ONTARIO GAS DSM EVALUATION CONTRACTOR

2015 Natural Gas Demand Side Management Annual Verification

Ontario Energy Board

Date: October 12, 2017

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AUDIT OPINION

The Evaluation Contractor team (DNV GL, Itron, and Dunsky) provides the following opinion on the utility-achieved savings, lost revenue, and shareholder incentive for the calendar year ended December 31, 2015. 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	Union Result	Enbridge Result
Shareholder Incentive	$7,039,894	$6,489,467
Lost Revenue	$151,791	$16,155
Verified Net Cumulative Savings	1,137,825,562 m^3	547,755,978 m^3
Total Dollars Spent (not reviewed)	$32,178,766	$35,779,973
Cost Effectiveness (TRC test)	2.9	2.2

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) programs[1] delivered in 2015. These verifications were conducted by the Evaluation Contractor (EC) team.

The annual verification assembles the results of all evaluation studies conducted on the 2015 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 Adjustment Mechanism (LRAM), DSM Variance Account (DSMVA), and DSM Shareholder Incentive (DSMSI) 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 DSMSI and LRAM amounts.
- Recommend changes to improve input assumptions, verification procedures, and the overall verification process.

1.1 Method summary

To verify the utility scorecard metrics discussed in the following sections, the EC conducted the activities listed below. To prepare for the program-specific activities, the EC requested tracking data and, where necessary, documentation for a sample of projects or participants from the utilities. The EC completed program-specific verifications and used the results to calculate the DSMSI and LRAM for both Enbridge and Union. We also calculated cost-effectiveness and reported program spending. The verification activities included:

- **Custom project savings:** Apply the results of the completed custom project savings verification (CPSV) of custom commercial, industrial, and Large Volume programs, which included a free ridership component, and include a provisional estimate for spillover.
- **Prescriptive project savings:** Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for the full population of measures.
- **Residential home retrofit projects:** Verify the savings for a sample of participants.
- **RunitRight projects:** Verify the savings for a sample of participants.
- **Market transformation projects:** Confirm participation status and program qualification for all non-savings metrics.

[1] Throughout this report, the word "program" is used to reflect the OEB's understanding of a program. The utilities define it differently. See APPENDIX M for additional detail.

- **Other projects:** Confirm the number of residential deep savings participants, the percent of C&I whole-building energy use saved by C&I program participants for Union, and the percent of Part 3 Low Income participants in the Low Income Building Management Performance program for Enbridge.

1.2 Results

Table 1-1, Table 1-2, and Table 1-3 show the Union verified savings, DSMSI, and LRAM results, respectively. Table 1-4 shows the cost-effectiveness ratio results for Union, and Table 1-5 shows the net present value for Union. Table 1-6 through Table 1-10 show the same information for Enbridge. All utility-defined programs pass the TRC, TRC-Plus, and PAC tests.

Table 1-1. Union verified savings results

Program	Draft Utility-Reported Savings*		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Resource Acquisition						
Home Reno Rebate	69,321,370	58,923,165	98%	85%	67,934,943	57,744,701
Energy Savings Kit	22,398,052	19,567,373	75%	88%	16,882,059	14,800,935
Total Residential	91,719,422	78,490,538	92%	86%	84,817,002	72,545,636
C&I Custom	1,473,918,718	678,002,610	98%	44%	1,443,912,081	635,817,233
C&I Prescriptive	208,919,006	182,411,887	100%	87%	208,919,006	182,411,887
Total C&I	1,682,837,724	860,414,497	98%	50%	1,652,831,087	818,229,120
Total Resource Acquisition	**1,774,557,146**	**938,905,035**	**98%**	**51%**	**1,737,648,089**	**890,774,755**
Large Volume						
Large Volume	1,253,971,028	578,023,195	135%	12%	1,691,806,721	194,870,020
Total Large Volume	**1,253,971,028**	**578,023,195**	**135%**	**12%**	**1,691,806,721**	**194,870,020**
Low Income						
Single Family (Part 9)	33,505,239	33,504,841	107%	100%	35,847,824	35,847,426
Multi-family (Part 3)	17,840,732	16,948,695	96%	95%	17,193,011	16,333,361
Total Low Income	**51,345,971**	**50,453,536**	**103%**	**98%**	**53,040,835**	**52,180,787**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
†These values are rounded.

Table 1-2. Union DSMSI results

Scorecard	Draft Utility-Reported DSMSI*	DSMSI
Resource Acquisition	$4,776,312	$4,010,638
Low Income	$2,192,257	$2,462,534
Large Volume	$0	$0
Market Transformation	$566,721	$566,721
Total	**$7,535,290**	**$7,039,894**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.

Table 1-3. Union LRAM results

Rate Class	Utility-Reported Draft LRAM	Verified LRAM
M4 Industrial	$77,105	$73,713
M5 Industrial	$38,366	$36,565
M7 Industrial	$33,512	$31,937
T1 Industrial	$2,789	$777
T2 Industrial	$1,050	$389
20 Industrial	$7,002	$6,845
100 Industrial	$5,578	$1,565
Total	**$165,411**	**$151,791**

Table 1-4. Union summary of cost-effectiveness ratio results

Scorecard	Draft using Utility-Reported Savings*			Final Verified Ratio		
	TRC	TRC-Plus**	PAC**	TRC	TRC-Plus	PAC
Residential Resource Acquisition	1.2	3.0	8.0	1.0	1.2	2.3
Commercial and Industrial Resource Acquisition	2.9			3.3	3.8	12.0
Low Income	1.0	1.1	0.9	1.3	1.4	1.1
Large Volume	4.7	5.4	26.3	6.0	6.9	10.2
Total Portfolio	**2.9**	**3.3**	**8.1**	**2.9**	**3.3**	**6.8**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results for the entire Resource Acquisition scorecard. Union only reported TRC in its filings for 2015.

Table 1-5. 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	TRC-Plus**	PAC**	TRC	TRC-Plus	PAC
Residential Resource Acquisition	96.7	120.4	117.9	0.4	2.6	6.8
Commercial and Industrial Resource Acquisition				105.4	128.0	124.7
Low Income	(0.02)	1.0	(1.1)	1.7	3.1	0.6
Large Volume	70.2	83.6	81.1	27.6	32.6	29.4
Total Portfolio	**166.9**	**205.1**	**197.9**	**135.2**	**166.3**	**161.5**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

Table 1-6. Enbridge verified savings results

Program	Draft Utility-Reported Savings*		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate**†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Resource Acquisition						
Home Energy Conservation	120,488,487	102,415,214	100%	85%	120,488,487	102,415,214
Total Residential	120,488,487	102,415,214	100%	85%	120,488,487	102,415,214
C&I Custom	812,730,242	558,925,884	95%	31%	773,928,967	240,326,475
C&I Prescriptive	128,765,764	106,286,730	98%	85%	125,724,435	106,455,571
Total C&I	941,496,006	665,212,614	96%	39%	899,653,401†	346,782,045†
Total Resource Acquisition	**1,061,984,493**	**767,627,828**	**96%**	**44%**	**1,020,141,888**	**449,197,259**
Low Income						
Single Family (Part 9)	28,410,725	28,343,978	99%	100%	28,067,264	28,132,657
Multi-family (Part 3)	69,505,240	69,226,782	101%	100%	70,147,603	70,426,062
Total Low Income	**97,915,965**	**97,570,760**	**100%**	**100%**	**98,214,867**	**98,558,719**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
†These values are rounded.
** The gross realization rate for C&I prescriptive, single family low income, and multi-family low income includes the removal rate for some measures, which was previously included in the net-to-gross adjustment. See APPENDIX C for more detail.

Table 1-7. Enbridge DSMSI results

Scorecard	Draft Utility-Reported DSMSI*	DSMSI
Resource Acquisition	$6,482,744	$2,632,886
Low Income	$1,724,691	$1,745,422
Residential Savings by Design	$1,076,493	$1,076,493
Commercial Savings by Design	$418,269	$418,269
Home Labelling	$616,397	$616,397
Total	**$10,318,594**	**$6,489,467**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.

Table 1-8. Enbridge LRAM results

Rate Class	Draft Utility-Reported LRAM*	LRAM
110	$18,795	$11,662
115	$6,478	$2,836
135	$330	$239
145	$2,267	$834
170	$953	$584
Total	**$28,822**	**$16,155**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.

Table 1-9. Enbridge summary of cost-effectiveness ratio results

Scorecard	Draft using Utility-Reported Savings*			Final Verified Ratio		
	TRC**	TRC-Plus	PAC	TRC	TRC-Plus	PAC
Resource Acquisition	3.3	3.8	6.0	2.3	2.7	2.7
Low Income	2.1	2.5	2.5	1.7	2.0	1.9
Total Portfolio	**3.1**	**3.6**	**5.2**	**2.2**	**2.6**	**2.5**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Enbridge only reported TRC-Plus and PAC in its filings for 2015.

Table 1-10. Enbridge 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**	TRC-Plus	PAC	TRC	TRC-Plus	PAC
Resource Acquisition	123.2	149.7	120.4	50.1	61.8	40.9
Low Income	9.2	11.8	10.7	6.0	8.1	6.2
Total Portfolio	**132.4**	**161.6**	**131.1**	**56.1**	**69.9**	**47.1**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Enbridge only reported TRC-Plus and PAC in its filings for 2015.

1.3 2015 annual verification recommendations

This section contains a summary of the recommendations from the EC's 2015 annual verification efforts, shown in the tables below. In the tables, the primary outcomes of the 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). The complete findings, recommendations, and outcomes of the 2015 annual verification efforts and other evaluations conducted on 2015 programs are found in section 5.

Table 1-11. Summary of recommendations that apply to the overall annual verification

#	Overall Annual Verification Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
O1A	Consider investing in a relational program tracking database.	✓	✓		✓	✓	✓
O1B	Enbridge should include site-level information for all measures installed through the program.		✓			✓	✓
O2A	Deliver tracking data in a single flat file.	✓	✓		✓	✓	✓
O2B	Consider investing in a relational program tracking database.	✓	✓		✓	✓	✓
O3A	Develop and maintain an electronic summary of the TRM.	✓	✓	✓	✓	✓	✓
O3B	Track prescriptive savings using unique measure descriptions that map to electronic TRM.	✓	✓	✓	✓	✓	✓

Table 1-12. Summary of recommendations that apply to RunitRight

#	RunitRight Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
RR1	Consider adding independent variables to the regression to account for school breaks.		✓			✓	
RR2A	Consider including the date when each activity was implemented.		✓			✓	
RR2B	Provide information on both the baseline and installed case.		✓			✓	
RR2C	Increase the level of documentation when a single change results in a significant portion of savings.		✓			✓	
RR3A	Consider including a basic description of all end-use equipment served by the gas meter.		✓			✓	
RR3B	Consider using engineering calculations to estimate electricity savings.		✓			✓	
RR3C	Consider reviewing the process for selecting the HDD reference temperature.		✓			✓	

Table 1-13. Summary of recommendations that apply to simulation modeling

#	Simulation Modeling Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
SM1	Provide simulation file and output to the evaluation team.	✓	✓		✓		✓
SM2	Provide more explicit support for major measure installations.	✓	✓				✓
SM3	Consider reviewing and modifying program processes to avoid data entry or outdated simulation result errors.	✓	✓		✓	✓	✓
SM4	Consider funding a study to verify the models produced by the utility agents.			✓		✓	

Table 1-14. Summary of recommendations that apply to cost-effectiveness

#	Cost-effectiveness Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
CE1	Allocate "sector"-level administrative costs and overhead to each individual program and report program-level cost-effectiveness results.	✓	✓		✓		✓
CE2	Use a consistent real discount rate of 4% when using real streams of benefits and costs.	✓	✓		✓		✓
CE3	Explore the possibility of better defining water avoided costs.	✓	✓	✓	✓		✓
CE4	Work towards better uniformity in methods and assumptions.	✓	✓	✓	✓		✓

Table 1-15. Summary of recommendations that apply to other areas

#	Other Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
OR1	When the C&I deep savings metric is used, deliver monthly billing data for each C&I participant.	✓					✓
OR2	Provide a detailed explanation for the DSMSI calculation.	✓	✓		✓		✓

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) programs[2] delivered in 2015. These verifications were conducted by the OEB's Evaluation Contractor (EC) team of DNV GL, Itron, and Dunsky.

The annual verification assembles the results of all evaluation studies conducted on the 2015 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 Adjustment Mechanism (LRAM), DSM Variance Account (DSMVA), and DSM Shareholder Incentive (DSMSI) 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 DSMSI and LRAM amounts.
- Recommend changes to improve input assumptions, verification procedures, and the overall verification process.

The LRAM, DSMVA, and DSMSI are based on the following metrics:

- LRAM: 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.
- 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 was verified for 2015 includes the program natural gas savings and 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 verified savings and program achievements were used to confirm the LRAM and DSMSI amounts.

2.1 Background

Enbridge and Union deliver energy efficiency programs under the Demand Side Management Framework for Natural Gas Distributors (2015-2020)[3] 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.

[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 M for additional detail.

[3] EB-2014-0134

In April 2016, 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 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 Stantec conducted a custom project savings verification (CPSV) and net-to-gross (NTG) study of the 2015 program year.[4] This report includes the results of that study. A spillover study of 2013-2014 programs has also been initiated; however, the results from that effort are not available for this report. Instead, a provisional value has been included in the NTG value based on secondary source research. See APPENDIX N for more information.

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 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 study[5] and received comment, advice, and input on the results of this annual verification. 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 2-1 and Table 2-2. To prepare for the program-specific 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. We also recreated the reported LRAM and DSMSI values using the reported savings and scorecard achievements to confirm that the calculations were done correctly.

Once the program-specific verifications were completed, the EC assembled the verified scorecard results and calculated the verified LRAM, DSMSI, 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 embedded in APPENDIX N. The results presented in this report are based on data collected from:

- Union and Enbridge tracking databases (Round 1 of data requests)
- Union and Enbridge project documentation (Round 2 of data requests)
- The results of the CPSV / NTG study

The two data and documentation requests are explained in detail in APPENDIX A. A description of the data received is explained in detail in APPENDIX B. The recommendations related to these activities are listed in section 5.

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4 "2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation". Prepared for the Ontario Energy Board. August 15, 2017.

5 Throughout the rest of this report, "CPSV/NTG" is used to refer to the study that resulted in custom program savings verification and net-to-gross results; however, not all aspects of the study were applied to all programs in the study. The Low Income participants were not included in the NTG portion of the study; pre-stipulated NTG results continue to be used for those measures. The Run it Right participants were not included in the CPSV portion of the study; verified gross savings were produced during the annual verification.

Table 2-1. Union 2015 annual verification activities, by scorecard

Program	Metrics	Activity
Resource Acquisition	Cumulative natural gas savings Number of residential deep savings participants Average percent of whole building energy use saved by the program	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for the full population of measures. Verify the savings for a sample of home retrofit participants. Confirm that the necessary factors (such as NTG assumptions) were applied correctly. Apply the results of the CPSV / NTG study. Verify the number of residential deep savings participants by reviewing the detailed documentation for a sample of participants. Collect the annual billing information for the full population of C&I deep savings participants and compare the verified energy savings to the annual energy use to confirm the percent of whole building natural gas use saved.
Large Volume	Cumulative natural gas savings	Confirm that the necessary factors (such as NTG assumptions) were applied correctly. Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for the full population of measures. Apply the results of the CPSV / NTG study.
Low Income	Cumulative natural gas savings	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for the full population of measures. Verify the savings for a sample of home retrofit participants. Confirm that the necessary factors (such as NTG assumptions) were applied correctly. Apply the results of the CPSV / NTG study.
Optimum Home	Percent of homes built by participating builders that are 20% more efficient than OCB	Review the program tracking data. Confirm the participation status of one builder, and confirm the program qualification of one home.

Table 2-2. Enbridge 2015 annual verification activities, by scorecard

Program	Metrics	Activity
Resource Acquisition	Cumulative natural gas savings Number of residential deep savings participants	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for the full population of measures. Verify the savings for a sample of home retrofit participants. Confirm that the necessary factors (such as NTG assumptions) were applied correctly. Apply the results of the CPSV / NTG study. Conduct a desk review of a sample of RunitRight participants to verify the reasonableness of the claimed savings. Verify the number of residential deep savings participants by reviewing the detailed documentation for a sample of participants.
Low Income	Cumulative natural gas savings Percent of Part 3 participants enrolled	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for the full population of measures. Verify the savings for a sample of home retrofit participants. Confirm that the necessary factors (such as NTG assumptions) were applied correctly. Apply the results of the CPSV / NTG study. Review documentation to confirm the Part 3 participant Low Income scorecard metric.
RSBD	Builders enrolled Number of efficient homes	Review the program tracking data. Confirm the participation status of one residential builder and the program qualification of one home.
CSBD	Number of developments	Review the program tracking data. Confirm the participation status of one commercial builder and the program qualification of one development.
Home Labelling	Number of listings represented by realtors Number of ratings performed	Review the program tracking data. Confirm the participation status of one realtor, and the ratings reported by that realtor.

3 Union Gas Limited

This section reports on the results of the annual verification and scorecard achievements of Union's 2015 DSM programs.

3.1 Scorecard achievements

Union has four scorecards: Resource Acquisition, Large Volume, Low Income, and Market Transformation. Table 3-1 shows an overview of the programs included in each scorecard. For a discussion of the calculations behind the DSMSI and LRAM, see APPENDIX J.

Table 3-1. Overview of Union 2015 programs by scorecard

Scorecard	Programs
Resource Acquisition	Commercial and Industrial Custom Commercial and Industrial Prescriptive Energy Savings Kit Home Reno Rebate
Large Volume	Large Industrial – T1, T2, R100
Low Income	Home Weatherization Program Affordable Housing Conservation (Multi-family custom and prescriptive)
Market Transformation	Optimum Home

Table 3-2 shows the Union scorecard for 2015, 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 3-2. Union's reported, unverified 2015 achievement, target, weight, and maximum shareholder incentive by scorecard

Scorecard	2015 Target	2015 Reported Achievement	Weight	Maximum Shareholder Incentive (if 150% of target achieved)
Union				
Resource Acquisition	816,561,818 CCM	938,905,035 CCM	90%	$5,761,833
	1,245 deep savings participants	2,537 participants	5%	
	8.88% of C&I whole building natural gas use saved	8.24% saved	5%	
Large Volume	206,256,017 Rate 1 CCM	78,919,835 CCM	60%	$1,862,877
	1,029,841,387 Rate T2/100 CCM	499,103,360 CCM	40%	
Low Income	26,000,000 single family CCM	33,504,841 CCM	60%	$2,810,129
	17,600,000 multi-family CCM	16,948,695 CCM	40%	
Market Transformation	30% of homes built by participating builders were 20% more efficient than OBC	50% of homes	100%	$566,721
TOTAL				**$11,001,560**

3.1.1 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
- The average percentage of C&I whole building energy use saved

To verify the natural gas savings, the EC team reviewed each program independently. The programs that contribute energy savings to the Resource Acquisition scorecard are shown in Table 3-3. The table also shows the appendix that has the detailed explanation of the verification activities for each program.

Table 3-3. Union Resource Acquisition programs and report location of detailed verification

Program	Location of Detailed Explanation	Description of Detailed Explanation
Residential Program		
Energy Savings Kit	APPENDIX E	How ESK savings were verified
Home Reno Rebate	APPENDIX D	How home retrofit program savings were verified
Commercial / Industrial Program		
Commercial and Industrial Custom	APPENDIX H APPENDIX N	How CPSV / NTG results and spillover are applied for annual verification
Commercial and Industrial Prescriptive	APPENDIX C	How prescriptive savings were certified

At a high level, the EC completed the following activities to produce verified savings for each Resource Acquisition program:

- **Energy Savings Kit:** The EC reviewed the per-unit savings to ensure that the approved values were used. We then applied adjustment factors from a previously-conducted verification study to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.
- **Home Reno Rebate:** The EC sampled 25 participants and reviewed the program documentation to confirm that the model savings matched the tracking data. We calculated an adjustment factor and applied it to the tracking savings to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.
- **Commercial and Industrial Custom:** The EC conducted site verifications as part of the CPSV / NTG study. We also did secondary source research to estimate spillover. We applied the results to produce verified savings for the following sectors:
  - Agriculture and Greenhouse
  - Commercial and Institutional Buildings
  - Industrial
- **Commercial and Industrial Prescriptive:** The EC confirmed energy savings for the population of measures by recreating the program tracking data using program-assumed quantities and approved energy savings per unit to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.

