracked) for small volume customers and 406,553 CCM (94.6% of tracked) for large volume customers of the Energy Leaders Initiative.



Comprehensive Energy Management – Enbridge

No savings were reported for this program in 2016.

Run it Right – Enbridge

Overview

Table 145 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Run it Right (RIR) Program, with the metric of CCM savings. The RIR Program has two metrics under separate scorecards, CCM Savings (Resource Acquisition) and Participants (Market Transformation). CCM Savings are discussed here, while the Participants metric is discussed in Appendix I.

As a result of this review, the EC verifies total savings of 1,937,342 CCM (50% of tracked savings) for large volume customers of the 2016 Run it Right program. Table 145 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 145: Enbridge Resource Acquisition scorecard achievement: Run it Right CCM metric*

Metric	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Large Volume Customers CCM	N/A	3,870,040	1,937,342	50.06%

*Not all values may compute exactly due to rounding.

†Enbridge’s draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Table 146 includes these variables:

- Cumulative Gross Savings – Tracking: Gross cumulative tracking savings for all customers in the Enbridge 2016 Run it Right program.
- RR: Gross realization rate based on engineering reviews.
- Att: Attribution ratio (the complement of free ridership) from the 2015 CPSV report.
- Spillover: Spillover ratio from 2013-2014 Spillover Study.
- Adj: Adjustment Ratio, the product of the RR and the sum of the Att ratio and Spillover ratio

Equation 7: Adjustment Ratio

$$\text{Adjustment Ratio} = RR * (\text{Att} + \text{Spillover})$$

- Verified Net Savings: Cumulative gross savings multiplied by the Adjustment Ratio

Equation 8: Verified Net Savings

$$\text{Verified Net Savings} = \text{Adjustment Ratio} * (\text{Cumulative Gross})$$

Table 146: Adjustment Factors Applied to Run it Right Program cumulative gross savings*

Measure Type	Tracking Gross Savings (CCM)	RR (%)	Att (%)	Spillover (%)	Adj* (%)	Verified Net Savings (CCM)
Large Volume Customers CCM	3,870,040	100.00%	50.06%	0.00%	50.06%	1,937,342

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 147 to verify the metrics for the Run it Right program.

Table 147: Documentation used to verify the Run it Right Program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	PDF document for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge Draft 2016 Report	2016 Demand Side Management Draft Annual Report, Enbridge Gas ⁴⁶
2015 CPSV Report	2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation ⁴⁷
2013-2014 Spillover Study	CPSV Participant Spillover Results ⁴⁸

Participant Selection

Enbridge first provided the Tracking File listing RIR participants with anonymized Program, Customer, and Site IDs, listing 70 individual projects. The EC randomly selected 10 projects, requesting full documentation by Project ID.

Methodology Review

The program methodology did not change for the 2016 program year. For the 2015 certification, a senior engineer reviewed the calculation methods and independently calculated savings for one site using the raw consumption data and defined program periods. The following conclusion from the 2015 certification^{49,50} remains valid:

The methodology used by the RIR program to estimate savings is appropriate for the application. No significant concerns were identified by the team; however, the RIR tool does not allow observation of all of the calculations performed. Independently-calculated savings were statistically equivalent to those calculated by the program for the one site reviewed.

Verify Gross Savings

For 2016, evaluation engineers reviewed the supporting documentation provided in the Project Files (pdf) for the sample of sites to identify the answers to the following questions:

- Is the building type correctly identified?
- How many months were used in the baseline, improvement, and reference periods?
- What type of model was used?

⁴⁶ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

⁴⁷ 2016 Natural Gas Demand Side Management Custom Savings Verification, DNV GL for the Ontario Energy Board, June 31, 2018

⁴⁸ DNV GL for the Ontario Energy Board, CPSV Participant Spillover Results, May 23, 2018

⁴⁹ DNV GL for the Ontario Energy Board, 2015 Natural Gas Demand Side Management Annual Verification, December 20, 2017, Appendix F

⁵⁰ It was not possible for Enbridge to have made changes because the 2015 evaluation results were delivered after the 2016 program was finished.

- What independent variables were used?
- What R-squared values were used for the baseline and reference models?
- What are the estimated savings during the reference period?
- Were capital project savings deducted?
- What percentage of consumption do the savings represent?
- What is driving the positive or negative savings claimed?
- Should a new baseline model be created?

The EC senior engineer used these questions (above) to review the calculations completed, the consumption pattern at the facility, and the baseline model. The EC senior engineer then asked three primary questions to assess the risk of savings accuracy as Low, Normal, or High. Three key questions were:

- Based on experience, is the baseline model specification reasonable?
- Based on experience, is the baseline time period definition reasonable?
- What is the assessed level of risk for achieving savings?

The EC assigned two sites as low-risk, five normal-risk, and three high-risk. Based on our experience, this distribution is consistent with similar programs. The baseline model specifications and time period definitions were reasonable for all projects examined. Overall, the savings claimed are reasonable, especially because both positive and negative savings are included in the program Tracking File and Project Files.

After the risk levels were assigned, the EC senior engineers identified similarities in the high-risk facilities:

- All high-risk facilities had final savings that were significantly impacted by weather normalization calculations in project files. The winter weather during the reference period was warmer than normal, introducing additional risk to the calculation methodology.
- The action registers of two high-risk facilities contained two entries written as opportunities rather than “actions taken”. The EC could not confirm these actions were completed. The EC recommends further review of final annual reports to ensure that only actions taken are listed in the action register.

All savings claims were supported by actions at the facility. Clear changes in the consumption patterns occurred. The EC’s review supports a savings claim for all sites.

Adjustment Values – Att and Spillover Ratios

The 2015 CPSV Report conveyed a single attribution ratio for the Run it Right program of 50%.⁵¹ The 2013-2014 Spillover study did not find any spillover savings for the program. The two ratios were combined with the RR to produce a program-level adjustment factor of 50%.

Verification Result

As a result of this review, the EC confirms the savings of 1,937,342 CCM (50% of tracked) for large volume customers of the Run it Right program.

⁵¹ This attribution rate was finalized after the end of the 2016 program, so Enbridge was unable to apply the factor to its tracking savings prior to evaluation. Without the finite population correction factor, the relative precision of this ratio is +/- 20% at the 90% confidence interval.

Appendix F Low Income Scorecards

This appendix describes the detailed process used to verify the metrics for the Low Income Scorecard programs for Enbridge (Table 148) and Union Gas (Table 149). The programs addressed in this appendix are:

- Winter Retrofit - Furnace End-of-Life Upgrade Program – Union
- Winter Retrofit – Single Family (Part 9)– Enbridge
- Winter Retrofit - Home Weatherization– Union
- Winter Retrofit – Indigenous Program – Union
- Low Income New Construction – Enbridge
- Low Income Multi-Residential – Affordable Housing Program – Enbridge
- Low Income Multi-Residential – Multi-Family Program (Social Assisted) – Union
- Low Income Multi-Residential – Multi-Family Program (Market Rate) – Union

Table 148. Enbridge 2016 Low Income scorecard*⁵²

Program	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
Single Family (Part 9)	CCM	28,814,754	28,814,754	23,842,500	31,790,000	47,685,000	45%
Multi-family (Part 3)	CCM	84,728,581	84,728,581	48,675,000	64,900,000	97,350,000	45%
Low Income New Construction	Applications	6	6	4	6	8	10%

*Not all values may compute exactly due to rounding.

Table 149. Union Gas 2016 Low Income scorecard*⁵³

Programs	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
Furnace End-of-Life	CCM	29,106	45,783,309	28,339,761	37,786,348	56,679,521	60%
Home Weatherization		45,754,203					
Indigenous†		0					
Multi-Family (Social and Assisted)	CCM	10,894,572	10,894,572	12,162,016	16,216,022	24,324,033	35%
Multi-Family (Market Rate)	CCM	8,151,189	8,151,189	1,979,863	2,639,817	3,959,726	5%

*Not all values may compute exactly due to rounding.

†Union Gas reported no program activity for the 2016 program year. As a result, this report does not verify or evaluate the Indigenous program, which is listed in program plans as the "Aboriginal program".

⁵² Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, FINAL REVISED February 24, 2016, Schedule C

⁵³ Ibid

Winter Retrofit - Furnace End-of-Life Upgrade Program – Union

Overview

Table 150 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Gas Furnace End-of-Life Upgrade program, with the metric of CCM savings. As a result of this review, the EC verifies 29,106 CCM (100% of tracked savings). Table 150 shows the reported, tracked, and verified scorecard achievements for the 2016 Union HRR program with the metric of CCM.

- Reported: Metric value reported in Union’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File.
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified in the Documents section.
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates verified values match tracked values.

Table 150. Union Low Income scorecard achievement: Furnace End-Of-Life Upgrade CCM metric*

Metric	Achievement			Savings Ratio
	Reported	Tracked	Verified	
Furnace End of Life CCM	29,106	29,106	29,106	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 151 to verify the metrics for the Furnace End-of-Life Upgrade program.

Table 151. Documentation used to verify the Furnace End-of-Life Upgrade program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union’s 2015-2020 DSM Plan, EB-2015-0029
Union’s Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ⁵⁴
December 2016 TRM	EB-2016-0246 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

Verify Cumulative Natural Gas Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC verified the tracked savings which resulted in a savings ratio of 100%. Twenty-four high efficiency units were installed as part of the program.

⁵⁴ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.



Verification Result

As a result of this review, the EC confirms the savings of 29,106 CCM (100% of tracked savings) for Union's Furnace End-of-Life Upgrade Program. This is equal to the reported and tracked program savings.

Winter Retrofit - Home Winterproofing – Enbridge

Overview

Table 152 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Home Winterproofing program, with the metric of CCM savings. As a result of this review, the EC verifies 28,814,754 CCM (99.99% of tracked savings). Table 152 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 152. Enbridge Low Income Scorecard Achievements: Home Winterproofing program*

Measure Class	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Prescriptive CCM	N/A	51,632	50,180	97.19%
Simulation-based CCM	N/A	28,764,574	28,764,574	100.00%
Total	28,816,206	28,816,206	28,814,754	99.99%

*Not all values may compute exactly due to rounding.

†Enbridge’s draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Documentation

The EC used the documentation shown in Table 153 to verify the metrics for the Home Winterproofing program.

Table 153. Documentation used to verify the Home Winterproofing program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Project Files	Various documents for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ⁵⁵
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution
TAPS Report	TAPS Verification Program 2012 Year End Research Report, Quadra Research. April 2013 ⁵⁶

⁵⁵ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

⁵⁶ TAPS Verification Program 2012 Year End Research Report, Study CR-604, Quadra Research, April 3, 2013

Simulation-based Savings

Participant Selection

The EC did not verify Private Homes and Social Housing savings separately, as there was no difference observed for measure life (25 years) or free-ridership (0%) for any Low Income program. Enbridge provided the tracking file listing 1,512 individual participant homes in the Winterproofing program. To certify the scorecard metric, the EC randomly selected 25 participants for review, requested additional documentation, confirmed receipt of the correct files, and reviewed documents to verify participation and eligibility.

Received Files

The typical file folder had the following information:

- Photographs of pre- and post-installation conditions
- Invoice information (PDF scans or photo of receipts)
- HOT2000 Model simulation Files (.HSE)
- HOT2000 Model Output Files (.TSV)

Calculate Realization Rate

The EC used a multi-step process to verify tracked energy savings for the 25 sampled homes, shown Figure 3 for the 2016 Winterproofing verification. The process was necessary because the simulation mode (EnerGuide or Expert⁵⁷) used by program delivery agents is not available to non-certified professionals. While the EC can attempt to run the Expert simulations in General mode, the runs may produce error warnings or result in a savings differential between the Expert result and General result. Therefore, this multi-step process was developed to verify savings:

- EC requested simulation (HSE) and output (TSV) files from the program
- Where possible, the simulation file was re-run and the results used to verify the tracking savings. If different simulation versions or modes were used, the savings could be slightly different; therefore, simulation savings were considered “verified” if they were within 2% of the tracking savings; in this case, the tracked savings value was accepted as the verified savings.
- If a simulation file was not provided, the file inputs were incompatible with General mode and would not run, the file ran but produced an error due to version or mode differences, or the file produced a difference in savings greater than 2%, the output file was used to verify the tracking savings. As with the simulation file, the EC accepted tracking savings values within 2% of the output file value as the verified savings.
- If the EC was unable to verify the tracking savings against the output file, the EC requested additional documentation from the program to explain the discrepancy. For this program, Enbridge provided instruction that allowed the EC to simulate all measures simultaneously (including interactive effects) instead of one measure at a time.⁵⁸

⁵⁷ “Expert” is the mode listed in the output files. This mode is also labelled as “EnerGuide” in simulation files. The EC uses both terms.

⁵⁸ Enbridge delivery agent recorded savings by adding savings per measure using general mode in HOT2000. When the EC reran the HSE file as received, HOT2000 output savings for only a single measure. Further communication with Enbridge to understand delivery agent methods and review of data by EC staff identified a remedy native to HOT2000 software, allowing for all measures to be simulated together, as done by other agents and as is good practice. After implementing this solution, the tracked savings values for all five homes matched within 2% of modelled savings.

- If no additional documentation or explanation was available, the EC would have compared the output file values to the project documentation to determine whether they were consistent. This verification step was not necessary for this program in this round of evaluation.

Figure 3. Overview of gross simulation savings verification for 2016 Winterproofing

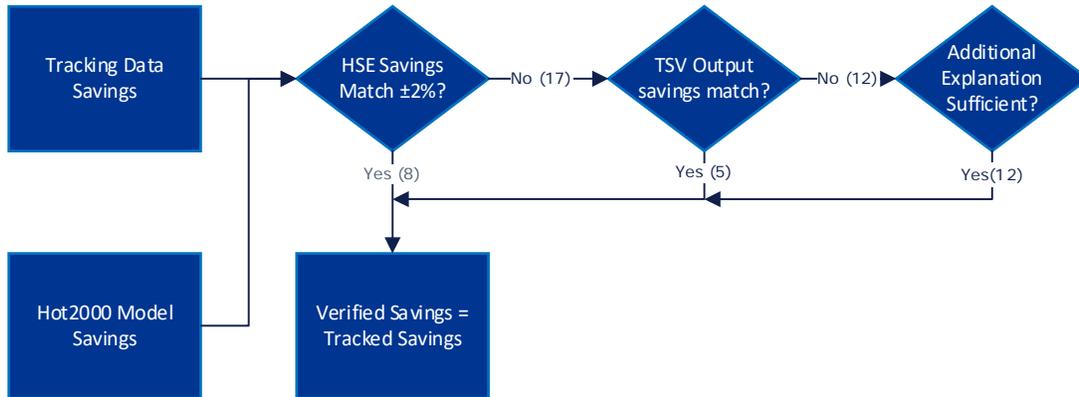


Table 154 shows how many customers were verified in each evaluation step.

Table 154. Overview of gross simulation savings verification

Evaluation Step	# Verified
Simulation re-run (HSE) and compared to tracking, verified if $\pm 2\%$	8
Output files (TSV) compared to tracking, verified if $\pm 2\%$	5
Additional explanation requested	12
Comparison to output file values	0
Total Verified	25

The gross savings realization rate is 100%, shown in Table 155.

Table 155. Enbridge Home Winterproofing realization rate*

Number of Houses	Realization Rate	90% Confidence Interval			
		Absolute Precision	Lower Bound	Upper Bound	Relative Precision
25	100.00%	0.00%	100.00%	100.00%	0.00%

*Not all values may compute exactly due to rounding.

Prescriptive Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC made some minor changes to the tracked savings which resulted in a (rounded) savings ratio of 97.19%, as shown in Table 156.

- **Programmable Thermostats:** Enbridge calculations were based on a savings value from the March 2015 TRM, but the correct value to use was that from the December 2015 TRM. The tracking gross annual savings value was 53 m³, whereas the value in the December update was 46 m³.
- **Kitchen Aerators:** Enbridge calculations were based on an adjustment factor taken from the 2012 TAPS Report. That report presents a weighted average installation rate of 66.5%, slightly different from the Enbridge value of 66.9%.

Table 156. Enbridge scorecard achievements (cumulative savings) by measure group*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement* (CCM)	Savings Ratio
Programmable Thermostats	15	11,925	10,350	86.79%
Bathroom Aerators	326	4,694	4,694	100.00%
Kitchen Aerators	257	9,834	9,957	101.25%
Showerheads 2.6+	58	25,179	25,179	100.00%
Total	656	51,632	50,180	97.19%

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC confirms the savings of 28,814,754 CCM (99.99% of tracked savings) for Enbridge's Home Winterproofing (single family Part 9) program.

Winter Retrofit - Home Weatherization – Union

Overview

Table 157 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Home Weatherization Program, with the metric of CCM savings. As a result of this review, the EC verifies 45,754,203 CCM (98.7% of reported and tracked savings).

Table 157. Union Low Income scorecard achievements: Home Weatherization program*

Measure Class	Achievement			Savings Ratio
	Reported	Tracked	Verified	
Prescriptive CCM	N/A	35,856	35,078	97.83%
Simulation-based CCM	N/A	46,316,609	45,719,125	98.71%
Total	46,352,465	46,352,465	45,754,203	98.71%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 158 to verify the metrics for the Home Weatherization program.

Table 158. Documentation used to verify the Home Weatherization program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	Various documents for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union's 2015-2020 DSM Plan, EB-2015-0029
Union's Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ⁵⁹
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

Simulation-based Savings

Participant Selection

The EC did not verify Private Homes and Social Housing savings separately, as there was no difference observed for measure life (25 years) or free-ridership (0%) for any Low Income program. Union provided the tracking file, listing 1,865 prescriptive measures and measures installed in Private Homes and Social Housing. The EC identified 1,748 individual sites within Private and Social Housing and randomly selected 25 participants for review, requested additional documentation, confirmed receipt of the correct files, and reviewed documents to verify participation and eligibility.

Received Files

The typical file folder had the following information:

⁵⁹ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

- Photographs of pre- and post-installation conditions
- HOT2000 Model simulation Files (.HSE)
- HOT2000 Model Output Files (.TSV)

Calculate Realization Rate

The EC used a multi-step process to verify tracked energy savings for the 25 sampled homes, shown in Figure 4 for the Home Weatherization program. The process was necessary because the simulation mode (EnerGuide or Expert⁶⁰) used by program delivery agents is not available to non-certified professionals. While the EC can attempt to run the Expert simulations in General mode, the runs may produce error warnings or result in a savings differential between the Expert result and General result. Therefore, this multi-step process was developed to verify savings:

- EC requested simulation (HSE) and output (TSV) files from the program
- Where possible, the simulation file was re-run and the results used to verify the tracking savings. If different simulation versions or modes were used, the savings could be slightly different; therefore, simulation savings were considered “verified” if they were within 2% of the tracking savings; in this case, the tracked savings value was accepted as the verified savings.
- If a simulation file was not provided, the file inputs were incompatible with General mode and would not run, the file ran but produced an error due to version or mode differences, or the file produced a difference in savings greater than 2%, the output file was used to verify the tracking savings. As with the simulation file, the EC accepted tracking savings values within 2% of the output file value as the verified savings.
- If the EC was unable to verify the tracking savings against the output file, the EC requested additional documentation from the program (utility) to explain the discrepancy.
- If no additional documentation or explanation was available, the EC compared output file values to project documentation to determine if the calculated model values were consistent with documentation. For this program, we found the project photos to be in agreement with the simulation file, so the verified savings were set equal to the TSV file value.

⁶⁰ “Expert” is the mode listed in the output files. This mode is also labelled as “EnerGuide” in simulation files. The EC uses both terms.

Figure 4. Overview of gross savings verification for 2016 Home Weatherization program

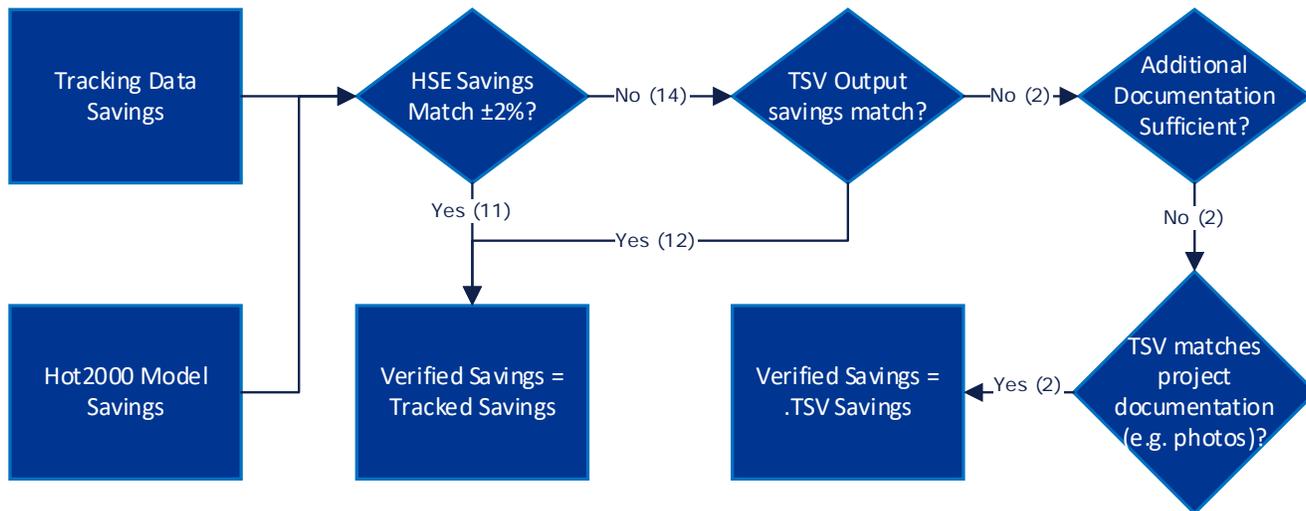


Table 159 shows how many customers were verified in each evaluation step. Savings for 23 homes were verified with comparison of tracking data against either simulation (HSE) or output (TSV) files.

Table 159. Overview of gross simulation savings verification

Evaluation Step	# Verified
Simulation re-run (HSE) and compared to tracking, verified if $\pm 2\%$	11
Output files (TSV) compared to tracking, verified if $\pm 2\%$	12
Additional explanation requested	0
Comparison to output file values	2
Total Verified	25

The gross savings realization rate (RR) is 98.7%, shown in Table 160.

Table 160. Union Home Reno Rebate realization rate*

Number of Houses	Realization Rate	90% Confidence Interval			
		Absolute Precision	Lower Bound	Upper Bound	Relative Precision
25	98.71%	1.85%	96.86%	100.56%	1.88%

*Not all values may compute exactly due to rounding.

Prescriptive Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC certified the tracked savings which resulted in a savings ratio of 97.9%, as shown in Table 161.

Table 161. Union scorecard achievements by measure group*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement (CCM)	Savings Ratio
Basic-Faucet Aerator-Bath	32	2,028	2,028	100%
Basic-Faucet Aerator-Kitchen	33	3,777	3,777	100%
Basic-Pipe Insulation - 2m	33	15,172	15,172	100%
Basic-Showerhead-1.25 gpm existing 2.0-2.5	7	3,188	3,049	96%
Basic-Showerhead-1.25 gpm existing 2.6+	8	6,970	6,970	100%
Basic-Thermostat-Programmable	6	4,722	4,099	87%
Total	119	35,856	35,078	98%

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC confirms the savings of 45,754,203 CCM (98.7% of tracked savings) for Union's Home Weatherization program.



Winter Retrofit – Indigenous Program – Union

Identified as the Aboriginal Program in the OEB Decision and Order, this program reported no savings or activity in 2016.

Low Income New Construction – Enbridge

Overview

Table 162 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Low Income New Construction Program, with the metric of participants. As a result of this review, the EC verifies the 2016 achievement of 6 participants (100% of tracked). Table 162 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 162. Enbridge Low Income scorecard achievement: Low Income New Construction program*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Low Income New Construction Participants	6	6	6	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 163 to verify the metrics for the Low Income New Construction (LINC) program.

Table 163: Documentation used to verify the Low Income New Construction program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	PDF document for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge Draft 2016 Report	2016 Demand Side Management Draft Annual Report, Enbridge Gas ⁶¹

Participant Selection

Enbridge first provided the Tracking file listing Program Year, Project Code (unique ID), Participant Status, Application Date, Charrette Date, and DCP Report Receipt. The spreadsheet listed six individual participants. The EC requested full documentation for all participants.

⁶¹ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Received Files

Enbridge provided the EC with document folders, titled by LINC Project number, containing project PDF documents. The EC first confirmed the titles received matched the IDs requested from the Tracking file. Project Files were properly redacted with name, address, and other information unavailable, as requested. The EC confirmed that documents for all participants had been received.

Verify Participation

The metric for the program is participants. To determine the definition of participant, the EC looked first to the OEB Decision, which identified a participant as someone who submits a Project Application⁶².

The OEB Decision also includes the Enbridge proposed metric of "New Construction Program Participants⁶³." This label differs slightly from "Number of Project Applications," and implies a second or additional definition for the metric. To identify if a record with a submitted a project application qualifies as a participant, the EC also reviewed the program description⁶⁴:

"Enbridge's proposed low-income new construction program will provide home builders with workshops, energy efficiency modeling (sic) tools, design options, energy efficiency education and financial incentives related to new affordable housing new construction developments."

From this, the EC determined that to demonstrate *participation*, Project Files should also provide documentation for *any* of the following:

- Workshop participation
- Energy efficiency modeling tools
- Design options
- Energy efficiency education
- Financial incentives

The EC evaluated the sampled participant files against the criteria above and determined that all six projects qualify as participants.

Verify Eligibility

The OEB Decision does not provide a clear definition for participant eligibility, instead pointing to approval of Enbridge's Plan. From the Plan, the EC found the following eligibility requirements:

- Submitted project application
- New affordable housing qualified by a municipal, provincial and/or federal housing program.
- Application identifies the project is specifically directed to affordable building developments, either single family (Part 9) or multi-residential (Part 3)

These criteria were based on an examination of the 2016-2020 offer descriptions, Enbridge's Plan, and the draft 2016 Report (Table 164).

⁶² Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, p. 64-65, 67, 78, and Schedule C

⁶³ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Schedule B

⁶⁴ Ibid, p. 30

Table 164. Eligibility requirements documentation

Document	Relevant Contents
2016-2020 OFFER DESCRIPTIONS ⁶⁵	<i>"The offer is specifically directed to residential and multi-residential affordable building developments and efforts will focus on working with and through municipal governments, private and non-profit local housing corporations."</i>
EVALUATION PLAN ⁶⁶	<ul style="list-style-type: none"> ▪ Developers and builders of new "affordable housing" as qualified by a municipal, provincial and/or federal housing program. ▪ Developers and builders of both single (sic) family Part 9 houses and multi-residential Part 3 buildings are eligible to participate.
DRAFT 2016 REPORT ⁶⁷	<p><i>"The offer is specifically directed to Residential and Multi-Residential building affordable developments, and will be focused on working with and through municipal governments, private and non-profit sector local housing corporations.</i></p> <p><i>Eligibility participants must meet the following criteria:</i></p> <ul style="list-style-type: none"> • <i>Developers and builders of new "affordable housing" as qualified by a municipal, provincial and/or federal housing program.</i> • <i>Developers and builders of both single family Part 9 houses and multi residential Part 3 buildings are eligible to participate"</i>

To confirm eligibility, the EC looked for documentation that indicates the development or project is specifically directed to affordable building developments, either single family (Part 9) or multi-residential (Part 3). Program Applications, a requirement for Program Participation, provided by Enbridge as requested Project Files contain identification of projects as Part 3 or Part 9 projects. However, Project Files did not indicate whether projects were qualified by any municipal, provincial and/or federal housing program. The EC asked that Enbridge provide confirmation that developers and builders of new "affordable housing" as qualified by a municipal, provincial and/or federal housing program. Enbridge staff responded as follows⁶⁸:

"In order to properly focus the LINC program on builders/developers of affordable housing, the program was designed with the criteria that builders were to be "qualified" by a municipal, provincial and/or federal housing program as a developer and/or builder of new "affordable housing".

Program managers make this determination early in the discussion in consideration of participation in the program in consultation with each builder.

For example, for the sample participant, LINC-004, Enbridge confirmed that (Developer/Builder) qualified to receive funding available to affordable housing providers for the (Project), from the (Municipality), the (County), the province (Provincial Program) as well as through (National Program). These entities recognized (Developer/Builder) status as a non-profit housing provider of

⁶⁵ Enbridge's Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 2, Schedule 1, page 45 of 100

⁶⁶ Enbridge's Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 2, Schedule 2, page 31 of 55

⁶⁷ Enbridge 2016 Demand Side Management Draft Annual Report, November 16, 2017, page 90

⁶⁸ Enbridge Employee "RE: Follow up request - LI New Construction and MT School Energy Competition" Message to DNV GL Employee, 2/5/2018, Email



affordable housing. In addition, (Developer/Builder) is a member of the Ontario Non-Profit Housing Association (ONPHA). "

Verification Result

As a result of this review, the EC confirms that all six projects meet the definition and eligibility requirements, resulting in a scorecard achievement of 6 participants.

Low Income Multi-Residential – Affordable Housing Program – Enbridge

Table 165 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Gas Affordable Housing Program, with the metric of CCM savings. The EC verifies the 2016 achievement of 2,905,947 CCM for prescriptive measures (100% of tracked), 81,822,634 CCM for custom measures (103% of tracked), and 84,728,581 CCM for all program measures (103% of reported and tracked savings). Table 165 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 165. Enbridge Low Income Scorecard achievements: Affordable Housing Program*

Measure Class	Achievement			Savings Ratio
	Reported†	Tracked	Verified	
Prescriptive CCM	N/A	2,905,947	2,905,947	100.00%
Custom CCM	N/A	79,439,445	81,822,634	103.00%
Total	82,345,391	82,345,391	84,728,581	102.89%

*Not all values may compute exactly due to rounding.

†Enbridge’s draft report does not include by-program breakouts for large and small volume customers, rather program totals and metric total

Documentation

The EC used the documentation shown in Table 166 to verify the metrics for the Affordable Housing program.

Table 166. Documentation used to verify the Affordable Housing Program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ⁶⁹
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

⁶⁹ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Report Language	Description or Citation
December 2012 TRM	EB-2012-0441 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution ⁷⁰
Multi-Residential Low Income Showerhead Verification	Multi-Residential Low Income Showerhead Verification, Ipsos Research ⁷¹
2015 CPSV Report	2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation

Verify Prescriptive Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC made some minor changes to the tracked savings which resulted in a (rounded) savings ratio of 100%, as shown in Table 167.

Table 167. Enbridge - prescriptive measures - scorecard achievements by measure group*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement (CCM)	Savings Ratio
Showerheads	610	163,701	163,701	100%
Condensing Boilers - Water	3	165,867	165,867	100%
Condensing Boilers - Space	1	72,604	72,604	100%
High Efficiency Boilers - Space	8	2,503,775	2,503,775	100%
Total	622	2,905,947	2,905,947	100%

*Not all values may compute exactly due to rounding.

Verify Custom Savings

The EC identified the custom savings totals from Enbridge Tracking Files shown in Table 168. The EC applied a realization rate from the 2015 CPSV report for Multi-Residential of 103%.

⁷⁰ 2012 TRM is the original source for Prescriptive High Efficiency Boiler savings, with greater detail than provided in later TRM summary sheets. For example, December 2015 TRM describes Free Ridership as "10/12/20%" whereas 2012 document describes when to apply these values.

⁷¹ Multi-Residential Low Income Showerhead Verification, Ipsos Research, March 28, 2013

Table 168. Enbridge - custom measures - scorecard achievements*

Measure Group	Installed Measures	Verified Net Savings (CCM)
Air Handling Unit	1	1,075,119
BAS	2	207,540
Boiler - Hydronic Condensing - Advancement	5	3,110,166
Boiler - Hydronic Condensing - Replacement	28	13,832,772
Boiler - Hydronic High Efficiency - Advancement	2	7,581,010
Boiler - Hydronic High Efficiency - Replacement	28	32,496,143
Controls	44	9,365,948
Heat Recovery/Economizer	1	383,407
HRV	1	607,644
Make Up Air Unit	10	3,257,479
Pipe Insulation	2	313,243
Reflective Panel	17	6,435,187
VFD	7	3,156,976
Total	148	81,822,634

*Not all values may compute exactly due to rounding.

Enbridge included seven advancement measures, which used expanded measure lives to account for early retirement of previously installed measures, allowing for greater cumulative savings, as demonstrated in Table 169.

Table 169. Advancement measures – measure life and cumulative savings*

Measure Group	Measure Life (Years)		Cumulative Savings (CCM)	
	Standard	Advance	Standard	Advance
Boiler - Hydronic Condensing - Advancement	11	20.831	353,342	689,174
Boiler - Hydronic Condensing - Advancement	11	25	173,250	405,563
Boiler - Hydronic Condensing - Advancement	11	25	251,196	588,027
Boiler - Hydronic Condensing - Advancement	8	24.142	259,648	807,059
Boiler - Hydronic Condensing - Advancement	9	25	216,819	620,343
Boiler - Hydronic High Efficiency - Advancement	9	21.226	1,755,522	4,264,510
Boiler - Hydronic High Efficiency - Advancement	15	20.956	2,304,870	3,316,500

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC confirms the total savings of 84,728,581 CCM (103% of tracked) for Enbridge's Affordable Housing Program.

Low Income Multi-Residential – Multi-Family Program (SA) – Union

Table 170 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Gas Multi-Family (Social and Assisted) Program, with the metric of CCM savings. As a result of this review, the EC verifies 6,817,951 CCM for prescriptive measures (108% of tracked), 4,076,621 CCM for custom measures (121% of tracked), and 10,894,572 CCM for all program measures (112% of tracked). Table 170 contains the following variables:

- Reported: Metric value reported in Union’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 170. Union Low Income scorecard achievements: Multi-Family Program (SA) *

Measure Class	Achievement			Savings Ratio
	Reported	Tracked	Verified	
Prescriptive CCM	N/A	6,318,325	6,817,951	107.91%
Custom CCM	N/A	3,369,109	4,076,621	121.00%
Total	9,687,434	9,687,434	10,894,572	112.46%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 171 to verify the metrics for the Multi-Family (Social and Assisted) program.

Table 171. Documentation used to verify the Multi-Family (Social and Assisted) program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union’s 2015-2020 DSM Plan, EB-2015-0029
Union’s Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ⁷²
December 2012 TRM	EB-2012-0441 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution ⁷³
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution
December 2016 TRM	EB-2016-0246 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

⁷² While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

⁷³ 2012 TRM is the original source for Prescriptive High Efficiency Boiler savings, with greater detail than provided in later TRM summary sheets. For example, December 2015 TRM describes Free Ridership as “10/12/20%” whereas 2012 document describes when to apply these values.

Report Language	Description or Citation
2015 CPSV Report	2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation

Verify Prescriptive Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC certified the tracked savings which resulted in a savings ratio of 108%, as shown in Table 172.

Table 172. Union - prescriptive measures - scorecard achievements by measure group*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement (CCM)	Savings Ratio
Condensing Boiler - Space	29	2,990,179	2,990,179	100%
Condensing Boiler - Water	5	333,230	333,230	100%
Condensing Water Heater	19	323,129	210,060	65%
Condensing Furnace	1	1,111	2,032	183%
Energy Recovery Ventilation	3	1,444,779	1,567,538	109%
Heat Recovery Ventilation	4	27,692	29,460	106%
Make Up Air Unit	9	1,198,206	1,685,454	141%
Total	70	6,318,325	6,817,952	108%

*Not all values may compute exactly due to rounding.

Verify Custom Savings

The EC identified the custom savings totals from Union Tracking Files shown in Table 173. The EC applied a realization rate from the 2016 CPSV report for Multi-Residential of 121%, attribution from the 2015 CPSV and NTG report of 95%, and zero spillover, identifying net cumulative savings of 4,076,621 CCM.

Table 173. Union Gas - custom measures - scorecard achievements*

Measure Group	Installed Measures	Verified Net Savings (CCM)
Boiler	3	3,239,636
Pipe	1	26,553
Roof	3	637,834
VFD/VSD	1	172,598
Total	8	4,076,621

*Not all values may compute exactly due to rounding.

Verification Result

As a result of this review, the EC confirms total savings of 10,894,572 CCM (112% of tracked) for Union's Multi-Family (Social and Assisted) Program.

Low Income Multi-Residential – Multi-Family Program (MR) – Union

Table 174 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Gas Multi-Family (Market Rate) Program, with the metric of CCM savings. The EC verifies 8,099,332 CCM for prescriptive measures (103% of tracked), 51,857 CCM for custom measures (121% of tracked), and 8,151,189 CCM for all program measures (103% of tracked savings). Table 174 contains the following variables:

- Reported: Metric value reported in Union’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 174. Union Low Income Scorecard achievement: Multi-Family (MR) Program*

Measure Class	Achievement			Savings Ratio
	Reported	Tracked	Verified	
Prescriptive CCM	N/A	7,848,261	8,099,332	103.20%
Custom CCM	N/A	42,856	51,857	121.00%
Total	7,891,117	7,891,117	8,151,189	103.30%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 175 to verify the metrics for the Multi-Family (Social and Assisted) program.

Table 175. Documentation used to verify the Multi-Family (Social and Assisted) program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union’s 2015-2020 DSM Plan, EB-2015-0029
Union’s Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ⁷⁴
December 2012 TRM	EB-2012-0441 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution ⁷⁵
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

⁷⁴ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

⁷⁵ 2012 TRM is the original source for Prescriptive High Efficiency Boiler savings, with greater detail than provided in later TRM summary sheets. For example, December 2015 TRM describes Free Ridership as “10/12/20%” whereas 2012 document describes when to apply these values.

Report Language	Description or Citation
2015 CPSV Report	2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation

Verify Prescriptive Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC certified the tracked savings which resulted in a savings ratio of 103%, as shown in Table 176.

Table 176. Union – prescriptive measures – scorecard achievements by measure group*

Measure Group	Installed Measures	Tracked Achievement (CCM)	Verified Achievement (CCM)	Savings Ratio
Condensing Boiler - Space Heating	28	6,646,271	6,646,271	100%
Condensing Boiler - Water Heating	9	523,164	523,164	100%
Make Up Air Unit	3	678,826	929,898	137%
Total	40	7,848,261	8,099,333	103%

*Not all values may compute exactly due to rounding.

Verify Custom Savings

Union reported only one custom project under the Low Income Multi-Family (Market Rate) Program, an early replacement window. The EC applied a realization rate from the 2016 CPSV report for Multi-Residential of 121%, attribution from the 2015 CPSV and NTG report of 95% and zero spillover, identifying net cumulative savings of 51,857 CCM.

Verification Result

As a result of this review, the EC confirms total savings of 8,151,190 CCM (103% of tracked) for Union's Multi-Family (Market Rate) Program.

Appendix G Large Volume Scorecards

This appendix describes the detailed process used to verify the metrics for the Large Volume Scorecard programs for Union, shown in Table 177. The program addressed in this appendix is the Large Volume program.

This appendix has two sub-sections. The first addresses the DSM shareholder incentive metrics for Large Volume. The second addresses the changes necessary for calculating lost revenue.

Table 177. Union Gas 2016 Large Volume (Rate T2/Rate 100) program scorecard*

Program	Metric	Verified Achievement		Metric Target†			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
Large Volume	CCM	79,848,302	79,848,302	668,168,041	890,890,721	1,336,336,082	100%

*Not all values may compute exactly due to rounding.

†Target value is not a fixed value, but is the three year rolling average cost effectiveness X 2016 Budget without overheads X 1.1 X 0.75. Lower band is set at 75% of that target value, upper band is 150% of that target value.

Shareholder Incentive Metric

Overview

Table 178 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Large Volume program, with the metric of CCM savings. As a result of this review, the EC verifies total savings of 392,779 CCM for prescriptive measures (47% of tracked), 79,455,523 CCM for custom measures (23% of tracked), and 79,848,302 CCM for all program measures (23% of tracked). Table 178 contains the following variables:

- Reported: Metric value reported in Union's draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Savings Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 178. Union Gas Large Volume scorecard achievements: large volume CCM Metrics by type*

Measure Class	Achievement			Savings Ratio
	Reported	Tracked	Verified	
Prescriptive CCM	N/A	834,921	392,779	47.04%
Custom CCM	N/A	346,096,223	79,455,523	22.96%
Total	346,931,144	346,931,144	79,848,302	23.02%

*Not all values may compute exactly due to rounding.

Table 179 includes these variables:

- Cumulative Gross Savings – Tracking: Gross cumulative tracking savings for all customers in the Union Large Volume program.
- RR: Gross realization rate from the 2016 CSPV report.
- Att: Attribution ratio (the complement of free ridership) from the 2015 CPSV report.

- Spillover: Spillover ratio from 2013-2014 Spillover Study.
- Adj: Adjustment Ratio, the product of the RR and the sum of the Att ratio and Spillover ratio

Equation 9: Adjustment Ratio

$$\text{Adjustment Ratio} = \text{RR} * (\text{Att} + \text{Spillover})$$

- Verified Net Savings: Cumulative gross savings multiplied by the Adjustment Ratio

Equation 10: Verified Net Savings

$$\text{Verified Net Savings} = \text{Adjustment Ratio} * (\text{Cumulative Gross})$$

Table 179. Adjustment factors applied to Large Volume Program cumulative gross savings*

Measure Type	Tracking Gross Savings (CCM) †	RR (%)	Att (%)	Spillover (%)	Adj* (%)	Verified Net Savings (CCM)
Prescriptive	582,030	100.00%	67.48%	0.00%	67.48%	392,779
Custom	844,735,539	100.98%	8.49%	0.82%	9.41%	79,455,523

*Not all values may compute exactly due to rounding.

†The tracking savings in this table reflect the updates to the December 2015 TRM

Significant differences existed between the original tracked data and verified prescriptive measure savings. This difference was due to change from utilization of the March 2015 TRM to the December 2015 TRM to identify savings by measure as a result of the decision and agreement of the EAC to normalize both utilities to the same document for the sake of consistency. Values in this table reflect the savings values reflected in the 2015 December TRM. Original tracking data showed savings of 1,214,945, utilizing savings values from the March 2015 Joint Savings Document, a reduction of 632,915 Gross CCM. Additionally, in Table 179:

- Realization Rate – Prescriptive measures do not receive a Realization Rate, thus set at 100%. The value shown for Custom measures is a weighted value, calculated using the measure specific ratios outlined in this section.
- ATT: For prescriptive measures, each measure is adjusted with free-ridership rates outlined in the December 2015 DSM Measures – this value is simply the quotient of the total prescriptive net savings to the total prescriptive gross savings. For custom measures the value displayed is truncated average based on sum of all individual adjustments using ratios found in this appendix section.
- Spillover: Prescriptive measures do not receive a Spillover rate, thus set at 0%. The value shown for Custom measures is a weighted value, calculated using the measure specific ratios outlined in this section.
- Adjustment values displayed are truncated (2 digit) averages based on sum of all individual adjustments using ratios found in this appendix section.

Documentation

The EC used the documentation shown in Table 180 to verify the metrics for the Large Volume program.

Table 180. Documentation used to verify the Large Volume program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union's 2015-2020 DSM Plan, EB-2015-0029
Union's Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ⁷⁶
December 2015 TRM	EB-2015-0344 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution
December 2016 TRM	EB-2016-0246 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution
2016 CPSV Report	2016 Natural Gas Demand Side Management Custom Savings Verification ⁷⁷
2015 CPSV Report	2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation ⁷⁸
2013-2014 Spillover Study	CPSV Participant Spillover Results, DNV GL for the Ontario Energy Board, May 23, 2018 ⁷⁹

Prescriptive Savings

In calculating net CCM, the EC reviewed natural gas savings for prescriptive measures from the Tracking File, using the procedures identified in Appendix L. The EC verified the tracked savings which resulted in a savings ratio of 100%, as shown in Table 181. Significant differences existed between the original tracked prescriptive savings and the tracked savings presented in this report. Union changed the source document for prescriptive savings per measure from the *March* 2015 DSM Measures to the *December* 2015 DSM Measures. The change was made at the request of the EAC, to be consistent with Enbridge. The tracked achievement in Table 181 reflects the updated values.

Table 181. Union – prescriptive measures – tracked and verified cumulative net savings (CCM) and ratio by measure group * 80

Measure Group	Installed Measures	Tracked Achievement (CCM) †	Verified Achievement (CCM)	Savings Ratio
Air Curtains	1	9,562	9,562	100%
Infrared Heaters	15	383,217	383,217	100%
Total	16	392,778	392,778	100%

*Not all values may compute exactly due to rounding.

†Significant differences existed between the original tracked data and verified prescriptive measure savings. This difference was due to change from utilization of the March 2015 TRM to the December 2015 TRM to identify savings by measure as a result of the decision and agreement of the EAC to normalize both utilities to the same document for the sake of consistency. Values in this table reflect the savings values reflected in the 2015 December TRM. Original tracking data showed savings of 834,921 CCM, utilizing savings values from the March 2015 Joint Savings Document, a reduction of 427,091 Net CCM.

⁷⁶ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

⁷⁷ 2016 Natural Gas Demand Side Management Custom Savings Verification, DNV GL for the Ontario Energy Board, June 31, 2018

⁷⁸ 2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation, DNV GL for the Ontario Energy Board, August 15, 2017

⁷⁹ DNV GL for the Ontario Energy Board, CPSV Participant Spillover Results, May 23, 2018

⁸⁰ Union changed the source document for prescriptive savings per measures from the March 2015 TRM to the December 2015 TRM. The tracked achievement in this table reflects the updated values.

Custom Savings

Union reported 55 custom projects under the Large Volume Program. The EC identified 55 tracked custom measures with tracked cumulative gross savings of 844,735,539 CCM. These projects are grouped by measure in Table 182.

Table 182. Union - custom measures – verified cumulative gross savings by measure group*

Measure Group	Installed Measures	Tracking Gross Savings (CCM)
Furnace	8	45,161,737
Heat Recovery	12	36,680,547
Insulation (Pipe)	9	436,040,149
Process Improvement	19	305,904,771
Steam and Hot Water	4	6,831,920
Steam and Hot Water (Traps)	3	14,116,415
Total	55	844,735,539

*Not all values may compute exactly due to rounding.

Adjustment Values – RR

The 2016 CPSV Report conveyed one gross realization rate for the program, 100.98%.

Adjustment Values – Att Ratios

The 2015 CPSV Report conveyed attribution ratios by measure group, as shown in Table 183. Because the ratios are being applied to a population outside of the one that was sampled, the EC recalculated the relative precision of the ratios without the finite population correction factor. Where the original sector/measure group precision did not meet the application criteria of +/- 20% or less, the EC combined groups, improving the precision, until the application criteria was met. Then the EC mapped the measures in the Union tracking data to these measure groups and applied the relevant rates at the measure level.

Table 183. 2016 Large Volume measure groups with matched CPSV domains and cumulative ATT ratios*⁸¹

Measure Group (From Union Tracking Data)	Domain (From 2015 CPSV Report)	ATT (From 2015 CPSV Report)	Relative Precision (+/-)
Furnace	Heat Recovery	6.59%	9%
Heat Recovery	Heat Recovery	6.59%	9%
Insulation (Pipe)	Hydronic Insulation	5.67%	12%
Process Improvement	Operational Improvements	12.55%	12%
Steam and Hot Water	Other Equipment	0.08%	0%
Steam and Hot Water	Leak Repair & Other	9.31%	11%
Steam and Hot Water (Traps)	Steam Trap	20.65%	17%

*Not all values may compute exactly due to rounding.

⁸¹ 2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation, Ontario Energy Board, October 12, 2017, page 54, Table 4-13

Adjustment Values – Spillover Ratios

The 2013-2014 Spillover Study conveyed one spillover ratios for the program, 0.82%.

Verify Cumulative Natural Gas Savings

The program-level adjustment factors shown in Table 179 were built up from a measure-level application of the RR, Att, and Spillover ratios. Each measure was assigned a RR, Att, or Spillover ratio based on its measure group. The EC calculated the measure-level net savings using Equation 9 and Equation 10, then summed the measure-level savings to produce program-level savings. The EC calculated the program-level adjustment ratio by dividing the program-level net savings by the program-level gross savings.

Table 184. 2016 Large Volume measure groups adjustment values and cumulative net savings*

Measure Type	Tracking Gross Savings (CCM)	RR (%)	Att (%)	Spillover (%)	Adj† (%)	Verified Net Savings (CCM)
Furnace	45,161,737	100.98%	6.59%	0.82%	7.48%	3,379,280
Heat Recovery	36,680,547		6.59%		7.48%	2,744,665
Insulation (Pipe)	436,040,149		5.67%		6.55%	28,576,337
Process Improvement	305,904,771		12.55%		13.50%	41,300,281
Steam and Hot Water (Furnace)	3,265,851		0.08%		0.91%	29,681
Steam and Hot Water (Other)	3,566,069		9.31%		10.23%	364,782
Steam and Hot Water (Traps)	14,116,415		20.65%		21.68%	3,060,497
Total	844,735,539	100.98%	8.49%	0.82%	9.41%	79,455,523

*Not all values may compute exactly due to rounding.

†Adjustment value displayed is truncated (2 digit) average based on sum of all individual adjustments by measure. Individual adjustment factors (RR, ATT, Spillover) are utilized for calculations at the 2 digit level, as displayed.

Verification Result

As a result of this review, the EC confirms total savings of 79,848,302 CCM (9.4% of tracked) for Union's Large Volume (Rate T2/Rate 100) Program.

Lost revenue savings

Overview

This section describes the detailed process used to verify the results for the 2016 Large Volume (Rate T2/Rate 100) Program's lost revenue accounting for applicable rate classes. For an explanation of lost revenue calculations, please refer to Appendix J.

Verified Annual Net Savings – Prescriptive

The EC adjusted the annual savings from the DSM shareholder incentive calculation to the best available information at the time of the evaluation, which is the December 2016 TRM. However, the measure-level inputs were unchanged from the DSM shareholder incentive source calculation to the December 2016 TRM, so the annual savings are the same, as shown in Table 185.

Table 185. Union – prescriptive measures – tracked gross and verified net annual savings (m3) by measure group*

Measure Group	Gross Tracking Savings (Annual m3)	Free Ridership	Prescriptive Adjustment	Net Verified Savings (Annual m3)
Air Curtains	671	5.00%	0.00%	637
Infrared Heaters	33,645	33.00%	0.00%	22,542
Total	34,316	32.45%	0.00%	23,180

*Not all values may compute exactly due to rounding.

The prescriptive savings adjustment factor, used to calculate net savings, is also unchanged between the planning period (DSM shareholder incentive value) to the evaluation.

Verified Annual Net Savings – Custom

For custom projects, an lost revenue-specific gross savings realization rate and Att factor are applied to the tracking savings. The lost revenue-specific gross savings realization rate does not include the effect of measure life adjustments. The lost revenue-specific Att factor accounts for dual baselines at the beginning of the installed measure life.

Total Verified Net Savings

Specific calculation inputs are shown with sources in Table 186.

Table 186. Custom Measures lost revenue inputs and sources

Input	Source
Gross Annual Savings	Union Tracking File
Adjustment Ratio	RR*(ATT+Spillover)
Realization Rate (RR)	2016 CPSV Evaluation (First Year Rate)
Attribution Ratio	2015 CPSV Evaluation
Spillover	2013-2014 Spillover Study

Verified Annual Net Saving for the Union Large Volume Program are shown below in Table 187.

Table 187. Union Gas Large Volume program verified annual net saving by measure type*

Measure Type	Net Verified Savings (Annual m3)	Net Verified Savings (1,000 Annual m3)
Prescriptive	23,180	3
Custom	6,748,874	2,755
Total	6,772,054	2,758

*Not all values may compute exactly due to rounding.

Lost revenue calculation

In Table 188 the total savings has been distributed by installation month (see Appendix J). The first row shows the savings without the proration.

Table 188. Large Volume annual savings by installation month*

Savings Type	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Without Monthly Proration	36	-	129	360	494	1,722	28	438	89	2,481	972	22
Total With Monthly Proration	36	-	108	270	330	1,004	14	183	30	620	162	2

*Not all values may compute exactly due to rounding.

Delivery Rates for Union Large Volume customers are listed in Table 189. The EC did not verify these values.

Table 189. Union Large Volume rate classes and delivery costs

Rate Class	Delivery Rate (\$/1,000 m3)
Large Industrial T2	\$0.08
Large Industrial R100	\$2.24

In Table 190, the rate classes have been applied to the annual savings prorated in Table 188.

Table 190. Large Volume annual savings by installation month – with monthly proration*

Rate Class	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T2 Industrial	31	0	106	341	480	1,717	0	438	89	2,430	904	22
100 Industrial	6	0	23	19	14	4	28	0	0	51	68	0
Total	36	0	129	360	494	1,722	28	438	89	2,481	972	22

*Not all values may compute exactly due to rounding.

Lost revenue

Savings for each rate class, with monthly proration factors applied, were summed, delivery rates applied, and revenue impact calculated.

Table 191. Union Large Volume lost revenue*

Rate Class	Savings Volume (1,000 m3)	Delivery Rate (\$/1,000 m3)	Revenue Impact (\$)
T2 Industrial	2,669	\$0.08	\$219
100 Industrial	89	\$2.24	\$199
Total	2,758	-	\$418

*Not all values may compute exactly due to rounding.

As a result of this review, the EC confirms lost revenue of \$418 for Union's Large Volume program.

Appendix H Market Transformation Scorecards

This appendix describes the detailed process used to verify the metrics for the Market Transformation Scorecard programs for Enbridge (Table 192) and Union Gas (Table 193). The programs addressed in this appendix are:

- Commercial New Construction – Commercial Savings by Design – Enbridge
- Commercial New Construction – Union
- Residential New Construction – Residential Savings by Design – Enbridge
- Residential New Construction – Optimum Home Program – Union
- School Energy Competition – Enbridge

Table 192. Enbridge 2016 market transformation & energy management scorecard⁸² * †

Programs	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
Residential Savings by Design	Builders	31	31	25	33	50	10%
	Homes Built	2,206	2,206	2,063	2,751	4,127	15%
Commercial Savings by Design	New Developments	43	43	25	33	50	25%
School Energy Competition	Participating Schools	25	25	41	55	83	10%
Run it Right	Participants	84	84	62	83	124	20%
Comprehensive Energy Management (CEM)	Participants	7	7	5	7	10	20%

*Not all values may compute exactly due to rounding.

†Programs in grey text are not similar to Union programs under the Market Transformation Scorecard, and not discussed in this Appendix. For these programs please refer to Appendix G.

Table 193. Union Gas 2016 market transformation scorecard*⁸³

Programs	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
Optimum Home	% Homes Built	70.09%	70.09%	50.00%	70.00%	100%‡	50%
Commercial New Construction†	Participants	0	0	6	8	12	50%

*Not all values may compute exactly due to rounding.

†Union Gas did not provide tracking data for any activity in the Commercial New Construction Program, and reported no program activity in its 2016 Annual Report⁸⁴

‡150% of 70.3% exceeds 100%, thus impossible to attain, as approved as Upper Band in Revised Decision and Order⁸⁵

⁸² Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Schedule C

⁸³ Ibid

⁸⁴ Union Gas 2016 Demand Side Management Draft Annual Report, November 16, 2017

⁸⁵ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016, page 4

Commercial New Construction – Commercial Savings by Design – Enbridge

Overview

Table 194 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Market Transformation Commercial Savings by Design (SBD) Program, with the metric of New Developments. As a result of this review, the EC verifies the 2016 achievement metric of 43 New Developments (100% ratio).

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values

Table 194. Enbridge market transformation scorecard achievement: Commercial SBD Program developments metric*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Commercial Savings by Design New Developments	43	43	43	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 195 to verify the metrics for the Commercial Savings by Design program.

Table 195. Documentation used to verify the Commercial Savings by Design program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Project Files	Two PDF documents
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ⁸⁶

Participant Selection

Enbridge provided the Tracking File listing Project Code (unique ID), program year, commitment date, a variable indicating the project “meets sq ft threshold”, IDP date, and a variable indicating if the “Final IDP Report Received”. The spreadsheet identified 43 participants, all with 2016 dates and ‘Yes’ marked in for both the threshold and report received variables. As tracking data indicated that all the 43 listed participants

⁸⁶ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

were equally qualified, the EC randomly selected 'SBDC-022' from the full list for document review. The EC requested all supporting documentation, including documentation that supports eligibility and participation criteria.

Received Files

The EC received three PDF documents in response to this request:

- "Commitment form": SBDC-022 Commitment Form.pdf
- "Terms and Conditions": Commitment Form_pg2.pdf
- "IDP report": SBDC-022 IDP Report Summary.pdf

The EC first confirmed the titles received matched the IDs requested. Enbridge redacted name, address, and other identifying information. The EC confirmed the signature dates on the commitment form matched the commitment date in the tracking file, and that the date on the IDP report matched the date recorded in the IDP date field of the tracking file.

Verify Participation

To determine the definition of New Developments, the EC looked first to the OEB Decision, which identified approval of the Enbridge ESC Plan⁸⁷:

Decisions

The OEB approves Enbridge's Commercial Savings by Design program. This program is similar to Enbridge's Residential Savings by Design, with the difference being the target market is commercial and industrial buildings as opposed to residential new construction. For the same reasons as the Residential Savings by Design program, the OEB finds that this program is consistent with guiding principles of the DSM Framework and drives integrated conservation savings prior to building construction.

Relevant criteria for "new development" are described in Enbridge's Plan "Budgets, Metrics and Targets"⁸⁸, paragraph 46:

- *For the purpose of assessing the "new developments enrolled" metric for SBD Commercial:*
 - i. *Only builders and developers who have "enrolled" in the program and completed the IDP process are eligible to be counted towards the target.*
 - ii. *"Enrolment" is defined as a signed MOU with a builder or developer containing a commitment to participate in the Enbridge Commercial Savings by Design offer for a 5-year period which will include undertaking an IDP adhering to an Enbridge approved IDP process (such as IEA Task 23 or the iiSBE developed IDP Tool) which also includes the requisite energy model, demonstrating how to achieve at least 15% total energy savings relative to the yet to be completed 2017 Ontario Building Code. The builder must also commit to constructing buildings or a building to the IDP standard within 5 years.*
 - iii. *The metric in the Commercial Savings by Design scorecard is based on the number of projects to which a developer commits, i.e., the same developer with different clients and different kinds of projects may be counted multiple times. A minimum 50,000 square feet requirement applies to each project. A project is defined as either a single building or multiples of the same building by the same company that add up to 50,000 square feet.*

From these definitions, the EC observed the following criteria:

⁸⁷ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Page 39

⁸⁸ Enbridge's Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 1, Schedule 4, 37 of 41

- Only projects from enrolled builders/developers count towards the metric. Enrollment is defined as:
 - A builder or developer committed to the CSBD offer for five years via an MOU
 - And undertaking the Enbridge approved IDP process for each development, which requires:
 - IDP includes energy model
 - IDP demonstrates how to achieve 15% energy savings over anticipated 2017 code. A close reading of the 2017 code⁸⁹ revealed it allowed projects that apply for permits through calendar year 2017 to comply with the 2012 ODP efficiency levels
 - Project must be at least 50,000 ft²
 - And a project is a single building or multiples of same building which sum to at least 50,000 ft²

The EC noted that the IDP submitted for SBDC-022 cited savings of 29.3% improvement against the 2012 OBC rather than the 2017 code. Because of the allowance in the 2017 code for projects permitted in 2017 to reference the 2012 OBC, a savings of 29.3% over the 2012 code meets the participation criterion.

Table 196. Enbridge Commercial Savings by Design participation criteria, project satisfaction, and explanation

Identified Criteria	Satisfied?	Explanation
Only projects from enrolled builders/developers count towards the metric	Yes	Following criteria meet definition for enrollment
Enrolment is defined as builder or developer committed to the CSBD offer for five years:	Yes	Terms and Conditions establishes that project must be completed within 5 years
Undertaking Enbridge approved IDP process for each development	Yes	IDP Report included in documentation
IDP includes energy model	Yes	IDP Report identifies eQuest v3.64 ⁹⁰
Sufficient energy savings achieved	Yes	See below
- IDP demonstrates how to achieve 15% energy savings over anticipated 2017 code	N/A	2017 code was not available at time of project
- IDP demonstrates how to achieve 15% above 2012 OBC	Yes	IPD report states savings of 29.3% over 2012 OBC.
Project must be at least 50,000 ft ²	Yes	Commitment Form identifies 252,458 ft ²
Project is a single building or multiples of same building which sum to at least 50,000 ft ²	Yes	Project consists of three towers with 252,458 ft ²

⁸⁹ <http://www.mah.gov.on.ca/Page15255.aspx> accessed on January 31, 2018

⁹⁰ ASHRAE 90.1-2010 section 11 as modified by Supplementary Standard SB-10 Division 3, Chapter 2 for generating reference and baseline models

As a result, the EC confirms that the submitted project meets the criteria for participation as a New Development for the Enbridge Commercial Savings by Design program.

Eligibility

Enbridge's Plan, approved by the OEB, further identifies eligibility criteria. As stated in Enbridge's Plan⁹¹:

The SBD Commercial offer is direct-to-builder/developer delivered by an internal sales team. Eligibility criteria include the following:

- *Commercial, multi-residential or industrial buildings covered under the Ontario Building Code Part 3;*
- *A minimum threshold of 50,000 square feet per project (including aggregate multi-location projects);*
- *Building(s) must be within Enbridge's franchise area, or for aggregate projects 75% of the project square footage must be in the franchise area;*
- *Building(s) must be in the design phase or earlier in the process;*
- *Building construction must be completed within five years of signing the agreement, and commissioning must be completed no more than one year after that; and,*
- *Builders will be eligible to participate in the offer multiple times for different projects*

These defined eligibility requirements overlap with the criteria Enbridge laid out for assessing enrolments. The EC used the Commitment Form and IDP Report to determine if the projects met these criteria.

Table 197 Enbridge Commercial Savings by Design eligibility criteria, project satisfaction, and explanation

Identified Criteria	Satisfied?	Explanation
Commercial, multi-residential or industrial buildings	Yes	IDP Report identifies project as "mixed-use condominium/commercial development"
50,000 ft ² minimum project size	Yes	Commitment Form identifies 252,458 ft ²
Within Enbridge territory	Yes	Application terms and conditions
Design phase or earlier	Yes	IDP performed to prior to construction, in design phase with development applications filed – construction expected to last to 2019.
Construction within 5 years	N/A	Eligibility for fuller program participation, not applicable for new enrollment.
Commissioning within 1 year of construction	N/A	

After reviewing these stated eligibility criteria and Project Files, the EC confirms the submitted project meets the eligibility criteria.

Verification Result

As a result of this review:

- The EC confirms proper documentation for the requested project
- Project files for the submitted project meet all requirements for a participant
- Project files for the submitted project meet further criteria for eligibility

⁹¹ Enbridge's Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 2, Schedule 1, 61 of 100



The EC confirms the scorecard metric of 43 projects for the Enbridge Commercial Savings by Design Program.



Commercial New Construction –Union

No savings or activities were reported for this program in 2016.

Residential New Construction – Residential Savings by Design – Enbridge

Overview

Table 198 shows the scorecard achievements for the 2016 Enbridge Residential Savings by Design (SBD) Program, with the metrics of enrolled builders and number of homes built. To limit confusion of discussing two separate measures within the same space, each metric will be discussed separately. Table 198 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Residential SBD program.

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values

Table 198. Enbridge Market Transformation scorecard achievement: Residential Savings by Design*

Program	Metric	Achievement			Ratio
		Reported	Tracked	Verified	
Residential Savings by Design	Builders	31	31	31	100.00%
	Homes Built	2,206	2,206	2,206	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 199 to verify the metrics for the Residential Savings by Design program.

Table 199. Documentation used to verify the Residential Savings by Design program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Project Files	Files documenting participation and eligibility for selected builder/project
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ⁹²

⁹² While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Enrolled Builders Metric

Participant Selection

Enbridge first provided the Tracking File listing Project Code (unique ID), Enrolment Year, IDP date, Signed Commitment (date), and a variable indicating whether the “Final IDP Report Received”. The spreadsheet identified 31 builders, all with 2016 IDP dates and ‘Yes’ populated for both the threshold and report received variables. As tracking data indicated that all the 31 listed builders were equally qualified, the EC randomly selected ‘SBDR-017’ from the full list for document review. The EC requested all supporting documentation, including documentation that supports eligibility and participation criteria.

Received Files

Enbridge provided three files to support project SBDR-017:

- “Project Application” - One image of project application form, dated May 17, 2016
- “IDP Report” - PDF scan of IDP Report, dated September 29, 2016
- “Terms and Conditions” - PDF scan of reverse side of project application, identifying terms and conditions of the project application

Verify Participation

To determine the definition of Enrolled Builders, the EC looked first to the OEB Decision, which identified approval of the Enbridge ESC Plan⁹³ stating: “The OEB approves Enbridge’s Residential Savings by Design program as proposed.” For further detail on criteria, the EC looked to Enbridge’s Plan which identified⁹⁴:

“For the purpose of assessing whether a builder is “enrolled” in SBD Residential:

i. The builder must have signed a Memorandum of Understanding (“MOU”) containing a commitment to participate in the Residential SBD program for a 3-year period

ii. The builder must have completed a program-approved Integrated Design Process (“IDP”), such as IEA Task 23 or the iiSBE developed IDP tool, including requisite energy modeling for homes the builder plans to construct in a new development. Homes to be completed in 2016 must demonstrate at least 25% total energy savings relative to the 2012 Ontario Building Code. Homes to be completed in 2017 and beyond must demonstrate total energy savings of at least 15% relative to the yet to be developed 2017 Ontario Building Code.

iii. Builders will be permitted to enroll in Enbridge’s Residential SBD offer more than once to avoid lost opportunities. In order to increase the scale of energy efficiency amongst participating builders, repeat builders will be offered progressively smaller incentives per home, but shall be permitted to collect these reduced incentives for a larger number of units.

iv. In order for a builder’s development to qualify as significant enough in size to participate in Enbridge’s SBD Residential offer, the development must include no less than 50 homes.”

The EC evaluated the sampled participant files against the criteria above and determined:

- Requirement i:

⁹³ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Page 34

⁹⁴ Enbridge’s Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 1, Schedule 4, Page 35-36 of 41

- Section 2c. of the Enbridge-provided Terms & Conditions includes the following: "...Applicant must successfully complete both components of the Program... by no later than three (3) years following the Application Date first noted above (the "Application Date")."
- This identifies an agreement to complete a project within three years, but does not indicate the commitment of a builder to participate in the Residential SBD program for three years.
- Requirement ii:
 - Section 2c. of the Enbridge-provided Terms & Conditions includes the following: "In order to apply for the Program and be eligible for financial incentives, the Applicant must successfully complete both components of the Program, including designing and constructing residential homes in the Enbridge franchise areas which exceed 25% of the 2012 OBC's energy performance .."
 - The submitted IDP Report identified 35% energy savings above 2012 OBC using the HOT2000 model.
- Requirement iii:
 - The EC does not find that this requirement is applicable to validating participation, only that it permits further participation.
- Requirement iv:
 - The Project Application identified the total development size of 400 homes, satisfying the requirement for no less than 50.

Verification Result

As a result, the EC confirms:

- Submitted builder meets most participation criteria
 - Submitted builder does not have MOU identifying agreement to participate "in the Residential SBD program for three years," only that projects would be completed before three years are over
 - While the EC does not find this significant enough to deny verification of the metric, this is an item for future clarification and/or correction
 - Submitted builder meets the participation criteria for IDP submission with sufficient savings
 - Submitted builder meets the participation criteria for project size

As a result, the EC confirms the scorecard metric of 31 Enrolled Builders.

Homes Built Metric

Participant Selection

Enbridge first provided the Tracking File listing Project Code and House ID (unique ID) for program homes. The spreadsheet identified 656 program rebated homes, separate from the 1,550 additional homes built to program requirements but not receiving program rebates. The EC randomly selected 'SBDRH-534' from the 656 program homes for document review. The EC requested all supporting documentation, including documentation that supports eligibility and participation criteria.

Received Files

Enbridge provided four files to support home SBDRH-534:

- "Summary" – PDF document outlining qualification documentation
- "ES Report" – PDF of ENERGY STAR for New Homes Report, BOP 12
- "HOT2000 screenshot" – JPG showing the Total Annual Fuel Consumption in megajoules (MJ) of the sampled house
- "Savings Summary" – Excel file which outlines the calculations that were made summarizing the HOT2000 calculation of energy savings and indicates the NRCan credits

In addition to these documents to support program homes, Enbridge also provided a confirmation letter to confirm additional non-rebated homes were built to the same IDP standard as program homes. The EC requested this letter by randomly selecting SBDR-074 from the list of non-program home projects.

- "Confirmation Letter" – Letter confirming participation of SBDR-074 in constructing 80 additional homes using the same procedures as the 50 constructed within the program.

Verify Participation

To determine the definition criteria for Homes Built, the EC first looked first to the OEB Decision, which identified approval of the Enbridge ESC Plan stating⁹⁵ "The OEB approves Enbridge's Residential Savings by Design program as proposed." For further detail on criteria, the EC looked to Enbridge's Plan which identified⁹⁶:

For the purpose of assessing the "homes built" metric for SBD Residential:

- A home must be completed by a participating builder who has completed the IDP process for the development.*
- A home which, as constructed, has features consistent with the builder's IDP and that make it 25% more efficient than a new home built to the 2012 Ontario Building Code if constructed in 2016, and 15% more efficient than a new home built to the yet to be completed 2017 Ontario Building Code.*
- Builders may apply the outcomes of the IDP to additional developments if the outcomes are applicable. The homes built in additional developments may be counted as homes built. However, the maximum number of homes for which a builder may receive incentives shall not increase.*

⁹⁵ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Page 34

⁹⁶ Enbridge's Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 1, Schedule 4, Page 36-37 of 41

iv. All homes constructed to the standard in a builder's development shall count towards the "homes built" metric even if rebates were not paid for all of them. Non-rebated units will be verified by a confirmation letter from the builder acknowledging that the homes were built to the IDP standard. Enbridge rebated units will be verified using the blower door test.