Table 3-4 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 (those savings which were found to be in place upon the EC's review) and net savings (those savings which have been adjusted to exclude free riders and include spillover).[6] The commercial and industrial custom program has been expanded to more refined sector subsets to match those in the utility-reported tracking data.

Table 3-4. Union's verified 2015 Resource Acquisition savings

Program	Draft Utility-Reported Savings*		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Resource Acquisition						
C&I Prescriptive	208,919,006	182,411,887	100%	87%	208,919,006	182,411,887
C&I Custom Ag and Greenhouse	611,477,005	281,279,422	97%	44%	592,368,700	262,534,051
C&I Custom Comm & Inst Buildings	268,582,354	123,547,883	89%	47%	239,199,444	112,642,330
C&I Custom Industrial	593,859,359	273,175,305	103%	43%	612,343,937	260,640,852
Energy Savings Kit	22,398,052	19,567,373	75%	88%	16,882,059	14,800,935
Home Reno Rebate	69,321,370	58,923,165	98%	85%	67,934,943	57,744,701
Total	**1,774,557,146**	**938,905,035**	**98%**	**51%**	**1,737,648,089**	**890,774,755†**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
†These values are rounded.

To verify the number of residential deep savings participants, the EC followed the process outlined in Table 3-5 and described in APPENDIX D. The EC found 2,529 qualifying deep savings participants compared to 2,537 reported by the program.

[6] The current spillover estimate is a provisional value based on secondary source research. There is a spillover study in progress. but the results are not ready.

Table 3-5. Union deep savings participant verification activities and outcomes

Verification Activity	Outcome
Confirm that two major measures were installed for each sampled site.	Confirmed for 6 of 25 sites using the supplied photos. For the remaining sites, photos only verified one major measure.*
Calculate verified cumulative savings for each sampled site and confirm over 11,000 cumulative m^3.	Three of 25 sites did not have cumulative savings over 11,000 cumulative m^3 but were identified as deep savings participants.
Calculate the average percent reduction across the sample and confirm greater than 25%.	By assuming that the total natural gas consumption was equal to the space and water heat consumption, we were able to calculate an average savings reduction of 29%.
Apply the gross realization rate to the population and determine the number of qualifying deep savings participants.	The EC found 2,529 qualifying deep savings participants compared to 2,537 reported by the program.

*Despite the low confirmation rate, the EC did not adjust the outcome based on the initial review. Though the activity did not confirm that there were two major measures, it also did not confirm that there were not. It's likely that the second major measure was more difficult to visually confirm, such as air sealing.

To verify the percentage of whole-building C&I savings, the EC:

- Confirmed the calculation method in the Union tracking data
- Updated savings based on the CPSV and prescriptive certification
- Calculated the verified result.

With the adjustment factors applied, the resulting scorecard metric is 8.08% of whole building energy use saved.

3.1.2 Large Volume

This section summarizes the results of the EC's review of the Union Large Volume scorecard. The metrics for the Large Volume scorecard are total cumulative natural gas savings by two different rate categories.

To verify natural gas savings, the EC reviewed the prescriptive and custom savings for Large Volume independently. Table 3-6 shows the appendix that has the detailed explanation of the verification activities for each type of project.

Table 3-6. Union Large Volume location of detailed verification

Program	Location of Detailed Explanation	Description of Detailed Explanation
Large Volume (custom projects)	APPENDIX H APPENDIX N	How CPSV / NTG results and spillover are applied for annual verification
Large Volume (prescriptive projects)	APPENDIX C	How prescriptive savings were certified

At a high level, the EC completed the following verification activities for each Large Volume program:

- **Custom Projects:** The EC conducted site verifications as part of the CPSV / NTG study. We also did secondary source research to estimate spillover. We applied the results to produce verified gross and net savings.

- **Prescriptive Projects:** The EC confirmed energy savings for the population of measures by recreating the program tracking data using program-assumed quantities and approved energy savings per unit to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.

Table 3-7 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 (those savings which were found to be in place upon the EC's review) and net savings (those savings which have been adjusted to exclude free riders and include spillover).[7] The program has been expanded to more refined rate subsets.

Table 3-7. Union's verified 2015 Large Volume savings

Program	Draft Utility-Reported Savings		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Large Volume						
Large Industrial-T1	171,240,007	78,919,835	154%	13%	263,624,641	33,725,518
Large Industrial-T2	1,002,106,837	462,016,235	131%	11%	1,309,850,111	147,448,803
Large Industrial-R100	80,624,184	37,087,125	147%	12%	118,331,969	13,695,699
Total	**1,253,971,028**	**578,023,195**	**135%**	**12%**	**1,691,806,721**	**194,870,020**

† These values are rounded.

3.1.3 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 and multi-family participants separately.

To verify energy savings, the EC team reviewed the prescriptive and custom savings for Low Income independently. Table 3-8 shows the appendix that has the detailed explanation of the verification activities for each type of project.

Table 3-8. Union Low Income programs and location of detailed verification

Program	Location of Detailed Explanation	Description of Detailed Explanation
Single Family Program		
Home Weatherization Program	APPENDIX D	How home retrofit program savings were verified
Affordable Housing Conservation Program		
Low Income Multi-family (custom projects)	APPENDIX H	How CPSV / NTG results are applied for annual verification
Low Income Multi-family (prescriptive projects)	APPENDIX C	How prescriptive savings were certified

At a high level, the EC completed the following verification activities for each Low Income program:

- **Multi-family Custom Projects:** The EC conducted site verifications as part of the CPSV and NTG study and applied the results to produce verified gross and net savings.

[7] The current spillover estimate is a provisional value based on secondary source research. There is a spillover study in progress. but the results are not ready.

- **Multi-family Prescriptive Projects:** The EC confirmed energy savings for the population of measures by recreating the program tracking data using program-assumed quantities and approved energy savings per unit to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.
- **Home Weatherization:** The EC sampled 25 participants and reviewed the program documentation to confirm that the model savings matched the tracking data. We calculated an adjustment factor and applied it to the tracking savings to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.

Table 3-9 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 (those savings which were found to be in place upon the EC's review) and net savings (those savings which have been adjusted to exclude free riders and include spillover).

Table 3-9. Union's verified 2015 Low Income savings

Program	Draft Utility-Reported Savings*		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Low Income						
Low Income Multi-family	17,840,732	16,948,695	96%	95%	17,193,011	16,333,361
Home Weatherization	33,505,239	33,504,841	107%	100%	35,847,824	35,847,426
Total	**51,345,970**	**50,453,536**	**103%**	**98%**	**53,040,835**	**52,180,787**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
†These values are rounded.

3.1.4 Market Transformation

This section summarizes the results of the EC's review of the Union Market Transformation scorecard. The metric for the Market Transformation scorecard is the percentage of homes built to Optimum Home standard by participating builders. The Optimum Home standard is greater than 20% above the Ontario Building Code 2012 (OBC). Union reported an achievement of 50.3% of homes built by participating builders, which was confirmed by the EC. The detailed verification efforts are described in APPENDIX I.

3.2 Program spending and cost-effectiveness

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

3.2.1 Program spending

The Union tracking database included a sheet that reported program spending by scorecard. Table 3-10 shows the Union budget for the portfolio overall. Additional spending detail is in APPENDIX L.

Table 3-10. Union portfolio budget overall

Spending Area	OEB-Approved Budget	Actual Spending	Difference ($)	Difference (%)
Programs Sub-total	$28,994,667	$29,134,697	($140,030)	9%
Research	$829,564	$329,116	$500,448	57%

Evaluation	$1,049,409	$525,012	$524,397	46%
Administration	$1,713,277	$2,189,940	($476,663)	38%
Total DSM Budget	**$32,588,000**	**$32,178,766**	**$409,234**	**7%**

3.2.2 Cost-effectiveness

Table 3-11 and Table 3-12 show summary results for the TRC, TRC-Plus, and PAC tests, including the cost-benefit ratio and the net present value. Additional detail is shown in APPENDIX M. While there is a general drop in cost-effectiveness results following the verification of savings, almost all OEB-defined programs still pass the cost-effectiveness threshold for all three tests. The only exception is the Home Reno Rebate program, which was not cost-effective when using draft utility reported savings, before any verification-related adjustment.[8] When the utility definition of program is used (see APPENDIX M), the threshold is always exceeded.

Table 3-11. Union summary of cost-effectiveness ratio results

Scorecard	Draft using Utility-Reported Savings*			Final Verified Ratio		
	TRC	TRC-Plus**	PAC**	TRC	TRC-Plus	PAC
Residential Resource Acquisition	1.2	3.0	8.0	1.0	1.2	2.3
Commercial and Industrial Resource Acquisition	2.9			3.3	3.8	12.0
Low Income	1.0	1.1	0.9	1.3	1.4	1.1
Large Volume	4.7	5.4	26.3	6.0	6.9	10.2
Total Portfolio	**2.9**	**3.3**	**8.1**	**2.9**	**3.3**	**6.8**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

Table 3-12. 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	TRC-Plus**	PAC**	TRC	TRC-Plus	PAC
Residential Resource Acquisition	96.7	120.4	117.9	0.4	2.6	6.8
Commercial and Industrial Resource Acquisition				105.4	128.0	124.7
Low Income	(0.02)	1.0	(1.1)	1.7	3.1	0.6
Large Volume	70.2	83.6	81.1	27.6	32.6	29.4
Total Portfolio	**166.9**	**205.1**	**197.9**	**135.2**	**166.3**	**161.5**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

As very low net-to-gross factors were applied to the Large Volume program, the TRC, TRC-Plus, and PAC net values dropped significantly. It is interesting to note that because both savings and costs are affected by the net-to-gross factor, the impact on the TRC and TRC-Plus ratios is far less significant. In addition, a high realization rate (135%) was applied to Union's Large Volume savings, resulting in an increase of the TRC-Plus ratio, even with a net-to-gross factor of only 12%.

[8] The Home Reno Rebate program is not required to be cost effective; only the utility-defined Residential program must be cost effective.

3.3 DSMSI and LRAM

This section reports on the results of the DSMSI and LRAM calculations. The recommendations related to these activities are listed in section 5. Table 3-14 shows the verified savings results for the Union portfolio.

Table 3-13. Union verified savings results

Program	Draft Utility-Reported Savings*		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Resource Acquisition						
Home Reno Rebate	69,321,370	58,923,165	98%	85%	67,934,943	57,744,701
Energy Savings Kit	22,398,052	19,567,373	75%	88%	16,882,059	14,800,935
Total Residential	91,719,422	78,490,538	92%	86%	84,817,002	72,545,636
C&I Custom	1,473,918,718	678,002,610	98%	51%	1,443,912,081	635,817,233
C&I Prescriptive	208,919,006	182,411,887	100%	87%	208,919,006	182,411,887
Total C&I	1,682,837,724	860,414,497	98%	50%	1,652,831,087	818,229,120
Total Resource Acquisition	**1,774,557,146**	**938,905,035**	**98%**	**51%**	**1,737,648,089**	**890,774,755**
Large Volume						
Large Volume	1,253,971,028	578,023,195	135%	12%	1,691,806,721	194,870,020
Total Large Volume	**1,253,971,028**	**578,023,195**	**135%**	**12%**	**1,691,806,721**	**194,870,020**
Low Income						
Single Family (Part 9)	33,505,239	33,504,841	107%	100%	35,847,824	35,847,426
Multi-family (Part 3)	17,840,732	16,948,695	96%	95%	17,193,011	16,333,361
Total Low Income	**51,345,971**	**50,453,536**	**103%**	**98%**	**53,040,835**	**52,180,787**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
†These values are rounded.

3.3.1 DSMSI

The EC gathered the verified scorecard achievements from section 3.1 and compared them to the defined upper and lower bands in the Union DSMSI calculation (see APPENDIX J for a description of the DSMSI calculation), shown in Table 3-14. The verified program achievements were entered into the Union tracking workbook DSMSI calculator, which was verified by the EC.

Table 3-14. Union's 2015 scorecard targets, lower band, upper band, and weight

Scorecard	Lower Band	2015 Target	Upper Band	Verified Achievement	Weight
Union					
Resource Acquisition	612,421,364 CCM 934 participants 7.88%	816,561,818 CCM 1,245 deep savings participants 8.88% of commercial whole building natural gas use saved	1,020,702,273 CCM 1,556 participants 9.88%	890,774,755 CCM 2,529 participants 8.08%	90% 5% 5%
Large Volume	154,692,013 CCM 772,381,040 CCM	206,256,017 Rate 1 CCM 1,029,841,387 Rate T2/100 CCM	257,820,021 CCM 1,287,301,734 CCM	33,725,518 CCM 161,144,502 CCM	60% 40%
Low Income	19,500,000 CCM 13,200,000 CCM	26,000,000 single family CCM 17,600,000 multi-family CCM	32,500,000 CCM 22,000,000 CCM	35,847,426 CCM 16,333,361 CCM	60% 40%
Market Transformation	25%	30% of homes built by participating builders were 20% more efficient than OBC	35%	50.3%	100%

The resulting shareholder incentive results are shown in Table 3-15.

Table 3-15. Union DSMSI results

Scorecard	Draft Utility-Reported DSMSI*	DSMSI
Resource Acquisition	$4,776,312	$4,010,638
Low Income	$2,192,257	$2,462,534
Large Volume	$0	$0
Market Transformation	$566,721	$566,721
Total	**$7,535,290**	**$7,039,894**

* Union-reported DSMSI values reflect those presented in Union's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.

3.3.2 LRAM

The EC summed the verified net annual savings by rate class and month. The summed savings were entered into the Union tracking workbook LRAM calculator, which was verified by the EC. Table 3-16 shows the results.

Table 3-16. Union LRAM results

Rate Class	Utility-Reported Draft LRAM	Verified LRAM
M4 Industrial	$77,105	$73,713
M5 Industrial	$38,366	$36,565
M7 Industrial	$33,512	$31,937
T1 Industrial	$2,789	$777
T2 Industrial	$1,050	$389
20 Industrial	$7,002	$6,845
100 Industrial	$5,578	$1,565
Total	**$165,411**	**$151,791**

4 Enbridge Gas Distribution, Inc.

This section reports on the results of the annual verification and scorecard achievements of Enbridge's 2015 DSM programs.

4.1 Scorecard achievements

Enbridge has five scorecards: Resource Acquisition, Low Income, Residential Savings by Design (RSBD), Commercial Savings by Design (CSBD), and Home Labelling. Table 4-1 shows an overview of the programs included in each scorecard. For a discussion of the calculations behind the DSMSI and LRAM, see APPENDIX J.

Table 4-1. Overview of Enbridge 2015 programs by scorecard

Scorecard	Programs
Resource Acquisition	Home Energy Conservation Commercial and Industrial Prescriptive Commercial and Industrial Custom RunitRight
Low Income	Low Income Multi-family Low Income Single Family
RSBD	RSBD
CSBD	CSBD
Home Labelling	Home Labelling

Table 4-2 shows the Enbridge scorecard for 2015, 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 4-2. Enbridge's unverified, reported 2015 achievement, target, weight, and maximum shareholder incentive by scorecard

Scorecard	2015 Target	2015 Reported Achievement	Weight	Maximum Shareholder Incentive (if 150% of target achieved)
Enbridge				
Resource Acquisition	1,011,900,000 CCM	767,627,826 CCM	92%	$6,482,744
	762 deep savings participants	5,646 participants	8%	
Low Income	24,100,000 single family CCM	28,343,978 CCM	50%	$2,495,721
	68,700,000 multi-family CCM	69,226,782 CCM	45%	
	40% of Part 3 participants enrolled	65% enrolled	5%	
Residential Savings by Design (Market Transformation)	18 Builders enrolled	19 Builders enrolled	20%	$1,076,493
	1,111 homes built 20% more efficient than OBC	1,987 of homes	13%	
Commercial Savings by Design (Market Transformation)	18 New developments enrolled	24 developments enrolled	33%	$418,269
Home Labelling (Market Transformation)	5,000 Realtor commitments	41,650 Realtor commitments	17%	$616,397
	4,500 Ratings performed	336 Ratings performed	17%	
TOTAL				**$11,089,624**

4.1.1 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 natural gas savings
- Number of residential deep savings participants

To verify natural gas savings, the EC team reviewed each program independently. The programs that contribute energy savings to the Resource Acquisition scorecard are shown in Table 4-3. The table also shows the appendix that has the detailed explanation of the verification activities.

Table 4-3. Enbridge Resource Acquisition report location of detailed verification

Program	Location of Detailed Explanation	Description of Detailed Explanation
Residential Program		
Home Energy Conservation	APPENDIX D	How home retrofit program savings were verified
Commercial / Industrial Program		
Commercial & Industrial Prescriptive	APPENDIX C	How prescriptive savings were certified
Commercial & Industrial Custom	APPENDIX H APPENDIX N	How CPSV / NTG results and spillover are applied for annual verification
RunitRight	APPENDIX F	How RunitRight gross savings were verified

At a high level, the EC completed the following verification activities for each Resource Acquisition program:

- **Home Energy Conservation:** The EC sampled 25 participants and reviewed the program documentation to confirm that the model savings matched the tracking data. We calculated an adjustment factor and applied it to the tracking savings to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.
- **Commercial and Industrial Prescriptive:** The EC confirmed energy savings for the population of measures by recreating the program tracking data using program-assumed quantities and approved energy savings per unit to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.
- **Commercial and Industrial Custom:** The EC conducted site verifications as part of the CPSV / NTG study. We also did secondary source research to estimate spillover. We applied the results to produce verified gross and net savings for the following sectors:
  - Commercial Custom
  - Industrial Custom
  - Multi-family
  - New Construction
  - Industrial Agriculture
  - RunitRight (net savings only)

- **RunitRight:** The EC sampled 10 participants to confirm that the calculated energy savings were reasonable. We calculated an adjustment factor and applied it to the tracking savings to produce verified gross savings. The EC applied the results of the NTG study and the secondary source spillover research to produce net savings.

Table 4-4 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 (those savings which were found to be in place upon the EC's review) and net savings (those savings which have been adjusted to exclude free riders and include spillover).[9] The commercial and industrial custom and prescriptive programs have been expanded to more refined sector subsets to match those in the utility-reported tracking data.

Table 4-4. Enbridge's verified 2015 Resource Acquisition savings

Program	Draft Utility-Reported Savings*		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate**†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Resource Acquisition						
Home Energy Conservation	120,488,487	102,415,214	100%	85%	120,488,487	102,415,214
Prescriptive Commercial	117,938,979	98,693,722	97%	86%	114,897,650	98,862,563
Custom Commercial	210,800,594	185,504,523	91%	21%	192,840,383	40,105,236
RunitRight	2,684,105	2,684,105	100%	53%	2,684,105	1,434,923
Custom Multi-family	152,593,766	122,075,013	91%	38%	139,592,777	53,699,388
C&I Custom New Construction	102,294,475	75,697,912	91%	22%	93,578,986	20,231,777
Custom Industrial	336,500,502	168,250,251	100%	36%	337,417,582	122,387,967
Prescriptive Industrial	10,826,785	7,593,008	100%	70%	10,826,785	7,593,008
Custom Industrial Ag	7,856,800	4,714,080	99%	32%	7,815,133	2,467,184
Total	**1,061,984,493**	**767,627,826**	**96%**	**44%**	**1,020,141,888**	**449,197,259†**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
** The gross realization rate for C&I prescriptive includes the removal rate for the multifamily showerhead measure, which was previously included in the net-to-gross adjustment. See APPENDIX C for more detail.
†These values are rounded.

To verify the number of residential deep savings participants, the EC followed the process outlined in Table 4-5 and described in APPENDIX D. The EC found 5,646 qualifying deep savings participants, which is the same number reported by the utility.

[9] The current spillover estimate is a provisional value based on secondary source research. There is a spillover study in progress. but the results are not ready.

Table 4-5. Enbridge deep savings participant verification activities and outcomes

Verification Activity	Outcome
Confirm that two major measures were installed for each sampled site.	Confirmed for 6 of 24 sites using the supplied photos. For the remaining sites, photos only verified one major measure.*
Calculate the average percent reduction across the sample and confirm greater than 25%.	By assuming that the total natural gas consumption was equal to the space and water heat consumption, we were able to calculate an average savings reduction of 31%.
Calculate the percent reduction for each sample site and compare it to the tracking values.	There were 2 sites with differences; overall, however, the adjusted result was still greater than 25%.
Apply the gross realization rate to the population and determine the number of qualifying deep savings participants.	The EC found 5,646 qualifying deep savings participants, which is the same number reported by the utility.

*Despite the low confirmation rate, the EC did not adjust the outcome based on the initial review. Though the activity did not confirm that there were two major measures, it also did not confirm that there were not. It's likely that the second major measure was more difficult to visually confirm, such as air sealing.

4.1.2 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 multi-family
- Total cumulative natural gas savings for single family
- The percentage of Part 3 participants who are also participating in the Low Income Building Performance Management (LIBPM) program

To verify natural gas savings, the EC team reviewed the prescriptive and custom savings for Low Income independently. Table 4-6 shows the appendix that has the detailed explanation of the verification activities for each type of project.

Table 4-6. Enbridge Low Income location of detailed verification

Program	Location of Detailed Explanation	Description of Detailed Explanation
Single Family Program		
Low Income Single Family: Winterproofing	APPENDIX D	How home retrofit program savings were verified
Low Income Single Family non-Winterproofing	APPENDIX C	How prescriptive savings were certified
Multi-family Program		
Low Income Multi-family (prescriptive projects)	APPENDIX C	How prescriptive savings were certified
Low Income Multi-family (custom projects)	APPENDIX H	How CPSV / NTG results are applied for annual verification

At a high level, the EC completed the following verification activities for each Low Income program:

- **Multi-family Custom Projects:** The EC conducted site verifications as part of the CPSV / NTG study. We applied the results to produce verified gross and net savings.
- **Winterproofing:** The EC sampled 25 participants and reviewed the program documentation to confirm that the model savings matched the tracking data. We calculated an adjustment factor and applied it to the tracking savings to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.
- **Single Family and Multi-family Prescriptive Projects:** The EC confirmed energy savings for the population of measures by recreating the program tracking data using program-assumed quantities and approved energy savings per unit to produce verified gross savings. Program-assumed free-ridership values were used to produce net savings.

Table 4-7 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 (those savings which were found to be in place upon the EC's review) and net savings (those savings which have been adjusted to exclude free riders and include spillover).

Table 4-7. Enbridge's verified 2015 Low Income savings

Program	Draft Utility-Reported Savings		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate**†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Low Income						
LI Multi-Family	69,505,240	69,226,782	101%	100%	70,147,603	70,426,062
Single Family	28,410,725	28,343,978	99%	100%	28,067,264	28,132,657
Total	**97,915,965**	**97,570,759**	**100%**	**100%**	**98,214,867**	**98,558,719**

** The gross realization rate for single family low income and multi-family low income includes the removal rate for some measures, which was previously included in the net-to-gross adjustment. See APPENDIX C for more detail.
†These values are rounded.

To verify the percentage of Part 3 buildings participating in the LIBPM program, the EC:

- Confirmed the calculation method
- Verified the calculation inputs
- Confirmed the overall utility-reported result of 65%.

4.1.3 Residential Savings by Design

This section summarizes the results of the EC's review of the Enbridge RSBD scorecard. The metrics for the RSBD scorecard are the number of builders participating in the RSBD program and the number of houses built to RSBD standard, which is greater than 25% above the Ontario Building Code (OBC) 2012. Enbridge reported achievements of 19 builders enrolled and 1,987 homes built, which was confirmed by the EC. By definition, an enrolled builder must have built a minimum of 50 homes in the previous year to qualify. The detailed verification efforts are described in APPENDIX I.

4.1.4 Commercial Savings by Design

This section summarizes the results of the EC's review of the Enbridge CSBD scorecard. The metric for the CSBD scorecard is the number of developments enrolled in the program. Enbridge reported an achievement of 24 developments enrolled, which was confirmed by the EC. The detailed verification efforts are described in APPENDIX I.

4.1.5 Home Labelling

This section summarizes the results of the EC's review of the Home Labelling scorecard. The scorecard metrics for the Home Labelling scorecard are the number of annual listings by realtors committed to the program and the number of ratings performed. Enbridge reported achievements of 41,650 listings and 336 ratings performed, which were confirmed by the EC.

4.2 Program spending and cost-effectiveness

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

4.2.1 Program spending

The Enbridge tracking database included reported program spending information. Table 4-8 summarizes the costs across the portfolio. Additional spending detail is in APPENDIX L.

Table 4-8. Enbridge program cost summary

Scorecard / Program	OEB-Approved Budget	Actual Spending			Difference	
		Indirect	Direct	Total	$	%
Program Costs						
Resource Acquisition Total	**$14,443,790**	**$13,838,372**	**$3,912,353**	**$17,750,725**	**$3,306,935**	**23%**
Residential	$1,872,720	$8,340,428	$1,021,867	$9,362,295	$7,489,575	400%
Commercial	$8,252,370	$3,923,856	$2,297,867	$6,221,724	($2,030,646)	-25%
Industrial	$4,318,700	$1,574,088	$592,619	$2,166,706	($2,151,994)	-50%
Low Income Total	**$6,864,090**	**$5,523,356**	**$1,033,006**	**$6,556,362**	**($307,728)**	**-4%**
Market Transformation Total	**$4,890,900**	**$1,899,739**	**$1,143,988**	**$3,043,727**	**($1,847,173)**	**-38%**
Overhead Total	**$6,603,160**	**$0**	**$7,869,780**	**$7,869,780**	**$1,266,620**	**19%**
Resource Acquisition	$4,731,485	$0	$5,639,080	$5,639,080	$907,595	19%
Low Income	$517,988	$0	$617,349	$617,349	$99,361	19%
Market Transformation	$1,353,687	$0	$1,613,352	$1,613,352	$259,665	19%
Incremental Costs	**$4,920,291**	**$179**	**$559,200**	**$559,378**	**($4,360,913)**	**-89%**
Total	**$37,722,231**	**$21,261,646**	**$14,518,327**	**$35,779,973**	**($1,942,258)**	**-5%**

4.2.2 Cost-effectiveness

Table 4-9 and Table 4-10 show summary results for the TRC, TRC-Plus, and PAC tests, including the cost-benefit ratio and the net present value. Additional detail is provided in APPENDIX M. While there is a general drop in cost-effectiveness results following the verification of savings, almost all OEB-defined programs still pass the cost-effectiveness threshold for both the TRC-Plus and the PAC tests. The only exception is the RunitRight program (see APPENDIX M), which was not cost-effective when using utility draft reported savings, before any verification-related adjustment.[10] When the utility definition of program is used (see APPENDIX M), the threshold is always exceeded.

Table 4-9. Enbridge summary of cost-effectiveness ratio results

Scorecard	Draft using Utility-Reported Savings*			Final Verified Ratio		
	TRC**	TRC-Plus	PAC	TRC	TRC-Plus	PAC
Resource Acquisition	3.3	3.8	6.0	2.3	2.7	2.7
Low Income	2.1	2.5	2.5	1.7	2.0	1.9
Total Portfolio	**3.1**	**3.6**	**5.2**	**2.2**	**2.6**	**2.5**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Enbridge only reported TRC-Plus and PAC in its filings for 2015.

Table 4-10. Enbridge 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**	TRC-Plus	PAC	TRC	TRC-Plus	PAC
Resource Acquisition	123.2	149.7	120.4	50.1	61.8	40.9
Low Income	9.2	11.8	10.7	6.0	8.1	6.2
Total Portfolio	**132.4**	**161.6**	**131.1**	**56.1**	**69.9**	**47.1**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Enbridge only reported TRC-Plus and PAC in its filings for 2015.

As very low net-to-gross factors were applied to the C&I custom sector, the TRC, TRC-Plus, and PAC net values dropped significantly. It is interesting to note that because both savings and costs are affected by the net-to-gross factor, the impact on the TRC ratio is far less significant.

4.3 DSMSI and LRAM

This section reports on the results of the DSMSI and LRAM calculations. The recommendations related to these activities are listed in section 5. Table 4-11 shows the verified savings results for the Enbridge portfolio.

[10] The RunitRight program is not required to be cost effective; only the utility-defined Resource Acquisition program must be cost effective.

Table 4-11. Enbridge verified savings results

Program	Draft Utility-Reported Savings*		Verification Results		Verified Savings	
	Gross Cumulative (m^3)	Net Cumulative (m^3)	Gross Realization Rate**†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Resource Acquisition						
Home Energy Conservation	120,488,487	102,415,214	100%	85%	120,488,487	102,415,214
Total Residential	120,488,487	102,415,214	100%	85%	120,488,487	102,415,214
C&I Custom	812,730,242	558,925,884	95%	31%	773,928,967	240,326,475
C&I Prescriptive	128,765,764	106,286,730	98%	85%	125,724,435	106,455,571
Total C&I	941,496,006	665,212,614	96%	39%	899,653,401†	346,782,045†
Total Resource Acquisition	**1,061,984,493**	**767,627,828**	**96%**	**44%**	**1,020,141,888**	**449,197,259**
Low Income						
Single Family (Part 9)	28,410,725	28,343,978	99%	100%	28,067,264	28,132,657
Multi-family (Part 3)	69,505,240	69,226,782	101%	100%	70,147,603	70,426,062
Total Low Income	**97,915,965**	**97,570,760**	**100%**	**100%**	**98,214,867**	**98,558,719**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
** The gross realization rate for C&I prescriptive, single family low income, and multi-family low income includes the removal rate for some measures, which was previously included in the net-to-gross adjustment. See APPENDIX C for more detail.
†These values are rounded.

4.3.1 DSMSI

The EC gathered the verified scorecard achievements from section 4.1 and compared them to the defined upper and lower bands in the Enbridge DSMSI calculation (see APPENDIX J for a description of the DSMSI calculation), shown in Table 4-12. The verified program achievements were entered into the Enbridge tracking workbook DSMSI calculator, which was verified by the EC.

Table 4-12. Enbridge's 2015 scorecard targets, lower band, upper band, and weight

Scorecard	Lower Band	2015 Target	Upper Band	Verified Achievement	Weight
Enbridge					
Resource Acquisition	758,900,000 CCM 571 participants	1,011,900,000 CCM 762 deep savings participants	1,264,900,000 CCM 952 participants	449,197,259 CCM 5,646 participants	92% 8%
Low Income	18,100,000 CCM 51,600,000 CCM 30%	24,100,000 single family CCM 68,700,000 multi-family CCM 40% of Part 3 in LIBPM	30,200,000 CCM 86,000,000 CCM 50%	28,132,657 CCM 70,426,062 CCM 65%	50% 45% 5%
Savings by Design Residential	13 builders 833 homes	18 builders enrolled 1,111 homes built by participating builders were 20% more efficient than OBC	22 builders 1,389 homes	19 builders 1,987 homes	60% 40%
Savings by Design Commercial	11 developments	18 developments enrolled	24 developments	24 developments	100%
Home Labelling	No listings 2,250 ratings	5,001 total listings from committed realtors 4,500 ratings performed	10,001 listings 6,750 ratings	41,650 listings 333 ratings	50% 50%

The resulting shareholder incentive results are shown in Table 4-13.

Table 4-13. Enbridge DSMSI results

Scorecard	Utility-Reported Draft DSMSI*	Verified DSMSI
Resource Acquisition	$6,482,744	$2,632,886
Low Income	$1,724,691	$1,745,422
Residential Savings by Design	$1,076,493	$1,076,493
Commercial Savings by Design	$418,269	$418,269
Home Labelling	$616,397	$616,397
Total	**$10,318,594**	**$6,489,467**

* Enbridge-reported DSMSI values reflect those presented in Enbridge's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.

4.3.2 LRAM

The EC summed the verified net annual savings by rate class and month. The summed savings were entered into the Union[11] tracking workbook LRAM calculator, which was verified by the EC. Table 4-14 shows the results.

Table 4-14. Enbridge LRAM results

Rate Class	Utility-Reported Draft LRAM*	Verified LRAM
110	$18,795	$11,662
115	$6,478	$2,836
135	$330	$239
145	$2,267	$834
170	$953	$584
Total	**$28,822**	**$16,155**

* Enbridge-reported LRAM values reflect those presented in Enbridge's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.

[11] The Enbridge tracking workbook calculation did not lend itself to easy update.

5 Findings and recommendations

This section contains the recommendations from the 2015 annual verification efforts and all other evaluations conducted on the 2015 programs. The annual verification recommendations are in the first section. CPSV / NTG recommendations are in the second section. Some recommendations overlap the various studies and are provided in all sections.

5.1 2015 annual verification recommendations

As part of the 2015 annual verification, a number of recommendations were identified. In the tables below, the primary outcomes of the 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 5-1. Summary of recommendations that apply to the overall annual verification

#	Overall Annual Verification Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
O1A	Consider investing in a relational program tracking database.	✓	✓		✓	✓	✓
O1B	Enbridge should include site-level information for all measures installed through the program.		✓			✓	✓
O2A	Deliver tracking data in a single flat file.	✓	✓		✓	✓	✓
O2B	Consider investing in a relational program tracking database.	✓	✓		✓	✓	✓
O3A	Develop and maintain an electronic summary of the TRM.	✓	✓	✓	✓	✓	✓
O3B	Track prescriptive savings using unique measure descriptions that map to electronic TRM.	✓	✓	✓	✓	✓	✓

Table 5-2. Summary of recommendations that apply to RunitRight

#	RunitRight Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
RR1	Consider adding independent variables to the regression to account for school breaks.		✓			✓	
RR2A	Consider including the date when each activity was implemented.		✓			✓	
RR2B	Provide information on both the baseline and installed case.		✓			✓	
RR2C	Increase the level of documentation when a single change results in a significant portion of savings.		✓			✓	
RR3A	Consider including a basic description of all end-use equipment served by the gas meter.		✓			✓	
RR3B	Consider using engineering calculations to estimate electricity savings.		✓			✓	
RR3C	Consider reviewing the process for selecting the HDD reference temperature.		✓			✓	

Table 5-3. Summary of recommendations that apply to simulation modeling

#	Simulation Modeling Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
SM1	Provide simulation file and output to the evaluation team.	✓	✓		✓		✓
SM2	Provide more explicit support for major measure installations.	✓	✓				✓
SM3	Consider reviewing and modifying program processes to avoid data entry or outdated simulation result errors.	✓	✓		✓	✓	✓
SM4	Consider funding a study to verify the models produced by the utility agents.			✓		✓	

Table 5-4. Summary of recommendations that apply to cost-effectiveness

#	Cost-effectiveness Recommendation	Applies to			Primary Outcome		
		Union	Enbridge	Evaluation	Reduce Costs	Improve Savings Accuracy	Decrease Risk
CE1	Allocate "sector"-level administrative costs and overhead to each individual program and report program-level cost-effectiveness results.	✓	✓		✓		✓
CE2	Use a consistent real discount rate of 4% when using real streams of benefits and costs.	✓	✓		✓		✓
CE3	Explore the possibility of better defining water avoided costs.	✓	✓	✓	✓		✓
CE4	Work towards better uniformity in methods and assumptions.	✓	✓	✓	✓		✓

Table 5-5. Summary of recommendations that apply to other areas

#	Other Recommendation	Applies to: Union	Applies to: Enbridge	Applies to: Evaluation	Primary Outcome: Reduce Costs	Primary Outcome: Improve Savings Accuracy	Primary Outcome: Decrease Risk
OR1	When the C&I deep savings metric is used, deliver monthly billing data for each C&I participant.	✓					✓
OR2	Provide a detailed explanation for the DSMSI calculation.	✓	✓		✓		✓

5.1.1 Overall annual verification recommendations

O1. Finding: The Enbridge tracking database does not currently include information that allows the evaluator to identify all the projects installed by a single customer. Without this information, the EC could not identify projects installed across customers to determine whether interactive effects may have reduced energy savings. Some prescriptive measures in the Enbridge data did not have site-level information at all, only a summary of the energy savings for that technology across all sites.

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 site-level information for every measure installed in the program.

Outcome: Confirmation that each installation is unique.

O2. Finding: Both utilities invested significant effort in developing Excel-based tracking workbooks that summarized data and calculated DSMSI based on utility-reported results. Union's workbook included a feature that was designed to allow evaluators to enter adjustment factors in a single location and automatically update DSMSI and LRAM calculations. Neither workbook was well suited for evaluation efforts.

Recommendation A: Deliver to evaluators a single, flat file of tracking data.[12] 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 LRAM and cost-effectiveness

The Union tracking data most closely followed this recommendation, but both utilities invested in workbook features that did not enhance evaluation efficiency.

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

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 often struggled to align tracking measures to the correct TRM measure, which resulted in repeated back-and-forth between evaluation and the utilities for clarification. During this process, the EC found that some Enbridge measures were assigned to the wrong sub-category by capacity or other size measure. The EC also found that some Enbridge measures were assigned outdated savings values from previously-approved TRMs.

Recommendation A: Develop and maintain 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.

Recommendation B: Track prescriptive savings using unique measure descriptions that clearly map to the electronic TRM.

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

5.1.2 RunitRight savings recommendations

RR1. Finding: Not all the RunitRight regression models provided a strong fit for the consumption data. In particular, school buildings, which have widely inconsistent occupancy throughout the year, show low R-squared values.

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

Recommendation: Consider including additional independent variables for schools to account for break periods, which may improve the regression fit.

Outcome: More confidence in the reported savings estimates.

RR2. **Finding:** The RunitRight documentation includes a description of the activities at each site, which are documented in the calculation workbook and annual site report. The same level of documentation is included for all activities, regardless of the percentage of savings contributed by that activity.

Recommendation A: Consider including the date when each activity was implemented.

Recommendation B: Provide information on both the baseline and installed case. For example, when a schedule is reset, provide the pre- and post-installation schedule.

Recommendation C: Increase the level of documentation on end use equipment when a change to that equipment results in a significant reduction in consumption.

Outcome: More confidence in the reported savings estimates.

RR3. **Finding:** The evaluator observed a number of opportunities to improve the savings estimates associated with the RunitRight program, including savings at the electric meter. Some sites had base loads that were unexpectedly sensitive to the reference temperature.

Recommendation A: Consider including a basic description of the end-use equipment served by the gas meter, such as DHW, heating, or cooking. This will help the reviewer better assess the consumption patterns occurring over time and the magnitude of base load and weather-sensitive savings estimated.

Recommendation B: Consider using engineering calculations to estimate electric energy savings to capture the full value of the program.

Recommendation C: Consider reviewing the process for selecting the HDD reference temperature to reduce baseload sensitivity.

Outcome: More accurate savings estimates.

5.1.3 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.

Recommendation: Provide both the building simulation file and the program output to the evaluation team. By delivering both, 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.

SM2. **Finding:** Both utilities have market-rate scorecard metrics that rely on a definition of deep savings that is related to the number of “major” measures installed at a site. Both utilities also collect and deliver photographs to support many of the changes made at a home retrofit site. However, the evaluator could not consistently confirm the number or type of major measures installed based on the photographs or other documentation provided.

Recommendation: Consider providing more explicit support for each major measure to eliminate uncertainty around the number of deep savings program participants.

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

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

SM4. **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: 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.

5.1.4 Cost-effectiveness recommendations

CE1. **Finding:** In some cases, the Union program costs were grouped together for several programs. To get program- or sector-level cost-effectiveness results, the EC prorated costs to programs based on natural gas savings.

Recommendation: Allocate “sector”-level administrative costs and overhead to each individual program and report program-level cost-effectiveness results.

Outcome: Greater certainty around program-level achievements.

CE2. **Finding:** Enbridge uses a real discount rate of 4% and applies it to streams of current (nominal) values. However, the real discount rate should only be applied to real (inflation-adjusted) streams of benefits and costs. Nominal discount rates should be applied to streams of current (nominal) values.

Recommendation: Use a consistent real discount rate of 4% for both Enbridge and Union when using “real” (inflation-adjusted) streams of benefits and costs.