From this definition and submitted documentation, the EC determined participation for SBDRH-534:

- Requirement i:
 - The EC did not evaluate whether the home selected was completed by a participating builder who had completed the IDP process for this development. Evaluation of the builder was done through random selection in verifying the Enrolled Builder metric (Section Residential New Construction – Residential Savings by Design – Enbridge). The EC assumed that portion of the requirements was met because the previous section confirmed builder participation.
- Requirement ii:
 - The Savings Summary worksheet, referencing the same values as the HOT2000 screenshot, demonstrated modelled As-built Energy Consumption (MJ) of 87,023 against modelled OBC SB-12 Package M Energy Consumption (MJ) of 107,365. The savings summary includes this savings with the 6,663.3 NRCan Credits, for an energy improvement of 27,005.6, or 25.15%. The EC finds that this satisfies criteria for energy savings of the 25% over 2012 Ontario Building Code requirements.
- Requirement iii:
 - The EC does not find that this requirement is applicable to validating participation, only that it permits further participation.
- Requirement iv:
 - The Confirmation Letter confirms that the randomly selected development, SBDR-074, included 80 non-rebated units in one development as indicated in Tracking Data. The EC finds that this satisfies the requirement for non-rebated units.

As a result, the EC finds that the randomly selected home, SBDRH-534, meets the efficiency qualification and that SBDR-074 meets the confirmation requirement for additional homes.

Verification Result

As a result, the EC confirms:

- The EC previously verified the Enrolled Builder Criteria
- Submitted documentation for SBDRH-534 demonstrates the home meets savings criteria
- Submitted letter for SBDR-074 confirms eligibility for additional non-rebated homes

As a result, the EC confirms 656 rebated program homes and 1,550 non-rebated homes, and thus the scorecard metric of 2,206 Homes Built.

Residential New Construction – Optimum Home Program – Union

Table 200 shows the reported, tracked, and verified scorecard achievements for the 2016 Union Gas Market Transformation Optimum Home Program, with the metric of “Percentage of Homes Built (>20% above OBC 2012) by Participating Builders”. Table 200 contains the following variables:

- Reported: Metric value reported in Union’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values

Table 200. Union Market Transformation Scorecard Achievement: Optimum Home homes built percentage metric*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Optimum Home % of Homes	70.09%	70.09%	70.09%	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 201 to verify the metrics for the Optimum Home program.

Table 201. Documentation used to verify the Optimum Home program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
2016 Optimum Homes	Excel spreadsheet listing all participating homes
Project Files	Various documents for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union’s 2015-2020 DSM Plan, EB-2015-0029
Union’s Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ⁹⁷

Participant Selection

Union Gas first provided the Tracking File listing anonymized builders with the number of total homes each constructed in 2016, number of program homes, and participating homes percentage calculated. This file demonstrated the claimed metric achievement, identifying 1,638 of 2,337 total homes built by 22 builders, as demonstrated in Table 202.

⁹⁷ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Table 202. Optimum Home claimed total and program homes built, by builder*

Builder	Total Homes Built	Optimum Homes Built	% of Homes Built
Builder A	192	90	47%
Builder B	44	3	7%
Builder C	49	49	100%
Builder D	1,009	1,009	100%
Builder E	162	162	100%
Builder F	49	49	100%
Builder G	32	21	66%
Builder H	42	32	76%
Builder I	36	-	0%
Builder J	87	87	100%
Builder K	56	56	100%
Builder L	-	-	NA
Builder M	48	-	0%
Builder N	2	-	0%
Builder O	-	-	NA
Builder P	62	50	81%
Builder Q	48	-	0%
Builder R	54	-	0%
Builder S	48	29	60%
Builder T	75	-	0%
Builder U	190	1	1%
Builder V	52	-	0%
Total	2,337	1,638	70.09%

*Not all values may compute exactly due to rounding.

In addition, Union Gas provided the 2016 Optimum Homes file with individual anonymized listings for the 1,638 program homes, identifying builder (anonymized), city, file number, and compliance path (ESNH Prescriptive, ESNH Performance, ERS, 20%> OEB). From these, the EC randomly selected one Builder and one program home for review and verification.

Union Gas provided documentation to support verification of the selected builder and program home in ten files:

- "Lot 314 Air Tightness Report" – PDF
- "Lot 314 Air Tightness Graph" – PDF
- "Lot 314 Energy Star Documentation" – PDF
- "Lot 314 Energy Star Compliance Report" – PDF
- "Lot 314 Air Tightness" – BLD
- "Lot 248 Energy Star Documentation" – PDF
- "Energy Star New Home Compliance Procedures" – PDF

- “Builder M Agreement” - PDF
- “Builder M Agreement Details” – PDF
- “Builder M Tracking” – Excel spreadsheet

The EC confirmed that the requested builder and site were documented in both the Program Files and in the Tracking File and 2016 Optimum Homes spreadsheets.

Metric Verification

To determine the definition of participating homes, the EC looked first to the OEB Decision, which stated that *“The OEB approves Union’s Optimum Home program as proposed in 2016⁹⁸. ”*

For criteria of participating homes, Union’s Plan⁹⁹ tabulates four “compliance paths” which may be used to demonstrate a home’s energy savings. This table includes both a listing of the four ‘Compliance Paths’, as well as activities to qualify. Compliance paths included:

- ENERGY STAR (Prescriptive)
- ENERGY STAR (Performance)
- EnerGuide Rating System (ERS) 83
- 20% > OBC 2012

The EC requested documentation for verification of site “D1356,” randomly selected from the 2016 Optimum Homes spreadsheet. This spreadsheet indicated that this site complied through the ESNH Prescriptive path. The compliance path qualification activity indicated that this path required three activities for qualification:

- On-site inspection
- Blower door test
- Energy Star for New Homes (ESNH) Version 12 Building Options Package (BOP), no modelling required

Files provided by Union Gas confirmed that the site contained documentation to support all three criteria required by the Prescriptive compliance path. The “Lot 248 Energy Star Documentation” supported both the on-site inspection and ESNH V12 BOP activities. This ENERGY STAR report demonstrates both the site score (credits) meet the threshold requirement as well as inspection date. Remaining documentation verified the blower door test. Those documents identified that this particular site was part of a batch sampling group and supported the batch group and the blower door test of another site within the group.

As a result, the EC confirms that the submitted project meets the criteria for participation for the Union Gas Optimum Homes program.

Verify Eligibility

The scorecard cites “Participating Builders” within the Optimum Home metric. To fully verify the metric, the EC examined Union’s Plan for definition of this portion of the metric:

⁹⁸ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Page 35

⁹⁹ Union’s Proposed 2015-2020 DSM Plan, 2015EB-2015-0029, Exhibit A, Tab 3, Appendix C, Page 28 of 77.

“The Market Transformation Metric measures the percentage of homes built to Optimum Home standards in relation to the total number of homes built in a program year by actual participating builders who remain enrolled in the program.”¹⁰⁰”

Union’s Plan¹⁰¹ identifies participating builders as those who “were enrolled throughout the[sic] 2012-2014”. The plan states that the program will not work to enrol new builders but will focus on existing builders, i.e. those enrolled in the first phase of the program. The EC confirmed that the provided document, “Builder M Agreement”, documented that the builder had participated prior to the current program year, enrolling in 2013.

Based on this, the EC confirmed that documentation was sufficient to verify participation of builders who remain enrolled in the program.

Verification Result

As a result of this review:

- The EC confirms proper documentation for the requested site and builder
- Project files for the randomly selected site meet energy savings compliance path activities
- Project files for randomly the selected builder demonstrate eligibility

The EC confirms documentation for the 2016 Optimum Home Program, with 1,638 Optimum Homes claimed out of 2,337 total participating builder homes for a metric result of 70.09%.

¹⁰⁰ Union’s Proposed 2015-2020 DSM Plan, 2015EB-2015-0029, Exhibit A, Tab 3, Page 30 of 73

¹⁰¹ Union’s Proposed 2015-2020 DSM Plan, 2015EB-2015-0029, Exhibit A, Tab 3, Appendix C, Pages 24 of 77

School Energy Competition – Enbridge

Table 203 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Market Transformation Program, with the metric of Participating Schools. As a result of this review, the EC verifies the 2016 achievement metric of 25 Participating Schools (100% ratio). Table 203 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 203. Enbridge market transformation & energy management scorecard achievement: School Energy Competition Schools metric*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
School Energy Competition Participating Schools	25	25	25	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 204 to verify the metrics for the School Energy Competition program.

Table 204. Documentation used to verify the School Energy Competition program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	Various documents for each requested participant, supporting program metrics
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ¹⁰²

Participant Selection

Enbridge first provided the Tracking File listing the Enbridge Account (number) and Project Code (unique ID). The spreadsheet identified twenty-five participants. The EC requested full documentation for all participants.

¹⁰² While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Received Files

The EC received eleven individual files:

- Six PDF scans of school application “hardcopies”
- Two JPG images of school application “hardcopies”
- One PDF of email confirming program registration of one participant which was “manually enrolled”
- One “Online Registrations” spreadsheet listing schools registered “online” without hardcopy, listing program ID, a timestamp variable, and estimated student population.
- One “ESC Activity Tracker” spreadsheet marking participation of all schools in various program elements and offerings

The EC first confirmed the titles received matched the IDs requested. Project Files were redacted with name, address, and other all other location, school, or site specific information unavailable. The EC confirmed that documents were received that included all participants.

Verify Participation

To determine the definition of Participating Schools, the EC looked first to the OEB Decision which identified approval of the Enbridge Plan¹⁰³:

Decision

The OEB approves Enbridge’s School Energy Competition program. The OEB finds this program provides both educational and energy conservation benefits. Further, this program is designed to engage a wide group of participants through a competition, which is innovative. The OEB also finds the involvement of students, potential future customers, to be consistent with the intent of the DSM Framework.

For specific definition, the EC then looked to Enbridge’s Plan which identifies¹⁰⁴:

“For the purpose of measuring the success of the Company’s School Energy Competition, a school will be considered “enrolled” at the time that energy monitoring begins using the Energy Management Information System (“EMIS”) provided via the offer. At a high level, monitoring is the third of the four steps which comprise the School Energy Competition.”

Further, Enbridge’s Plan identifies “Key Offer Evaluation Metrics¹⁰⁵”:

“A participant is a school that registers, implements, and has access to an EMIS system to log competition activities”

From this, the EC has identified that a “Participating School” is defined as a school that has:

- Registered and ‘logged in’ to the EMIS system.

School applications hardcopy images (PDF and JPG) do not provide evidence of having registered with or logged into any information system, including the EMIS system. The Online Registration spreadsheet identifies a list of program IDs and a “timestamp” for each. Neither registration provides evidence that the any of the 25 IDs have logged into the EMIS system.

The ESC Activity Tracker is a program tracking spreadsheet, identifying program elements completed by each school. For each ID, the spreadsheet identifies activities which that ID participated in, summarized in Table 205.

¹⁰³ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Page 43

¹⁰⁴ Enbridge’s Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 1, Schedule 4, 34 of 41

¹⁰⁵ Enbridge’s Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 2, Schedule 2, Page 48 of 55

Table 205. Enbridge ESC activities and participant counts*

Program Element	# of Schools Participating
Accessed Website	25
Signed Up For Challenge	25
Create EcoTeam	8
Conduct School Energy Audit	4
Develop Energy Savings Action Plan	4
Create Communications Strategy	3
Conduct Ongoing Energy Performance Walkthroughs	1
Conduct Home Energy Audit	3
Earth Day Activities	7
Art Project	4
Ugly Sweater Day	1
Offsite Energy Efficiency Day	1
School Energy Savings	25
Webinar	4
Social Media	6
Earth Hour - BONUS	3

*Not all values may compute exactly due to rounding.

The spreadsheet confirms that each of the 25 IDs have “accessed website”, “signed up for challenge”, and did “School Energy Savings” but does not provide a more complete description of these labels or evidence that the schools specifically registered for or logged into the EMIS system. The EC requested confirmation that ESC Activities as tracked in the spreadsheet represent EMIS registration – Enbridge staff responded with confirmation¹⁰⁶:

“In order to provide the schools with their EMIS data, a website was created that contained a link to a dashboard, which showed each school their EMIS data. Enbridge was then able to track that all participating schools accessed the website.”

Verify Eligibility

The EC first looked to the OEB Decision to determine specific criteria for participant eligibility, then to Enbridge’s Plan which identifies¹⁰⁷:

“Participating schools must be part of a board within one of the publicly funded systems (English/French/Public/Catholic) in Ontario within the Enbridge franchise area.”

School applications hardcopy images (PDF and JPG) all identify student populations and school title (“Teacher”, “Science Teacher”, “Principal”) for eight records. The PDF email and Online Registration spreadsheet do not provide any information confirming that each record is a school. Further, none of the Project Files provided confirm that any of the IDs are within one of the publicly funded systems nor do they provide any information that would allow the EC to independently confirm school status through public

¹⁰⁶ Enbridge Employee “RE: Follow up request - LI New Construction and MT School Energy Competition” Message to DNV GL Employee, 2/1/2018, Email

¹⁰⁷ Enbridge’s Proposed 2015-2020 DSM Plan, EB-2015-0049, Exhibit B, Tab 2, Schedule 2, Page 47 of 55



records. The EC requested confirmation that claimed participants were publicly funded schools, Enbridge staff confirmed all schools belonged to public school boards¹⁰⁸.

Verification Result

As a result of this review, the EC confirms:

- Participants meet the participation criteria
- Any participants meet the eligibility requirements

As a result, the EC confirms the scorecard metric of 25 Schools.

¹⁰⁸ Enbridge Employee "RE: Follow up request - LI New Construction and MT School Energy Competition" Message to DNV GL Employee, 2/1/2018, Email

Appendix I Performance Based (Union) and Market Transformation (Enbridge) Scorecards

This appendix describes the detailed process used to verify the metrics for the Performance-Based Scorecard programs for Union Gas (Table 207) and the similar programs for Enbridge that are contained under the Market Transformation Scorecard (Table 206). As noted in the OEB Decision and Order, the programs listed below are similar and thus included together. The programs addressed in this appendix are:

- Commercial & Industrial Operational Efficiency Improvement – Run it Right – Enbridge
- Commercial & Industrial Operational Efficiency Improvement – RunSmart – Union
- Commercial & Industrial Energy Management – Comprehensive Energy Management – Enbridge
- Commercial & Industrial Energy Management – Strategic Energy Management – Union

Table 206. Enbridge 2016 market transformation & energy management scorecard*†

Programs	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric	Lower Band	Target	Upper Band	
Residential Savings by Design	Builders	31	31	25	33	50	10%
	Homes Built	2,206	2206	2,063	2,751	4,127	15%
Commercial Savings by Design	New Developments	43	43	25	33	50	25%
School Energy Competition	Participating Schools	25	25	41	55	83	10%
Run it Right	Participants	84	84	62	83	124	20%
Comprehensive Energy Management (CEM)	Participants	7	7	5	7	10	20%

*Not all values may compute exactly due to rounding.

†Programs in grey text are not similar to Union programs under the Performance Based Scorecard, and not discussed in this Appendix. For these programs please refer to Appendix F: Market Transformation Scorecard

Table 207. Union Gas 2016 performance-based scorecard*

Programs	Metrics	Verified Achievement		Metric Target			Weight
		Program	Scorecard Metric Total	Lower Band	Target	Upper Band	
RunSmart	Participants	32	32	21	28	41	50%
Strategic Energy Management (SEM)	Participants	3	3	2	3	5	50%

*Not all values may compute exactly due to rounding.

Commercial & Industrial Operational Efficiency Improvement – Run it Right – Enbridge

Table 208 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Run it Right (RIR) Program, with the metric of Participants. The RIR Program has two metrics under separate scorecards, CCM Savings (Resource Acquisition) and Participants (Performance Based). Participants are discussed here, while the CCM Savings metric is discussed in Appendix E. As a result of this review, the EC verifies the 2016 achievement metric of 84 participants (95% ratio). Table 208 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 208. Enbridge market transformation & energy management scorecard achievement: Run it Right*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Run it Right Participants	88	84	84	95.45%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 209 to verify the metrics for the Run it Right program.

Table 209. Documentation used to verify the Run it Right program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Project Files	PDF scans of program participant documentation
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ¹⁰⁹

Participant Selection

Enbridge first provided the Tracking File listing RIR Project Codes, Account Numbers, and Confirmation Date. The spreadsheet listed 88 individual projects located at 84 Enbridge accounts (one account having 5 projects listed). The EC requested full documentation for ten randomly selected projects.

¹⁰⁹ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Received Files

The EC received three PDF documents for each project:

- One program application,
- One Investigation report, and
- One implementation time record.

The EC first confirmed the document IDs received matched the IDs requested. The EC confirmed that the “Opportunity Code” listed in the Project Files matched Account Numbers listed in the Tracking File, and that documents for all participants had been received. Project Files were with name, address, and other information unavailable.

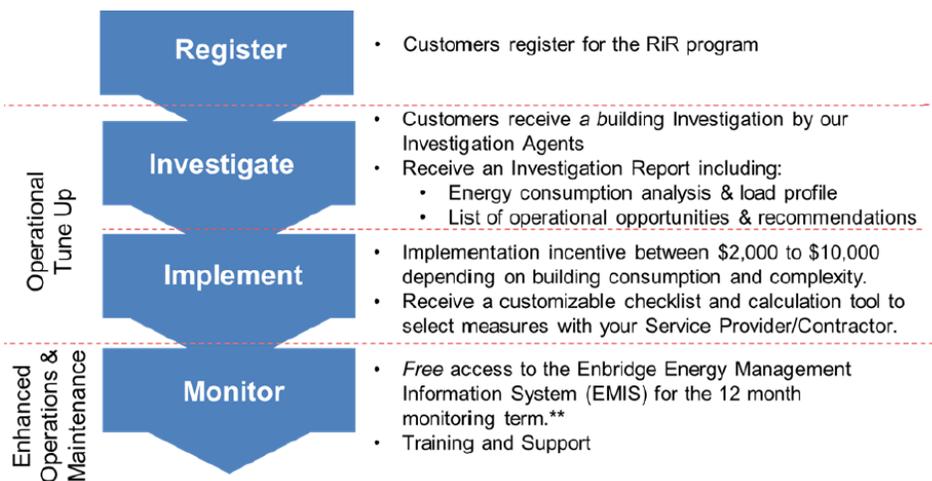
Verify Participation

Enbridge’s Plan states¹¹⁰ that:

Customers shall be deemed a “participant” in Enbridge’s RiR offer for the purpose of the MTEM scorecard once they have entered the monitoring stage of the offer, which is the fourth of four steps inherent to this offer.

Enbridge’s plan further documents the four steps inherent to the offer to be: Register, Investigate, Implement, and Monitor (Figure 5). Combining the definition on p. 34 of 41 with the figure, the EC interprets “participation” to require evidence of completing all four steps, including site energy use or savings monitoring that would be produced by the fourth step.

Figure 5. Image of RiR Process Elements from Enbridge Plan¹¹¹



Enbridge provided redacted program applications for all ten randomly selected sites, satisfying intentional enrollment – the “register” step identified in Figure 5. In addition, Enbridge provided investigation reports. Investigation reports provided estimated savings (analysis) for a site, as well as estimated savings by recommended measure. The document also contains a signature below language that certifies installation of

¹¹⁰ Enbridge Gas Program Plan: DSM Plan Overview and Guiding Principles, EB-2015-0049, Tab 1, Schedule 4, Page 34 of 41

¹¹¹ Enbridge Gas Program Plan: DSM Plan Overview and Guiding Principles, EB-2015-0049, Tab 2, Schedule 1, Page 87 of 100



the operational measures. This document satisfies the second and third steps identified in Figure 5 for all projects submitted.

Implementation time record documents documented the execution of recommended work from the investigation reports, satisfying the third step as defined. Subsequent communication with Enbridge representatives verified that with equipment installation or process installation, sites are automatically enrolled for monitoring thereby satisfying the fourth requirement for all sampled sites.

Verification Result

As a result of this review, the EC verifies all sampled records, and verifies all 84 participants (95% of reported, 100% of tracked).

Commercial & Industrial Operational Efficiency Improvement – RunSmart – Union

Table 210 shows the scorecard achievement for the 2016 Union RunSmart program, with the metric of Participants. As a result of this review, the EC certifies the 2016 achievement metric of 32 participants (100% ratio). Table 210 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 210. Union Gas 2016 performance-based scorecard achievement: RunSmart Program participants*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
RunSmart Participants	32	32	32	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 211 to verify the metrics for the RunSmart program.

Table 211. Documentation used to verify the RunSmart program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	PDF scans of program participant documentation
Activity Report	Excel spreadsheet documenting customer class and DSM activity from January 2014 through December 2016
Consumption Report	Excel spreadsheet documenting 2016 participant gas consumption
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union’s 2015-2020 DSM Plan, EB-2015-0029
Union’s Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ¹¹²

Participant Selection

Union Gas first provided the Tracking File listing RunSmart participants with anonymized Program, Customer, and Site IDs, listing 32 individual participants. DNV GL randomly selected ten participants, requesting full documentation by Participant ID.

¹¹² While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Received Files

The EC received ten PDF documents and ten excel documents, each titled by Participant ID. The EC first confirmed the Participant IDs matched those requested. All files were properly redacted with name, address, and other information unavailable, as requested. The EC confirmed that the Account Numbers, Customer IDs, and Site IDs matched across all documentation.

Verify Participation

Union's Plan defines RunSmart participants¹¹³ as the "number of customers that enter into an agreement with Union and participate in a site walk-through within a program year". The EC confirmed documentation supported participation of all ten randomly-selected participants by verifying the Project Files contained for each site:

- A technical expert (consultant) documented walk-through of the company facility
- A completed and signed walk-through checklist submitted for qualification
- All documents had required signatures of the customer, technical expert (consultant), and Union account manager

The EC confirmed documentation supports participation of all ten randomly-selected participants.

Verify Eligibility

Union's Plan defined the participant metric from the "number of customers without prior DSM participation history, consuming greater than 50,000 m³ per year of natural gas." Union's 2016 Annual Report further clarified customer type as targeted to mid-sized commercial customers¹¹⁴ with an annual consumption in excess of 50,000 m³, and that "without prior DSM participation" are participants who have never participated or not participated in the last two years.

Provided Activity Reports and Consumption Reports documented for each participant:

- Customer type
- Prior participation
- 2016 annual consumption

The EC confirmed customer types for all ten participants matched the descriptions provided in Union's Plan and draft 2016 Report, with no documented DSM participation from January 2014 through December 2016. Annual Consumption Reports documented 2016 annual consumption for nine of ten participants over the targeted 50,000 m³, with one participant's annual consumption below that level.

Further documentation provided by Union was provided to establish eligibility of the participant found to have sub-eligible consumption levels. Union submitted consumption records for the 12 months immediately preceding screening, from March 2015-February 2016, with 54,287 m³ consumed. This is in contrast to the original consumption record from January-December 2016 with consumption of 43,708 m³. The higher level explicitly satisfies the consumption level requirement.

¹¹³ Description of RunSmart Participants from Overview of Union's Proposed 2015-2020 DSM Plan, 2015EB-2015-0029, Exhibit A, Tab 3, Page 33 of 73

¹¹⁴ Mid-size commercial customer examples of offices, multi-family buildings, schools, and hospitals are provided. Union Gas 2016 Demand Side Management Draft Annual Report, November 16, 2017, page 88



The EC confirmed the eligibility of ten of ten randomly-selected participants.

Verification Result

As a result of this review, the EC confirms that:

- Participant records were correctly sent to the EC for all randomly selected participants
- All participants met the participation definition
- All randomly selected participants met the eligibility definition

The EC confirms nine of ten participants meet all requirements, and certifies the 2016 achievement metric at 100% of 32 participants.

Commercial & Industrial Energy Management – Comprehensive Energy Management – Enbridge

Overview

Table 212 shows the reported, tracked, and verified scorecard achievements for the 2016 Enbridge Comprehensive Energy Management (CEM) program, with the metric of Participants. As a result of this review, the EC certifies the 2016 achievement metric of seven participants (100% ratio). Table 212 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values

Table 212. Enbridge market transformation & energy management scorecard achievement: CEM participants metric*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Comprehensive Energy Management Participants	7	7	7	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 213 to verify the metrics for the Home Energy Conservation (HEC) program.

Table 213. Documentation used to verify the Comprehensive Energy Management program

Report Language	Description or Citation
Enbridge-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Enbridge DSM programs
Project Files	Two PDF documents
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Enbridge Plan	Enbridge Gas Multi-Year DSM Plan (2015-2020), EB-2015-0049
Enbridge’s Draft 2016 Report	Enbridge 2016 Demand Side Management Draft Annual Report ¹¹⁵

¹¹⁵ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Participant Selection

Enbridge provided the Tracking File listing CEM Project Codes, Account Numbers, and Energy Model date. The spreadsheet listed seven individual participants. The EC requested full documentation for all participants.

Received Files

The EC received seven PDF documents, titled by CEM Project number. The EC first confirmed the titles received matched the IDs requested. Project Files were properly redacted with name, address, and other information unavailable, as requested. The EC confirmed that the "Opportunity Code" listed in the Project Files matched Account Numbers listed in the Tracking File, and that documents for all participants had been received.

Verify Participation

Clear and specific criteria for participation in the CEM program were not readily available, rather that the CEM program is intended to be a multi-year, 'holistic' process with ongoing and multi-year engagement resulting in energy savings. As a result, the EC understands evidence of initial engagement and a specific agreement to participate sufficient to verify participants for the purposes of the Market Transformation Scorecard metric of 'participants'.

The provided Project Files demonstrated that each participant applied for participation in the CEM program, signed by an applicant representative and Enbridge Manager. In addition, the applications include declarations that the applicant:

- Acknowledges and confirms that they will commit resources to participate and identify energy efficiency opportunities
- Will create internal energy awareness
- Share energy data with Enbridge
- Allow continued communication with Enbridge

The EC confirmed documentation supports participation of all seven participants.

Eligibility

The EC also used the Project File to confirm eligibility of each participant^{116,117}, namely to verify that customers met annual gas consumption between 340,000 m³ and 5,000,000 m³. Project Files identified previous year gas consumption for the seven customers:

- One customer with less than 340,000 m³
- Four customers with consumption between 340,000 m³ and 5,000,000 m³
- Two customers with consumption greater than 5,000,000 m³.

The EC immediately confirmed documentation supported eligibility for four of seven participants. Upon further review with the EAC it was determined that inclusion of the three additional participants was

¹¹⁶ Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, page 47

¹¹⁷ Enbridge Gas Program Plan: DSM Plan Overview and Guiding Principles, EB-2015-0049, Exhibit B, Tab 2, Schedule 1, Page 53 of 100



permissible. Because of internal inconsistencies within the Enbridge plan, this decision was difficult, but the EC verifies the 2016 achievement metric of seven participants because of the following reasons.

- Two of the three participants that were initially disallowed fall close to the annual gas consumption target market guidelines suggested in Exhibit B, Tab 2, Schedule 1, Page 53 of 100. Those guidelines were 340,000 to 5,000,000 m³. One participant fell just short at approximately 330,000 m³; the other was slightly over at 5.4 million m³. Both are reasonably close to the expectations set by the plan as approved by the Board.
- The third participant is significantly outside of the range at more than 14 million m³. However, language in other parts of the plan make it clear that the target is large and complex commercial and industrial customers; therefore, DNV GL feels that participants with consumption larger than the stated guideline are reasonably close to the expectations set by the plan, while participants with consumption significantly lower would not be. Since the third participant is significantly larger, the EC verifies the eligibility of this participant.

Verification Result

As a result of this review, the EC confirms that:

- Participant records were correctly sent to the EC for the census of 2016 participants
- Documentation confirmed all participants met the participation definition
- Documentation confirmed four of seven participants met the eligibility definition
- Further review by EAC permitted the remaining three participants

The EC confirms the scorecard metric of 7 participants for the Enbridge Comprehensive Energy Management Program.

Commercial & Industrial Energy Management – Strategic Energy Management - Union

Table 214 the reported, tracked, and verified scorecard achievements 2016 Union Strategic Energy Management (SEM) program, with the metric of Participants. As a result of this review, the EC certifies the 2016 achievement metric of 3 participants (100%). Table 214 contains the following variables:

- Reported: Metric value reported in Enbridge’s draft 2016 report. The EC used this value as a cross check to validate tracking data; it is included for transparency.
- Tracked: Metric value identified in Tracking File
- Verified: Metric value verified from review of Tracking File, Project Files, and other relevant documents identified above.
- Ratio: Ratio of verified to tracked savings. A value of 100% indicates that verified values match tracked values.

Table 214. Union Gas 2016 performance-based scorecard achievement: SEM program*

Metric	Achievement			Ratio
	Reported	Tracked	Verified	
Strategic Energy Management Participants	3	3	3	100.00%

*Not all values may compute exactly due to rounding.

Documentation

The EC used the documentation shown in Table 215 to verify the metrics for the Strategic Energy Management program.

Table 215. Documentation used to verify the Strategic Energy Management program

Report Language	Description or Citation
Union-Provided Documentation	
Tracking File	Excel spreadsheet tracking metrics for all 2016 Union DSM programs
Project Files	PDF scans of program participant documentation
Activity Report	Excel spreadsheet documenting customer class and DSM activity from January 2013 through December 2016
Consumption Report	Excel spreadsheet documenting 2016 participant gas consumption
Documents Used by EC	
OEB Decision	OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016 and OEB Revised Decision and Order, EB-2015-0029/EB-2015-0049, February 24, 2016
Union Plan	Union’s 2015-2020 DSM Plan, EB-2015-0029
Union’s Draft 2016 Report	Union Gas 2016 Demand Side Management Draft Annual Report ¹¹⁸

Participant Selection

Union first provided the Tracking File listing SEM Participant IDs, Customer IDs, and Site IDs. The spreadsheet listed three individual participants. The EC requested full documentation for all participants.

¹¹⁸ While the EC recognizes and understands that the draft report will be updated and finalized, the final was not available at the time of this evaluation, thus the draft is cited for reference.

Received Files

The EC received three PDF documents and three Excel documents, titled by SEM customer ID. The EC first confirmed the titles received matched the IDs requested. Project Files were properly redacted with name, address, and other information unavailable, as requested. The EC confirmed that documents for all participants had been received.

Verify Participation

Specific criteria for the Participant metric in the Union SEM program were not readily available. Reviewed documentation provide explanation that the SEM program is intended to be one of ongoing and multi-year engagement resulting in energy savings. As a result, the EC understands evidence of initial engagement and specific agreement to participate are sufficient to identify participants for the purposes of the Performance-Based Scorecard metric of 'participants'.

Project Files provided to the EC were scans of "Strategic Energy Management Program Memorandum of Understanding" for each of the three participants. Each memorandum contained:

- Partially redacted customer information to protect customer confidentiality
- Agreement of understanding of SEM plan for customer facility
- Description of each company's primary product
- Articles describing program:
 - I. MOU Purpose
 - II. SEM program term, eligibility, guarantee, and other details
 - III. System Incentives
 - IV. Financial Incentives
 - V. Terms, Termination, Amendments and Agreement
- Signatures of both parties

The EC confirms that the MOUs are sufficient documentation of participation of all three participants.

Verify Eligibility

Union's Plan identifies two criteria for participant eligibility¹¹⁹, namely that participants are "industrial manufacturing customers, consuming greater than 1,000,000 m³ per year of natural gas." In addition, program staff provided additional guidance that SEM participants must not have participated in Union's Integrated Energy Management System in the previous three years. Provided Project Files and Consumption Reports together documented

- Facility descriptions match those of industrial manufacturing customers
- Both parties agree and affirm natural gas consumption of more than 1,000,000 m³ per year throughout program participation
- Facility 2016 natural gas consumption of more than 1,000,000 m³

¹¹⁹ Description of SEM Participants from Overview of Union's Proposed 2015-2020 DSM Plan, 2015EB-2015-0029, Exhibit A, Tab 3, Page 34 of 73

- 
- Participation in Union DSM programs over the previous three years did not include Integrated Energy Management System Projects

The EC confirmed the eligibility of all participants.

Verification Result

As a result of this review, the EC confirms that:

- Participant records were correctly sent to the EC as Project Documentation for all participants
- Documentation confirmed all participants met the participation definition
- Documentation confirmed all participants met the eligibility definition

The EC confirmed all participants meet all requirements, and certifies the 2016 achievement metric of three participants.

Appendix J Review of lost revenue and DSM shareholder incentive calculations

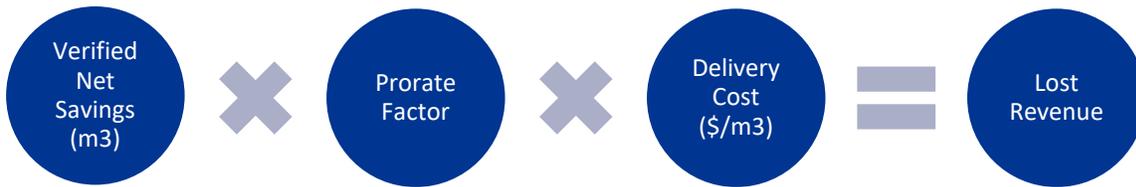
This appendix describes the EC team's review of the lost revenue and demand side management shareholder incentive calculations.

Lost revenue calculations

Figure 6 illustrates the basic approach to the lost revenue calculation. It is based on the following factors:

- The verified net natural gas savings (in annual cubic meters) by applicable rate class using the best available information at the time of the verification
- The delivery cost of the natural gas by rate class
- The month in which the measure was installed, represented in the equation below as a prorata factor

Figure 6. Lost revenue calculation



Lost revenues are summed across all measures in a rate class. Then the lost revenues for all applicable rate classes are summed to calculate total lost revenues per utility.

The applicable rate classes for Enbridge and Union are shown in Table 216.

Table 216. Rate classes for lost revenue calculation

Enbridge	Union
Rate 110	M4 Industrial
Rate 115	M5 Industrial
Rate 135	M7 Industrial
Rate 145	T1 Industrial
Rate 170	T2 Industrial
	20 Industrial
	100 Industrial

The methods to compute each of the components shown in Figure 6 are described in the following sections.

Lost revenue: Verified Net Savings

The lost revenue calculation first utilizes verified net savings, calculated using best available inputs and assumptions at the time of the verification. For prescriptive program savings, this is currently the December 2016 update to the TRM. This differs from the savings used for the DSM shareholder incentive calculation, which uses the energy savings at the time of program planning.

Lost revenue: Prorate Factor Calculation

The prorate factor is simply the proportion of the annual net savings that will be included in the lost revenue calculation, based on the number of months the gas-saving measure was installed. Table 217 shows the prorate factors for each installation month. Prorated savings are calculated by multiplying the measure's annual savings by the ratio for the month it was installed.

Table 217. Lost revenue installation month savings ratio*

Month	Ratio (12-Month+1)/12
January	1.0000
February	0.9167
March	0.8333
April	0.7500
May	0.6667
June	0.5833
July	0.5000
August	0.4167
September	0.3333
October	0.2500
November	0.1667
December	0.0833

For example, the calculation assigns 12 months of savings to measures installed in January and one month of savings to measures installed in December.

*Not all values may compute exactly due to rounding.

Lost revenue: Delivery Cost Calculation

Delivery rates are expressed as cost per 1000 cubic meters. Prorated energy savings are divided by 1000 to convert savings in cubic meters to savings in thousands of cubic meters, which are then multiplied by the delivery rate for the respective rate class to determine lost revenue by rate class. The delivery rate is not verified as part of this evaluation.

Lost revenue: Summing lost revenue Savings

Lost revenue for each rate class is calculated by summing the lost revenue for all measures within the rate class. Total lost revenue for each utility is calculated by summing the lost revenue across all applicable rate classes:

$$Total\ Lost\ Revenue = \sum_{Rate\ Class}^{Utility} \sum_{Measure}^{Rate\ Class} Lost\ Revenue$$

DSM shareholder incentive calculations

The DSM shareholder incentive calculations are more complex than the lost revenue calculations. DSM shareholder incentive calculations are based on:

- The verified program achievements compared to the target metrics for that scorecard

- The weight placed on each metric within each scorecard
- The maximum incentive achievable for that scorecard

Because all three of these factors vary by utility and scorecard, a simple diagram is not possible. DNV GL independently calculated DSM shareholder incentive values for both utilities. The following sections lay out the calculation methodology, as well as inputs used for each utility.

The EC confirmed the lower band, upper band, target metric, weights, maximum incentives, rate classes, and rates for both utilities with the EAC.

DSM shareholder incentive: verification savings values

Where lost revenue verified net savings uses energy savings values that represent the best available information at the time of the verification, DSM shareholder incentive verified savings are calculated using the savings values leveraged during the program planning process.

DSM shareholder incentive: metric score

DSM shareholder incentive calculations are based on the verified metric achievement identified within each scorecard compared to the target value. For each metric, DNV GL first determines the percent of metric achieved.

$$\% \text{ Metric Achieved} = \frac{\text{achieved metric}}{\text{target metric}}$$

If the achieved metric is less than or equal to the 2016 Target, the Metric Score is then calculated as:

$$\text{Metric Score} = 1 - \frac{0.25 * (\text{target metric} - \text{achieved metric})}{(\text{target metric} - \text{lower band})}$$

If the achieved metric is greater than the 2016 Target, the Metric Score is then calculated as:

$$\text{Metric Score} = 1 + \frac{0.5 * (\text{achieved metric} - \text{target metric})}{(\text{upper band} - \text{target metric})}$$

DSM shareholder incentive: weighted metric score

The weighted metric score is determined by multiplying the metric score by its corresponding weight. Each metric within the scorecard is weighted, with all weights within each scorecard summing to 100%. Per the OEB Decision and Order, the OEB approved maximum and minimum achievement limits per metric of 200% and 0%, respectively¹²⁰. As a result, all Metric Scores are capped at 200%, thereby limiting the influence of any one metric within the weighted scorecard achievement calculation to twice its weight.

DSM shareholder incentive: weighted scorecard achievement

The weighted metrics within each scorecard are summed to calculate the weighted scorecard achievement:

¹²⁰ OEB Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, page 80

$$\text{weighted scorecard achievement} = \sum_{\text{Scorecard}} (\text{weight} * \text{Metric Score})$$

DSM shareholder incentive: incentive calculation

The weighted scorecard achievement (WSA) is then used to calculate the Shareholder Incentive for that Scorecard. The appropriate calculation is dependent on the WSA value, as demonstrated in Table 218.

Table 218. Calculation to determine shareholder incentive

SWS Value	Incentive
<.75	0
.75 ≤ WSA < 1	$(40\% \times \text{Max Incentive}) \frac{(WSA - 0.75)}{.25}$
1 ≤ WSA < 1.5	$(40\% \text{ Max Incentive}) + (60\% \text{ Max Incentive}) * \frac{(WSA - 1)}{0.5}$
1.5 ≤ WSA	Max Incentive

The shareholder incentives for each scorecard are summed to calculate each utility's total incentive:

$$\text{Total Incentive} = \sum_{\text{Utility}} \text{Scorecard Incentive}$$

Example Calculations

Lost revenue

As an example, a widget carries a 2016 lost revenue verified savings value of 500 m³ (annual, net savings). If that unit was installed in January, 500 m³ (500 x 1.000) would be verified for lost revenue. If that same unit were installed in July, 250 m³ (500 x 0.500) would be verified and if installed in November, 83.33 m³ (500 x .1667). Table 219 shows the prorated total savings for all widgets with one installed per month, in 1000 m³.

Table 219. Example lost revenue savings total for single rate class with monthly widget installation*

Month	Ratio (12- Month+1)/12	Units Installed	Lost Revenue Net Annual Gas Savings (m ³)	Prorated Energy Savings (m ³)	Lost Revenue Energy Savings (1000 m ³)
January	1.00	1	500	500.00	0.50
February	0.92	1	500	458.33	0.46
March	0.83	1	500	416.67	0.42
April	0.75	1	500	375.00	0.38
May	0.67	1	500	333.33	0.33
June	0.58	1	500	291.67	0.29
July	0.50	1	500	250.00	0.25
August	0.42	1	500	208.33	0.21
September	0.33	1	500	166.67	0.17
October	0.25	1	500	125.00	0.13
November	0.17	1	500	83.33	0.08
December	0.08	1	500	41.67	0.04
Total					3.25

*Not all values may compute exactly due to rounding.

In Table 220, the above example savings total is represented by Rate Class II – one widget per month was the sum of all measures performed within customers in that rate class. The verified lost revenue energy savings for the class are multiplied by the rate for that class to determine the lost revenue for that rate class; lost revenue for Rate Class II totalling \$48.75 from energy savings of 3.25 at a rate of \$15.00 per 1000 m³. All applicable rate class lost revenue are then summed for total lost revenue.

Table 220. Example total lost revenue*

Rate Class	Lost Revenue Energy Savings (1000 m ³)	Rate (\$/1000 m ³)	Lost Revenue
I	25.00	\$5.55	\$138.75
II	3.25	\$15.00	\$48.75
III	150.00	\$1.50	\$225.00
IV	100.00	\$4.00	\$400.00
V	5.10	\$25.50	\$130.05
VI	1.26	\$10.00	\$12.60
Total Lost Revenue			\$955.15

*Not all values may compute exactly due to rounding.

DSM shareholder incentive

The first step in calculating the DSM shareholder incentive is to calculate the percent of the target metric that was achieved, which is a simple ratio of the achieved metric divided by the target metric. The second step is to determine the correct formula based on whether the verified achievement for the scorecard metric was at, above, or below the annual target. In the example in Table 221, the verified achievement for Scorecard A CCM was below the 2016 Target, so the formula for achievement below target is used to determine the metric score. The Verified Achievement for participants was above the 2016 Target, so the alternative calculation is used. Both formulas are illustrated below.

Table 221. Example metric score*

Scorecard	Metric	Verified Achievement	Lower Band	2016 Target	Upper Band	Metric Score
Scorecard A	CCM	9,000,000	7,500,000	10,000,000	15,000,000	0.9
	Participants	250	150	200	300	1.25

*Not all values may compute exactly due to rounding.

$$CCM \text{ Metric Score} = 1 - \frac{.25 * (10,000,000 - 9,000,000)}{(10,000,000 - 7,500,000)} = 1 - 0.1 = 0.9$$

$$Participant \text{ Metric Score} = 1 + \frac{0.5 * (250 - 200)}{(300 - 200)} = 1 + .25 = 1.25$$

The metric score for each metric is then multiplied by the applicable weight. In this example, CCM savings is weighted at 75% and participants at 25%. The weighted metric scores for the scorecard are summed for the weighted scorecard achievement.

Table 222. Example scorecard weighted score (SWS)*

Scorecard	Metric	Metric Score	Weight	Weighted Metric Score	Weighted Scorecard Achievement
Scorecard A	CCM	0.9	75%	0.675	0.9875
	Participants	1.25	25%	0.3125	

*Not all values may compute exactly due to rounding.



For Scorecard A, if we assume a maximum incentive value of \$100,000, a weighted scorecard achievement of 0.9875 would result in an incentive of \$38,000, as demonstrated below.

$$(40\% \times \$100,000) \frac{(0.9875 - .75)}{.25} = \$40,000 \times \frac{(0.2375)}{.25} = \$40,000 \times 0.95 = \$38,000$$

Appendix K Lost revenue and DSM shareholder incentive: detailed tables

Enbridge DSM shareholder incentive

Table 223. Enbridge's 2016 Resource Acquisition targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Small Volume Customers CCM Savings	239,378,409	319,171,212	478,756,818	394,823,056	40%	124%	49.48%
Large Volume Customers CCM Savings	498,464,605	664,619,473	996,929,209	328,747,651	40%	49%	19.79%
Residential Deep Savings Participants	6,194	8,259	12,389	12,986	20%	157%	31.45%
Verified Total Weighted Scorecard Achieved							100.71%
Verified Scorecard Incentive Achieved							\$2,773,187

*Not all values may compute exactly due to rounding.

Table 224. Enbridge's 2016 Low Income scorecard targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Single Family (Part 9) CCM Savings	23,842,500	31,790,000	47,685,000	28,814,754	45%	91%	40.79%
Multi Family (Part 3) CCM Savings	48,675,000	64,900,000	97,350,000	84,728,581	45%	131%	58.75%
New Construction Participants	4	6	8	6	10%	100%	10.00%
Verified Total Weighted Scorecard Achieved							109.54%
Verified Scorecard Incentive Achieved							\$1,214,841

*Not all values may compute exactly due to rounding.

Table 225. Enbridge's 2016 Market Transformation scorecard targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Residential Savings by Design Builders	25	33	50	31	10%	94%	9.38%
Residential Savings by Design Homes Built	2,063	2,751	4,127	2,206	15%	80%	12.03%
Commercial Savings by Design Developments	25	33	50	43	25%	130%	32.35%
School Energy Competition Schools	41	55	83	25	10%	45%	4.64%
Run it Right Participants	62	83	124	84	20%	101%	20.24%
Comprehensive Energy Management Participants	5	7	10	7	20%	100%	20.00%
Verified Total Weighted Scorecard Achieved							98.64%
Verified Scorecard Incentive Achieved							\$492,023

*Not all values may compute exactly due to rounding.

Union DSM shareholder incentive

Table 226. Union's 2016 Resource Acquisition targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
CCM Savings	910,578,270	1,214,104,360	1,821,156,541	814,757,917	75%	67%	50.33%
Participants	2,475	3,300	4,950	6,595	25%	200%	49.96%
Verified Total Weighted Scorecard Achieved							100.29%
Verified Scorecard Incentive Achieved							\$2,583,320

*Not all values may compute exactly due to rounding.

Table 227. Union's 2016 Large Volume targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
CCM Savings	668,168,041	890,890,721	1,336,336,082	79,848,302	100%	9%	8.96%
Verified Total Weighted Scorecard Achieved							8.96%
Verified Scorecard Incentive Achieved							\$0

*Not all values may compute exactly due to rounding.

Table 228. Union's 2016 Low Income targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Single Family CCM	28,339,761	37,786,348	56,679,521	45,783,309	60%	121%	72.70%
Multi Family S&A CCM	12,162,016	16,216,022	24,324,033	10,894,572	35%	67%	23.51%
Multi Family MR CCM	1,979,863	2,639,817	3,959,726	8,151,189	5%	309%†	10.00%
Verified Total Weighted Scorecard Achieved							106.21%
Verified Scorecard Incentive Achieved							\$1,240,947

*Not all values may compute exactly due to rounding.

†As the metric has exceeded the maximum 200%, the weighted scorecard achievement for this metric is calculated using 200%. However, the full value is displayed here.

Table 229. Union's 2016 Market Transformation targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
Homes Built	53%	70%	100%	70.09%	50%	100%	50.08%
New Developments	6	8	12	0	50%	0%	0.00%
Verified Total Weighted Scorecard Achieved							50.08%
Verified Scorecard Incentive Achieved							\$0

*Not all values may compute exactly due to rounding.

Table 230. Union's 2016 Performance Based targets, achievements, and incentive*

Metric	Lower Band	Target	Upper Band	Verified Achievement	Weight	% Metric Achieved	Weighted Metric Score
RunSmart Participants	21	28	41	32	50%	114%	57.69%
SEM Participants	2	3	5	3	50%	100%	50.00%
Verified Total Weighted Scorecard Achieved							107.69%
Verified Scorecard Incentive Achieved							\$61,844

*Not all values may compute exactly due to rounding.

Enbridge Lost Revenue

Table 231. Enbridge lost revenue volumes (10³ m³) by rate class, prorated by month*

Rate Class	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rate 110	0	0	21	11	24	79	0	3	22	90	45	203
Rate 115	0	0	0	0	0	0	3	7	0	14	16	82
Rate 135	0	0	0	0	0	0	0	0	0	0	11	7
Rate 145	0	0	0	0	0	0	0	0	0	13	3	0
Rate 170	0	0	0	227	18	0	26	0	0	2	16	211
Total	0	0	21	238	42	79	29	10	22	120	91	503

*Not all values may compute exactly due to rounding.

Table 232. Enbridge lost revenue volumes (10³ m³) total volume, delivery rates, and revenue impact by rate class*

Rate Class	Savings Volume (1,000 m3)	Delivery Rate (\$/1,000 m3)	Revenue Impact (\$)
Rate 110	498	\$18.53	\$9,230
Rate 115	122	\$9.78	\$1,196
Rate 135	18	\$16.70	\$298
Rate 145	17	\$19.65	\$325
Rate 170	500	\$7.22	\$3,607
Total	1,155		\$14,656

*Not all values may compute exactly due to rounding.

Union Lost Revenue

Table 233. Union lost revenue volumes (10³ m³) by rate class, prorated by month*

Rate Class	Savings Volume by Month (1,000 m3)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
M4 Industrial	1,547	104	647	602	17	46	314	70	75	220	130	98
M5 Industrial	1,013	338	1,426	1,269	78	79	186	0	20	0	185	17
M7 Industrial	294	654	837	84	2	281	196	355	741	190	7	282
T1 Industrial	53	0	64	142	161	0	0	0	237	176	57	77
T2 Industrial	31	0	89	256	320	1,002	0	183	30	608	151	2
20 Industrial	556	0	15	0	0	0	0	18	19	52	6	0
100 Industrial	6	0	19	14	10	2	14	0	0	13	11	0
Total	3,499	1,096	3,097	2,368	588	1,410	711	626	1,121	1,258	546	476

*Not all values may compute exactly due to rounding.

Table 234. Union lost revenue volumes (10³ m³) total volume, delivery rates, and revenue impact by rate class*

Rate Class	Savings Volume (1,000 m3)	Delivery Rate (\$/1,000 m3)	Revenue Impact (\$)
M4 Industrial	3,870	\$11.57	\$44,781
M5 Industrial	4,611	\$25.64	\$118,225
M7 Industrial	3,923	\$3.53	\$13,830
T1 Industrial	968	\$0.76	\$736
T2 Industrial	2,669	\$0.08	\$219
20 Industrial	665	\$5.55	\$3,691
100 Industrial	89	\$2.24	\$199
Total	16,760		\$181,682

*Not all values may compute exactly due to rounding.

Appendix L Prescriptive Savings Verification

This appendix describes the detailed process used to verify the reported (tracked) prescriptive and quasi-prescriptive savings for Enbridge and Union. Both purely prescriptive and quasi-prescriptive measures are captured within a single workbook for each utility.

Data Sources

Verification of prescriptive measures relies on several data sources provided by Enbridge and Union.

Tracking Files

The EC received one tracking file each from Enbridge and Union. Both tracking files are Excel files, and include prescriptive measures and additional information for measures from non-prescriptive programs, such as savings and other program metrics. A more complete description of the tracking file, as well as other data received, is provided in Appendix D.

TRM - Joint Submissions

The EC utilized documents titled "New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution," referred to in this report as TRMs. The EC used the December 2015 TRM, EB-2015-0344, as the primary source for identifying prescribed values, such as energy savings and measure life, for prescriptive measures. In addition to that primary TRM, the EC also used the December 2012 TRM¹²¹ and the December 2016 TRM¹²².

Other Supporting Documentation

The Joint Submission documents did not contain all of the necessary detail to verify the savings for all measures. Some measures were described at a level of detail that was not contained in the December 2015 Joint Submission. For example, Union Gas' C&I Prescriptive Air Curtains measure descriptions were expanded in the December 2016 TRM (EB-2016-0246) to include additional sizes or efficiencies. All prescriptive measures and corresponding verification sources are listed in Table 237 and Table 238.

In addition to the TRMs, the EC also used the following for verification of savings for prescriptive measures, as cited in Table 237 and Table 238.

- C&I Prescriptive showerheads, Enbridge, "Showerhead Verification Among Rental Buildings", Ipsos Research, March, 2012
- C&I Prescriptive boiler cycling controls, Union, "Boiler Cycling Controls Document": DSM Opportunities Associated with Boiler Load Controls, NGTC
- Low Income Showerheads, Enbridge, "Multi-Residential Low Income Showerhead Verification": 2012 Multi-Residential Low Income Showerhead Verification for Enbridge Gas, Ipsos Research, March 2013
- "TAPS Report", TAPS Verification Program 2012 Year End Research Report, Study CR-604, Quadra Research, April 3, 2013

¹²¹ EB-2012-0441 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

¹²² EB-2016-0246 New and Updated DSM Measures - Joint Submission from Union Gas Ltd. and Enbridge Gas Distribution

Overall Methodology

The EC used a straightforward process to consistently verify savings for both utilities, summarized in Figure 7.

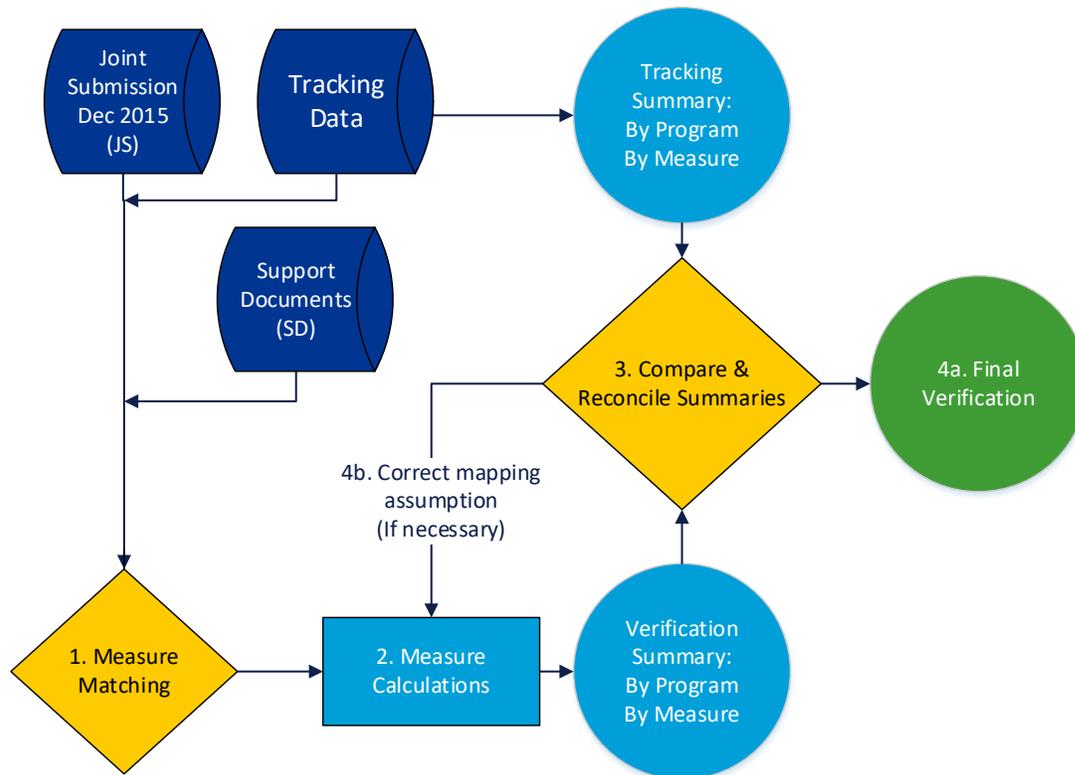


Figure 7. Savings verification process

The process includes the following high-level steps. Additional detail is presented below.

1. Manually match individual project measure savings against Joint Submission (JS) and Support Documents (SD) values, based first on measure name and then on other attributes, to calculate savings.
2. Calculate gross and net annual and lifetime savings for all measures.
3. Compare the summarized calculated savings and the tracked savings to identify discrepancies or disagreements.
4. When the EC determined that a discrepancy was due to an error in assigning the correct savings value, the EC assigned a new savings value to the measure and re-compared totals (4b). Once the EC resolved the correct savings value (through continued investigation of measure or clarification with utility) the record was verified (4a).

Table 235 shows the variables used from the utility tracking data to verify, summarize, and reconcile savings values. While variables such as measure life or free-ridership were present in the tracking data, these were not used by the EC to calculate verified savings, but to identify discrepancies between

verification and tracking summaries when comparing and reconciling savings totals. The EC used TRM or SD values for the verified savings calculations.

Table 235. Tracking variables used for prescriptive savings verification

Tracking Variable	Used In		
	Verification/ Summary	Tracking Summary	Compare & Reconcile Summaries
Program Year	X		X
Scorecard	X		X
Program	X		X
Program Offering	X		X
Offering Classification	X		X
Decision Type (Early Replace, Retrofit, etc.)	X		X
Measure Name	X		X
Lost Revenue Rate Class	X		X
Customer ID	X		X
Site ID	X		X
Building Type	X		X
Project ID	X		X
Number of Units	X		X
Measure Life			X
Energy Load			X
Service Class (for Avoided Costs)			X
Free Rider			X
Adjustment Factor			X
Gross Annual Natural Gas Savings (m3)		X	X
Net Annual Natural Gas Savings (m3)		X	X
Gross Cumulative Natural Gas Savings (m3)		X	X
Net Cumulative Natural Gas Savings (m3)		X	X
Capacity/Unit	X		X

1. Measure Matching

The EC manually mapped measures into groups. Measures were filtered by name to assign them to a group, then matched against the TRM and SD measures to identify the correct savings values. For each project, the EC confirmed that the savings value listed for the measure matched the value listed for that measure type in the TRM and SD. Savings tables in this section utilize measure names and units from the TRM wherever possible. Utilities utilized different units (BTU vs kBTU) or name variations, those are not used here.

Table 237 and Table 238 list all tracked measure groups and their corresponding savings values and JS or SC source for Enbridge and Union, respectively.

2. Measure Calculations

There are two types of prescriptive measure calculations: Pure-Prescriptive and Quasi-Prescriptive. Quasi-Prescriptive measure savings require more than the per unit savings and the number of units to determine annual gross savings. For example, some boiler measures require the capacity of the boiler. Table 236 summarizes the differences between the two types.

Table 236. Explanation of calculation inputs for two types of prescriptive measures

Savings Type	Purely Prescriptive	Quasi-Prescriptive
Annual Gross	Per Unit Savings * # of Units	Unit Capacity Savings * Unit Capacity * # of Units
Annual Net	Annual Gross * (1 - Free Ridership) * Adjustment	
Lifetime Gross	Annual Gross * Measure Life	
Lifetime Net (CCM)	Annual Net * Measure Life	

The EC used standard Excel formulas that reference columns and rows (e.g. "=A3*B3*C3") for the initial calculations. As a crosscheck to identify any potential errors in the calculations, the EC specified the formulas a second way. The secondary method utilized named ranges inside the formulas, rather than referencing cells in the context-less column-row matter.

Table 239 and Table 240 list all calculated measure totals, as verified by the EC.

3. Compare & Reconcile Summaries

The EC summed savings values from utility tracking and from EC verification calculations by program and measure type, and tabulated by Annual Gross, Annual Net, Lifetime Gross, Lifetime Net, and project measure counts. The EC did this with the Pivot Table function in Excel, creating Tracking (utility tracking data) and Verification (EC calculated) Summaries, which provided two benefits. First, the EC was able to identify discrepancies between listed measure names, because any differences would result in a different number of summary rows between the two tables. Second, the pivot tables allowed for quick and accurate updates when the EC performed adjustments to our original matches.

By reviewing differences between the two summaries, the EC identified errors in the EC matches and differences between the EC matches and the original utility tracking data, allowing us to investigate the discrepancies. Table 241 and Table 242 list all verification discrepancies where:

- **The tracking data did not contain sufficient information to identify savings:** In general, these measures were resolved with additional documentation and resulted in no change to savings. They are listed in this appendix to document the evaluation process and communication between the evaluator and the utility.
- **The tracking data was incorrect:** This may have been because different savings factors were identified through the verification process. The tables include the details for each measure.



4. Final Verification

Once all tracked measures were matched to TRM values, the savings calculated, and all discrepancies reconciled or explained, verified savings summaries were finalized. Final savings totals for each program are available within the appropriate appendix in this report.

Savings Calculation Values

Savings tables in this section utilize measure names and units from the TRM wherever possible. Utilities utilized different units (BTU vs KBTU) or name variations, those are not used here.

Table 237. Enbridge measure savings calculation values*

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Direct - Large	Direct Install Air Doors 10 x 10	Pure	December 2015 TRM	20,796.00	unit	15	5%	0%
C&I Direct - Large	Direct Install Air Doors 8 x 10	Pure	December 2015 TRM	15,135.00	unit	15	5%	0%
C&I Direct - Large	Direct Install Air Doors 8 x 8	Pure	December 2015 TRM	12,108.00	unit	15	5%	0%
C&I Direct - Small	Direct Install Air Doors 10 x 10	Pure	December 2015 TRM	20,796.00	unit	15	5%	0%
C&I Direct - Small	Direct Install Air Doors 8 x 10	Pure	December 2015 TRM	15,135.00	unit	15	5%	0%
C&I Direct - Small	Direct Install Air Doors 8 x 8	Pure	December 2015 TRM	12,108.00	unit	15	5%	0%
C&I Prescriptive - Large	Air Door 10 x 10	Pure	December 2015 TRM	20,796.00	unit	15	5%	0%
C&I Prescriptive - Large	Air Door Double 7 x 6 Door	Pure	December 2015 TRM	2,686.00	unit	15	5%	0%
C&I Prescriptive - Large	Air Door Single 7 x 3	Pure	December 2015 TRM	671.00	unit	15	5%	0%
C&I Prescriptive - Large	Condensing Boiler 100-199 MBH DWH	Quasi	December 2015 TRM	0.01332	BTU/hour	25	5%	0%
C&I Prescriptive - Large	Condensing High Efficiency Furnace 75-149 KBTU	Quasi	December 2015 TRM	3.11	KBTU/hour	18	18%	0%
C&I Prescriptive - Large	Condensing MUA 1 Speed Multi-Res	Quasi	December 2015 TRM	0.91900	CFM	20	5%	0%
C&I Prescriptive - Large	Condensing MUA 1 Speed Other	Quasi	December 2015 TRM	0.40700	CFM	20	5%	0%
C&I Prescriptive - Large	Condensing Storage Water Heater - Low Retail (75-250 KBTU)	Quasi	December 2015 TRM	1.36	KBTU/hour input capacity	15	5%	0%
C&I Prescriptive - Large	Condensing Tankless Water Heater - Low Multi-Res (>=200 KBTU)	Mixed	December 2015 TRM	326 + 0.00079	unit + BTU/hour	20	2%	0%
C&I Prescriptive - Large	DCKV 10,001-15,000 CFM	Pure	December 2015 TRM	17,529.00	unit	15	5%	0%
C&I Prescriptive - Large	DCKV 5,001-10,000 CFM	Pure	December 2015 TRM	10,517.00	unit	15	5%	0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive - Large	DCKV Up to 5000 CFM	Pure	December 2015 TRM	4,207.00	unit	15	5%	0%
C&I Prescriptive - Large	DCV Single Zone Retail with NO Maintenance	Quasi	December 2015 TRM	0.39200	ft ²	10	5%	0%
C&I Prescriptive - Large	Destratification Fan	Pure	December 2015 TRM	1,734.00	unit	15	10%	0%
C&I Prescriptive - Large	Dishwasher Single-Tank Conveyer High Temp	Pure	December 2015 TRM	560.00	unit	20	27%	0%
C&I Prescriptive - Large	Dishwasher Stationary Rack High Temp	Pure	December 2015 TRM	922.00	unit	15	20%	0%
C&I Prescriptive - Large	Dishwasher Under-Counter Low Temp	Pure	December 2015 TRM	333.00	unit	10	40%	0%
C&I Prescriptive - Large	ERV Office 65% - 74%	Quasi	December 2015 TRM	0.49000	CFM	14	5%	0%
C&I Prescriptive - Large	ERV Vent Low Integrated Office	Quasi	December 2015 TRM	2.36	CFM	14	5%	0%
C&I Prescriptive - Large	ERV Vent Low Stand Office	Quasi	December 2015 TRM	2.36	CFM	14	5%	0%
C&I Prescriptive - Large	ERV Vent Medium Integrated Retail Restaurant	Quasi	December 2015 TRM	3.68	CFM	14	5%	0%
C&I Prescriptive - Large	Fryer	Pure	December 2015 TRM	1,408.00	unit	12	20%	0%
C&I Prescriptive - Large	High Efficiency Boiler >2000MBH - 12%	Pure	December 2012 TRM, December 2015 TRM	27,325.00	unit	25	12%	0%
C&I Prescriptive - Large	High Efficiency Boiler >2000MBH - 20%	Pure	December 2012 TRM, December 2015 TRM	27,325.00	unit	25	20%	0%
C&I Prescriptive - Large	High Efficiency Boiler 1000-1499MBH - 12%	Pure	December 2012 TRM, December 2015 TRM	12,141.00	unit	25	12%	0%
C&I Prescriptive - Large	High Efficiency Boiler 1000-1499MBH - 12% DWH	Pure	December 2012 TRM, December 2015 TRM	5,431.00	unit	25	12%	0%
C&I Prescriptive - Large	High Efficiency Boiler 1000-1499MBH - 20% DWH	Pure	December 2012 TRM, December 2015 TRM	5,431.00	unit	25	20%	0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive - Large	High Efficiency Boiler 1500-1999MBH - 20% DWH	Pure	December 2012 TRM, December 2015 TRM	7,475.00	unit	25	20%	0%
C&I Prescriptive - Large	High Efficiency Boiler 300-599MBH - 12%	Pure	December 2012 TRM, December 2015 TRM	3,496.00	unit	25	12%	0%
C&I Prescriptive - Large	High Efficiency Boiler 300-599MBH - 12% DWH	Pure	December 2012 TRM, December 2015 TRM	1,861.00	unit	25	12%	0%
C&I Prescriptive - Large	High Efficiency Boiler 300-599MBH - 20% DWH	Pure	December 2012 TRM, December 2015 TRM	1,861.00	unit	25	20%	0%
C&I Prescriptive - Large	High Efficiency Boiler 600-999MBH - 12% DWH	Pure	December 2012 TRM, December 2015 TRM	3,076.00	unit	25	12%	0%
C&I Prescriptive - Large	HRV Vent Low Stand Office Cx	Quasi	December 2015 TRM	1.78	CFM	14	5%	0%
C&I Prescriptive - Large	HRV Ventilation Medium Standalone Retail	Quasi	December 2015 TRM	2.78	CFM	14	5%	0%
C&I Prescriptive - Large	Industrial Air Door 10 x 10	Pure	December 2015 TRM	20,796.00	unit	15	5%	0%
C&I Prescriptive - Large	Industrial Infrared Single Stage 50,000-164,999	Quasi	December 2015 TRM	11.50	KBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Large	Infrared Single Stage 165,000-300,000	Quasi	December 2015 TRM	11.50	KBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Large	Infrared Single Stage 50,000-164,999	Quasi	December 2015 TRM	11.50	KBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Large	Ozone Washer Extractor =/ 60lbs	Quasi	December 2015 TRM	0.03670	lbs/year	15	8%	0%
C&I Prescriptive - Large	Ozone Washer Extractor >60lbs <500lbs	Quasi	December 2015 TRM	0.03670	lbs/year	15	8%	0%
C&I Prescriptive - Large	School Board Boiler Elementary	Pure	December 2015 TRM	12,217.00	unit	25	12%	0%
C&I Prescriptive - Large	School Board Boiler Secondary	Pure	December 2015 TRM	49,476.00	unit	25	12%	0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive - Large	Showerhead - Direct Install	Pure	December 2015 TRM, Showerhead Verification Among Rental Buildings	30.60	unit	10	10%	16%
C&I Prescriptive - Large	Showerhead - Prescriptive	Pure	December 2015 TRM, Showerhead Verification Among Rental Buildings	30.60	unit	10	10%	16%
C&I Prescriptive - Small	Air Door 8 x 10	Pure	December 2015 TRM	15,135.00	unit	15	5%	0%
C&I Prescriptive - Small	Air Door Double 7 x 3 Door	Pure	December 2015 TRM	1,343.00	unit	15	5%	0%
C&I Prescriptive - Small	Air Door Double 7 x 6 Door	Pure	December 2015 TRM	2,686.00	unit	15	5%	0%
C&I Prescriptive - Small	Air Door Single 7 x 3	Pure	December 2015 TRM	671.00	unit	15	5%	0%
C&I Prescriptive - Small	Condensing Boiler <100 MBH DWH	Quasi	December 2015 TRM	0.02170	BTU/hour	25	5%	0%
C&I Prescriptive - Small	Condensing Boiler 100-199 MBH	Quasi	December 2015 TRM	0.01019	BTU/hour	25	5%	0%
C&I Prescriptive - Small	Condensing Boiler 100-199 MBH DWH	Quasi	December 2015 TRM	0.01332	BTU/hour	25	5%	0%
C&I Prescriptive - Small	Condensing Boiler 200-299 MBH	Quasi	December 2015 TRM	0.01019	BTU/hour	25	5%	0%
C&I Prescriptive - Small	Condensing Boiler 200-299 MBH DWH	Quasi	December 2015 TRM	0.00996	BTU/hour	25	5%	0%
C&I Prescriptive - Small	Condensing High Efficiency Furnace 75-149 KBTU	Quasi	December 2015 TRM	3.11	KBTU/hour	18	18%	0%
C&I Prescriptive - Small	Condensing Storage Water Heater - Low Retail (75-250 KBTU)	Quasi	December 2015 TRM	1.36	KBTU/hour input capacity	15	5%	0%
C&I Prescriptive - Small	Condensing Tankless Water Heater - Low - Retail (>75 and <200 KBTU)	Mixed	December 2015 TRM	212+0.00079	unit + BTU/hour	20	2%	0%
C&I Prescriptive - Small	Condensing Unit Heater 30-100 KBTU	Quasi	December 2015 TRM	7.89	kBTU/hour input capacity	18	0%	0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive - Small	DCKV 10,001-15,000 CFM	Pure	December 2015 TRM	17,529.00	unit	15	5%	0%
C&I Prescriptive - Small	DCKV 5,001-10,000 CFM	Pure	December 2015 TRM	10,517.00	unit	15	5%	0%
C&I Prescriptive - Small	DCKV Up to 5000 CFM	Pure	December 2015 TRM	4,207.00	unit	15	5%	0%
C&I Prescriptive - Small	DCV Single Zone Office with Maintenance - NC	Quasi	December 2015 TRM	0.11200	ft ²	15	20%	0%
C&I Prescriptive - Small	DCV Single Zone Retail with Maintenance	Quasi	December 2015 TRM	0.39200	ft ²	15	5%	0%
C&I Prescriptive - Small	DCV Single Zone Retail with Maintenance - NC	Quasi	December 2015 TRM	0.39200	ft ²	15	20%	0%
C&I Prescriptive - Small	DCV Single Zone Retail with NO Maintenance	Quasi	December 2015 TRM	0.39200	ft ²	10	5%	0%
C&I Prescriptive - Small	DCV Single Zone Retail with NO Maintenance - NC	Quasi	December 2015 TRM	0.39200	ft ²	10	5%	0%
C&I Prescriptive - Small	Destratification Fan	Pure	December 2015 TRM	1,734.00	unit	15	10%	0%
C&I Prescriptive - Small	Dishwasher Single-Tank Conveyer High Temp	Pure	December 2015 TRM	560.00	unit	20	27%	0%
C&I Prescriptive - Small	Dishwasher Stationary Rack High Temp	Pure	December 2015 TRM	922.00	unit	15	20%	0%
C&I Prescriptive - Small	Dishwasher Under-Counter Low Temp	Pure	December 2015 TRM	333.00	unit	10	40%	0%
C&I Prescriptive - Small	ERV Vent Low Integrated Office	Quasi	December 2015 TRM	2.36	CFM	14	5%	0%
C&I Prescriptive - Small	ERV Vent Low Stand Office	Quasi	December 2015 TRM	2.36	CFM	14	5%	0%
C&I Prescriptive - Small	ERV Vent Medium Integrated Retail Restaurant	Quasi	December 2015 TRM	3.68	CFM	14	5%	0%
C&I Prescriptive - Small	Fryer	Pure	December 2015 TRM	1,408.00	unit	12	20%	0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive - Small	High Efficiency Boiler 600-999 MBH - 20%	Pure	December 2012 TRM, December 2015 TRM	6,633.00	unit	25	20%	0%
C&I Prescriptive - Small	High Efficiency Boiler 600-999 MBH - 20% DWH	Pure	December 2012 TRM, December 2015 TRM	3,076.00	unit	25	20%	0%
C&I Prescriptive - Small	HRV Office 65% - 74%	Quasi	December 2015 TRM	0.41000	CFM	14	5%	0%
C&I Prescriptive - Small	Industrial Air Door 10 x 10	Pure	December 2015 TRM	20,796.00	unit	15	5%	0%
C&I Prescriptive - Small	Industrial Air Door 8 x 10	Pure	December 2015 TRM	15,135.00	unit	15	5%	0%
C&I Prescriptive - Small	Industrial Air Door 8 x 8	Pure	December 2015 TRM	12,108.00	unit	15	5%	0%
C&I Prescriptive - Small	Industrial Air Door Double 7 x 6 Door	Pure	December 2015 TRM	2,686.00	unit	15	5%	0%
C&I Prescriptive - Small	Industrial Air Door Single 7 x 3 Door	Pure	December 2015 TRM	671.00	unit	15	5%	0%
C&I Prescriptive - Small	Industrial Infrared 2-Stage 165,000-300,000	Quasi	December 2015 TRM	13.10	kBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Industrial Infrared 2-Stage 50,000-164,999	Quasi	December 2015 TRM	13.10	kBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Industrial Infrared Single Stage 0-49,999	Quasi	December 2015 TRM	11.50	kBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Industrial Infrared Single Stage 165,000-300,000	Quasi	December 2015 TRM	11.50	kBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Industrial Infrared Single Stage 50,000-164,999	Quasi	December 2015 TRM	11.50	kBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Infrared 2-Stage 0-49,999	Quasi	December 2015 TRM	13.10	kBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Infrared 2-Stage 165,000-300,000 - NC	Quasi	December 2015 TRM	13.10	kBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Infrared 2-Stage 50,000-164,999	Quasi	December 2015 TRM	13.10	kBTU/hour input capacity	17	33%	0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive - Small	Infrared 2-Stage 50,000-164,999 - NC	Quasi	December 2015 TRM	13.10	KBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Infrared Single Stage 165,000-300,000	Quasi	December 2015 TRM	11.50	KBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Infrared Single Stage 50,000-164,999	Quasi	December 2015 TRM	11.50	KBTU/hour input capacity	17	33%	0%
C&I Prescriptive - Small	Ozone Washer Extractor =/ 60lbs	Quasi	December 2015 TRM	0.03670	lbs/year	15	8%	0%
C&I Prescriptive - Small	Ozone Washer Extractor >60lbs <500lbs	Quasi	December 2015 TRM	0.03670	lbs/year	15	8%	0%
C&I Prescriptive - Small	School Board Boiler Elementary	Pure	December 2015 TRM	12,217.00	unit	25	12%	0%
C&I Prescriptive - Small	Showerhead - Direct Install	Pure	December 2015 TRM, Showerhead Verification Among Rental Buildings	30.60	unit	10	10%	16%
C&I Prescriptive - Small	Showerhead - Prescriptive	Pure	December 2015 TRM, Showerhead Verification Among Rental Buildings	30.60	unit	10	10%	16%
Single Family Part 9	Bathroom Aerators	Pure	December 2015 TRM, TAPS Report	6.40	unit	10	0%	78%
Single Family Part 9	Kitchen Aerators	Pure	December 2015 TRM, TAPS Report	11.56	unit	10	0%	67%
Single Family Part 9	Programmable Thermostats	Pure	December 2015 TRM	46.00	unit	15	0%	0%
Single Family Part 9	Showerheads 2.6+	Pure	December 2015 TRM, Multi-Residential Low Income Showerhead Verification	49.50	household	10	0%	12%
Low Income - Multi-Residential	Condensing Boiler 100-199 MBH DWH	Quasi	December 2015 TRM	0.01332	BTU/hour	25	0%	0%
Low Income - Multi-Residential	Condensing Boiler 200-299 MBH	Quasi	December 2015 TRM	0.01019	BTU/hour	25	0%	0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
Low Income - Multi-Residential	Condensing Boiler 200-299 MBH DWH	Quasi	December 2015 TRM	0.00996	BTU/hour	25	0%	0%
Low Income - Multi-Residential	High Efficiency Boiler Seasonal 1500-1999 MBH	Pure	December 2012 TRM, December 2015 TRM	19,189.00	unit	25	0%	0%
Low Income - Multi-Residential	High Efficiency Boiler Seasonal 300-599 MBH	Pure	December 2012 TRM, December 2015 TRM	3,496.00	unit	25	0%	0%
Low Income - Multi-Residential	High Efficiency Boiler Seasonal 600-999 MBH	Pure	December 2012 TRM, December 2015 TRM	6,633.00	unit	25	0%	0%
Low Income - Multi-Residential	Showerheads	Pure	December 2015 TRM, Multi-Residential Low Income Showerhead Verification	30.60	unit	10	0%	12%
Low Income - Multi-Residential	Showerheads - DI	Pure	December 2015 TRM, Multi-Residential Low Income Showerhead Verification	30.60	unit	10	0%	12%
Residential Adaptive Thermostats	Residential Adaptive Thermostat	Pure	December 2015 TRM	185.00	unit	15	4%	0%

*Not all values may compute exactly due to rounding.

Table 238. Union Gas measures savings calculation values*

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive	Air Curtains-Double Door - (2)7x3	Pure	December 2016 TRM	1,343.00	unit	15	5.0%	0.0%
C&I Prescriptive	Air Curtains-Double Door - (2)7x6	Pure	December 2016 TRM	2,686.00	unit	15	5.0%	0.0%
C&I Prescriptive	Air Curtains-Shipping Doors - 10x10	Pure	December 2015 TRM	20,796.00	unit	15	5.0%	0.0%
C&I Prescriptive	Air Curtains-Shipping Doors - 8x10	Pure	December 2015 TRM	15,135.00	unit	15	5.0%	0.0%
C&I Prescriptive	Air Curtains-Shipping Doors - 8x8	Pure	December 2015 TRM	12,108.00	unit	15	5.0%	0.0%
C&I Prescriptive	Air Curtains-Single Door - 7x3	Pure	December 2016 TRM	671.00	unit	15	5.0%	0.0%
C&I Prescriptive	Air Curtains-Single Door - 7x6	Pure	December 2016 TRM	1,343.00	unit	15	5.0%	0.0%
C&I Prescriptive	Air Curtains-Single Door - 8x6	Pure	December 2015 TRM	1,622.00	unit	15	5.0%	0.0%
C&I Prescriptive	Boiler Cycling Control - All other CI Purchased	Pure	Boiler Cycling Control Subdocument	11,689.00	unit	20	10.0%	0.0%
C&I Prescriptive	Boiler Cycling Control - MURB Purchase	Pure	Boiler Cycling Control Subdocument	5,235.00	unit	20	10.0%	0.0%
C&I Prescriptive	CEE Tier 2 Front-Loading Clothes Washer	Pure	December 2015 TRM	117.00	unit	11	10.0%	0.0%
C&I Prescriptive	Condensing Boiler SH - => 1,000 MBtu/hr	Quasi	December 2015 TRM	0.01040	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler SH - 300 to 999 MBtu/hr	Quasi	December 2015 TRM	0.01040	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler SH - up to 299 MBtu/hr	Quasi	December 2015 TRM	0.01019	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler WH - => 1,000 MBtu/hr - >1000MBH	Quasi	December 2012 TRM	0.00644	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler WH - => 1,000 MBtu/hr - >1500MBH	Quasi	December 2012 TRM	0.00591	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler WH - 300 to 999 MBtu/hr - > 300 MBH	Quasi	December 2012 TRM	0.00735	BTU/hour	25	5.0%	0.0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive	Condensing Boiler WH - 300 to 999 MBtu/hr - > 600 MBH	Quasi	December 2012 TRM	0.00608	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler WH - up to 299 MBtu/hr - (<100 MBTU/hour)	Quasi	December 2015 TRM	0.02170	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler WH - up to 299 MBtu/hr - (100 to 199 MBTU/hour)	Quasi	December 2015 TRM	0.01332	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Boiler WH - up to 299 MBtu/hr - (200 to 299 MBTU/hour)	Quasi	December 2015 TRM	0.00996	BTU/hour	25	5.0%	0.0%
C&I Prescriptive	Condensing Gas Tankless Water Heater - High (>=200 MBTU/hour)	Mixed	December 2016 TRM	326+0.00179	unit + BTU/hour	20	2.0%	0.0%
C&I Prescriptive	Condensing Gas Tankless Water Heater - High (>75 and <200 MBTU/hour)	Mixed	December 2016 TRM	212+0.00179	unit + BTU/hour	20	2.0%	0.0%
C&I Prescriptive	Condensing Gas Tankless Water Heater - Low (>=200 MBTU/hour)	Mixed	December 2016 TRM	326+0.00079	unit + BTU/hour	20	2.0%	0.0%
C&I Prescriptive	Condensing Gas Tankless Water Heater - Low (>75 and <200 MBTU/hour)	Mixed	December 2016 TRM	212+0.00079	unit + BTU/hour	20	2.0%	0.0%
C&I Prescriptive	Condensing Gas Tankless Water Heater - Med (>75 and <200 MBTU/hour)	Mixed	December 2016 TRM	212+0.00129	unit + BTU/hour	20	2.0%	0.0%
C&I Prescriptive	Condensing Storage Water Heater - High	Quasi	December 2015 TRM	3.09	kBTU/hour input capacity	15	5.0%	0.0%
C&I Prescriptive	Condensing Storage Water Heater - Low	Quasi	December 2015 TRM	1.36	kBTU/hour input capacity	15	5.0%	0.0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive	Condensing Storage Water Heater - Medium	Quasi	December 2015 TRM	2.22	kBTU/hour input capacity	15	5.0%	0.0%
C&I Prescriptive	DCKV < 5000 cfm - RF	Pure	December 2015 TRM	4,207.00	unit	15	5.0%	0.0%
C&I Prescriptive	DCKV 10000-15000 cfm - NC	Pure	December 2015 TRM	17,529.00	unit	15	5.0%	0.0%
C&I Prescriptive	DCKV 10000-15000 cfm - RF	Pure	December 2015 TRM	17,529.00	unit	15	5.0%	0.0%
C&I Prescriptive	DCKV 5000 - 9999 cfm - NC	Pure	December 2015 TRM	10,517.00	unit	15	5.0%	0.0%
C&I Prescriptive	DCKV 5000 - 9999 cfm - RF	Pure	December 2015 TRM	10,517.00	unit	15	5.0%	0.0%
C&I Prescriptive	DCV-Office-RTU/MUA => 2500 sq ft-w/o plan - NC	Quasi	December 2015 TRM	0.11200	ft ²	10	20.0%	0.0%
C&I Prescriptive	DCV-Office-RTU/MUA => 2500 sq ft-w/o plan - RF	Quasi	December 2015 TRM	0.11200	ft ²	10	5.0%	0.0%
C&I Prescriptive	DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan - NC	Quasi	December 2015 TRM	0.11200	ft ²	10	20.0%	0.0%
C&I Prescriptive	DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan - RF	Quasi	December 2015 TRM	0.11200	ft ²	10	5.0%	0.0%
C&I Prescriptive	DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan - NC	Quasi	December 2015 TRM	0.39200	ft ²	10	20.0%	0.0%
C&I Prescriptive	DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan - RF	Quasi	December 2015 TRM	0.39200	ft ²	10	5.0%	0.0%
C&I Prescriptive	Dishwasher - Rack Conveyor Single HT	Pure	December 2015 TRM	560.00	unit	20	27.0%	0.0%
C&I Prescriptive	Dishwasher - Stationary Rack Door Type HT	Pure	December 2015 TRM	922.00	unit	15	20.0%	0.0%
C&I Prescriptive	Dishwasher - Stationary Rack Door Type LT	Pure	December 2015 TRM	2,120.00	unit	15	20.0%	0.0%
C&I Prescriptive	Dishwasher - Undercounter HT	Pure	December 2015 TRM	142.00	unit	10	40.0%	0.0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive	Dishwasher - Undercounter LT	Pure	December 2015 TRM	333.00	unit	10	40.0%	0.0%
C&I Prescriptive	Energy Star Convection Oven	Pure	December 2015 TRM	865.00	unit	12	20.0%	0.0%
C&I Prescriptive	Energy Star Fryer	Pure	December 2015 TRM	1,408.00	unit	12	20.0%	0.0%
C&I Prescriptive	ERV 1 - MURB In-Suite	Quasi	December 2015 TRM	6.64	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV 1 - MURB,Healthcare,Nursing	Quasi	December 2015 TRM	6.64	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV 2 - Hotel,Restaurant,Retail	Quasi	December 2015 TRM	3.68	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV 3 - Off,Whse,Ed & All Other Comm	Quasi	December 2015 TRM	2.36	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV65 - High - MURB,Healthcare,Nursing	Quasi	December 2016 TRM	1.37	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV65 - Low - Office, Whse, School	Quasi	December 2016 TRM	0.49000	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV65 - Med - Hotel,Restaurant,Retail	Quasi	December 2016 TRM	0.76000	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV75 - Low - Office, Whse, School	Quasi	December 2016 TRM	0.86000	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV75 - Med - Hotel,Restaurant,Retail	Quasi	December 2016 TRM	1.34	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV85 - Low - Office, Whse, School	Quasi	December 2016 TRM	1.23	CFM	14	5.0%	0.0%
C&I Prescriptive	ERV85 - Med - Hotel,Restaurant,Retail	Quasi	December 2016 TRM	1.93	CFM	14	5.0%	0.0%
C&I Prescriptive	Furnace - Condensing - High Efficiency - NC	Quasi	December 2016 TRM	2.33	kBTU/hour	18	17.5%	0.0%
C&I Prescriptive	Furnace - Condensing - High Efficiency - R	Quasi	December 2015 TRM	3.11	kBTU/hour	18	17.5%	0.0%
C&I Prescriptive	HRV 1 - MURB In-Suite	Quasi	December 2015 TRM	5.00	CFM	14	5.0%	0.0%
C&I Prescriptive	HRV 1 - MURB,Healthcare,Nursing	Quasi	December 2015 TRM	5.00	CFM	14	5.0%	0.0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive	HRV 2 - Hotel,Restaurant,Retail, Rec	Quasi	December 2015 TRM	2.78	CFM	14	5.0%	0.0%
C&I Prescriptive	HRV 3 - Off,Whse,Man,Ed,Other Comm	Quasi	December 2015 TRM	1.78	CFM	14	5.0%	0.0%
C&I Prescriptive	HRV65 - High - MURB In-Suite	Quasi	December 2016 TRM	1.16	CFM	14	5.0%	0.0%
C&I Prescriptive	HRV65 - High - MURB,Healthcare,Nursing	Quasi	December 2016 TRM	1.16	CFM	14	5.0%	0.0%
C&I Prescriptive	HRV75 - High - MURB,Healthcare,Nursing	Quasi	December 2016 TRM	1.93	CFM	14	5.0%	0.0%
C&I Prescriptive	Infrared Heating 1-Stage - NC	Quasi	December 2015 TRM	0.00860	BTU/hour	17	33.0%	0.0%
C&I Prescriptive	Infrared Heating 1-Stage - RF	Quasi	December 2015 TRM	0.01150	BTU/hour	17	33.0%	0.0%
C&I Prescriptive	Infrared Heating 2-Stage - NC	Quasi	December 2015 TRM	0.00980	BTU/hour	17	33.0%	0.0%
C&I Prescriptive	Infrared Heating 2-Stage - RF	Quasi	December 2015 TRM	0.01310	BTU/hour	17	33.0%	0.0%
C&I Prescriptive	MUA 01- MURB<C Imp Effic 1000-4999cfm	Quasi	December 2015 TRM	0.91900	CFM	20	5.0%	0.0%
C&I Prescriptive	MUA 02- MURB<C Imp Effic =>5000 cfm	Quasi	December 2015 TRM	0.91900	CFM	20	5.0%	0.0%
C&I Prescriptive	MUA 06- MURB<C Effic + VFD => 5000 cfm	Quasi	December 2015 TRM	3.00	CFM	20	5.0%	0.0%
C&I Prescriptive	MUA 07- Other Comm Imp Effic 1000-4999 cfm	Quasi	December 2015 TRM	0.40700	CFM	20	5.0%	0.0%
C&I Prescriptive	MUA 10- Other Comm Effic + 2 speed =>5000cfm	Quasi	December 2015 TRM	1.22	CFM	20	5.0%	0.0%
C&I Prescriptive	MUA 11- Other Comm Effic + VFD 1000-4999 cfm	Quasi	December 2015 TRM	2.03	CFM	20	5.0%	0.0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
C&I Prescriptive	MUA 12- Other Comm Effic + VFD =>5000 cfm	Quasi	December 2015 TRM	2.03	CFM	20	5.0%	0.0%
C&I Prescriptive	Ozone WE =< 60 lbs cap	Quasi	December 2015 TRM	0.03670	lbs/year	15	8.0%	0.0%
C&I Prescriptive	Ozone WE >60 lbs & < 500lbs	Quasi	December 2015 TRM	0.03670	lbs/year	15	8.0%	0.0%
C&I Prescriptive	Unit Heater - NC	Quasi	December 2015 TRM	0.00592	BTU/hour	18	0.0%	0.0%
C&I Prescriptive	Unit Heater - R	Quasi	December 2015 TRM	0.00798	BTU/hour	18	0.0%	0.0%
Furnace End-of-Life	Furnace End of Life - LISF	Quasi	December 2016 TRM	1.05	kBTU/hour input capacity	18	0.0%	0.0%
Home Weatherization	Faucet Aerator - Bath	Pure	December 2015 TRM	6.40	unit	10	1.0%	0.0%
Home Weatherization	Faucet Aerator - Kitchen	Pure	December 2015 TRM	11.56	unit	10	1.0%	0.0%
Home Weatherization	Pipe Insulation - 2m	Pure	December 2015 TRM	4.72	ft	15	1.0%	0.0%
Home Weatherization	Showerhead - 1.25 GPM Existing 2.0-2.5	Pure	December 2015 TRM	44.00‡	unit	10	1.0%	0.0%
Home Weatherization	Showerhead - 1.25 GPM Existing 2.6+	Pure	December 2015 TRM	88.00†	unit	10	1.0%	0.0%
Home Weatherization	Thermostat - Programmable	Pure	December 2015 TRM	46.00	unit	15	1.0%	0.0%
Large Volume	Air Curtains-Single Door - 7X3	Pure	December 2016 TRM	671.00	unit	15	5.0%	0.0%
Large Volume	Infrared Heating 1-Stage - NC	Quasi	December 2015 TRM	0.00860	BTU/hour	17	33.0%	0.0%
Large Volume	Infrared Heating 1-Stage - RF	Quasi	December 2015 TRM	0.01150	BTU/hour	17	33.0%	0.0%
Large Volume	Infrared Heating 2-Stage - RF	Quasi	December 2015 TRM	0.01310	BTU/hour	17	33.0%	0.0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
Multi-Family (Market Rate)	Condensing Boiler Space Heating - >= 1,000 MBTU/hour - LIMFMR	Quasi	December 2015 TRM	0.01040	BTU/hour	25	5.0%	0.0%
Multi-Family (Market Rate)	Condensing Boiler Space Heating - 300 to 999 MBTU/hour - LIMFMR	Quasi	December 2015 TRM	0.01040	BTU/hour	25	5.0%	0.0%
Multi-Family (Market Rate)	Condensing Boiler Space Heating - up to 299 MBTU/hour - LIMFMR	Quasi	December 2015 TRM	0.01019	BTU/hour	25	5.0%	0.0%
Multi-Family (Market Rate)	Condensing Boiler Water Heating - 300 to 999 MBTU/hour - LIMFMR	Quasi	December 2012 TRM	0.00735	BTU/hour	25	5.0%	0.0%
Multi-Family (Market Rate)	MUA 05- MURB & LTC Effic + VFD 1000-4999 CFM - LIMFMR	Quasi	December 2015 TRM	3.00	CFM	20	5.0%	0.0%
Multi-Family (Market Rate)	MUA 06- MURB & LTC Effic + VFD => 5000 CFM - LIMFMR	Quasi	December 2015 TRM	3.00	CFM	20	5.0%	0.0%
Multi-Family (Social and Assisted)	Condensing Boiler Space Heating - >= 1,000 MBTU/hour - LIMF	Quasi	December 2015 TRM	0.01040	BTU/hour	25	5.0%	0.0%
Multi-Family (Social and Assisted)	Condensing Boiler Space Heating - 300 to 999 MBTU/hour - LIMF	Quasi	December 2015 TRM	0.01040	BTU/hour	25	5.0%	0.0%
Multi-Family (Social and Assisted)	Condensing Boiler Space Heating - up to 299 MBTU/hour - LIMF	Quasi	December 2015 TRM	0.01019	BTU/hour	25	5.0%	0.0%
Multi-Family (Social and Assisted)	Condensing Boiler Water Heating - 300 to 999 MBTU/hour - LIMF	Quasi	December 2012 TRM	0.00735	BTU/hour	25	5.0%	0.0%
Multi-Family (Social and Assisted)	Condensing Boiler Water Heating - up to 299 MBTU/hour - LIMF - (100 to 199 MBTU/hour)	Quasi	December 2015 TRM	0.01332	BTU/hour	25	5.0%	0.0%

Program	Measure	Pure or Quasi	Source	Savings Factor (m ³)	Unit	EUL	Free Ridership	Adjustment Factor
Multi-Family (Social and Assisted)	Condensing Boiler Water Heating - up to 299 MBTU/hour - LIMF - (200 to 299 MBTU/hour)	Quasi	December 2015 TRM	0.00996	BTU/hour	25	5.0%	0.0%
Multi-Family (Social and Assisted)	Condensing Gas Tankless Water Heater - High - LIMF	Mixed	December 2016 TRM	212+0.00179	unit + BTU/hour	20	2.0%	0.0%
Multi-Family (Social and Assisted)	Condensing Storage Water Heater - High	Quasi	December 2015 TRM	0.00309	kBTU/hour input capacity	15	5.0%	0.0%
Multi-Family (Social and Assisted)	ERV 1 - MURB, Healthcare, Nursing - LIMF	Quasi	December 2015 TRM	6.64	CFM	14	5.0%	0.0%
Multi-Family (Social and Assisted)	Furnace - Condensing - High Efficiency - R LIMF	Quasi	December 2015 TRM	0.00311	kBTU/hour	18	17.5%	0.0%
Multi-Family (Social and Assisted)	HRV 1 - MURB, Healthcare, Nursing - LIMF	Quasi	December 2015 TRM	5.00	CFM	14	5.0%	0.0%
Multi-Family (Social and Assisted)	MUA 01- MURB & LTC Imp Effic 1000-4999 CFM - LIMF	Quasi	December 2015 TRM	0.91900	CFM	20	5.0%	0.0%
Multi-Family (Social and Assisted)	MUA 03- MURB & LTC Effic + 2 speed 1000-4999 CFM - LIMF	Quasi	December 2015 TRM	2.45	CFM	20	5.0%	0.0%
Multi-Family (Social and Assisted)	MUA 05- MURB & LTC Effic + VFD 1000-4999 CFM - LIMF	Quasi	December 2015 TRM	3.00	CFM	20	5.0%	0.0%
Multi-Family (Social and Assisted)	MUA 06- MURB & LTC Effic + VFD => 5000 CFM - LIMF	Quasi	December 2015 TRM	3.00	CFM	20	5.0%	0.0%

*Not all values may compute exactly due to rounding.

‡This value was calculated from the TRM Detail for Showerheads, given that the TRM tables only consider showerheads replacing base equipment with efficiency of 2.5 GPM, whereas the measure description indicates that the base equipment has an *average* efficiency of 2.25 GPM

†This value was calculated from the TRM Detail for Showerheads, given that the TRM tables only consider showerheads replacing base equipment with efficiency of 2.5 GPM, whereas the measure description indicates that the base equipment has an *average* efficiency of 2.25 GPM

Savings Calculation Measure Totals

Table 239. Enbridge Measure Savings, Tracked and Verified, by Annual and Cumulative, Gross and Net*

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Direct - Large	Direct Install Air Doors 10 x 10	20,796	19,756	311,940	296,343	20,796	19,756	311,940	296,343
C&I Direct - Large	Direct Install Air Doors 8 x 10	272,430	258,809	4,086,450	3,882,128	272,430	258,809	4,086,450	3,882,128
C&I Direct - Large	Direct Install Air Doors 8 x 8	36,324	34,508	544,860	517,617	36,324	34,508	544,860	517,617
C&I Direct - Small	Direct Install Air Doors 10 x 10	1,538,904	1,461,959	23,083,560	21,929,382	1,538,904	1,461,959	23,083,560	21,929,382
C&I Direct - Small	Direct Install Air Doors 8 x 10	3,359,970	3,191,972	50,399,550	47,879,573	3,359,970	3,191,972	50,399,550	47,879,573
C&I Direct - Small	Direct Install Air Doors 8 x 8	326,916	310,570	4,903,740	4,658,553	326,916	310,570	4,903,740	4,658,553
C&I Prescriptive - Large	Air Door 10 x 10	20,796	19,756	311,940	296,343	20,796	19,756	311,940	296,343
C&I Prescriptive - Large	Air Door Double 7 x 6 Door	10,744	10,207	161,160	153,102	10,744	10,207	161,160	153,102
C&I Prescriptive - Large	Air Door Single 7 x 3	1,342	1,275	20,130	19,124	1,342	1,275	20,130	19,124
C&I Prescriptive - Large	Cond Boiler 100-199MBH Cx DWH	10,390	9,870	259,740	246,753	10,390	9,870	259,740	246,753
C&I Prescriptive - Large	Cond HF 75-149 Kbtu's Cx	249	205	4,478	3,695	249	205	4,478	3,695
C&I Prescriptive - Large	Condensing MUA 1 Speed Multi-Res	9,492	9,018	189,847	180,355	9,492	9,018	189,847	180,355
C&I Prescriptive - Large	Condensing MUA 1 Speed Other	8,954	8,506	179,080	170,126	8,954	8,506	179,080	170,126
C&I Prescriptive - Large	Cond Strge W/H Low Retail 75-250 Kbtu Cx	136	129	2,040	1,938	136	129	2,040	1,938
C&I Prescriptive - Large	Cond Tankless Low Multi-Res >=200 Kbtu Cx	2,062	2,021	41,248	40,423	2,062	2,021	41,248	40,423
C&I Prescriptive - Large	DCKV 10,001-15,000 CFM	35,058	33,305	525,870	499,577	35,058	33,305	525,870	499,577
C&I Prescriptive - Large	DCKV 5,001-10,000 CFM	63,102	59,947	946,530	899,204	63,102	59,947	946,530	899,204

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive - Large	DCKV Up to 5000 CFM	25,242	23,980	378,630	359,699	25,242	23,980	378,630	359,699
C&I Prescriptive - Large	DCV Single Zone Retail with NO Maintenance Cx Offer	50,507	47,982	505,072	479,819	50,507	47,982	505,072	479,819
C&I Prescriptive - Large	Destratification Fan	57,222	51,500	858,330	772,497	57,222	51,500	858,330	772,497
C&I Prescriptive - Large	Dishwasher Single-Tank Conveyer High Temp	2,800	2,044	56,000	40,880	2,800	2,044	56,000	40,880
C&I Prescriptive - Large	Dishwasher Stationary Rack High Temp	2,766	2,213	41,490	33,192	2,766	2,213	41,490	33,192
C&I Prescriptive - Large	Dishwasher Under-Counter Low Temp	333	200	3,330	1,998	333	200	3,330	1,998
C&I Prescriptive - Large	ERV Office 65% - 74% -	686	652	9,604	9,124	686	652	9,604	9,124
C&I Prescriptive - Large	ERV Vent Low Int Office Cx	9,440	8,968	132,160	125,552	9,440	8,968	132,160	125,552
C&I Prescriptive - Large	ERV Vent Low Stand Office	2,242	2,130	31,388	29,819	2,242	2,130	31,388	29,819
C&I Prescriptive - Large	ERV Vent Med Int Retail Res Cx	21,896	20,801	306,544	291,217	21,896	20,801	306,544	291,217
C&I Prescriptive - Large	Fryer	5,632	4,506	67,584	54,067	5,632	4,506	67,584	54,067
C&I Prescriptive - Large	High Boiler >2000MBH Cx Offer - 12%	27,325	24,046	683,125	601,150	27,325	24,046	683,125	601,150
C&I Prescriptive - Large	High Boiler >2000MBH Cx Offer - 20%	27,325	21,860	683,125	546,500	27,325	21,860	683,125	546,500
C&I Prescriptive - Large	High Boiler 1000-1499MBH Cx Offer - 12%	24,282	21,368	607,050	534,204	24,282	21,368	607,050	534,204
C&I Prescriptive - Large	High Boiler 1000-1499MBH Cx Offer - 12% DWH	5,431	4,779	135,775	119,482	5,431	4,779	135,775	119,482
C&I Prescriptive - Large	High Boiler 1000-1499MBH Cx Offer - 20% DWH	16,293	13,034	407,325	325,860	16,293	13,034	407,325	325,860
C&I Prescriptive - Large	High Boiler 1500-1999MBH Cx Offer - 20% DWH	14,950	11,960	373,750	299,000	14,950	11,960	373,750	299,000

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive - Large	High Boiler 300-599MBH Cx Offer - 12%	13,984	12,306	349,600	307,648	13,984	12,306	349,600	307,648
C&I Prescriptive - Large	High Boiler 300-599MBH Cx Offer - 12% DWH	3,722	3,275	93,050	81,884	3,722	3,275	93,050	81,884
C&I Prescriptive - Large	High Boiler 300-599MBH Cx Offer - 20% DWH	3,722	2,978	93,050	74,440	3,722	2,978	93,050	74,440
C&I Prescriptive - Large	High Boiler 600-999MBH Cx Offer - 12% DWH	3,076	2,707	76,900	67,672	3,076	2,707	76,900	67,672
C&I Prescriptive - Large	HRV Vent Low Stand Office Cx	2,492	2,367	34,888	33,144	2,492	2,367	34,888	33,144
C&I Prescriptive - Large	HRV Vent Med Stand Retail Cx	11,120	10,564	155,680	147,896	11,120	10,564	155,680	147,896
C&I Prescriptive - Large	Industrial Air Door 10 x 10	41,592	39,512	623,880	592,686	41,592	39,512	623,880	592,686
C&I Prescriptive - Large	Ind Infrared Single Stage 50,000-164,999 Cx Offer	48,300	32,361	821,100	550,137	48,300	32,361	821,100	550,137
C&I Prescriptive - Large	Infrared Single Stage 165,000-300,000 Cx Offer	13,225	8,861	224,825	150,633	13,225	8,861	224,825	150,633
C&I Prescriptive - Large	Infrared Single Stage 50,000-164,999 Cx Offer	88,953	59,598	1,512,193	1,013,169	88,953	59,598	1,512,193	1,013,169
C&I Prescriptive - Large	Ozone Washer Extractor =/<60lbs Cx Offer	305,377	280,947	4,580,658	4,214,206	305,377	280,947	4,580,658	4,214,206
C&I Prescriptive - Large	Ozone Washer Extractor >60lbs<500lbs Cx Offer	283,650	260,958	4,254,746	3,914,366	283,650	260,958	4,254,746	3,914,366
C&I Prescriptive - Large	School Board Boiler Elementary	36,650	32,252	916,250	806,300	36,651	32,253	916,275	806,322
C&I Prescriptive - Large	School Board Boiler Secondary	98,953	87,079	2,473,824	2,176,965	98,952	87,078	2,473,800	2,176,944
C&I Prescriptive - Large	Showerhead - Direct Install	56,855	43,238	568,548	432,381	56,855	43,238	568,548	432,381
C&I Prescriptive - Large	Showerhead - Prescriptive	14,290	10,868	142,902	108,677	14,290	10,868	142,902	108,677
C&I Prescriptive - Small	Air Door 8 x 10	45,405	43,135	681,075	647,021	45,405	43,135	681,075	647,021
C&I Prescriptive - Small	Air Door Double 7 x 3 Door	5,372	5,103	80,580	76,551	5,372	5,103	80,580	76,551

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive - Small	Air Door Double 7 x 6 Door	21,488	20,414	322,320	306,204	21,488	20,414	322,320	306,204
C&I Prescriptive - Small	Air Door Single 7 x 3	5,368	5,100	80,520	76,494	5,368	5,100	80,520	76,494
C&I Prescriptive - Small	Condensing Boiler <100 MBH DWH	3,255	3,092	81,375	77,306	3,255	3,092	81,375	77,306
C&I Prescriptive - Small	Condensing Boiler 100-199 MBH	10,455	9,932	261,374	248,305	10,455	9,932	261,374	248,305
C&I Prescriptive - Small	Condensing Boiler 100-199 MBH DWH	4,649	4,416	116,217	110,406	4,649	4,416	116,217	110,406
C&I Prescriptive - Small	Condensing Boiler 200-299 MBH	21,766	20,678	544,146	516,939	21,766	20,678	544,146	516,939
C&I Prescriptive - Small	Condensing Boiler 200-299 MBH DWH	15,787	14,997	394,665	374,932	15,787	14,997	394,665	374,932
C&I Prescriptive - Small	Condensing High Efficiency Furnace 75-149 KBTU	2,908	2,399	52,341	43,182	2,908	2,399	52,341	43,182
C&I Prescriptive - Small	Condensing Storage Water Heater - Low Retail (75-250 KBTU)	102	97	1,530	1,454	102	97	1,530	1,454
C&I Prescriptive - Small	Condensing Tankless Water Heater - Low - Retail (>75 and <200 kBTU)	738	724	14,768	14,473	738	724	14,768	14,473
C&I Prescriptive - Small	Condensing Unit Heater 30-100 kBTU	2,367	2,367	42,606	42,606	2,367	2,367	42,606	42,606
C&I Prescriptive - Small	DCKV 10,001-15,000 CFM	122,703	116,568	1,840,545	1,748,518	122,703	116,568	1,840,545	1,748,518
C&I Prescriptive - Small	DCKV 5,001-10,000 CFM	294,476	279,752	4,417,140	4,196,283	294,476	279,752	4,417,140	4,196,283
C&I Prescriptive - Small	DCKV Up to 5000 CFM	46,277	43,963	694,155	659,447	46,277	43,963	694,155	659,447
C&I Prescriptive - Small	DCV Single Zone Office with Maintenance - NC	8,836	7,069	132,539	106,031	8,836	7,069	132,539	106,031
C&I Prescriptive - Small	DCV Single Zone Retail with Maintenance	6,272	5,958	94,080	89,376	6,272	5,958	94,080	89,376
C&I Prescriptive - Small	DCV Single Zone Retail with Maintenance - NC	44,399	35,519	665,986	532,789	44,399	35,519	665,986	532,789

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive - Small	DCV Single Zone Retail with NO Maintenance	96,785	91,946	967,848	919,456	96,785	91,946	967,848	919,456
C&I Prescriptive - Small	DCV Single Zone Retail with NO Maintenance - NC	9,212	7,370	92,120	73,696	9,212	7,370	92,120	73,696
C&I Prescriptive - Small	Destratification Fan	57,222	51,500	858,330	772,497	57,222	51,500	858,330	772,497
C&I Prescriptive - Small	Dishwasher Single-Tank Conveyer High Temp	560	409	11,200	8,176	560	409	11,200	8,176
C&I Prescriptive - Small	Dishwasher Stationary Rack High Temp	4,610	3,688	69,150	55,320	4,610	3,688	69,150	55,320
C&I Prescriptive - Small	Dishwasher Under-Counter Low Temp	4,329	2,597	43,290	25,974	4,329	2,597	43,290	25,974
C&I Prescriptive - Small	ERV Vent Low Integrated Office	5,900	5,605	82,600	78,470	5,900	5,605	82,600	78,470
C&I Prescriptive - Small	ERV Vent Low Stand Office	9,770	9,282	136,786	129,946	9,770	9,282	136,786	129,946
C&I Prescriptive - Small	ERV Vent Medium Integrated Retail Restaurant	2,208	2,098	30,912	29,366	2,208	2,098	30,912	29,366
C&I Prescriptive - Small	Fryer	178,816	143,053	2,145,792	1,716,634	178,816	143,053	2,145,792	1,716,634
C&I Prescriptive - Small	High Efficiency Boiler 600-999 MBH - 20%	13,265	10,612	331,625	265,300	13,266	10,613	331,650	265,320
C&I Prescriptive - Small	High Efficiency Boiler 600-999 MBH - 20% DWH	3,076	2,461	76,900	61,520	3,076	2,461	76,900	61,520
C&I Prescriptive - Small	HRV Office 65% - 74%	492	467	6,888	6,544	492	467	6,888	6,544
C&I Prescriptive - Small	Industrial Air Door 10 x 10	20,796	19,756	311,940	296,343	20,796	19,756	311,940	296,343
C&I Prescriptive - Small	Industrial Air Door 8 x 10	30,270	28,757	454,050	431,348	30,270	28,757	454,050	431,348
C&I Prescriptive - Small	Industrial Air Door 8 x 8	108,972	103,523	1,634,580	1,552,851	108,972	103,523	1,634,580	1,552,851
C&I Prescriptive - Small	Industrial Air Door Double 7 x 6 Door	2,686	2,552	40,290	38,276	2,686	2,552	40,290	38,276

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive - Small	Industrial Air Door Single 7 x 3 Door	671	637	10,065	9,562	671	637	10,065	9,562
C&I Prescriptive - Small	Industrial Infrared 2-Stage 165,000-300,000	2,293	1,536	38,973	26,112	2,293	1,536	38,973	26,112
C&I Prescriptive - Small	Industrial Infrared 2-Stage 50,000-164,999	43,230	28,964	734,910	492,390	43,230	28,964	734,910	492,390
C&I Prescriptive - Small	Industrial Infrared Single Stage 0-49,999	920	616	15,640	10,479	920	616	15,640	10,479
C&I Prescriptive - Small	Industrial Infrared Single Stage 165,000-300,000	26,910	18,030	457,470	306,505	26,910	18,030	457,470	306,505
C&I Prescriptive - Small	Industrial Infrared Single Stage 50,000-164,999	91,195	61,101	1,550,315	1,038,711	91,195	61,101	1,550,315	1,038,711
C&I Prescriptive - Small	Infrared 2-Stage 0-49,999	2,096	1,404	35,632	23,873	2,096	1,404	35,632	23,873
C&I Prescriptive - Small	Infrared 2-Stage 165,000-300,000 - NC	49,780	33,353	846,260	566,994	49,780	33,353	846,260	566,994
C&I Prescriptive - Small	Infrared 2-Stage 50,000-164,999	45,981	30,807	781,677	523,724	45,981	30,807	781,677	523,724
C&I Prescriptive - Small	Infrared 2-Stage 50,000-164,999 - NC	123,140	82,504	2,093,380	1,402,565	123,140	82,504	2,093,380	1,402,565
C&I Prescriptive - Small	Infrared Single Stage 165,000-300,000	56,925	38,140	967,725	648,376	56,925	38,140	967,725	648,376
C&I Prescriptive - Small	Infrared Single Stage 50,000-164,999	250,240	167,661	4,254,080	2,850,234	250,240	167,661	4,254,080	2,850,234
C&I Prescriptive - Small	Ozone Washer Extractor =/<60lbs	74,077	68,151	1,111,157	1,022,264	74,077	68,151	1,111,157	1,022,264
C&I Prescriptive - Small	Ozone Washer Extractor >60lbs<500lbs	20,897	19,225	313,455	288,378	20,897	19,225	313,455	288,378
C&I Prescriptive - Small	School Board Boiler Elementary	146,600	129,008	3,664,998	3,225,198	146,604	129,012	3,665,100	3,225,288
C&I Prescriptive - Small	Showerhead - Direct Install	68,085	51,779	680,850	517,786	68,085	51,779	680,850	517,786
C&I Prescriptive - Small	Showerhead - Prescriptive	37,791	28,740	377,910	287,401	37,791	28,740	377,910	287,401
Single Family Part 9	Bathroom Aerators	2,086	469	20,864	4,694	2,086	469	20,864	4,694
Single Family Part 9	Kitchen Aerators	2,971	996	29,709	9,957	2,971	996	29,709	9,957

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
Single Family Part 9	Programmable Thermostats	795	795	11,925	11,925	690	690	10,350	10,350
Single Family Part 9	Showerheads 2.6+	2,871	2,518	28,710	25,179	2,871	2,518	28,710	25,179
Low Income - Multi-Residential	Condensing Boiler 100-199 MBH DWH	2,651	2,651	66,267	66,267	2,651	2,651	66,267	66,267
Low Income - Multi-Residential	Condensing Boiler 200-299 MBH	2,904	2,904	72,604	72,604	2,904	2,904	72,604	72,604
Low Income - Multi-Residential	Condensing Boiler 200-299 MBH DWH	3,984	3,984	99,600	99,600	3,984	3,984	99,600	99,600
Low Income - Multi-Residential	High Efficiency Boiler Seasonal 1500-1999 MBH	76,756	76,756	1,918,900	1,918,900	76,756	76,756	1,918,900	1,918,900
Low Income - Multi-Residential	High Efficiency Boiler Seasonal 300-599 MBH	3,496	3,496	87,400	87,400	3,496	3,496	87,400	87,400
Low Income - Multi-Residential	High Efficiency Boiler Seasonal 600-999 MBH	19,899	19,899	497,475	497,475	19,899	19,899	497,475	497,475
Low Income - Multi-Residential	Showerheads	17,870	15,672	178,704	156,723	17,870	15,672	178,704	156,723
Low Income - Multi-Residential	Showerheads - DI	796	698	7,956	6,977	796	698	7,956	6,977
Residential Adaptive Thermostats	Residential Adaptive Thermostat	3,150,550	3,024,528	47,258,250	45,367,920	3,150,550	3,024,528	47,258,250	45,367,920

*Not all values may compute exactly due to rounding.

Table 240. Union Gas Measure Savings, Tracked and Verified, by Annual and Cumulative, Gross and Net*

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive	Air Curtains-Double Door - (2)7x3	8,058	7,655	120,870	114,827	8,058	7,655	120,870	114,827
C&I Prescriptive	Air Curtains-Double Door - (2)7x6	32,232	30,620	483,480	459,306	32,232	30,620	483,480	459,306
C&I Prescriptive	Air Curtains-Shipping Doors - 10x10	288,470	274,047	4,327,050	4,110,698	291,144	276,587	4,367,160	4,148,802
C&I Prescriptive	Air Curtains-Shipping Doors - 8x10	18,914	17,968	283,710	269,525	30,270	28,757	454,050	431,348
C&I Prescriptive	Air Curtains-Shipping Doors - 8x8	22,695	21,560	340,425	323,404	36,324	34,508	544,860	517,617
C&I Prescriptive	Air Curtains-Single Door - 7x3	12,078	11,474	181,170	172,112	12,078	11,474	181,170	172,112
C&I Prescriptive	Air Curtains-Single Door - 7x6	8,058	7,655	120,870	114,827	8,058	7,655	120,870	114,827
C&I Prescriptive	Air Curtains-Single Door - 8x6	2,668	2,535	40,020	38,019	6,488	6,164	97,320	92,454
C&I Prescriptive	Boiler Cycling Control - All other CI Purchased	35,067	31,560	701,340	631,206	35,067	31,560	701,340	631,206
C&I Prescriptive	Boiler Cycling Control - MURB Purchase	10,470	9,423	209,400	188,460	10,470	9,423	209,400	188,460
C&I Prescriptive	CEE Tier 2 Front-Loading Clothes Washer	1,872	1,685	20,592	18,533	1,872	1,685	20,592	18,533
C&I Prescriptive	Condensing Boiler SH - => 1,000 MBtu/hr	1,874,246	1,780,534	46,856,160	44,513,352	1,874,246	1,780,534	46,856,160	44,513,352
C&I Prescriptive	Condensing Boiler SH - 300 to 999 MBtu/hr	1,530,381	1,453,862	38,259,520	36,346,544	1,530,381	1,453,862	38,259,520	36,346,544
C&I Prescriptive	Condensing Boiler SH - up to 299 MBtu/hr	417,922	397,026	10,448,062	9,925,659	417,922	397,026	10,448,062	9,925,659
C&I Prescriptive	Condensing Boiler WH - => 1,000 MBtu/hr - >1000MBH	25,773	24,484	644,322	612,106	25,773	24,484	644,322	612,106
C&I Prescriptive	Condensing Boiler WH - => 1,000 MBtu/hr - >1500MBH	105,198	99,938	2,629,950	2,498,453	105,198	99,938	2,629,950	2,498,453
C&I Prescriptive	Condensing Boiler WH - 300 to 999 MBtu/hr - > 300 MBH	83,819	79,628	2,095,485	1,990,711	83,819	79,628	2,095,485	1,990,711
C&I Prescriptive	Condensing Boiler WH - 300 to 999 MBtu/hr - > 600 MBH	26,752	25,414	668,800	635,360	26,752	25,414	668,800	635,360

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive	Condensing Boiler WH - up to 299 MBtu/hr - (<100 MBTU/hour)	5,447	5,174	136,168	129,359	5,447	5,174	136,168	129,359
C&I Prescriptive	Condensing Boiler WH - up to 299 MBtu/hr - (100 to 199 MBTU/hour)	28,705	27,269	717,615	681,734	28,705	27,269	717,615	681,734
C&I Prescriptive	Condensing Boiler WH - up to 299 MBtu/hr - (200 to 299 MBTU/hour)	6,972	6,623	174,300	165,585	6,972	6,623	174,300	165,585
C&I Prescriptive	Condensing Gas Tankless Water Heater - High (>=200 MBTU/hour)	1,512	1,482	30,240	29,635	1,511	1,481	30,224	29,620
C&I Prescriptive	Condensing Gas Tankless Water Heater - High (>75 and <200 MBTU/hour)	3,336	3,269	66,720	65,386	3,338	3,271	66,753	65,418
C&I Prescriptive	Condensing Gas Tankless Water Heater - Low (>=200 MBTU/hour)	1,548	1,517	30,960	30,341	1,547	1,516	30,936	30,317
C&I Prescriptive	Condensing Gas Tankless Water Heater - Low (>75 and <200 MBTU/hour)	4,831	4,734	96,620	94,688	4,832	4,736	96,645	94,712
C&I Prescriptive	Condensing Gas Tankless Water Heater - Med (>75 and <200 MBTU/hour)	2,992	2,932	59,840	58,643	2,991	2,931	59,814	58,618
C&I Prescriptive	Condensing Storage Water Heater - High	68,757	65,319	893,841	849,149	47,108	44,752	706,615	671,284
C&I Prescriptive	Condensing Storage Water Heater - Low	10,441	9,919	135,733	128,946	4,565	4,337	68,481	65,057
C&I Prescriptive	Condensing Storage Water Heater - Medium	40,472	38,448	526,136	499,829	17,047	16,194	255,701	242,916
C&I Prescriptive	DCKV < 5000 cfm - RF	48,010	45,610	720,150	684,143	42,070	39,967	631,050	599,498
C&I Prescriptive	DCKV 10000-15000 cfm - NC	18,924	17,978	283,860	269,667	17,529	16,653	262,935	249,788
C&I Prescriptive	DCKV 10000-15000 cfm - RF	18,924	17,978	283,860	269,667	17,529	16,653	262,935	249,788
C&I Prescriptive	DCKV 5000 - 9999 cfm - NC	57,430	54,559	861,450	818,378	52,585	49,956	788,775	749,336
C&I Prescriptive	DCKV 5000 - 9999 cfm - RF	57,430	54,559	861,450	818,378	52,585	49,956	788,775	749,336
C&I Prescriptive	DCV-Office-RTU/MUA => 2500 sq ft-w/o plan - NC	4,385	3,508	43,852	35,082	4,385	3,508	43,852	35,082

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive	DCV-Office-RTU/MUA => 2500 sq ft-w/o plan - RF	3,228	3,066	32,275	30,661	3,228	3,066	32,275	30,661
C&I Prescriptive	DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan - NC	579	463	5,793	4,634	579	463	5,793	4,634
C&I Prescriptive	DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan - RF	885	841	8,850	8,408	885	841	8,850	8,408
C&I Prescriptive	DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan - NC	114,464	91,571	1,144,640	915,712	114,464	91,571	1,144,640	915,712
C&I Prescriptive	DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan - RF	71,109	67,553	711,088	675,534	71,109	67,553	711,088	675,534
C&I Prescriptive	Dishwasher - Rack Conveyor Single HT	560	409	11,200	8,176	560	409	11,200	8,176
C&I Prescriptive	Dishwasher - Stationary Rack Door Type HT	6,454	5,163	96,810	77,448	6,454	5,163	96,810	77,448
C&I Prescriptive	Dishwasher - Stationary Rack Door Type LT	91,160	72,928	1,367,400	1,093,920	91,160	72,928	1,367,400	1,093,920
C&I Prescriptive	Dishwasher - Undercounter HT	284	170	2,840	1,704	284	170	2,840	1,704
C&I Prescriptive	Dishwasher - Undercounter LT	1,332	799	13,320	7,992	1,332	799	13,320	7,992
C&I Prescriptive	Energy Star Convection Oven	865	692	10,380	8,304	865	692	10,380	8,304
C&I Prescriptive	Energy Star Fryer	47,872	38,298	574,464	459,571	47,872	38,298	574,464	459,571
C&I Prescriptive	ERV 1 - MURB In-Suite	413,219	392,558	5,785,060	5,495,807	475,524	451,747	6,657,330	6,324,464
C&I Prescriptive	ERV 1 - MURB,Healthcare,Nursing	396,099	376,294	5,545,390	5,268,120	441,726	419,640	6,184,164	5,874,956
C&I Prescriptive	ERV 2 - Hotel,Restaurant,Retail	166,584	158,255	2,332,180	2,215,571	183,246	174,083	2,565,438	2,437,166
C&I Prescriptive	ERV 3 - Off,Whse,Ed & All Other Comm	454,999	432,249	6,369,986	6,051,486	505,316	480,050	7,074,426	6,720,704
C&I Prescriptive	ERV65 - High - MURB,Healthcare,Nursing	14,022	13,321	196,307	186,492	14,022	13,321	196,307	186,492
C&I Prescriptive	ERV65 - Low - Office, Whse, School	21,592	20,512	302,286	287,172	21,592	20,512	302,286	287,172
C&I Prescriptive	ERV65 - Med - Hotel,Restaurant,Retail	7,220	6,859	101,080	96,026	7,220	6,859	101,080	96,026
C&I Prescriptive	ERV75 - Low - Office, Whse, School	688	654	9,632	9,150	688	654	9,632	9,150
C&I Prescriptive	ERV75 - Med - Hotel,Restaurant,Retail	3,095	2,941	43,336	41,169	3,095	2,941	43,336	41,169

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive	ERV85 - Low - Office, Whse, School	44,219	42,008	619,059	588,106	44,219	42,008	619,059	588,106
C&I Prescriptive	ERV85 - Med - Hotel, Restaurant, Retail	15,374	14,606	215,241	204,479	15,374	14,606	215,241	204,479
C&I Prescriptive	Furnace - Condensing - High Efficiency - NC	5,284	4,360	95,120	78,474	5,284	4,360	95,120	78,474
C&I Prescriptive	Furnace - Condensing - High Efficiency - R	16,162	13,333	290,908	239,999	29,566	24,392	532,191	439,057
C&I Prescriptive	HRV 1 - MURB In-Suite	8,178	7,769	114,492	108,767	8,700	8,265	121,800	115,710
C&I Prescriptive	HRV 1 - MURB, Healthcare, Nursing	91,592	87,012	1,282,288	1,218,174	107,000	101,650	1,498,000	1,423,100
C&I Prescriptive	HRV 2 - Hotel, Restaurant, Retail, Rec	1,566	1,488	21,924	20,828	1,668	1,585	23,352	22,184
C&I Prescriptive	HRV 3 - Off, Whse, Man, Ed, Other Comm	74,139	70,432	1,037,950	986,053	84,532	80,306	1,183,451	1,124,278
C&I Prescriptive	HRV65 - High - MURB In-Suite	1,518	1,443	21,258	20,195	1,518	1,443	21,258	20,195
C&I Prescriptive	HRV65 - High - MURB, Healthcare, Nursing	577	548	8,071	7,668	577	548	8,071	7,668
C&I Prescriptive	HRV75 - High - MURB, Healthcare, Nursing	8,799	8,359	123,184	117,025	8,799	8,359	123,184	117,025
C&I Prescriptive	Infrared Heating 1-Stage - NC	755,208	505,989	15,104,160	10,119,787	451,027	302,188	7,667,459	5,137,198
C&I Prescriptive	Infrared Heating 1-Stage - RF	385,157	258,055	7,703,136	5,161,101	307,591	206,086	5,229,039	3,503,456
C&I Prescriptive	Infrared Heating 2-Stage - NC	419,749	281,232	8,394,980	5,624,637	169,981	113,887	2,889,677	1,936,084
C&I Prescriptive	Infrared Heating 2-Stage - RF	180,290	120,794	3,605,800	2,415,886	97,595	65,389	1,659,115	1,111,607
C&I Prescriptive	MUA 01- MURB<C Imp Effic 1000-4999cfm	9,299	8,834	139,482	132,508	10,173	9,665	203,467	193,293
C&I Prescriptive	MUA 02- MURB<C Imp Effic =>5000 cfm	4,200	3,990	63,000	59,850	4,595	4,365	91,900	87,305
C&I Prescriptive	MUA 06- MURB<C Effic + VFD => 5000 cfm	60,444	57,422	906,660	861,327	62,100	58,995	1,242,000	1,179,900
C&I Prescriptive	MUA 07- Other Comm Imp Effic 1000-4999 cfm	5,049	4,797	75,737	71,950	5,012	4,762	100,244	95,232
C&I Prescriptive	MUA 10- Other Comm Effic + 2 speed =>5000cfm	7,500	7,125	112,500	106,875	7,320	6,954	146,400	139,080

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
C&I Prescriptive	MUA 11- Other Comm Effic + VFD 1000-4999 cfm	20,079	19,075	301,185	286,126	19,691	18,706	393,820	374,129
C&I Prescriptive	MUA 12- Other Comm Effic + VFD =>5000 cfm	127,967	121,569	1,919,511	1,823,535	125,495	119,220	2,509,892	2,384,397
C&I Prescriptive	Ozone WE =< 60 lbs cap	213,895	196,783	3,208,425	2,951,751	213,895	196,783	3,208,424	2,951,750
C&I Prescriptive	Ozone WE >60 lbs & < 500lbs	198,916	183,003	2,983,740	2,745,040	198,916	183,003	2,983,739	2,745,040
C&I Prescriptive	Unit Heater - NC	2,145	2,145	38,617	38,617	2,013	2,013	36,230	36,230
C&I Prescriptive	Unit Heater - R	947	947	17,037	17,037	1,184	1,184	21,303	21,303
Furnace End-of-Life	Furnace End of Life - LISF	1,617	1,617	29,106	29,106	1,617	1,617	29,106	29,106
Home Weatherization	Faucet Aerator - Bath	205	203	2,048	2,028	205	203	2,048	2,028
Home Weatherization	Faucet Aerator - Kitchen	381	378	3,815	3,777	381	378	3,815	3,777
Home Weatherization	Pipe Insulation - 2m	1,022	1,011	15,325	15,172	1,022	1,011	15,325	15,172
Home Weatherization	Showerhead - 1.25 GPM Existing 2.0-2.5	322	319	3,220	3,188	308	305	3,080	3,049
Home Weatherization	Showerhead - 1.25 GPM Existing 2.6+	704	697	7,040	6,970	704	697	7,040	6,970
Home Weatherization	Thermostat - Programmable	318	315	4,770	4,722	276	273	4,140	4,099
Large Volume	Air Curtains-Single Door - 7x3	671	637	10,065	9,562	671	637	10,065	9,562
Large Volume	Infrared Heating 1-Stage - NC	1,440	965	28,800	19,296	860	576	14,620	9,795
Large Volume	Infrared Heating 1-Stage - RF	864	579	17,280	11,578	690	462	11,730	7,859
Large Volume	Infrared Heating 2-Stage - RF	59,290	39,724	1,185,800	794,486	32,095	21,504	545,615	365,562
Multi-Family (Market Rate)	Condensing Boiler Space Heating - >= 1,000 MBTU/hour - LIMFMR	220,480	209,456	5,512,000	5,236,400	220,480	209,456	5,512,000	5,236,400
Multi-Family (Market Rate)	Condensing Boiler Space Heating - 300 to 999 MBTU/hour - LIMFMR	47,746	45,359	1,193,660	1,133,977	47,746	45,359	1,193,660	1,133,977

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
Multi-Family (Market Rate)	Condensing Boiler Space Heating - up to 299 MBTU/hour - LIMFMR	11,617	11,036	290,415	275,894	11,617	11,036	290,415	275,894
Multi-Family (Market Rate)	Condensing Boiler Water Heating - 300 to 999 MBTU/hour - LIMFMR	22,028	20,927	550,699	523,164	22,028	20,927	550,699	523,164
Multi-Family (Market Rate)	MUA 05- MURB & LTC Effic + VFD 1000-4999 CFM - LIMFMR	24,277	23,063	364,153	345,946	24,942	23,695	498,840	473,898
Multi-Family (Market Rate)	MUA 06- MURB & LTC Effic + VFD => 5000 CFM - LIMFMR	23,360	22,192	350,400	332,880	24,000	22,800	480,000	456,000
Multi-Family (Social and Assisted)	Condensing Boiler Space Heating - >= 1,000 MBTU/hour - LIMF	24,960	23,712	624,000	592,800	24,960	23,712	624,000	592,800
Multi-Family (Social and Assisted)	Condensing Boiler Space Heating - 300 to 999 MBTU/hour - LIMF	83,273	79,109	2,081,820	1,977,729	83,273	79,109	2,081,820	1,977,729
Multi-Family (Social and Assisted)	Condensing Boiler Space Heating - up to 299 MBTU/hour - LIMF	17,669	16,786	441,737	419,650	17,669	16,786	441,737	419,650
Multi-Family (Social and Assisted)	Condensing Boiler Water Heating - 300 to 999 MBTU/hour - LIMF	2,933	2,786	73,316	69,650	2,933	2,786	73,316	69,650
Multi-Family (Social and Assisted)	Condensing Boiler Water Heating - up to 299 MBTU/hour - LIMF - (100 to 199 MBTU/hour)	5,301	5,036	132,534	125,907	5,301	5,036	132,534	125,907
Multi-Family (Social and Assisted)	Condensing Boiler Water Heating - up to 299 MBTU/hour - LIMF - (200 to 299 MBTU/hour)	5,797	5,507	144,918	137,672	5,797	5,507	144,918	137,672
Multi-Family (Social and Assisted)	Condensing Gas Tankless Water Heater - High - LIMF	1,704	1,670	34,080	33,398	1,705	1,671	34,093	33,411
Multi-Family (Social and Assisted)	Condensing Storage Water Heater - High	23,460	22,287	304,980	289,731	12,396	11,777	185,947	176,650
Multi-Family (Social and Assisted)	ERV 1 - MURB, Healthcare, Nursing - LIMF	108,630	103,199	1,520,820	1,444,779	117,860	111,967	1,650,040	1,567,538

Program	Measure	Tracked				Verified			
		Annual		Cumulative		Annual		Cumulative	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net
Multi-Family (Social and Assisted)	Furnace - Condensing - High Efficiency - R LIMF	75	62	1,346	1,111	137	113	2,463	2,032
Multi-Family (Social and Assisted)	HRV 1 - MURB, Healthcare, Nursing - LIMF	2,082	1,978	29,149	27,692	2,215	2,104	31,010	29,460
Multi-Family (Social and Assisted)	MUA 01- MURB & LTC Imp Effic 1000-4999 CFM - LIMF	3,961	3,763	59,409	56,439	4,333	4,116	86,662	82,329
Multi-Family (Social and Assisted)	MUA 03- MURB & LTC Effic + 2 speed 1000-4999 CFM - LIMF	8,730	8,294	130,950	124,403	11,025	10,474	220,500	209,475
Multi-Family (Social and Assisted)	MUA 05- MURB & LTC Effic + VFD 1000-4999 CFM - LIMF	23,652	22,469	354,780	337,041	24,300	23,085	486,000	461,700
Multi-Family (Social and Assisted)	MUA 06- MURB & LTC Effic + VFD => 5000 CFM - LIMF	47,742	45,355	716,130	680,324	49,050	46,598	981,000	931,950

*Not all values may compute exactly due to rounding.

Savings Verification Discrepancies

Table 241. Enbridge measure verification discrepancies

Program	Measure	Issue	Resolution	Tracked Annual Net Savings (m ³)	Certified Annual Net Savings (m ³)
C&I Prescriptive - Large	School Board Boiler Elementary	Rounding error	-	32,252	32,253
C&I Prescriptive - Large	School Board Boiler Secondary	Rounding error	-	87,079	87,078
C&I Prescriptive - Large	Showerhead - Direct Install	Measure description lacks detail to match to TRM.	Enbridge confirmed measure details.	43,238	43,238
C&I Prescriptive - Large	Showerhead - Prescriptive	Measure description lacks detail to match to TRM.	Enbridge confirmed measure details.	10,868	10,868
C&I Prescriptive - Small	High Efficiency Boiler 600-999 MBH - 20%	Rounding error	-	10,612	10,613
C&I Prescriptive - Small	School Board Boiler Elementary	Rounding error	-	129,008	129,012
Single Family Part 9	Programmable Thermostat	Incorrect savings value, possibly taken from previous TRM.	Update to December 2015 TRM values	795	690
Single Family Part 9	Bathroom Aerators	Measure description lacks detail to match to TRM. TRM table value is truncated.	Used savings value from detailed measure description and assumptions.	469	469
Single Family Part 9	Kitchen Aerators	Measure description lacks detail to match to TRM. TRM table value is truncated.	Used savings value from detailed measure description and assumptions.	996	996
Low Income - Multi Residential	Condensing Boiler 100-199 MBH DWH	Free-ridership rate of 0% applied in tracking does not match nearest measure match in TRM.	Verified free-ridership of 0% in EB-2012-0394, Exhibit B, Tab 2, Schedule 9, page 9 of 28	2,651	2,651
Low Income - Multi Residential	Condensing Boiler 200-299 MBH DWH	Free-ridership rate of 0% applied in tracking does not match nearest measure match in TRM.	Verified free-ridership of 0% in EB-2012-0394, Exhibit B, Tab 2, Schedule 9, page 9 of 28	3,984	3,984
Low Income - Multi Residential	Showerheads	Measure description lacks detail to match to TRM.	Enbridge confirmed measure details.	15,672	15,672
Low Income - Multi Residential	Showerheads - DI	Measure description lacks detail to match to TRM.	Enbridge confirmed measure details.	698	698

Table 242. Union measure verification discrepancies

Program	Measure	Issue	Resolution	Tracked Annual Net Savings (m ³)	Certified Annual Net Savings (m ³)
C&I Prescriptive	Condensing Gas Tankless Water Heater - High (>=200 MBTU/hour)	Rounding error.	-	1,482	1,481
C&I Prescriptive	Condensing Gas Tankless Water Heater - High (>75 and <200 MBTU/hour)	Rounding error.	-	3,269	3,271
C&I Prescriptive	Condensing Gas Tankless Water Heater - Low (>=200 MBTU/hour)	Rounding error.	-	1,517	1,516
C&I Prescriptive	Condensing Gas Tankless Water Heater - Low (>75 and <200 MBTU/hour)	Rounding error.	-	4,734	4,736
C&I Prescriptive	Condensing Gas Tankless Water Heater - Med (>75 and <200 MBTU/hour)	Rounding error.	-	2,932	2,931
C&I Prescriptive	Ozone WE =< 60 lbs cap	Rounding error.	-	196,783	196,783
Home Weatherization	Faucet Aerator - Bath	Savings value truncated in TRM table.	Used savings value from detailed description in TRM.	203	203
Home Weatherization	Faucet Aerator - Kitchen	Savings value truncated in TRM table.	Used savings value from detailed description in TRM.	378	378
Multi-Family (Social and Assisted)	Condensing Gas Tankless Water Heater - High - LIMF	Rounding error.	-	1,670	1,671

Appendix M Program Spending Tables

Table 243. Enbridge 2016 approved and spent budget*

Scorecard/Program	OEB- Approved Budget	Actual Spending			Difference	
		Indirect	Direct	Total	\$	%
Resource Acquisition Total	\$29,303,625	\$30,176,888	\$4,060,752	\$34,237,640	-\$4,934,015	-17%
Home Energy Conservation	\$12,148,317	\$19,276,705	\$2,780,753	\$22,057,458	-\$9,909,141	-82%
Residential Adaptive Thermostats	\$876,371	\$1,624,495	\$42,258	\$1,666,753	-\$790,382	-90%
C&I Custom	\$7,020,664	\$5,707,596	\$1,038,523	\$6,746,119	\$274,545	4%
C&I Direct Install	\$4,955,421	\$2,388,106	\$2,796	\$2,390,902	\$2,564,519	52%
C&I Prescriptive	\$2,196,952	\$960,100	\$41,572	\$1,001,671	\$1,195,281	54%
Energy Leaders Initiative	\$400,000	\$72,744	\$1,031	\$73,775	\$326,225	82%
Run it Right	\$1,260,162	\$147,142	\$153,820	\$300,962	\$959,200	76%
Comprehensive Energy Management	\$48,805	\$0	\$0	\$0	\$48,805	100%
Small Commercial New Construction	\$396,933	\$0	\$0	\$0	\$396,933	100%
Low Income Total	\$10,201,788	\$5,684,818	\$1,443,734	\$7,128,552	\$3,073,236	30%
Single Family (Part 9)	\$5,806,064	\$3,779,498	\$763,852	\$4,543,350	\$1,262,714	22%
Multi Residential (Part 3)	\$3,279,028	\$1,866,183	\$460,142	\$2,326,325	\$952,703	29%
New Construction	\$1,116,696	\$39,137	\$219,740	\$258,877	\$857,819	77%
Market Transformation Total	\$5,614,683	\$3,876,444	\$1,613,797	\$5,490,241	\$124,442	2%
Residential SBD	\$3,250,842	\$2,747,934	\$721,187	\$3,469,121	-\$218,279	-7%
Commercial SBD	\$1,345,890	\$1,128,355	\$270,585	\$1,398,940	-\$53,050	-4%
CEM	\$464,930	\$155	\$106,651	\$106,806	\$358,124	77%
Run it Right	\$250,824	\$0	\$225,819	\$225,819	\$25,005	10%
School Energy Competition	\$302,197	\$0	\$289,555	\$289,555	\$12,642	4%
Overhead Total	\$7,741,021	\$0	\$7,121,236	\$7,121,236	\$619,785	8%
Resource Acquisition	\$5,033,048	\$0	\$4,630,077	\$4,630,077	\$402,971	8%
Low Income	\$1,743,622	\$0	\$1,604,019	\$1,604,019	\$139,603	8%
Market Transformation	\$964,351	\$0	\$887,140	\$887,140	\$77,211	8%
Portfolio Overhead	\$3,500,000	\$0	\$1,670,616	\$1,670,616	\$1,829,384	52%
Research	\$1,000,000	\$0	\$248,279	\$248,279	-\$751,721	-75%
Evaluation	\$1,500,000	\$0	\$1,327,235	\$1,327,235	-\$172,765	-12%
Administration	\$1,000,000	\$0	\$95,101	\$95,101	-\$904,899	-90%
Total	\$56,361,117	\$39,738,150	\$15,910,135	\$55,648,285	\$712,832	1%

*Not all values may compute exactly due to rounding.