Outcome: More accurate cost-effectiveness results.

CE3. **Finding:** Water rates are currently used as a proxy for the water avoided costs. Water avoided costs should only include the marginal impact from reduced consumption. Using the full rate as the avoided cost may be appropriate in some jurisdictions with a completely variable rate structure. However, those with high fixed costs (which, in our experience, can represent 75% to 80% of water costs) should use a true avoided cost.

Recommendation: Explore the possibility of better defining water avoided costs.

Outcome: More accurate cost-effectiveness results.

CE4. **Finding:** The EC found major discrepancies in the way the utilities calculate cost-effectiveness. Some areas of discrepancies included the discount rate, the use of a non-energy benefit adder, the format of reporting results, and the allocation of administration and overhead costs by program. While there is always a balance to be found between uniform methods and the need to account for each specific utility's needs, greater uniformity could be achieved.

Recommendation: Work towards a better uniformity of cost-effectiveness methods and assumptions between the two gas utilities.

Outcome: More accurate and consistent cost-effectiveness results.

5.1.5 Other recommendations

OR1. **Finding:** The Union scorecard includes a metric that relies on an understanding of the whole-building energy use for each C&I program participant. The program data included the total annual consumption at each site, normalized by a regional (north or south) estimate of heating degree days. The calculation appeared to assume that industrial sites were not weather-sensitive but commercial sites were.

Recommendation: When the C&I deep savings metric is used, deliver monthly billing data for each C&I participant to allow the EC to verify the annual consumption values and the weather sensitivity assumptions. Provide the supporting information (and calculation, if possible) for the normalized regional heating degree days.

Outcome: Greater certainty around scorecard achievements.

OR2. **Finding:** The evaluator was unable to locate a source document that supports the utilities' calculation of DSMSI. Given the importance of the shareholder incentive, it is appropriate to have a clearly defined and detailed explanation of how it is calculated.

Recommendation: Provide a detailed explanation for the DSMSI calculation for review by the EC and OEB.

Outcome: Greater certainty around shareholder incentives.

5.2 CPSV / NTG findings and recommendations

As part of the CPSV / NTG evaluations, a number of recommendations were identified. 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 5-6: Energy savings and program performance recommendations

#	Energy Savings and Program Performance Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
ES1	The utilities should continue in their commitment to accuracy.	✓	✓				✓	✓
ES2	Evaluate free-ridership for the programs annually and couple the free-ridership evaluation with process evaluation			✓		✓		
ES3	Error ratios from this report inform sample design for future evaluation.			✓	✓			✓
ES4	Align the program design with cumulative net goals	✓	✓			✓		
ES5	Do not pay incentives until after installation is complete.	✓	✓					✓
ES6	Develop policies to collaborate across electric and gas projects to avoid double-counting fuel savings and increases from energy efficiency measures.	✓	✓					✓
ES7	Consider establishing a policy to define rules around energy savings calculation for fuel switching and district heating/cooling measures.	✓	✓	✓				✓
ES8	Consider establishing a policy that defines an eligibility floor and cap based on simple payback period for energy efficiency projects.	✓	✓			✓		✓
ES9	Consider establishing an official definition for EUL and implementing a study to define EULs for program measures	✓	✓	✓				✓
ES10	Track metrics for how long it takes from the final installation verification to the posting of incentive payments.	✓	✓				✓	
ES11	Increase transparency of "influence adjustments" and do not include in gross	✓				✓	✓	✓

#	Energy Savings and Program Performance Recommendation	Applies to: Union	Applies to: Enbridge	Applies to: Evaluation	Primary Outcome: Reduce Costs	Primary Outcome: Increase Savings	Primary Outcome: Increase Customer Satisfaction	Primary Outcome: Decrease Risk
	savings							
ES12	Conduct a process evaluation to improve Large Volume influence on customer projects	✓				✓	✓	
ES13	Consider approaches to market that leverage third-party vendors.	✓	✓		✓	✓		

Table 5-7: Verification process recommendations

#	Verification Process Recommendation	Applies to: Union	Applies to: Enbridge	Applies to: Evaluation	Primary Outcome: Reduce Costs	Primary Outcome: Increase Savings	Primary Outcome: Increase Customer Satisfaction	Primary Outcome: Decrease Risk
VP1	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.	✓	✓		✓			✓
VP2	The verification and utility staff should agree to a code of conduct for each role during onsite visits.	✓	✓	✓			✓	

Table 5-8: Documentation and Support recommendations

#	Documentation and Support Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DS1	Take steps to improve documentation: • 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	✓	✓			✓		✓
DS2	Ensure that incremental costs are supported by invoices or other documentation	✓	✓					✓
DS3	Increase the amount of documentation and source material for projects that have greater energy savings.	✓	✓					✓
DS4 A	Digitize and file project documentation for all projects as they are completed and paid during project closeout.	✓	✓		✓			✓
DS4 B	Until the utilities can implement an effective digital document storage process, the evaluation should allow more time for the utilities to assemble and deliver the documentation.			✓	✓			✓

#	Documentation and Support Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DS5	Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner.	✓			✓			✓
DS6	Use a consistent summary workbook.		✓		✓			✓

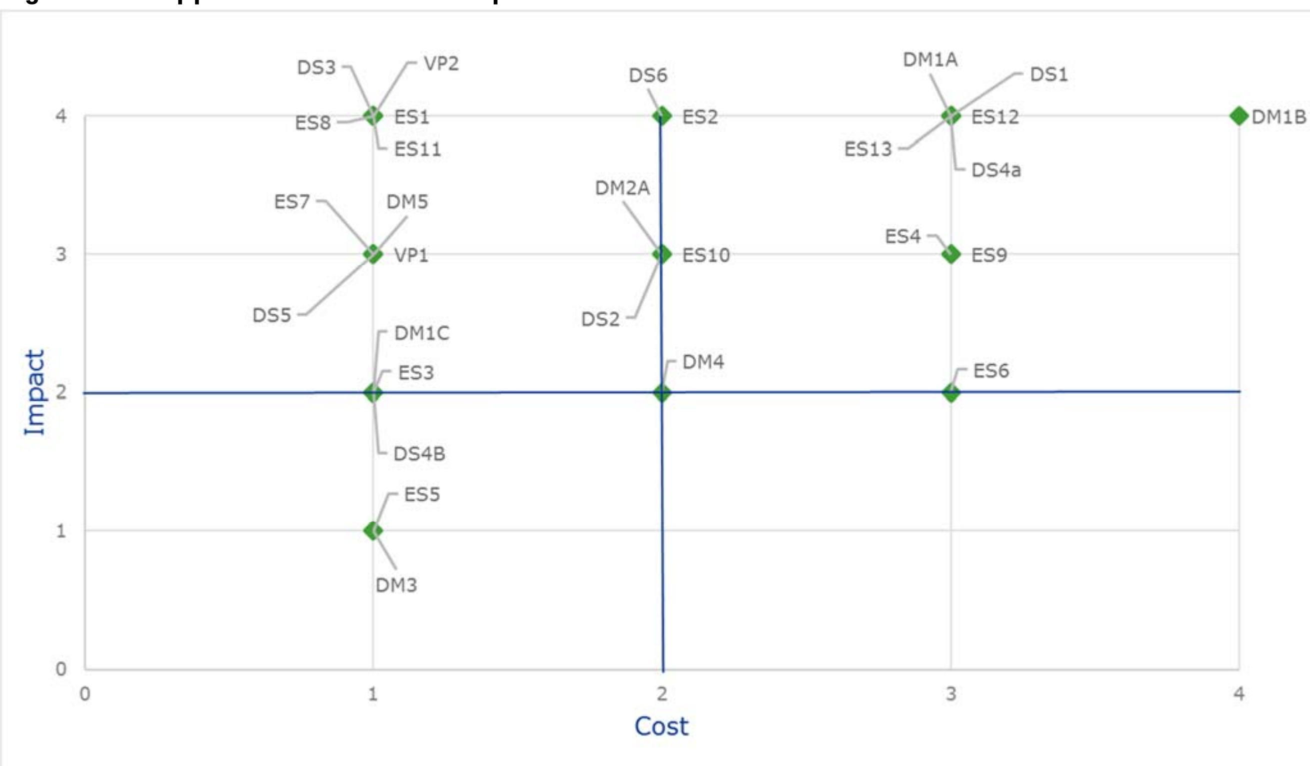
Table 5-9: Data management recommendations

#	Data Management Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DM1 A	Track contacts associated with projects in the program tracking database.	✓	✓		✓			✓
DM1 B	Strongly consider investing in relational program tracking databases.	✓	✓		✓			✓
DM1 C	Include structure for improved data integrity in the evaluator request for contact information for the 2016 and 2017 savings verification and evaluation.			✓	✓		✓	
DM2 A	Consider offering bonus incentives early in the year to combat the “hockey stick” phenomenon where a large percent of projects get closed in the fourth quarter of the year (which results in rushed QC for data).	✓	✓		✓			✓
DM3	Track and provide to evaluators dates for key milestones in the project.	✓	✓		✓			✓
DM4	Maintain a customer identifier in the database to clearly identify related sites.	✓	✓		✓		✓	

#	Data Management Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DM5	Include EUL (also remaining useful life for dual baselines), NTG, and each of the key savings types (i.e., annual and cumulative, gross and net) in the program tracking extracts provided to evaluators.	✓	✓			✓		✓

Figure 5-1 shows an approximate cost vs. impact relation ship for each of the recommendations on a 4-point scale. The upper left quadrant of the figure shows the recommendations that are relatively low cost that would have a high impact. Those in the upper right are recommendations where both cost and impact are high.

Figure 5-1: Approximate Cost vs. Impact of each recommendation



5.2.1 Energy savings and program performance

ES1. 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 understandings of their customers' building and process systems. We had numerous opportunities to interact with these engineers on phone calls and site visits, and have grown to respect their knowledge and engagement with the types of systems that matter to their customers.

Both utilities showed a commitment to finding accurate savings. 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 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.

ES2. Finding: Free-ridership in the utilities' programs is high

Recommendation: With high free-ridership and rapidly changing programs, consistent evaluation of free-ridership annually and free-ridership evaluation coupled with process evaluation will help identify specific ways for each program to manage and reduce free-ridership.

Outcome: Effective free-ridership management will allow the programs to increase their net savings significantly in future years.

ES3. Finding: Relative precision targets were exceeded for some programs and not met for others.

Recommendation: Error ratios from the results provided in this report should be used to inform sample design for future evaluation years.

Outcome: Better defined error ratios for the measures in the programs will allow more efficient sample design for future evaluations, improving precisions and reducing costs.

ES4. Finding: Attribution for the programs came primarily through acceleration rather than changes in efficiency or quantity/size. This is partly due to the measures that dominate the programs: controls, maintenance, and optimisation. These measures do not have varying efficiencies, so the programs are either affecting the number of units implemented or accelerating the measure. Acceleration is less valuable to programs that are seeking to meet cumulative net goals. Acceleration periods tend to be considerably shorter than the estimated useful life (EUL) of a measure and thus the partial attribution that results is low relative to cumulative gross savings.

Recommendation: To align the programs with cumulative net goals, the utilities should seek to:

- continue promoting long life measures and consider discontinuing promotion of short lived measures
- proactively upsell equipment purchases from standard to efficient products
- target hard to reach customers who have not participated in the past
- promote EE measures with low market penetration (such as heat reflector panels)

- motivate customers to increase the scope of their projects, some options include multi-measure bonuses or escalating incentive structures that pay more for doing more

Outcome 1: Focusing on proactive sales rather than reactive will help the net-to-gross (NTG) ratio.

Outcome 2: Effective free-ridership management will allow the program to increase net savings significantly in future years.

ES5. Finding: A handful (<5) of respondents indicated that all or part of their incentivized project had not yet been installed over a year after the incentive was paid.

Recommendation: Do not pay incentives until after installation is complete.

Outcome: Cost-effectiveness of the program will increase as it avoids paying for savings that do not materialize.

ES6. Finding: Some customers receive incentives from their electric provider and natural gas utility to complete the same EE measure. Both providers may claim the same changes in energy use, resulting in overlap when aggregated across fuels at the provincial level.

Recommendation: Develop policies to collaborate across electric and gas projects to avoid double-counting fuel savings and increases from energy efficiency measures.

Outcome: More accurate energy and carbon savings estimates across the province.

ES7. 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.

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

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

ES8. Finding: Projects with very long and very short simple payback periods often have low NTG ratios. However, from a customer service standpoint, it may be difficult for utilities to deny incentives to customers unless they have pre-established rules to point to.

Recommendation: Consider establishing a policy that defines an eligibility floor and cap based on simple payback period for energy efficiency projects.

Outcome: The rule will give utilities a guideline to restrict the program to projects that are more likely to result in net savings. It will also allow the utilities to reject potentially poor projects without a large effect on customer satisfaction.

ES9. Finding: Members of the EAC and evaluation team have different understandings of the definition of some evaluation inputs.

Recommendation: Consider establishing an official definition for EUL and implementing a study to define EUL for all measures, especially steam traps, pipe leaks, steam leaks, condensate leaks, and pipe insulation.

Outcome: The study will improve the accuracy of lifetime savings estimates.

ES10. Finding: A handful (<5) of sites reported unhappiness with delays in receiving their incentive payment (5 months).

Recommendation: Track metrics for how long it takes from the final installation verification to the posting of incentive payments. Consider holding program managers accountable to these metrics by considering them during performance reviews, building in performance bonuses if all payments are posted within one month, and/or implementing a penalty if it takes greater than three months to post any payments.

Outcome: Improved customer satisfaction.

ES11. Finding: Influence adjustments were made to projects that adjusted the gross savings for "net" or program influence reasons. Accounting of which projects had these adjustments was not maintained by the program and the adjustments were included in different places in project calculation workbooks, making their identification challenging. In addition, the program NTG was also applied to these projects, effectively double discounting savings in scorecards.

Recommendation: If the utility chooses to continue making influence adjustments to the savings upon which it calculates savings, these adjustments should be made more transparent and not included in 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.

ES12. Finding: Union's Large Volume program has a very high amount of free-ridership.

Recommendation: This evaluation did not include a process evaluation. Union should consider conducting a process evaluation focused on how to reduce the rate of free-ridership. Three options that the Union might consider are:

- Eliminate measure types with high free-ridership (Union indicated that most maintenance type measures were eliminated in 2016).
- Use an application process that includes a committee review that can reject free riders. This option is hard for utilities to manage as it can affect customer satisfaction negatively
- Clear payback criteria such as initial payback must be longer that X years and the incentive paid must reduce payback below Y years. This has the advantage of being a rule that account representatives can explain when talking to customers.
- Non-energy benefits of projects that large industrial customers gravitate to are often large compared to energy saving benefits, so simple payback criteria will not eliminate all free rider projects. Awareness of this issue should be promoted among the implementation team.

Outcome: Effective free-ridership management may allow the program to increase its net savings significantly in future years.

ES13. Finding: Vendor attribution did not increase overall program attribution significantly. Of the vendors that customers cited as influences, few indicated that either program had much effect on the projects.

Recommendation: The utilities should consider approaches to market that leverage third-party vendors. A process evaluation that includes vendor interviews might uncover opportunities.

Outcome: Effective leveraging of vendors could both increase NTG ratios and increase program uptake.

5.2.2 Verification processes

VP1. 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 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 states: 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 states: 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.

VP2. Finding: Verification engineers and verification forms caused confusion with site contacts and the length of visits also led to a handful of customer complaints. Utility staff at a handful of sites responded to questions in place of participating customers and in one case interfered with data collection.

Recommendation: The verification and utility staff should agree to a code of conduct for each role. The teams should receive clear direction as to the dos and don’ts of all parties involved in site visits, including both verification engineers and utility staff should they attend the visit. Open lines of communication between the site team and utility staff should be maintained to reduce misunderstandings and ensure that the teams are on the same page as to each other’s role.

In general, the following should be part of standard verification practices:

- Ensure site engineer reviews final site report for accuracy post-audit.
- Align data collection forms with site report structure to reduce communication and transcription errors.
- Ensure data appropriate to determining EUL is collected while on-site (i.e., make EUL determination a primary, rather than secondary focus).
- Request specific documentation or data from systems prior to site visit (allowing for adequate time for site contact to obtain).

Outcome: Improved data collection and customer satisfaction.

5.2.3 Documentation and support

DS1. **Finding:** 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
- Energy intensity changes presented without providing the data to justify it
- 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
- Scanned documents that were unreadable
- Input adjustments that approximate other effects, but are not explained
- Insufficient access to customer data (by customers) for confidentiality reasons.
- 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
- Etools files not provided for many industrial boiler & boiler add-on projects

Recommendation: Several steps could be taken to improve data quality:

- 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.

DS2. **Finding:** Invoices were not always included with documentation, and we saw a handful (<5) of cases where utility program staff were overclaiming incremental costs. This did not appear to be systemic, but higher incremental costs enable payment of a larger incentive.

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.

DS3. 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%.

DS4. Finding: Enbridge did not maintain complete digital project files prior to the evaluation request. Union appeared to have digital documentation that was not completely assembled prior to evaluation.

Recommendation A: Digitize and file project documentation for all projects as they are completed and paid during project closeout. PDF and Excel files associated with a project should be stored in a way that allows them to be easily found and associated with a specific project and/or customer. The best practice is to include a document repository as part of the program tracking system with a separate folder for each project.

Recommendation B: Until the utilities can implement an effective digital document storage process, the evaluation should allow more time for the utilities to assemble and deliver the documentation.

Outcome: In our experience, DSM programs that store complete and well-organized digital records experience less evaluation risk. In other words, their gross savings adjustments are closer to 100%. This happens for three reasons:

- Digitization facilitates internal review of project documentation, providing additional opportunities to identify missing information and errors
- Assembly during project closeout improves the comprehensiveness of the documentation because less time has elapsed than if it was assembled for evaluation, so less information is lost or forgotten

Easy retrieval makes it more likely that the complete file is sent to the evaluation team, reducing the information gap between implementation and evaluation.

DS5. 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. 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.

DS6. **Finding:** The 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

DM1. **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 put significant burden on utility staff. When contact information was provided, there were significant data integrity issues including contacts listed in the wrong places, partial addresses, and incorrect or missing phone numbers and email addresses.

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.

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. This allows programs to easily clarify aspects of projects during implementation and to provide accurate, timely, and usable contact information to evaluators and verifiers. 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 B: 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 C: For 2016 (and perhaps 2017), we do not anticipate that contact information will have been entered into the program tracking databases. When the evaluation requests contact information for the 2016 and 2017 savings verification and evaluation, the contact request spreadsheet will be updated 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).

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.

DM2. Finding: Both utilities have indicated that inputting and/or extracting data necessary for annual reporting and evaluation requires significant effort.

Recommendation A: Consider offering bonus incentives early in the year to combat the "hockey stick" phenomenon where a large percent of projects get closed in the fourth quarter of the year.

Outcome: Reduced burden on program staff, more consistency in meeting annual filing deadlines.

Recommendation B: See recommendation DM1B. The utilities should consider investing in a new database.

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

DM3. 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 "installation 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.

DM4. Finding: Customers with multiple sites are not tracked in the program tracking database. A few property management groups had many sites selected in the sample, but it was not clear from project tracking or the provided contact information that the sites were related. Property management firms were the most significant but not the only customer type where this was true.

Recommendation: Maintain a customer identifier in the database to clearly identify related sites. This is easiest to deploy in a relational database see recommendation DM1B.

Outcome: Reduced evaluation costs and reduced customer burden. In some cases, a failure to identify related sites can result in multiple calls to the same customer, which a customer identifier would avoid. In addition, tracking related sites could improve program implementation by increasing awareness of connected opportunities.

DM5. Finding: EUL and cumulative gross savings were not provided in the standard program tracking database extracts. The evaluation team backed out the missing information from the fields provided.

Recommendation: Include EUL (also remaining useful life for dual baselines), NTG, and each of the key savings types (i.e., annual and cumulative, gross and net) in the program tracking database.

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. DATA AND DOCUMENTATION REQUESTS

There were officially two data and documentation requests during the 2015 Annual Verification. In practice, there was repeated back-and-forth between the EC and the utility teams with questions and follow-up information. The 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 January 6, 2017, and the second is a copy of the email sent January 31, 2017.