Table 244: Union 2016 approved and spent budget*

Program/Scorecard	OEB-Approved Budget	Actual Spend	Difference	
			\$	%
Resource Acquisition Scorecard				
Residential Incentives/Promotion	\$7,233,000	\$9,689,152	-\$2,456,152	-34%
Residential Administration	\$819,657	\$510,346	\$309,311	38%
Residential Evaluation	\$559,000	\$1,001,900	-\$442,900	-79%
Total Residential Program	\$8,611,657	\$11,201,397	-\$2,589,740	-30%
Commercial Prescriptive Incentives/Promotion	\$15,063,000	\$4,023,711	\$2,479,497	16%
Commercial Custom Incentives/Promotion		\$1,245,610		
Small Industrial Custom Incentives/Promotion		\$3,498,813		
Greenhouse & Agriculture Incentives & Promotion		\$3,815,369		
Commercial/Industrial Administration	\$4,064,176	\$3,680,463	\$383,713	9%
Commercial/Industrial Evaluation	\$189,000	\$120,578	\$68,422	36%
Total Commercial/Industrial Program	\$19,316,176	\$16,384,544	\$2,931,632	15%
Total Resource Acquisition Scorecard	\$27,927,833	\$27,585,942	\$341,891	1%
Low-Income Scorecard				
Low-Income Single Family (HWP) Incentives/Promotion	\$6,355,000	\$7,588,591	-\$1,233,591	-19%
Low-Income Single Family Furnace EOL Incentives/Promotion	\$761,000	\$7,800	\$753,200	99%
Low-Income Single Family Indigenous Incentives/Promotion	\$8,000	\$13,632	-\$5,632	-70%
Low-Income Multi-Family Prescriptive Incentives/Promotion	\$2,651,000	\$1,463,285	\$883,632	33%
Low-Income Multi-Family Custom Incentives/Promotion		\$304,083		
Low-Income Administration	\$1,432,342	\$861,489	\$570,853	40%
Low-Income Evaluation	\$220,128	\$161,733	\$58,395	27%
Total Low-Income Scorecard	\$11,407,470	\$10,400,612	\$1,006,858	9%
Large Volume Scorecard				
Large Industrial Rate T2 Incentives/Promotion	\$3,150,000	\$2,246,028	\$708,445	22%
Large Industrial Rate 100 Incentives/Promotion		\$195,526		
Large Industrial T2/R100 Administration	\$787,000	\$509,939	\$277,061	35%
Large Industrial T2/R100 Evaluation	\$63,000	\$37,682	\$25,318	40%
Total Large Volume T2/R100 Scorecard	\$4,000,000	\$2,989,176	\$1,010,824	25%

Program/Scorecard	OEB-Approved Budget	Actual Spend	Difference	
			\$	%
Market Transformation Scorecard				
Optimum Home Incentives/Promotion	\$841,000	\$665,825	\$175,175	21%
Commercial Savings By Design Incentives/Promotion	\$500,000	\$28,786	\$471,214	94%
Market Transformation Administration	\$335,250	\$302,149	\$33,101	10%
Market Transformation Evaluation	\$26,820	\$7,933	\$18,887	70%
Total Market Transformation Scorecard	\$1,703,070	\$1,004,693	\$698,377	41%
Performance-Based Scorecard				
RunSmart Incentives/Promotion	\$297,000	\$93,103	\$163,745	55%
SEM Incentives/Promotion		\$40,152		
RunSmart/SEM Administration	\$216,000	\$140,948	\$75,052	35%
RunSmart/SEM Evaluation	\$35,000	\$401	\$34,599	99%
Total Performance-Based Scorecard	\$548,000	\$274,604	\$273,396	50%
Programs Sub-Total	\$45,586,373	\$42,255,026	\$3,331,347	7%
Portfolio Budget				
Research	\$1,500,000	\$517,567	\$982,433	65%
Evaluation	\$1,300,000	\$168,121	\$1,131,879	87%
Administration	\$2,935,000	\$2,364,580	\$570,420	19%
Total DSM Costs (before Projects)	\$51,321,373	\$45,305,294	\$6,016,079	12%

*Not all values may compute exactly due to rounding.

Appendix N Cost-Effectiveness Methodology

Overview

The OEB requires the utilities to deliver portfolios that are cost effective at the “program” level. Each utility defines “program” differently from the other utility, and both utilities define “program” differently from the OEB, as shown in Table 245. Throughout this report, the EC has used the OEB definitions. The relevant cost effectiveness results will be based on the utilities’ definition of program.

Table 245: 2016 “Programs” as defined by the OEB, Enbridge, and Union

Utility-Defined Programs	OEB-Defined Programs
Enbridge	
Resource Acquisition	Home Energy Conservation
	Residential Adaptive Thermostats
	Commercial and Industrial Custom
	Commercial and Industrial Direct Install
	Commercial and Industrial Prescriptive
	Energy Leaders Initiative
	Run it Right
Low Income	Single Family (Part 9)
	Multi-residential (Part 3)
Market Transformation	Residential Savings by Design
	Commercial Savings by Design
	School Energy Competition
	Run it Right
	Comprehensive Energy Management
Union	
Residential Resource Acquisition	Home Reno Rebate
C&I Resource Acquisition	Commercial and Industrial Custom
	Commercial and Industrial Prescriptive
Low Income	Home Weatherization
	Furnace End of Life
	Low Income Multi-Family
Large Volume	Large Volume
Market Transformation	Residential Savings by Design
	Commercial Savings by Design
Performance Based	Run it Right
	Strategic Energy Management

To calculate cost effectiveness, the EC first built a cost-effectiveness model using the utilities’ claimed and verified savings. This step had several goals, including:

- Building a comprehensive model that could be easily modified to assess the impact of changing assumptions and methodology to calculate the TRC-Plus and PAC tests

- Ensuring consistency of cost-effectiveness calculations by regrouping both utilities in the same model

The EC model was then modified to adjust gross savings using realization rates and free ridership from the annual savings verification activities and the provisional spillover rate. Because the realization rates for other savings (electricity, water) were generally either not available or much less precise, the gas realization rates were used for all savings.

The EC cost effectiveness methodology applied in 2016 is consistent with what was done for the 2015 analysis.

Results

Table 246 and Table 247 show summary results for Enbridge TRC-Plus and PAC tests. Table 248 and Table 249 show the same information for Union. There are additional tables located at the end of this section with more detailed results.

All of the utility-defined programs pass the Board-defined cost-effectiveness threshold of 0.7 for Low Income programs and 1.0 for all other programs using the TRC-Plus test.

Table 246. Enbridge summary of cost-effectiveness ratio results*

Scorecard	Draft using Utility-Tracking Savings†		Final Verified Ratio	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	2.6	3.8	2.7	2.9
Low Income	1.9	1.9	1.9	2.0
Total Portfolio	2.5	3.5	2.6	2.7

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

Table 247. Enbridge summary of cost-effectiveness net present value results*

Scorecard	Draft Net Present Value (M\$) using Utility-Tracking Savings†		Final Verified Net Present Value (M\$)	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	123.8	109.4	95.5	72.9
Low Income	9.5	8.0	10.0	8.4
Total Portfolio	133.3	117.4	105.5	81.3

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

Table 248. Union summary of cost-effectiveness ratio results*

Scorecard	Draft using Utility-Tracking Savings†		Final Verified Ratio	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	3.2	6.5	3.0	5.4
Low Income	1.5	1.2	1.5	1.2
Large Volume	6.2	19.8	5.0	4.6
Total Portfolio	3.4	6.1	2.9	4.3

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

Table 249. Union summary of cost-effectiveness net present value results*

Scorecard	Draft Net Present Value (M\$) using Utility-Tracking Savings†		Final Verified Net Present Value (M\$)	
	TRC-Plus	PAC	TRC-Plus	PAC
Resource Acquisition	152.7	151.5	124.8	121.5
Low Income	4.9	1.6	5.3	1.9
Large Volume	57.7	56.3	12.7	10.6
Total Portfolio	215.3	209.4	142.7	134.1

*Not all values may compute exactly due to rounding.

†Values calculated from original utility tracking data, pre-verification.

There were several OEB-defined programs that did not meet the Board-defined cost effectiveness threshold. Specifically, using the PAC and TRC-Plus tests, Enbridge’s Resource Acquisition RunItRight program fell short of 1.0. Using the TRC-Plus test, Union’s Low Income Furnace End-of-Life Upgrade program fell short of 0.7.

Cost-effectiveness framework

The EC notes that the utilities made efforts to incorporate most of the EC’s recommendations for calculating cost effectiveness following the 2015 verification activities. Specifically, the utilities applied more uniform cost-effectiveness methods and assumptions in 2016. The EC found alignment between the use of a NEB adder, and the format of reporting results.

Recommendations made by the EC following the 2015 verification results activities, that were not changed by utilities in 2016, are noted below:

- While the discount rate appears to be aligned there was a methodological inconsistency between utilities. Union calculated their discount rate using 4% as their real discount rate and an inflation rate of 1.68% to get a combined discount rate of 5.7472%. Enbridge did not show how their discount rate was calculated and simply applied a discount rate of 5.75%. The impacts are minor; however, for consistency, it would be best if both utilities were using identical discount rates.
- Water avoided costs are still based on water rates. The utilities followed the EC’s 2015 approach and reduced the water avoided costs by 75% to simulate the removal of the fixed-cost portion of the rate. As is the case for gas and electricity, water avoided costs should only include the marginal impact from reduced consumption. Fixed costs (which, in our experience, can represent about 75% to 80% of water costs) must be excluded. On the other hand, water rates are often predominantly or exclusively variable, notably to promote conservation, and are thus a bad proxy of avoided costs.
- In 2015, the EC recommended that “sector”-level administrative costs and overhead be allocated to each individual program and the utilities report program-level cost-effectiveness results. In 2016, there are still inconsistencies in how administrative and overhead costs are allocated. For example, Union identifies administration and evaluation costs at the scorecard level whereas Enbridge details spending as direct and indirect at the OEB-defined program level and then has an explicit ‘overhead’ spend at the scorecard level. To facilitate the analysis, the EC recommends that the utilities report spending in a consistent format and apportion the overhead costs to individual programs.

There were slight variations between the methodology applied in utility-reported cost-effectiveness calculator and that of the EC, specifically:

- The EC and Enbridge treat the annual savings of measures with dual baselines differently, specifically hydronic condensing boilers and hydronic high efficiency boilers in Commercial Custom and Multi-Residential. The EC calculated an average annual savings based on the cumulative energy savings divided by the measure's EUL.
- Enbridge applies a 'reduction factor' to account for the percent of non-installs and removals to both resource savings and costs. This adjustment factor is correctly applied to the savings; however, it should not be applied to the costs as costs are still incurred. The EC removed the adjustment to costs in our analysis.
- The EC applied the gross savings adjustment factor for custom gas to the custom electric and water savings as a proxy for fuel-specific adjustments.

Recommendations

This analysis has shown the robustness of DSM results, as cost-effectiveness is generally maintained through the adjustment of claimed savings, net-to-gross factors, discount rates, and water avoided costs.

The EC has the following recommendations results from the cost-effectiveness analysis:

- Allocate "portfolio"-level administrative cost and all overhead costs, to each individual program and report program-level cost-effectiveness results.
- Apply a consistent discount rate.
- Ensure any 'reduction factor' is applied to resource savings but not to costs.
- Explore the possibility of better defining water avoided costs.

Table 250: Enbridge overall PAC results* †

Program	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results				
Resource Acquisition	148,471,703	39,093,536	109,378,167	3.80
Low Income	16,508,871	8,473,694	8,035,177	1.95
Portfolio	164,980,574	47,567,230	117,413,343	3.47
Verified Final Results				
Resource Acquisition	112,019,000	39,094,000	72,926,000	2.87
Low Income	16,870,000	8,474,000	8,396,000	1.99
Portfolio	128,889,000	47,567,000	81,322,000	2.71

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.

Table 251: Enbridge Residential PAC results* †

Program	Annual net savings (m3)	Program-level Incentives (\$)	Program-level general admin costs (\$)	Portfolio Budget (\$)	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results								
Residential	3,024,528	1,624,000	42,000	71,000	7,450,000	1,667,000	5,783,000	4.47
Home Energy Conservation	14,988,260	19,277,000	2,781,000	358,000	37,497,000	22,057,000	15,440,000	1.70
Utility-Tracking Draft Results	18,012,788	20,901,000	2,823,000	429,000	44,947,000	23,724,000	21,223,000	1.89
Verified Final Results								
Residential	3,024,528	1,624,000	42,000	86,000	7,450,000	1,667,000	5,783,000	4.47
Home Energy Conservation	14,988,260	19,277,000	2,781,000	514,000	37,497,000	22,057,000	15,440,000	1.70
Final Verified Results	18,012,788	20,901,000	2,823,000	601,000	44,947,000	23,724,000	21,223,000	1.89

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.

Table 252: Enbridge Commercial PAC results* †

Program	Annual net savings (m3)	Program-level Incentives (\$)	Program-level general admin costs (\$)	Portfolio Budget (\$)	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results								
Run-it-Right	774,008	147,000	380,000	6,000	706,000	527,000	180,000	1.34
Commercial Prescriptive	2,758,718	842,000	42,000	70,000	6,936,000	884,000	6,052,000	7.85
Commercial Direct Install	2,459,618	1,172,000	1,000	58,000	6,058,000	1,173,000	4,885,000	5.17
Energy Leaders Initiative	72,577	73,000	1,000	1,000	114,000	74,000	40,000	1.55
Custom	18,555,516	3,830,000	599,000	516,000	51,011,000	4,428,000	46,583,000	11.52
Utility-Tracking Draft Results	24,620,438	6,064,000	1,022,000	650,000	64,825,000	7,086,000	57,740,000	9.15
Verified Final Results								
Run-it-Right	387,468	147,000	380,000	4,000	354,000	527,000	-173,000	0.67
Commercial Prescriptive	2,758,722	842,000	42,000	85,000	6,936,000	884,000	6,052,000	7.85
Commercial Direct Install	2,459,618	1,172,000	1,000	70,000	6,058,000	1,173,000	4,885,000	5.17
Energy Leaders Initiative	67,119	73,000	1,000	1,000	106,000	74,000	32,000	1.43
Custom	7,795,102	3,830,000	599,000	287,000	22,855,000	4,428,000	18,427,000	5.16
Final Verified Results	13,468,030	6,064,000	1,022,000	448,000	36,309,000	7,086,000	29,223,000	5.12

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.

Table 253: Enbridge Industrial PAC results* †

Program	Annual net savings (m3)	Program-level Incentives (\$)	Program-level general admin costs (\$)	Portfolio Budget (\$)	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results								
Industrial Direct Install	2,817,955	1,216,000	2,000	66,000	6,267,000	1,218,000	5,049,000	5.15
Industrial Custom	13,944,195	1,878,000	440,000	342,000	31,467,000	2,318,000	29,149,000	13.58
Industrial Prescriptive	416,028	118,000	0	10,000	966,000	118,000	848,000	8.20
Utility-Tracking Draft Results	17,178,177	3,212,000	442,000	418,000	38,700,000	3,654,000	35,046,000	10.59
Verified Final Results								
Industrial Direct Install	2,817,955	1,216,000	2,000	80,000	6,267,000	1,218,000	5,049,000	5.15
Industrial Custom	10,409,534	1,878,000	440,000	313,000	23,531,000	2,318,000	21,213,000	10.15
Industrial Prescriptive	416,028	118,000	0	13,000	966,000	118,000	848,000	8.20
Final Verified Results	13,643,516	3,212,000	442,000	406,000	30,764,000	3,654,000	27,110,000	8.42

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.

Table 254: Enbridge Low Income PAC results* †

Program	Annual net savings (m3)	Program-level Incentives (\$)	Program-level general admin costs (\$)	Portfolio Budget (\$)	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results								
Multi Residential	3,943,515	1,866,000	460,000	128,000	12,296,000	2,326,000	9,970,000	5.29
Single Family	1,155,349	3,779,000	764,000	45,000	4,213,000	4,543,000	-331,000	0.93
Utility-Tracking Draft Results	5,098,864	5,646,000	1,224,000	173,000	16,509,000	6,870,000	9,639,000	2.40
Verified Final Results								
Multi Residential	4,058,039	1,866,000	460,000	161,000	12,657,000	2,326,000	10,331,000	5.44
Single Family	1,155,256	3,779,000	764,000	55,000	4,213,000	4,543,000	-331,000	0.93
Final Verified Results	5,213,295	5,646,000	1,224,000	216,000	16,870,000	6,870,000	10,000,000	2.46

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.

Table 255: Enbridge overall TRC-Plus results* †

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	Program Costs (\$)	Overhead (\$) ‡	TRC Plus Costs (\$)	TRC Plus Value (\$)	TRC Plus Ratio
Utility-Tracking Draft Results								
Resource Acquisition	59,811,403	68,546,000	201,239,000	4,287,000	4,630,000	77,462,000	123,776,000	2.60
Low Income	5,098,864	7,654,000	19,990,000	1,224,000	1,604,000	10,482,000	9,508,000	1.91
Verified Final Results								
Resource Acquisition	45,124,334	46,261,000	150,685,000	4,287,000	4,630,000	55,178,000	95,507,000	2.73
Low Income	5,213,295	7,654,000	20,432,000	1,224,000	1,604,000	10,482,000	9,951,000	1.95

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.
‡ Portfolio overhead costs for research, evaluation and administration are not being applied at the program level. Consistent with what was done in 2015, the EC calculated costs as the sum of all OEB-defined program costs, including program admin and overhead costs and spread these costs across all programs based on their weighted savings contribution. Costs do not include market transformation or portfolio overhead costs.

Table 256: Enbridge Residential TRC-Plus results* †

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	TRC Plus Costs (equipment) (\$)	TRC Plus Value (equipment) (\$)	TRC Plus Ratio (equipment)	Program Admin Costs (\$)	TRC Plus Ratio (program)
Utility-Tracking Draft Results								
Residential	4,905,000	13,388,000	4,905,000	8,483,000	2.73	42,000	4,905,000	2.71
Home Energy Conservation	21,227,000	47,079,000	21,227,000	25,853,000	2.22	2,781,000	21,227,000	1.96
Utility-Tracking Draft Results	26,131,000	60,468,000	26,131,000	34,336,000	2.31	2,823,000	26,131,000	2.09
Verified Final Results								
Residential	3,024,528	4,905,000	13,388,000	4,905,000	8,483,000	2.73	42,000	2.71
Home Energy Conservation	14,988,260	21,227,000	47,079,000	21,227,000	25,853,000	2.22	2,781,000	1.96
Final Verified Total	18,012,788	26,131,000	60,468,000	26,131,000	34,336,000	2.31	2,823,000	2.09

*Not all values may compute exactly due to rounding.
 †All dollar values are rounded to the nearest thousand.

Table 257: Enbridge Commercial TRC-Plus results* †

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	TRC Plus Costs (equipment) (\$)	TRC Plus Value (equipment) (\$)	TRC Plus Ratio (equipment)	Program Admin Costs (\$)	TRC Plus Ratio (program)
Utility-Tracking Draft Results								
Run-it-Right	774,008	229,000	812,000	229,000	583,000	3.55	380,000	1.33
Commercial Prescriptive	2,758,718	2,926,000	10,656,000	2,926,000	7,730,000	3.64	42,000	3.59
Commercial Direct Install	2,459,618	566,000	6,508,000	566,000	5,941,000	11.49	1,000	11.48
Energy Leaders Initiative	72,577	145,000	238,000	145,000	93,000	1.64	1,000	1.57
Custom	18,555,516	28,235,000	65,881,000	28,235,000	37,646,000	2.33	599,000	2.28
Utility-Tracking Draft Results	24,620,438	32,101,000	84,094,000	32,101,000	51,993,000	2.62	1,022,000	2.54
Verified Final Results								
Run-it-Right	387,468	229,000	407,000	229,000	178,000	1.77	380,000	0.67
Commercial Prescriptive	2,758,722	2,926,000	10,487,000	2,926,000	7,561,000	3.58	42,000	3.53
Commercial Direct Install	2,459,618	566,000	6,508,000	566,000	5,941,000	11.49	1,000	11.48
Energy Leaders Initiative	67,119	145,000	220,000	145,000	75,000	1.52	1,000	1.51
Custom	7,795,102	9,095,000	28,066,000	9,095,000	18,970,000	3.09	599,000	2.90
Final Verified Total	13,468,030	12,961,000	45,687,000	12,961,000	32,725,000	3.52	1,022,000	3.27

*Not all values may compute exactly due to rounding.

†All dollar values are rounded to the nearest thousand.

Table 258: Enbridge Industrial TRC-Plus results* †

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	TRC Plus Costs (equipment) (\$)	TRC Plus Value (equipment) (\$)	TRC Plus Ratio (equipment)	Program Admin Costs (\$)	TRC Plus Ratio (program)
Utility-Tracking Draft Results								
Industrial Direct Install	2,817,955	652,000	6,684,000	652,000	6,031,000	10.25	2,000	10.22
Industrial Custom	13,944,195	9,040,000	48,844,000	9,040,000	39,804,000	5.40	440,000	5.15
Industrial Prescriptive	416,028	621,000	1,149,000	621,000	528,000	1.85	0	1.85
Utility-Reported Draft Results	16,762,149	9,692,000	55,528,000	9,692,000	45,836,000	5.73	442,000	5.48
Verified Final Results								
Industrial Direct Install	2,817,955	652,000	6,684,000	652,000	6,031,000	10.25	2,000	10.22
Industrial Custom	10,409,534	5,896,000	36,698,000	5,896,000	30,802,000	6.22	440,000	5.79
Industrial Prescriptive	416,028	621,000	1,149,000	621,000	528,000	1.85	0	1.85
Final Verified Total	13,643,516	7,169,000	44,530,000	7,169,000	37,362,000	6.21	442,000	5.85

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.

Table 259: Enbridge Low Income TRC-Plus results* †

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	TRC Plus Costs (equipment) (\$)	TRC Plus Value (equipment) (\$)	TRC Plus Ratio (equipment)	Program Admin Costs (\$)	TRC Plus Ratio (program)
Utility-Tracking Draft Results								
Multi Residential	3,943,515	4,100,000	15,133,000	4,100,000	11,033,000	3.69	460,000	3.32
Single Family	1,155,349	3,554,000	4,857,000	3,554,000	1,303,000	1.37	764,000	1.12
Utility-Reported Draft Results	5,098,864	7,654,000	19,990,000	7,654,000	12,336,000	2.61	1,224,000	2.25
Verified Final Results								
Multi Residential	4,058,039	4,100,000	15,577,000	4,100,000	11,477,000	3.80	460,000	3.42
Single Family	1,155,256	3,554,000	4,855,000	3,553,695	1,301,000	1.37	764,000	1.12
Final Verified Total	5,213,295	7,654,000	20,432,000	7,654,000	12,779,000	2.67	1,224,000	2.30

*Not all values may compute exactly due to rounding.
†All dollar values are rounded to the nearest thousand.

Table 260: Union Low Income PAC results*

Program	Annual net savings (m3)	Program-level Incentives (\$)	Program-level general admin costs (\$)	Portfolio Budget (\$)	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results								
Furnace End-of-Life Upgrade	1,617	6,565	1,700	342	5,948	8,266	-2,318	0.72
Home Weatherization	1,855,587	5,622,504	2,707,625	544,104	8,703,983	8,330,128	373,855	1.04
LI Multi Family Custom	159,528	159,361	199,306	40,051	581,468	358,667	222,801	1.62
LI Multi Family Prescriptive	674,044	862,395	827,524	166,293	2,719,917	1,689,920	1,029,998	1.61
Utility-Reported Draft Total	2,690,776	6,650,825	3,736,155	750,790	12,011,316	10,386,980	1,624,335	1.16
Verified Final Results								
Furnace End-of-Life Upgrade	1,617	6,582	1,677	337	5,948	8,259	-2,312	0.72
Home Weatherization	1,831,715	5,673,867	2,636,890	529,890	8,703,737	8,310,756	392,981	1.05
LI Multi Family Custom	193,029	131,322	237,920	47,811	703,576	369,242	334,334	1.91
LI Multi Family Prescriptive	678,113	839,055	859,668	172,753	2,870,334	1,698,723	1,171,611	1.69
Final Verified Total	2,704,473	6,650,825	3,736,155	750,790	12,283,595	10,386,980	1,896,614	1.18

*Not all values may compute exactly due to rounding.

Table 261: Union Resource Acquisition PAC results*

Program	Annual net savings (m3)	Program-level Incentives (\$)	Program-level general admin costs (\$)	Portfolio Budget (\$)	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results								
Home Reno Rebate	4,778,732	8,394,192	2,807,206	1,182,753	22,433,462	11,201,397	11,232,065	2.00
CI Prescriptive	8,346,662	3,794,752	956,519	226,392	32,460,136	4,751,271	27,708,864	6.83
Commercial & Institutional Buildings-Banner	1,298,242	384,965	142,762	33,789	4,699,566	527,727	4,171,840	8.91
Commercial & Institutional Buildings-Contrax	2,523,346	759,090	281,503	66,627	8,335,470	1,040,594	7,294,877	8.01
Industrial-Banner	1,726,334	332,519	187,777	44,443	6,127,214	520,296	5,606,919	11.78
Industrial-Contrax	14,594,206	2,749,666	1,552,762	367,512	46,108,370	4,302,427	41,805,942	10.72
Agriculture & Greenhouse-Banner	2,971,870	475,722	265,095	62,743	8,787,893	740,816	8,047,076	11.86
Agriculture & Greenhouse-Contrax	20,426,230	2,890,621	1,610,792	381,246	50,087,918	4,501,413	45,586,505	11.13
Utility-Reported Draft Total	56,665,620	19,781,526	7,804,415	2,365,505	179,040,030	27,585,942	151,454,088	6.49
Verified Final Results								
Home Reno Rebate	4,412,701	8,394,192	2,807,206	1,182,753	22,433,462	11,201,397	11,232,065	2.00
CI Prescriptive	8,034,431	3,752,733	1,132,063	267,940	30,942,450	4,884,796	26,057,654	6.33
Commercial & Institutional Buildings-Banner	1,141,557	478,987	155,977	36,917	4,132,376	634,964	3,497,413	6.51
Commercial & Institutional Buildings-Contrax	1,598,938	676,552	220,311	52,144	5,255,530	896,864	4,358,667	5.86
Industrial-Banner	1,517,983	400,794	205,158	48,557	5,387,722	605,953	4,781,769	8.89
Industrial-Contrax	10,364,185	2,716,113	1,390,322	329,065	33,180,753	4,106,435	29,074,319	8.08
Agriculture & Greenhouse-Banner	2,326,197	457,830	257,824	61,022	6,878,622	715,654	6,162,968	9.61
Agriculture & Greenhouse-Contrax	16,598,039	2,904,326	1,635,554	387,107	40,893,173	4,539,880	36,353,293	9.01
Final Verified Total	45,994,029	19,781,526	7,804,415	2,365,505	149,104,089	27,585,942	121,518,148	5.41

*Not all values may compute exactly due to rounding.

Table 262: Union Large Volume PAC results*

Program	Annual net savings (m3)	Program-level Incentives (\$)	Program-level general admin costs (\$)	Portfolio Budget (\$)	PAC Benefits (\$)	PAC Costs (\$)	PAC Value (\$)	PAC Ratio
Utility-Tracking Draft Results								
Large Industrial R100	760,781	195,520	10,135	3,991	1,166,585	205,655	960,930	5.67
Large Industrial T2	30,401,798	2,245,713	537,808	211,789	58,152,232	2,783,520	55,368,711	20.89
Utility-Tracking Draft Total	31,162,579	2,441,233	547,943	215,780	59,318,817	2,989,176	56,329,641	19.84
Verified Final Results								
Large Industrial R100	206,829	195,519	12,315	4,850	327,290	207,835	119,456	1.57
Large Industrial T2	6,374,291	2,245,714	535,627	210,930	13,309,342	2,781,341	10,528,000	4.79
Final Verified Total	6,581,121	2,441,233	547,943	215,780	13,636,632	2,989,176	10,647,456	4.56

*Not all values may compute exactly due to rounding.

Table 263: Union Low Income TRC-Plus results*

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	TRC Plus Costs (equipment) (\$)	TRC Plus Value (equipment) (\$)	TRC Plus Ratio (equipment)	Program Admin Costs (\$)	TRC Plus Ratio (program)
Utility-Tracking Draft Results								
Furnace End-of-Life Upgrade	1,617	11,856	6,840	11,856	-5,016	0.58	1,700	0.50
Home Weatherization	1,855,587	4,746,461	10,807,853	4,746,461	6,061,392	2.28	2,707,625	1.45
LI Multi Family Custom	159,528	703,448	686,500	703,448	-16,948	0.98	199,306	0.76
LI Multi Family Prescriptive	674,044	661,828	3,218,843	661,828	2,557,014	4.86	827,524	2.16
Utility-Tracking Draft Total	2,690,776	6,123,593	14,720,035	6,123,593	8,596,442	2.40	3,736,155	1.49
Verified Final Results								
Furnace End-of-Life Upgrade	1,617	11,856	6,840	11,856	-5,016	0.58	1,677	0.51
Home Weatherization	1,831,715	4,746,705	10,806,718	4,746,705	6,060,013	2.28	2,636,890	1.46
LI Multi Family Custom	193,029	703,448	830,665	703,448	127,217	1.18	237,920	0.88
LI Multi Family Prescriptive	678,113	660,030	3,479,770	660,030	2,819,740	5.27	859,668	2.29
Final Verified Total	2,704,473	6,122,039	15,123,993	6,122,039	9,001,954	2.47	3,736,155	1.53

*Not all values may compute exactly due to rounding.

Table 264: Union Resource Acquisition TRC-Plus results*

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	TRC Plus Costs (equipment) (\$)	TRC Plus Value (equipment) (\$)	TRC Plus Ratio (equipment)	Program Admin Costs (\$)	TRC Plus Ratio (program)
Utility-Tracking Draft Results								
Home Reno Rebate	4,778,732	14,122,882	28,308,737	14,122,882	14,185,855	2.00	2,807,206	1.67
CI Prescriptive	8,346,662	9,422,215	39,080,554	9,422,215	29,658,338	4.15	956,519	3.77
Commercial & Institutional Buildings-Banner	1,298,242	3,344,180	16,736,263	3,344,180	13,392,083	5.00	142,762	4.80
Commercial & Institutional Buildings-Contrax	2,523,346	3,137,794	10,027,537	3,137,794	6,889,743	3.20	281,503	2.93
Industrial-Banner	1,726,334	2,721,836	7,054,086	2,721,836	4,332,250	2.59	187,777	2.42
Industrial-Contrax	14,594,206	13,357,949	54,173,505	13,357,949	40,815,556	4.06	1,552,762	3.63
Agriculture & Greenhouse-Banner	2,971,870	2,695,477	10,261,776	2,695,477	7,566,299	3.81	265,095	3.47
Agriculture & Greenhouse-Contrax	20,426,230	13,896,212	57,601,106	13,896,212	43,704,894	4.15	1,610,792	3.71
Utility-Tracking Draft Total	56,665,620	62,698,545	223,243,564	62,698,545	160,545,019	3.56	7,804,415	3.17
Verified Final Results								
Home Reno Rebate	4,412,701	14,122,882	28,308,737	14,122,882	14,185,855	2.00	2,807,206	1.67
CI Prescriptive	8,034,431	9,640,117	36,932,234	9,640,117	27,292,117	3.83	1,132,063	3.43
Commercial & Institutional Buildings-Banner	1,141,557	2,615,004	14,716,366	2,615,004	12,101,362	5.63	155,977	5.31
Commercial & Institutional Buildings-Contrax	1,598,938	2,394,173	6,395,001	2,394,173	4,000,828	2.67	220,311	2.45
Industrial-Banner	1,517,983	2,128,357	6,202,729	2,128,357	4,074,372	2.91	205,158	2.66
Industrial-Contrax	10,364,185	10,081,380	39,335,149	10,081,380	29,253,769	3.90	1,390,322	3.43
Agriculture & Greenhouse-Banner	2,326,197	2,107,746	8,032,287	2,107,746	5,924,541	3.81	257,824	3.40
Agriculture & Greenhouse-Contrax	16,598,039	11,246,654	47,027,149	11,246,654	35,780,495	4.18	1,635,554	3.65
Final Verified Total	45,994,029	54,336,314	186,949,652	54,336,314	132,613,339	3.44	7,804,415	3.01

*Not all values may compute exactly due to rounding.

Table 265: Union Large Volume TRC-Plus results*

Program	Annual net savings (m3)	Measure Incremental Costs (\$)	TRC Plus Benefits (\$)	TRC Plus Costs (equipment) (\$)	TRC Plus Value (equipment) (\$)	TRC Plus Ratio (equipment)	Program Admin Costs (\$)	TRC Plus Ratio (program)
Utility-Tracking Draft Results								
Large Industrial R100	760,781	184,987	1,386,670	184,987	1,201,683	7.50	10,135	7.11
Large Industrial T2	30,401,798	10,424,167	67,510,292	10,424,167	57,086,124	6.48	537,808	6.16
Utility-Tracking Draft Total	31,162,579	10,609,155	68,896,962	10,609,155	58,287,807	6.49	547,943	6.18
Verified Final Results								
Large Industrial R100	206,829	56,494	385,701	56,494	329,208	6.83	12,315	5.61
Large Industrial T2	6,374,291	2,543,224	15,430,744	2,543,224	12,887,519	6.07	535,627	5.01
Final Verified Total	6,581,121	2,599,718	15,816,445	2,599,718	13,216,727	6.08	547,943	5.02

*Not all values may compute exactly due to rounding.

Natural Gas Demand Side Management - Detailed Plan for 2016 Annual Verification

submitted to the Ontario Energy Board

Revision Date: February 6, 2018





Introduction

This document has been prepared for the Ontario Energy Board (OEB) and outlines the detailed plan for conducting the annual verification of Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) programs delivered in 2016. These verifications will be conducted by the Evaluation Contractor (EC) team.

The overall objectives of the evaluations are to:

- Provide an independent opinion on whether the lost-revenue adjustment mechanism (LR), DSM Variance Account (DSMVA), and DSM Shareholder Incentive (DSMSI) were reasonable, appropriate, and calculated correctly.
- Recommend future evaluation research opportunities to enhance the assumptions used to calculate DSMSI and LR amounts.
- Recommend changes to improve input assumptions, verification procedures, and the overall verification process.

The LR, DSMVA, and DSMSI are based on the following metrics:

- LR: the verified natural gas energy savings (in annual cubic meters) by rate class and the cost of the natural gas by rate class for the program year.
- DSMVA: the actual money collected, by rate class, for implementing DSM programs during the program year and the actual DSM costs incurred by the programs.
- DSMSI: the actual program achievements compared to the scorecard metrics for that program, the weight placed on each metric within each scorecard, and the maximum incentive achievable for that scorecard.

Therefore, the information that must be verified for 2016 includes the program natural gas savings and the program achievements compared to the scorecard metrics. The EC will also review the money collected and spent by the programs but will not conduct a full financial audit of the reported amounts. The OEB may conduct financial audits of the gas utilities DSM spending as it sees fit. The verified savings and program achievements will be used to confirm the LR and DSMSI amounts.

The remainder of this document provides the following:

- An overview of the 2016 programs and their scorecard metrics
- A list of the data, documentation, and other information necessary to conduct the verification
- A list of the activities that will be conducted as part of the verification
- An accounting of the expected verification outcomes and the process for reviewing those outcomes
- A proposed schedule for completing the verification

While some information related to the verification of custom projects (i.e. Custom Project Savings Verification, or CPSV) can be found in this document, it is not considered part of the "annual verification" and the details are located elsewhere.



Reported Metrics to Verify

To verify the LR and DSMSI, the EC must verify the reported utility achievements for each scorecard, as well as verify the energy savings achieved by each LR rate class. Table and Table show the 2016 targets, weights, and maximum shareholder incentive by scorecard (resource acquisition, large volume, low income, and market transformation) for Union and Enbridge, respectively. It also shows the 2016 achievement for each utility as identified in their tracking data. Because some scorecards are a compilation of the achievements of multiple programs, Table and Table show the scorecard metrics and energy savings tracked by program.

Table 266. Enbridge's Reported 2016 achievement, target, weight, and maximum shareholder incentive by scorecard¹²³

Scorecard	Program	Metric	2016 Target	2016 Tracking Data Achievement †	Weight	Maximum Incentive
Resource Acquisition	C&I Custom C&I Direct Install C&I Prescriptive Comprehensive Energy Management Energy Leaders Initiative	Large Volume Customers» – CCM*	664,619,473	546,841,603	40%	\$6,792,500
	Home Energy Conservation Residential Adaptive Thermostats Run it Right Small Commercial New Construction	Small Volume Customers – CCM	319,171,212	413,832,316	40%	
	Home Energy Conservation	Deep Savings Participants (homes)	8,259	12,986	20%	
Low Income	Home Winterproofing	CCM	31,790,000	28,816,206	45%	\$2,403,500
	Low Income Multi Residential	CCM	64,900,000	82,345,391	45%	
	Low Income New Construction	Project Applications	6	6	10%	
Market Transformation	Commercial Savings by Design	Sites Built	2,751	2,206	15%	\$1,254,000
		New Developments	33	43	25%	
	Comprehensive Energy Management	Participants	7	7	20%	
	Residential Savings by Design	Builders	33	31	10%	
	Run it Right	Participants	83	88	20%	
School Energy Competition	Schools	55	25	10%		
TOTAL						\$10,450,000

*CCM= Cumulative Cubic Meters

†Values from tracking file submitted to EC by Enbridge, 2016 Annual Report Tracker DNV_2017.09.26.xlsx

‡ Values provided by Enbridge in response to previous draft version of this document

»Large volume consumers include commercial customers with a 3 year average annual consumption of greater than 75,000m³/year or industrial customers with a 3 year average consumption of greater than 340,000m³/year

¹²³ Unless specifically noted, from Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Schedule C

Table 267. Union's Reported 2016 achievement, target, weight, and maximum shareholder incentive by scorecard¹²⁴

Scorecard	Program	Metric	2016 Target	2016 Tracking Data Achievement†	Weight	Maximum Incentive
Resource Acquisition	C&I Custom C&I Direct Install C&I Prescriptive Home Reno Rebate	CCM*	1,214,104,360	994,755,290	75%	\$6,402,042
	Home Reno Rebate	Participants	3,300	6,595	25%	
Large Volume	Large Volume Program	CCM	890,890,721	346,931,144	100%	\$2,614,993
Low Income	Indigenous Furnace End-of-Life Low Income – Part 9	CCM	37,786,348	46,381,571	60%	\$916,941
	Multi-Family (Social and Assisted)	CCM	16,216,022	9,687,434	35%	
	Multi-Family (Market Rate)	CCM	2,639,817	7,891,117	5%	
Market Transformation	Commercial New Construction	New enrolled developments	8	0	50%	\$390,404
	Optimum Home	% of homes	70.3%	70.09%	50%	
Performance Based	RunSmart	Participants	28	32	50%	\$125,621
	Strategic Energy Management	Participants	3	3	50%	
Total						\$10,450,000

*CCM= Cumulative Cubic Meters

† Values from tracking file submitted to EC by Union Gas, 2016 Data Request for Auditor - SHI tracking database.xlsx

¹²⁴ Unless specifically noted, from Ontario Energy Board Decision and Order, EB-2015-0029/EB-2015-0049, January 20, 2016, Schedule C

Table 268. Enbridge 2016 reported achievement by program¹²⁵

Program		2016 Reported Metric Achieved	
		CCM	Other
Resource Acquisition	C&I Custom	550,503,382	-
	C&I Direct Install	79,163,595	-
	C&I Prescriptive	51,377,481	-
	Home Energy Conservation	229,695,730	12,986 Deep Savings Participants (homes)
	Energy Leaders Initiative	725,770	
	Residential Adaptive Thermostats	45,367,920	-
	Run it Right (RA)	3,870,040	-
	Small Commercial New Construction	0	-
Low Income	Low Income – Part 9	28,816,206	-
	Low Income Multi Residential	82,345,391	-
	Low Income New Construction	-	6 Project Applications
Market Transformation	Commercial Savings by Design	-	43 New Developments
	Comprehensive Energy Management (MT)	-	7 Participants
	Residential Savings by Design	-	31 Builders 2,206 Homes Built
	Run it Right (MT)	-	88 Participants
	School's Energy Competition	-	25 Schools

¹²⁵ Summarized from Enbridge Demand Side Management Draft Annual Report, November 16, 2017

Table 269. Union 2016 reported achievement by program ¹²⁶

Program		2016 Reported Metric Achieved	
		CCM	Other
Resource Acquisition	C&I Custom	707,753,039	-
	C&I Direct Install	0	-
	C&I Prescriptive	167,540,559	-
	Home Reno Rebate	119,461,693	6,595 Participants
Large Volume	Large Volume	346,931,144	-
Low Income	Indigenous	0	-
	Furnace End-of-Life	29,106	-
	Home Weatherization	46,352,465	-
	Multi-Family (Market Rate)	7,891,117	-
	Multi-Family (Social and Assisted)	9,687,434	-
Market Transformation	Commercial New Construction	-	0 New Developments
	Optimum Home	-	70.09% of homes built
Performance-Based	Run Smart	-	32 Participants
	Strategic Energy Management	-	3 Participants

¹²⁶ Summarized from Union Gas 2016 Demand Side Management Draft Annual Report, November 16, 2017

Metric Verification Activities

To verify the information reported in section 0, the EC will conduct the activities outlined in Table 270 and Table 271. Scorecard metrics for verification fall into two basic categories – TRM measures and Other measures. Tasks for verification of program metrics are defined as:

None: No reported program activity or savings; no action to be taken unless there is a change in reported savings or activity.

Confirm Tracking: Confirmation of data within submitted tracking data contributing to savings values.

- For prescriptive measures, this is done by confirming measure-level inputs for measures were appropriate (free-ridership ratio, savings per unit, etc.) then confirming net savings using those inputs are correctly performed to recreate and verify savings.
- For metrics other than CCM, confirmation that tracking records match reported metrics (e.g. number of participants in tracking data match utility reported values)

Apply factors: Application of relevant factor(s) that are not otherwise applied. For example, application of CPSV factors. Programs where this is the only activity performed by the Annual Verification indicate program evaluation occurring separate from the Annual Verification, with results submitted for inclusion in the annual verification for use in LR and DSMSI calculations.

Desk Review: File review of relevant documentation to confirm that non-prescriptive metrics are appropriately utilized. Unless specifically mentioned otherwise, desk review methods will be similar to the 2015 verification. Desk review includes tasks such as review of HOT2000 records or confirmation of customer participation and eligibility of for participation metrics.

Additional Sample Size (non-tracking, non-prescriptive): Sample required *in addition to* data provided in tracking documents for desk review. For example, HOT2000 records for a sample of relevant participants or documentation to confirm participation and eligibility in Commercial & Industrial Energy Management programs. Additional sample is in relation to the Annual Verification project only, and not related to other projects (i.e. CPSV). Programs without additional sample size identified will utilize tracking data for the evaluation.

To prepare for the program-specific activities, the EC will request tracking data and documentation, specified in section 0.

Table 270. 2016 Annual verification activities by program: Enbridge

	Program	None	Confirm Tracking	Apply Factors	Desk Review	Additional Sample
Resource Acquisition	C&I Custom			✓		
	C&I Direct Install		✓	✓		
	C&I Prescriptive		✓	✓		
	Comprehensive Energy Management	✓				
	Energy Leaders Initiative			✓	✓	Census
	Home Energy Conservation		✓	✓		25
	Residential Adaptive Thermostats		✓	✓		
	RunitRight		✓	✓	✓	10
	Small Commercial New Construction	✓				
Low Income	Low Income – Part 9		✓	✓	✓	25
	Multi Residential (Prescriptive)		✓	✓		
	Multi Residential (Custom)			✓		
	New Construction		✓		✓	Census
Market Transformation	Commercial Savings by Design		✓		✓	1 Builder 1 Development
	Comprehensive Energy Management		✓		✓	Census
	Residential Savings by Design		✓		✓	1 Builder 1 Home
	RunitRight		✓		✓	10
	School's Energy Competition		✓		✓	Census

Table 271. 2016 Annual verification activities by program: Union

	Program	None	Confirm Tracking	Apply Factors	Desk Review	Additional Sample
Resource Acquisition	C&I Custom			✓		
	C&I Direct Install	✓				
	C&I Prescriptive		✓	✓		
	Home Reno Rebate		✓	✓	✓	25
Large Volume	Large Volume (Custom)			✓		
	Large Volume (Prescriptive)		✓	✓		
Low Income	Indigenous	✓				
	Furnace End-of-Life		✓	✓		
	Home Weatherization		✓	✓	✓	25
	Multi-Family (Market Rate, Prescriptive)		✓	✓		
	Multi-Family (Market Rate, Custom)			✓		
	Multi-Family (Social & Assisted, Prescriptive)		✓	✓		
	Multi-Family (Social & Assisted, Custom)			✓		
Market Transformation	Commercial New Construction	✓				
	Optimum Home		✓		✓	1 Builder 1 Home
Performance-Based	RunSmart		✓		✓	10
	Strategic Energy Management		✓		✓	Census



Necessary Information

DNV GL will request data and documentation in three rounds. The first documentation request addressed the tracking data for each program, and has been already received by DNV GL. The second requested full documentation for specific participants and/or projects (indicated by Desk Review and Sample Size in Table 270 and Table 271) has also already been submitted and most of the data has been submitted to the EC. The third request is to capture any additional data as they are identified, and are often project-specific. The third request period is expected to close in conjunction with the completion of discussing discrepancies in reporting sums and certified savings with the utilities

The detailed data requested as part of the two documentation requests are shown in Table 272 and Table 273. Per the schedule outlined in section 0, the EC has already received tracking data for Round 1 and the majority of data for Round 2. Round 3 data requests continue to be ongoing.

Table 272: Detailed data requested for each documentation request: Enbridge

Documentation Request	Scorecard	Requested Information
Round 1: Completed	All	A download of the Enbridge Year 2016 tracking data for all programs with all fields except those that include personally identifiable information such as name, address, telephone number, or account ID.
Round 2	All	<p>A copy of any previous verification and evaluation studies that apply to Year 2016 savings calculations, <i>including</i> measure level studies identifying savings values for prescriptive or quasi-prescriptive savings calculations approaches outside of standard TRM.</p> <p>A copy of operational and quality assurance documentation associated with the tracking database</p> <p>Additional necessary data for savings verification of all quasi-prescriptive measures in <i>all</i> programs such as: Capacity (flow, ft2, etc.), and TRM offer name (Controls)</p>
	Resource Acquisition	<p>C&I Custom: None anticipated within scope of Annual Verification project.</p> <p>C&I Direct Install: None anticipated within scope of Annual Verification project</p> <p>C&I Prescriptive: All necessary data elements for verification of quasi-prescriptive measures.</p> <p>Comprehensive Energy Management: None anticipated (no program activity).</p> <p>Home Energy Conservation: Full and detailed documentation for a randomly selected sample of 25 participants.</p> <p>Pilot: Full and detailed documentation for pilot program including approved metrics definitions. Full and detailed documentation for a census of participants.</p> <p>Residential Adaptive Thermostats: None anticipated.</p> <p>RunitRight: Full and detailed documentation for 10 randomly selected RunitRight participants.</p> <p>Small Commercial: None anticipated (no program activity).</p>
	Low Income	Home Winterproofing: Full and detailed documentation for a randomly selected sample of 25 participants. Additional data for all

Documentation Request	Scorecard	Requested Information
		<p>quasi-prescriptive measures in all programs: Capacity (flow, ft2, etc.), and TRM offer name (Controls)</p> <p>LI Multi Residential: Additional data for all quasi-prescriptive measures in all programs: Capacity (flow, ft2, etc.), and TRM offer name (Controls).</p> <p>LI New Construction: Full and detailed documentation for a census of participants.</p>
	Market Transformation	<p>Commercial Savings by Design: Full documentation for one randomly selected builder and one randomly selected development.</p> <p>Comprehensive Energy Management: Full and detailed documentation for a census of participants.</p> <p>Residential Savings by Design: Full documentation for one randomly selected builder and one randomly selected development.</p> <p>RunitRight: Full and detailed documentation for 10 randomly selected RunitRight participants.</p> <p>School Energy Competition: Full and detailed documentation for a census of participants.</p>
Round 3	Market Transformation	Follow up for specific builders and developments for Commercial and Residential Savings by Design programs.
	All	Follow up requests for any other programs as may be required.

Table 273. Detailed data requested for each documentation request: Union

Documentation Request	Program/Scorecard	Requested Information
Round 1: Completed	All	A download of the Union Year 2016 tracking data for all programs with all fields except those that include personally identifiable information such as name, address, telephone number, or account ID.
Round 2	All	<p>A copy of any previous verification and evaluation studies that apply to Year 2016 savings calculations, <i>including</i> measure level studies identifying savings values for prescriptive or quasi-prescriptive savings calculations approaches outside of standard TRM.</p> <p>A copy of operational and quality assurance documentation associated with the tracking database</p> <p>Additional necessary data for savings verification of all quasi-prescriptive measures in <i>all</i> programs such as: Capacity (flow, ft2, etc.), and TRM offer name (Controls)</p>
	Resource Acquisition	<p>C&I Custom: None anticipated within scope of Annual Verification project</p> <p>C&I Direct Install: None anticipated (no program activity).</p> <p>C&I Prescriptive: All necessary data elements for verification of quasi-prescriptive measures not included in original tracking data such as missing capacity values or "sub-documents".</p> <p>Home Reno Rebate: Full and detailed documentation for a randomly selected sample of 25 Home Energy Conservation participants.</p>
	Large Volume	No additional data anticipated for Annual Verification.
	Low Income	<p>Home Weatherization: Full and detailed documentation for a randomly selected sample of 25 participants. Additional data for all quasi-prescriptive measures in all programs: Capacity (flow, ft2, etc.), and TRM offer name (Controls)</p> <p>Furnace End-of-Life: None anticipated</p> <p>Indigenous: None anticipated (no program activity).</p> <p>Multi-Family (ALL): Additional data for all quasi-prescriptive measures in all programs: Capacity (flow, ft2, etc.), and TRM offer name (Controls, etc.).</p>

Documentation Request	Program/Scorecard	Requested Information
	Market Transformation	Commercial New Construction: None anticipated (no program activity). Optimum Home: Full documentation for one randomly selected builder and one randomly selected development. Full and detailed documentation to confirm claimed percentage. Commercial New Construction: Full documentation for one randomly selected builder and one randomly selected development.
	Performance Based	RunSmart: Full and detailed documentation for 10 randomly selected participants. Strategic Energy Management: Full and detailed documentation for census of participants.
Round 3	Market Transformation	Follow up for specific builders and developments for Optimum Home.
	All	Follow up requests for any other programs as may be required.

Outcomes and Review Process

The annual verification process will produce verified energy savings and scorecard achievements (metrics by utility, scorecard, and program) for the 2016 program year. Following the verification of each metric, the EC will calculate updated LR, DSMVA, and DSMSI amounts that can be used in the clearance of accounts proceedings. To accomplish the goal of increasing transparency, the EC will submit individual metric reports of the full verification in a scheduled series of weekly releases, identified as 'mini-reviews'. This process has begun with the submission of the first section, REVIEW OF LR AND DSMSI CALCULATIONS on January 12, 2018. Additional sections are scheduled for submission to the EAC on the schedule included in section 0.

Structure of the 2016 Annual Verification will remain largely similar to the previous verification report, the 2015 Annual Verification. However, the EC understands a desire for revisions to the structure to the report by stakeholders. To that end, the EC will work to incorporate structural changes to the report. For example, appendices will be restructured to more closely match the order and sequence of programs as found within the 2015-2020 Decision and Order. The structure proposed will group programs under scorecards and in conjunction or sequence with 'like programs'. Additional changes to the report will be made following receipt of all feedback, scheduled for submission to the EC by January 26, 2018. Pending receipt of that feedback, the general structure of the report is as follows.



The EC will assemble the verification methodology, reported achievements, and verified results into a single report for review and comment by the OEB and Evaluation Advisory Committee (EAC). The EC will also include recommendations for future improvements, high-level results from additional evaluation studies conducted on the 2016 program year data (such as the CPSV study), and the full reports of those studies in attached appendices. In effect, the annual verification process will produce a report that summarizes all of the recent evaluation and verification studies completed, their outcomes, and how they were applied to the 2016 program year.

At a high level, the verification report will include the following sections:

- **Executive Summary:** This section will summarize the introduction and objective of the document and report on the verified scorecard achievements for the 2016 program year. The Executive Summary will also include the verified LR, DSMVA, and DSMSI amounts.
- **Introduction:** This section will introduce the verification study, its objectives, and how the document reports the accomplishments. This section will also summarize the evaluation and verification activities undertaken to verify the 2016 program year savings and scorecard metrics. The section will be a high-level summary of the activities and use appendices to provide additional detail
- **Results:** These sections, one per utility, will report on the results of the annual verification and summarize the high-level results of additional evaluation activities. It will report on the scorecard achievements, program spending and cost effectiveness, and application of those results to the LR and DSMSI calculations and the final outcomes.
- **Findings and Recommendations:** This section will summarize the LR, DSMVA, and DSMSI final results and summarize any recommendations made throughout the annual verification report, including those made in the additional evaluation reports.
- **Appendices**¹²⁷: Additional documentation, including data and documentation requests, data descriptions, detailed savings verifications, LR and DSMI calculations, program spending, and cost effectiveness are examples of possible appendices to be included in the report.

The EC team proposes an unusual review structure to coordinate with the CPSV. We propose to distribute an incomplete draft report that includes all of the necessary verification factors EXCEPT the final results of the CPSV study on April 13. The next two weeks (until April 27) would be used for review, comment, and addressing the comments on the annual verification report, minus the CPSV results. When the CPSV results are finalized, on or around July 13, they would be incorporated into the annual report, and submitted for review of the draft report. The AV report would be finalized after this additional round of review.

The AV schedule is shown in Section 0.

¹²⁷ Appendices will include the 'mini-reviews' for identification of verified scorecard metrics in an ongoing basis throughout the project.

Schedule

This section outlines the project tasks and schedule for the 2016 annual verification. The schedule is shown in Table 274, which lists each verification task and end dates for completing that task. The schedule is designed to limit interference with the CPSV study as much as possible¹²⁸.

Table 274. Schedule of deliverables

Task	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July
Planning										
Detailed plan submission		10								
Initial tracking data review										
Initial data request	C									
Initial data delivery	C									
Identify sample for detailed review		C								
Documentation request: Round 2		C								
Document delivery: Round 2			C							
Documentation request: Round 3			Ongoing							
Document delivery: Round 3			Ongoing							
Mini-Reviews¹²⁹ (date sent to EAC/comment due)										
(E) Comprehensive Energy Management				19/26						
(U) Strategic Energy Management										
(U) RunSmart										
(E) School Energy Competition					6/9					
(E) Low Income New Construction										
(E) Commercial Savings by Design										
(U) Optimum Home										
(E) Residential Savings by Design					9/16					
(E) C&I Prescriptive										
(U) C&I Prescriptive										
(E) C&I Direct Install										
(E) Residential Adaptive Thermostat					16/23					
(U) Furnace End of Life										

¹²⁸ Deliverables for the 2016 Annual Verification are partially reliant on the CPSV schedule and deliverables. We will be as responsive to this as possible, and deliver more quickly whenever possible.

¹²⁹ All mini review dates are particularly sensitive to the timely delivery of all necessary data and documentation to the EC

Task	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July
(E) Low Income Multi-Family					23/2					
(U) Low Income Multi-Family (SA)										
(U) Low Income Multi-Family (MR)										
(E) Home Energy Conservation						2/16				
(E) Low Income Part 9										
(U) Home Reno Rebate										
(U) Home Weatherization										
(E) RunitRight						16/23				
(E) Energy Leaders										
Verified results										
Verify DSMVA, LR, DSMSI calculations						23				
Assemble results							13			
Produce verified scorecard metrics							13			
Apply CPSV results										20
Reporting										
Mini-Reviews										
Draft results without CPSV							13			
Draft report with all factors (incl. CPSV)										20
Project Management										

The EC has highlighted the tasks that require utility involvement and the dates of that involvement in Table 275. There are three documentation delivery periods: one for the initial tracking data (complete), a follow-up period to deliver detailed documentation for a sample of measures from select programs and additional required information (mostly complete), and a third ongoing period for issues as identified and incurred. To better facilitate initial communication, DNV GL included a preparatory meeting within this timeline to be concluded by November 22, 2017 with each of the utilities. There are also multiple review periods: for the mini-reviews of each sub-section to be submitted to the EAC for review starting January 19, for review of the draft results (planned for submission to the EAC on April 13), and for review of the draft report including CPSV factors (planned for submission to the EAC on July 20).

EAC involvement is also necessary to complete the annual assessment. The EC requests that the EAC review and comment on mini-review sections within one week of submission, draft results within two weeks of submission, and the draft report within two weeks of submission.

Table 275. Utility involvement during 2016 annual verification activities

Utility Involvement	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Assemble and deliver initial tracking data	C										
Preparatory meeting with utilities		C									
Assemble and deliver requested documentation – Round 2			C								
Assemble and deliver requested documentation – Round 3			Ongoing								
Mini-Reviews				Ongoing							
Review draft report							27				
Review report with all results (incl. CPSV factors)											3



About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.



Appendix P Report: Custom Measure Life Review

Union Gas Limited (Union) and Enbridge Gas Distribution Inc. (Enbridge) provide a range of demand side management (DSM) programs to their customers. One such offering is the C&I custom program. The Commercial and Industrial (C&I) custom programs. The C&I custom programs contribute a significant portion of the lifetime natural gas savings achieved by the utilities each year. A key input into determining the lifetime savings is the measure life of the installed equipment.

The Ontario Energy Board (OEB) decided to complete research specifically geared toward reviewing the measure lives used by the utilities. There were two main research goals of this study.

1. Review the measure lives used by the utilities to determine if they are reasonable and appropriate based on the current literature.
2. Determine if additional Ontario-specific measure life research is warranted in the future.

In order to accomplish these goals, Michaels Energy completed a detailed literature review on 20 different custom measure lives from jurisdictions across North America. After completing the literature review, Michaels Energy compiled recommended measure lives for each of the 20 researched measures.

Final Report:
**Custom
Measure Life
Review**

May 10, 2018

Ontario Energy Board

2300 Yonge Street

Toronto | Ontario M4P 1E4

Michaels No.: O6717AAN



Ontario Energy
Board

Contents

Executive Summary	1
1. Introduction and Methods.....	3
1.1 Measure Selection	4
1.2 Secondary Literature Review	6
2. Literature Review Findings	8
2.1 Measure Life Benchmarking	8
2.2 Source Basis.....	10
2.2.1 ASHRAE Handbook	11
2.2.2 California DEER Database	11
2.2.3 GDS Measure Life Report	12
2.2.4 ERS Measure Life Study	12
2.3 Measure Life Primary Research.....	12
2.3.1 Space Heating and Domestic Hot Water Boilers	13
2.3.2 Steam Traps.....	13
2.3.3 VFD on Make-Up Air Units	14
2.3.4 Building Automation Systems	14
2.4 Source Conclusions.....	14
3. Recommendations and Future Research.....	16
3.1.1 Updates to Measure Lives.....	16
3.1.2 Future Research.....	17
3.1.3 Recommended Measure Lives.....	19
Appendix A Measure Selection Memo	21
Appendix B Measure Level Research	36
Appendix C Measure Life Data	44

Executive Summary

Union Gas Limited (Union) and Enbridge Gas Distribution Inc. (Enbridge) provide a range of demand side management (DSM) programs to their customers. One such offering is the C&I custom program. The Commercial and Industrial (C&I) custom programs. The C&I custom programs contribute a significant portion of the lifetime natural gas savings achieved by the utilities each year. A key input into determining the lifetime savings is the measure life of the installed equipment.

The Ontario Energy Board (OEB) decided to complete research specifically geared toward reviewing the measure lives used by the utilities. There were two main research goals of this study.

1. Review the measure lives used by the utilities to determine if they are reasonable and appropriate based on the current literature.
2. Determine if additional Ontario-specific measure life research is warranted in the future.

In order to accomplish these goals, Michaels Energy completed a detailed literature review on 20 different custom measure lives from jurisdictions across North America. After completing the literature review, Michaels Energy compiled recommended measure lives for each of the 20 researched measures. The recommended measure lives can be seen in Table 1.

Table 1
Recommended Measure Lives

Measure	Recommended Measure Life
All other industrial equipment	20
Boiler - Industrial Process	20
Boiler - Space heating	25
Pipe Insulation	14
Boiler - Domestic Hot Water	25
Boiler Controls	15
Energy Curtains	10
Heat Recovery - Commercial	15
Heat Recovery - Industrial	20
Exhaust Fan Controls	15
Heat Reflector Panels	15
Economizers - Conventional and condensing	20
Steam Trap	6
Infiltration Controls - Air Doors	15
Infiltration Controls - Dock Seals	10
IR Poly	5
VFD retrofit on MUA	15
Heat Exchanger	17
Building Automation System	15
Ovens & Thermal Oxidizers	20
Reverse Osmosis (RO) Water Conditioner	20
Building Envelope	25

Based on the results of the literature review, 15 of the 20 measures use lifetime estimates that are consistent with the available literature. There are five measures where Michaels Energy does recommend that the measure life be updated.

- Boiler Controls – Reduced from 20 years to 15 years. This measure does not include burner modification measures, such as linkageless controls.
- VFD for Make-up Air Units – Increased from 10 to 15 years to be consistent with the literature and available primary data.
- Infiltration Controls: Door Seals and Air Doors – Reducing the life from 15 to 10 years for dock door and ramp seals, but leaving air doors at 15 years.
- Pipe Insulation: Reduce the measure life from 20 to 14 years.
- Building Automation Systems: Reduce the measure life from 20 years to 15 years.

Additionally, the literature review revealed that there are two individual measures which would benefit from primary research.

- Pipe Insulation Measures
- Building Automation Systems

In addition to those specific measures, Michaels Energy suggests implementing an ongoing data collection effort for custom measures. This would create a dataset that could be continually mined for updates to custom measure lives in the future, as well as inform other measure lives throughout the province.

1. Introduction and Methods

Union Gas Limited (Union) and Enbridge Gas Distribution Inc. (Enbridge) provide a range of demand side management (DSM) programs to their customers. The commercial and industrial (C&I) custom programs offered by the utilities constitute a notable portion of the portfolio budgets (18%), portfolio savings (43%), and shareholder incentives(31%)¹.

Due to the size of the C&I custom programs, the lifetime savings achieved by the programs are a significant factor in determining if the utilities achieved their savings targets, and whether a shareholder incentive will be paid. A key input into determining the lifetime savings is the measure life of the installed equipment. Lifetime savings, or cumulative cubic meters (CCM), are calculated by multiplying the first year savings by the measure life, as shown in the equation below.

$$CCM = First_Year_Savings \times Measure_Lifetime$$

Measure life, in the context of this research, is considered to be equivalent to the definition provided in the Uniform Methods Project (UMP), Chapter 13, Section 2.1.1.1².

[This is the median number of years that a measure is in place and operational after installation. This definition implicitly includes equipment life and measure persistence (defined below), but not savings persistence.

- *“Equipment life” is the number of years installed equipment will operate before it fails.*
- *“Measure persistence” takes into account business turnover, early retirement or failure of the installed equipment, and any other reason the measure would be removed or discontinued.]*

The Ontario Energy Board (OEB) decided to complete research specifically geared toward reviewing the measure lives used by the utilities. Through a competitive bid process, the OEB contracted with Michaels Energy. There were three main research goals of this study.

1. Review the measure lives used by the utilities to determine if they are reasonable and appropriate based on the current literature.
2. Understand the source basis used to estimate measure life.
3. Determine if Ontario-specific measure life research is warranted in the future.

In order to accomplish these goals, Michaels Energy first selected 20 different custom measure lives currently found in Union’s and Enbridge’s custom measure life tables³. The measure life for each of the selected measures was examined via a detailed literature review using program documents, research and manufacturer data.

¹ 2016 – 2018 OEB EM&V Plan, Table 2-4.

² Violette, Daniel, M. Chapter 13: Assessing Persistence and Other Evaluation Issues Cross-Cutting Protocols. Uniform Methods Project. <https://energy.gov/sites/prod/files/2013/11/f5/53827-13.pdf>

³ EB-2016-0246, Exhibit B, Tab 1, Tab 2, Page 11-15. Filed 2016-12-21.

1.1 | Measure Selection

Michaels Energy used a data-driven framework to select 20 different measures for further review. Union and Enbridge provided Michaels Energy 2016 custom program tracking data. Michaels Energy worked with the utilities to map the tracking data to the appropriate measure category from the custom measure life tables.

Each measure category was analyzed using six different criteria to determine if it would be selected for the secondary literature review⁴. The criteria used were as follows:

- **Measure Frequency:** The number of units claimed by Enbridge, Union, or both based on 2016 program data.
- **Measure Impacts:** Even if a measure has small numbers of individual projects completed each year, their natural gas impacts (cumulative savings) may be significant to the custom programs as a whole.
- **Age of Referenced Sources:** Older sources may still be valid, but additional investigation was completed to ensure any more recent sources confirm assumptions or suggest an alternate value.
- **The Basis of Referenced Sources:** Cited sources were examined to determine if they are based on primary data, secondary data, a specific jurisdiction, or engineering assumption. Measures which were sourced from primary data were less likely to be included, assuming other criteria mentioned here are also met.
- **Differences Between Utilities:** Technologies which have different measure lives for each of the two utilities. In some instances, this may be acceptable, for example, different types of customers who routinely utilize a particular measure.
- **Michaels Experience:** Leverage Michaels Energy's previous experience evaluating custom programs to identify measures which are inconsistent with values we typically use.

In order to determine which measures were selected for further research, Michaels Energy examined each of the characteristics listed above and assigned a point value to each measure. The higher the assigned points, the more likely the measure should be selected for inclusion and further review. For example, the most popular measure from 2016, space heating boilers, would receive 20 points, while measures which had no participation would be given 0 points.

Michaels Energy believes that measures which constitute a large portion of savings should receive a higher priority for review. Therefore, cumulative savings was given the most weight in our points system at 40. Source age was given the least with 10. The other characteristics were scored out of 20 points each.

A summary of the final scoring can be seen in Table 2.

⁴ Michaels Energy combined Union and Enbridge program data and analyzed a combined set of measures for both utilities.

Table 2
Full Scoring Matrix

Measure	Sector	Cummulative Savings	Source Basis	Frequency	Source Age	Utility Differences	Total Points
All other industrial equipment	Industrial	38	20	13	10	0	81
Boiler - Industrial Process	Industrial	36	15	12	2	10	75
Boiler - Space heating	Commercial	34	5	20	2	10	71
Outside Pipe Insulation	All	40	5	16	4	0	65
Boiler - Domestic Hot Water	Commercial	30	5	17	2	10	64
Boiler Controls	All	26	5	19	2	10	62
Energy Curtains	Greenhouse	32	15	10	3	0	60
Heat Recovery	All	22	15	8	3	10	58
Exhaust Fan Controls	Commercial	28	15	1	4	0	48
Heat Reflector Panels	All	1	20	14	10	0	45
Economizers - Conventional and condensing	All	18	15	7	4	0	44
Steam Trap	Industrial	14	1	15	2	10	42
Boiler Combustion Tune-Up	All	0	20	0	10	10	40
Infiltration Controls - Dock Seals, Air Doors	Industrial	4	15	18	2	0	39
IR Poly	Greenhouse	12	15	5	2	0	34
VFD retrofit on MUA	Commercial	1	20	3	10	0	34
Heat Exchanger	Commercial	16	15	1	2	0	34
Building Automation System	All	24	5	2	2	0	33
Ovens & Thermal Oxidizers	Industrial	1	20	1	10	0	32
Reverse Osmosis (RO) Water Conditioner	Industrial	1	20	1	10	0	32
Building Envelope	All	1	20	1	10	0	32
Recommissioning, Retro-Commissioning	All	10	15	1	5	0	31
Boiler Air Makeup (line)	Industrial	0	20	0	10	0	30
Boiler - Oxy-Fuel	Industrial	0	20	0	10	0	30
Boiler - Low Nox	Industrial	0	20	0	10	0	30
Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	All	6	15	6	3	0	30
Electric Loop Controllers	Commercial	0	20	0	10	0	30
PLCs	Industrial	0	20	0	10	0	30
Flame Supervision	Industrial	0	20	0	10	0	30
Ion Exchange Water Conditioner	Industrial	0	20	0	10	0	30
Windows	All	0	20	0	10	0	30
Furnaces	All	20	5	1	4	0	30
Combustion Tune-up	All	0	15	0	4	10	29
Roof/Ceiling insulation	Commercial	2	15	9	2	0	28
Make-Up Air	Commercial	8	5	4	5	0	22
Grain Dryer	Commercial	1	15	1	4	0	21
Building Optimization Program/RunSmart - Behavioral Savings Project	Commercial	0	15	0	5	0	20
Dessicant Cooling	Commercial	0	15	0	4	0	19
Turndown controls on Modulating Boiler	Commercial	0	15	0	4	0	19
Cooling Tower for HVAC	Commercial	0	15	0	2	0	17
Infrared Heaters	Commercial	0	15	0	2	0	17
Tank Exterior Insulation	All	1	5	1	4	0	11
Air Sealing	All	0	5	0	4	0	9
Steam Piping Leaks	Industrial	0	5	0	4	0	9
Steam Valve	Industrial	0	5	0	4	0	9

Based on Michaels' analysis of the program data and current referenced resources, Michaels Energy conducted further research on the following 20 measures.

- All other industrial equipment
- Boiler - Industrial Process
- Boiler - Space heating
- Outside Pipe Insulation
- Boiler - Domestic Hot Water
- Boiler Controls
- Energy Curtains
- Heat Recovery
- Exhaust Fan Controls
- Heat Reflector Panels
- Economizers - Conventional and condensing
- Steam Trap
- Infiltration Controls - Dock Seals, Air Doors
- IR Poly
- VFD retrofit on MUA
- Heat Exchanger
- Building Automation System
- Ovens & Thermal Oxidizers
- Reverse Osmosis (RO) Water Conditioner
- Building Envelope

One measure, boiler combustion tune-ups, was initially scored high enough to be selected in the top 20 measures. However, feedback from Enbridge indicated that they had not offered this measure for several years. Union also had no participation for combustion tune-ups in 2016. Therefore, boiler combustion tune-ups were not selected for further review.

The measures selected for review represent a significant portion of the savings from 2016. The 20 measures selected represent 85% of Union's 2016 custom program savings, and 96% of Enbridge's 2016 custom program savings.

1.2 | Secondary Literature Review

After selecting the measures for review, Michaels Energy completed a thorough literature review. The first step in the literature review was to determine if the measure life assumptions used by Union and Enbridge were consistent with industry standard practice. Michaels Energy systematically stepped through five different categories of research materials for each measure.

1. **Recent Evaluation Reports:** Recent evaluation reports of Enbridge or Union custom programs can provide recent research for projects completed right in Ontario. Most well-rounded custom program evaluations will address measure life for each project reviewed. They can also be great tools for finding provincial or regional data sources.
2. **Technical Reference Manuals:** Technical reference manuals (TRMs) contain significant amounts of detailed engineering data. Michaels Energy took the final list of researchable measures and scanned our known list of TRMS which contain those measures. Our team compiled a list of all TRMs found to include a given measure, as well as the measure life assumed in each TRM. A summary of the referenced TRMs can be found in Appendix B. In many cases, the technical assumptions used, including measure life, are sourced from

a specific research study. As part of our research, we tracked down the source document and ensured that the actual source was well reasoned and applicable to the measures found in Ontario.

3. **Measure Studies:** Beyond TRMs and Ontario evaluation reports, there are a plethora of other research studies completed for DSM programs across the United States and Canada every year. Michaels Energy used our wide knowledge base from our projects across both the United States and Canada to help uncover research relating to measure lives. Some of the referenced measure studies include those from the U.S. Department of Energy (DOE), National Resources Canada (NRCAN), California IOU Savings Retention Studies, Measure Life studies from the U.S., and data from the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
4. **Manufacturer Data:** Custom projects also contain a wide array of equipment that doesn't fit a typical category or isn't likely to be found in a TRM. There are not many TRMs that contain regenerative thermal oxidizers or steam turbines driven by wood pulp fired boilers. Manufacturers publish rated lifetimes for nearly all equipment. In cases such as those mentioned previously, they can sometimes be the only source of estimated measure life information. Michaels Energy examined manufacturer literature for air doors, loading dock door seals, boiler economizers, energy curtains, IR poly, and RO water filtration systems to supplement the existing energy efficiency literature.
5. **Michaels Energy Data:** Michaels Energy has an extensive library of previously calculated and evaluated custom projects. We mined our data and Ontario evaluation experience for Ontario specific insights and programmatic approaches to measure lives.

After completing the literature review, Michaels Energy examined the measure life data and determined variances between the utilities' custom measure life tables and industry norms. Noted differences were further examined to determine if they were justified. Some of the key factors considered were climate, installation practices, and commercial versus industrial participation. A complete benchmark table can be found in Appendix C.

Measures, where differences between the Ontario measure lives and industry seemed appropriate, are discussed under section 2.1. Michaels Energy did not recommend changes to measures lives which were consistent with industry values. However, all of these measures were considered for further research depending on life uncertainty and the contribution to lifetime savings.

Complementary to the benchmarking activity was also assessing the sources cited by the different jurisdictions. Understanding if a measure life was based on primary research, secondary research, or engineering judgment was necessary for understanding the uncertainty in measure life estimates.

2. Literature Review Findings

After completing the literature review, Michaels Energy aggregated the results to benchmark the measure lives used by Union and Enbridge. Variations between industry standard and current Union and Enbridge measure lives were used as a starting point for identifying any measure life changes and future research priorities.

During the examination of individual measures, Michaels Energy also assessed the basis of the cited measure life resources. This was identified as a key research priority during the early stages of this study. The source basis was used to inform the relative uncertainty surrounding each estimated measure life. Additionally, measure lives which were already based on primary data were considered lower priority candidates for Ontario specific research in the future.

2.1 | Measure Life Benchmarking

The measure lives used by Union and Enbridge were compared against the Ontario Technical Reference Manual, and an additional 20 TRMs from different states in the U.S. Technical Reference Manuals provide a significant repository of technical and engineering data, including estimates of measure life. Additionally, they often contain citations and references for other research and evaluation studies. Michaels Energy leveraged these cited resources during the literature review.

The first benchmarking step provided a high-level comparison to other jurisdictions and was used to help inform recommendations for future research specific to Ontario. A summary of the benchmarking results can be seen in Table 3. The average measure life shown is an unweighted average.

Table 3
Measure Life Benchmarking Comparison⁵

Measure	Custom Measure Life (UGL/EGD)	Average Researched Life
All other industrial equipment	20/20	18
Boiler - Industrial Process	20/20	20
Boiler - Space heating	20/25	22
Pipe Insulation	20/20	14
Boiler - Domestic Hot Water	20/25	20
Boiler Controls	20/15	14
Energy Curtains	10/10	13
Heat Recovery - Commercial	15/15	18
Heat Recovery - Industrial	20/15	17
Exhaust Fan Controls	15/ -	13
Heat Reflector Panels	15/15	25
Economizers - Conventional and condensing	20/ -	15
Steam Trap	6/6	6
Infiltration Controls - Dock Seals, Air Doors	15/15	10
IR Poly	5/5	5
VFD retrofit on MUA	10/ -	15
Heat Exchanger	17/ -	17
Building Automation System	20/ -	15
Ovens & Thermal Oxidizers	20/ -	18
Reverse Osmosis (RO) Water Conditioner	20/ -	20
Building Envelope	20/25	22

The benchmarking showed that the Ontario utilities use measure lives which are the same as industry for five measures, higher than average for 12 measures, and lower than average for four measures.

There are five different custom measure lives indicated in red in Table 3. In each of these cases, Union and Enbridge use a different value for the measure life. Three of those instances, space heating boilers, domestic hot water boilers, and building envelope are due to Union capping measure lives at 20 years.

The measures in Table 3 highlighted in green show those where the measure life claimed by the utilities differs by five years or more from the benchmarked results. Five years corresponds to a difference of at least 20 percent. In total, there are seven measure lives which differ. The

⁵ Heat exchangers are displayed showing the average measure life of commercial (14 years) and industrial (20 years). Referenced sources did not separate these end uses.

remaining 13 measures show good agreement between the values used by Union and Enbridge and other parts of North America.

It is important to note that good agreement is not equivalent to correct. Even though 20 years is widely used as the measure life for industrial equipment, it does not mean that the *correct* measure life is 20 years. Michaels Energy considered the uncertainty associated with any particular measure life in addition to the agreement between industry averages when recommending measure life changes and further research. However, those measures with good agreement were not recommended for immediate changes.

The measures which were found to deviate from the industry average were:

- Outside Pipe Insulation
- Boiler Controls
- Heat Reflector Panels
- Economizers – Conventional and Condensing
- Infiltration Controls – Dock Door Seals, Air Doors
- VFD and Make-up Air Units
- Building Automation Systems

Michaels Energy completed further investigation of the seven measures where the measure life was found to differ from industry averages. Based on our previous experience evaluating custom measure projects in Ontario, Michaels Energy determined that out of the seven measures found to deviate, only economizers do so for justifiable reasons. The remaining six measures were considered for updates based on the literature. These six measures also constituted the short list of measures which were considered for recommended primary research.

Union currently claims a 20-year measure life for economizers. Boiler economizers were popular measures for industrial customers and greenhouses for Union during 2016. These customers tend to install larger boilers, with larger systems and are designed to operate longer hours throughout the year. Michaels Energy believes that a 20-year measure life is reasonable for the larger industrial installations commonly seen in Ontario. Economizers can also be installed on commercial buildings. Commercial installations would be expected to have a lower measure life of 15 years. Michaels Energy recommends that this measure be split into an industrial category with a 20 year life, and a commercial category with a 15 year life.

Enbridge currently uses the “Heat Recovery” measure for boiler stack economizers, which has a 15-year life. Enbridge has a similar mix of industrial versus commercial installations for boiler stack economizers and should consider adding an industrial boiler stack economizer classification with a 20-year measure life to be consistent⁶.

2.2 | Source Basis

In order to inform the uncertainty associated with the assumed measure lives, the original source of the measure life must be understood. Where possible, Michaels Energy traced the evaluation reports, DOE Rulings, TRMs and other research reports back to the original sources for measure

⁶ Michaels did not “audit” the utilities use of the custom measure life tables as part of this research. Instead, differences in how measure lives are applied are being identified for future improvements.

life. In most cases, this was a multi-step process of going from an original report to the cited source, and then again to a third common reference. Most of the referenced documents were found to base measure life estimates on literature reviews of other jurisdictions for the measures selected for investigation. A majority of the measure sources investigated used one of four different sources.

1. 2011 or 2015 ASHRAE Handbook, HVAC Applications. Chapter 37, Table 4 – Comparison of Service Life Estimates.
2. Database for Energy Efficiency Resources (DEER) Estimated Useful Life Tables.
3. Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures prepared by GDS Associates in June 2007.
4. Measure Life Study Report. Prepared for the Massachusetts Joint Utilities by ERS in 2005.

Michaels Energy has provided brief summaries of the key literature sources within this section for reference.

2.2.1 | ASHRAE Handbook

The ASHRAE Handbook Comparison of Service Life Estimates is a popular reference and was ultimately based on primary data collection. Prior to 2005, the measure life estimates provided in the HVAC Applications handbook were derived from an ASHRAE research project which took place in 1976⁷.

However, beginning in 2005, an online database was started and seeded with information from 163 different commercial buildings⁸. The database contains standard information on each piece of equipment including major end-use, equipment type, equipment operating hours, building type, building location, building area, year and month installed, year and month removed, and the reason for removal. The database is open to being populated by engineers and facility owners who are replacing their equipment. The database contents can be openly downloaded from the ASHRAE website⁹. As of this report, there were more than 345 different buildings that have reported details on nearly 39,000 different pieces of equipment.

One notable concern with this dataset is that much of the data has not been updated since 2008. A majority of the measures indicate they were installed prior to 2005, and very few new entries have been added since that time. The information available from ASHRAE does not specify if work is being done to update the database regularly. However, this remains one of the most robust datasets of actual installed and replaced equipment data that is available publicly.

2.2.2 | California DEER Database

The California Database for Energy Efficiency Resources (DEER) is a commonly cited source for many energy efficiency related parameters, including measure life. The measure lives found in the DEER database were originally developed in 2000 for inclusion in the 2001 version of the DEER

⁷ 2015 ASHARE Handbook, HVAC Applications. Chapter 37, page 2.

⁸ Ibid.

⁹ https://xp20.ashrae.org/publicdatabase/service_life.asp

database. Over the years there have been studies to update some of the measure lives included in DEER¹⁰, but a majority of those updates focused on lighting technologies.

Many of the DEER measure lives were and still remain based on the data contained in California DSM Measurement Advisory Committee (CADMAC) Protocol F, available on the CALMAC website¹¹. The most commonly cited source within this document appears to be engineering judgment. However, several of the measures in the DEER database have been updated or verified using primary data collection in California.

2.2.3 | GDS Measure Life Report

The Measure Life Report prepared by GDS in 2007 was the third common resource cited for measure life. The measure lives recommended from this study were the result of completing a literature review of recent measure life sources. The cited sources include the aforementioned DEER database and ERS measure life studies, as well as other research studies from the Northeast U.S. and California.

2.2.4 | ERS Measure Life Study

Similar to the GDS study, the measure life research completed by ERS in 2005 included a benchmarking component and a detailed literature review component. The benchmarking compared the measure lives used in Massachusetts to those used by 11 different utilities. Additionally, ERS completed an examination of the research done in the state of California.

During the early 2000's, the California utilities completed a number of retention studies. The retention studies attempted to measure the life of energy efficient equipment that had been installed through the programs up to 9 years prior. Retention studies use the known failure rates during the first years of a product, to estimate the median effective life. For example, the SDG&E Ninth year retention study completed in 2004 examined equipment that had been originally installed during the 1994 and 1995 program years.

These retention studies were based on surveys and site visit verification with customers who completed a wide range of measures. The sample sizes for some measures were very small (i.e., one customer). However, the full list of 16 different studies covers many popular measures, including some of the measures of interest for the Ontario gas utilities.

2.3 | Measure Life Primary Research

During the literature review, Michaels Energy was able to locate primary research related to four different custom measures included in this study. Included in the following sections are summaries of the data collection found.

¹⁰ One such example is "Revised/updated EULs Based on Retention and Persistence Studies Results", prepared by SERA, Inc., July 9, 2005

¹¹ <http://www.calmac.org/cadmac-protocols.asp>

2.3.1 | Space Heating and Domestic Hot Water Boilers

The measure life for space heating and domestic hot water boilers from across the literature was found to reference one of three common sources.

1. 2011 or 2015 ASHRAE Handbook, HVAC Applications. Chapter 37, Table 4 – Comparison of Service Life Estimates.
2. Database for Energy Efficiency Resources (DEER) Estimated Useful Life Tables.
3. Measure Life Report – Residential and Commercial/Industrial Lighting and HVAC Measures prepared by GDS Associates in June 2007.

Out of the three key referenced sources, the ASHRAE Service Life Estimates were able to be traced back to the primary data.

The ASHRAE dataset was also used as the basis for the U.S. Department of Energy's (US DOE) most recent rule-making on commercial packaged boiler efficiency standards¹². The US DOE mined the data to develop a probability distribution of the ages and estimated failure rates for commercial packaged boilers. Based on the data included in the ASHRAE database, the US DOE estimates that commercial boilers have a mean failure age¹³ of 24.8 years.

Enbridge currently uses a 25-year measure life for space heating and domestic hot water boilers. Union uses a 20-year measure life; however, this is due to Union's policy of capping measure lives at 20 years¹⁴. Absent the cap, Michaels Energy believes that a 25-year measure life is most appropriate for space heating and domestic hot water boilers.

2.3.2 | Steam Traps

Currently, the Enbridge custom measure life table references an impact evaluation from Massachusetts as the source for the six-year steam trap measure life. The 2013 Prescriptive Gas Evaluation – Phase 1 Steam Trap Evaluation¹⁵, conducted research in the following areas to assess measure life:

- Conduct in-depth industry and literature research on the steam trap measure with a focus on the measure lifetime assumption being used.
- Conduct and provide a summary of meetings with vendors/manufacturers most active with repair/replacement of steam traps in Massachusetts
- Collect actual Massachusetts gas customer facility data that supports steam trap lifetime conclusions

¹² TECHNICAL SUPPORT DOCUMENT: ENERGY EFFICIENCY PROGRAM FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT: COMMERCIAL PACKAGED BOILERS. December 9, 2016. file:///C:/Users/mtf/Downloads/00_CPB_ECS_FinalRule_TSD_Complete_2016-12-20.pdf

¹³ The U.S. DOE uses the term "mean failure age" which Michaels Energy used for consistency. In reality, the ASHRAE data includes both equipment which had failed, and equipment which was replaced early for other reasons.

¹⁴ Union Gas Custom Measure Life Table

¹⁵ Massachusetts 2013 Prescriptive Gas Impact Evaluation Steam Trap Evaluation Phase 1: FINAL. DNV – GL. June 17, 2015. <http://ma-eeac.org/wordpress/wp-content/uploads/MA-2013-Prescriptive-Gas-Impact-Evaluation-Steam-Trap-Evaluation-Phase-1.pdf>

The data gathered by the study team indicated that most jurisdictions use measure lives that range between three and six years. Vendors interviewed as part of the research indicated that steam traps are capable of lasting for more than five years, but that water quality was a significant factor. The customer sites visited had annual steam trap failure rates between 10 and 20 percent, indicating a five to ten-year measure life.

The final conclusion of this report was that a six-year measure life was appropriate for steam traps. Enbridge and Union both utilize a six-year measure life for steam trap replacements. Thus, no changes are recommended for steam traps at this time.

2.3.3 | VFD on Make-Up Air Units

Variable frequency drive (VFD) measure life was commonly sourced from the DEER database. The original estimate for VFD measure life was based on engineering judgment. This was later validated using the retention studies completed by the California utilities.

A total of ten different VFD measures were examined across the retention studies, each with a reported measure life between 10 and 16 years, with confidence intervals of up to 10 years. The research was used to confirm a 15-year measure life for fan VFDs currently used in the DEER database.

2.3.4 | Building Automation Systems

Similar to VFDs, the California retention studies also examined building automation systems¹⁶. The DEER database estimate for building automation systems was originally based on engineering judgment; that was later validated with research findings.

A total of four different measures were studied in the various California retention studies. Three of those studies recommended a 15-year life, and one recommended a 14-year life. This ultimately confirmed the 15-year measure life used in DEER.

2.4 | Source Conclusions

Of the four most commonly referenced sources for measure lives, only the ASHRAE database is based solely on primary data collection. The other common sources are based on a combination of engineering judgment, benchmarking to other utilities, and examining primary-researched measures from other jurisdictions. Michaels Energy looked through each of the foundational sources to determine the most applicable basis for the industry average measure life. The results can be seen in Table 4. The green highlighted measures were retained from the benchmarking analysis to show again which measures differed from industry consensus.

¹⁶ The CA studies use the energy management system name, but are effectively identical to building automation systems.

Table 4
Source Basis Summary

Measure	Researched Average Life	Source Basis
All other industrial equipment	18	Engineering Judgement
Boiler - Industrial Process	20	Engineering Judgement
Boiler - Space heating	22	Primary Data
Outside Pipe Insulation	14	Engineering Judgement
Boiler - Domestic Hot Water	20	Primary Data
Boiler Controls	14	Engineering Judgement
Energy Curtains	13	Engineering Judgement
Heat Recovery - Commercial	18	Engineering Judgement
Heat Recovery - Industrial	17	Engineering Judgement
Exhaust Fan Controls	13	Engineering Judgement
Heat Reflector Panels	25	Engineering Judgement
Economizers - Conventional and condensing	15	Engineering Judgement
Steam Trap	6	Primary Data
Infiltration Controls - Dock Seals, Air Doors	10	Engineering Judgement
IR Poly	5	Engineering Judgement
VFD retrofit on MUA	15	Primary Data
Heat Exchanger	17	Engineering Judgement
Building Automation System	15	Primary Data
Ovens & Thermal Oxidizers	18	Engineering Judgement
Reverse Osmosis (RO) Water Conditioner	20	Engineering Judgement
Building Envelope	22	Engineering Judgement

3. Recommendations and Future Research

Michaels Energy examined those measures which differed from industry standards and researched the source basis for the measures. Based on the deviation from industry consensus, applicability of the industry standard to Ontario, and the source basis of the measure life, Michaels Energy has developed several recommendations. The first set is focused on recommended changes to current measure lives. The second are priorities for future research in Ontario.

3.1.1 | Updates to Measure Lives

Michaels Energy was able to determine that a majority of the custom measure lives were sourced from a small number of literature sources. Each of these was more than 10 years old, and only a few measures were found to be based on primary research. Only one reference was based solely on primary data, the ASHRAE Handbook Comparison of Service Life Estimates.

Therefore, it must be acknowledged that the recommended changes to measure lives are based on the best available literature, program data, and Michaels' best engineering judgment.

3.1.1.1 | Boiler Controls

Boiler controls cover a wide range of measures including boiler reset, sequencing, and temperature lockout. Union Gas separates burner modifications, such as linkageless controls, into a separate category. Enbridge does not have a separate category for these types of modifications. However, Enbridge uses a lower 15-year measure life for boiler related controls. Additionally, Enbridge applies the 15 year controls life to other HVAC controls, such as demand controlled ventilation.

Excluding burner modifications, "soft" boiler controls such as reset and lockout are not expected to last as long as the boiler itself. These types of controls typically have lifetimes similar to other HVAC controls. Industry consensus for HVAC controls is 10-15 years. Lifetimes in this range are also what Michaels Energy uses for HVAC controls in our custom program implementation¹⁷.

Therefore, Michaels Energy recommends using a 15-year measure life for boiler controls. This does not include burner modifications, which are currently assigned a separate measure life by Union. Enbridge could consider adding a separate category for burner modifications, which would use a 20-year life similar to Union.

3.1.1.2 | VFD for Make-Up Air Units

Variable frequency drives are popular measures within prescriptive and custom programs. Most of the reports reviewed indicate that a 15-year measure life for variable frequency drives is

¹⁷ Michaels Energy provides custom rebate technical support for utility clients in the Midwest. We typically use 10-15 year measure lives for custom controls measures in this work.

appropriate. Currently, Union and Enbridge utilize a 10-year measure life for variable frequency drives.

The strong industry agreement is in line with Michaels Energy experience and engineering judgment as well. Additionally, the ultimate source used for the 15-year measure life was primary data collection from California. Therefore, Michaels Energy recommends that the measure life for variable frequency drives for make-up air units be increased to 15 years.

3.1.1.3 | Infiltration Controls – Dock Seals and Air Doors

Currently, a 15-year measure life is claimed for loading dock door seals and air doors. This is a reasonable assumption for mechanical equipment, such as air doors. However, loading dock door or ramp seals are large, heavy-duty foam gaskets that are, in some instances, exposed to weather. The two different types of equipment warrant different measure lives. Therefore, Michaels Energy recommends that these be split into two different measure lives.

The first would remain 15 years for air doors, air curtains, and fast closing doors. These mechanical pieces of equipment have the longer 15-year lifespan.

The loading dock door and ramp gasket measure life were indicated to be 10 years in the two cold weather sources that utilize this measure^{18,19}. However, the measure life was determined based on engineering judgment and not any associated primary data.

Michaels Energy recommends that the lifetime for loading dock door and ramp seals be reduced to 10 years to be consistent with what is used in other cold-weather states. Manufacturers²⁰ typically assume a 1 year warranty period for these seals, which further indicates a shorter lifespan than normal mechanical equipment.

It is important to note that dock door seals are becoming a common occurrence in cold-weather warehouse applications. This measure could also be included in further research, either through vendor interviews or program participant interviews. Based on Michaels Energy past experience verifying savings for Union Gas' custom program, this measure has been regularly included in the program over the last five years. Due to the small lifetime savings, however, Michaels Energy did not include it as a suggested research priority.

3.1.2 | Future Research

Many of the measures examined are ultimately based on engineering judgment. Several of the measures reviewed showed the measure lives currently claimed in Ontario differed from the industry standards. In addition, a subset of those measures was either significant contributors to the overall lifetime savings claimed in 2016, or the measures themselves have high variability and uncertainty. Finally, even though the measure lives claimed by Union and Enbridge deviate from industry averages, the industry averages were not based on primary research. This adds considerable uncertainty to the industry average.

¹⁸ MN Technical Reference Manual, page 302.

¹⁹ Focus on Energy (WI) 2017 Technical Reference Manual.

²⁰ For example Chalfant and Rite Hite.

Due to the uncertainty, Michaels Energy is not recommending immediate updates to two of the measures; pipe insulation and building automation systems. These were two such measures where primary research should be considered a high priority. Michaels Energy recommends dedicated primary research for the types of applications installed in Ontario to be sure that lifetime values are appropriate.

3.1.2.1 | Pipe Insulation

Pipe insulation is the first, and Michaels Energy believes, the highest priority for additional research. Pipe insulation had the highest lifetime gas savings of all measures completed during 2016. The 20-year measure life claimed by Union and Enbridge is higher than the industry average of 14 years. The types of installations for pipe insulation include many indoor (commercial) and potential outdoor (industrial) applications as well.

The most popular sources referenced for measure life were the ASHRAE Handbook, which Union and Enbridge reference, and the GDS Measure Life study. The ASHRAE Handbook lists 20 years for “molded” insulation and 24 years for “blanket” insulation, while the GDS report has ranged from 10 years to 25 years depending on the source.

The degree of disagreement within the industry, new insulating products that are available, wide range of applications within Ontario, and large contribution to lifetime custom savings indicate that primary data collection is warranted. Ideally, future work could distinguish different expected lifetimes for commercial buildings (indoor HVAC) from industrial (indoor/outdoor hazardous environment) and exterior (exposed to weather or buried) insulation applications.

Prior to completing the primary research, Michaels recommends reducing the measure life for pipe insulation to 14 years. This is consistent with the industry average, and accounts for a portion of the insulation being installed outdoors or in hazardous environments where it is unlikely to last 20 years.

3.1.2.2 | Building Automation Systems

Building Automation Systems, also known as Energy Management Systems, are increasingly popular measures for customers. This can be seen in the 2016 program data as building automation systems were the 9th largest contributor to total lifetime savings.

Building automation systems can vary significantly in their setup and overall usage between commercial and industrial customers. Union Gas had both commercial, and greenhouse buildings install building automation systems during 2016. Additionally, industrial customers such as asphalt and concrete plants monitor energy usage in significantly different ways.

Many of the referenced reports suggest a 15-year measure life for building automation systems. This is in contrast to the measure life utilized by Union of 20 years. Enbridge claims a 15-year measure life for building automation systems processed through the program. The ASHRAE database has 97 different building controls systems that were installed and removed prior to 2007, with an average installed time of 21 years.

Outside of the ASHRAE database, the studies completed in California are out of date. Building automation systems have changed substantially since the mid-1990's when most of the studied

measures were installed. Additionally, much of the research was focused on commercial installations and not the industrial applications which can be seen in Ontario.

Therefore, even though some older primary data exists for building automation systems, the progress of the technology over the last 20 years, the variability of installations, and the popularity of building automation system projects suggests this measure warrants additional research.

Prior to completing the primary research, Michaels Energy recommends that a 15 year measure life be used. This is most consistent with the literature, and Michaels Energy believes is more consistent with our expected building automation system lifetimes.

3.1.2.3 | Other Measures

As noted in Section 2.4, many measure lives are ultimately based on engineering judgment. While there is some primary research into measure lives, most of it is based on technologies installed more than 20 years ago.

Michaels' research into measure life showed that there were additional measures which contributed significantly to lifetime savings in 2016, and were not based on primary research.

- Other Industrial Equipment
- Energy Curtains
- Exhaust Fan Controls
- Boiler Controls
- Heat Exchangers

While the measure life assumptions could be bolstered by primary research for those listed above, Michaels Energy does not believe they are high enough priority to warrant dedicated study. Instead, Michaels Energy believes that an on-going data collection effort, similar to ASHRAE's database, would be the most beneficial and cost-effective method for building a primary dataset.

Many custom projects already have documentation which provides details of the existing equipment age and location. The existing universe of custom projects or those which are completed in the future could be mined for information about all of the measures of interest for this study and more. The ASHRAE database currently contains information from 345 individual buildings. Just during 2016, the custom programs in Ontario completed 1,360 different custom projects. Assuming each project was at a different building, a dataset of similar scale to ASHRAE's specifically for Ontario could be built within several years.

3.1.3 | Recommended Measure Lives

Michaels Energy developed a full table of recommended measure life values for the 20 different technologies researched. This is a single table which is applicable to both Union and Enbridge. These measure life values should be updated once any Ontario specific primary research is completed.

Table 5
Recommended Measure Lives

Measure	Recommended Measure Life
All other industrial equipment	20
Boiler - Industrial Process	20
Boiler - Space heating	25
Pipe Insulation	14
Boiler - Domestic Hot Water	25
Boiler Controls	15
Energy Curtains	10
Heat Recovery - Commercial	15
Heat Recovery - Industrial	20
Exhaust Fan Controls	15
Heat Reflector Panels	15
Economizers - Conventional and condensing	20
Steam Trap	6
Infiltration Controls - Air Doors	15
Infiltration Controls - Dock Seals	10
IR Poly	5
VFD retrofit on MUA	15
Heat Exchanger	17
Building Automation System	15
Ovens & Thermal Oxidizers	20
Reverse Osmosis (RO) Water Conditioner	20
Building Envelope	25

Appendix A | Measure Selection Memo

Selection Methodology and Analysis

The methodology Michaels Energy used is consistent with the process outlined in our final work plan. We selected the measures for further study by examining the following criteria:

- **Measure Frequency:** The number of units claimed by Enbridge, Union, or both based on 2016 program data.
- **Measure Impacts:** Even if a measure has small numbers of individual projects completed each year, their natural gas impacts may be significant to the custom programs as a whole.
- **Age of Referenced Sources:** Older sources may still be valid, but the additional investigation will be completed to ensure any more recent sources confirm assumptions or suggest an alternate value.
- **The Basis of Referenced Sources:** Cited sources will be examined to determine if they are based on primary data, secondary data, a specific jurisdiction, or engineering assumption. Measures which are sourced from primary data will be less likely to be included, assuming other criteria mentioned here are also met.
- **Differences Between Utilities:** Technologies which have different measure lives for each of the two utilities. In some instances, this may be acceptable, for example, different types of customers who routinely utilize a particular measure.
- **Michaels Energy Experience:** As explained in our proposal, Michaels Energy has examined thousands of custom projects. Our research team has the depth of knowledge about measures and their associated measure lives. We'll leverage this experience to identify any measures which don't have measure lives consistent with our experience.

In order to determine which measures were selected for further research, Michaels Energy examined each of the characteristics listed above and assigned a point value to each measure. The higher the assigned points, the more likely the measure should be selected for inclusion and further review. For example, the most popular measure from 2016, space heating boilers, would receive 20 points, while measures which had no participation would be given 0 points.

Michaels Energy believes that measures which constitute a large portion of savings should receive a higher priority for review. Therefore, cumulative savings was given the most weight in our points system at 40. Source age was given the least with 10. The other characteristics were scored out of 20 points each.

Program Data Analysis

Michaels Energy received 2016 custom program data for Enbridge and Union. The program data did not contain the exact same measure descriptions as the utilities' custom measure life tables. Therefore, the program data needed to be mapped to the measure life tables.

The program data contained fields for end-use, building type, measure type, and technology type. These features were used to map each project in the program data to the appropriate measure classification from the custom measure life tables. An example of this mapping for 10

different measures is shown in Table 1. The columns for “Equipment Type” and “Technology” were taken from the program data, while the “Measure Classification” column is from the custom measure life tables.

Table 6
Example Measure Mapping

Utility	Equipment Type	Technology	Measure Classification	Count	Lifetime Savings
Enbridge	BAS	BAS	Building Automation System	1	7,431,645
Union	Building	Boiler - Space heating	Boiler - Space heating	1	384,100
Union	Building	Exhaust Fan Controls	Exhaust Fan Controls	1	4,530,660
Union	Building	New Construction	Unclassified	3	8,525,620
Enbridge	Building Envelope	Roof Insulation	Roof/Ceiling insulation	14	5,993,800

A full table containing all of the measure mappings can be found in Appendix B.

Measure types which were not listed in the most recent custom measure life tables were labeled with “Unclassified,” such as the Building – New Construction measure shown in Table 1. Michaels Energy carried the unclassified measure label throughout the analysis to provide context on its relative contribution to savings and measure counts. However, unclassified measures were not scored. Unclassified measures were evaluated for inclusion separately, as described in the last analysis section of this memo.

Measure Frequency

Measure frequency is simply the number of units installed during the 2016 program year. Table 2 shows the summary of the measure frequency seen in the 2016 program year for Union, Enbridge, and combined.

Table 7
Measure Frequency²¹

Measure Classification	Union Count	Enbridge Count	Total Count	Points
Boiler - Space heating	17	150	167	20
Boiler Controls	3	151	154	19
Infiltration Controls - Dock Seals, Air Doors	43	70	113	18
Boiler - Domestic Hot Water	26	77	103	17
Outside Pipe Insulation	61	42	103	16
Steam Trap	3	58	61	15
Heat Reflector Panels	0	59	59	14
Unclassified	49	10	59	-
All other industrial equipment	49	9	58	13
Boiler - Industrial Process	7	46	53	12
Prescriptive	0	46	46	11
Energy Curtains	35	10	45	10
Roof/Ceiling insulation	29	14	43	9
Heat Recovery	41	1	42	8
Economizers - Conventional and condensing	17	23	40	7
Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	23	5	28	6
IR Poly	23	1	24	5
Make-Up Air	13	11	24	4
VFD retrofit on MUA	1	23	24	3
Building Automation System	21	1	22	2
Building Envelope	8	9	17	1
Furnaces	14	1	15	1
Heat Exchanger	14	0	14	1
Tank Exterior Insulation	11	1	12	1
Exhaust Fan Controls	10	0	10	1
Grain Dryer	9	0	9	1
Ovens & Thermal Oxidizers	7	0	7	1
Recommissioning, Retro-Commissioning	4	0	4	1
Fire Supression	2	0	2	1
PLC	1	0	1	1
Reverse Osmosis (RO) Water Conditioner	1	0	1	1
Total	541	818	1,359	

Space heating boilers, boiler controls, and infiltration control measures rounded out the top three most common measures from 2016. All three were more popular, based on counts of measures, for Enbridge than Union.

²¹ The "Prescriptive" classification is based on Enbridge's use of the Ontario TRM for measures life values consistent with the note provided on Enbridge's custom measure life table. "Where site specific information or a relevant prescriptive measure life is available to support an alternate measure life value for a specific custom project, Enbridge will use the alternate value for that custom project."

Measure Impacts

After examining measure frequency, Michaels Energy also examined the cumulative impacts resulting from each measure. Table 3 shows the cumulative cubic meters attributed to each measure classification from the 2016 program data for both utilities and in total. Similar to the frequency analysis, points were assigned based on rank. However, since there were not 40 different measures, points were dropped by two each time. Measures were also given at least one point if savings were claimed.

Table 8
Cumulative Measure Impacts

Measure Classification	Union Lifetime Savings (CCM)	Enbridge Lifetime Savings (CCM)	Lifetime Savings (CCM)	Points
Outside Pipe Insulation	529,356,770	23,635,200	552,991,970	40
All other industrial equipment	454,903,539	1,861,200	456,764,739	38
Boiler - Industrial Process	24,699,909	290,661,155	315,361,064	36
Boiler - Space heating	31,325,404	136,392,069	167,717,473	34
Energy Curtains	137,881,567	10,400,900	148,282,467	32
Boiler - Domestic Hot Water	78,498,112	69,391,975	147,890,087	30
Exhaust Fan Controls	119,155,605	0	119,155,605	28
Boiler Controls	4,994,860	109,805,190	114,800,050	26
Building Automation System	106,741,148	7,431,645	114,172,793	24
Heat Recovery	107,863,618	1,716,660	109,580,278	22
Furnaces	97,010,462	658,530	97,668,992	20
Unclassified	76,732,834	7,116,475	83,849,309	-
Economizers - Conventional and condensing	44,554,733	25,909,980	70,464,713	18
Heat Exchanger	63,393,112	0	63,393,112	16
Steam Trap	14,116,415	46,504,092	60,620,507	14
IR Poly	55,638,201	477,995	56,116,196	12
Recommissioning, Retro-Commissioning	48,679,220	0	48,679,220	10
Make-Up Air	27,421,693	7,054,755	34,476,448	8
Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	32,006,019	1,626,000	33,632,019	6
Infiltration Controls - Dock Seals, Air Doors	13,904,024	17,825,175	31,729,199	4
Roof/Ceiling insulation	20,079,180	5,993,800	26,072,980	2
Ovens & Thermal Oxidizers	24,265,940	0	24,265,940	1
VFD retrofit on MUA	572,210	20,711,100	21,283,310	1
Tank Exterior Insulation	14,913,510	15,285	14,928,795	1
Heat Reflector Panels	0	13,413,720	13,413,720	1
Building Envelope	1,388,500	8,370,025	9,758,525	1
Prescriptive	0	9,417,895	9,417,895	1
Grain Dryer	3,268,400	0	3,268,400	1
Fire Suppression	1,704,540	0	1,704,540	1
PLC	527,955	0	527,955	1
Reverse Osmosis (RO) Water Conditioner	494,460	0	494,460	1
Total	2,136,091,940	816,390,821	2,952,482,761	

There are many measures which provide significant impacts and show up frequently. Pipe insulation, boilers, industrial equipment, energy curtains, are all popular and provide significant impacts. However, furnaces, exhaust fan controls, heat recovery, and heat exchangers provide large impacts even though they are less popular measures.

Age of Sources

The third parameter Michaels Energy examined was the age of the referenced sources from the custom measure life tables. Many of the referenced sources are less than 10 years old. The utilities have also indicated that as part of the annual custom program savings verification, their verification contractors complete a review of the custom measure lives for sampled projects.

A summary of the ages of the referenced sources can be seen in Table 4. Measures with no cited source were given 10 points. Referenced sources 20 years old or more were also given 10 points, with points declining linearly down to zero if a source was published in 2018.

Table 9
Cited Source Age

Measure	Age	Points
Boiler Combustion Tune-Up	NA	10
Boiler Air Makeup (line)	NA	10
Boiler - Oxy-Fuel	NA	10
Boiler - Low Nox	NA	10
Heat Reflector Panels	NA	10
VFD retrofit on MUA	NA	10
Ovens & Thermal Oxidizers	NA	10
Electric Loop Controllers	NA	10
PLCs	NA	10
Flame Supervision	NA	10
Reverse Osmosis (RO) Water Conditioner	NA	10
Ion Exchange Water Conditioner	NA	10
All other industrial equipment	NA	10
Windows	NA	10
Building Envelope	NA	10
Building Optimization Program/RunSmart - Behavioral Savings Project	10	5
Make-Up Air	10	5
Recommissioning, Retro-Commissioning	10	5
Economizers - Conventional and condensing	7	4
Grain Dryer	8	4
Combustion Tune-up	8	4
Dessicant Cooling	7	4
Exhaust Fan Controls	8	4
Turndown controls on Modulating Boiler	8	4
Outside Pipe Insulation	7	4
Air Sealing	7	4
Tank Exterior Insulation	7	4
Steam Piping Leaks	7	4
Steam Valve	7	4
Furnaces	7	4
Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	6	3
Energy Curtains	6	3
Heat Recovery	6	3
Boiler - Industrial Process	4	2
Boiler - Space heating	3	2
Boiler - Domestic Hot Water	3	2
Boiler Controls	3	2
IR Poly	4	2
Building Automation System	3	2
Cooling Tower for HVAC	4	2
Infiltration Controls - Dock Seals, Air Doors	4	2
Heat Exchanger	4	2
Roof/Ceiling insulation	4	2
Steam Trap	3	2
Infrared Heaters	3	2

One important finding of this step is identifying measures where there is not a cited source. In some cases, such as industrial process improvements, this is expected. Measure lives for customer specific industrial equipment are not widely studied. Engineering judgment is the default for determining measure lives for industrial equipment.

Basis of Sources

Another characteristic Michaels Energy examined was the basis of the cited sources in the custom measure life tables. Both Enbridge and Union provided a list of cited sources within their custom measure life tables. These sources were examined to determine if they were based on primary data, a detailed literature review, a secondary source comparison, or engineering judgment.

It is important to note that this assessment does not provide any insight on the accuracy of the measure life that is currently used in the custom measure life tables. Measures may be based on engineering judgment, and still be correct. However, Michaels Energy would be more likely to select measures with measure lives based on engineering judgment to ensure that any available research is uncovered.

When assigning points for the source basis, Michaels Energy used four different classifications.

- **Primary Data (Primary)** – Based on studies that strove to collect primary data specifically on measure life. Sources in this category were given 1 point.
- **Detailed Data Review (Data)** – A literature review that focused on data collected from manufacturers and case studies of actual installations. Sources in this category were given 5 points.
- **Secondary Literature Comparison (Secondary)** – A literature review to ensure that the current measure life is consistent with other jurisdictions. These sources were given 15 points.
- **Engineering Judgment (Engineering)** – Assessment of the measure life based on engineering judgment and experience. Measures based on engineering judgment were also given 15 points.

Michaels Energy attempted to follow the source “trail” for each cited source from the custom measure life tables when making this assessment. For instance, the Massachusetts Prescriptive Steam Trap Evaluation, referenced by Enbridge, assessed measure life for steam traps. The research completed by this study focused on finding literature based on data from manufacturers of steam traps, in addition to customer steam trap surveys. Due to the use of primary data collection of actual steam trap turnover in facilities, this source was classified as using primary data.

Michaels Energy will complete this same type of digging during the next phase of this research as well. Our goal is to find credible, data-driven sources for validating or updating the lifetimes of the measures selected.

A summary of the assessment of the sources is shown in Table 5.

Table 10
Source Basis Review

Measure	Source Basis	Points
Boiler Combustion Tune-Up	Engineering	15
Boiler Air Makeup (line)	Engineering	15
Boiler - Oxy-Fuel	Engineering	15
Boiler - Low Nox	Engineering	15
Heat Reflector Panels	Engineering	15
VFD retrofit on MUA	Engineering	15
Ovens & Thermal Oxidizers	Engineering	15
Electric Loop Controllers	Engineering	15
PLCs	Engineering	15
Flame Supervision	Engineering	15
Reverse Osmosis (RO) Water Conditioner	Engineering	15
Ion Exchange Water Conditioner	Engineering	15
All other industrial equipment	Engineering	15
Windows	Engineering	15
Building Envelope	Engineering	15
Boiler - Industrial Process	Secondary	15
Building Optimization Program/RunSmart - Behavioral Savings Project	Secondary	15
IR Poly	Secondary	15
Grain Dryer	Secondary	15
Cooling Tower for HVAC	Secondary	15
Combustion Tune-up	Secondary	15
Dessicant Cooling	Secondary	15
Exhaust Fan Controls	Secondary	15
Infiltration Controls - Dock Seals, Air Doors	Secondary	15
Turndown controls on Modulating Boiler	Secondary	15
Heat Exchanger	Secondary	15
Roof/Ceiling insulation	Secondary	15
Recommissioning, Retro-Commissioning	Secondary	15
Infrared Heaters	Secondary	15
Boiler - Space heating	Data	5
Boiler - Domestic Hot Water	Data	5
Boiler Controls	Data	5
Economizers - Conventional and condensing	Data	5
Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	Data	5
Energy Curtains	Data	5
Building Automation System	Data	5
Heat Recovery	Data	5
Make-Up Air	Data	5
Outside Pipe Insulation	Data	5
Air Sealing	Data	5
Tank Exterior Insulation	Data	5
Steam Piping Leaks	Data	5
Steam Valve	Data	5
Furnaces	Data	5
Steam Trap	Primary	1

Differences Between Utilities

The final analysis step was to compare the measure lives used by the two utilities. Differences in lifetime for the same measure were flagged, and assigned points. Overall, many of the measure lives were the same between the utilities. However, there were several notable differences.

The first difference is that Union caps all of their measure lives at 20 years, while Enbridge does not. Union noted this cap in its custom measure life table for boiler measures. Enbridge uses a 25-year measure life for boiler related measures.

The second difference is in the combustion tune-up measure. Union uses a one-year measure life, while Enbridge uses a five year lifetime. Both of these estimates were based on engineering judgment, according to the measure life tables.

Additional differences between the utilities are shown below.

- Boiler Controls – Union 20, Enbridge 15
- Heat Recovery, Industrial – Union 20, Enbridge 15

Each measure where a difference was found was given an additional 10 points.

Unclassified Measures

Measures listed as unclassified were not able to be directly attributed to a measure life from the custom measure life table. However, Michaels Energy felt it was necessary to evaluate how significant of a contribution unclassified measures provided. Additionally, if there were some common measures, it may be possible to add measure lives to the custom measure table.

Table 6 shows all the unclassified measures based on their contribution to lifetime savings achieved in 2016. The “Rank” column shown is how the measures rank compared to all measures from 2016. Greenhouse Other, for example, contributed the 16th most savings in 2016.

Table 11
Summary of Unclassified Measures

Utility	Equipment Type	Technology	Measure Classification	Count	Lifetime Savings	Rank
Union	Greenhouse	Other	Unclassified	10	42,551,160	16
Union	Heat Recovery	Heat Exchanger - Clean	Unclassified	7	19,966,568	32
Union	Building	New Construction	Unclassified	3	8,525,620	50
Enbridge	Space Heating	5 Year Industrial	Unclassified	1	3,769,170	76
Union	HVAC	Destratification	Unclassified	23	2,689,905	86
Enbridge	Heating	Kitchen Ventilation	Unclassified	1	2,320,620	90
Union	Greenhouse	Multiple Measures	Unclassified	1	1,056,006	108
Union	Other	Other	Unclassified	1	875,060	112
Union	Controls	Other	Unclassified	1	416,540	129
Enbridge	Water Heating	10 Year Space	Unclassified	1	377,460	131
Enbridge	Cooking	10 Year Industrial	Unclassified	1	350,400	132
Union	Controls	Sensors	Unclassified	1	268,160	135
Union	HVAC	Setbacks	Unclassified	1	239,115	137
Enbridge	Water Heating	High Extraction Washer	Unclassified	4	200,360	140
Union	HVAC	HVAC Improvement	Unclassified	1	144,700	141
Enbridge	Water Heating	10 Year Water	Unclassified	1	51,830	145
Enbridge	Water Heating	Pool Heating	Unclassified	1	46,635	147

Greenhouse – Other, and Heat Exchanger Cleaning were the most significant unclassified measures during 2016. The other measures do not contribute significantly to the custom savings for either Union or Enbridge. In fact, the total contribution to savings for unclassified measures was 2.8% for the 2016 program year.

Based on the results of Table 6, Michaels Energy does not suggest including the unclassified measures in our review. Greenhouse – Other is likely combinations of several different measures. Many greenhouse measures are covered under other measure classifications already described. Heat Exchanger – Cleaning also does not contribute enough to the lifetime savings as a whole to warrant further investigation. Should these measures become more popular in the future, additional research could be undertaken at that time.

Measures Selected for Review

Based on Michaels’ analysis of the program data and current referenced resources, Michaels Energy plans to conduct further research on the following 20 measures.

- All other industrial equipment
- Boiler - Industrial Process
- Boiler - Space heating
- Outside Pipe Insulation
- Boiler - Domestic Hot Water
- Boiler Controls
- Energy Curtains
- Heat Recovery
- Exhaust Fan Controls
- Heat Reflector Panels
- Economizers - Conventional and condensing
- Steam Trap
- Infiltration Controls - Dock Seals, Air Doors

- IR Poly
- VFD retrofit on MUA
- Heat Exchanger
- Building Automation System
- Ovens & Thermal Oxidizers
- Reverse Osmosis (RO) Water Conditioner
- Building Envelope

One measure, boiler combustion tune-ups was initially scored high enough to be selected in the top 20 measures. However, feedback from Enbridge indicated that they have not offered this measure for several years. Union also had no participation for combustion tune-ups in 2016. Therefore, boiler combustion tune-ups was not selected for further review.

The measures selected for review represent a significant portion of the savings from 2016. The 20 measures selected represent 85% of Union's 2016 custom program savings, and 96% of Enbridge's 2016 custom program savings.

A full scoring summary for all of the measures in the measure life tables can be found in Appendix A.

Appendix A – Full Scoring Matrix

Measure	Sector	Measure Life	Frequency	Cummulative Savings	Source Age	Source Basis	Utility Differences	Total Points
All other industrial equipment	Industrial	20	13	38	10	20	0	81
Boiler - Industrial Process	Industrial	20	12	36	2	15	10	75
Boiler - Space heating	Commercial	20	20	34	2	5	10	71
Outside Pipe Insulation	Industrial	20	16	40	4	5	0	65
Boiler - Domestic Hot Water	Commercial	20	17	30	2	5	10	64
Boiler Controls	All	20	19	26	2	5	10	62
Energy Curtains	Greenhouse	10	10	32	3	15	0	60
Heat Recovery	Commercial	15	8	22	3	15	10	58
Exhaust Fan Controls	Commercial	15	1	28	4	15	0	48
Heat Reflector Panels	All	20	14	1	10	20	0	45
Economizers - Conventional and condensing	All	20	7	18	4	15	0	44
Steam Trap	Industrial	20	15	14	2	1	10	42
Boiler Combustion Tune-Up	All	1	0	0	10	20	10	40
Infiltration Controls - Dock Seals, Air Doors	Industrial	20	18	4	2	15	0	39
IR Poly	Greenhouse	5	5	12	2	15	0	34
VFD retrofit on MUA	Commercial	15	3	1	10	20	0	34
Heat Exchanger	Commercial	20	1	16	2	15	0	34
Building Automation System	All	20	2	24	2	5	0	33
Ovens & Thermal Oxidizers	Commercial	15	1	1	10	20	0	32
Reverse Osmosis (RO) Water Conditioner	Industrial	20	1	1	10	20	0	32
Building Envelope	All	25	1	1	10	20	0	32
Recommissioning, Retro-Commissioning	All	10	1	10	5	15	0	31
Boiler Air Makeup (line)	Industrial	20	0	0	10	20	0	30
Boiler - Oxy-Fuel	Industrial	20	0	0	10	20	0	30
Boiler - Low Nox	Industrial	20	0	0	10	20	0	30
Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	All	20	6	6	3	15	0	30
Electric Loop Controllers	Commercial	20	0	0	10	20	0	30
PLCs	Industrial	20	0	0	10	20	0	30
Flame Supervision	Industrial	20	0	0	10	20	0	30
Ion Exchange Water Conditioner	Industrial	20	0	0	10	20	0	30
Windows	All	6	0	0	10	20	0	30
Furnaces	All	20	1	20	4	5	0	30
Combustion Tune-up	All	1	0	0	4	15	10	29
Roof/Ceiling insulation	Commercial	14	9	2	2	15	0	28
Make-Up Air	Commercial	15	4	8	5	5	0	22
Grain Dryer	Commercial	20	1	1	4	15	0	21
Building Optimization Program/RunSmart - Behavioral Savings Project	Commercial	5	0	0	5	15	0	20
Dessicant Cooling	Commercial	15	0	0	4	15	0	19
Turndown controls on Modulating Boiler	Commercial	10	0	0	4	15	0	19
Cooling Tower for HVAC	Commercial	15	0	0	2	15	0	17
Infrared Heaters	Commercial	18	0	0	2	15	0	17
Tank Exterior Insulation	All	20	1	1	4	5	0	11
Air Sealing	All	20	0	0	4	5	0	9
Steam Piping Leaks	Industrial	20	0	0	4	5	0	9
Steam Valve	Industrial	20	0	0	4	5	0	9

Appendix B – Measure Mapping

Utility	Equipment Type	Technology	Measure Classification	Count	Lifetime Savings
Enbridge	BAS	BAS	Building Automation System	1	7,431,645
Union	Building	New Construction	Unclassified	3	8,525,620
Union	Building	Exhaust Fan Controls	Exhaust Fan Controls	1	4,530,660
Union	Building	Boiler - Space heating	Boiler - Space heating	1	384,100
Enbridge	Building Envelope	Roof Insulation	Roof/Ceiling insulation	14	5,993,800
Union	Controls	BAS	Building Automation System	5	65,184,400
Union	Controls	Linkageless	Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	12	12,847,240
Union	Controls	Burner	Boiler Controls	2	3,290,580
Union	Controls	Recommissioning, Retro-Commissioning	Recommissioning, Retro-Commissioning	1	2,441,000
Union	Controls	Boiler - linkageless	Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	1	2,437,860
Union	Controls	Boiler Controls	Boiler Controls	1	1,704,280
Union	Controls	VFD on MUA	VFD retrofit on MUA	1	572,210
Union	Controls	PLC	PLC	1	527,955
Union	Controls	Other	Unclassified	1	416,540
Union	Controls	Sensors	Unclassified	1	268,160
Enbridge	Cooking	10 Year Industrial	Unclassified	1	350,400
Union	Furnace	Furnace	Furnaces	9	75,237,657
Union	Furnace	Oven	Ovens & Thermal Oxidizers	4	20,958,580
Union	Furnace	Other	Furnaces	2	17,236,932
Union	Furnace	HE Grain Dryer	Grain Dryer	9	3,268,400
Union	Furnace	Burner	Furnaces	1	622,412
Enbridge	Generic	Furnace	Furnaces	1	658,530
Enbridge	Generic	Combustion Control	Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	1	93,480
Union	Greenhouse	Energy Curtain	Energy Curtains	35	137,881,567
Union	Greenhouse	Triple IR Poly Roof	IR Poly	21	54,939,836
Union	Greenhouse	Other	Unclassified	10	42,551,160
Union	Greenhouse	Hot Water Storage	Heat Recovery	9	27,460,173
Union	Greenhouse	Control System	Building Automation System	12	26,049,628
Union	Greenhouse	Pipe	Outside Pipe Insulation	4	25,628,900
Union	Greenhouse	Condensing Economizer	Economizers - Conventional and condensing	12	23,124,393
Union	Greenhouse	Boiler	Boiler - Space heating	14	22,537,234
Union	Greenhouse	Linkageless	Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	10	16,720,919
Union	Greenhouse	Building Automation System	Building Automation System	3	11,901,220
Union	Greenhouse	Boiler - Space heating	Boiler - Space heating	1	4,421,260
Union	Greenhouse	Economizer	Economizers - Conventional and condensing	1	4,421,260
Union	Greenhouse	Multiple Measures	Unclassified	1	1,056,006
Union	Greenhouse	Side Walls	IR Poly	2	698,365
Union	Greenhouse	Infiltration Controls - Dock Seals, Air Doors	Infiltration Controls - Dock Seals, Air Doors	1	35,720
Union	Heat Recovery	Heat Exchanger - Industrial	Heat Exchanger	10	43,252,480
Union	Heat Recovery	Condensate Return	Heat Recovery	6	30,382,210
Union	Heat Recovery	Heat Exchanger - Clean	Unclassified	7	19,966,568
Union	Heat Recovery	Other	Heat Recovery	3	13,702,300
Union	Heat Recovery	Compressor Air Recovery	Heat Recovery	12	13,020,420
Union	Heat Recovery	Economizer	Economizers - Conventional and condensing	2	10,972,580
Union	Heat Recovery	Hot Water Storage	Heat Recovery	1	6,356,920
Union	Heat Recovery	Condensing Economizer	Economizers - Conventional and condensing	1	5,820,460
Union	Heat Recovery	Glycol System	Heat Recovery	1	4,801,820
Union	Heat Recovery	Heat Recovery	Heat Recovery	3	2,151,975
Union	Heat Recovery	Preheating	Heat Recovery	1	2,069,160
Union	Heat Recovery	Pool	Heat Recovery	1	1,909,420
Union	Heat Recovery	Heat Transfer Improvement	Heat Exchanger	3	1,525,712
Union	Heat Recovery	Blowdown Recovery	Heat Recovery	1	909,060
Union	Heat Recovery	Recuperator	Heat Recovery	1	777,100
Union	Heat Recovery	Boiler	Heat Recovery	1	454,900
Enbridge	Heating	Boiler - Hydronic High Efficiency - Replacement	Boiler - Space heating	84	117,202,525
Enbridge	Heating	Pipe Insulation	Outside Pipe Insulation	39	20,907,200
Enbridge	Heating	VFD	VFD retrofit on MUA	23	20,711,100
Enbridge	Heating	Humidification	Boiler Controls	1	18,804,795
Enbridge	Heating	Reflective Panel	Heat Reflector Panels	59	13,413,720
Enbridge	Heating	DCV 15 yr	Boiler Controls	8	11,376,765
Enbridge	Heating	Building Envelope	Building Envelope	9	8,370,025
Enbridge	Heating	Dock Seals	Infiltration Controls - Dock Seals, Air Doors	38	8,247,330
Enbridge	Heating	Destratification	Prescriptive	33	6,900,960
Enbridge	Heating	Boiler - Hydronic Condensing - Advancement	Boiler - Space heating	21	5,563,844
Enbridge	Heating	Boiler - Hydronic High Efficiency - Advancement	Boiler - Space heating	10	5,110,258
Enbridge	Heating	Air Curtain	Infiltration Controls - Dock Seals, Air Doors	9	4,357,710
Enbridge	Heating	Envelope Infiltration	Infiltration Controls - Dock Seals, Air Doors	17	3,643,680
Enbridge	Heating	Steam Pipe Insulation	Outside Pipe Insulation	3	2,728,000
Enbridge	Heating	Kitchen Ventilation	Unclassified	1	2,320,620
Enbridge	Heating	Roof Top Unit	Boiler Controls	3	1,725,510
Enbridge	Heating	Steam Boiler Blowdown	Heat Recovery	1	1,716,660
Enbridge	Heating	DCV 10 yr	Prescriptive	3	1,326,610
Enbridge	Heating	High Speed Door	Infiltration Controls - Dock Seals, Air Doors	5	1,281,570
Enbridge	Heating	Thermostat - Programmable	Prescriptive	10	1,190,325
Enbridge	Heating	Boiler - Steam - Replacement	Boiler - Space heating	1	723,700
Enbridge	Heating	Linkageless Control	Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	2	527,655
Enbridge	Heating	Burner	Boiler - Space heating	1	500,892

Utility	Equipment Type	Technology	Measure Classification	Count	Lifetime Savings
Union	HVAC	Exhausts	Exhaust Fan Controls	2	87,458,020
Union	HVAC	Recommissioning, Retro-Commissioning	Recommissioning, Retro-Commissioning	1	42,614,540
Union	HVAC	MUA	Make-Up Air	11	23,651,725
Union	HVAC	Exhaust Fan Controls	Exhaust Fan Controls	4	20,105,820
Union	HVAC	Heat Exchanger - Industrial	Heat Exchanger	1	18,614,920
Union	HVAC	Fume Hoods	Exhaust Fan Controls	2	6,804,305
Union	HVAC	Boiler - Space heating	Boiler - Space heating	1	3,982,810
Union	HVAC	ERV/HRV	Heat Recovery	1	3,868,160
Union	HVAC	Make-Up Air	Make-Up Air	2	3,769,968
Union	HVAC	BAS	Building Automation System	1	3,605,900
Union	HVAC	Destratification	Unclassified	23	2,689,905
Union	HVAC	Furnace	Furnaces	1	647,610
Union	HVAC	Exhaust Cascading	Exhaust Fan Controls	1	256,800
Union	HVAC	Setbacks	Unclassified	1	239,115
Union	HVAC	HVAC Improvement	Unclassified	1	144,700
Union	Infiltration	Dock Doors Seals	Infiltration Controls - Dock Seals, Air Doors	27	7,474,704
Union	Infiltration	Automatic Doors	Infiltration Controls - Dock Seals, Air Doors	14	5,331,520
Union	Infiltration	Air Curtain	Infiltration Controls - Dock Seals, Air Doors	1	1,062,080
Union	Infiltration	Roof	Building Envelope	1	108,140
Union	Infiltration	Wall	Building Envelope	1	49,420
Union	Insulation	Pipe	Outside Pipe Insulation	53	496,854,225
Union	Insulation	Roof	Roof/Ceiling insulation	29	20,079,180
Union	Insulation	Tank	Tank Exterior Insulation	8	13,475,840
Union	Insulation	Outside Pipe Insulation	Outside Pipe Insulation	2	5,412,880
Union	Insulation	tank exterior insulation	Tank Exterior Insulation	3	1,437,670
Union	Insulation	Refractory	Outside Pipe Insulation	1	1,224,645
Union	Insulation	Wall	Building Envelope	5	1,212,480
Union	Insulation	Fittings & Valves	Outside Pipe Insulation	1	236,120
Union	Insulation	Door	Building Envelope	1	18,460
Union	Other	Recommissioning, Retro-Commissioning	Recommissioning, Retro-Commissioning	2	3,623,680
Union	Other	Ovens & TO	Ovens & Thermal Oxidizers	2	2,513,880
Union	Other	Fire Supression	Fire Supression	2	1,704,540
Union	Other	Other	Unclassified	1	875,060
Enbridge	Process	Direct Contact Water Heater - Replacement	Boiler - Domestic Hot Water	1	2,883,325
Enbridge	Process Heating	Roof	All other industrial equipment	9	1,861,200
Union	Process Improvement	Other	All other industrial equipment	32	397,252,894
Union	Process Improvement	Line Speed Improvements	All other industrial equipment	4	16,159,160
Union	Process Improvement	Increased Yields	All other industrial equipment	3	15,711,820
Union	Process Improvement	Furnace Load Scheduling	All other industrial equipment	1	14,557,920
Union	Process Improvement	Idle Mode Minimization	All other industrial equipment	1	3,011,220
Union	Process Improvement	Integration	All other industrial equipment	1	2,156,600
Union	Process Improvement	Parasitic Load Reduction	All other industrial equipment	4	910,325
Union	Process Improvement	Dryer	Ovens & Thermal Oxidizers	1	793,480
Union	Process Improvement	Furnace	All other industrial equipment	1	289,080
Enbridge	Space Heating	Condensing Boiler	Boiler - Space heating	29	5,911,250
Enbridge	Space Heating	5 Year Industrial	Unclassified	1	3,769,170
Enbridge	Space Heating	High Efficiency Boiler	Boiler - Space heating	3	729,950
Enbridge	Space Heating	Air Doors	Infiltration Controls - Dock Seals, Air Doors	1	294,885
Union	Steam and Hot Water	Boiler	Boiler - Domestic Hot Water	20	55,029,572
Union	Steam and Hot Water	Other	Boiler - Industrial Process	7	24,699,909
Union	Steam and Hot Water	DHW Upgrade	Boiler - Domestic Hot Water	5	23,350,520
Union	Steam and Hot Water	Traps	Steam Trap	3	14,116,415
Union	Steam and Hot Water	all other industrial	All other industrial equipment	2	4,854,520
Union	Steam and Hot Water	Furnace	Furnaces	1	3,265,851
Union	Steam and Hot Water	Reverse Osmosis	Reverse Osmosis (RO) Water Conditioner	1	494,460
Union	Steam and Hot Water	Economizer	Economizers - Conventional and condensing	1	216,040
Union	Steam and Hot Water	Direct Contact Water Heater	Boiler - Domestic Hot Water	1	118,020
Enbridge	Steam Generation	Greenhouse Double Poly	IR Poly	1	477,995
Enbridge	Steam Generation	Insulation	Boiler - Industrial Process	1	38,535
Enbridge	Ventilation	Steam Trap	Steam Trap	58	46,504,092
Enbridge	Ventilation	Heat Recovery/Economizer	Economizers - Conventional and condensing	23	25,909,980
Enbridge	Ventilation	Air Handling Unit	Boiler Controls	8	4,918,455
Enbridge	Ventilation	Steam Linkageless Control	Boiler - Linkage-Less Controls, Modulating Motors, Mod Motors	2	1,004,865
Enbridge	Ventilation	Boiler - Hydronic High Efficiency	Boiler - Space heating	1	649,650
Enbridge	Water Heating	Industrial Equipment	Boiler - Industrial Process	45	290,622,620
Enbridge	Water Heating	Controls	Boiler Controls	131	72,979,665
Enbridge	Water Heating	Boiler - Hydronic Condensing - Replacement	Boiler - Domestic Hot Water	76	66,508,650
Enbridge	Water Heating	Greenhouse Curtains	Energy Curtains	10	10,400,900
Enbridge	Water Heating	Make Up Air Unit	Make-Up Air	11	7,054,755
Enbridge	Water Heating	10 Year Space	Unclassified	1	377,460
Enbridge	Water Heating	High Extraction Washer	Unclassified	4	200,360
Enbridge	Water Heating	10 Year Water	Unclassified	1	51,830
Enbridge	Water Heating	Pool Heating	Unclassified	1	46,635
Enbridge	Water Heating	Tank Insulation	Tank Exterior Insulation	1	15,285

Appendix B | Measure Level Research

Measure	Findings	Source
All other Industrial Equipment	Enbridge: 20 years for Industrial & Industrial Process Equipment	-
	Union: 20 years	
	Maine C&I: 15 years for new construction, 13 years for retrofit	1
	New Jersey: 10 years for custom industrial process measures, 18 years for custom non-process industrial measures	-
Boiler – Industrial Process	Enbridge: 20 years for industrial process boilers	-
	Union: 20 years for boilers greater than 2500 MBHp	38
	Arkansas: 20 years for all boilers	2
	DEER: 20 years	-
Boiler – Space Heating	Enbridge: 25 years	3
	Union: 20 years	44
	Arkansas: 20 years	2
	California: 20 years	2
	Connecticut: 15 years for condensing boilers, 20 years for non-condensing boilers	-
	Illinois: 20 years	4
	Indiana: 20 years, based on modeling and Ohio PUC Case No. 08-0833-GA-UNC	
	Maine Res: 20 years, citing	5
	Maine C&I: Varies from 24-35 years	6
	Massachusetts: 20 years – see noted source, EUL value adjusted for early replacement and replace on failure based on Cadmus’ 2012 Net-to-Gross, Market Effects, and Equipment Replacement Timing report	7
	Mid-Atlantic: 20 years	8
	Minnesota: 20 years	2
	New Jersey: 20 years for small commercial and residential, 25 years for all others	-
	New Mexico: 25 years	9
New York: 24 years for water tube hot water, 30 years for water tube steam, 25 years for fire tube hot water and fire tube steam, 35 years for hot water cast iron, 20 years for steam cast iron	10	
Rhode Island: 25 years	11	

Measure	Findings	Source
	Vermont: 25 years	-
	Wisconsin: 20 years	-
	DEER: 20 years	-
Outside Pipe Insulation	Enbridge: 20 years, citing 2011 ASHRAE Handbook	3
	Illinois: 15 years, citing GDS Associates 2007 Measure Life Report	5
	Massachusetts: 15 years	11
	Minnesota: 13 years for residential HW pipe insulation in unconditioned spaces	2
	New York: 11 years for residential hot water with gas heating	12
	Rhode Island: 15 years	13
	Wisconsin: 10 years	14
Boiler – Domestic Hot Water	Enbridge: 25 years	3
	Union: 20 years	44
	Maine Res: 20 years for all boilers	5
	Massachusetts: 20 years	11
	Rhode Island: 15 years for indirect water heaters using a boiler	11
Boiler Controls	Enbridge: 15 years	-
	Union: 20 years	44
	Arkansas: 20 years for cutout & reset controls, citing	15
	Illinois: 20 years for space heating boiler lockout & reset controls, 16 years for linkageless controls, and 18 years for oxygen trim controls	16, 17
	Indiana: 10 years for oxygen trim controls for space heating boilers	-
	Maine C&I: 20 years for lockout & reset controls and 21 years for modulating controls, and 15 years for oxygen trim controls	18, 19
	Massachusetts: 15 years for lockout & reset controls	11
	Mid-Atlantic: 15 years for residential boiler reset controls	20
	Minnesota: 5 years for adding lockout, reset, or oxygen trim controls to an existing boiler, 15 years for fully modulating burners	21, 22
	New Jersey: 7 years for adding reset controls to a residential heating boiler	-
	New York: 15 years for boiler reset controls	-
	Rhode Island: 15 years for reset controls	23
	Vermont: 15 years for reset controls in multifamily housing units	-
	Wisconsin: 5 years for reset controls	24
	CALMAC: 15 years	12

Measure	Findings	Source
Energy Curtains	Union: 10 years	45
	Connecticut: 15 years for air curtains	-
	Illinois: 15 years for industrial air curtains	25
Heat Recovery	Union: 15 years for Commercial, 20 years for Industrial	45
	Connecticut: 15 years for domestic hot water heat recovery, 14 years for HVAC plate/heat pump and rotary type HVAC heat recovery systems, heat recovery from refrigeration systems has EUL of 10 years for retrofit and 13 years for lost opportunity (no source specified for lost opportunity EUL)	12
	Minnesota: 20 years for residential drainpipe heat exchanger	26
	New Jersey: 24 years for commercial heat exchangers, 20 years for industrial heat exchangers	-
	Vermont: 10 years for dairy farm milk cooling system heat recovery, 25 years for drain water heat recovery	-
	Wisconsin: 15 years for refrigeration heat recovery in dairy applications	-
	DEER: 10 years for heat recovery from a central refrigeration system, 14 years for heat recovery from a compressed air system	-
Exhaust Fan Controls	Union: 15 years for Kitchen DCV	28
	Arkansas: 15 years for Kitchen DCV	28
	California: 15 years for kitchen exhaust hood DCV	30
	Connecticut: 10 years for process equipment interlock for exhaust fans with machine operations	5
	Delaware: 15 years for HVAC VFD applications, including exhaust fans	31
	Illinois: 15 years for kitchen DCV	32
	Maine C&I: 13 years for HVAC VFDs, including exhaust fans	1, 5
	Massachusetts: 15 years for retrofit HVAC VFDs, including exhaust fans, 13 years for lost opportunity (no source for lost opportunity EUL)	1
	Minnesota: 15 years for kitchen DCV, 15 years for parking garage exhaust fan CO control	33, 34
	Rhode Island: 15 years for HVAC VSDs, including exhaust fans	1
	Wisconsin: 5 years for parking garage ventilation controls	-
Heat Reflector Panels	Enbridge: 25 years for residential, 15 years for commercial/industrial	35
	Union: 15 years	-

Measure	Findings	Source
Economizers: Conventional and Condensing	Connecticut: 7 years for retrofit HVAC air or water-side economizer, 10 years for lost opportunity, 10 years for dual-enthalpy economizer controls	5
	Union: 20 years	45
	Delaware: 10 years for dual-enthalpy economizers	8
	Illinois: 5 years for HVAC economizer repair or optimization, 15 years for refrigeration economizer, 15 years for boiler stack economizer	28, 36, 8
	Indiana: 10 years for dual-enthalpy HVAC economizer	2
	Maine C&I: 20 years for boiler stack economizer	11
	Massachusetts: 10 years for dual-enthalpy HVAC economizer lost opportunity applications, 7 years for retrofit applications	1, 5
	Mid-Atlantic: 10 years for dual-enthalpy HVAC economizer for commercial facilities	8
	Minnesota: 10 years for C&I unitary equipment economizers	5
	New York: 10 years for dual-enthalpy economizers for C&I facilities	12
	Rhode Island: 10 years for dual-enthalpy economizers for C&I facilities	1
	Vermont: 14 years for dual-enthalpy economizers, 15 years for refrigeration economizers	-
	Wisconsin: 10 years for adding economizing to an existing RTU	2
	DEER: 15 years for water-side economizer	-
	Steam Traps	Union: 7 years
Enbridge: 6 years		38
Arkansas: 5 years		15
California: 6 years		29
Illinois: 6 years		37
Massachusetts: 6 years for process steam traps		5
Minnesota: 6 years		2
New York: 6 years		28
Rhode Island: 6 years		38
Wisconsin: 6 years		-
DEER: 6 years		
Infiltration Controls – Dock Seals, Air Doors	Union: 15 years	28
	Enbridge: 15 years for Air Doors	5
	Minnesota: 10 years for C&I loading dock door and pit seals	-

Measure	Findings	Source
	Wisconsin: 10 years for new or replacement dock door seals or dock pit/ramp external seals	-
IR Poly	Union: 5 years	28
	Enbridge: 5 years for double poly greenhouses	-
	DEER: 5 years for IR film for greenhouses	-
VFD Retrofit on MUA	Union: 10 years	-
	Ontario: 20 years	40
	California: 15 years	2
	Connecticut: 15 years	41
	Illinois: 15 years	36
	Indiana: 15 years	2
	Maine C&I: 13 years	1, 5
	Massachusetts: 15 years for lost opportunity, 13 years for retrofit	1
	Mid-Atlantic: 15 years	31
	Minnesota: 15 years	2
	New Mexico: 15 years	36
	New York: 15 years	28
	Rhode Island: 15 years	1
	Texas: 15 years	28
	Vermont: 15 years	-
	Wisconsin: 15 years	8
DEER: 15 years	-	
Heat Exchanger	Ontario: 14 years for ERVs	42
	Union: 14 years for commercial, 20 years for industrial	28
	Connecticut: 14 years for rotary and plate-type heat recovery systems	2
	Illinois: 15 years for ERVs	43
	Minnesota: 15 years	43
	New Jersey: 20 years for industrial heat exchangers	-
	Rhode Island: 20 years	11
	Wisconsin: 15 years for well water/milk heat exchangers	21
	DEER: 14 years for air-to-air heat exchangers	-
	Union Gas: 20 years	44, 45
	Arkansas: 15 years for individual boiler and fan controls	15

Measure	Findings	Source
Building Automation System	Connecticut: 15 years for lost opportunity applications, 10 years for retrofit applications	5
	Illinois: 10 years for building sensors	46
	Indiana: 15 years	-
	Maine C&I: 10 years	47
	Massachusetts: 15 years for lost opportunity applications, 10 years for retrofit applications	1
	New Jersey: 15 years	-
	Rhode Island: 15 years	7, 23
	DEER: 15 years	-
Ovens & Thermal Oxidizers	Union: 20 years	-
	Wisconsin: 15 years for Industrial Ovens	-
Reverse Osmosis (RO) Water Conditioner	Union: 20 years	-
Building Envelope	Ontario: 25 years	-
	Enbridge: 25 years	-
	Union: 20 years for ceiling/roof insulation	28
	Arkansas: 20 years	2
	California: 10 years for reflective window film	2
	Connecticut: 20 years for insulation, 15 years for cool roof, 10 years for window insulation and films, 15 years for new windows	2
	Delaware: 25 years	5
	Illinois: 20 years	2, 5
	Indiana: 15 years	2
	Maine C&I: 25 years	5
	New York: 15 years for cool roof, 10 years for window films, 20 years for window glazing, 30 years for opaque shell insulation	12, 28, 27
	Rhode Island: 25 years	21
	Texas: 15 years for cool roof, 10 years for solar screens, 11 years for residential air infiltration reduction, 25 years for insulation and windows	48, 49
	Vermont: 15 years	-
Wisconsin: 20 years for air sealing, 25 years for attic or wall insulation, 20 years for attic insulation with air sealing	5	

Measure	Findings	Source
	DEER: 20 years for insulation and high-performance windows, 11 years for low-income weatherization, 15 years for cool roof, 10 years for solar screens	-

Sources

1. ERS, Measure Life Study Prepared for the Massachusetts Joint Utilities, November 2005
2. Database for Energy Efficient Resources (DEER) 2008
3. 2011 ASHRAE Handbook, HVAC Applications
4. technical support documents for federal residential appliance standards
5. GDS, Measure Life Report, Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007
6. Department of Energy "Buildings Energy Data Book", 2011
7. EPA 2009 Life Cycle Cost Estimates
8. Focus on Energy business programs measure life study, 2009
9. Massachusetts 2011 TRM
10. 2015 ASHRAE Handbook
11. GDS Associates & Summit Blue Consulting 2009 Natural Gas Energy Efficiency Potential in Massachusetts report
12. Database for Energy Efficient Resources (DEER) - no publication year specified
13. Energy & Resource Solutions 2005 Measure Life Study prepared for the Massachusetts Joint Utilities
14. PA Consulting Group
15. NYSERDA Natural Gas Database
16. Brooklyn Union Gas Company's Gas Energy Efficiency Program Implementation Plan
17. Focus on Energy
18. Illinois 2015 TRM
19. Michigan Master Database of Deemed Savings 2014
20. New York 2014 TRM
21. The Cadmus Group (2012), Massachusetts 2011 Residential Retrofit Multifamily Program Impact Analysis, Prepared for the Massachusetts Program Administrators
22. Illinois 2014 TRM
23. ACEEE 2006 Emerging Technologies Report
24. Cadmus EUL response Memo, 8/26/2013
25. Navigant Consulting Measures and Assumptions for DSM Planning report, 2009
26. Ohio 2010 TRM
27. Energy Trust
28. Department for Energy Efficient Resources (DEER) 2014
29. SCG work paper SCWP100310A, Revision 9, Deemed Program for Commercial Steam Traps, Aug. 2012
30. PG&E workpaper, Commercial Kitchen Demand Ventilation Controls, 6/18/2012
31. Navigant 2013 Incremental Cost Study Phase Two Final Report
32. PG&E Workpaper: Commercial Kitchen Demand Ventilation Controls - Electric, 2004-2005

33. PGE Workpaper PGECOFST116, Commercial Kitchen Demand Ventilation Controls, December 21, 2007
34. 2015 Michigan Energy Measures Database, Measure W-CO-HV-100036-C-WR-WR-WR-WR-01
35. N. Canada, "Durability Section", Novitherm
36. Vermont TRM
37. CLEAResult "Steam Traps Revision #1" dated August 2011
38. DNV GL MA 2013 Prescriptive Gas Impact Evaluation: Steam Trap Evaluation Phase 1
39. Energy and Environmental Analysis, Inc. Steam Trap Workpaper for PY 2006-2008. Prepared for Southern California Gas Company. December 2006
40. ASHRAE Handbook - HVAC Applications I-P addition, 2008
41. Appliance Magazine. U.S. Appliance Industry: Market Share, Life Expectancy & Replacement Market, and Saturation Levels. January 2010
42. "Evaluation of Natural Gas DSM Measures: ERVs & HRVs," March 12, 2010
43. "Demand Control Ventilation Using CO2 Sensors", by US Department of Energy Efficiency and Renewable Energy
44. ASHRAE Service Life & Maintenance Cost Database (Jan 14, 2015)
45. Union Gas 2011 DSM Audited Results
46. Interviews with vendors and contractors
47. Nexant, Business Incentive Program Impact Evaluation, unpublished draft, May 2017
48. Public Utilities Commission of Texas Docket No. 36779
49. Public Utilities Commission of Texas Docket No. 41070

Appendix C | Measure Life Data

Measure	Ontario TRM	Enbridge	Union	Arkansas	California	Connecticut	Delaware	Illinois	Indiana	Maine	Maine C/I	Massachuse	Mid-Atlantic	Minnesota	New Jersey	New Mexico	New York	Rhode Island	Texas	Vermont	Wisconsin	CALMAC	Michaels
All other industrial equipment	20	20	20								15				14								20
Boiler - Industrial Process	20	25	20	20																		20	20
Boiler - Space heating	25	25	20	20		15		20	20	20	30	20	20	20	20	25	25	25		25	20	20	25
Outside Pipe Insulation	20	20	20			10		15				15						15			10		14
Boiler - Domestic Hot Water	25	25	20							20		20						15					25
Boiler Controls	15	15	20	20				20	10		20	15		5			15	15		15	5	15	15
Energy Curtains	10	10	10			15		15															10
Heat Recovery - Commercial	14	15	15			14		15						15	24			20		25	15	14	15
Heat Recovery - Industrial	14	15	20			14		15						15	20			20		25	15	14	20
Exhaust Fan Controls	15		15	15	15	10	15	15			13	15		15				15				5	15
Heat Reflector Panels	25	15	15																				15

Measure	Ontario TRM	Enbridge	Union	Arkansas	California	Connecticut	Delaware	Illinois	Indiana	Maine	Maine C/I	Massachuse	Mid-Atlantic	Minnesota	New Jersey	New Mexico	New York	Rhode Island	Texas	Vermont	Wisconsin	CALMAC	Michaels
Economizers - Conventional and condensing			20			10	10	15	10		20	10	10	10			10	10		10	10	15	20
Steam Trap		6	7	5	6			6				6		6			6	6			6	6	6
Infiltration Controls - Dock Seals, Air Doors		15	15											10							10		10
IR Poly		5	5																			5	5
VFD retrofit on MUA	20		10	15	15	15		15	15		13	15	15	15	15	15	15	15	15	15	15	15	15
Heat Exchanger (Plate-Plate or Tube-Tube) - Commercial			14			14												20			15		17
Heat Exchanger (Plate-Plate or Tube-Tube) - Industrial			20			14								20									17
Heat Exchanger (Air-Air) - Commercial	14	14	14			14		15			20			15								14	17
Heat Exchanger (Air-Air) - Industrial	14		20			14		15			20			15	20							14	17
Building Automation System	20		20	15		15			15		10	15			15			15				15	15
Ovens & Thermal Oxidizers	20		20																		15		20

Measure	Ontario TRM	Enbridge	Union	Arkansas	California	Connecticut	Delaware	Illinois	Indiana	Maine	Maine C/I	Massachuse	Mid-Atlantic	Minnesota	New Jersey	New Mexico	New York	Rhode Island	Texas	Vermont	Wisconsin	CALMAC	Michaels
Reverse Osmosis (RO) Water Conditioner	20		20																				20
Building Envelope	25	25	20	20		20	25	20	15		25						25	25		15		20	25



Appendix Q Report: Custom Program Savings Verification

This report has been prepared for the Ontario Energy Board (OEB). The study includes results from Custom Program Savings Verification (CPSV) of Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) programs delivered in 2016.