First documentation request

Memo to: Tina Nicholson, Union Gas Deborah Bullock, Enbridge Gas	**Date:**	January 6, 2017
Copied to: Valerie Bennett, OEB Josh Wasylyk, OEB	**Prep. By:**	Tammy Kuiken, DNV GL

Ontario Gas Portfolio Data Request

This memo formally requests anonymized program tracking data for all Enbridge[13] and Union[14] projects submitted as part of the non-custom program filings for the 2015 program year. It also requests additional reports, data, and other documentation to support the Evaluation Contractor's (EC's) verification of the 2015 program year impacts and scorecard achievements. The deadline for this request is January 20, 2017.

Data already received

Through the CPSV and NTG efforts, we have received and confirmed the completeness of data for the 2015 programs listed in Table A-1.

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

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

Table A-1: 2015 Programs/projects already confirmed

Union Programs	Enbridge Programs
Completeness confirmed	
C&I Custom	Commercial Custom
Large Volume (Custom projects only)	Industrial Custom
Low Income Multi-family (Custom projects only) [15]	Run-it-Right
Market Rate Multi-family (Custom projects only) [16]	

Non-tracking data requested

The EC team is requesting additional data to support our verification of the 2015 program year impacts and scorecard achievements. In addition to the tracking data requested in the rest of this memo, we ask that Union and Enbridge send:

- A copy of Year 2015 verification and evaluation studies
- A copy of any previous verification and evaluation studies that apply to Year 2015 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 2015, if they are not already included in the tracking data
- FOR UNION ONLY: Year 2015 whole-building billing data for all commercial program participants, which will be used to confirm the percent-savings scorecard metric for C&I programs
- FOR ENBRIDGE ONLY: Documentation that confirms the enrollment percentage for the Part 3 scorecard metric

Tracking data requested

The additional programs/projects for which we are requesting 2015 tracking data are shown in Table A-2. Please provide all **anonymized** records associated with the measures installed through these programs as part of the 2015 program year.

[15] Provided August 15th, 2016.

[16] Relevant projects included as part of the C&I Custom program

Table A-2: Additional 2015 programs/projects requested now

Union Programs	Enbridge Programs
Resource Acquisition Requested	
Home Reno Rebate	Residential Home Energy Conservation
Energy Savings Kit	Commercial Prescriptive
Market Rate Multi-family (Prescriptive projects only)	Industrial Prescriptive
Commercial Prescriptive	
Large Volume Requested	
Large Volume (Prescriptive projects only)	
Low Income Requested	
Low Income Weatherization	Low Income Home Winterproofing
Low Income Multi-family Housing (Prescriptive projects only)	Low Income Multi-family Housing (Prescriptive projects only)
Market Transformation Requested	
Optimum Home	Residential Savings by Design
	Commercial Savings by Design
	Home Labelling

The first step in the verification is to confirm that the provided tracking data matches the participant/measure counts and savings reported in the 2015 filings. To perform step one, the evaluation requires the database fields shown in Table A-3. 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 A-3: 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 resource manual (TRM) or agreed-on prescriptive savings documentation applicable to the 2015 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 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 A-4. This list is not comprehensive; please provide all necessary fields for calculating the prescriptive measure savings.

Table A-4: 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 / existing installation	Connects the tracking measure to the appropriate savings value in the TRM.
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 A-5 which includes the fields listed in Table A-3 and Table A-4, in addition to any similar or relevant fields that will aid in the verification. The deadline for this request is January 20, 2017.

Please contact Shane Sankey with any questions or concerns related to this contact information request at (608) 259-9152 ext 70216 or shane.sankey@dnvgl.com.

Thank you in advance for your assistance.

Advance 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. Table A-5 shows the programs that will be included in the documentation request and a brief description of the quantity and type of documentation that will be requested. The final details will be established after the EC reviews the tracking data requested in this memo.

The EC will send the second documentation request on Jan 31, 2017 with a due date of Feb 14, 2017.

Table A-5: Documentation requested in the second round of data requests

Program	Description of Documentation
Union	
Home Reno Rebate	Full documentation for a number (estimate 25 or less) of participants, including HOT2000 model outputs.
Low Income Weatherization	Full documentation for a number (estimate 25 or less) of participants, including HOT2000 model outputs.
Optimal Home	Full documentation for at least one completed house to confirm it meets program requirements. Full documentation for at least one participating builder.
Enbridge	
Home Energy Conservation	Full documentation for a number (estimate 25 or less) of participants, including HOT2000 model outputs.
Low Income Weatherization	Full documentation for a number (estimate 25 or less) of participants, including HOT2000 model outputs.
Residential Savings by Design	Full documentation for at least one completed house to confirm it meets program requirements. Full documentation for at least one participating builder.
Commercial Savings by Design	Full documentation for at least one completed development to confirm it meets program requirements. Full documentation for at least one participating builder.
Home Labelling	Full documentation of at least one realtor commitment and subsequent ratings performed.

Second documentation request

(email sent January 31, 2017)

Enbridge & Union teams,

We have prepared our second data request pertaining to the 2015 Annual Verification. In this request, we are asking for complete documentation for a sample of participants for some of the programs you deliver. For any data pertaining to residential customers or accounts, please anonymize the information prior to sending it to us. The deadline for this request is February 14, 2017.

Here (Table A-6) is a breakdown of the documentation requested in the second round of these data requests. Tomorrow, we will send a secure file listing the specific participants that have been sampled. Here is an overview of what we will request.

Table A-6: Documentation requested in the second round of data requests

Program	Description of Documentation
Union	
Home Reno Rebate	Full documentation for 25 participants, including HOT2000 model outputs.
Low Income Weatherization	Full documentation for 25 participants, including HOT2000 model outputs.
Optimal Home	Full documentation for one completed house to confirm it meets program requirements. Full documentation for one participating builder.
Enbridge	
Home Energy Conservation	Full documentation for 25 participants, including HOT2000 model outputs.
Low Income Weatherization	Full documentation for 25 participants, including HOT2000 model outputs.
Residential Savings by Design	Full documentation for one completed house to confirm it meets program requirements. Full documentation for one participating builder.
Commercial Savings by Design	Full documentation for one completed development to confirm it meets program requirements. Full documentation for one participating builder.
Home Labelling	Full documentation of one realtor commitment and subsequent ratings performed.

APPENDIX B. DESCRIPTION OF DATA RECEIVED

This appendix describes the initial data received from the utilities in response to the data requests shown in APPENDIX A. The appendix also describes the EC process for verifying that the correct data was received. As discussed in APPENDIX A, 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.

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
  - A breakout of the Energy Savings Kit measures by rate class
  - A summary spreadsheet with savings by scorecard, program, and rate class
  - The utility-calculated scorecard results and shareholder incentive based on the utility-reported results
  - The utility-reported budget spending by program and activity (incentives/promotion, administration, evaluation, and promotion costs)
  - A number of tables that format the previous information and add cost-effectiveness results based on utility-reported results
  - A calculation of the C&I deep savings metric
  - A summary of the Optimum Homes built and verified in 2015, by vendor, and the total new gas attachments in 2015
  - 2015 avoided costs
- An Excel file with:
  - The tracking data for 2015, including custom and prescriptive programs
  - A calculation of the Lost Revenue Adjustment Mechanism based on utility-reported results
  - 2015 avoided costs
- An Excel file with the detailed (non-summarized) data for Optimum Home
- Reports from previously-conducted Energy Savings Kit verification studies
- Prescriptive savings tables applicable to 2015
- A document summarizing the Union tracking database procedures
- A report from a previously-conducted custom projects attribution study

Despite some difficulties, the Union data satisfied the initial data request. Some notes on the tracking data:

- The Union tracking data (the first Excel file 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.
- The Union workbook relies heavily on Excel data management formulas to summarize information by program and measure. The formulas are often directed to named data ranges that are difficult to identify and track. This made it harder for the EC team to confirm that the calculation was operating correctly.

- It is unclear whether each record (row) in the data represents the same level of participation. For example, prescriptive projects are listed at the measure level, with one row for air curtain, one row for faucet aerator, etc. However, the custom projects are delineated by equipment vs. infrared poly vs. O&M and whether the measure affects baseload or is weather sensitive. It's unclear whether the custom measures are also tracked at the measure level.
- The data also does not contain a unique identifier, which made it difficult to communicate follow-up data requests with Union.

To verify that we received the correct data, the EC compared the summarized energy savings values with those reported by Union in their annual report. We initially struggled to map the program names to the program offerings and the resulting scorecard; Union provided this mapping in a follow-up email. Ultimately, there were discrepancies in four projects, which had already been identified by Union when they submitted their data. With those adjustments, the EC verified that we had received a complete submission.

Enbridge: first submission

Enbridge's first data submission included the following:

- An Excel file with:
  - The tracking data for 2015, including custom and prescriptive programs, contained in multiple sheets within the workbook
  - A sheet with the prescriptive and quasi-prescriptive measures, with each measure listed individually and summed to the overall measure category.
  - A sheet with the RunitRight savings estimates
  - A sheet summarizing showerhead installations in multi-family residences
  - A sheet summarizing the Home Energy Conservation measures by residence and energy savings
  - A sheet summarizing the Winterproofing energy savings by residence
  - A sheet summarizing the TAPS installations by residence
  - A sheet that incorporates all the previous summaries with the custom project savings for overall savings for the portfolio.
  - 2015 avoided costs and multiple sheets supporting the avoided costs
  - A master reporting sheet that shows, by program and scorecard, the utility-calculated energy savings, number of participants, program-level costs, and cost-effectiveness results based on utility-reported results.
  - The utility-calculated scorecard results and shareholder incentive based on the utility-reported results
- An Excel file with the custom C&I projects from 2013, 2014, and 2015 with two highlighted projects that were removed from the program between delivery of the annual report and the evaluation documentation request.

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. Most sheets 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, the air curtain 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.

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. With the two removals reported by Enbridge, the EC verified that we had received a complete submission.

Union: second submission

Union's second data submission included the following:

- Forty-nine HOT2000 files with personally-identifiable information redacted
- Pre-post installation photos and invoices for the Home Reno Rebate program
- Documentation for Optimum Home Builder T
- Documentation for Optimum Home customer H310

The data satisfied the documentation request.

Enbridge: second submission

Enbridge's second data submission included the following:

- Forty-eight folders with HOT2000 files, pre-post installation photos, and invoices for Home Energy Conservation
- Twenty-five folders with HOT2000 files, pre-post installation photos, and invoices for Winterproofing
- A spreadsheet listing the participating Home Labelling realtors
- A spreadsheet describing the Part 3 buildings metric calculation for the scorecard
- A workbook listing the participating Commercial Savings by Design builders
- A workbook listing the participating Residential Savings by Design builders
- A workbook listing the SBD-compliant homes built by the participating Residential Savings by Design builders

The data satisfied the documentation request.

Recommendations

The EC has the following recommendations resulting from these verification activities:

- **Consider investing in relational program tracking databases.** Relational program tracking databases and customer relationship management (CRM) systems allow for multiple measures to be associated with a single customer. Within this kind of format, each participant should receive a unique customer ID that allows multiple projects or measures to be connected to the single customer or account, with unique IDs attached to each measure.
- **Deliver the tracking data in a single flat worksheet.** While the utility workbooks were helpful to show the EC how the utilities calculate shareholder incentives, lost revenue, and cost-effectiveness, we would prefer to receive the data in a single flat worksheet with no additional summary information. If possible, the data should be delivered using the guidelines in the following bullets. In the event that relational databases are adopted, the entire database can be delivered to the EC and we will assemble it into a single flat file. Guidelines for data delivery:
    - One row per installed measure
    - All measures connected to a unique customer or account identification number
    - No intermediary summary information, such as the sum of savings by measure or building type
    - Related information, such as program name and measures description, that allows the EC to apply the verification results appropriately to calculate shareholder incentive, lost revenue, and cost-effectiveness
- **Enbridge: Ensure that all site-level information is included in the tracking data.**

APPENDIX C. PRESCRIPTIVE SAVINGS VERIFICATION

This appendix describes the detailed process used to certify the reported (tracked) prescriptive and quasi-prescriptive savings for Union and Enbridge. It also describes the process used to verify the Union scorecard metric related to deep savings through the C&I prescriptive and custom programs.

Union: certify prescriptive and quasi-prescriptive savings

The EC reviewed tracked natural gas savings for prescriptive and quasi-prescriptive measures for several Union energy efficiency programs. Tracked gas savings were compared to the OEB's Approved Savings Values Tables ("Savings Tables").[17] Review of the prescriptive and quasi-prescriptive measures resulted in no changes between the original tracked and certified savings, for a savings ratio of 100% of tracked savings, as shown in Table C-1.

Table C-1: Union total claimed and certified gas savings with savings ratio

Measure Group	Original Claimed Savings (m^3)	Certified Savings (m^3)	Savings Ratio
Prescriptive	2,751,561	2,751,561	100%
Quasi-prescriptive	8,935,625	8,935,625	100%
Total	**11,687,186**	**11,687,186**	**100%**

The tracked savings for most measures were easily identified and matched to the correct measure description and prescriptive savings in the Savings Tables. For those that weren't, Table C-2 shows certified annual savings, issues, and their resolutions. There were two primary issues:

- Measure names in the tracking data were not easily matched with those in the Savings Tables.
- The appropriate savings values for measures such as pipe insulation, showerheads, and make-up air units were included in sub-documents to clarify and provide specific values in the Savings Tables. The EC referenced sub-documents 'Basic-Showerhead-1.25 gpm average existing stock (contractor installed)', 'Residential and Low-income pipe wrap subdoc - 2015 SHI', and 'MUA Substantiation Document - 2015 SHI CORRECT'.

Ultimately, all questions were adequately addressed, with Union's claimed gas savings matching verified calculations.

Table C-3 and Table C-4 show the Union tracking and certified annual and lifetime net savings, by measure, for pure prescriptive and quasi-prescriptive measures.

[17] OEB Approved Savings Values Tables represent the input assumptions (natural gas savings values and measure life information for individual technologies and pieces of equipment) that have been approved by the OEB in the past and are applicable to the calculation of overall performance for the 2015 program year.

Table C-2: Union savings certification issues and resolutions, by measure and type

Measure	Measure Type	Issue	Resolution	Tracked Annual Savings (m^3)	Certified Annual Savings (m^3)
Basic-Pipe Insulation - 2m (Low Income, SF)	Prescriptive	Savings values claimed did not match available savings for identifiable like measures in Savings Table.	Union provided approved sub-documents. Upon review, claimed savings values were verified.	1,073	1,073
Basic-Showerhead-1.25 gpm existing 2.0-2.5 (Low Income, SF)	Prescriptive			137	137
Basic-Showerhead-1.25 gpm existing 2.6+ (Low Income, SF)	Prescriptive			1,045	1,045
ERV 6- => 2000 cfm Off, Whse, Ed & All Other Comm	Quasi-Prescriptive	Union data marked single record as having zero savings.	Union verified that zero savings in records was intentional, not a data error.	295,774	295,774
HRV 4- =>2,000cfm-Off,Whse,Man,Ed,Other Comm	Quasi-Prescriptive	Union data marked single record as having zero savings.	Union verified that zero savings in records was intentional, not a data error.	126,512	126,512
Condensing Boiler WH - => 1,000 MBtu/hr	Quasi-Prescriptive	Original Union descriptions not sufficient to properly identify specific boiler type and assign savings. Re-assigned to Savings Tables Categories below.		36,108	
Condensing Boiler WH - => 1,000 MBtu/hr LIMF	Quasi-Prescriptive			11,540	
Condensing Boiler WH - 300 to 999 MBtu/hr	Quasi-Prescriptive			163,685	
Condensing Boiler WH - 300 to 999 MBtu/hr LIMF	Quasi-Prescriptive			34,791	
Condensing Boiler WH - up to 299 MBtu/hr	Quasi-Prescriptive			62,560	
Condensing Boiler WH - up to 299 MBtu/hr LIMF	Quasi-Prescriptive			1,961	
Condensing Boiler - DHW (100 to 199 Mbtu/h)	Quasi-Prescriptive		Union response and explanation allowed proper identification of all boiler types, and thus assign savings values.		19,955
Condensing Boiler - DHW (1000+ Mbtu/h)	Quasi-Prescriptive				36,108
Condensing Boiler - DHW (200 to 299 Mbtu/h)	Quasi-Prescriptive				44,565
Condensing Boiler - DHW (300+ Mbtu/h)	Quasi-Prescriptive				134,490
Condensing Boiler - DHW (600+ Mbtu/h)	Quasi-Prescriptive				75,527

Measure	Measure Type	Issue	Resolution	Tracked Annual Savings (m³)	Certified Annual Savings (m³)
MUA 01- MURB&LTC Imp Effic 1000-4999cfm	Quasi-Prescriptive	Savings values claimed did not match available savings for identifiable like measures in Savings Table.	Union provided sub-document with clarifying and detailed savings values for MUA units.	6,384	6,384
MUA 01- MURB&LTC Imp Effic 1000-4999cfm LIMF	Quasi-Prescriptive			1,596	1,596
MUA 02- MURB&LTC Imp Effic =>5000 cfm	Quasi-Prescriptive			9,768	9,768
MUA 02- MURB&LTC Imp Effic =>5000 cfm LIMF	Quasi-Prescriptive			9,576	9,576
MUA 05- MURB&LTC Effic + VFD 1000-4999 cfm	Quasi-Prescriptive			16,783	16,783
MUA 05- MURB&LTC Effic + VFD 1000-4999 cfm LIMF	Quasi-Prescriptive			52,448	52,448
MUA 06- MURB&LTC Effic + VFD => 5000 cfm LIMF	Quasi-Prescriptive			157,871	157,871
MUA 07- Other Comm Imp Effic 1000-4999 cfm	Quasi-Prescriptive			6,485	6,485
MUA 08- Other Comm Imp Effic => 5000 cfm	Quasi-Prescriptive			35,473	35,473
MUA 09- Other Comm Effic + 2 speed 1000-4999cfm	Quasi-Prescriptive			3,200	3,200
MUA 11- Other Comm Effic + VFD 1000-4999 cfm	Quasi-Prescriptive			8,849	8,849
MUA 12- Other Comm Effic + VFD =>5000 cfm	Quasi-Prescriptive			21,632	21,632

Table C-3: Union tracking and certified savings, annual and lifetime, pure-prescriptive measures

Measure	Draft Utility-Reported Net Savings*		Realization Rate	Certified Net Savings	
	Annual (m^3)	Cumulative (m^3)		Annual (m^3)	Cumulative (m^3)
Air Curtains-Pedestrian >=48 sq ft & < 96 sq ft	28,514	427,714	100%	28,514	427,714
Air Curtains-Pedestrian >=96 sq ft	18,883	283,247	100%	18,883	283,247
Air Curtains-Shipping >=100 sq ft	352,346	5,285,183	100%	352,346	5,285,183
Air Curtains-Shipping >=64 sq ft & < 80 sq ft	7,187	107,801	100%	7,187	107,801
Condensing Gas Water Heater 1- 100gal/day	6,939	90,204	100%	6,939	90,204
Condensing Gas Water Heater 2- 500gal/day	37,321	485,170	100%	37,321	485,170
Condensing Gas Water Heater 3- 1000gal/day	184,181	2,394,356	100%	184,181	2,394,356
DCKV < 5000 cfm - NC	4,561	68,414	100%	4,561	68,414
DCKV < 5000 cfm - RF	45,610	684,143	100%	45,610	684,143
DCKV 10000-15000 cfm - NC	17,978	269,667	100%	17,978	269,667
DCKV 5000 - 9999 cfm - NC	21,823	327,351	100%	21,823	327,351
DCKV 5000 - 9999 cfm - RF	130,940	1,964,106	100%	130,940	1,964,106
Dishwasher - Rack Conveyor Multi HT	3,101	62,021	100%	3,101	62,021
Dishwasher - Rack Conveyor Single HT	1,226	24,528	100%	1,226	24,528
Dishwasher - Stationary Rack Door Type HT	24,341	365,112	100%	24,341	365,112
Dishwasher - Stationary Rack Door Type LT	125,504	1,882,560	100%	125,504	1,882,560
Dishwasher - Stationary Rack Single Rack HT	738	11,064	100%	738	11,064
Dishwasher - Undercounter HT	852	8,520	100%	852	8,520
Energy Star Fryer	79,974	959,693	100%	79,974	959,693
Condensing Gas Water Heater 3- 1000gal/day LIMF	11,788	153,239	100%	11,788	153,239
Basic-Faucet Aerator-Bath	279	2,788	100%	279	2,788
Basic-Faucet Aerator-Kitchen	549	5,493	100%	549	5,493
Basic-Pipe Insulation - 2m	1,073	16,091	100%	1,073	16,091
Basic-Showerhead-1.25 gpm existing 2.0-2.5	137	1,366	100%	137	1,366
Basic-Showerhead-1.25 gpm existing 2.6+	1,045	10,454	100%	1,045	10,454
Basic-Thermostat-Programmable	210	3,148	100%	210	3,148
Astat - WIFI $25	3,927	58,910	100%	3,927	58,910
ESK Pull- Customer Initiated Others (Coupon/Req)	13,017	153,945	100%	13,017	153,945
ESK Pull- Customer Initiated Web Request	539,382	6,379,094	100%	539,382	6,379,094
ESK Push- Door to Door	1,054,602	12,472,428	100%	1,054,602	12,472,428
Pstat- D2C $25	26,464	396,959	100%	26,464	396,959
Smart thermostats $25	7,069	106,037	100%	7,069	106,037

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation.

Table C-4: Union tracking and certified savings, annual and lifetime, quasi-prescriptive measures

Measure	Draft Utility-Reported Net Savings*		Realization Rate	Certified Net Savings	
	Annual (m^3)	Cumulative (m^3)		Annual (m^3)	Cumulative (m^3)
Condensing Boiler - DHW (100 to 199 Mbtu/h)	19,955	498,884	100%	19,955	498,884
Condensing Boiler - DHW (1000+ Mbtu/h)	36,108	902,711	100%	36,108	902,711
Condensing Boiler - DHW (200 to 299 Mbtu/h)	44,566	1,114,151	100%	44,566	1,114,151
Condensing Boiler - DHW (300+ Mbtu/h)	134,490	3,362,248	100%	134,490	3,362,248
Condensing Boiler - DHW (600+ Mbtu/h)	75,527	1,888,174	100%	75,527	1,888,174
Condensing Boiler SH - => 1,000 MBtu/hr	2,027,129	50,678,225	100%	2,027,129	50,678,225
Condensing Boiler SH - => 1,000 MBtu/hr LIMF	61,256	1,531,400	100%	61,256	1,531,400
Condensing Boiler SH - 300 to 999 MBtu/hr	1,252,507	31,312,684	100%	1,252,507	31,312,684
Condensing Boiler SH - 300 to 999 MBtu/hr LIMF	135,425	3,385,629	100%	135,425	3,385,629
Condensing Boiler SH - up to 299 MBtu/hr	270,050	6,751,244	100%	270,050	6,751,244
Condensing Boiler SH - up to 299 MBtu/hr LIMF	15,073	376,813	100%	15,073	376,813
DCV-Office-RTU/MUA => 2500 sq ft-w/o plan	2,721	27,214	100%	2,721	27,214
DCV-Office-RTU/MUA up to 2499 sq ft-w/o plan	2,302	23,024	100%	2,302	23,024
DCV-Retail-RTU/MUA => 5000 sq ft-w/o plan	289,033	2,890,334	100%	289,033	2,890,334
DCV-Retail-RTU/MUA up to 4999 sq ft-w/o plan	15,151	151,510	100%	15,151	151,510
Destratification Fan	856,732	12,850,974	100%	856,732	12,850,974
ERV 1- up to 1999 cfm MURB, Healthcare, Nursing	154,143	2,157,995	100%	154,143	2,157,995
ERV 2- => 2000 cfm MURB, Healthcare, Nursing	442,355	6,192,964	100%	442,355	6,192,964
ERV 3- up to 1999 cfm Hotel, Restaurant, Retail	64,909	908,732	100%	64,909	908,732
ERV 4- => 2000 cfm Hotel, Restaurant, Retail	57,110	799,543	100%	57,110	799,543
ERV 5- up to 1999 cfm Off,Whse,Ed & All Other Comm	167,053	2,338,746	100%	167,053	2,338,746
ERV 6- => 2000 cfm Off,Whse,Ed & All Other Comm	295,774	4,140,840	100%	295,774	4,140,840
HRV 1- 500 to 1999cfm-Hotel,Restaurant,Retail,Rec	14,823	207,523	100%	14,823	207,523
HRV 2- =>2,000cfm-Hotel,Restaurant,Retail,Rec	22,474	314,630	100%	22,474	314,630
HRV 3- 500 to 1999cfm-Off,Whse,Man,Ed,Other Comm	20,781	290,931	100%	20,781	290,931
HRV 4- =>2,000cfm-Off,Whse,Man,Ed,Other Comm	126,512	1,771,173	100%	126,512	1,771,173
HRV 5- MURB, Healthcare, Nursing	101,891	1,426,467	100%	101,891	1,426,467
Infrared Heating 1-Stage - NC <50k	33,807	676,132	100%	33,807	676,132
Infrared Heating 1-Stage - NC 165k+	216,115	4,322,304	100%	216,115	4,322,304
Infrared Heating 1-Stage - NC 50k-165k	296,266	5,925,319	100%	296,266	5,925,319
Infrared Heating 1-Stage - RF <50k	9,937	198,749	100%	9,937	198,749

Measure	Draft Utility-Reported Net Savings*		Realization Rate	Certified Net Savings	
	Annual (m^3)	Cumulative (m^3)		Annual (m^3)	Cumulative (m^3)
Infrared Heating 1-Stage - RF 165k+	246,555	4,931,093	100%	246,555	4,931,093
Infrared Heating 1-Stage - RF 50k-165k	393,291	7,865,821	100%	393,291	7,865,821
Infrared Heating 2-Stage - NC <50k	1,297	25,942	100%	1,297	25,942
Infrared Heating 2-Stage - NC 165k+	71,342	1,426,832	100%	71,342	1,426,832
Infrared Heating 2-Stage - NC 50k-165k	196,433	3,928,652	100%	196,433	3,928,652
Infrared Heating 2-Stage - RF <50k	2,594	51,885	100%	2,594	51,885
Infrared Heating 2-Stage - RF 165k+	77,827	1,556,544	100%	77,827	1,556,544
Infrared Heating 2-Stage - RF 50k-165k	206,339	4,126,787	100%	206,339	4,126,787
MUA 01- MURB&LTC Imp Effic 1000-4999cfm	6,384	95,760	100%	6,384	95,760
MUA 01- MURB&LTC Imp Effic 1000-4999cfm LIMF	1,596	23,940	100%	1,596	23,940
MUA 02- MURB&LTC Imp Effic =>5000 cfm	9,768	146,513	100%	9,768	146,513
MUA 02- MURB&LTC Imp Effic =>5000 cfm LIMF	9,576	143,640	100%	9,576	143,640
MUA 05- MURB&LTC Effic + VFD 1000-4999 cfm	16,783	251,741	100%	16,783	251,741
MUA 05- MURB&LTC Effic + VFD 1000-4999 cfm LIMF	52,448	786,720	100%	52,448	786,720
MUA 06- MURB&LTC Effic + VFD => 5000 cfm LIMF	157,871	2,368,067	100%	157,871	2,368,067
MUA 07- Other Comm Imp Effic 1000-4999 cfm	6,485	97,278	100%	6,485	97,278
MUA 08- Other Comm Imp Effic => 5000 cfm	35,473	532,088	100%	35,473	532,088
MUA 09- Other Comm Effic + 2 speed 1000-4999cfm	3,200	48,005	100%	3,200	48,005
MUA 11- Other Comm Effic + VFD 1000-4999 cfm	8,849	132,739	100%	8,849	132,739
MUA 12- Other Comm Effic + VFD =>5000 cfm	21,632	324,473	100%	21,632	324,473
Ozone WE =< 60 lbs cap & => 200,000 lbs/yr	88,691	1,330,369	100%	88,691	1,330,369
Ozone WE >60 lbs & =< 120lbs & => 200,000 lbs/yr	59,216	888,242	100%	59,216	888,242

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation.

Union: verify percent of deep savings for C&I

To verify the Union scorecard metric related to the percent of whole-building C&I savings, the EC:

- **Identified the deep savings metric explanation in the Union 2015 plan.** The metric is defined as the ratio between the weather-normalized 2015 program savings to the weather-normalized 2014 consumption for all C&I participants.
- **Confirmed the calculation in the Union tracking workbook.** The workbook has a sheet specific to the deep savings metric which has hard-coded energy savings values by "Contract or Banner Customer Number". The sheet also has hard-coded 2014 annual consumption for each customer. The 2014 annual consumption for industrial customers is not normalized; presumably under the assumption that the

industrial load is process-driven, not weather-driven. For commercial customers, the 2014 consumption is multiplied by the equation below, where HDD is heating degree days. There are two separate adjustments; one for facilities in the South and one for the North, each with its own value of HDD.

$$normalized\ consumption = \frac{(normal\ HDD - 2014\ HDD)}{normal\ HDD} * C\&I\ baseload\ elasticity\ factor$$

- **Verified the site-level pre-adjusted savings values.** The EC confirmed the site-level savings estimates for each C&I site by summing the savings from the tracking data by Contrax or Banner number and comparing to the deep savings spreadsheet.
- **Adjusted the savings based on the custom project savings verification (CPSV) and prescriptive certification results.** The EC applied the appropriate realization rates from the CPSV and prescriptive certification efforts. For the prescriptive certification, shown in Table C-1, the savings ratio was 100%. For the CPSV study, the overall gross savings realization rate was 98%, shown in Table C-5.

Table C-5: Union custom C&I realization rate

Domain	n	Ratio	90% Confidence Interval				Error Ratio	% Program Savings
			+/-	Lower Bound	Upper Bound	Relative Precision		
Agriculture & Greenhouse-Banner	4	100%	14%	87%	114%	14%	0.12	3%
Agriculture & Greenhouse-Contrax	27	97%	3%	94%	100%	3%	0.06	38%
Commercial & Institutional Buildings-Banner	12	87%	15%	72%	102%	17%	0.29	3%
Commercial & Institutional Buildings-Contrax	17	87%	27%	60%	114%	31%	0.54	15%
Industrial-Banner	12	98%	15%	83%	113%	16%	0.23	3%
Industrial-Contrax	37	102%	7%	95%	110%	7%	0.21	37%
Low Income Multi-Family Custom	5	100%	0%	100%	100%	0%	0.00	0%
Overall	**114**	**98%**	**4%**	**94%**	**101%**	**4%**	**0.20**	**100%**

Monthly billing data was not provided, so the EC could not confirm the annual 2014 consumption. With the adjustment factors applied, the resulting verified scorecard metric is 8.08% of whole building energy use saved.

Enbridge: certify prescriptive and quasi-prescriptive savings

The EC reviewed tracked natural gas savings for prescriptive and quasi-prescriptive measures for several Enbridge energy efficiency programs. Tracked gas savings were compared to the OEB's Savings Tables. Review of the prescriptive and quasi-prescriptive measures resulted in a savings ratio of 98.9% of tracked savings, as shown in Table C-6.

Table C-6: Enbridge total claimed and certified gas savings with savings ratio

Measure Group	Original Claimed Net Annual Savings (m^3)	Certified Net Annual Savings (m^3)	Savings Ratio
Prescriptive	2,672,814	2,615,853	97.9%
Quasi-prescriptive	3,824,270	3,812,871	99.7%
Total	**6,497,084**	**6,428,724**	**98.9%**

The EC found few issues with the savings for prescriptive measures. The savings for bathroom aerators for the Low Income program were significantly underreported because they were initially calculated using the suites or households in which they were installed instead of the quantity of aerators installed. The verified savings include the appropriate correction.

Some of the quasi-prescriptive savings were over-reported. Table C-7 shows certified annual savings, issues, and their resolutions. There were two primary issues:

- Multiple measures (based on equipment capacity or building type) were included in a single reporting category.
- Individual reports had calculation issues.

Table C-8 and Table C-9 show the Enbridge tracking and certified annual and lifetime net savings, by measure, for pure prescriptive and quasi-prescriptive measures.

Some Enbridge measures include “removal rates” that account for direct-install equipment that is later removed by the user. These measures include market-rate and low income multifamily showerheads and single family low income bathroom aerators, kitchen aerators, and showerheads. Enbridge included the effect of the removal rates in their net savings, not gross, which results in a net savings number that does not exclusively account for free ridership and spillover. To avoid confusion, the EC team moved the adjustment from the net savings to gross savings when reporting verified results.[18]

[18] The transfer was made by dividing the net savings by (1-removal rate) and multiplying the gross savings by (1-removal rate).

Table C-7: Enbridge savings certification issues and resolutions, by measure and type

Measure	Measure Type	Issue	Resolution	Tracked Annual Net Savings (m^3)	Certified Annual Net Savings (m^3)
LI Prescriptive - Bathroom Aerators	Prescriptive	Specific aerator type, identifying gpm, not identifiable.	Specific aerator type provided in March telephone conference call.	638	773
		Total savings calculated off households, not measures.	April response document confirmed that savings to be calculated from number of measures.		
		Unidentified Reduction Factor included in data.	Enbridge claimed reduction factor is accepted.		
LI Prescriptive - Kitchen Aerators	Prescriptive	Specific aerator type, identifying gpm, not identifiable.	Specific aerator type provided in March telephone conference call.	1,500	1,500
		Unidentified Reduction Factor included in data.	Enbridge claimed reduction factor is accepted.		
LI Prescriptive - Showerheads 2.6+	Prescriptive	Specific type, identifying gpm, not identifiable.	Specific aerator type provided in March telephone conference call.	6,020	6,020
		Total savings calculated off households, not measures.	Enbridge confirmed intentional that savings based on suite, not measures.		
		Unidentified Reduction Factor included in data.	Enbridge claimed reduction factor is accepted.		
LI Prescriptive – Novitherm Reflective Panels	Prescriptive	Enbridge data calculated lifetime savings using 18 year measure life	TRM value for measure life of 25 years used, an increase from 18 year citation.	**CCM:** 10,296	**CCM:** 14,320
RA.DCKV.1	Prescriptive	Some calculations used outdated TRC/CCM calculator.	Corrected savings calculated for units using outdated calculator.	54,731	43,963
RA.DCKV.2	Prescriptive			283,704	259,770
RA.DCKV.3	Prescriptive			107,867	99,915
RA.DISH.ST.RACK.HT	Prescriptive	In the course of supplying site-specific information, Enbridge discovered that the original count of units was incorrect.	Corrected savings calculated using the correct number of units.	24,341	25,078
RA.DISH.ST.RACK.LT	Prescriptive			376,512	361,148
RA.DISH.HT	Prescriptive			1,278	1,363
LW.MR.HEBO (Space Htg)	Quasi-Prescriptive	Enbridge identified calculation and data entry error.	Enbridge provided corrected values for inclusion in certified values.	130,116	137,254

Measure	Measure Type	Issue	Resolution	Tracked Annual Net Savings (m^3)	Certified Annual Net Savings (m^3)
RA.CB 2 (Space Htg)	Quasi-Prescriptive	Savings for 1 of 5 measures not matching.	Equipment capacity reported incorrectly for calculations. Enbridge provided corrected values.	13,485	13,485
RA.CB 3 (Space Htg)	Quasi-Prescriptive	One unit incorrectly reported as condensing boiler for space heat was for DHW.	Unit redefined as Condensing Boiler for DHW. Total savings unchanged.	40,746	38,664
RA.CB 3 (Water Htg)	Quasi-Prescriptive			-	2,082
RA.COND.MUA	Quasi-Prescriptive	In the course of evaluating savings, EC requested additional equipment information to calculate and confirm savings. In resulting additional data submission, Enbridge included revised savings value for RA.COND.MUA savings.	The revised submission agreed with EC calculations, but was different from original value.	11,875	11,590
RA.DCV - 15 Year ML	Quasi-Prescriptive	Mixed category with both Commercial and Retail measures, which have different savings calculations	Redefined into separate categories. One measure was utilizing wrong savings calculation, claiming Retail savings but classified as Commercial, resulting in savings reductions.	964,074	953,587
RA.HEBO (Space Htg)	Quasi-Prescriptive	Multiple Savings types/classes included in single category. Savings calculation issues with misc. reports	Reclassified into correct sub-categories by capacity. Corrected savings calculated	486,228	479,409
RA.HEBO.MR (Space Htg)	Quasi-Prescriptive	Multiple Savings types/classes included in single category. Savings calculation issues with misc. reports	Reclassified into correct sub-categories by capacity. Corrected savings calculated	288,426	296,885
RA.HEBO.MR (Water Htg)	Quasi-Prescriptive	Multiple Savings types/classes included in single category. Savings calculation issues with misc. reports	Reclassified into correct sub-categories by capacity. Corrected savings calculated	45,462	29,580

Measure	Measure Type	Issue	Resolution	Tracked Annual Net Savings (m^3)	Certified Annual Net Savings (m^3)
RA.OZ, RA.OZ.2, RA.OZ.3, RA.OZ.5	Quasi-Prescriptive	Multiple Savings types/classes included in single category, ultimately causing underreporting	Reclassified into correct sub-categories by capacity.	607,874	614,455

Table C-8: Enbridge tracking and certified savings, annual and lifetime, pure-prescriptive measures

Measure	Draft Utility-Reported Net Savings*		Annual Realization Rate†	Certified Net Savings	
	Annual (m^3)	Cumulative (m^3)		Annual (m^3)	Cumulative (m^3)
LI Prescriptive - Bathroom Aerators	638	6,379	121%	773	7,733
LI Prescriptive - Kitchen Aerators	1,500	14,999	100%	1,500	14,999
LI Prescriptive - Novitherm Reflective Panels	572	10,296	100%	573	14,320
LI Prescriptive - Programmable Thermostats	2,862	42,930	100%	2,862	42,930
LI Prescriptive - Showerheads 2.6+	6,020	60,197	100%	6,020	60,197
Multi Family Low Income Showerheads	198,543	1,985,432	100%	198,543	1,985,432
RA.AIR	5,703	85,543	100%	5,703	85,543
RA.AIR.2	15,978	239,671	100%	15,978	239,671
RA.AIR.4	17,968	269,525	100%	17,968	269,525
RA.AIR.4.IND	17,968	269,525	100%	17,968	269,525
RA.AIR.5	78,299	1,174,485	100%	78,299	1,174,485
RA.AIR.5.IND	58,724	880,864	100%	58,724	880,864
RA.DCKV.1	54,731	820,971	80%	43,963	659,447
RA.DCKV.2	283,704	4,255,563	92%	259,770	3,896,549
RA.DCKV.3	107,867	1,618,002	93%	99,915	1,498,730
RA.DISH.HT	1,278	12,780	107%	1,363	13,632
RA.DISH.LT	3,397	33,966	100%	3,397	33,966
RA.DISH.RACKCON.MULTI.LT	1,802	36,047	100%	1,802	36,047
RA.DISH.RACKCON.SINGL	818	16,352	100%	818	16,352
RA.DISH.RACKCON.SINGL LT	51,240	1,024,803	100%	51,240	1,024,803
RA.DISH.ST.RACK.HT	24,341	365,112	103%	25,078	376,176
RA.DISH.ST.RACK.LT	376,512	5,647,680	96%	361,248	5,418,720
RA.FS.FRYER	105,882	1,270,579	100%	105,882	1,270,579
RA.FS.OVEN	6,228	74,736	100%	6,228	74,736
RA.FS.STCOOK	7,111	85,334	100%	7,111	85,334
RA.SCH.P (Elementary School)	193,517	4,837,932	100%	193,517	4,837,932
RA.SCH.P (Secondary School)	261,233	6,530,832	100%	261,233	6,530,832
RA.SHA	788,377	7,883,769	100%	788,377	7,883,769

†These values are rounded.