ONTARIO GAS DSM EVALUATION CONTRACTOR

2016 Natural Gas Demand Side Management Custom Savings Verification

Ontario Energy Board

Date: July 31, 2018



Table of contents

TABLE OF CONTENTS	ii
GLOSSARY OF TERMS AND KEY CONCEPTS	1
1 EXECUTIVE SUMMARY	4
1.1 Background	4
1.2 Methodology summary	5
1.3 Results	5
2 INTRODUCTION.....	15
1.1 Background	15
2.1 Methodology summary	16
3 UNION COMMERCIAL, INDUSTRIAL, AND MULTI-FAMILY PROGRAMS.....	20
3.1 Summary of Data Collection	20
3.2 Gross Savings Realization Rate	21
3.3 Discrepancy Summary	22
4 UNION LARGE VOLUME.....	27
4.1 Summary of Data Collection	27
4.2 Gross Savings Realization Rate	28
4.3 Discrepancy Summary	29
5 ENBRIDGE COMMERCIAL, INDUSTRIAL, AND MULTI-RESIDENTIAL PROGRAMS	33
5.1 Summary of Data Collection	33
5.2 Gross Savings Realization Rate	34
5.3 Discrepancy Summary	35
6 FINDINGS AND RECOMMENDATIONS.....	40
6.1 Energy savings and program performance	48
6.2 Verification processes	50
6.3 Documentation and support	51
6.4 Data management	55
APPENDIX A FINAL SAMPLE ACHIEVEMENT	58
APPENDIX B TECHNICAL POLICY APPROACHES.....	59
APPENDIX C ADDITIONAL RESULTS	74
APPENDIX D SAMPLE DESIGN	75
APPENDIX E SAMPLE EXPANSION AND RATIO ESTIMATION.....	86
APPENDIX F SITE LEVEL SAVINGS RESULTS	95

GLOSSARY OF TERMS AND KEY CONCEPTS

Adjustment factor	The adjustment factors are ratios of savings that allow evaluation findings from a sample of projects to be applied to and “adjust” the population of program savings. Realization rates, and ratios are other common terms.
Baseline, base case	Energy use / equipment in place if the program measure had not been done
Building envelope	Exterior surfaces (e.g., walls, windows, roof, and floor) of a building that separate the conditioned space from the outdoors.
Capacity expansion (CE)	Measure that allows customer to increase production/productivity
CCM	Cumulative Cubic meters (cumulative m ³)
Code	Measure required by regulations for safety, environmental, or other reasons
C&I	Commercial and Industrial
Custom Program Savings Verification (CPSV)	Activities related to the collection, analysis, and reporting of data for purposes of measuring gross custom program impacts.
Customer - Enbridge	Unique customers can be identified based on the Con_acc_num and the contact information provided by Enbridge. A customer may have multiple site addresses, decision makers, Con_acc_nums, and utilities. Customers can only be identified for records for which we received contact information (ie records associated with con_acc_num that have measures in the sample or backup sample).
Customer - Union	Unique customers can be identified based on the AIMS ID and the contact information provided by Union. A customer may have multiple site addresses, decision makers, AIMS IDs, and utilities. Customers can only be identified for records for which we received contact information (ie records associated with AIMS ID that have measures in the sample or backup sample).
Demand side management (DSM)	Modification of perceived customer demand for a product through various methods such as financial incentives, education, and other programs
Early replacement (ER)	Measure that replaces a piece of equipment that is not past EUL and in good operating condition
Domain	Grouping of like projects. A domain may be defined as projects within a specific sector or a category of measure types, end uses or other.
Dual Baseline	Savings calculation approach which addresses or combines the savings associated with early replacement and the savings after the early replacement period.
Early replacement Period (ER Period)	Years that the existing equipment would have continued to be in use. This is the same as RUL.
Energy Advisors	Energy Advisors are utility and/or program staff who provide information to customers about energy saving opportunities and program participation, this term includes, but is not limited to, Enbridge’s Energy Solutions Consultants and Union’s Account Managers
Estimated useful life (EUL)	Typically, the median number of years that the measure will remain in service
Ex ante	Program claimed or reported inputs, assumptions, savings, etc.
Ex post	Program inputs, assumptions, savings, etc. which are verified after the claimed savings are finalized. Does not include assessment of program influence. Synonym for verified gross savings.
Gross savings	Gross savings are changes in energy consumption and/or demand directly caused by program-related actions by participants regardless of reasons for participation (savings relative to baseline, defined above)
In situ	Existing measure, conditions, and settings

Incentive	An incentive is a transfer payment from the utility to participants of a DSM program. Incentives can be paid to customers, vendors or other parties as part of a DSM program.
Incremental cost	The difference in purchase price (and any differences in related installation, implementation costs), at the time of purchase, between the efficient measure and the base case measure. In some early retirements and retrofits, the full cost of the efficient technology is the incremental cost.
Industry standard practice (ISP)	Common measure implemented within the industry
Input assumptions	Assumptions such as operating characteristics and associated units of resource savings for DSM technologies and measures
Lifetime cumulative savings	Total natural gas savings (CCM) over the life of a DSM measure. Can be claimed, gross, or net. Sometimes referred to as just “cumulative” or “lifetime.”
Maintenance (Maint.)	Repair or maintain, restore to prior efficiency
Measure – Enbridge	Measures are identified in the tracking data as a unique combination of project code, project sub code, and ESM project ID. Multiple measures may belong to the same project.
Measure – Union	Measure refers to a project # in the tracking data. When referring to Union programs, measure and project are used interchangeably as there is one level provided in the tracking data.
Measurement and Verification (M&V)	Verification of savings using methods not including attribution/free-ridership assessment.
MF	Multifamily (multi-residential).
New construction (NC)	New buildings or spaces
Non-early replacement period (non-ER period)	Years after the ER period up to the EUL
Normal replacement (NR)	Measure that replaces a piece of equipment that has reached or is past its EUL and in good operating condition
Persistence	The extent to which a DSM measure remains installed, and performing as originally predicted, in relation to its EUL
Program evaluation	Activities related to the collection, analysis, and reporting of data for purposes of measuring program impacts from past, existing, or potential program impacts
Project - Enbridge	Projects are identified in the tracking data based on the project code. A project may have multiple measures as indicated by sub-codes in the current data tracking system.
Project – Union	Projects are identified in the tracking data based on project # or project ID. When referring to Union programs, measure and project may be used interchangeably as there is one level provided in the tracking data.
Remaining useful life (RUL)	The number of years that the existing equipment would have remained in service and in good operating condition. This is the same as ER Period.
Realization Rate	A combination of adjustment factors, which represents ratios between two savings values. For example, the final realization rate is the ratio between evaluated savings and program claimed savings.
Replace on burnout (ROB)	Measure that replaces a failed or failing piece of equipment
Retrofit add-on (REA)	Measure reduces energy use through modification of an existing piece of equipment
Site	Sites are identified based on unique site addresses provided by Union and Enbridge through the contact information data request. A site may have multiple units of analysis, measures, and projects. Sites can be identified by the evaluation only for records for which we receive contact information – ie records associated with con_acc_num (EGD) or AIMS ID (Union) that have projects in the sample or backup sample.

System optimization (OPT)	Improve system or system settings to exceed prior efficiency
TSER	Telephone Supported Engineering Review
Unit of Analysis – Enbridge	The level at which the data are analyzed, which in 2016 is a “measure” or sub-project level for Enbridge
Union Influence Factor	Factor applied by Union to a small number of projects in 2016. The factor reduced ex ante (claimed) savings to account for anticipated partial free ridership. In this report, the savings reported have the factor removed.
Unit of Analysis - Union	The level at which the data are analyzed, which in 2016 is a project for Union. A project is equivalent to a measure for Union as the database did not have a sub-project level.
Vendors	Program trade allies, business partners, contractors and suppliers who work with program participants to implement energy saving measures

1 EXECUTIVE SUMMARY

This report has been prepared for the Ontario Energy Board (OEB). The study includes results from Custom Program Savings Verification (CPSV) of Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) programs delivered in 2016.

The study provides verified savings ratios and verified gross savings totals. Projects included are shown in Table 1. In this study of 2016 programs, custom Market-Rate Multi-Residential (Multi-family) projects are included, while custom Low Income Multi-Residential projects are not included.

Table 1: CPSV by program

Program		2016
		CPSV
Union Custom	Large Volume	✓
	Commercial & Industrial*	✓
Enbridge Custom	Commercial*	✓
	Industrial	✓

*Custom Market-Rate Multi-Residential (Multi-family) projects are included as a part of this program.

1.1 Background

Enbridge and Union deliver energy efficiency programs under the Demand Side Management Framework for Natural Gas Distributors (2015-2020)¹ developed by the OEB.

In April 2016, the OEB hired an Evaluation Contractor (EC) team led by DNV GL to develop an overall evaluation, measurement, and verification (EM&V) plan. The objectives of the plan were to:

- Assess portfolio impacts to determine annual savings results, shareholder incentive and lost revenue amounts, and future year targets.
- Assess the effectiveness of energy efficiency programs on their participants and/or market, including results on various scorecard items.
- Identify ways in which programs can be changed or refined to improve their performance.

Under the plan, the DNV GL team conducted a verification of gross savings for custom projects implemented as part of the 2016 program year. Verification entails reviewing a statistical sample of measures installed through the programs. For this sample of measures, the DNV GL team reviewed savings calculations, ensured reasonable approaches were used, and conducted phone and/or onsite verification of implemented measures to verify the accuracy of assumptions and inputs. This report is a result of that study.

An evaluation advisory committee (EAC) provides input and advice to the OEB on the evaluation and audit of DSM results. The EAC consists of representatives from Union and Enbridge as well as representatives from non-utility stakeholders, independent experts, staff from the Independent Electricity System Operator (IESO), and observers from the Environmental Commissioner of Ontario and the Ministry of Energy. The DNV GL team worked closely with the EAC throughout this study and received comments, advice, and input on methodology and results. We thank them for their involvement.

¹ EB-2014-0134

1.2 Methodology summary

The results presented in this report are based on data collection from the following four primary sources, supplemented with secondary source information:

- Union and Enbridge tracking databases
- Union and Enbridge project documentation
- In-Depth Interviews with a sample of participating customers and vendors
- On-site visit to a sample of participating customer sites

The data collection with a sample of participating customers included site visits and telephone interviews supporting a detailed measurement and verification (M&V) analysis. Table 2 shows the targeted and completed data collection activities.

Table 2. Data collection activities*

Target Group	Activity	Targeted Measures	Completed Measures
Enbridge			
Participating Customers	M&V Site Visit (On-site)	48	26
	TSER Interview		26
Union			
Participating Customers	M&V Site Visit (On-site)	62	54
	TSER Interview		16
Overall			
Participating Customers	M&V Site Visit (On-site)	110	80
	TSER Interview		42

*This table reports the number of measures targeted and completed as measures were used to design the sample before customers and sites had been identified.

At a high level, the gross savings verification (CPSV) study employed the following methodology:

- **Review program data and documentation.** The evaluation started with a review of the program tracking data, which formed the basis of the sample, and an initial review of the program documentation. Once the sample was selected, additional documentation was provided by the programs to describe the energy efficiency measures and support the tracking savings estimates, also called the ex ante estimates.
- **Design and select the sample.** The tracking data was used to design and select a sample. Full documentation and contact information was requested for all sites within the sample.
- **Collect data.** Data was collected to verify the ex ante energy savings.
- **Analyze the results.** The collected data was used to verify the gross savings at each site.
- **Report the results.** The final step was to report the results.

1.3 Results

The outcome of the exercise produced verified gross savings for the 2016 programs studied. Table 3 provides the results of the evaluation for Union Custom programs and Table 4 provides the results of the evaluation for Enbridge Custom programs.

Table 3: Union custom programs verified gross savings results*

Program	Claimed Savings	Effective Gross Realization Rate	Verified Gross Savings
Commercial and Industrial Custom	1,538,593,562	100.70%	1,549,389,975
Custom Large Volume	844,735,540	100.98%	853,013,948

*Ratios in this table have been rounded and are the effective overall ratios, calculated by first applying the ratios by segment and then dividing the total verified savings by the total claimed savings. Claimed and verified savings each have the "Union influence factor" removed.

Table 4: Enbridge custom programs verified gross savings results*

Program	Claimed Savings	Effective Gross Realization Rate	Verified Gross Savings
Custom C&I and Market Rate Multi-residential	825,138,165	109.02%	899,531,473

*Ratios in this table have been rounded and are the effective overall ratios, calculated by first applying the ratios by segment and then dividing the total verified savings by the total claimed savings.

1.3.1 Findings

Key findings from the study include:

- Both utilities generally produce solid ex ante engineering estimates of savings that are not systematically biased. Much of the variation in gross realization rates is driven by changes in operating conditions that are often difficult to anticipate in ex ante savings estimation
- Both utilities could provide better supporting documentation of assumptions and inputs in their savings estimates and each could benefit from investing in a modern program tracking database with document storage capabilities

1.3.2 Recommendations

Recommendations from the evaluation are summarized in to . In the tables the primary outcomes of the recommendation are classified into four categories: reduce costs, increase savings, increase (or maintain) customer satisfaction and decrease risk (multiple types of risk are in this category including risk of adjusted savings, risk to budgets or project schedules, and others). For a more thorough explanation of recommendations and the findings on which they are based, see section 6.

Table 5: Energy savings and program performance recommendations

#	Energy Savings and Program Performance		Applies to			Primary Beneficial Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
1	Both utilities exhibit a strong commitment to accurate energy savings estimate	The utilities should continue in their commitment to accuracy.	✓	✓				✓	✓
2	The CPSV effort found realization rates near 100% and identified adjustments for most projects.	Continue performing custom savings verification on a regular basis.			✓				✓
3	Relative precision targets were met or surpassed for all programs	Use error ratio assumptions from the results provided in this report in future evaluation years, but with more conservative bounding than performed this year.			✓	✓			✓
4	Some measures have difficult-to-define baseline technologies.	Establish a policy to define rules around energy savings calculation for fuel switching and district heating/cooling measures.	✓	✓	✓				✓
5	Review of documentation for gross evaluation showed that several projects were high free rider risks.	Review projects with large incentives for free ridership risk. Develop clear program rules that allow the utility to reject free rider projects.	✓	✓			✓		✓
6	Influence adjustments were made to projects that adjusted the gross savings for "net" or program influence reasons.	Increase transparency of "influence adjustments" and do not include in gross savings	✓				✓	✓	✓
7	There is not a clear policy to determine "standard" baselines.	Establish a clear policy to determine and define "standard" baselines	✓	✓	✓	✓			✓

#	Energy Savings and Program Performance		Applies to			Primary Beneficial Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
8	Some measures in each utility program are routine maintenance or periodic repairs that are considered standard care in other jurisdictions.	Establish a clear policy regarding eligibility of maintenance and repair measures for the programs.	✓	✓	✓	✓			✓
9	The programs did not consistently account for interactivity among measures.	Add an interactivity check to the programs' internal QC process for savings estimates.	✓	✓	✓	✓			✓

Table 6: Verification process recommendations

#	Verification Process		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
10	DNV GL was unable to obtain access to all the equipment at all the sites selected for verification.	Modify contracts to require participants to agree to comply with EM&V as part of the requirements for participation in the program.	✓	✓		✓			✓
11	Future evaluations should consider large HVAC to be high rigour rather than standard rigour.	Consider large HVAC measures for higher rigour verification.			✓				✓

Table 7: Documentation and Support recommendations

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
12	Incremental improvement in project documentation by both utilities was observed in the 2016 CPSV. Project documentation for some projects lacked sufficient details to allow evaluators to reproduce the calculations made by program staff or third-party vendors.	<p>Take steps to improve documentation:</p> <ul style="list-style-type: none"> • Implement an electronic tracking system that archives all materials • Include explicit sources for all inputs and assumptions in the project documentation. • Store background studies and information sources with the project files and make them available to evaluators. • Provide evaluators full access to customer data. • Provide pre- and post-installation photos, where available. • Document and provide internal M&V documents where available. • Institute a checklist as part of project closeout to ensure all relevant project documentation is assembled as ready for verification 	✓	✓			✓		✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
13	Explanations of complex projects were not consistently clear making it hard to understand what process is actually producing energy savings.	Improve clarity and details of documentation explaining the source of energy savings for complex projects.	✓	✓					✓
14	Ex ante savings estimates based on annual energy consumption for industrial sites did not always include sufficient information documenting production.	Include site production totals in relevant years in the savings estimates based on annual energy consumption for industrial sites	✓	✓					✓
15	Enbridge Boilers use a 73% assumed thermal efficiency for in situ boilers that have been in place for more than 10 years.	Estimate boiler degradation from name plate efficiency to determine the baseline boiler efficiency rather than a flat number	✓	✓					✓
16	Pipe insulation is a significant source of savings for the Union Gas programs. Documentation for the source of factors used in calculations and of in situ conditions was not consistently provided.	Document baseline conditions of pipe insulation (and other measures) using photos and text descriptions to provide context. Explicitly tie the documentation of baseline condition to the heat loss rate used for the savings calculation.	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
17	Enbridge documentation did not always include a prose explanation and supporting documentation for baseline types (ROB, ER) and remaining useful life (RUL).	Always complete the "Base Case Overview" in the form with a prose description of the base case. The description should reference included emails and photos to document in situ conditions and features that are carried over into the baseline system.		✓					✓
18	The utilities should use longer duration data in ex ante savings estimates when possible.	Use longer duration data in ex ante savings estimates. When time periods less than a year are used, documentation should be provided to indicate why the period used is applicable to a full year and why a full year was not able to be used.	✓	✓		✓			✓
19	In situ boiler name plate information, age and operating condition are all helpful for determining the designed performance and reasonable range of actual efficiency for the system as well as providing context to better determine remaining useful life (RUL)	Document in situ boiler name plate information, age and operating condition for all projects where boiler efficiency affects savings	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
20	Items that may be obvious to the ex ante team can be non-obvious to an outside party.	Review ex ante documentation from an outside perspective to help identify gaps	✓	✓					✓
21	At large sites with multiple spaces containing similar equipment, ex ante documentation did not always identify which space or piece of equipment was affected by the project.	Include additional descriptions of spaces and equipment affected to differentiate among similar spaces and equipment at the site.	✓	✓					✓
22	Invoices were not always included with documentation, and sources for incremental costs were not always clear.	Ensure that incremental costs are supported by invoices or other documentation, especially for add-on and optimization measures where the total cost and incremental cost are likely to be the same.	✓	✓				✓	✓
23	Larger projects appeared to fall under the same documentation standards as smaller projects.	Increase the amount of documentation and source material for projects that have greater energy savings.	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
24	Union's custom project summary workbook is a good approach to documentation. The workbook is not used in a consistent manner across all projects.	Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner. Identify a common approach for common measures and, if necessary, document deviations and the reasons for the deviations in a clearly labelled field on the summary sheet.	✓			✓			✓
25	Enbridge Etools does not sufficiently document sources of inputs and assumptions.	Use a consistent summary workbook.		✓		✓			✓

Table 8: Data management recommendations

#	Data Management		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
26 A	Neither Union nor Enbridge currently track participating customer or participating vendor contact information in their program tracking database. Providing the information to the evaluation puts significant burden on utility staff. In 2016, the data provided by utility staff was much more consistent and clear relative to 2015.	Track contacts associated with projects in the program tracking database.	✓	✓		✓		✓	✓
26 B		Strongly consider investing in relational program tracking databases.	✓	✓		✓	✓	✓	✓
26 C		Continue to use improved structure for data integrity in the evaluator request for contact information for the 2017 savings verification and evaluation.			✓	✓		✓	
27	The extracts from the utility program tracking database do not include dates for key project milestones.	Track and provide to evaluators dates for key milestones in the project.	✓	✓		✓			✓
29	EUL and cumulative gross savings were not provided in a consistent manner in the Enbridge program tracking database extract	Include separate fields in the program tracking database for all components of gross and net cumulative and first year savings.	✓	✓			✓		✓

2 INTRODUCTION

This report has been prepared for the Ontario Energy Board (OEB). The study includes results from Custom Program Savings Verification (CPSV) of Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) programs delivered in 2016.

The study provides verified savings ratios and verified gross savings totals. Projects included are shown in Table 9. In this study of 2016 programs, custom Market-Rate Multi-Residential (Multi-family) projects are included, while custom Low Income Multi-Residential projects are not included.

Table 9: CPSV by program

Program		2016
		CPSV
Union Custom	Large Volume	✓
	Commercial & Industrial*	✓
Enbridge Custom	Commercial*	✓
	Industrial	✓

*Custom Market-Rate Multi-Residential (Multi-family) projects are included as a part of this program.

1.1 Background

Enbridge and Union deliver energy efficiency programs under the Demand Side Management Framework for Natural Gas Distributors (2015-2020)² developed by the OEB.

In April 2016, the OEB hired an Evaluation Contractor (EC) team led by DNV GL to develop an overall evaluation, measurement, and verification (EM&V) plan. The objectives of the plan were to:

- Assess portfolio impacts to determine annual savings results, shareholder incentive and lost revenue amounts, and future year targets.
- Assess the effectiveness of energy efficiency programs on their participants and/or market, including results on various scorecard items.
- Identify ways in which programs can be changed or refined to improve their performance.

Under the plan, the DNV GL team conducted a verification of gross savings for custom projects implemented as part of the 2016 program year. This report is a result of that study.

An evaluation advisory committee (EAC) provides input and advice to the OEB on the evaluation and audit of DSM results. The EAC consists of representatives from Union and Enbridge as well as representatives from non-utility stakeholders, independent experts, staff from the Independent Electricity System Operator (IESO), and observers from the Environmental Commissioner of Ontario and the Ministry of Energy. The DNV GL team worked closely with the EAC throughout this study and received comment, advice, and input on methodology and results. We thank them for their involvement.

² EB-2014-0134

2.1 Methodology summary

The results presented in this report are based on data collection from the following four primary sources, supplemented with secondary source information:

- Union and Enbridge tracking databases
- Union and Enbridge project documentation
- In-Depth Interviews with a sample of participating customers and vendors
- On-site visit to a sample of participating customer sites

The data collection with a sample of participating customers included site visits and telephone interviews supporting a detailed measurement and verification (M&V) analysis. Table 2 shows the targeted and completed data collection activities.

Table 10. Data collection activities*

Target Group	Activity	Targeted Measures	Completed Measures
Enbridge			
Participating Customers	M&V Site Visit (On-site)	48	26
	TSER Interview		26
Union			
Participating Customers	M&V Site Visit (On-site)	62	54
	TSER Interview		16
Overall			
Participating Customers	M&V Site Visit (On-site)	110	80
	TSER Interview		42

*This table reports the number of measures targeted and completed as measures were used to design the sample before customers and sites had been identified.

At a high level, the gross savings verification (CPSV) study employed the following methodology:

- **Review program data and documentation.** The evaluation started with a review of the program tracking data, which formed the basis of the sample, and an initial review of the program documentation. Once the sample was selected, additional documentation was provided by the programs to describe the energy efficiency measures and support the tracking savings estimates, also called the ex ante estimates.
- **Design and select the sample.** The tracking data was used to design and select a sample. Full documentation and contact information was requested for all sites within the sample.
- **Collect data.** Data was collected to verify the ex ante energy savings.
- **Analyze the results.** The collected data was used to verify the gross savings at each site.
- **Report the results.** The final step was to report the results.

Key features of the methodology include:

- The **sample design** employed a stratified random sample that targeted 10% relative precision with 90% confidence at the program level. Details of the sampling methods are presented in Appendix C. Final sample achievements are provided in Appendix A.

- **Ratio estimation** was used to expand sample results to the population. The evaluation collected data on all sampled or backup projects that a customer contact could speak to rather than only the first selected. In our calculation of sampling error (+/-, confidence intervals, relative precision and error ratios), we used two-tailed 90-percent confidence limits and clusters defined by customers to appropriately estimate error when multiple units are collected from a single source.³ The approach used is described in Appendix E.
- The **gross savings verification** used a combination of on-site data collection and interviews to collect primary data. Calculation of lifetime gross savings used a dual baseline approach to more accurately estimate savings for early replacement measures. Detailed site reports for each of the sites visited or called were prepared by the DNV GL team and reviewed by the EAC.

2.1.1 Understanding Statistical Error

Statistical error is reported for all of the ratio results in this report. The studies were designed with sample designs targeting 10% relative precision with 90% confidence (90/10) based on the best available assumptions at the start of the evaluation. Table 11 describes each of the statistics provided in this report.

Table 11: Relevant statistics.

Term	Definition
Ratio/Adjustment factor	A point estimate of the evaluation findings expressed as a percent.
+/- or Absolute Precision	If the evaluation were repeated several times, selecting samples from the same population, 90% ⁴ of the time the ratio would be within this range of the ratio
Confidence interval	The upper bound is defined by the ratio plus the absolute precision. the lower bound is defined by the ratio minus the absolute precision.
Relative Precision	The relative precision is calculated as the absolute precision divided by the ratio itself. By convention, relative precisions are the statistic that are targeted in sampling (i.e., 90/10 is a relative precision metric)
Error Ratio	The error ratio is an approximation of the coefficient of variation (cv) that is used in sample design. It is calculated as a function of relative precision.
Finite population correction (FPC)	FPC is a factor that reduces the measured error of samples drawn from small populations (less than 300). FPC applies when the ratio is applied to the same population from which the sample was drawn. Statistics reported in the body of this report all employ the FPC factor.

Figure 1 shows an example of:

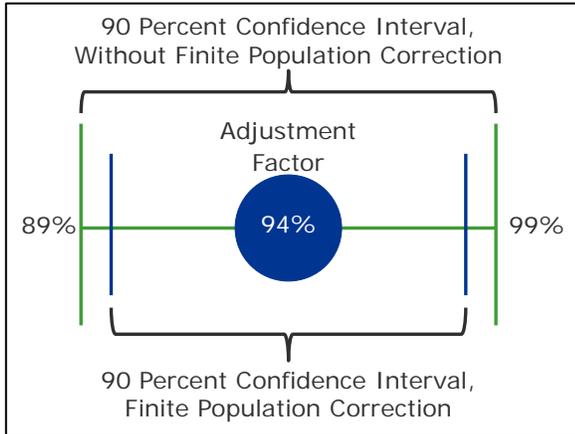
- the adjustment factor (ratio) as a blue point

³ Where a single site had two contacts, the site was used as the cluster to ensure conservative (higher) error estimates.

⁴ 90% is the confidence limit that we are using.

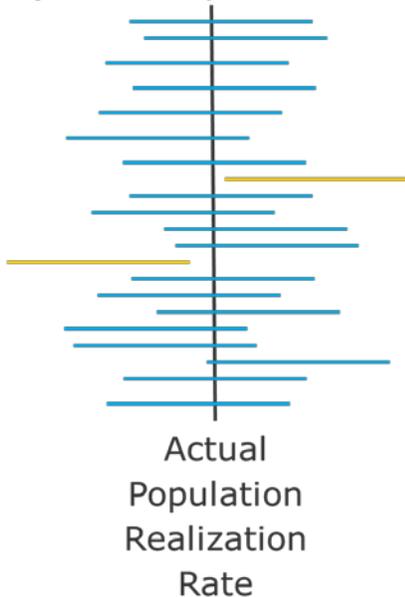
- the 90% confidence interval *with finite population correction* (blue)
- the 90% confidence interval *without finite population correction* (green)

Figure 1: Ratio diagram example



The plus/minus (\pm) error (%) indicated at the 90% confidence interval is the absolute difference between the estimated percentage and the upper or lower confidence bound. For example, in Figure 1, the ratio is 94% and the non-FPC 90% confidence interval is ± 5 percentage points (i.e., $94\% \pm 5\%$).⁵ Another way of saying this is that there is a 90% probability that the actual ratio for the next year's program lies between 89 and 99%. Figure 2 demonstrates this concept by showing twenty hypothetical confidence intervals calculated from twenty different samples of the same population. Eighteen out of twenty (90%) include the true population ratio (overlap the black line representing the true ratio).

Figure 2. Ninety Percent Confidence Interval



⁵ The critical value for calculating the confidence interval \pm for each adjustment factor is determined using Student's t-distribution and $n-1$ for the degrees of freedom, where n is the sample size. For 2-tailed estimates (ratios that could be above or below 100%) the appropriate t-stat used to calculate precision from the standard error is close to 1.645.



Note: Each horizontal line represents a confidence interval, while the black vertical line is the actual population realization rate. Yellow confidence intervals do not include the actual ratio.

The relative precision of the ratio is calculated as $5\%/94\% = 5.3\%$.

For low ratios, relative precisions may be quite high, even when the confidence interval around the ratio is quite narrow. Consider a ratio of 5% with the same 5% absolute precision as in the above example. While the absolute precisions are the same, the latter ratio (5%) has a relative precision of $5\%/5\% = 100\%$. In absolute terms, we still are 90% confident the ratio is below 10%, despite the very high (100%) relative precision.

We reported the relative precision in all cases at the 90% confidence level. That is, whether the relative precision is large or small, we have the same 90% confidence that the range defined by the point estimate +/- the absolute error captures the true unknown value. The "midpoint" estimate (the ratio) is the best (statistically most likely) estimate, while the confidence interval is calculated as an interval around that point. Thus, in all cases, we reported the best point estimate, with a symmetric 90% confidence interval (using the t-score for a 2-tailed 90% confidence interval).

3 UNION COMMERCIAL, INDUSTRIAL, AND MULTI-FAMILY PROGRAMS

Custom programs for commercial and industrial (C&I) customers have been designed to encourage commercial and industrial customers to reduce their energy consumption by providing customer-specific energy efficiency and conservation solutions. The custom programs provide financial incentives, technical expertise, and guidance with respect to energy-related decision making and business justification, including helping customers to prioritize energy efficiency projects against their own internal competing factors and demonstrating the competitive advantage customers can gain through efficiency upgrades. These custom programs differ from the prescriptive programs as they provide tailored services and varying financial incentives based on overall natural gas savings realized by the customer to address customer-specific needs. Custom program performance is measured in cumulative gas savings (CCM), also known as total lifetime savings.

Union Custom C&I program focuses on advancing customer energy efficiency and productivity by providing a mix of custom incentives, education, and awareness to C&I customers across all segments. The objective of the Custom program is to generate long-term and cost-effective energy savings for Union's customers.

The Union Custom program 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 program 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.

A subset of the projects in these programs is part of the multi-family or multi-residential segment. In this report, we refer to these projects as Market-Rate Multi-family (MR MF) in order to distinguish them from the low income multi-family (LI MF).⁶

All projects implemented as part of these programs and claimed in 2016 as custom projects are included in the scope of the CPSV study.

3.1 Summary of Data Collection

Table 12 summarizes the CPSV data collection efforts for the Union Custom C&I programs. The table shows the portion of the program that:

- Completed on-site visits
- Completed telephone-supported engineering reviews (TSER)
- Did not respond to an evaluation attempt at contact
- Was not contacted by the evaluation team.⁷

The data collected is represented as the number of sites, the number of measures, and cumulative ex ante natural gas savings (ex ante CCM). The proportion of the program in each category is also represented in Figure 3. In the figure, size categories within segments (eg. Industrial) are ordered with 1 being the smallest stratum within each segment. The full sample design and achievement by strata can be found in

⁶ Previous rounds of CPSV have included Low Income Multi-family custom projects in the evaluation. This evaluation did not include LI MF. For clarity, we will continue to use the Market Rate Multi-family term throughout this report.

⁷ Sites or measures where contact was not attempted were either not selected for contact in sampling or in the backup sample or were not contacted due to strata quotas being met.

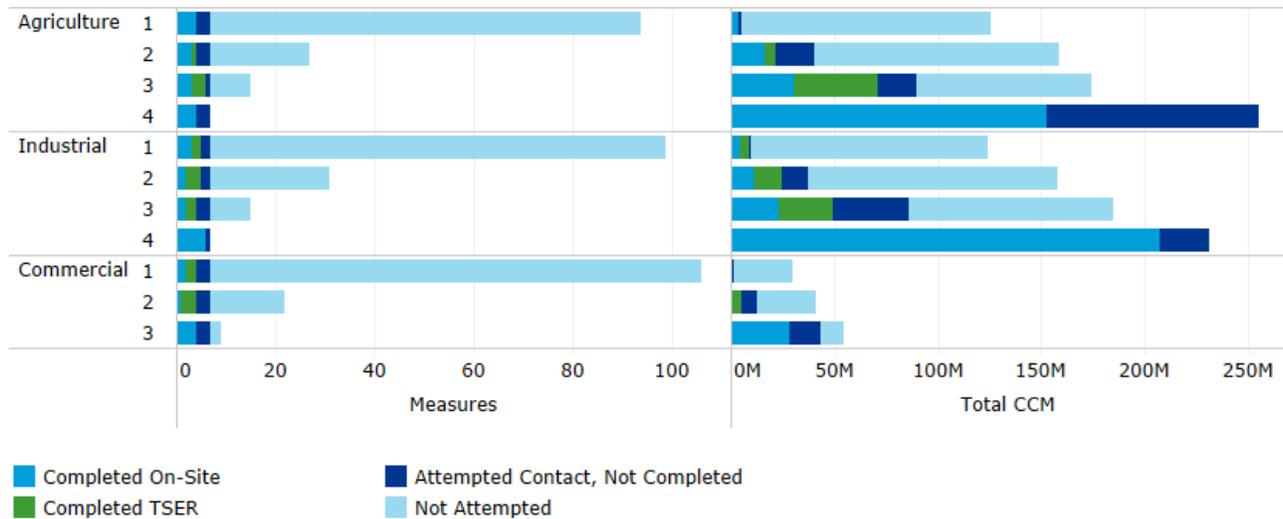
Table 31 in Appendix A. By collecting data on all sampled measures at a site rather than only the first selected, the evaluation exceeded the targeted number of measures. The study had a customer response rate of 62% and achieved the targeted 90/10 relative precision for the cumulative gross realization rate at the program overall level shown in Table 13.

Table 12: Summary of CPSV data collection for the Union Custom C&I Program*

Data Collection Category	Targeted	Completed		
	# Measures	# Sites	# Measures	Ex Ante CCM
Completed On-Site	44	25	34	479,196,561
Completed TSER		15	16	96,074,417
Attempted Contact, Not Completed		25	27	238,281,964
Not Attempted		246	355	725,040,620
Total		311	432	1,538,593,562

* Please see the glossary for definitions of site and measure.

Figure 3: Summary of CPSV data collection for the Union Custom C&I Program



3.2 Gross Savings Realization Rate

The gross savings realization rate represents the differences in ex post and ex ante savings due to differences in calculation methods, EUL, calculation parameters, or other engineering-related adjustments. Table 13 shows the cumulative gross savings realization rate by segment for the Union Custom C&I program, while Table 14 shows the first-year gross savings realization rate, which is used for calculating lost revenue (LRAM). The table shows the number of units of analysis (n), gross savings realization rate (Ratio), precision at the 90% confidence interval, error ratio, and percent of program savings. The percent of program savings represents the relative contribution that each domain makes to the overall result.

Union’s C&I programs overall had a sample weighted 101% cumulative gross realization rate. The segments had variation in cumulative gross realization rates ranging from 99% to 112%, resulting in an overall cumulative gross realization rate of 101%. Together the Agriculture and Industrial segments make up 92% of program savings and had cumulative gross realization rates of 100% and 99% respectively. The

Commercial segment, which includes MR MF projects, had a realization rate of 112% and was 8% of savings. Relative precision for the program overall was 6% at 90% confidence.

Table 13: Cumulative gross savings realization rate for the Union Custom C&I program

Sector	n		Ratio	90% Confidence Interval			Error Ratio	% Program Savings	
	Measures	Sites		+/-	Lower Bound	Upper Bound			Relative Precision
Agriculture	18	9	100.10%	10%	90%	110%	10%	0.20	46%
Commercial	12	12	112.45%	26%	86%	138%	23%	0.45	8%
Industrial	20	19	99.20%	8%	91%	108%	8%	0.21	45%
Overall*	50	40	100.53%	6%	95%	107%	6%	0.24	100%

*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

The first-year savings realization rates vary somewhat from the cumulative gross savings realization rates, with Agriculture and Industrial segments being a little higher and the Commercial segment a little lower. First-year savings differ from cumulative gross savings primarily due to being based on a ratio of annual rather than cumulative savings.

Table 14: First-year gross savings realization rate for the Union Custom C&I program

Sector	n		Ratio	90% Confidence Interval			Error Ratio	% Program Savings	
	Measures	Sites		+/-	Lower Bound	Upper Bound			Relative Precision
Agriculture	18	9	101.07%	7%	94%	108%	7%	0.16	46%
Commercial	12	12	109.59%	26%	83%	136%	24%	0.47	8%
Industrial	20	19	102.66%	7%	96%	109%	6%	0.16	45%
Overall*	50	40	102.24%	5%	97%	107%	5%	0.19	100%

*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

Cumulative gross savings for the program are shown in Table 15.

Table 15: Verified gross savings CCM results for the Union Custom C&I program

Program	Claimed Savings	Effective Gross Realization Rate	Verified Gross Savings
Agricultural	714,290,651	100.10%	715,004,942
Commercial	125,860,716	112.45%	141,530,375
Industrial	698,442,195	99.20%	692,854,657

3.3 Discrepancy Summary

This section presents detailed results of the various discrepancies between ex ante and ex-post savings. The final realization rate for the program was close to 100%, but the verification found discrepancies in 70% of the projects reviewed. The realization rate and pattern of adjustments indicate that there was not a systemic bias in utility savings estimates to either over or under estimate savings for this program.

Table 16 shows that 15 of the 50 measures had no adjustment, while 35 measures were adjusted based on verification findings. Eighteen of the 35 adjustments were small: verified savings were within 20% of utility

tracked savings. Of the 35 adjusted measures 17 had adjustments increasing savings (adjustment greater than 100%) and 18 decreasing savings (adjustment less than 100%).

Table 16: Adjustment Summary – Union Custom C&I

Effect of Adjustment on Utility Tracked Savings	Size of Adjustment	Number of Measures	Percent of Measures
Increase	Small (100% < Adj. < 120%)	9	18%
	Large (Adj. > 120%)	8	16%
	Total	17	34%
Decrease	Small (80% < Adj. < 100%)	9	18%
	Large (Adj. < 80%)	9	18%
	Total	18	36%
No Change	Adj. = 100%	15	30%
Grand Total		50	100%

Four randomly selected examples of measures with large adjustments are described below. They are included here in order to provide readers with examples of the types of differences that can be identified through the CPSV process. Examples described reference the site ID, which is also used in Figure 4 in this section and Table 62 in Appendix F.

Examples of large adjustments that resulted in increased utility savings (adjustments greater than 120%).

- The sampled measure at site UO037 was measure that recovers (re-uses) heat from a process to reduce gas consumption. The ex post savings (verified savings) for the measure were 175% of the ex ante (utility tracked) savings. The reason for discrepancy between the ex ante and ex post savings was that the verification was able to include more post-measure production data in its analysis. These data and the verification engineer’s interview with the customer showed that production had increased due to exogenous factors, leading to more gas savings than anticipated at the time the measure was installed.
- The sampled measure at site UO145 was a replacement of deteriorated dock door seals on a heated loading dock. The ex post savings for the measure were 150% of the ex ante savings. The ex post analysis found that the ex ante measure life of 10 years was not consistent with Union’s measure life guide. The verification increased the measure life from 10 to 15 years to match Union’s measure life guide

Examples of large adjustments that resulted in decreased utility savings (adjustments less than 80%).

- The sampled measure at site UO077 was a combination of HVAC system control logic upgrades and leaking steam valve replacements. The ex post savings for the measure were 40% of the ex ante savings. The verification found three discrepancy sources:
 - Measure life was reduced from 20 to 11.5 years. The verification used a savings weighted measure life to account for different measure lives for the two components of the measure.

- Ex ante savings assumed a 100% leakage rate for steam valves replaced. Verification assumed that the replaced valves had 66% leakage rate based on a study provided to the verification team by Enbridge.
- Ex ante analysis contained an algebraic error in VFD savings analysis (part of the HVAC system control saving estimate). The verification corrected the error.
- The sampled measure at site UO144 was exhaust heat recovery measure (re-circulation of heated air that would otherwise be exhausted after a process). The verification found that the air flow rate used in the ex ante savings estimate was higher than the system was designed to provide and measured air flow rates provided by the customer to the verification team were lower than designed. Ex post savings estimates used the average air flow rate provided by the customer. The verification also found a different operating schedule than was used in ex ante estimates. Where ex ante assumed operation 24/7 (24 hours a day/7 days a week), the verification found that there was a portion of the winter where the site operated the equipment 24/6. Ex post savings estimates used the verified operating schedule.

Figure 4 plots the ex ante tracked cumulative savings and the realization rate for each measure in the sample. The plot is sorted with the smallest measure on the left and largest on the right. The upper plot shows the relative size of each measure. The lower plot shows the realization rate for each measure. In both plots, measures with green bars have a realization rate greater than 100% (verified savings greater than utility tracked savings). Measures with blue bars represent a realization rate less than 100% (verified savings lower than utility tracked savings).

The plot provides a high-level view of the individual site findings and shows that there was not a systematic bias to savings estimates based on measure size.

Figure 4: Sample Measure Realization Rates sorted by size – Union Custom C&I program

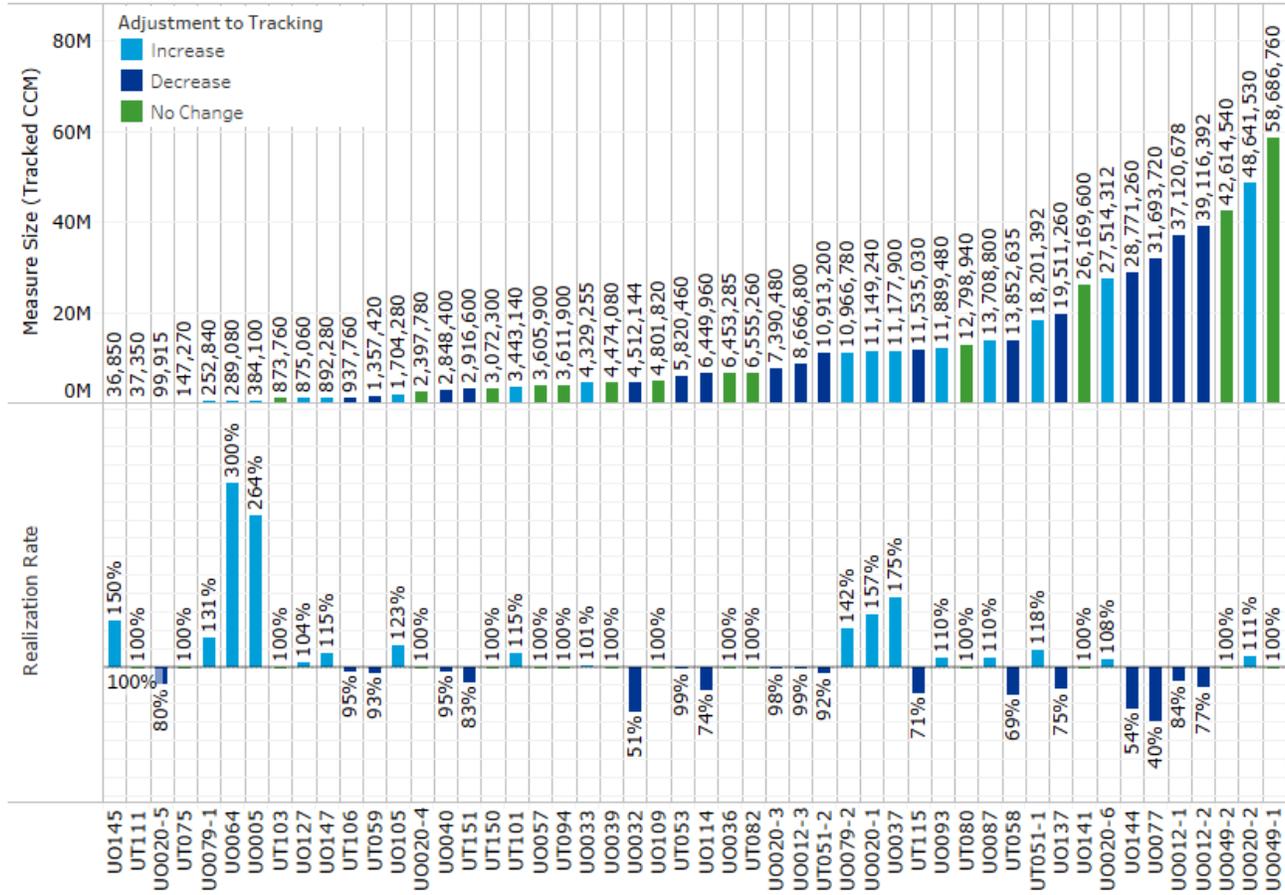


Figure 5 shows the types of discrepancies found by the verification. The verification found no discrepancies for 30% of sampled measures. The major categories of discrepancies were energy efficient measure operating conditions, measure life and interactivity, each of which were a reason for adjustment for 20-30% of measures in the sample.

More complete documentation of energy efficient measure operating conditions by the utility could reduce the frequency of this type of discrepancy, but this type of discrepancy is in part outside the utility's control (see recommendations in section 6.3).

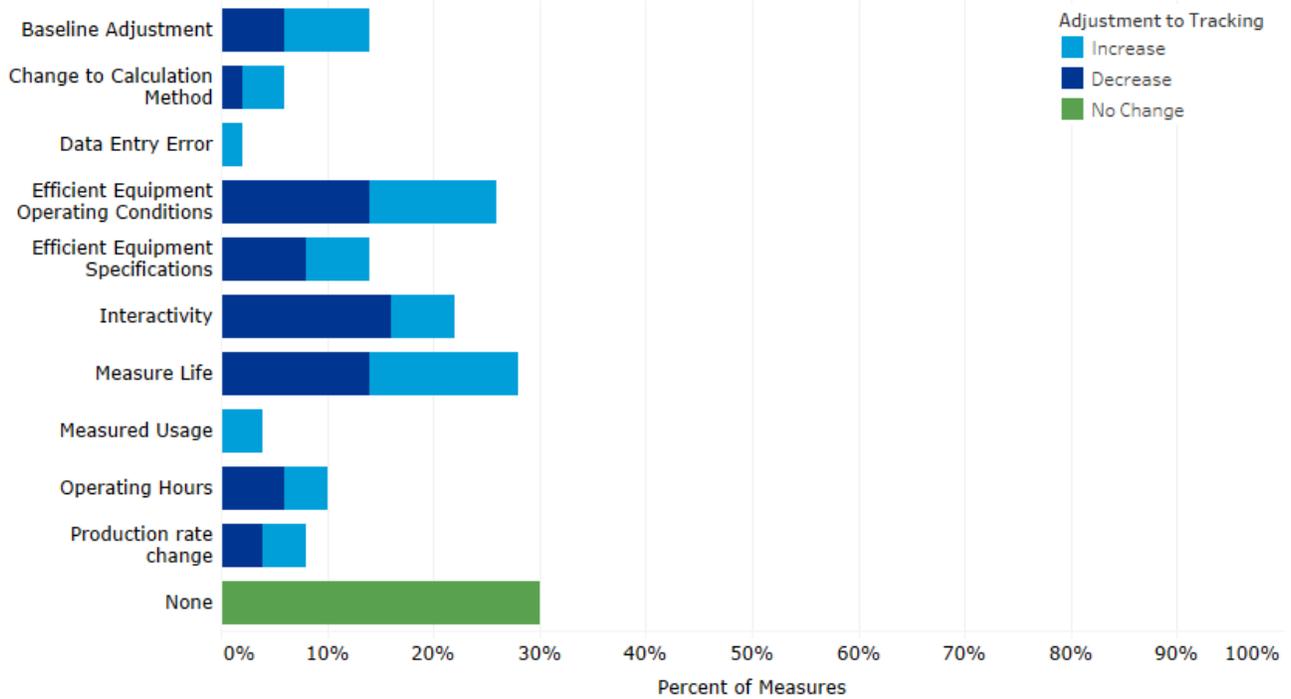
In the case of measure life adjustments, there were two primary reasons:

1. Small changes to measure life caused by a change to savings-weighted average measure life for a bundle of measures in Virtual Grower when the savings for one or more measures was adjusted for equipment operating conditions or specifications found through the verification.
2. A change in boiler measure life from the 20 years assumed by Union in its custom measure life table to 25 years, which is consistent with Enbridge's measure life table and a more reasonable estimate for these measures.

The program can reduce its risk of adjustment for interactivity by making an explicit check in its QC process to review if multiple measure installations at a site have been appropriately accounted for in savings estimates (see recommendation 9 in section 6.1).

In each discrepancy category we found both increases and decreases in savings, which, combined with the overall realization rate near 100% is evidence that the program estimates are not systematically biased.

Figure 5: Savings discrepancies - Union Custom C&I



4 UNION LARGE VOLUME

Union encourages the adoption of energy efficient equipment, technologies, and actions through direct customer interaction via its Large Volume program. The Large Volume program in 2016 was applicable to customers in Rate T2/Rate 100.

The program uses a direct access budget mechanism for the customer incentive budget process. This mechanism grants each customer direct access to the 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 Large Volume program is the only “direct access” program offered in Ontario.

Custom projects implemented as part of this program and claimed in 2016 were included in the CPSV study. There were eight (8) prescriptive projects in the 2016 Large Volume program that are not included in CPSV.

4.1 Summary of Data Collection

Table 17 summarizes the CPSV data collection efforts for Union Large Volume. The table shows the portion of the program that:

- Completed on-site visits
- Did not respond to an evaluation attempt at contact
- Was not contacted by the evaluation team.⁸

The data collected is represented in Table 17 as the number of sites, the number of measures, and cumulative ex ante natural gas savings (ex ante CCM). The proportion of the program in each category is also represented in Figure 6. In the figure, size categories are ordered with 1 being the smallest stratum. The full sample design and achievement by strata can be found in Table 32 in Appendix A. By collecting data on all sampled measures at a site rather than only the first selected, the evaluation exceeded the targeted number of measures. The study had a customer response rate of 67% and achieved the targeted 90/10 relative precision for the cumulative gross realization rate at the program overall level shown in Table 18.

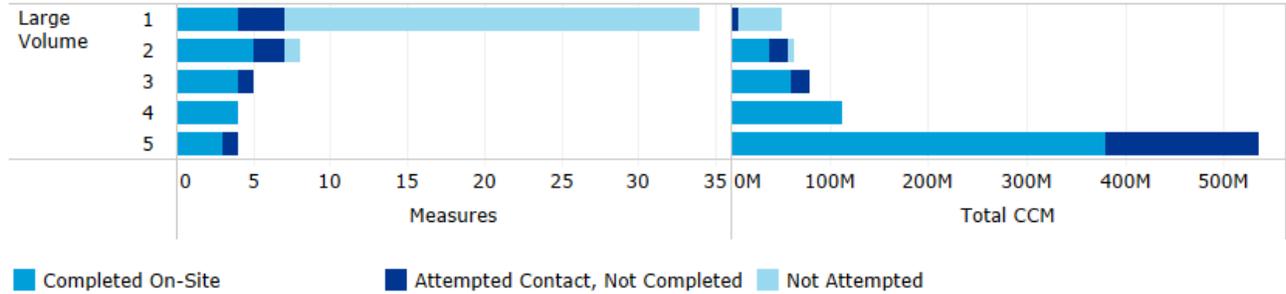
Table 17: Summary of CPSV data collection for Union Large Volume*

Data Collection Category	Targeted	Completed		
	# Measures	# Sites	# Measures	Ex Ante CCM
Completed On-Site	18	10	20	596,108,908
Attempted Contact, Not Completed		5	7	198,476,837
Not Attempted		11	28	50,149,795
Total		26	55	844,735,540

* Please see the glossary for definitions of site and measure.

⁸ Sites or measures where contact was not attempted were either not selected for contact in sampling or in the backup sample or were not contacted due to strata quotas being met.

Figure 6: Summary of CPSV data collection for Union Large Volume



4.2 Gross Savings Realization Rate

The gross savings realization rate represents the differences in ex post and ex ante savings due to differences in calculation methods, EUL, calculation parameters, or other engineering-related adjustments. Table 18 shows the cumulative gross savings realization rate for the Union Large Volume program while Table 19 shows the first-year gross savings realization rate, which is used for calculating lost revenue (LRAM). The table shows the number of units of analysis (n), gross savings realization rate (Ratio), precision at the 90% confidence interval, error ratio, and percent of program savings. The percent of program savings represents the relative contribution that each domain makes to the overall result.

The Union Large Volume program overall had a 101% cumulative gross realization rate and a 104% first-year gross realization rate. Relative precision for the program overall was 10% at 90% confidence.

Table 18: Cumulative gross savings realization rate for the Union Large Volume program

Sector	n		Ratio	90% Confidence Interval			Error Ratio	% Program Savings	
	Measures	Sites		+/-	Lower Bound	Upper Bound			
Large Volume	20	10	100.98%	10%	91%	111%	10%	0.24	100%

First-year savings differ from cumulative gross savings primarily due to being based on a ratio of annual rather than cumulative savings.

Table 19: First-year gross savings realization rate for the Union Large Volume program

Sector	n		Ratio	90% Confidence Interval			Error Ratio	% Program Savings	
	Measures	Sites		+/-	Lower Bound	Upper Bound			
Large Volume	20	10	103.92%	4%	100%	108%	4%	0.10	100%

Cumulative gross savings for the program are shown in Table 20.

Table 20: Verified gross CCM savings results for the Union Large Volume program

Program	Claimed Savings	Effective Gross Realization Rate	Verified Gross Savings
Large Volume	844,735,540	100.98%	853,013,948

4.3 Discrepancy Summary

This section presents detailed results of the various discrepancies between ex ante and ex-post savings. The final realization rate for the program was close to 100%, but the verification found discrepancies in 70% of the projects reviewed. The realization rate and pattern of adjustments indicate that there was not a systemic bias in utility savings estimates to either over or under estimate savings for this program.

Table 21 shows that 5 out of 20 measures had no adjustment, while 15 measures were adjusted based on verification findings. Eleven of the 15 adjustments were small: verified savings were within 20% of utility tracked savings. Of the 15 adjusted measures 7 had adjustments increasing savings (adjustments greater than 100%) and 8 decreasing savings (adjustment less than 100%).

Table 21: Adjustment Summary – Union Large Volume

Effect of Adjustment on Utility Tracked Savings	Size of Adjustment	Number of Measures	Percent of Measures
Increase	Small (100% < Adj. < 120%)	5	25%
	Large (Adj. > 120%)	2	10%
	Total	7	35%
Decrease	Small (80% < Adj. < 100%)	6	30%
	Large (Adj. < 80%)	2	10%
	Total	8	40%
No Change	Adj. = 100%	5	25%
Grand Total		20	100%

The four measures with large adjustments are described below. Projects described include the site ID in parentheses for reference to Figure 7 in this section and Table 63 in Appendix F.

Two measures had large adjustments that resulted in increased utility savings (adjustments greater than 120%).

- UO007-2 was one of two measures completed at site UO007. The measure consisted of removing scale from the inside of a heat exchanger. This saves gas by improving heat transfer rate of the heat exchanger raising the input temperature of water into a gas-fired steam boiler. The ex post savings (verified savings) for the measure were 499% of the ex ante (utility tracked) savings. The ex post savings are higher than ex ante due to two factors:
 - The customer reported to the verification team that the system operated for more hours than were used in the ex ante calculation
 - The customer provided information that supported a longer measure life than assumed in the ex ante savings estimate (4 years in ex post, 1 year in ex ante).
- UO028-2 was one of two measures completed at site UO028. The measure consisted of replacing worn out insulation on an industrial furnace. The ex post savings for the measure were 174% of the ex ante savings. The ex post savings are higher than ex ante due to two factors:

- The customer provided a full year of post-measure production and gas consumption data to the verification team whereas the utility estimate was based on a partial year (a full year had not passed when the utility finalized its estimates). The change in data increased savings by 5%.
- The customer and manufacturer each provided information that supported a longer measure life than assumed in the ex ante savings estimate (5 years in ex post, 3 years in ex ante).

Two measures large adjustments that resulted in decreased utility savings (adjustments less than 80%).

- UO140-1 was one of two measures completed at site UO140. The measure consisted of replacing a steam pipe system. The ex post savings (verified savings) for the measure were 59% of the ex ante (utility tracked) savings. The ex post savings are lower than ex ante due to two factors:
 - The verification found that an exogenous change had eliminated gas use for part of the system prior to the change in piping. The utility included this gas use as part of the savings.
 - The utility used an unsupported 25-year measure life in ex ante savings estimate, while the verification used the Union measure life guide's "All other industrial equipment" value of 20 years
- UO131-2 was one of two measures completed at site UO131. The measure consisted of cleaning furnace tubing that results in improved heat transfer for heat exchangers that feed heat into a natural gas fired process. The ex post savings (verified savings) for the measure were 70% of the ex ante (utility tracked) savings. The ex post savings are lower than ex ante due to two factors:
 - The customer provided information that supported a lower load factor than that used in the ex ante savings estimate.
 - The customer provided information that supported a shorter measure life than assumed in the ex ante savings estimate (8 years in ex post, 10 years in ex ante).

Figure 7 plots the ex ante tracked cumulative savings and the realization rate for each measure in the sample. The plot is sorted with the smallest measure on the left and largest on the right. The upper plot shows the relative size of each measure. The lower plot shows the realization rate for each measure. In both plots, measures with green bars have a realization rate greater than 100% (verified savings greater than utility tracked savings). Measures with blue bars represent a realization rate less than 100% (verified savings lower than utility tracked savings).

The plot provides a high-level view of the individual site findings and shows that there was not a systematic bias to savings estimates based on measure size.

Figure 7: Sample Measure Realization Rates sorted by size –Union Large Volume

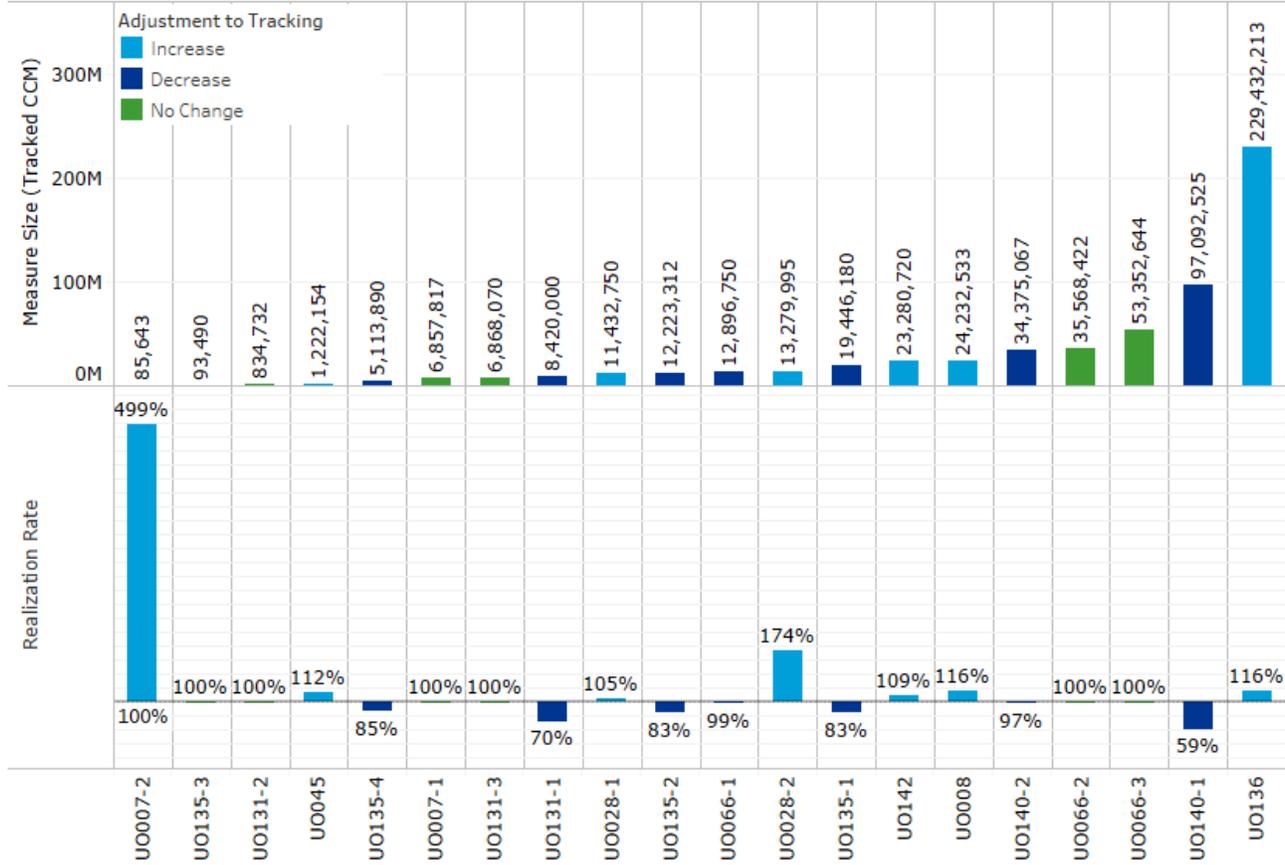
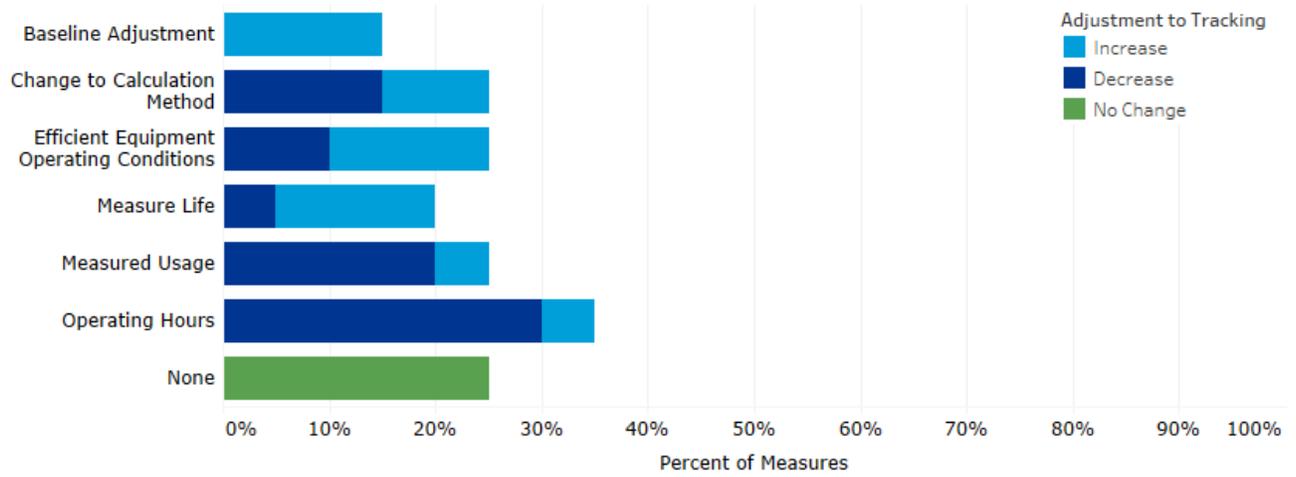


Figure 8 shows the types of discrepancies found by the verification. Seventy-five percent of measures had an adjustment, with the most common reason being different operating hours found by the verification. Operating hours can change after installation, making it hard for programs to reduce risk of adjustment for this reason.

In each discrepancy category we found both increases and decreases in savings, which, combined with the overall realization rate near 100% is evidence that the program estimates are not systematically biased.

Figure 8: Savings discrepancies - Union Large Volume



5 ENBRIDGE COMMERCIAL, INDUSTRIAL, AND MULTI-RESIDENTIAL PROGRAMS

Custom programs for commercial and industrial customers have been designed to encourage commercial and industrial customers to reduce their energy consumption by providing customer-specific energy efficiency and conservation solutions. The custom programs provide financial incentives, technical expertise, and guidance with respect to energy related decision making and business justification, including helping customers to prioritize energy efficiency projects against their own internal competing factors and demonstrate the competitive advantage customers can gain through efficiency upgrades. These custom programs differ from the prescriptive programs as they provide tailored services and varying financial incentives based on overall natural gas savings realized by the customer to address customer-specific needs. Custom program performance is measured in cumulative gas savings (CCM), also known as total lifetime savings.

Enbridge's 2016 Draft Annual Report describes the goal of the Commercial Custom offer as to "promote energy efficiency and to reduce natural gas use through the capture of energy efficiency opportunities in commercial buildings, including retrofits of building components and upgrades at the time of replacement. The objective is to provide technical support, business support services, and financial incentives to help customers meet energy efficiency and budgetary goals."

Enbridge's 2016 Draft Annual Report describes the goal of the Industrial Custom offer as "designed to capture cost-effective energy savings within the industrial sector by delivering customized energy solutions, including providing technical and financial support to customers. Industrial ESCs focus on assisting customers with the adoption of energy efficient technologies by overcoming financial, knowledge or technical barriers. This offer provides engineering technical support, business support services, and financial incentives to help customers meet production, energy efficiency, and budgetary needs."

A subset of the projects in these programs is part of the multi-family or multi-residential segment. In this report we refer to these projects as Market-Rate Multi-family (MR MF) in order to distinguish them from the low income multi-family (LI MF).⁹

All projects implemented as part of these programs and claimed in 2016 are custom projects and are included in the scope of the CPSV study.

5.1 Summary of Data Collection

Table 22 summarizes the CPSV data collection efforts for the Enbridge Custom C&I and Market Rate Multi-Family programs. The table shows the portion of the program that:

- Completed on-site visits
- Completed telephone supported engineering reviews (TSER)
- Did not respond to an evaluation attempt at contact
- Was not contacted by the evaluation team.¹⁰

⁹ Previous rounds of CPSV have included Low Income Multi-family custom projects in the evaluation, though they were not included in the scope for 2016 CPSV. For clarity, we will continue to use the Market Rate Multi-family term throughout this report.

¹⁰ Sites or measures where contact was not attempted were not selected for contact in sampling or in the backup sample.

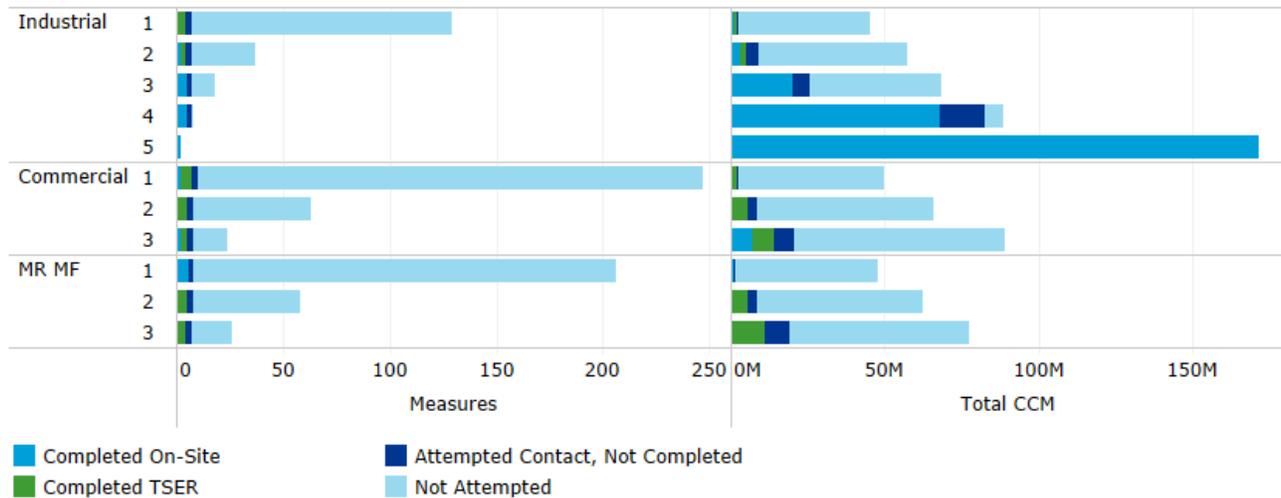
The data collected is represented as the number of sites, the number of measures, and cumulative ex ante natural gas savings (ex ante CCM). The proportion of the program in each category is also represented in Figure 9. In the figure, size categories within segments (eg. Industrial) are ordered with 1 being the smallest stratum within each segment. The full sample design and achievement by strata can be found in Table 33 in Appendix A. By collecting data on all sampled measures at a site rather than only the first selected, the evaluation exceeded the targeted number of measures. The study had a customer response rate of 63% and achieved the targeted 90/10 relative precision for the cumulative gross realization rate at the program overall level shown in Table 23.

Table 22: Summary of CPSV data collection for Enbridge CI&MF*

Data Collection Category	Targeted	Completed		
	# Measures	# Sites	# Measures	Ex Ante CCM
Completed On-Site	48	20	26	272,996,175
Completed TSER		25	26	32,994,580
Attempted Contact, Not Completed		26	27	46,592,039
Not Attempted		531	739	472,555,371
Total		602	818	825,138,165

* Please see the glossary for definitions of site and measure.

Figure 9: Summary of CPSV data collection for Enbridge CI&MF



5.2 Gross Savings Realization Rate

The gross savings realization rate represents the differences in ex post and ex ante savings due to differences in calculation methods, EUL, calculation parameters, or other engineering-related adjustments. Table 23 shows the cumulative gross savings realization rate by domain for the Enbridge Custom C&I and MF program while Table 24 shows the first-year gross savings realization rate, which is used for calculating lost revenue (LRAM). The table shows the number of units of analysis (n), gross savings realization rate (Ratio), precision at the 90% confidence interval, error ratio, and percent of program savings. The percent of program savings represents the relative contribution that each domain makes to the overall result.

Enbridge's C&I and MF program overall had a sample weighted 109% gross realization rate. These domains were found to have variation in gross realization rate ranging from 96% to 114%, resulting in an overall gross realization rate of 109%. The largest segment for these programs is the industrial segment. Relative precision for the program overall was 7% at 90% confidence.

Table 23: Cumulative gross savings realization rate for the Enbridge Custom C&I program

Sector	n		Ratio	90% Confidence Interval			Error Ratio	% Program Savings	
	Measures	Sites		+/-	Lower Bound	Upper Bound			
Commercial	17	16	96.80%	10%	87%	107%	11%	0.25	25%
Industrial	20	16	113.47%	13%	100%	127%	12%	0.28	52%
MR MF	15	13	112.10%	13%	100%	125%	11%	0.24	23%
Overall	52	45	109.24%	8%	101%	117%	7%	0.31	100%

*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

First-year gross realization rates were slightly lower than cumulative gross realization rates for all segments.

Table 24: First-year gross savings realization rate for the Enbridge Custom C&I program

Sector	n		Ratio	90% Confidence Interval			Error Ratio	% Program Savings	
	Measures	Sites		+/-	Lower Bound	Upper Bound			
Commercial	17	16	95.79%	10%	86%	106%	10%	0.24	25%
Industrial	20	16	110.36%	12%	98%	123%	11%	0.27	52%
MR MF	15	13	110.80%	17%	94%	128%	15%	0.33	23%
Overall	52	45	106.51%	8%	99%	114%	7%	0.30	100%

*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

Cumulative gross savings for the program are shown in Table 25.

Table 25: Verified gross CCM savings results for the Enbridge Custom C&I program

Program	Claimed Savings	Effective Gross Realization Rate	Verified Gross Savings
Commercial	204,979,463	96.80%	198,420,119
Industrial	431,638,126	113.47%	489,779,784
MR MF	188,520,576	112.10%	211,331,570

5.3 Discrepancy Summary

This section presents detailed results of the various discrepancies between ex ante and ex-post savings. The final realization rate for the program was close to 100%, but the verification found discrepancies in 77% of the projects reviewed. The realization rate and pattern of adjustments indicate that there was not a systemic bias in utility savings estimates to either over or under estimate savings for this program.

Table 26 shows that 9 of the 52 measures had no adjustment, while 43 measures were adjusted based on verification findings. Nineteen of the 43 adjustments were small: verified savings were within 20% of utility

tracked savings. Of the 43 adjusted measures 22 had adjustments increasing savings (adjustment greater than 100%) and 21 decreasing savings (adjustment less than 100%).

Table 26: Adjustment Summary – Enbridge Custom C&I

Effect of Adjustment on Utility Tracked Savings	Size of Adjustment	Number of Measures	Percent of Measures
Increase	Small (100% < Adj. < 120%)	9	17%
	Large (Adj. > 120%)	13	25%
	Total	22	42%
Decrease	Small (80% < Adj. < 100%)	10	19%
	Large (Adj. < 80%)	11	21%
	Total	21	40%
No Change	Adj. = 100%	9	17%
Grand Total		52	100%

Four randomly selected examples of measures with large adjustments are described below. They are included here in order to provide readers with examples of the types of differences that can be identified through the CPSV process. Projects described include the site ID in parentheses for reference to Figure 10 in this section and Table 64 in Appendix F.

Examples of large adjustments that resulted in increased utility savings (adjustments greater than 120%).

- EO013-2 was one of two measures completed at site EO013. The measure consisted of the installation of on/off controls for a humidification system. This allowed the system to be turned off during non-production hours. The ex post savings (verified savings) for the measure were 297% of the ex ante (utility tracked) savings. The ex post savings are higher than ex ante due to four factors:
 - The customer reported to the verification team that the system operated for more hours than were used in the ex ante calculation
 - The utility calculator had an incorrect hard coded value for baseline operating hours (corrections resulted in an increase in ex post savings relative to ex ante)
 - The utility calculator used a value from a steam table that was misread (correcting this resulted in a small increase in ex post savings relative to ex ante)
 - The utility used an unsupported 15-year measure life in ex ante savings estimate, while the verification used the Enbridge measure life guide's "Industrial Process" value of 20 years.
- The sampled measure at site ET046 was installation of five dock door seals on a heated warehouse where no dock door seals had been installed previously. The ex post savings for the measure were 162% of the ex ante savings. The ex post savings are higher than ex ante due to two factors:
 - The customer reported to the verification team that the warehouse operates for more hours during the heating season than were used in the ex ante calculation.

- The customer reported to the verification team that temperature setpoint in the affected space was higher than assumed in the ex ante calculation.

Examples of large adjustments that resulted in decreased utility savings (adjustments less than 80%).

- The sampled measure at site EO011 was a ventilation control scheduling measure. Make-up air unit controls settings were modified to reduce flow rates where possible instead of operating at a constant volume. The ex post savings for the measure were 48% of the ex ante savings. The verification found three discrepancy sources, the net effect of which was a reduction in savings:
 - Customer reported a less efficient domestic hot water heat source rather than direct fired. The DHW boiler also had controls installed on it. Interactive savings from these controls were accounted for in the ex post savings, but not the ex ante.
 - The customer's building automation system (BAS) showed higher flowrates during both on and off peak periods.
 - The customer's building automation system (BAS) showed a shorter daily peak period each day.
- EO010-2 was one of two measures completed at site EO010. The measure consisted of filtering and re-using heated process water to avoid heating make up city water. The ex post savings (verified savings) for the measure were 13% of the ex ante (utility tracked) savings. The ex post savings are lower than ex ante due to four factors:
 - The customer reported that it had recently taken steps to close the facility where the measure was installed. This reduced the measure life for the savings from this measure.
 - The customer reported lower water temperatures for the reclaimed heated process water than used in the ex ante estimate (resulting in lower ex post savings relative to ex ante)
 - The customer reported lower boiler make up flow rate than used in the ex ante estimate (resulting in lower ex post savings relative to ex ante)
 - The customer reported higher boiler efficiency than used in the ex ante estimate (resulting in lower ex post savings relative to ex ante)

Figure 10 plots the ex ante tracked cumulative savings and the realization rate for each measure in the sample. The plot is sorted with the smallest measure on the left and largest on the right. The upper plot shows the relative size of each measure. The lower plot shows the realization rate for each measure. In both plots, measures with green bars have a realization rate greater than 100% (verified savings greater than utility tracked savings). Measures with blue bars represent a realization rate less than 100% (verified savings lower than utility tracked savings).

The plot provides a high-level view of the individual site findings and shows that there was not a systematic bias to savings estimates based on measure size.

Figure 10: Sample Measure Realization Rates sorted by size – Enbridge Custom C&I program

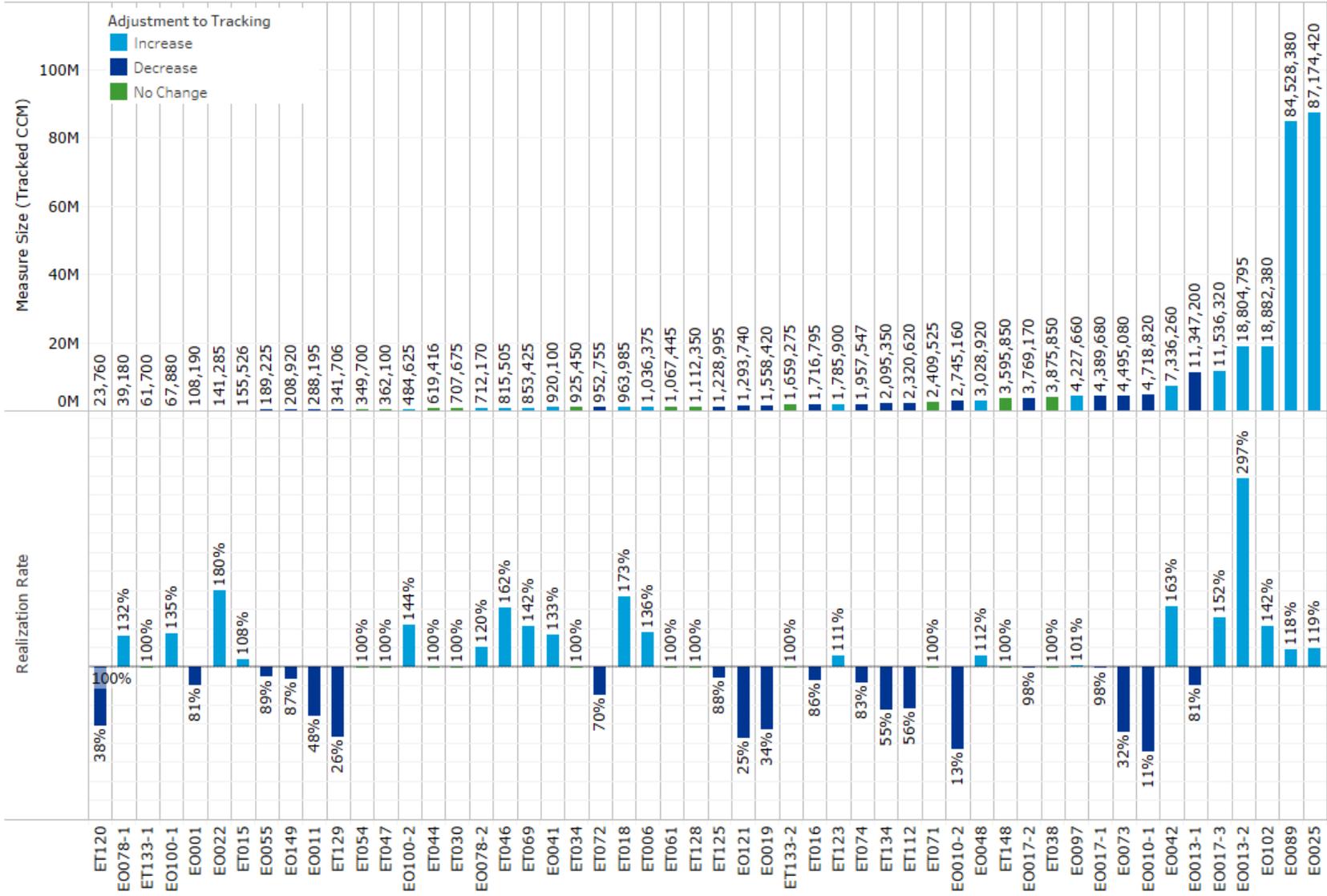
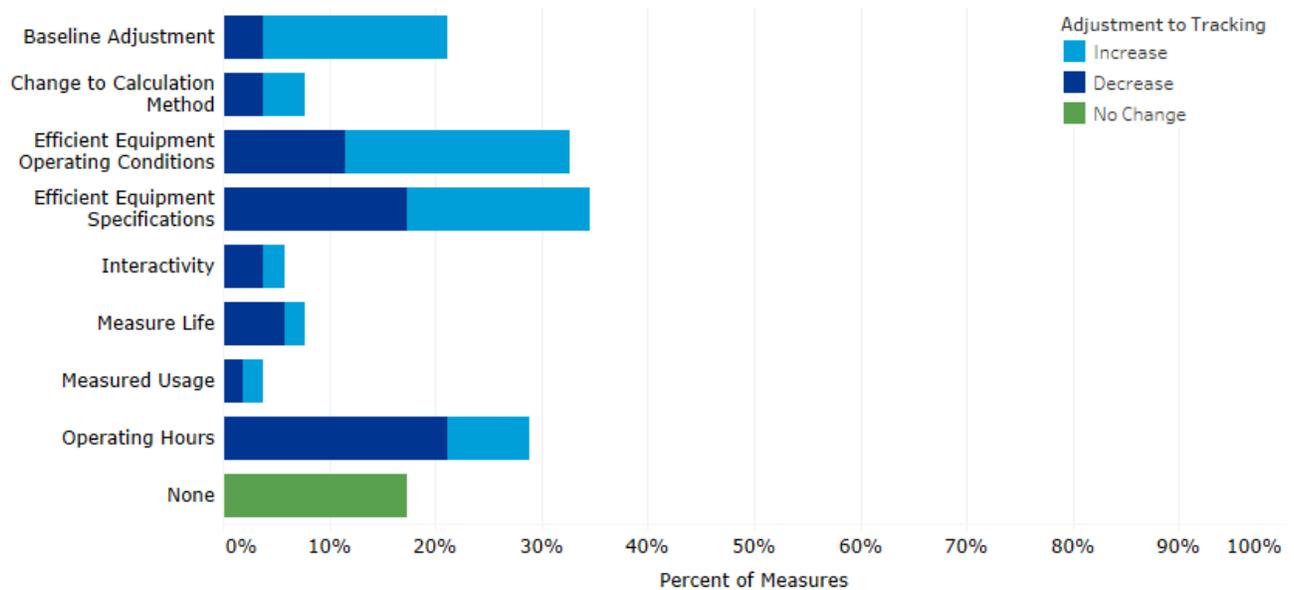


Figure 11 shows the types of discrepancies found by the verification. Operating conditions, efficient equipment specifications and baseline adjustments were three of the most common discrepancies found. The program can reduce each of these types of discrepancies by documenting projects more thoroughly with sources for values used and more complete descriptions of conditions found at the time of installation (see recommendations in section 6.3). While more complete documentation of energy efficient measure operating conditions by the utility could reduce the frequency of this type of discrepancy, but this type of discrepancy is in part outside the utility’s control.

In each discrepancy category we found both increases and decreases in savings, which, combined with the overall realization rate near 100% is evidence that the program estimates are not systematically biased.

Figure 11: Savings discrepancies – Enbridge Custom C&I program



6 FINDINGS AND RECOMMENDATIONS

The tables in this section present the key findings and recommendations from the study. The tables show the party to whom the recommendation applies and the primary beneficial outcome of the recommendation. We classified outcomes into four categories: reduce costs, increase savings, increase (or maintain) customer satisfaction and decrease risk (multiple types of risk are in this category including risk of adjusted savings, risk to budgets or project schedules, and others). Details of the findings, recommendations and outcomes follow the tables.

Table 27: Energy savings and program performance recommendations

#	Energy Savings and Program Performance		Applies to			Primary Beneficial Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
1	Both utilities exhibit a strong commitment to accurate energy savings estimate	The utilities should continue in their commitment to accuracy.	✓	✓				✓	✓
2	The CPSV effort found realization rates near 100% and identified adjustments for most projects.	Continue performing custom savings verification on a regular basis.			✓				✓
3	Relative precision targets were met or surpassed for all programs	Use error ratio assumptions from the results provided in this report in future evaluation years, but with more conservative bounding than performed this year.			✓	✓			✓
4	Some measures have difficult-to-define baseline technologies.	Establish a policy to define rules around energy savings calculation for fuel switching and district heating/cooling measures.	✓	✓	✓				✓
5	Review of documentation for gross evaluation showed that several projects were high free rider risks.	Review projects with large incentives for free ridership risk. Develop clear program rules that allow the utility to reject free rider projects.	✓	✓			✓		✓

#	Energy Savings and Program Performance		Applies to			Primary Beneficial Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
6	Influence adjustments were made to projects that adjusted the gross savings for "net" or program influence reasons.	Increase transparency of "influence adjustments" and do not include in gross savings	✓				✓	✓	✓
7	There is not a clear policy to determine "standard" baselines.	Establish a clear policy to determine and define "standard" baselines	✓	✓	✓	✓			✓
8	Some measures in each utility program are routine maintenance or periodic repairs that are considered standard care in other jurisdictions.	Establish a clear policy regarding eligibility of maintenance and repair measures for the programs.	✓	✓	✓	✓			✓
9	The programs did not consistently account for interactivity among measures.	Add an interactivity check to the programs' internal QC process for savings estimates.	✓	✓	✓	✓			✓

Table 28: Verification process recommendations

#	Verification Process		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
10	DNV GL was unable to obtain access to all the equipment at all the sites selected for verification.	Modify contracts to require participants to agree to comply with EM&V as part of the requirements for participation in the program.	✓	✓		✓			✓
11	Future evaluations should consider large HVAC to be high rigour rather than standard rigour.	Consider large HVAC measures for higher rigour verification.			✓				✓

Table 29: Documentation and Support recommendations

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
12	Incremental improvement in project documentation by both utilities was observed in the 2016 CPSV. Project documentation for some projects lacked sufficient details to allow evaluators to reproduce the calculations made by program staff or third-party vendors.	<p>Take steps to improve documentation:</p> <ul style="list-style-type: none"> • Implement an electronic tracking system that archives all materials • Include explicit sources for all inputs and assumptions in the project documentation. • Store background studies and information sources with the project files and make them available to evaluators. • Provide evaluators full access to customer data. • Provide pre- and post-installation photos, where available. • Document and provide internal M&V documents where available. • Institute a checklist as part of project closeout to ensure all relevant project documentation is assembled as ready for verification 	✓	✓			✓		✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
13	Explanations of complex projects were not consistently clear making it hard to understand what process is producing energy savings.	Improve clarity and details of documentation explaining the source of energy savings for complex projects.	✓	✓					✓
14	Ex ante savings estimates based on annual energy consumption for industrial sites did not always include sufficient information documenting production.	Include site production totals in relevant years in the savings estimates based on annual energy consumption for industrial sites	✓	✓					✓
15	Enbridge Boilers use a 73% assumed thermal efficiency for in situ boilers that have been in place for more than 10 years.	Estimate boiler degradation from name plate efficiency to determine the baseline boiler efficiency rather than a flat number	✓	✓					✓
16	Pipe insulation is a significant source of savings for the Union Gas programs. Documentation for the source of factors used in calculations and of in situ conditions was not consistently provided.	Document baseline conditions of pipe insulation (and other measures) using photos and text descriptions to provide context. Explicitly tie the documentation of baseline condition to the heat loss rate used for the savings calculation.	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
17	Enbridge documentation did not always include a prose explanation and supporting documentation for baseline types (ROB, ER) and remaining useful life (RUL).	Always complete the "Base Case Overview" in the form with a prose description of the base case. The description should reference included emails and photos to document in situ conditions and features that are carried over into the baseline system.		✓					✓
18	The utilities should use longer duration data in ex ante savings estimates when possible.	Use longer duration data in ex ante savings estimates. When time periods less than a year are used, documentation should be provided to indicate why the period used is applicable to a full year and why a full year was not able to be used.	✓	✓		✓			✓
19	In situ boiler name plate information, age and operating condition are all helpful for determining the designed performance and reasonable range of actual efficiency for the system as well as providing context to better determine remaining useful life (RUL)	Document in situ boiler name plate information, age and operating condition for all projects where boiler efficiency affects savings	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
20	Items that may be obvious to the ex ante team can be non-obvious to an outside party.	Review ex ante documentation from an outside perspective to help identify gaps	✓	✓					✓
21	At large sites with multiple spaces containing similar equipment, ex ante documentation did not always identify which space or piece of equipment was affected by the project.	Include additional descriptions of spaces and equipment affected to differentiate among similar spaces and equipment at the site.	✓	✓					✓
22	Invoices were not always included with documentation, and sources for incremental costs were not always clear.	Ensure that incremental costs are supported by invoices or other documentation, especially for add-on and optimization measures where the total cost and incremental cost are likely to be the same.	✓	✓				✓	✓
23	Larger projects appeared to fall under the same documentation standards as smaller projects.	Increase the amount of documentation and source material for projects that have greater energy savings.	✓	✓					✓

#	Documentation and Support		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
24	Union's custom project summary workbook is a good approach to documentation. The workbook is not used in a consistent manner across all projects.	Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner. Identify a common approach for common measures and, if necessary, document deviations and the reasons for the deviations in a clearly labelled field on the summary sheet.	✓			✓			✓
25	Enbridge Etools does not sufficiently document sources of inputs and assumptions.	Use a consistent summary workbook.		✓		✓			✓

Table 30: Data management recommendations

#	Data Management		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
26 A	Neither Union nor Enbridge currently track participating customer or participating vendor contact information in their program tracking	Track contacts associated with projects in the program tracking database.	✓	✓		✓		✓	✓
26 B		Strongly consider investing in relational program tracking databases.	✓	✓		✓	✓	✓	✓

#	Data Management		Applies to			Primary Outcome			
	Finding	Recommendation	Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
26 C	database. Providing the information to the evaluation puts significant burden on utility staff. In 2016, the data provided by utility staff was much more consistent and clear relative to 2015.	Continue to use improved structure for data integrity in the evaluator request for contact information for the 2017 savings verification and evaluation.			✓	✓		✓	
27	The extracts from the utility program tracking database do not include dates for key project milestones.	Track and provide to evaluators dates for key milestones in the project.	✓	✓		✓			✓
29	EUL and cumulative gross savings were not provided in a consistent manner in the Enbridge program tracking database extract	Include separate fields in the program tracking database for all components of gross and net cumulative and first year savings.	✓	✓			✓		✓

6.1 Energy savings and program performance

- Finding:** Both utilities exhibit a strong commitment to accurate energy savings estimates. Both utilities have made significant investments in developing calculation tools which model savings accurately. For example, Union's dock door seal calculator is well considered and designed, and Enbridge's Etools calculator is very thorough in attempting to model savings for key measures.

Both utilities chose to retain engineers with strong understanding of their customers' building and process systems and showed a commitment to finding accurate savings estimates. On several occasions, both on the phone and in writing, the evaluation team suggested a value that would have increased savings in a way that the utility program engineer did not think was valid. When this happened, neither utility was shy in suggesting that we may want to make a more conservative choice.

Recommendation: The utilities should continue in their commitment to accuracy.

Outcome: Accurate energy savings.

- 2. Finding:** The CPSV effort this year found realization rates near 100% and identified adjustments for most projects. Across the programs a near equal number of adjustments increased and decreased savings and one third of projects had a large adjustment (verified savings more than 20% different from tracked).

Recommendation: Continue performing custom savings verification on a regular basis. Even a study that results in an adjustment of near 100% is still valuable because the programs know that their savings estimates will be reviewed. Knowing a review will be conducted improves the quality of ex ante estimates. The review itself also results in information that improves future program savings estimates.

Outcome: Accurate energy savings.

- 3. Finding:** Relative precision targets were met or surpassed for all programs. The sample design incorporated the previous year's error ratios (ERs) and averaged them with the assumption used in 2015. ERs were further bounded (minimum ER was 0.25, maximum 0.60) to limit the risk of over- or under- collecting data. There was one segment (Union Commercial) where precision was not as good as expected.

Recommendation: The process used to develop error ratios assumptions from the results provided in this report should be continued in future evaluation years, possibly with more conservative bounding (potentially increasing the maximum ER) to avoid under-collection of data for any segments.

Outcome: Realistic estimates of error ratios result in an appropriate amount of data collected to meet targets.

- 4. Finding:** Some measures (e.g., geothermal heat pumps, combined heat and power, and those that save district heating energy) have difficult-to-define baseline technologies. Multiple different baselines are possible for these projects depending on how one looks at the scope of the project: how non-gas energy changes and offsite gas use are considered in savings estimates are two of the challenging aspects.

Recommendation: Consider establishing a policy to define rules around energy savings calculations and baselines for fuel switching and district heating/cooling measures.

Outcome: Less risk of adjustment and a better alignment between province energy efficiency goals and program implementation.

- 5. Finding:** Through the gross verification process, we reviewed project documentation and had conversations with customers about their installed measures. While the focus of this report is not on net savings, we did observe a handful of projects (out of the 122 evaluated) that appeared to be clearly at high risk for free ridership. These projects included maintenance type measures, projects that were far along in planning prior to utility involvement, projects with very short paybacks, and projects that included significant non-energy benefits.

Recommendation: Review projects with large incentives for free ridership risk. Develop clear program rules that allow the utility to reject free rider projects.

Outcome: Increased savings, reduced risk of free ridership, more efficient use of program funds.

6. Finding: Union made influence adjustments to projects that adjusted the gross savings for “net” or program influence reasons. Accounting of which projects had these adjustments was not maintained by Union and the adjustments were included in different places in project calculation workbooks, making their identification and validation challenging. In addition, the program NTG was also applied to these projects, effectively double discounting savings in scorecards.

Recommendation: If Union chooses to continue making influence adjustments to the savings upon which it calculates savings, it should make these adjustments more transparent and exclude them from the reported gross savings for the program in scorecards. Instead the specific project influence adjustment should be included in the scorecard in place of the general program or domain level NTG factor.

Outcome: Reduced risk of double adjustments.

7. Finding: There is not a clear policy to determine what standard to use for replace on burnout or new construction baselines. The 2016 verification used a code or minimum available baseline where required, in alignment with the 2015 net-to-gross study. Without a clear policy there is uncertainty for all stakeholders as to what the appropriate baseline should be. This uncertainty affects all aspects of the programs, including what measures are offered, what incentives are paid and how measures are evaluated.

Recommendation: Establish a clear policy to determine and define baseline standards where an “industry standard” baseline would be applicable.

Outcome: Consistency of approach across utilities, evaluators and studies will reduce risk of adjustment and evaluation cost.

8. Finding: Some measures in each utility program are routine maintenance or periodic repairs that are considered standard care in other jurisdictions.

Recommendation: Establish a clear policy regarding eligibility of maintenance and repair measures for the programs.

Outcome: Reduced free ridership risk.

9. Finding: The programs did not consistently account for interactivity among measures. In several cases, we saw an overestimation of the combined boiler efficiency improvement yielded by the addition of linkageless controls and condensate heat recovery measures and an overestimation of savings for subsequent measures that interact with earlier measures within the same program year.

Recommendation: Add an interactivity check to the programs’ internal QC process for savings estimates.

Outcome: More accurate savings estimates and a reduced evaluation risk.

6.2 Verification processes

10. Finding: DNV GL was unable to obtain access to all the equipment at all the sites selected for verification. Both Enbridge and Union have several large projects with industrial companies, including food processing, refineries, and other industries. In many cases, the customer refused to provide SCADA (Supervisory Control and Data Acquisition) system data or similar trend data to allow a reasonable

verification of the project. This means we were unable to do more than a reasonableness check on the savings.

A review of the Enbridge contract shows that the customer is not required to provide the information that is necessary for EM&V. The most relevant sections are:

Item 6: Payment of the Incentive Payment is subject to the completion of a satisfactory site inspection of the improvements, including the installed equipment by an authorized representative of Enbridge.

Item 9: Upon request within eighteen months of the commissioning date of the Project, and with reasonable notice, the Customer agrees to provide authorized representatives of Enbridge with access to the Project, and with required information or data relating to the project for the purposes of the Application and these General Terms and Conditions.

Neither of these are sufficient for EM&V.

Recommendation: Modify contracts to require participants to agree to comply with EM&V as well as utility representatives as part of the requirements for participation in the program.

Outcome: Reduced evaluation costs and risks. Participant non-compliance requires evaluators to request documentation for a large backup sample, and to survey and/or visit additional sites to obtain sufficient data for the evaluation. The process of contacting a site and getting a refusal costs time and money, as does the substitution of an additional site to make up for the unobtained data. In some cases, there might not be additional sites to sample, in which case the evaluation estimates will have lower precision than they would with full compliance.

11. Finding: Large HVAC and HVAC controls projects proved more complex to evaluate than planned.

Recommendation: Future evaluations should consider large HVAC to be high rigour rather than standard rigour.

Outcome: Better alignment of rigour with uncertainty will improve accuracy of savings estimates and provide more cost-effective evaluation.

6.3 Documentation and support

12. Finding: Incremental improvement in project documentation by both utilities was observed in the 2016 CPSV. Project documentation for some projects lacked sufficient details to allow evaluators to reproduce the calculations made by program staff or third-party vendors. Specific issues included:

- Project data or details missing
- Insufficient measure-level details to fully describe what was installed
- Descriptions that were difficult to understand
- Use of black box tools
- Hardcoded information in calculation spreadsheets
- Undocumented assumptions
- Sources referenced but not included or available, such as feasibility studies and historical analysis of energy use that was left out of the project documentation
- Input adjustments that approximate other effects, but are not explained
- Insufficient access to customer data (by customers).

- Modelling files that could not be opened
- Adjustments to savings estimates for safety or influence that were not clearly marked, sourced, or carried out in a consistent fashion

Recommendation: Improve data quality. Possible steps include:

- Implement an electronic tracking system that archives all materials
- Include explicit sources for all inputs and assumptions in the project documentation.
- Store background studies and information sources with the project files and make them available to evaluators.
- Provide evaluators full access to customer data.
- Provide pre- and post-installation photos, where available.
- Document and provide internal M&V documents where available.
- Institute a checklist as part of project closeout to ensure all relevant project documentation is assembled as ready for verification

Outcome: Properly explaining and sourcing the savings calculation method and assumptions allows the evaluating engineer to more easily identify what needs to be verified. It also makes it easier to determine whether the methods and assumptions are reasonable and use ex ante assumptions rather than seek documented values elsewhere.

13. Finding: Explanations of complex projects were not consistently clear making it hard to understand what process is producing energy savings. This was seen with large HVAC control projects with MUAs, AHUs, heat recovery projects, and custom process projects, and others.

Recommendation: Improve the documentation/explanation of the source of energy savings for complex projects that are related to complex systems. Use figures, diagrams, and equations as needed, especially for cascading or multi-staged measures. Parameters such as the heating source, and the efficient case peak and off-peak period flowrates and schedules should be recorded and sourced. If there are additional units not included in the measure, these should be documented and considered in savings estimates (even if the effect is zero).

Outcome: Increased accuracy of savings estimates. Reduced evaluation risk.

14. Finding: Ex ante savings estimates based on annual energy consumption for industrial sites did not always include sufficient information documenting production. The change in energy use pre- and post-measure is sensitive to changes in production.

Recommendation: Savings estimates based on annual energy consumption for industrial sites should include information from the site on amount of production in the years used. It's not enough to say "not much is changed, they run 24/7". If detailed production data are not available, the utilities should get percentage differences year to year (e.g.: if year 1=100%; is year 2 exactly the same, or is it 95% or 110% of production the previous year).

Outcome: Documenting production changes and using them in savings estimates will improve accuracy and reduce evaluation risk.

15. Finding: Enbridge Boilers use a 73% assumed thermal efficiency for in situ boilers that have been in place for more than 10 years. This is based on a 2% de-rate of a 2007 combustion efficiency study that

found an average combustion efficiency of 74.6% for 39 boilers aged 12-38 years (average 24.5). The study, which EGD provided to the evaluation team, did not attempt to tie the degraded combustion efficiency to the original rated efficiency of the boilers. The study is also now more than 10 years old, so its findings are likely out of date and should only at most apply to 20-year-old or more boilers. For 2016, the evaluation used the 73% value since a better option was unavailable at the time.

Recommendation: Use a degradation from name plate efficiency to determine the baseline boiler efficiency rather than a flat number. The 2017 CPSV effort should include in the scope secondary research to determine a degradation factor or curve to be used for the 2017 and 2018 CPSV and could be incorporated by the utilities for the 2019 program year until primary research is completed or a better approach is developed.

Outcome: Improving this key assumption will improve savings estimates for a significant portion of savings in the Enbridge portfolio and the process would also be applicable to Union sites where baseline boiler efficiencies are required and not based on site tests of boiler performance.

16. Finding: Pipe insulation is a significant source of savings for the Union Gas programs. Union estimates heat loss rate for damaged baseline insulation less than that from a simple bare pipe assumption, which is reasonable and appropriate. Documentation for the source of the factors used in the calculation and documentation (via photos and/or a description of the pipe insulation condition) was not consistently provided.

Recommendation: Document baseline conditions using photos and text descriptions to provide context. Tie the documentation of baseline condition to the heat loss rate used in a clear way.

Outcome: Improving documentation of baseline conditions and clarity in calculations will reduce evaluation risk improve consistency of approach among the Union engineering team.

17. Finding: Enbridge documentation did not always include a prose explanation and supporting documentation for baseline types (ROB, ER) and remaining useful life (RUL). "See Etools for base case" is not sufficient: Etools is not designed to provide context and sources to support the values included.

Recommendation: Always complete the "Base Case Overview" with a prose description of the base case. The description should reference included emails and photos to document in situ conditions and features that are carried over into the baseline system.

Outcome: Improved descriptions and documentation will reduce evaluation risk and help Enbridge ensure that accurate information has been entered into Etools.

18. Finding: Duration of pre- post- data (energy consumption, production output, raw material consumption, etc.) used for savings estimates were too brief in several instances.

Recommendation: The utilities should use longer duration data in ex ante savings estimates when possible. When time periods less than a year are used, the utilities should document why the period used is applicable to a full year and why a full year was not able to be used.

Outcome: Increased accuracy of savings estimates.

19. Finding: The utilities did not always gather boiler nameplate data for in situ systems. The age and operating condition was also not always recorded or described. This was a concern on boiler projects,

but also for projects where boiler efficiency has an effect on savings, such as greenhouses, pipe insulation and heat recovery.

Recommendation: In situ boiler name plate information, age and operating condition are all helpful for determining the designed performance and reasonable range of actual efficiency for the system as well as providing context to better determine remaining useful life (RUL)

Outcome: Improving documentation of the in situ boiler will reduce uncertainty in savings estimates and reduce evaluation risk.

20. Finding: Items that may be obvious to the ex ante team can be non-obvious to an outside party. Examples from sites this year included in situ burners that could not be turned off and whether heating needs were equal to or greater than the amount of heat recovered.

Recommendation: Review ex ante documentation from an outside perspective to identify where documentation or explanation could be added.

Outcome: Reduced evaluation risk.

21. Finding: At large sites with multiple spaces containing similar equipment, ex ante documentation did not always identify which space or piece of equipment was affected by the project.

Recommendation: Include additional descriptions of spaces and equipment affected to differentiate among similar spaces and equipment at the site.

Outcome: Reduced evaluation risk.

22. Finding: Invoices were not always included with documentation, and sources for incremental costs were not always clear.

Recommendation: Ensure that incremental costs are supported by invoices or other documentation, especially for add-on and optimization measures where the total cost and incremental cost are likely to be the same. Equipment replacement measures may require an additional standard efficiency quote to produce incremental cost.

Outcome: Incremental cost is an important component of simple payback, which is often used to judge the economic benefit of energy efficiency projects. It is also an input to some benefit-cost tests.

23. Finding: Larger projects appeared to fall under the same documentation standards as smaller projects.

Recommendation: Increase the amount of documentation and source material for projects that have greater energy savings.

Outcome: Projects that are better documented tend to have more accurate savings estimates and receive fewer evaluation adjustments than those that are less documented. Large projects have a greater effect on overall savings adjustment factors. Therefore, large projects with better documentation are more likely to result in adjustment factors closer to 100%.

24. Finding: Union custom projects utilized a project application summary workbook that summarizes the key project inputs, calculations, and most details. In general, this is a good approach that facilitates internal review and evaluation. We also found that the workbooks had improved source documentation

relative to the 2015 projects. One challenge was that different projects used the workbook in different ways:

- The notes section was sometimes used to identify and highlight specific unique approaches and features in projects, but not always.
- Calculations internal to the summary page were consistent for most projects, but not all (additional factors were sometimes added).
- Sub-methods critical to the calculation were contained in hidden sheets.
- Safety and influence adjustments were inserted in different locations and not always explained.

Recommendation: Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner. Identify a common approach for common measures and, if necessary, document deviations and the reasons for the deviations in a clearly labelled field on the summary sheet.

Outcome: A consistent summary workbook aids both internal and external quality assurance, quality control, and measurement and verification.

25. Finding: Enbridge Etools is used as both a calculation tool and as a communication tool with customers. While it appears to serve the needs of the program, this form of communication is difficult for the evaluation efforts.

- Etools does not easily allow for assumptions to be sourced within the record.
- Some Etools selections may be site-specific and some may be defaults; the calculator does not distinguish.
- Energy savings that are calculated outside of Etools are hard-entered in Etools but not always sourced.

Recommendation: Use a consistent summary workbook.

Outcome: A consistent summary workbook aids both internal and external quality assurance, quality control, and measurement and verification.

6.4 Data management

27. Finding: Neither Union nor Enbridge currently track participating customer or participating vendor contact information in their program tracking database. Providing the information to the evaluation puts significant burden on utility staff. In 2016, the data provided by utility staff was much more consistent and clear relative to 2015.

Recommendation A: Track contacts associated with projects in the program tracking database. At a minimum, the program tracking database should include:

- Project site address
- Customer mailing address
- Primary customer contact name
- Primary customer contact phone
- Primary customer contact email
- Primary customer contact mailing address

- Addresses are best tracked as multiple fields including:
 - ◆ Street address line 1
 - ◆ Street address line 2
 - ◆ City
 - ◆ Province
 - ◆ Postal code

Phone number fields should include data validation to enforce a consistent format and avoid missing or extra digit errors. Phone extensions should be tracked in a field separate from the ten-digit phone number and be restricted to numeric data only.

The best practice is to maintain contacts in a table separate from specific project or customer data. This allows for a single contact to be connected to multiple accounts and/or projects as necessary without creating duplication. This structure also makes it easier to associate multiple contacts with a single project, and decreases quality control costs.

Vendor contact information should also be tracked in the database, in the same table as the participating customer contact information. With a relational database, the contact ID from the table can be added to a project record in the role consistent with the contact's participation (such as vendor, decision maker, or technical expert) with a separate table that allows a single vendor contact to be associated with multiple projects.

Outcome A: Reduced burden on utility staff to seek contact information for projects, whether for internal or evaluation use. Reduced evaluation costs and improved sample design expectations.

Recommendation B: The utilities should strongly consider investing in relational program tracking databases. Relational program tracking databases and customer relationship management (CRM) systems allow for multiple contacts to be associated with a single account and/or project. The incremental cost of implementation is low if it is part of the initial database design, populated as projects are started, and updated once they are complete.

For the implementation team, a query-able one-stop shop for information provides a wealth of information that can improve delivery. For example, these databases can help programs understand how contractors work across projects, identify when projects have hit snags and need attention, and give the program team access to key customer context such as historical participation, and different contacts that have worked with the program.

For evaluation, this allows programs to easily clarify aspects of projects during implementation and to provide accurate, timely, and usable contact information to evaluators and verifiers.

Outcome B: Improved customer satisfaction from better delivery, and a reduced burden on utility staff for tracking information. A relational database would also streamline aggregation of program data for scorecards and make providing data simpler for annual savings evaluation and verification.

Recommendation C: When the evaluation requests contact information for savings verification and evaluation, the contact request spreadsheet will continue to provide additional fields to enforce data integrity (e.g., specific fields for a parsed address and company name for the technical and decision-making contacts). If the program tracking databases are able to report contact information, this

spreadsheet should be modified to reduce burden on utility staff while maintaining high levels of data integrity.

Outcome C: Reduced evaluation costs due to less data cleaning and research to fill missing information. Improved data collection with less returned advance letters and more accurate connection between projects and contacts.

28. Finding: The extracts from the utility program tracking database do not include dates for key project milestones. Enbridge's data did not include any dates and Union's included only the "install date."

Recommendation: Track and provide to evaluators dates for key milestones in the project. Dates for project start, installation, and those that define the program year provide useful context for interviewers that is not always easy to find in project documentation

Outcome: Improved data collection through more informed interviewers and reduced evaluation costs through less need to search for dates in documentation.

29. Finding: EUL and cumulative gross savings were not provided in a consistent manner in the Enbridge program tracking database extract. The EUL inconsistency is the result of a work around for advanced (accelerated) projects used by Enbridge to report accurate dual baseline saving estimates and first year savings. Communicating the workaround consistently within the evaluation team led to some re-work.

Recommendation: Include separate fields in the program tracking database for:

- EUL
- RUL
- gross first year annual savings
- gross post-RUL annual savings
- NTG,
- gross cumulative gross
- net cumulative savings
- net first year savings.

Outcome: Improved data integrity results in less evaluation risk and more accurate savings totals. Providing each of the key savings types and their components allows evaluation to confirm that the savings provided are internally consistent.

APPENDIX A FINAL SAMPLE ACHIEVEMENT

The tables below (Table 31 to Table 33) show the achieved sample for each stratum in the sample designs. The tables are specific to each program and show the categorical stratification (segment) and size strata (larger numbers are bigger projects). Sampling was done at the measure level. The target column shows the number of units we attempted to complete. The complete column shows the number of measures randomly selected and completed. Percent of frame cumulative savings is the percent of total savings in the sample frame (population studied) in each category. Note that in some cases measures beyond the target were completed. These completed measures were at sites with multiple measures in the sample.

Table 31: CPSV Sample Achievement for Union CI&MF

Segment	Size Stratum	Max CCM Savings	Measures			Percent of Frame CCM Savings	
			Target	Complete	Frame Total	Strata %	% Complete
Agriculture	1	4,261,610	4	4	94	8%	<1%
	2	7,684,892	4	4	27	10%	1%
	3	18,614,920	4	6	15	11%	5%
	4	48,641,530	4	4	7	17%	10%
Industrial	1	3,232,840	4	5	99	8%	<1%
	2	9,619,900	4	5	31	10%	2%
	3	17,016,460	4	4	15	12%	3%
	4	58,686,760	4	6	7	15%	13%
Commercial	1	871,240	4	4	106	2%	<1%
	2	3,523,200	4	4	22	3%	<1%
	3	13,708,800	4	4	9	4%	2%

Table 32: CPSV Sample Achievement for Union Large Volume

Segment	Size Stratum	Max CCM Savings	Measures			Percent of Frame CCM Savings	
			Target	Complete	Frame Total	Strata %	% Complete
Large Volume	1	5,028,828	4	4	34	6%	<1%
	2	14,392,750	4	5	8	8%	5%
	3	23,280,720	3	4	5	9%	7%
	4	35,568,422	3	4	4	13%	13%
	5	229,432,213	4	3	4	63%	45%

Table 33: CPSV Sample Achievement for Enbridge CI&MF

Segment	Size Stratum	Max CCM Savings	Measures			Percent of Frame CCM Savings	
			Target	Complete	Frame Total	Strata %	% Complete
Industrial	1	986,520	4	4	129	5%	<1%
	2	2,582,265	4	4	37	7%	<1%
	3	4,908,156	4	5	18	8%	2%
	4	18,882,380	4	5	8	11%	8%
	5	87,174,420	2	2	2	21%	21%
Commercial	1	619,416	6	7	247	6%	<1%
	2	1,858,425	5	5	63	8%	<1%
	3	8,794,260	5	5	24	11%	<1%
MR MF	1	644,347	5	6	206	6%	<1%
	2	1,760,525	5	5	58	8%	<1%
	3	7,117,525	4	4	26	9%	<1%

APPENDIX B TECHNICAL POLICY APPROACHES

This appendix memorializes some of the more noteworthy topics that arose during the evaluation as part of Evaluation Advisory Committee (EAC) review of CPSV site reports. In many cases these decisions carry forward decisions made during the 2015 CPSV (as noted in the text).

Measure categories and baseline selection

Table 34 shows the CPSV team's definitions of which baseline is appropriate for various situations. These are guidelines that apply to almost all projects. Some situations may require an exception, in which case the reasoning was described in the site report. In most cases where a code or market minimum baseline was an option, we used that rather than a customer specific baseline. This approach was used in order to maintain consistency of approach with the 2015 net-to-gross study, making the results of that study applicable in conjunction with the results from this study.

Table 34: Measure categories and associated baselines

Measure Type	Gross Savings, based on remaining useful life from facility contact and documentation		Examples	Notes
	Early Repl. Baseline	Normal Repl. Baseline		
Replace on Burnout (ROB) and Existing Equipment More Efficient than Code or Where No Code Applies	NA	In-Situ (use new equipment with the same size/rating and in-situ efficiency)	Unique measures where no code/Industry Standard Practice (ISP) exists; Drum Dryers	
Replace on Burnout (ROB) and Existing Equipment Less Efficient than Code	NA	Code/Standard Market Efficiency	Replacing a boiler which was no longer practical to operate	
New Construction (NC) / Capacity Expansion (CE)	NA	Code/Standard Market Efficiency or Minimum on Market/Customer Specific	New boiler for new space or system. Any new construction or natural gas load adding/increasing. Other recently constructed non-participating buildings onsite are a reasonable baseline	Minimum on market / customer specific applies where there is no enforced code
Retrofit Add On (REA)	In-Situ	Code/Standard Market Efficiency or Minimum on Market/Customer-specific	Equipment controls; addition of boiler economizer; pipe/tank insulation	Minimum on market / customer specific applies where there is no enforced code

Measure Type	Gross Savings, based on remaining useful life from facility contact and documentation		Examples	Notes
	Early Repl. Baseline	Normal Repl. Baseline		
Early Replacement (ER) and Existing Equipment More Efficient than Code or Where No Code Applies	In-Situ	In-Situ (use new equipment with the same size/rating and in-situ efficiency)	Greenhouse components, such as a site with degraded double-layer polyethylene walls which then installs triple layer but uses single layer poly walls as the baseline (this is a regressive baseline) to estimate savings. Must use double layer (new not degraded) as the baseline in this case.	
Early Replacement (ER) and Existing Equipment Less Efficient than Code	In-Situ	Code/Standard Market Efficiency or Minimum on Market/Customer Specific	Regenerative Thermal Oxidizer (RTO) – required to meet local air quality emissions requirements, that a recuperative or direct-fired oxidizer cannot achieve.	
Maintenance (Including Repair or Maintain to Code or Restoration to Prior Efficiency Level)	NA	In-Situ	Re-tube boilers to rated efficiency levels; Repair or clean heat exchanger; Replace heat exchanger oil; Rewind motors; Repair or Replace faulty/leaking valves, pipes, ductwork, etc.; Re-pipe condensate return lines.	
System Optimization (OPT)	NA	In-Situ	Revamp Process Control Strategy; De-bottlenecking to increase production and m ³ /widget; Modifying the sequence of processes.	

Estimated useful life

The EUL of the new measure applied to all categories of measures:

For most measures, we based EULs on those found in the Utility Measure Life Guide,¹¹ when present and reasonable. Site contacts were asked about their expectations for the EUL of the measure installed. Whether to use the Utility measure life guide or the site contact information was based on the judgement of the evaluation engineer and a simple decision matrix shown in Table 35.

¹¹ Union Gas Limited, Enbridge Gas Distribution Inc. (2016, December 21). EB-2016-0246 Joint Summary Table of Measures Assumptions. Toronto.

Table 35: EUL decision matrix

		Is there a measure specific (not other/process) EUL in the utility measure life guide?	
		Yes	No
Does site contact provide information that supports an EUL value determination?	Yes	Use utility measure life guide unless site contact has site specific reason for EUL value provided	Use site contact reported EUL
	No	Use utility measure life guide	Use utility measure life guide for other/process, ex ante EUL, or, in rare cases, secondary sources such as manufacturers or other studies

When EULs were not present in the Utility Measure Life Guide, and site contacts were not knowledgeable we would then base EULs on those used in other North American jurisdictions. In rare cases, manufacturer information could have been used to determine the applicable EUL for measures that were not found in a survey of EUL guides and TRMs.

The RUL of the existing equipment limited the EUL of the implemented measure for the following categories of measures:

- Retrofit Add-on (REA)
- System Optimization (OPT)
- Maintenance

RUL was determined based on the best available evidence. In some cases, the preponderance of evidence suggested that a REA measure was likely to be re-used with new equipment when the existing equipment was replaced. Evidence to support using an EUL rather than RUL for REA measures required that the re-use was both feasible (REA measure must be compatible with a wide range of substitute equipment) and likely (ISP was re-use for the application and/or site contact indicates that re-use was planned).

There are situations where the RUL of the existing measure is more than likely longer than the EUL of the REA measure. Pipe insulation is an example: in almost all cases we would expect existing pipes to outlast the insulation installed on them.

Site engineers and interviewers used a list of questions to help determine the RUL of existing equipment. Due to time constraints, project specifics and the site contact’s willingness/ability to respond, not all questions were asked of all sites. In 2016, we made this process more formalized as detailed below.

The following section provide the methodology we used for determining the applicable RULs. Question wording onsite and on telephone interviews did vary from the language used here as the questions were delivered in the context of the broader conversation about the implemented measures.

Framing Questions

These questions are intended to get the respondent thinking about their rebated equipment in the context of:

- Their broader facility or process
- Their typical maintenance and equipment replacement practices
- The performance of the equipment relative to their current needs

Interviewers should ask these questions before moving to the measure-type-specific questions shown in the following sections.

- For all add-on measures, interviewers should ask these questions of the pre-existing energy using equipment that the add-on measure is reducing load for (host equipment). Wording should be informed by observed equipment condition.
- For add-on measures that replaced a pre-existing add-on interviewers should ask these questions referring to the pre-existing add-on in addition to and separate from the host equipment.
- For replacement measures interviewers should ask these questions referring to the condition of the replaced equipment at the time of replacement.

Maintenance

- frequency
- costs relative to that anticipated for a new unit
- costs over time (are they increasing or decreasing)

Performance

- Is/was it meeting needs?
- performing at its rated specification?
- Degrading more or less quickly between maintenance/repairs?

Any components whose failure would cause replacement of the equipment?

- Which component is it?
- How much longer do you think it will last?

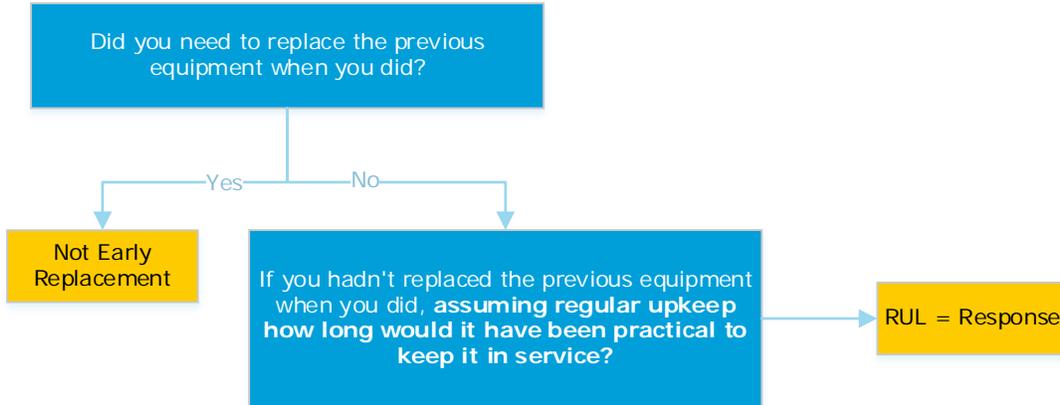
Equipment Replacement

The equipment replacement measure type refers to equipment that is installed in place of another piece of equipment being removed. In this case, the EUL of the installed equipment is split into two periods:

- **ER Period:** This is the period representing the RUL of the existing (replaced) equipment. During this period, the existing equipment is the baseline.
- **Non-ER Period:** The remaining EUL (after subtracting out the RUL) is referred to the non-ER period. During this period, the new standard efficiency baseline shall be used.

We determine the RUL for equipment replacement measures by asking the question shown in Figure 12.

Figure 12. Equipment Replacement Data Collection Flow Chart



It is important to ensure that the respondent understands that regular maintenance and upkeep should be assumed.

Note that the question does not refer to the program. We are trying to understand how long the equipment would have stayed in service had it not been replaced at the time it was. This is different from a timing/acceleration question that might be found in a free ridership question sequence in that the reasons for replacing now rather than later are not material in the gross context.

Put simply, for this gross-only evaluation, we do not care when a customer would have replaced their equipment without the program. Instead we are seeking to understand how much longer it would have been practical to keep the equipment in use.

Add-on Equipment

The add-on equipment measure type refers to equipment that is added to an existing system or piece of equipment to make it more efficient, such as a control or insulation. There are many potential periods within the EUL of the installed add-on equipment. These periods include:

- **ER Period 1:** The period where the existing add-on equipment (or none, if the existing equipment did not have any applicable add-on equipment) and existing host equipment could have continued operating in the same manner. During this period, the baseline would be the existing host equipment with the existing add-on (if any).
- **ER Period 2:** There could be a second ER period on rare occasions, for two reasons:
 - If the existing add-on equipment (if there was one) would have failed or been replaced, but the existing host equipment was still operating effectively. During this period, the baseline would be the existing host equipment with new standard efficiency add-on equipment.¹²
 - If the existing host equipment failed, but the existing add-on equipment could have been used with the new host equipment. During this period, the baseline would be the new host equipment (whatever the customer will most likely install) with the existing add-on equipment.

¹² Note that the "new std. eff. add-on" case may not include an add-on at all. For example, the standard efficiency case for many motors is not to use a motor drive but to allow the motor to run by itself. Sometimes customers even replace an existing VFD-driven motor with one that does not have a VFD.

- 
- **Non-ER Period:** The period after both the existing host equipment and the existing add-on (if any) would have failed or had to have been changed/replaced. During this period, the baseline is the new host equipment with a new standard efficiency add-on.¹²

These periods are represented visually in Figure 13. In this figure, the labels are defined as follows:

- **Exist. Add-on RUL > 0:** Existing add-on equipment was early replacement.
- **Exist. Host RUL > 0:** The add-on was installed on existing host equipment.
- **EUL of New Add-on > RUL of Exist. Host:** The host equipment will be replaced during the life of the new add-on
- **New Add-on Compatible with New Host:** The new add-on equipment is practical to reuse with whatever replaces the existing host equipment, as determined by the questions in Figure 12.

Figure 13. Add-on Equipment Periods

Scenario					<-----New Add-on Equipment EUL----->		
#	Exist. Add-on RUL >0	Exist. Host RUL >0	EUL of New Add-on > RUL of Exist. Host	New Add-on Compatible with New Host.	Baseline is:		
					ER Period 1	ER Period 2	Non ER Period
1	yes	yes	yes	yes	Exist. Host Pre-exist. Add-on	Exist. Host New Std. Eff. Add-on ¹²	New Host New Std. Eff. Add-on ¹²
2	yes	yes	yes	no	Exist. Host Pre-exist. Add-on ¹²	Exist. Host New Std. Eff. Add-on ¹²	No Savings
3	yes	yes	no	-	Exist. Host Pre-exist. Add-on (or none)	n/a	Exist. Host New Std. Eff. Add-on ¹²
4	yes	no	-	yes	New Host Pre-exist. Add-on.	n/a	New Host New Std. Eff. Add-on ¹²
5	no	yes	yes	yes	Exist. Host New Std. Eff. Add-on ¹²	n/a	New Host New Std. Eff. Add-on ¹²
6	no	yes	yes	no	Exist. Host New Std. Eff. Add-on ¹²	n/a	No Savings
7	no	yes	no	-	n/a	n/a	Exist. Host New Std. Eff. Add-on ¹²
8	no	no	-	yes	n/a	n/a	New Host New Std. Eff. Add-on ¹²

Using the example of a boiler and a boiler controller, here is how these scenarios would work:

- **Scenario 1:**
 - Customer had an existing boiler with an existing controller.
 - Existing controller and boiler both had an RUL greater than zero.
 - Boiler RUL was greater than the existing controller RUL
 - New controller EUL is greater than the existing boiler RUL
 - Controller would be compatible with a new boiler.
- **Scenario 2**
 - Customer had an existing boiler with an existing controller.
 - Existing controller and boiler both had an RUL greater than zero.
 - Boiler RUL was greater than the existing controller RUL
 - New controller EUL is greater than the existing boiler RUL
 - Controller would not be compatible with a new boiler.
- **Scenario 3**
 - Customer had an existing boiler with an existing controller.
 - Existing controller and boiler both had an RUL greater than zero.
 - Boiler RUL was greater than the existing controller RUL
 - New controller EUL is less than the existing boiler RUL
 - Controller would not be compatible with a new boiler.
- **Scenario 4**
 - Customer had an existing controller which was re-installed on a new boiler.
 - Existing controller had an RUL greater than zero.
 - New boiler EUL is greater than the existing controller EUL
- **Scenario 5**
 - Customer had an existing boiler with an RUL greater than zero.
 - Existing controller had failed or did not exist
 - New controller EUL is greater than the existing boiler RUL
 - Controller would be compatible with a new boiler.
- **Scenario 6**
 - Customer had an existing boiler with an RUL greater than zero.
 - Existing controller had failed or did not exist
 - New controller EUL is greater than the existing boiler RUL
 - Controller would not be compatible with a new boiler.
- **Scenario 7**
 - Customer had an existing boiler with an RUL greater than zero.
 - Existing controller had failed or did not exist
 - New controller EUL is less than the existing boiler RUL
- **Scenario 8**
 - Customer installed a new controller on a new boiler

Additional examples using other technologies:

- **Scenario 1:** A customer replaces damper driven speed control with a VFD on a make-up air (MUA) unit. The customer says that the VFD is easily removable, and could easily be reused on a new MUA. The

damper speed control had an RUL of 5 years, the MUA an RUL of 10 years, and the VFD has an EUL of 15 years.

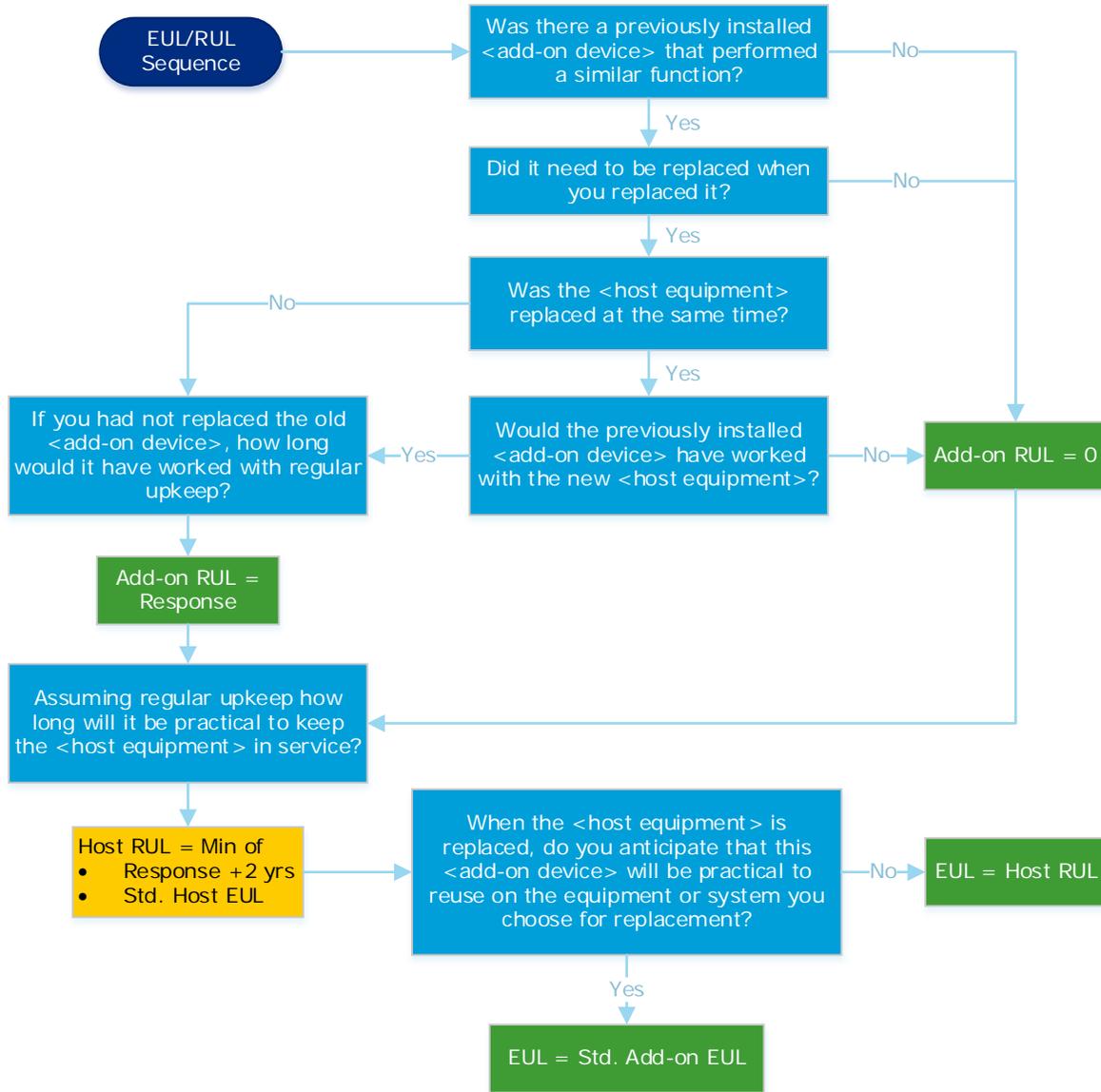
Period	Length (yrs)	Baseline
ER Period 1	5	Exist. Host Exist. Add-on
ER Period 2	5	Exist. Host New Std. Eff. Add-on ¹²
Non ER Period	5	New Host New Std. Eff. Add-on ¹²

- Scenario 2:** A customer adds a vendor-specific linkageless control to their existing steam boiler. The existing boiler did not have any similar controls. The customer says that the boiler has an RUL of 5 years. They do not like the existing system vendor, and so in a new system they would not find it practical to recycle the used vendor-specific linkageless control. The linkageless control has a standard EUL of 10 years, though in this case the EUL is limited to 5 years.

Period	Length (yrs)	Baseline
Non ER Period	5	Exist. Host Exist. Add-on ¹²

We determine the RUL and EUL for add-on measures by asking the questions shown in Figure 14. The purpose is to make sure that we get as much meaningful, accurate, and consistent information as possible from the customer, to minimize resorting to default guidelines.

Figure 14. Add-on Equipment Data Collection Flow Chart¹³



For customers who are hesitant to answer, we will get approximate information by providing bracketed categories (e.g. “is it more or less than 10 years” ... “is it more or less than 5 years”) and will incorporate any information we have available from the documentation or our own sources to help inform this value.

Summary

In the past, there was significant debate amongst the EAC on how we determined the length and nature of the EUL and RUL periods, particularly when the savings for one or more periods might have been zero.

For this reason, we have chosen to make explicit how we are going to ask about these issues, and collect the information necessary to reasonably quantify them. There will still be situations where we must follow

¹³ Note that we add 2 years to the final equipment life question response because the equipment was installed in 2016 but we are asking about it in 2018.

default guidelines about items like RUL and whether equipment could be reused on new host equipment, though our proposed approach should reduce the number of times this is necessary.

Greenhouse baselines

For this round of CPSV, the evaluation team accepted most of the baseline assumptions used by the utilities, as applicable codes for commercial greenhouses do not provide specific guidance toward defining minimum efficiency levels for any of the equipment included in the utility programs. Further, Industry Standard Practice (ISP) for Ontario has not been studied. The baseline assumptions used by the utilities are generally closer to a “minimum available on the market” baseline rather than ISP. This approach is consistent with that used for the 2015 CPSV and NTG studies.

In accepting the program baseline for gross savings, the CPSV adjustment was likely to be small. However, a larger number of participants would likely say that they would have installed something significantly more efficient than the program baseline in the absence of the program, resulting in a NTG adjustment farther from 100%. If the evaluation team had used our experience of ISP in other jurisdictions as the baseline for gross savings, the CPSV adjustment was likely to be larger. However, more participants would be likely to say that they would have installed something that was the same as the ISP baseline, resulting in a NTG adjustment closer to 100%. Either way, the net savings would be similar.

Due to the number and size of these projects and the anticipated continued growth in greenhouse construction, we recommend scoping and undertaking a greenhouse baseline study in the future.

Union topics

Union specific topics that required significant decisions during the verification included evaluation approach to “influence factors,” and steam traps.

Influence factors

Previous CPSV efforts identified that Union was risking high free ridership on some project types including steam traps and steam leak repairs. The auditor recommended that Union discount savings to only claim the portion that they believe the program had influence on. Union implemented this recommendation by applying influence factors (the evaluation team’s term) to projects that reduced ex ante savings to account for anticipated partial free ridership. This reduced the incentives paid to customers as well. Union’s approach was conservative in that by reducing gross savings for these projects, a separate program-level NTG factor was also applied further reducing the claimed net savings.