Table C-9: Enbridge tracking and certified savings, annual and lifetime, quasi-prescriptive measures

Measure	Draft Utility-Reported Net Savings*		Annual Realization Rate†	Certified Net Savings	
	Annual (m^3)	Cumulative (m^3)		Annual (m^3)	Cumulative (m^3)
LW.MR.HEBO (Space Htg)	130,116	3,252,900	105%	137,254	3,431,359
LW.MR.HEBO (Water Htg)	7,475	186,875	100%	7,475	186,882
RA.CB 1 (Space Htg)	1,046	26,149	100%	1,045	26,137
RA.CB 2 (Space Htg)	13,485	337,131	100%	13,485	337,123
RA.CB 3 (Space Htg)	40,746	1,018,661	95%	38,664	966,598
RA.CB 3 (Water Htg)	-	-	N/A	2,082	52,041
RA.COND.MUA	11,845	178,125	98%	11,590	173,850
RA.DCV - 10 Year ML - Retail	44,099	440,990	100%	44,099	440,989
RA.DCV - 15 Year ML - Commercial	21,260	318,901	51%	10,767	161,498
RA.DCV - 15 Year ML - Retail	942,814	14,142,213	100%	942,820	14,142,305
RA.ERV 1	51,041	714,569	100%	51,041	714,569
RA.ERV.3	5,772	80,811	100%	5,772	80,811
RA.HEB.199	1,248	31,208	100%	1,248	31,192
RA.HEB.99	272	6,793	100%	272	6,797
RA.HEBO (Space Htg)	486,228	12,155,704	99%	479,409	11,985,219
RA.HEBO (Water Htg)	1,638	40,942	100%	1,637	40,933
RA.HEBO.MR (Space Htg)	288,426	7,210,640	103%	296,885	7,422,115
RA.HEBO.MR (Water Htg)	45,462	1,136,540	65%	29,580	739,511
RA.HRV	19,465	272,504	100%	19,464	272,497
RA.HRV.2	1,736	24,299	94%	1,632	22,841
RA.HRV.3	74,246	1,039,448	100%	74,247	1,039,453
RA.INFRD	5,345	106,900	100%	5,345	106,900
RA.INFRD.2	266,827	5,336,535	100%	266,827	5,336,535
RA.INFRD.3	133,193	2,663,855	100%	133,193	2,663,855
RA.INFRD.4	3,243	64,856	100%	3,243	64,856
RA.INFRD.5	83,262	1,665,240	100%	83,262	1,665,240
RA.INFRD.6	213,946	4,278,912	100%	213,946	4,278,912
RA.INFRD.IND.2	154,664	3,093,283	100%	154,664	3,093,283
RA.INFRD.IND.3	129,525	2,590,496	100%	129,525	2,590,496
RA.INFRD.IND.5	17,999	359,976	100%	17,999	359,976
RA.INFRD.IND.6	19,943	398,864	100%	19,943	398,864
RA.OZ	157,130	2,356,943	107%	168,221	2,523,310
RA.OZ.2	44,366	665,491	100%	44,366	665,488

Measure	Draft Utility-Reported Net Savings*		Annual Realization Rate†	Certified Net Savings	
	Annual (m^3)	Cumulative (m^3)		Annual (m^3)	Cumulative (m^3)
RA.OZ.3	223,036	3,345,534	102%	227,129	3,406,931
RA.OZ.5	183,343	2,750,147	95%	174,740	2,621,094

†These values are rounded.

Recommendations

The EC has the following recommendations resulting from these verification activities:

- **Consider investing in relational program tracking databases.** Relational program tracking databases and customer relationship management (CRM) systems allow for multiple measures to be associated with a single customer. Within this kind of format, each participant should receive a unique customer ID that allows multiple projects or measures to be connected to the single customer or account, with unique IDs attached to each measure.
- **Deliver the tracking data in a single flat worksheet.** While the utility workbooks were helpful to show the EC how the utilities calculate shareholder incentives, lost revenue, and cost-effectiveness, the EC would prefer to receive the data in a single flat worksheet with no additional summary information. If possible, the data should be delivered using the guidelines in the following bullets. In the event that relational databases are adopted, the entire database can be delivered to the EC and we will assemble it into a single flat file. Guidelines for data delivery:
  - One row per installed measure
  - All measures connected to a unique customer or account identification number
  - No intermediary summary information, such as the sum of savings by measure or building type
  - Related information, such as program name and measures description, that allows the EC to apply the verification results appropriately to calculate shareholder incentive, lost revenue, and cost-effectiveness
- **Develop and maintain an electronic summary of the TRM.** To facilitate savings certification, the TRM should be summarized in an electronic spreadsheet, 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 helps the savings certification identify when, for example, a previous measure was not updated correctly.
- **Track prescriptive savings using unique measure descriptions that clearly map to the electronic TRM.** To facilitate savings certification, each record in the tracking data should easily and immediately map to the electronic TRM. This allows the EC to confirm which measure is installed and identify the appropriate savings estimate for that measure.
- **Deliver additional data for the C&I deep savings verification.** Union should deliver billing data for each C&I participant to allow the EC to verify the annual consumption values. In addition, Union should provide supporting information (and a calculation, if possible) for the normalized heating degree days to allow the EC to verify that the correct values are used.

APPENDIX D. RESIDENTIAL RETROFIT PROGRAM VERIFICATION

This appendix describes the detailed process used to verify the reported residential retrofit program savings and number of deep savings participants for Union and Enbridge. The programs addressed are the Home Reno Rebate and Low Income Weatherization programs for Union and the Home Energy Conservation and Winterproofing programs for Enbridge.

Union Home Reno Rebate program

The EC requested the full documentation from a sample of 25 participants of the Home Reno Rebate program. The sample was selected at random from the population of participants in the tracking data. The EC received 25 file folders, one for each participant. The typical file folder had the following information:

- Photographs of pre- and post-installation conditions
- A redacted data collection form with personally identifiable information removed
- HOT2000 simulation output in the form of a TSV file, which contained some inputs and some simulation-produced results, including the simulated estimate of annual gas and electric usage.

The folders did not contain the actual building simulation files, only the simulation output. The folders also contained different identification numbers than those in the tracking data. The EC requested and received a mapping file to connect the tracking records to the correct simulation results. One file did not appear to have both the pre-installation and post-installation simulation results; after a follow-up request, the file was declared the correct output with an incorrect file name.

The EC created an analysis sheet that calculated the simulation-based energy savings[19] and compared it to the tracking data. All 25 sites had differences between the tracking results and the simulation results; however, a certain level of discrepancy had been expected.[20] The EC defined a tolerance band of ±2% of natural gas or electricity savings. Nine projects fell within the tolerance band, leaving 16 projects that showed discrepancies between the simulation results and tracking savings.

The EC requested an explanation for the discrepancies. Union provided the following comment:

> Union relies upon its service providers to run HOT2000 in accordance with the requirements of Union's program. This sometimes involves running models that are different than what is required by NRCan for use of the HOT2000 software. Service providers do their best to retain all appropriate model scenarios/corrections/amendments but sometimes not all get saved. Service providers are also the parties responsible for data entering the HOT2000 output used by Union for program results. Service providers do their best to ensure data entered captures all modeling amendments but some changes may not ultimately get captured as well as they should be.

[19] The calculation subtracted the energy use of the post-installation simulation results from the energy use of the pre-installation simulation results.

[20] The program delivery agents use HOT2000 in the EnerGuide Rating mode, which is only available for Service Organizations and Energy Advisors licensed to deliver the EnerGuide Rating Service for Natural Resources Canada. All other entities must use the General mode, which does not have the same capabilities. HOT2000 simulations created in EnerGuide mode might not run in the General mode. If they do run, the General mode may produce different savings results.

Union reviewed the 16 projects and provided the explanations for the discrepancies shown in Table D-1. The table also shows how each discrepancy was addressed by the EC to produce verified savings. Four of the projects could not be explained; Union suggested they might be models that include upgrades that did not receive an incentive, but Union did not have confirmation of that assumption. They may also have been data entry errors. The EC chose to treat them as if they were data entry errors because it is the option that assigns responsibility to the utilities.

Table D-1: Union: description of Home Reno Rebate discrepancies and how they were addressed

Discrepancy	#	How Addressed for Verified Savings
Data entry error	5	The verified savings were set equal to those calculated from the simulation output.
HOT2000 model includes upgrades that did not receive an incentive	3	The verified savings were set equal to the tracking savings.
Unknown; might be either of the first two discrepancies	4	The EC assumed a data entry error and the verified savings were set equal to those calculated from the simulation output.
Something was initially modeled incorrectly; new model uploaded but tracking not changed	3	The verified savings were set equal to those calculated from the simulation output.

The EC used the results of the review to produce a realization rate for electric and gas, shown in Table D-2. The gross savings realization rate for natural gas is 98%.

Table D-2: Union Home Reno Rebate gross savings realization rate

Fuel	n Houses	Ratio	90% Confidence Interval			
			+/-	Lower Bound	Upper Bound	Relative Precision
Natural Gas	25	98%	6%	92%	104%	7%
Electricity	25	88%	18%	70%	106%	21%

The EC also reviewed the number of deep savings participants, which is one of the Resource Acquisition scorecard metrics. The deep savings metric measures participants that "achieve a minimum gas savings of 11,000 cumulative m^3 (based on HOT2000 software used in EnerGuide mode), and implement a minimum of two major measures in their home as outlined in Exhibit A, Tab 3, Appendix A, Section 1.0."[21] The aggregate of all of the deep savings homes must also achieve at least a 25% reduction in their annual gas usage for space and water heating. The major measures include basement insulation, exterior wall insulation, attic insulation, air sealing, furnace/boiler installation, water heater installation, or a window/door/skylight.

Table D-3 shows the EC activities used to verify the number of deep savings participants and the outcome of each activity.

[21] EB-2015-0029 – Union Gas Limited – 2015-2020 DSM Plan, Exhibit A, Tab 2, Page 13 of 38.

Table D-3: Union deep savings participant verification activities and outcomes

Verification Activity	Outcome
Confirm that two major measures were installed for each sampled site.	Confirmed for 6 of 25 sites using the supplied photos. For the remaining sites, photos only verified one major measure.*
Calculate verified cumulative savings for each sampled site and confirm over 11,000 cumulative m^3.	Three of 25 sites did not have cumulative savings over 11,000 cumulative m^3 but were identified as deep savings participants.
Calculate the average percent reduction across the sample and confirm greater than 25%.	By assuming that the total natural gas consumption was equal to the space and water heat consumption, we were able to calculate an average savings reduction of 29%.
Apply the gross realization rate to the population and determine the number of qualifying deep savings participants.	The EC found 2,529 qualifying deep savings participants compared to 2,537 reported by the program.

*Despite the low confirmation rate, the EC did not adjust the outcome based on the initial review. Though the activity did not confirm that there were two major measures, it also did not confirm that there were not. It's likely that the second major measure was more difficult to visually confirm, such as air sealing.

Union Low Income Weatherization program

The EC requested the full documentation from a sample of 25 participants of the Low Income Weatherization program replacement measures. The replacement measures are the whole-house improvements, as opposed to the retrofit measures, which are select direct-install equipment such as faucet aerators and showerheads. The sample was selected at random from the population of participants in the tracking data. The EC received 25 file folders, one for each participant. The typical file folder contained the following documentation:

- Photographs of pre- and post-installation conditions
- A redacted declaration and consent form with personally identifiable information removed
- Two HOT2000 simulation files

One of the simulation files was not immediately transferred; the EC submitted an additional request and it was provided.

The EC created an analysis sheet that calculated the simulation-based energy savings and compared it to the tracking data. Each pre- and post-installation simulation file was opened, run, and the energy usage was entered in the analysis sheet. The savings were determined by subtracting the post-installation results from the pre-installation results.

The EC was unable to run both pre- and post-installation simulations for seven of the 25 sites. Of those that were run, the energy savings from the simulation matched the tracking savings for eight customers. The EC requested additional information for the seven un-run sites and explanations for the 10 sites that were run but had discrepancies. Union responded with the output from the TSV files for 15 of the 17 sites; two could not be re-run.

With the additional files, the EC could finalize the verified savings for the Union Low Income Weatherization program. The simulation savings matched the tracking savings for 19 of the 25 sites. For four records, the savings differed, possibly because of data entry errors; the EC set the verified savings equal to those calculated from the simulation output for those sites. The final two sites were removed from the sample because their savings could not be verified.

The EC used the results of the review to produce a realization rate for electric and gas, shown in Table D-4. The gross savings realization rate for natural gas is 107%.

Table D-4: Union Low Income Weatherization gross savings realization rate

Fuel	n Houses	Ratio	90% Confidence Interval			
			+/-	Lower Bound	Upper Bound	Relative Precision
Natural Gas	23	107%	10%	93%	117%	9%
Electricity	23	99%	15%	84%	114%	16%

Enbridge Home Energy Conservation program

The EC requested the full documentation from a sample of 25 participants of the Home Energy Conservation program. The sample was selected at random from the population of participants in the tracking data. The EC received many file folders; in many but not all cases, there were two folders per site. The typical file folder had the following information:

- Photographs of pre- and post-installation conditions
- A redacted participation form with personally identifiable information removed
- Invoice information
- HOT2000 simulation files

One site's simulations were modeled in REM/Rate and could not be verified; this site was removed from the sample.

The EC created an analysis sheet that calculated the simulation-based energy savings[22] and compared it to the tracking data. Fourteen of the 24 sites were verified to have savings within ±2% of natural gas and electricity savings, leaving 10 projects that showed discrepancies between the simulation results and tracking savings.

The EC requested an explanation for the discrepancies. Enbridge provided the TSV files for each of the 10 simulations. Two sites were found to have a difference greater than 2% between tracking and verified savings, which resulted from data entry errors. The EC set verified savings for those sites equal to the simulation results.

The EC used the results of the review to produce a realization rate for gas savings, shown in Table D-5. The EC did not calculate an electricity realization rate because the program did not summarize the electricity savings in the documentation they provided. The gross savings realization rate for natural gas is 100%.

[22] The calculation subtracted the energy use of the post-installation simulation results from the energy use of the pre-installation simulation results.

Table D-5: Enbridge Home Energy Conservation gross savings realization rate

Fuel	n Houses	Ratio	90% Confidence Interval			
			+/-	Lower Bound	Upper Bound	Relative Precision
Natural Gas	24	100%	2%	98%	102%	2%

The EC also reviewed the number of deep savings participants, which is one of the Resource Acquisition scorecard metrics. The deep savings metric measures participants with "at least two major measures."[23] The aggregate of all of the deep savings homes must also achieve at least a 25% reduction in their annual gas usage for space and water heating.

Table D-6 shows the EC activities used to verify the number of deep savings participants and the outcome of each activity.

Table D-6: Enbridge deep savings participant verification activities and outcomes

Verification Activity	Outcome
Confirm that two major measures were installed for each sampled site.	Confirmed for 6 of 24 sites using the supplied photos. For the remaining sites, photos only verified one major measure.*
Calculate the average percent reduction across the sample and confirm greater than 25%.	By assuming that the total natural gas consumption was equal to the space and water heat consumption, we were able to calculate an average savings reduction of 31%.
Calculate the percent reduction for each sample site and compare it to the tracking values.	There were 2 sites with differences; overall, however, the adjusted result was still greater than 25%.
Apply the gross realization rate to the population and determine the number of qualifying deep savings participants.	The EC found 5,646 qualifying deep savings participants, which is the same number reported by the utility.

*Despite the low confirmation rate, the EC did not adjust the outcome based on the initial review. Though the activity did not confirm that there were two major measures, it also did not confirm that there were not. It's likely that the second major measure was more difficult to visually confirm, such as air sealing.

Enbridge Winterproofing program

The EC requested the full documentation from a sample of 25 participants of the Winterproofing program. The sample was selected at random from the population of participants in the tracking data. The EC received 25 file folders, one for each participant. The typical file folder contained the following documentation:

- Photographs of pre- and post-installation conditions
- Redacted data collection forms with personally identifiable information removed
- Simulation files or output reports: these included HOT2000 or REM/Rate

The EC created an analysis sheet that calculated the simulation-based energy savings and compared it to the tracking data. Each pre- and post-installation simulation file was opened, run, and the energy savings were entered in the analysis sheet. The savings were determined by subtracting the post-installation results from the pre-installation results.

[23] EB-2015-0049 – Enbridge Gas Distribution Inc. – Multi-Year Demand Side Management Plan (2015 to 2020), Exhibit B, Tab 1, Page 6 of 19.

The EC requested additional information on many of the files. The request and resolution are shown in Table D-7. One site was found to have a difference greater than 2% between tracking and verified savings, which resulted from a data entry error. The EC set verified savings for that site equal to the simulation results.

Table D-7: Enbridge Winterproofing follow-up questions and resolution

Follow-up Question	Resolution
Seven sites had only one simulation file.	The software allows for a comparison of both the base and upgrade case in one file.
Four sites had post-installation files with different file numbers, which was inconsistent with the naming convention.	The delivery agent does not follow the same naming convention; the provided files were correct.
Two sites had pre- and post-installation simulations that showed the same consumption.	The pre-installation file had a base and upgrade case; the second file was sent in error.
Seven sites had energy savings that were greater than 2% different from the tracking savings.	Enbridge provided screen shots for each site supporting the tracking data.

The EC used the results of the review to produce a realization rate for gas savings, shown in Table D-8. The EC did not calculate an electricity realization rate because the information to do so was not consistently available. The gross savings realization rate for natural gas is 99%.

Table D-8: Enbridge Winterproofing gross savings realization rate

Fuel	n Houses	Ratio	90% Confidence Interval			
			+ / -	Lower Bound	Upper Bound	Relative Precision
Natural Gas	25	99%	< 1%	98%	100%	< 1%

Overall savings

The overall tracking and verified savings for the home retrofit programs are shown in Table D-9.

Table D-9. Overall tracking and verified savings for home retrofit programs

Program	Utility-Reported Draft Gross Cumulative Savings (m^3)	Gross Realization Rate†	Verified Gross Cumulative Savings (m^3)
Union			
Home Reno Rebate	69,321,370	98%	67,934,943
Home Weatherization	33,505,239	107%	35,847,824
Enbridge			
Home Energy Conservation	120,488,487	100%	120,488,487
Winterproofing	28,410,725	99%	28,067,264

†These values are rounded.

Recommendations

The EC has the following recommendations resulting from these verification activities:

- **Provide both the building simulation file and program output to the evaluation team.** The EC was unable to verify all of the tracking savings directly from the simulation files because some simulations could not be run. Providing both the output files and the simulation models would allow the EC to verify savings without additional follow-up.
- **Review program processes to improve the quality of the tracking data.** The EC identified a number of inaccurate savings entries due to data entry mistakes or outdated results. Many of these errors could be avoided through changes in program processes. Consider reviewing and modifying program processes to avoid similar errors in the future.
- **Provide more explicit support for the major measures installed at each site.** For the market-rate programs, the EC could not verify that the deep savings participants had installed two major measures using the photographs provided with the documentation. Consider providing more explicit support for each major measure to eliminate uncertainty.
- **Consider funding a study to verify the models produced by the delivery agents.** An in-depth review of the simulation models is outside the scope of this verification. Consider funding a study to conduct an in-depth review of the models to ensure they conform to standard industry practice.

APPENDIX E. ENERGY SAVINGS KIT VERIFICATION

This appendix describes the detailed process used to certify the reported Energy Savings Kit savings for Union. The EC applied the adjustment factors that were identified in previous evaluations, including:

- Final Report Following an Impact Evaluation of the Union Gas ESK-Residential Program: Pull Initiative 2014
- Final Report Following an Impact Evaluation of the Union Gas ESK Residential Program: Door-to-Door Drop-off Initiative 2014
- Final Report Following an Audit of the Union Gas ESK-Helping Homes Conserve-HHC-Program Low-income Initiative 2012

The adjustment factors from these reports are shown in Table E-1. Table E-2 shows the tracking and verified savings for market-rate residential by rate class. Table E-3 shows the tracking and verified savings for Low Income residential by rate class.