The approach taken by Union demonstrated the utility’s concern with free ridership and represented a proactive way of addressing it.

In this evaluation, Union provided non-influence adjusted savings for the population of measures. This report used these non-influence corrected savings as both the ex ante savings for verified sites and as the total ex ante savings for the Union programs.

Steam traps

The CPSV team used a six (6) year EUL for these measures, consistent with 2015 CPSV. The reasoning in 2015, which we carried forward in 2016 is described below.



In previous project documentation, Union typically used seven (7) year EULs and Enbridge usually used six (6) year EULs. The CPSV team used a single EUL for both utilities, adopting a six (6) year EUL. The six-year value was based on a 2015 Massachusetts study and is also consistent with the California DEER database, Massachusetts evaluations and the Wisconsin Focus on Energy TRM. The Michigan MEMD (Michigan Efficient Measure Database) uses a five (5) year EUL.

Project documentation provided by Union to support a longer EUL for Union projects consisted of three reports from customers documenting their practices and survey results. Each of the three sites provided was a petrochemical plant.

The reports showed failure rates that could be consistent with 7, 11 and 13 years respectively.

Methodologically, 1/"failure rate" is a way to estimate the EUL, but it assumes that all traps fail randomly. Many factors affect the life to the steam trap: temperature, pressure, flowrate, operating hours, quality of the installation of the steam trap, location of the steam trap in the system (e.g., near elbows and constrictions, or in a straight line of pipe, or somewhere where near forklift traffic), presence of low concentrations of chemicals in the steam and more. The steam traps replaced as part of a program are going to be more likely to be those with a higher rate of failure than those of the facility as a whole.

DNV GL also reviewed the project files sent for the 2015 CSPV sample. While most of the project files do not report the number of traps surveyed, the evaluation team found two others in the 2015 project files that did (the two largest, one petrochemical and one other manufacturing). The failure rates in those sites were consistent with 4.3 and 8.1 years, but it was not clear how often they conduct surveys, so these could have been multi-year failures (longer implied EUL with a 1/"failure rate" method).

Five large customers are not necessarily representative of the program population, and the steam traps replaced by the program are likely to fail at a rate greater than those not replaced. The evaluation team does not have enough evidence to support a longer steam trap EUL for Union and used 6 years as the EUL, consistent with the current best available research (the Massachusetts study).¹⁴

Union uses three general approaches to calculating savings from steam traps. Most of the projects fall into approaches 1 and 2, with only a few projects using approach 3.

1. Standard: A calculation tool takes inputs provided by vendors and applies them to a simplified version of the Spirax Sarco equation, then applying a derating factor. Similar to the approach used by many vendors.
2. Chemical and Refinery: A calculation tool which uses four different equations depending on pressure and steam trap type, including choked and non-choked versions of both the Napier equation and ANSI standard equation. Generally applied to large chemical and refinery plants with thermodynamic traps.
3. Ad-Hoc: This approach represents a variety of methods which take different outputs which are likely to have been based on different assumptions from simple vendor calculations without specifically stating assumptions and converts steam loss to natural gas savings.

¹⁴ Massachusetts 2013 Prescriptive Gas impact Evaluation. Prepared by DNVGL for Massachusetts Gas Program Administrators and Massachusetts Energy Advisory Council, June 2015.



For this round of evaluation, we accepted Union's methodology for Approaches 1 and 2, retaining their savings estimates unless we learned something from the site contact about the pressure, leak rate, or other condition that differed from the ex ante assumption/documentation. Where site information differed from the documentation, the methodology used to estimate ex post savings was determined on a case-by-case basis. For Approach 3, we planned to recalculate savings using a formula from the Illinois TRM, which generally produces savings estimates similar to the results from the Enbridge and Union Approach 1 methods. Approach 3 was in the end not used.

In the future, we propose that Union document and provide the orifice sizes used to check the vendor calculations. We also propose that Union provide all documentation, including charts, tables, and vendor documentation where needed, to evaluate Approach 2 sites. Union should also provide Excel calculators with live formulas rather than hardcoded values when the values were determined based on a formula or table as opposed to a chart or curve. If the chart or curve was the source, Union should provide a copy of the source material.

Some options for increasing the evaluation rigour for steam traps, might entail one or more of the following options:

- attempting to independently gather orifice sizes and maximum flow capacity charts by reaching out to vendors ourselves to develop a database which would allow us to independently verify calculations,
- purchasing a license for steam trap auditing software allowing for independent verification, or
- developing an assessment of measure life using DNV GL's ultrasonic leak detector to assess failure rate at participating sites.

Boiler Measure Lives

In the 2016 CPSV, we harmonized the boiler measure lives for the two utilities. Previously, Union used 20 years for boilers, while Enbridge used 25 years. DNV GL senior engineers were asked which was more reasonable and consensus was that 25 years is a reasonable estimate of measure life for most large boiler applications.

Enbridge topics

Enbridge specific topics that required significant decisions during the verification included evaluation approach to boilers and steam traps.

Boilers

For the 2016 evaluation of the Enbridge programs, the DNV GL team accepted the Etools calculation method along with the inputs used by Enbridge, except in cases where we were able to verify with site contacts a different condition than what was shown in the documentation. This approach is consistent with 2015.

For the future evaluations, the evaluation team will:

- look for more existing evidence from Enbridge (including emails from the customers, photographs, inspection reports, cut sheets, invoices, and conversation notes) to explain why site-specific inputs were used.

- request that Enbridge explicitly state for DHW boiler replacements in buildings with storage tanks whether the existing tank was replaced as part of the boiler replacement, and whether the existing tank was insulated.
- recommend that the DHW tank insulation be included as a separate measure from boiler replacement.
- consider additional research and reporting that includes:
 - pursuing a detailed review of the ASRAE 155P research,
 - pursuing a review of the Etools calculator which digs into the underlying assumptions and formulas, and
 - writing a detailed memo which summarizes the results of these reviews.

One benefit would be greater clarity around the remaining calculation uncertainties and a better understanding of their effect. Another would be the identification of areas where the calculation rigor can be cost-effectively increased through further research.

During the evaluation, we noted that Enbridge's approach to boiler implementation appeared to take more of the boiler system into account than prescriptive and custom programs implemented elsewhere. This may be motivated by the savings estimation approach that Etools takes and provides justification for on average higher savings estimates from Etools than prescriptive boiler savings estimates elsewhere.

Due to the unique approach to market and calculation that Enbridge takes, future CPSV efforts should consider using an empirical measurement approach to directly estimate usage and/or savings for boilers. Empirical measurement could take the form of billing analysis or an on-site metering study which either measures natural gas directly or measures proxy values (such as flue gas temperature, water flow, or combustion fan electrical usage). On-site metering studies are becoming more cost effective as end-use natural gas metering expertise and the accuracy of meters to measure proxy variables continue to increase. An empirical sample-based study would not prevent Enbridge from using a custom calculation approach, but would help to calibrate the custom calculation and may provide value to the ASHRAE committee attempting to quantify seasonal efficiency. A billing analysis approach to estimate savings for multifamily and/or commercial boiler replacements may yield reasonable statistical significance due to the large numbers of boilers installed by Enbridge and the fact that boiler usage represents the large majority of gas usage in most buildings.

Steam traps

For this round of evaluation, consistent with 2015, the evaluation team accepted Enbridge's approach and savings estimates for steam trap evaluations unless we learned something from the site contact about the pressure, leak rate, or other condition that differed from the ex ante assumption/documentation. Where site contacts provided different information to the verifier than that included in the ex ante documentation, the approach used to estimate ex post savings was determined on a case by case basis (depending on what was different).

For their steam trap savings estimates, Enbridge uses an internal database of vendor-provided orifice sizes to check the calculations done by vendors. Based on a review of the formulas used by each vendor,



calculations with a sample of pressures and leak rates used by each vendor, and a comparison to Spirax Sarco (whose calculation approach is generally recognized as superior by independent industry experts), Enbridge determines an vendor-specific average derating factor which is applied to the steam losses reported by each vendor. These derating factors are used to convert vendor savings estimates to ex ante program estimates.

The estimates that each contractor's approach produces can vary widely depending on orifice size, leak rate, pressure, and whether condensate is returned or not, so we deviated from Enbridge's method where applicable based on site-specific information.

The Enbridge estimates appear accurate for a group of projects averaged together. The evaluation checked these estimates using an alternative calculation method (based on the Illinois TRM approach) and achieved a similar total savings, though site specific estimates varied widely.

In the future, we will consider requesting that Enbridge document the orifice sizes they used to check the calculations done by vendor for the evaluated site and independently confirm the calculated savings. We will also consider increasing the rigour for steam traps which could entail one or more of the following options: attempting to independently gather orifice sizes by reaching out to vendors ourselves to develop a database, purchasing a license for steam trap auditing software, or assessing the measure life using DNV GL's ultrasonic leak detector to assess failure rate at participating sites.

APPENDIX C ADDITIONAL RESULTS

This appendix provides additional domain-level ratio results for the 2016 verification. The results in this appendix are not used in calculating verified gross savings, but are useful for better understanding the CPSV results. In the tables, results with less than 5 completes or absolute precision (+/-) greater than 20% are not shown. Large Volume ratios are not reported here, as Large Volume ratios were not assigned specific measure types.

Table 36: Cumulative gross savings realization rate for the Union Custom C&I program, by measure type

Measure Type	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Sites		+/-	Lower Bound	Upper Bound	Relative Precision		
Greenhouse	12	8	100.41%	13%	87%	113%	13%	0.22	35%
Non-Process Heating	13	12	94.03%	11%	83%	105%	11%	0.22	23%
Other	17	16	102.42%	13%	90%	115%	12%	0.28	26%
Process and Process Heating	8	8	107.21%	13%	94%	121%	13%	0.19	16%

Table 37: Cumulative gross savings realization rate for the Union Custom C&I program, by sector and measure type

Sector	Measure Type	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Sites		+/-	Lower Bound	Upper Bound	Relative Precision		
Agriculture	Greenhouse	12	8	100.41%	13%	87%	113%	13%	0.22	35%
	Other	6	5	99.06%	3%	96%	102%	3%	0.03	10%
Industrial	Non-Process Heating	7	6	88.51%	9%	80%	98%	10%	0.12	19%
	Process and Process Heating	6	6	107.66%	16%	92%	123%	14%	0.18	15%

Table 38: Cumulative gross savings realization rate for the Enbridge Custom C&I program, by measure type

Measure Type	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Sites		+/-	Lower Bound	Upper Bound	Relative Precision		
Boilers	14	13	111.87%	9%	102%	121%	8%	0.18	26%
Heating Controls	11	10	95.36%	15%	80%	111%	16%	0.29	14%
Process	12	10	103.55%	9%	94%	113%	9%	0.17	36%

Table 39: Cumulative gross savings realization rate for the Enbridge Custom C&I program, by sector and measure type

Sector	Measure Type	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Sites		+/-	Lower Bound	Upper Bound	Relative Precision		
Commercial	Boilers	6	5	106.40%	12%	94%	119%	12%	0.14	8%
Industrial	Process	12	10	103.55%	9%	94%	113%	9%	0.17	36%
MR MF	Boilers	8	8	115.10%	14%	101%	129%	12%	0.18	17%

APPENDIX D SAMPLE DESIGN

This section presents the stratification plan using the data provided by Union and Enbridge for 2016 custom C&I and multi-family projects.

Explore the Tracking Data

For both utilities, we describe a row in the tracking data as a “measure.” Enbridge’s tracking data has a clear project identifier that groups rows of measures into projects. Union’s tracking data does not have an project identifier that groups rows of measures together. Our review of Union’s data showed that there are sites that have multiple measures in a year, which is an indication that Union’s tracking data records are likely similar to a “measure” row in the Enbridge data in most cases.

Union CIMF

All savings in this section and throughout the Union CIMF sample design include influence correction factors as sampling was done prior to having non-influence corrected savings.

The Industrial segment of the Union CIMF program makes up more than three quarters of the savings in the program and more than half of the measures. Figure 15 and Table 40 provide an overview of the number of measures, average measure size and total CCM for each segment. In the figure and table, we can see that Agriculture makes more sense as a third segment for Union than MR MF based on number of measures and savings totals. Figures later in this section will include the Union MR MF projects in the Union Commercial segment.

Figure 15: High level view - Union CIMF Program

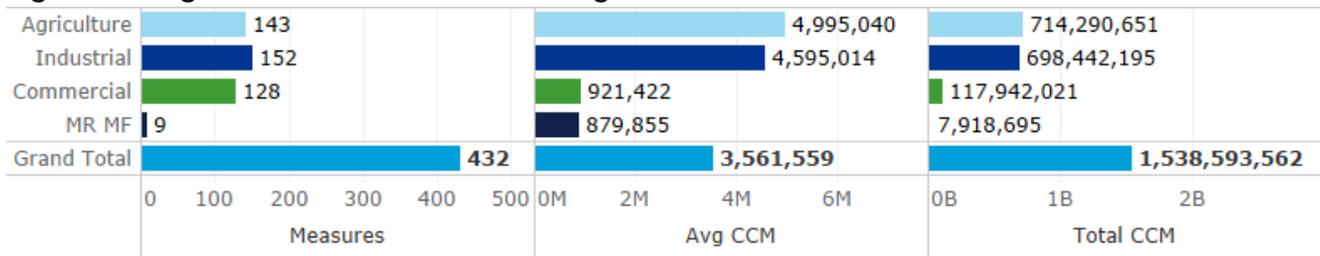


Table 40: High level view - Union CIMF Program

Segment	Measures	Average CCM per Measure	Total CCM
Agriculture	143	4,995,040	714,290,651
Industrial	152	4,595,014	698,442,195
Commercial	128	921,422	117,942,021
MR MF	9	879,855	7,918,695
Total Union CIMF	432	11,391,331	1,538,593,562

Distributions of the major measure types are shown in Figure 16 and Table 41. This figure shows that each segment has different dominant measure types that we hoped would have sufficient precision to report as separate domains. The table and figure include the MR MF measures and savings as part of the Commercial segment.

Figure 16: Potential reporting measure types - Union CIMF

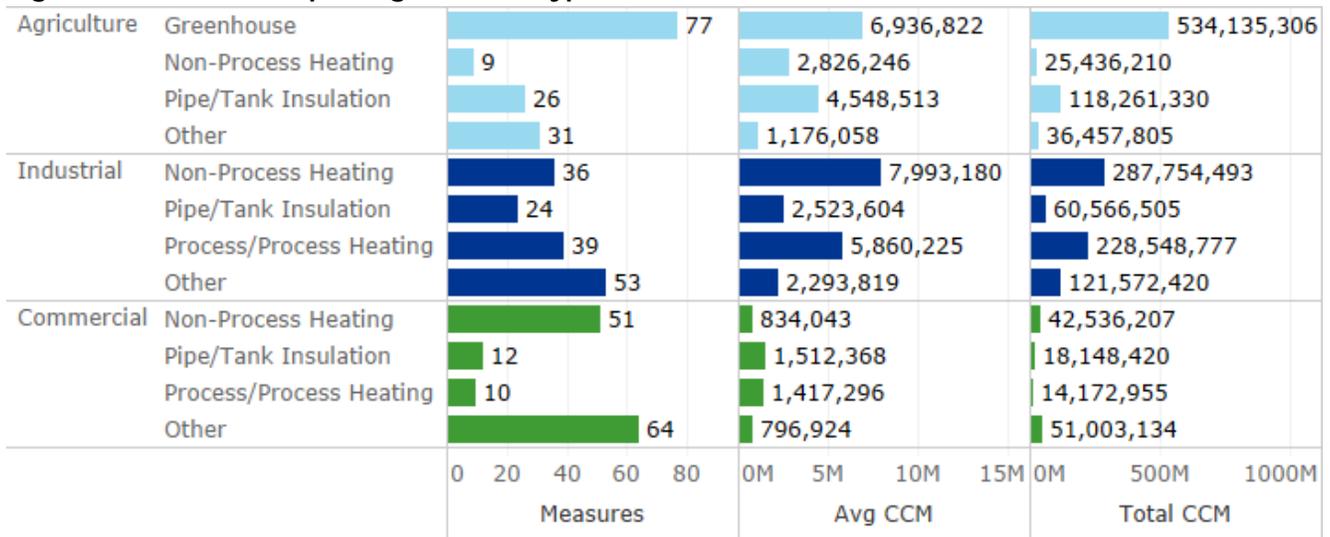


Table 41: Potential reporting measure types - Union CIMF

Segment	Potential Reporting Category	Measures	Average CCM per Measure	Total CCM
Agriculture	Greenhouse	77	6,936,822	534,135,306
	Non-Process Heating	9	2,826,246	25,436,210
	Pipe/Tank Insulation	26	4,548,513	118,261,330
	Other	31	1,176,058	36,457,805
Industrial	Non-Process Heating	36	7,993,180	287,754,493
	Pipe/Tank Insulation	24	2,523,604	60,566,505
	Process and Process Heating	39	5,860,225	228,548,777
	Other	53	2,293,819	121,572,420
Commercial and MR MF	Non-Process Heating	51	834,043	42,536,207
	Pipe/Tank Insulation	12	1,512,368	18,148,420
	Process and Process Heating	10	1,417,296	14,172,955
	Other	64	796,924	51,003,134
Total Union CIMF		432	38,719,099	1,538,593,562

Union Large Volume

All savings in this section and throughout the Union Large Volume sample design include influence correction factors as sampling was done prior to having non-influence corrected savings. Figure 17 and Table 42 provide an overview of the number of measures, average measure size and total CCM for each segment. The number of projects in Large Volume are low enough that it is unlikely we will be able to disaggregate into reporting categories after the analysis.

Figure 17: High level view - Union Large Volume Program



Table 42: High level view - Union Large Volume Program

Segment	Measures	Average CCM per Measure	Total CCM
Large Volume	55	13,679,693	752,383,093

Enbridge CIMF

The Industrial segment of the Enbridge CIMF program makes up more than half of the savings in the program and less than one quarter of the measures. Figure 18 and Table 43 provide an overview of the number of measures, average measure size in CCM and total CCM for each segment.

Figure 18: High level view of Enbridge CIMF Program

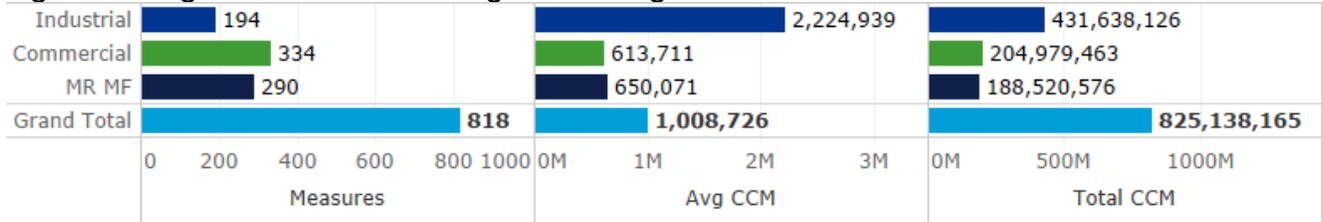


Table 43: High level view of Enbridge CIMF Program

Segment	Measures	Average CCM per Measure	Total CCM
Industrial	194	2,224,939	431,638,126
Commercial	334	613,711	204,979,463
MR MF	290	650,071	188,520,576
Total Enbridge CIMF	818	1,008,726	825,138,165

Distributions of the major measure types are shown in Figure 19 and Table 44. This figure shows that each segment has different dominant measure types that we hoped would have sufficient precision to report as separate domains.

Figure 19: Potential reporting measure types - Enbridge CIMF

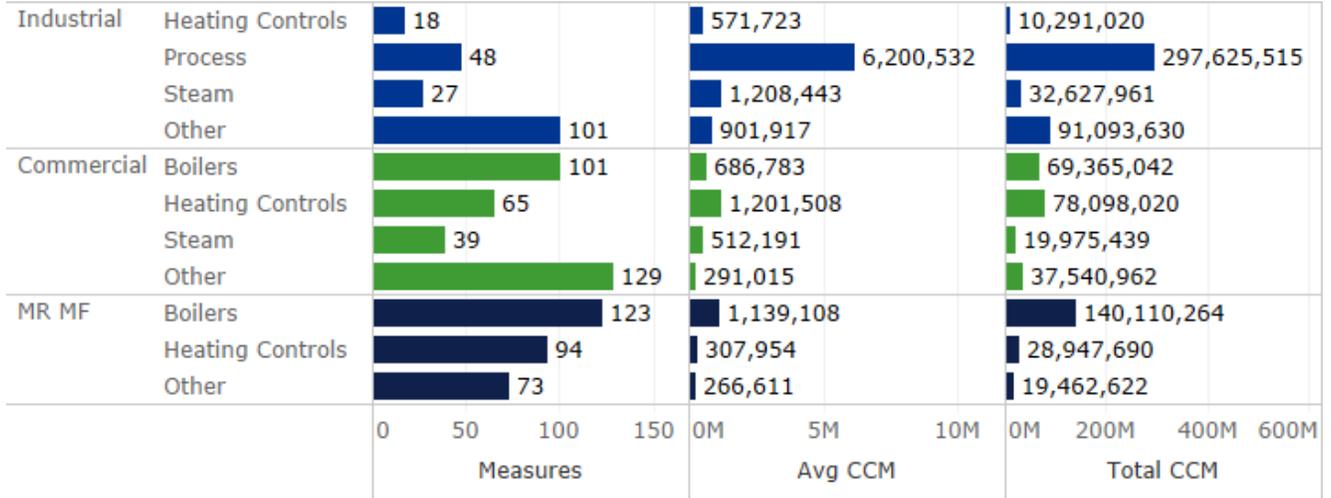


Table 44: Potential reporting measure types - Enbridge CIMF

Segment	Potential Reporting Category	Measures	Average CCM per Measure	Total CCM
Industrial	Heating Controls	18	571,723	10,291,020
	Process	48	6,200,532	297,625,515
	Steam	27	1,208,443	32,627,961
	Other	101	901,917.13	91,093,630
Commercial	Boilers	101	686,783	69,365,042
	Heating Controls	65	1,201,508	78,098,020
	Steam	39	512,191	19,975,439
	Other	129	291,015	37,540,962
MR MF	Boilers	123	1,139,108	140,110,264
	Heating Controls	94	307,954	28,947,690
	Other	73	266,611	19,462,622
Total Enbridge CIMF		818	1,008,726	825,138,165

Define the Unit of Analysis

In the 2015 CPSV/NTG study, the evaluation combined multiple similar measures for a customer into a single unit of analysis primarily as a way of reducing data collection burden during the NTG surveys. For 2016, NTG is not included in the project scope, so we did not employ the aggregation step and instead defined the unit of analysis as a row in the tracking data provided, which we defined as a measure.

Stratify the CPSV Data

For the 2016 gross savings verification effort, DNV GL stratified by:

- **Segment (Industrial vs. Commercial vs. Multifamily or Agriculture).** The 2015 gross savings verification found that there were differences in variability for the gross realization rates by segment, which is an indication that stratifying by segment should improve precision (relative to not using segment) for a given sample size. Segments were clearly defined in the tracking data¹⁵ and the evaluation uses these definitions.
- **Measure size (CCM).** Within each segment, up to six size strata were assigned. The number of size strata within the categorical groupings were limited to ensure a minimum number of target completes per strata, with the exception of the largest strata which may only have one to three sites in the population for some groupings.

Preliminary samples were developed using two other stratification levels, each of which was employed to reduce budget risk for the evaluation. These categories were not ultimately used in the final sample design for this evaluation, but they will be used in setting the verification rigour and data collection method for sites. Our test of the sample design without the categories produced a sample and backup sample selection that sufficiently limits risk without stratification by these categories.

- **Rigour (Standard vs. High).** Stratifying by evaluation rigour level allows the evaluation to more accurately estimate costs based on the effort required to verify the measure. The preliminary rigour level for each measure was determined based on the complexity of calculation, the size of the individual measure and the proportion of program savings from measures of its type.
- **Data collection method (On-site vs. TSER).** Stratifying by data collection method also provides more evaluation cost certainty. For some measure types it is important for verification to view the measure on-site and observe specific aspects of operations, while for other measures a phone verification can adequately collect the necessary information to verify key inputs. The preliminary assignment of data collection method for each site was determined based on our judgement of the value of on-site verification relative to phone verification for the measure. All sites that were assigned high rigour were defaulted to on-site data collection as part of the rigour definition.

Stratification for the three programs are shown in Figure 20, Figure 21, and Figure 22 (Table 45, Table 46, and Table 47). The strata with the smallest measures are to the left (Sky Blue) with each stratum further to the right having progressively larger measures. Size is relative within each categorical grouping: for example, the largest measures in stratum 3 in the Union Commercial group may be (and in this case, are) smaller than those in stratum 2 for the Union Industrial group. Each stratum within a group has similar total

¹⁵ Enbridge variable: "Market_Type" distinguishes all three segments; Union variable "Service Class (for Avoided Costs)" distinguishes Industrial and Commercial, while "building type" was used to separate multifamily from commercial.

savings amounts, except for the largest stratum, which often contains a small number of very large projects whose total savings are greater than the other strata for the segment. At the same time, smaller strata have more measures.

Figure 20: Stratification for Union CI&MF

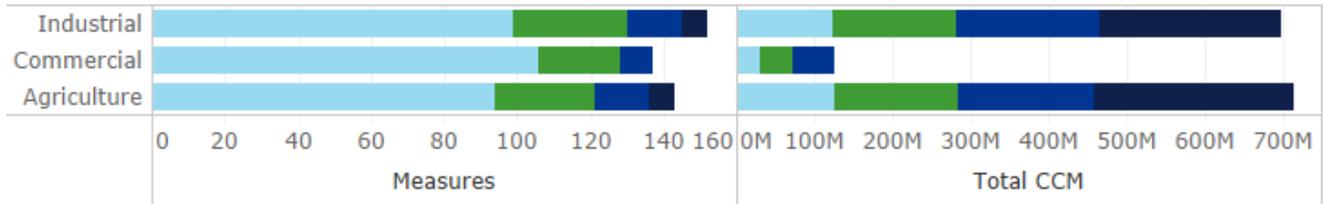


Table 45: Stratification for Union CI&MF

Segment	Size Stratum	Measures	Total CCM
Agriculture	1	94	125,520,095
	2	27	158,914,347
	3	15	174,558,203
	4	7	255,298,006
	5	0	0
Industrial	1	99	124,141,861
	2	31	157,704,435
	3	15	184,879,999
	4	7	231,715,900
	5	0	0
Commercial	1	106	29,769,001
	2	22	41,330,575
	3	9	54,761,140
	4	0	0
	5	0	0
Total Union CIMF		432	1,538,593,562

Figure 21: Stratification for Union Large Volume

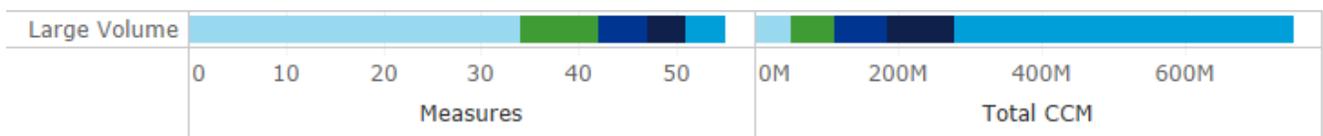


Table 46: Stratification for Union Large Volume

Segment	Size Stratum	Measures	Total CCM
Large Volume	1	34	50,827,042
	2	8	61,052,789
	3	5	72,082,797
	4	4	95,413,460
	5	4	473,007,005
Total Large Volume		55	752,383,093

Figure 22: Stratification for Enbridge CI & MF

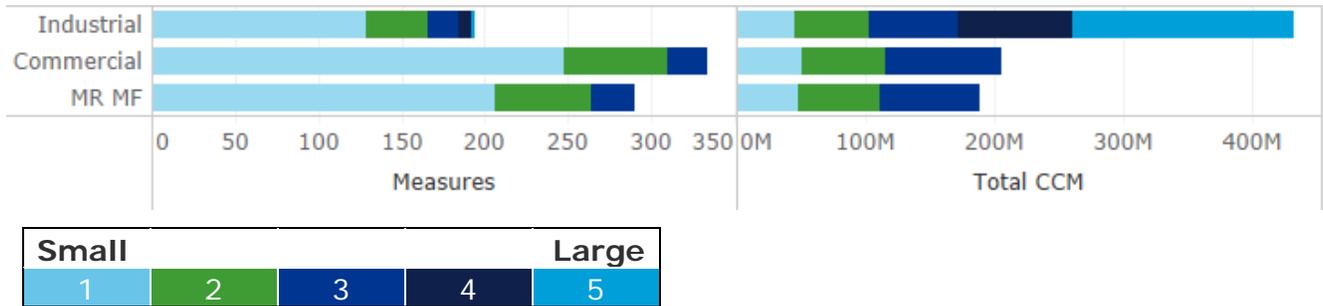


Table 47: Stratification for Enbridge CI & MF

Segment	Size Stratum	Measures	Total CCM
Industrial	1	129	45,359,137
	2	37	57,258,581
	3	18	68,495,230
	4	8	88,822,378
	5	2	171,702,800
Commercial	1	247	50,012,116
	2	63	65,850,731
	3	24	89,116,616
	4	0	0
	5	0	0
MR MF	1	206	48,048,524
	2	58	62,697,336
	3	26	77,774,716
	4	0	0
	5	0	0
Total Enbridge CIMF		818	825,138,165

Design the Samples

Table 48 shows the estimated error ratio (ER)¹⁶ used in the sample design. The ER's used are based on an average of the 2015 CPSV results and 2015 assumption for complex measures (0.4). We further bounded

¹⁶ Another term for error ratio is coefficient of variance (CV)

the ER, that is we would not use a ER less than 0.25 or greater than 0.60 in order to limit the risk of over or under collecting data. The upper bound was used on the Large Volume ER.

Table 48: Estimated error ratio used in sample designs

Utility	Program	Segment	ER
Enbridge	CI&MF	Industrial	0.26
		Commercial & MF	0.58
Union	CI&MF	Agriculture	0.33
		Industrial	0.33
		Commercial & MF	0.50
	Large Volume	0.60	

The samples were designed to meet a 10% relative precision at 90% confidence threshold for each program. Table 49 shows the number of measures in the sample frame, the targeted sample size and the anticipated relative precision for each program. Figure 23, Figure 24, and Figure 25 (Table 50, Table 51, and Table 52) show the sample design for the programs. The figures show how the larger strata tend to have a higher sampling rate than the smaller strata. For example, for Enbridge Industrial, the largest stratum, #5 was sampled with certainty (all measures and savings are green), while the stratum with the smallest measures, #1 was sampled at a lower rate, (the majority of measures and savings in the stratum are sky blue). Measures within each stratum were selected randomly.

Table 49: Sample size and anticipated precision for each program

Utility	Program	Sample Frame (N)	Sample Size (n)	Anticipated Relative Precision @ 90% Confidence
Enbridge	CIMF	818	48	10%
Union	CIMF	432	44	10%
	Large Volume	55	18	9%

Figure 23: Sample Design – Union CIMF

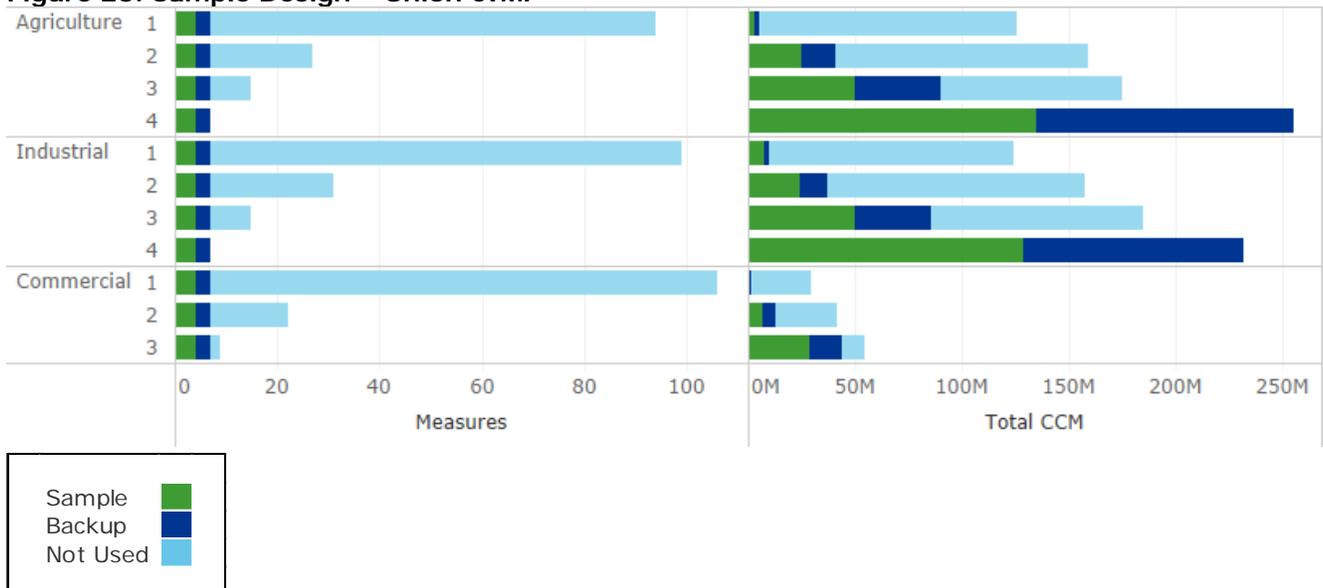


Table 50: Sample Design – Union CIMF

Segment	Stratum	Measures			Total CCM		
		Sample	Backup	Not Used	Sample	Backup	Not Used
Agriculture	1	4	3	87	3,138,035	2,194,205	120,187,855
	2	4	3	20	24,701,684	15,961,575	118,251,088
	3	4	3	8	49,965,990	40,081,372	84,510,841
	4	4	3	0	134,482,472	120,815,534	0
	5	0	0	0	0	0	0
Industrial	1	4	3	92	7,567,200	2,268,090	114,306,571
	2	4	3	24	24,048,780	13,157,365	120,498,290
	3	4	3	8	49,718,955	36,164,520	98,996,524
	4	4	3	0	128,636,380	103,079,520	0
	5	0	0	0	0	0	0
Commercial	1	4	3	99	663,370	581,480	28,524,151
	2	4	3	15	6,770,020	5,952,395	28,608,160
	3	4	3	2	28,933,420	14,670,580	11,157,140
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
Total Union CIMF		44	33	355	458,626,306	354,926,636	725,040,620

Figure 24: Sample Design – Union Large Volume

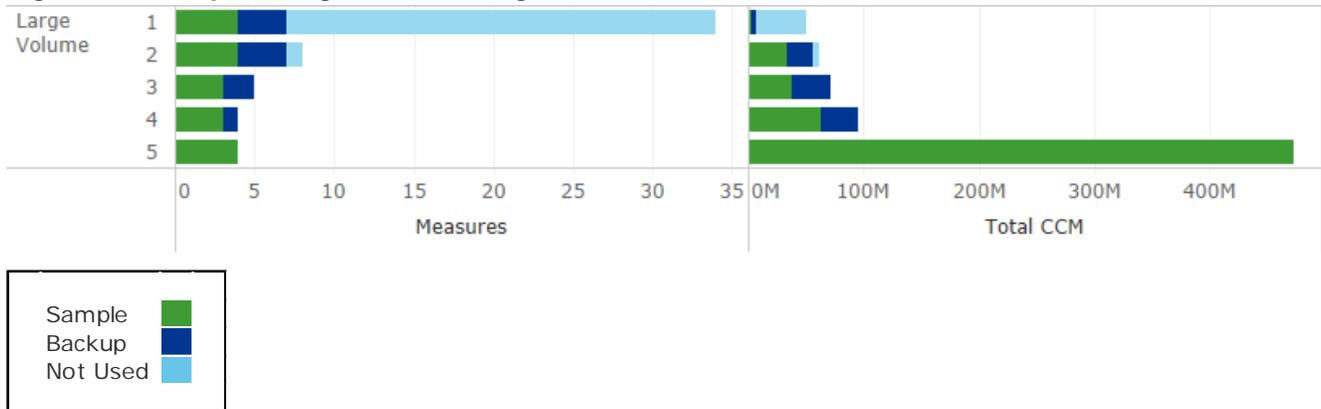


Table 51: Sample Design – Union Large Volume

Segment	Stratum	Measures			Total CCM		
		Sample	Backup	Not Used	Sample	Backup	Not Used
Large Volume	1	4	3	27	2,470,650	4,049,170	44,307,222
Large Volume	2	4	3	1	33,578,637	21,969,692	5,504,460
Large Volume	3	3	2	0	38,400,057	33,682,740	0
Large Volume	4	3	1	0	63,401,880	32,011,580	0
Large Volume	5	4	0	0	473,007,005	0	0
Total Large Volume		18	9	28	610,858,229	91,713,182	49,811,682

Figure 25: Sample Design – Enbridge CIMF

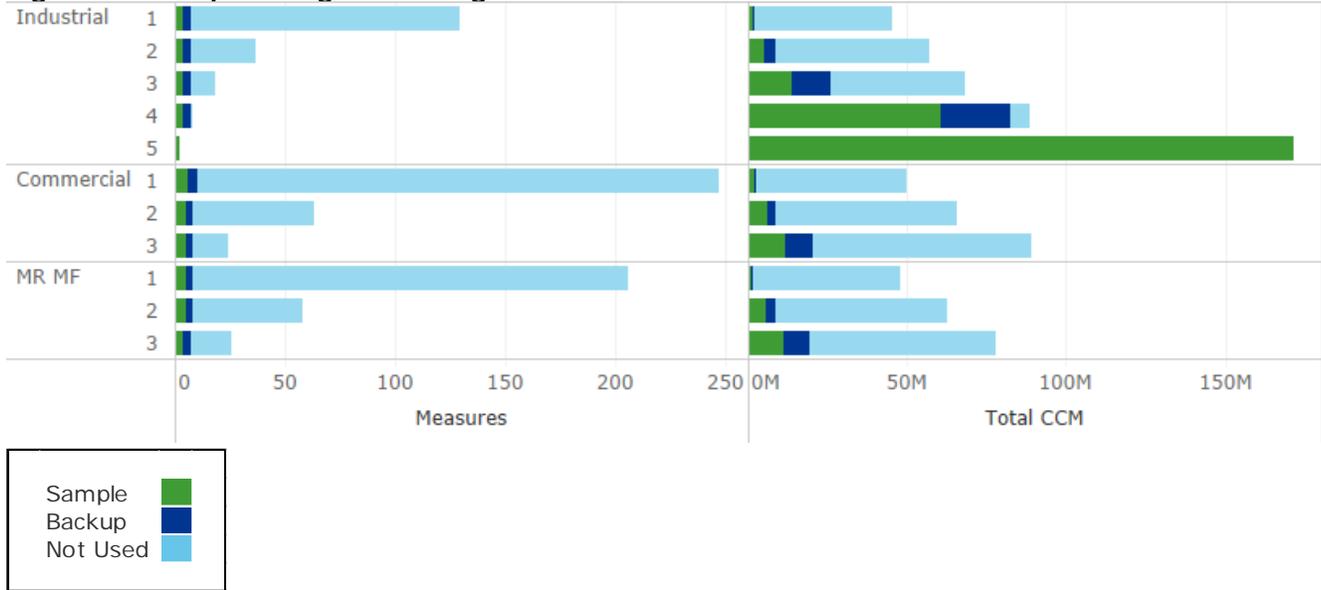


Table 52: Sample Design – Enbridge CIMF

Segment	Stratum	Measures			Total CCM		
		Sample	Backup	Not Used	Sample	Backup	Not Used
Industrial	1	4	3	122	1,718,210	565,197	43,075,730
	2	4	3	30	5,337,405	3,547,950	48,373,226
	3	4	3	11	13,787,335	12,140,840	42,567,055
	4	4	3	1	60,570,695	22,149,023	6,102,660
	5	2	0	0	171,702,800	0	0
Commercial	1	6	4	237	1,885,751	529,830	47,596,535
	2	5	3	55	5,987,410	2,569,850	57,293,471
	3	5	3	16	11,849,840	8,614,951	68,651,825
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
MR MF	1	5	3	198	922,195	671,025	46,455,304
	2	5	3	50	5,353,600	3,378,865	53,964,871
	3	4	3	19	11,215,147	8,084,875	58,474,694
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
Total Enbridge CIMF		48	31	739	290,330,388	62,252,406	472,555,371

Prepare the Sample and Backup Sample

We submitted a documentation request to the utilities when we delivered the final scope of work. For the 2016 CPSV sample, we requested documentation and contact information for 75% more measures than were in the primary sample (by stratum, rounded down to the nearest integer). The 75% additional constitutes the initial backup for the CPSV sample. This provided a small buffer beyond the minimum 60% response rate.

Backups for each sampled site/contact were only contacted if needed to meet the targeted number of completes.

Once we received the requested contact information, we identified instances where a contact was involved in multiple measures, even across sites. While the engineering reviews are conducted at the site level, the technical expert may have been involved in measures at multiple sites. Using this contact information and taking into account cross-site involvement, we assembled the sample frame. Table 53 shows the number of sample and backup measures for each program.

Table 53: Sample and backup sample totals by program

Utility	Program	Sample	Backup	Grand Total
Enbridge	CIMF	48	31	79
Union	CIMF	44	33	77
	Large Volume	18	9	27
	Union Total	62	42	104

Table 54 shows our anticipated completes by rigour and data collection method. The sample design did not have explicit targets for rigour or data collection method, so the final totals collected were expected to be different than what is shown in the table. Note that while rigour was specific to measure, sites selected for both TSER and on-site measures received an on-site.

Table 54: Sample totals by Program, Rigour and Data Collection Method

Utility	Program	Rigour - Data Collection Method	Measures	Sites*	Total Sample CCM
Enbridge	CIMF	High – On-site	12	9	247,585,630
		Standard – On-site	8	8	7,419,945
		Standard - TSER	28	27	35,324,813
Union	CIMF	High – On-site	18	18	345,975,616
		Standard – On-site	10	10	25,753,345
		Standard - TSER	16	16	86,897,345
	Large Volume	High – On-site	6	5	299,162,147
		Standard – On-site	12	8	311,696,082

*Because one site can have measures in different categories, the total sites reported in this table are greater than the total number of sites in the primary sample overall (referenced later): there are 94 sites in the primary sample, while the total in the site column of this table is 101.

APPENDIX E SAMPLE EXPANSION AND RATIO ESTIMATION

Sample Weights

This appendix describes how we calculate the sample weights for each stratum. In lay terms, the weight is simply the number of units in the sample frame (N) divided by the number of completed units in the sample (n). The interpretation of the weight is that each completed sample unit represents N/n units in the population (sample frame).

Notation:

N_x = number of units of analysis in stratum X

n_x = number of completed sample units of analysis in stratum X

The weight W_x is calculated as

$$W_x = N_x / n_x$$

We can understand the weight as meaning the response for one sampled unit in stratum X is representative of W_x units in the population. Table 55 shows a simple example. In the example, we completed 2 surveys with participants in the “North” and 10 surveys with participants in the “South.” The weight for the “Northerners” is greater than that of the “Southerners,” but because we completed more surveys with “Southerners” the combined weight of the “South” will be in proportion to its share of the population (both the population and sum of weights is 20).

Table 55: Example Sample Weights

Stratum Definition	Sample Frame (N)	Sample Completes (n)	Weight (W)	Interpretation
North	10	2	5 = 10/2	Each response represents 5 Northern participants
South	20	10	2 = 20/10	Each response represents 2 Southern participants

Without sample weights, the data collected from the “North” would be 17% (2/12) of the final result, while with weights, the “North” is 33% (10/30). The un-weighted result would be less accurate than the weighted result if the measured value differs along North/South lines. For example, if the “North” is more conservative than the “South” then political surveys without sample weights would end up with inaccurate results. If responding to surveys is negatively correlated with conservatism, then the weights help correct for the systemic bias in response rates.

The sample weight associated with an observation is consistent regardless of the segmentation of the data that we report by (reporting domains). This means that we can segment the data multiple ways in the report, with the final overall results consistent no matter the domain.

Special Cases

There are some special cases where the sample weight for a measure needs to be set to one (1) in order to use the data collected without biasing the result. Our sample designs target measures within a site and sample weights are developed at that level as well. When we collect data from a customer we will collect



data on all of a customer's sampled and primary backup measures in a single interview or site visit. This maximizes the data collected on each customer contact, without overburdening multi-measure customers, but can require special handling to ensure that extra data collected does not bias the sample. In this verification, all customers randomly selected into the sample and backup had contact attempted, so there were no instances where a measure was treated a special case for the reason described here.

Ratio Estimation

The calculation of the adjustment factors for tracking system gross savings uses appropriate case weights corresponding to the sampling rate as discussed above.

This evaluation will only produce new values for the gross realization rate (influence correction factors, engineering verification factors and gross realization rates) shown in this appendix. Net-to-gross ratios will be determined outside of the scope of this study. The NTG ratios are included in this appendix to provide the full picture of net savings calculation using ratio estimation.

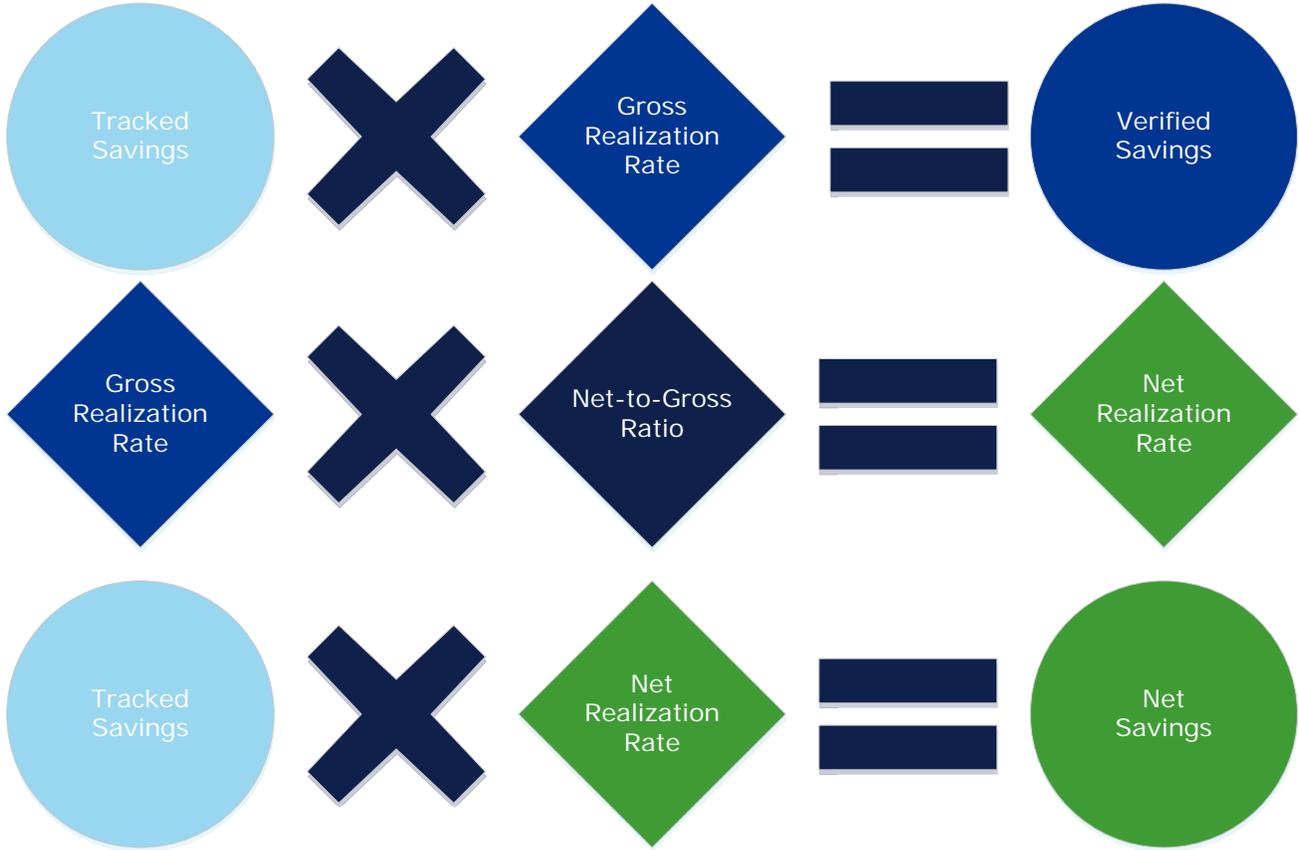
For an individual measure:

- The engineering verification factor is derived from the data collected during the participant survey data collection for TSER projects and through the on-site visits for other projects. Differences between the reported measure and the measure installed at the facility are accounted for here. The engineering adjustment factor is the ratio of the evaluator-verified savings to the program-reported savings.

The majority of the CPSV process involves determining the evaluator-verified savings estimate for each measure. The measure-level results are then combined using weights from the sample design to an overall adjustment factor.

Individual measure results are expanded to the estimate population savings (circles) using ratios (diamonds), as shown in Figure 26. Ratios are applied for each of the primary reporting domains and then summed to calculate the total for the program overall. For programs without an influence correction factor, the gross realization rate is calculated directly from the sample verified and tracked savings (as described below).

Figure 26: Ratios used to estimate verified and net savings



Two general ratio calculation approaches are employed: directly calculated and combined. The description of the process is easiest to understand through an example. The example below has three directly calculated adjustment factors: the installation rate, the engineering adjustment, and the net-to-gross factor. Each of these is calculated as a ratio estimator over the sample of interest (Cochran, 1977, p.165). The formulas for these factors are given below.

Notation: The following terms are used in calculating the adjustment factors:

- G_{Tj} = tracking estimate of gross savings for measure j
- G_{Ej} = engineer verified estimate of gross savings for measure j ,
- w_{Vj} = weighting factor for measure j used to expand the CPSV sample to the full population
- V = number of measures in the CPSV sample

The gross realization rate is calculated directly:

$$R_V = \frac{\sum_{j=1}^V G_{Ej}w_{Vj}}{\sum_{j=1}^V G_{Tj}w_{Vj}}$$

Ratio Estimation Example

This section provides an example of the ratio estimation procedure. The results in this section are for explanatory purposes only.

The installed savings, and engineering verified savings, are calculated at the measure level and summed to the Measure Type level for each customer in the sample that completed a survey. Attribution is collected at the measure type level and is a function of the verified measure type savings for the customer. The sample weights are applied to the measure type level savings which is the unit of analysis. Table 56 shows the reported, installed and verified savings and NTG for Example Customer A's four measures reported in the program tracking database.

Table 56: Example Customer A in CPSV and NTG Sample

Measures	Measure Type	Reported m3	Installed m3	Verified m3	NTG
Space Heat Boiler 1	Space Heat	80,000	80,000	100,000	100%
Space Heat Boiler 2	Space Heat	56,000	56,000	55,000	
Process Heat	Process Heat	150,000	150,000	120,000	80%
Steam Trap Repair	Maintenance	12,000	12,000	14,000	20%

DNV GL engineers confirmed the customer installed all of the measures that were reported by the program; therefore, installed savings are equal to the reported savings. If a measure was initially reported as not installed, a second DNV GL engineer would contact the customer to verify this result. The engineering review produced adjustments to the installed savings for the first three of Customer A's reported measures, resulting in differences between the verified gross savings and installed savings for those measures.

The attribution rate is calculated for each measure type using the customer and supplier survey, if applicable, for Example Customer A using the methods that will be provided with the survey instruments. The measure type level attribution rates are then applied to the aggregated measure type level verified gross savings to estimate measure level net savings. Example Customer A received 100% attribution for the two space heat measures, 80% attribution for the process heat measure, and 20% attribution for the maintenance measure. Table 57 shows the verified gross and net savings for Example Customer A.

Table 57: Example Customer A Net Savings

Measure Type	Verified m3	NTG	Net m3
Space Heat	155,000	100%	155,000
Process Heat	120,000	80%	96,000
Maintenance	14,000	20%	2,800

Similar estimates are created for each customer in the sample. For this example, we assume Example Customers A to F comprise the Industrial Sector sample. Table 58 shows the un-weighted customer and commercial sector savings results.

Table 58: Example Industrial Sector Measure Type Level Sample

Customer	Measure Type	Reported m3	Installed m3	Verified m3	Net m3
A	Space Heat	136,000	136,000	155,000	155,000
A	Process Heat	150,000	150,000	120,000	96,000

A	Maintenance	12,000	12,000	14,000	2,800
B	Process Heat	250,000	250,000	180,000	180,000
B	Maintenance	20,000	20,000	14,000	0
C	Space Heat	150,000	150,000	140,000	35,000
D	Process Heat	80,000	80,000	81,000	81,000
E	Space Heat	70,000	70,000	70,000	0
F	Space Heat	14,000	14,000	13,000	0

Each customer in the sample frame is assigned to a sampling stratum as described in the sampling plan. Each customer in the sample is assigned a sampling weight based on the sample design and the number of completed sample points in each stratum. Assume that Example Customers A and C each have a space heat measure in a stratum that has four measures in the sample frame. The sampling weight for the space heat measures for Customers A and C is equal to the number of customers in the sample frame stratum divided by the number of stratum customers in the sample, or $4/2 = 2$. The weighted savings for each customer is equal to the weight times the savings value. Table 59 shows the weights and savings (un-weighted and weighted) for each customer in the Example Industrial Sector if we assume the measure type weights shown.

Table 59: Example Industrial Sector Measure Type Level Weighted Savings

Customer	Measure Type	Weight	Reported m3		Installed m3		Verified m3		Net m3	
			unweighted	weighted	unweighted	weighted	unweighted	weighted	unweighted	weighted
A	Space Heat	2	136,000	272,000	136,000	272,000	155,000	310,000	155,000	310,000
A	Process Heat	3.5	150,000	525,000	150,000	525,000	120,000	420,000	96,000	336,000
A	Maintenance	20	12,000	240,000	12,000	240,000	14,000	280,000	2,800	56,000
B	Process Heat	1	250,000	250,000	250,000	250,000	180,000	180,000	180,000	180,000
B	Maintenance	18	20,000	360,000	20,000	360,000	14,000	252,000	0	0
C	Space Heat	2	150,000	300,000	150,000	300,000	140,000	280,000	35,000	70,000
D	Process Heat	3.5	80,000	280,000	80,000	280,000	81,000	283,500	81,000	283,500
E	Space Heat	15	70,000	1,050,000	70,000	1,050,000	70,000	1,050,000	0	0
F	Space Heat	25	14,000	350,000	14,000	350,000	13,000	325,000	0	0

The next step is to determine program overall adjustment factors. For kWh the Industrial Sector the installation rate, engineering verification factor, and attribution adjustment factor are:

$$3,627,000 \text{ weighted installed m}^3 / 3,627,000 \text{ weighted reported m}^3 = 100\% \text{ installation rate}$$

$$3,380,500 \text{ weighted verified gross m}^3 / 3,627,000 \text{ weighted installed m}^3 = 93.2\% \text{ eng. verification factor}$$

$$1,235,500 \text{ weighted net m}^3 / 3,380,500 \text{ weighted verified gross m}^3 = 36.5\% \text{ attribution adjustment.}$$

The verified gross realization rate (RR) is the product of the installation rate and the engineering verification factor, or $100\% \text{ times } 93.2\% = 93.2\%$ for this example. The net RR is the product of the verified gross RR and the attribution adjustment, or $93.2\% \text{ times } 36.5\% = 34\%$ for this example.

The same principle can be applied to each Measure Type to get the Measure Type level adjustment factors. With the unit of analysis remaining the same (at the measure type level), the same process can be used to produce adjustment factors for any domain that we are able to define for the whole sample.

Applying Ratios to Domains

Ration application refers to multiplying the gross RR and net RR times the program tracking savings to produce the total verified and net savings results for a program.

The general formula for total verified gross savings is:



The general formula for total net savings is:



The body of the report discusses how to calculate the population adjustment factors, which are based on a finite, fixed distribution of projects. You can also calculate for subsets, called domains. Viewing domain-level results allows for insights into program performance that can lead to program improvements. Domain-level ratios can also be used to apply ratios and calculate overall program savings totals. The ratio results will be generated for each of the domains of interest (subsets of the population that stakeholders agree are important) and overall for each of the utilities' programs.

The level at which one applies the ratios has an effect on the overall verified and net savings estimate for each program. There are two basic approaches that we take. The first is to apply the overall program ratio. This is appropriate to retrospective evaluation where the population that the applied ratio is the same as the population of study and is static.

The second is to apply the ratio at the domain level. This is appropriate for all uses and recommended for estimating savings for programs or program years that are not the same as the population of study. Another approach is to apply the ratio at the stratum level. This is really a subset of the domain application approach where the domain used is the sample strata.

We recommend applying ratios by domains in most cases in order to improve accuracy. Assuming a sufficient sample size in each domain, domain-level precisions are usually sufficient for the approach. While 90/10 relative precision is typically the threshold targeted for an overall result, precisions usually have lower threshold for domain-level application as the resulting precision of the overall result will be better than the component parts.

If one domain has an extreme adjustment, the accuracy of the overall result is improved if domain level ratios are applied to the domain level savings. Table 60 shows an example where we apply the gross RR and net RR directly and by domains. The sample weighted savings in the example closely match the population savings: one domain, process heat, is 3.2% different, while the other domains are each within 3% and overall the difference is less than 1%. The ratios and resulting savings are also similar, within one percent of

one another. Though the results in the example are similar, the final net savings are more accurate when calculated by domains. In the example, both space heat and maintenance measures had very different attributions from process heat and each were slightly over-represented in the weighted sample savings, which resulted in lower net savings when we applied the overall ratio directly.

Table 60: Example of Ratios Applied Overall vs. by Domains

Measure Type	A	B	C	D	Verified Gross Savings (A*C)	Net Savings (A*D)
	Population m3	Sample Weighted m3	Gross RR	Net RR		
Space Heat	1,950,000	1,972,000	99.6%	19.3%	1,943,078	375,761
Process Heat	1,090,000	1,055,000	83.7%	75.8%	912,810	826,024
Maintenance	585,000	600,000	88.7%	9.3%	518,700	54,600
Overall - Ratios Applied Directly	3,625,000	3,627,000	93.2%	34.1%	3,378,636	1,234,819
Overall - Ratios Applied by Domains and Summed	3,625,000		93.1%	34.7%	3,374,589	1,256,384
Difference			0.1%	-0.6%	4,047	-21,566

Neither applying the overall ratio directly nor by domains has an inherent systemic bias, but when the differences among the domain ratios are significant, applying by domains results in improved accuracy.

The choice between how to apply the ratios does not affect whether or which domains are reported. There is a large inherent value in looking at program results by multiple domains in order to better understand where the program is doing well and what areas have room for improvement.

Criteria for selecting domains for reporting and application

DNV GL will select the domains that are reported and those that will be applied to estimate gross savings for the programs.

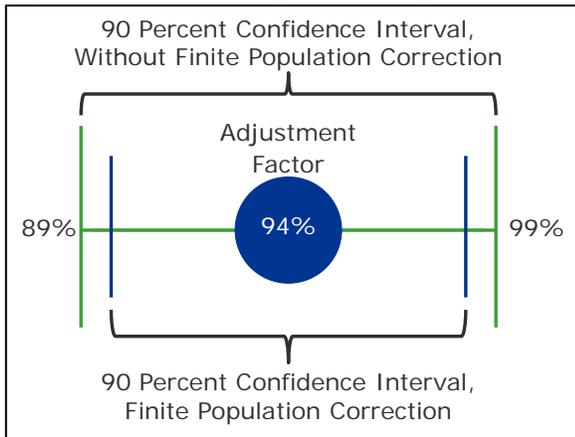
Table 61: Relevant statistics.

Term	Definition
Ratio/Adjustment factor	A point estimate of the evaluation findings expressed as a percent.
+/- or Absolute Precision	If the evaluation were repeated several times selecting samples from the same population, 90% ¹⁷ of the time the ratio would be within this range of the ratio
Confidence interval	The upper bound is defined by the ratio plus the absolute precision. the lower bound is defined by the ratio minus the absolute precision.
Relative Precision	The relative precision is calculated as the absolute precision divided by the ratio itself. By convention, relative precisions are the statistic that are targeted in sampling (ie. 90/10 is a relative precision metric)
Finite population correction (FPC)	FPC is a factor that reduces the measured error of samples drawn from small populations (less than 300). FPC applies when the ratio is applied to the same population from which the sample was drawn.

Figure 27 shows an example:

- the adjustment factor (ratio) as a blue point
- the 90% confidence interval *with finite population correction* (blue)
- the 90% confidence interval *without finite population correction* (green)

Figure 27: Ratio Diagram Example



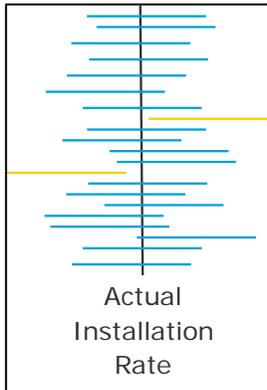
The plus/minus (\pm) error (%) indicated at the 90% confidence interval is the absolute difference between the estimated percentage and the upper or lower confidence bound. For example, in Figure 27, the ratio is 94% and the non-FPC 90% confidence interval is ± 5 percentage points (i.e., $94\% \pm 5\%$).¹⁸ Another way of saying this is that there is a 90% probability that the actual ratio for the next year’s program lies between 89 and 99 percent. Figure 28 demonstrates this concept by showing twenty hypothetical confidence intervals

¹⁷ 90% is the confidence limit that we are using.

¹⁸ The critical value for calculating the confidence interval \pm for each adjustment factor is determined using Student’s t-distribution and n-1 for the degrees of freedom, where n is the sample size. For 2-tailed estimates (ratios that could be above or below 100%) the appropriate t-stat used to calculate precision from the standard error is close to 1.645.

calculated from twenty different samples of the same population. Eighteen out of twenty (90 percent) include the true population ratio.

Figure 28: Ninety Percent Confidence Interval



Note: Each horizontal line represents a confidence interval. Yellow confidence intervals do not include the actual ratio.

The relative precision of the ratio is calculated as $5\%/94\% = 5.3\%$.

For low ratios, relative precisions may be quite high, even when the confidence interval around the ratio is quite narrow. Consider a ratio of 40% with the same 5% absolute precision as in the above example. While the absolute precisions are the same, the latter ratio (40%) has a relative precision of $5\%/40\% = 12.5\%$.

Because relative precisions can over-represent error for low ratios (and under-represent errors for ratios above 100%), we prefer to set thresholds for reporting and application based on the absolute precision rather than the relative precision. Where prospective application (applying the results of a study to a different program year than the one studied) is used, FPC-off errors are appropriate and the thresholds for reporting and application may be relaxed somewhat depending context and needs.

For determining which ratios to report and apply we use the following rules:

- The minimum sample size for a reporting or application domain will be five.
- The absolute precision threshold for reporting ratio for a domain will be +/- 20% at 90% confidence with FPC-on.
- The absolute precision threshold for applying ratio for a domain will be +/- 15% at 90% confidence with FPC-on for retrospective application.
- The absolute precision threshold for applying ratio for a domain will be +/- 20% at 90% confidence with FPC-off for prospective application.

Reporting domains are defined as combinations of categorizations where sample sizes and precisions allow:

- Stratification segments
- Measure types

APPENDIX F SITE LEVEL SAVINGS RESULTS

This appendix provides the verification results for each measure in the sample. For each measure the utility's tracking savings, the verification's verified savings and the realization rate are provided.

Table 62: Site level verification results – Union Custom C&I program

Segment	Measure Type	Measure ID	Utility Tracking CCM	Verified CCM	Realization Rate
Union - CIMF - Agriculture	Greenhouse	UO020-2	48,641,530	54,170,404	111%
		UO012-2	39,116,392	30,148,954	77%
		UO012-1	37,120,678	31,173,952	84%
		UO020-6	27,514,312	29,680,700	108%
		UT051-1	18,201,392	21,464,750	118%
		UT115	11,535,030	8,200,690	71%
		UO020-1	11,149,240	17,449,695	157%
		UO079-2	10,966,780	15,542,020	142%
		UO020-3	7,390,480	7,271,460	98%
		UO032	4,512,144	2,311,654	51%
		UO033	4,329,255	4,382,340	101%
		UO147	892,280	1,022,400	115%
	Other	UT051-2	10,913,200	10,041,060	92%
		UO012-3	8,666,800	8,566,000	99%
		UT053	5,820,460	5,765,480	99%
		UO020-4	2,397,780	2,397,780	100%
		UO079-1	252,840	331,410	131%
UO020-5	99,915	79,515	80%		
Union - CIMF - Commercial	Non-Process Heating	UO057	3,605,900	3,605,900	100%
		UT151	2,916,600	2,433,840	83%
		UT106	937,760	889,304	95%
		UO005	384,100	1,015,300	264%
		UT075	147,270	147,270	100%
		UT111	37,350	37,350	100%
	Process and Process Heating	UO039	4,474,080	4,474,080	100%
		UO127	875,060	910,200	104%
	Other	UO087	13,708,800	15,024,760	110%
		UO114	6,449,960	4,804,200	74%
		UT103	873,760	873,760	100%
UO145		36,850	55,275	150%	

Segment	Measure Type	Measure ID	Utility Tracking CCM	Verified CCM	Realization Rate
Union - CIMF - Industrial	Non-Process Heating	U0049-1	58,686,760	58,686,760	100%
		U0049-2	42,614,540	42,614,540	100%
		U0077	31,693,720	12,835,564	40%
		U0144	28,771,260	15,436,580	54%
		UT080	12,798,940	12,798,940	100%
		U0036	6,453,285	6,453,285	100%
		UT101	3,443,140	3,974,680	115%
	Process and Process Heating	U0141	26,169,600	26,169,600	100%
		U0137	19,511,260	14,722,040	75%
		U0093	11,889,480	13,029,700	110%
		U0040	2,848,400	2,697,040	95%
		U0105	1,704,280	2,093,160	123%
		U0064	289,080	867,240	300%
	Other	UT058	13,852,635	9,512,174	69%
		U0037	11,177,900	19,539,280	175%
		UT082	6,555,260	6,555,260	100%
		U0109	4,801,820	4,801,820	100%
		UT094	3,611,900	3,611,900	100%
		UT150	3,072,300	3,072,300	100%
		UT059	1,357,420	1,266,920	93%

Table 63: Site level verification results – Union Custom Large Volume program

Segment	Measure Type	Measure ID	Utility Tracking CCM	Verified CCM	Realization Rate
Union - Large Volume - Large Volume	All Large Volume	UO136	229,432,213	266,008,380	116%
		UO140-1	97,092,525	57,515,840	59%
		UO066-3	53,352,644	53,352,640	100%
		UO066-2	35,568,422	35,568,420	100%
		UO140-2	34,375,067	33,420,220	97%
		UO008	24,232,533	28,095,700	116%
		UO142	23,280,720	25,305,140	109%
		UO135-1	19,446,180	16,090,040	83%
		UO028-2	13,279,995	23,171,265	174%
		UO066-1	12,896,750	12,801,500	99%
		UO135-2	12,223,312	10,113,744	83%
		UO028-1	11,432,750	12,061,200	105%
		UO131-1	8,420,000	5,927,680	70%
		UO131-3	6,868,070	6,858,000	100%
		UO007-1	6,857,817	6,857,817	100%
		UO135-4	5,113,890	4,336,345	85%
		UO045	1,222,154	1,368,265	112%
		UO131-2	834,732	834,732	100%
UO135-3	93,490	93,489	100%		
UO007-2	85,643	427,720	499%		

Table 64: Site level verification results – Enbridge Custom C&I program

Segment	Measure Type	Measure ID	Utility Tracking CCM	Verified CCM	Realization Rate
Enbridge - CIMF - Commercial	Boilers	ET133-2	1,659,275	1,659,275	100%
		ET006	1,036,375	1,407,000	136%
		ET034	925,450	925,450	100%
		ET047	362,100	362,100	100%
		ET054	349,700	349,700	100%
		ET133-1	61,700	61,700	100%
	Heating Controls	EO097	4,227,660	4,269,930	101%
		EO048	3,028,920	3,391,200	112%
		ET071	2,409,525	2,409,525	100%
		ET112	2,320,620	1,308,150	56%
		EO011	288,195	139,050	48%
		EO001	108,190	87,240	81%
	Steam	ET044	619,416	619,416	100%
	Other	ET134	2,095,350	1,162,350	55%
		ET072	952,755	670,275	70%
		ET046	815,505	1,324,890	162%
ET120		23,760	9,105	38%	
Enbridge - CIMF - Industrial	Process	EO025	87,174,420	103,422,320	119%
		EO089	84,528,380	99,392,000	118%
		EO102	18,882,380	26,735,080	142%
		EO017-3	11,536,320	17,586,040	152%
		EO013-1	11,347,200	9,219,600	81%
		EO042	7,336,260	11,946,580	163%
		EO010-1	4,718,820	511,547	11%
		EO073	4,495,080	1,432,320	32%
		EO017-1	4,389,680	4,285,640	98%
		EO017-2	3,769,170	3,696,880	98%
		EO019	1,558,420	526,720	34%
		EO121	1,293,740	326,020	25%
	Steam	ET129	341,706	88,032	26%
		ET015	155,526	168,480	108%
	Other	EO013-2	18,804,795	55,850,860	297%
		EO010-2	2,745,160	349,112	13%
		ET125	1,228,995	1,079,145	88%
		ET061	1,067,445	1,067,445	100%
		EO041	920,100	1,219,440	133%
		ET030	707,675	707,475	100%

Segment	Measure Type	Measure ID	Utility Tracking CCM	Verified CCM	Realization Rate
Enbridge - CIMF - MR MF	Boilers	ET038	3,875,850	3,882,469	100%
		ET148	3,595,850	3,602,596	100%
		ET074	1,957,547	1,619,094	83%
		ET123	1,785,900	1,975,150	111%
		ET128	1,112,350	1,112,350	100%
		ET018	963,985	1,665,150	173%
		ET069	853,425	1,208,850	142%
		EO100-2	484,625	696,765	144%
	Heating Controls	EO078-2	712,170	852,945	120%
		EO149	208,920	181,710	87%
		EO055	189,225	168,195	89%
		EO022	141,285	254,820	180%
		EO078-1	39,180	51,585	132%
	Other	ET016	1,716,795	1,480,140	86%
EO100-1		67,880	91,780	135%	



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