Table E-1: Union: adjustment factors for Energy Savings Kits

Kit Measure	Adjustment Factor
Pull – Energy-efficient showerhead	55%
Pull – Kitchen faucet aerator	71%
Pull – Bathroom faucet aerator	81%
Pull – Pipe wrap	98%
Door-to-Door – Energy-efficient showerhead	50%
Door-to-Door – Kitchen faucet aerator	68%
Door-to-Door – Bathroom faucet aerator	80%
Door-to-Door – Pipe wrap	95%
Helping Homes Conserve – Showerhead	80%
Helping Homes Conserve – Kitchen faucet aerator	81%
Helping Homes Conserve – Bathroom faucet aerator	86%
Helping Homes Conserve – Pipe insulation	94%

Table E-2: Union: tracking and verified gross energy savings for residential Energy Savings Kits by rate class

Rate class	Measure	Draft Utility-Reported Savings		Adjustment Factor	Verified Savings	
		Annual Gross Savings (m^3)	Cumulative Gross Savings (m^3)		Annual Gross Savings (m^3)	Cumulative Gross Savings (m^3)
M1 South Residential	Pstat	5,300	79,500	100%	5,300	79,500
M1 South Residential	Pstat	36,146	542,190	100%	36,146	542,190
M1 South Residential	Pstat	-	-	100%	-	-
M1 South Residential	Pstat	11,183	167,745	100%	11,183	167,745
M1 South Residential	ESK Pull - Energy-efficient Showerhead	217,580	2,175,800	55%	119,669	1,196,690
M1 South Residential	ESK Pull - Kitchen Faucet Aerator	57,164	571,642	71%	40,587	405,866
M1 South Residential	ESK Pull - Bathroom Faucet Aerator	31,648	316,480	81%	25,635	256,349
M1 South Residential	ESK Pull - Pipe Wrap	153,097	2,296,458	98%	150,035	2,250,529
M1 South Residential	ESK D2D - Energy-efficient Showerhead	570,372	5,703,720	50%	285,186	2,851,860
M1 South Residential	ESK D2D - Kitchen Faucet Aerator	149,852	1,498,523	68%	101,900	1,018,996
M1 South Residential	ESK D2D - Bathroom Faucet Aerator	82,963	829,632	80%	66,371	663,706
M1 South Residential	ESK D2D - Pipe Wrap	401,334	6,020,017	95%	381,268	5,719,016
01 North Residential	Pstat	1,590	23,850	100%	1,590	23,850
01 North Residential	Pstat	10,282	154,230	100%	10,282	154,230
01 North Residential	Pstat	-	-	100%	-	-
01 North Residential	Pstat	1,219	18,285	100%	1,219	18,285
01 North Residential	ESK Pull - Energy-efficient Showerhead	81,180	811,800	55%	44,649	446,490
01 North Residential	ESK Pull - Kitchen Faucet Aerator	21,328	213,282	71%	15,143	151,430
01 North Residential	ESK Pull - Bathroom Faucet Aerator	11,808	118,080	81%	9,564	95,645
01 North Residential	ESK Pull - Pipe Wrap	57,121	856,818	98%	55,979	839,682
01 North Residential	ESK D2D - Energy-efficient Showerhead	-	-	50%	-	-
01 North Residential	ESK D2D - Kitchen Faucet Aerator	-	-	68%	-	-
01 North Residential	ESK D2D - Bathroom Faucet Aerator	-	-	80%	-	-
01 North Residential	ESK D2D - Pipe Wrap	-	-	95%	-	-
	Total	**1,901,169**	**22,398,052**	**N/A**	**1,361,705**	**16,882,059**

Table E-3: Union: tracking and verified gross energy savings for Home Weatherization Program basic measures by rate class

Rate class	Measure	Draft Utility-Reported Savings*		Adjustment Factor	Verified Savings	
		Annual Gross Savings (m^3)	Cumulative Gross Savings (m^3)		Annual Gross Savings (m^3)	Cumulative Gross Savings (m^3)
M1 South Residential	HHC - Energy-efficient Showerhead 2-2.5	138	1,380	80%	110	1,104
M1 South Residential	HHC - Energy-efficient Showerhead 2.6+	1,056	10,560	80%	844.80	8,448
M1 South Residential	HHC - Kitchen Faucet Aerator	555	5,549	81%	449	4,495
M1 South Residential	HHC - Bathroom Faucet Aerator	282	2,816	86%	242	2,422
M1 South Residential	HHC - Pipe Wrap	1,084	16,254	94%	1,019	15,279
	Total	**3,114**	**36,559**	**N/A**	**2,665**	**31,747**

APPENDIX F. RUNITRIGHT VERIFICATION

This appendix describes the detailed process used to certify the reported RunitRight (RiR) savings for Enbridge. The EC reviewed the RunitRight models, energy savings calculations, and related files to identify any concerns regarding the methodology used by the program, and significant risks for savings accuracy. We also identified opportunities for improvement and suggested future evaluation activities.

The EC randomly selected 10 of 28 participating sites for review. The tasks in the file review included:

- **Data review:** Compare savings claimed for the program to the savings stated in the individual spreadsheets.
  - **Conclusion:** the savings were confirmed to match.
- **Methodology review:** A senior engineer reviewed the calculation methods and independently calculated savings for one site using the raw consumption data and defined program periods.
  - **Conclusion:** 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.
- **Savings review:** Evaluation engineers reviewed the spreadsheets, regression models, and supporting documentation 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?
  - What independent variables were used?
  - What R-squared values were used for the baseline and reference models?
  - What is the p-value?
  - What balance points were used in the baseline and reference models?
  - What are the estimated savings during the reference period?
  - What are the normalized annual savings?
  - Were capital project savings deducted?
  - What percentage of consumption do the savings represent?
  - Were the measures completed as invoiced?
  - Could the measures have resulted in these savings?
- **Savings risk assessment:** The EC assessed the risk of savings accuracy as Low, Normal, or High based on the calculation review completed, a review of the consumption pattern at the facility, and a review of the baseline model used. Three key questions were answered:
  - 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?

  - **Conclusion:** The baseline model specifications and time period definitions were reasonable. One site was assigned Low risk, five were assigned Normal risk and four were assigned High risk.
  - Three of the four high risk facilities were schools. The regression models were a poor fit for the consumption data, resulting in substantial uncertainty in any savings estimate. The EC

recommends an assessment of other independent variables for schools, such as an in-session/out-of-session variable to capture break periods.

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

Recommendations

The EC has the following recommendations resulting from these verification activities:

- **Consider additional independent variables when modeling school consumption.** The regressions did not fit school consumption effectively. Additional independent variables accounting for break periods may improve the fit.
- **Provide more information about each site.** Include a basic description of the end-use equipment served by the gas meter, such as DHW, heating, or cooking.
- **Improve the activity documentation.** Include the date of each implemented activity in the calculation workbook and site report. Provide both the baseline and installed values; for example, the pre- and post-installation schedule for a schedule reset. Increase the detail of the end use equipment when a single change results in a significant reduction in consumption.
- **Consider quantifying electric savings through engineering calculations.** While billing data may not be available, engineering calculations would help the program demonstrate the full value it is providing.
- **Consider reviewing the process for selecting the HDD reference temperature.** The EC observed multiple sites where the base load consumption was unexpectedly sensitive to the reference temperature. If in error, the result may be negative baseline savings estimates and poor summer regression results.

APPENDIX G. LOW INCOME MULTI-FAMILY VERIFICATION

This appendix describes the detailed process used to verify the percentage of Part 3 participants enrolled in the Enbridge Low Income Building Performance Management (LIBPM) program, which is one of the scorecard metrics. The equation for calculating the metric is:

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

Where:

- X is the number of new LIBPM buildings in the current year which have participated in another aspect of the Low Income program in a previous year of the 2012-2014 plan
- Y is the number of new LIBPM buildings participating in the current year which have not previously participated in the Low Income program
- Z is the number of buildings in the current year which have implemented custom projects other than LIBPM.[24]

In response to an EC request, Enbridge provide an Excel workbook with the following information:

- A sheet describing the calculation and showing the values for x, y, and z as well as the calculation result based on utility-reported data.
- A sheet listing the 121 participants in the 2015 LIBPM program, with flags for previous participation
- A sheet listing the number of participants installing custom projects in 2015 who did not participate in the LIBPM program.

To verify this information, the EC:

- Confirmed that all reported 2015 Low Income Part 9 buildings were included in the LIBPM workbook. We found that 12 buildings were not, but the projects were prescriptive, not custom, so there was no result in the calculation input. The correct z value is 66, as reported by the program
- Confirmed the x and y counts of buildings. We confirmed the program (x + y) total of 121 buildings.

Given the information, the EC calculated the following:

$$\%\, LIBPM = \frac{(121)}{(121 + 66)} = 65\%$$

The EC result is the same as the reported utility result.

[24] EB-2015-0049 – Enbridge Gas Distribution Inc. – Multi-Year Demand Side Management Plan (2015 to 2020), Exhibit B, Tab 1, Schedule 3, Page 8 of 19.

APPENDIX H. CUSTOM PROJECT VERIFICATION

This appendix describes the detailed process used to determine the CPSV results and how they are applied to the utility-reported gross savings to get verified gross savings. It also describes the process used to determine the free ridership-based study results which are combined with spillover as discussed in APPENDIX N.[25]

The primary reporting domains in the CPSV / NTG study report do not align to the programs for LRAM and DSMSI. To get the appropriate effective adjustment factors, the EC:

- Applied the measure-level CPSV and free ridership ratios to the population of tracking data
- Summed the verified cumulative savings across the desired group (program for Resource Acquisition and Low Income; rate class for Large Volume)
- Summed the tracking cumulative savings across the same group
- Divided the sum of verified gross by the sum of tracking gross and the sum of verified net by the sum of verified gross to get CPSV and free ridership[26] adjustments that most closely follow our sample design.

Table H-1 shows the CPSV and free ridership adjustment factors.

Table H-1. Union CPSV and NTG adjustment factors by subset

Program	CPSV Adjustment†	Free Ridership Adjustment*†
C&I Custom Comm & Inst Buildings	89%	44%
C&I Custom Ag and Greenhouse	97%	41%
C&I Custom Industrial	103%	39%
Low Income Multi-Family Custom	89%	95%
Large Industrial R100	147%	8%
Large Industrial T1	154%	9%
Large Industrial T2	131%	8%

†These values are rounded.
* This is presented in the form of a NTG ratio based solely on free ridership. Technically, this value is 1 minus free ridership.

To get the appropriate adjustment factors for the Enbridge custom projects, the EC followed the same process. Table H-2 shows the adjustment factors.

[25] "2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation". Prepared for the Ontario Energy Board. August 15, 2017.

[26] In this analysis, the "free ridership adjustment" is in the form of a NTG ratio based on free ridership alone. It is more accurate to say that the value calculated by dividing the sum of verified net by the sum of verified gross is 1 minus the free ridership value.

Table H-2. Enbridge CPSV and NTG adjustment factors

Program	CPSV Adjustment†	Free Ridership Adjustment*†
Custom Commercial	91%	17%
C&I Custom New Construction	91%	18%
Custom Multi-family	91%	35%
Custom Industrial Ag	99%	28%
Custom Industrial	100%	33%
RunitRight	100%	50%

†These values are rounded.
* This is presented in the form of a NTG ratio based solely on free ridership. Technically, this value is 1 minus free ridership.

APPENDIX I. MARKET TRANSFORMATION VERIFICATION

This appendix describes the detailed process used to verify the scorecard metrics for the market transformation programs for both utilities. The programs addressed in this appendix are Union's Optimum Home program and Enbridge's Residential Savings by Design, Commercial Savings by Design, and Home Labelling programs.

Union Optimum Home

The scorecard metric for the Union Optimum Home program is the percentage of homes built to Optimum Home standard by participating builders. The Optimum Home standard is greater than 20% above the Ontario Building Code 2012 (OBC). The target is 30% of homes built. Union reported an achievement of 50.3% of homes built.

To support the metric achievement, Union provided a spreadsheet showing the participating builders (anonymized), the number of Optimum Homes built and verified in 2015 by those builders, and the total number of new gas attachments in 2015 for those builders. The reported number of Optimum Homes was 1,246 and the total new attachments was 2,477 for the 50.3% achievement.

To verify the metric, the EC:

- Confirmed program participation for one randomly selected builder
- Confirmed Optimum Home status for one randomly selected home

The EC selected Builder T and requested all documentation related to that builder. We received:

- Signed participation paperwork for Builder T
- Documentation confirming the number of new attachments requested by Builder T in 2015
- Documentation confirming the number of Optimum Home qualifying homes

The EC confirmed:

- Builder T is a participant in the Optimum Homes program
- Builder T requested 30 new attachments in 2015
- Builder T built 21 Optimum Home-qualifying homes in 2015, defined as homes that have an Energy Star for New Homes Compliance Report from NRCan with an Evaluation Date in 2015

Per the NRCan website[27] for Energy Star New Homes, an Energy Star certified new home is, on average, 20% more efficient than a home built to code; therefore, homes with an Energy Star certification will, on average, exceed the metric.

The EC also selected home H310 built by Builder H and requested all documentation related to that home. We received:

- Documentation of the air test and results by a third-party consulting firm
- An Energy Star for New Homes compliance report

[27] http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/5057

- A workbook showing the Energy Star for New Homes Energy Advisor Verification Checklist

The EC confirmed:

- Home H310 built by Builder T conforms to Optimum Home requirements.
- The home has gas water and space heat.

As a result of this review, the EC confirms the reported Optimum Home scorecard metric of 50.3%.

Enbridge Residential Savings by Design

The scorecard metrics for the Enbridge Residential Savings by Design (RSBD) program are the number of builders enrolled in the program and the number of homes built to RSBD standard. The RSBD standard is greater than 25% above the Ontario Building Code 2012 (OBC). The targets are 18 builders enrolled and 1,111 homes built. Enbridge reported achievements of 19 builders enrolled and 1,987 homes built. By definition, an enrolled builder must have built a minimum of 50 homes in the previous year to qualify.

To support the metric achievement, Enbridge provided a spreadsheet showing the participating builders, confirmation that they built more than 50 homes in the prior year, and the integrated design process (IDP) date for each builder. Enbridge also provided a workbook listing the houses built to RSBD standard, by builder, that received an incentive, and the number of reported houses, by builder, self-reported through letters.

To verify the metrics, the EC:

- Confirmed program participation for one randomly selected builder
- Confirmed RSBD status for one randomly selected home

The EC selected Builder #65 and requested all documentation related to that builder. We received:

- A copy of the builder commitment form, which confirms that the builder completed more than 50 homes in the previous year
- Notes from the visioning session
- The agenda from the Integrated Design Charrette
- The findings from the integrated design process (IDP)

The EC confirmed:

- Builder #65 is a participant in the RSBD program and joined in 2015
- Builder #65 self-reported a minimum of 50 homes build in 2014
- Builder #65 participated in the visioning workshop and IDP session and designed a townhome that is 27.6% better than OBC

The EC also selected home HL88 and requested all documentation related to that home. We received:

- Documentation of the air test and results by a third-party consulting firm
- An SBD modelling summary sheet
- A HOT2000 model file

The EC confirmed:

- Home RSBD conforms to RSBD requirements.

As a result of this review, the EC confirms the reported RSBD scorecard metrics of 19 builders and 1,987 homes built.

Enbridge Commercial Savings by Design

The scorecard metric for the Enbridge Commercial Savings by Design (CSBD) program is the number of developments enrolled in the program. The target is 18 new developments enrolled. Enbridge reported an achievement of 24 developments enrolled. To qualify, the development must exceed 50,000 square feet in size.

To support the metric achievement, Enbridge provided a spreadsheet showing the participating builders and the developments that were enrolled in 2015.

To verify the metrics, the EC confirmed program participation for one randomly selected developer. The EC selected the development by Builder #54 and requested all documentation related to that builder and development. We received:

- A copy of the application form for the builder
- Pre-meeting notes from the ½-day visioning session with the builder
- A report on the findings from the integrated design workshop.
- An email confirming that the size of the development is greater than 50,000 square feet.

The EC confirmed:

- Builder #54 is a participant in the CSBD program
- Builder #54 participated in the visioning workshop and IDP session and designed a development that is 34.2% better than OBC

As a result of this review, the EC confirms the reported CSBD scorecard metric of 24 developments enrolled.

Enbridge Home Labelling

The scorecard metrics for the Enbridge Home Labelling program are the number of annual listings by realtors committed to the program and the number of ratings performed. The targets are 5,000 listings and 4,500 ratings performed. Enbridge reported achievements of 41,650 listings and 336 ratings performed.

To support the metric achievement, Enbridge provided a spreadsheet that listed all of the addresses that received a Home Labelling rating and another spreadsheet showing the number of listings represented by each committed realtor. To verify the number of addresses, the EC:

- Confirmed program participation for one randomly selected realtor
- Confirmed the number of listings represented by that realtor
- Confirmed the ratings completed by that realtor

The EC selected a realtor and requested all documentation related to that office. We received:

- The brokerage commitment form
- Proof of labelling at three addresses related to that realtor
- An updated labelling tracking spreadsheet

In assembling the documentation for the requested realtor, Enbridge discovered a duplicate entry. They reviewed all of the documentation in the program and found three duplicates in total, reducing the number of completed ratings to 333.

The EC confirmed:

- The realtor is a participant in the Home Labelling program
- The realtor represents 2000 listings per year.
- The builder completed three ratings in 2015

As a result of this review, the EC confirms the reported Home Labelling scorecard metric of 333 ratings and 41,650 listings.

APPENDIX J. REVIEW OF LRAM AND DSMSI CALCULATIONS

This appendix describes the EC team's review of the lost revenue adjustment mechanism (LRAM) and demand side management shareholder incentive (DSMSI) calculations.

The LRAM calculation is based on:

- The verified net natural gas savings (in annual cubic meters) by rate class
- The delivery cost of the natural gas by rate class
- The month in which the measure was installed

The DSMSI calculation is based on:

- The actual 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

The detailed DSMSI calculations for each utility are outlined in the following sections. The EC was unable to identify or locate the source of approval for the calculations. The two utility calculations are very similar and follow the same principles and do not violate the general direction approved by the OEB; therefore, the EC will use the methodology provided by the utilities.

The EC confirmed the lower band, upper band, target metric, and weights for both utilities.

LRAM: Union

Union delivered a calculation workbook for LRAM which includes the tracking savings, an input sheet for adjustment factors, and a sheet with avoided costs. The LRAM calculation for a given rate class and month is as follows:

- The verified net energy savings for the given rate class and month are summed.
- The savings are multiplied by the following calculation, which pro-rates the savings for the remainder of the year and divides by 1000 to produce the savings volume in thousands of cubic meters.

$$\frac{(12 - Month\,\# + 1)}{(12)(1000)}$$

For example, the savings for a particular rate class for measures installed in July would be multiplied by:

$$\frac{(12 - 7 + 1)}{(12)(1000)} = \left(\frac{6}{12}\right)\left(\frac{1}{1000}\right)$$

The equation allots energy savings from that project to half of the year and converts it to thousands of cubic meters.

The savings from each month are summed across rate classes and multiplied by an annual delivery rate for that class to get the revenue impact for each class.

The revenue impact from each rate class is summed across classes to get the total LRAM for Union. Only the contract rate cases are included in the LRAM calculations.

LRAM: Enbridge

Enbridge delivered a calculation workbook for LRAM which includes the tracking savings, a sheet to calculate the budgeted LRAM values, a sheet to calculate the actual LRAM values, and a sheet showing the distribution margin rates. The actual LRAM calculation for a given rate class and month is as follows:

- The annual net savings are summed by rate class and sector and the month in which the measure was installed.
- The savings by rate class and sector and month are divided by 12 to produce monthly savings and applied to each month from the installation month through the rest of the year.
- The savings are summed across months for each sector.
- The savings are summed across sectors for each rate class.

The Enbridge calculation workbook does not calculate the actual LRAM, it calculates the LRAM variance, which shows the difference between the actual LRAM and the budgeted LRAM for the year.[28] To calculate the actual LRAM (consistent with the Union calculation above), the EC multiplied the actual net savings summed across sectors for each rate by the distribution margin to get LRAM.

The revenue impact from each rate class is summed across classes to get the total LRAM for Enbridge. Only the contract rate cases are included in the LRAM calculations.

[28] After the draft report was produced, Enbridge provided a calculation workbook that included the actual LRAM in addition to the LRAM variance.

DSMSI: Union

The Union tracking workbook includes a sheet for calculating the DSMSI based on utility-reported results. The DSMSI is calculated based on the metric achievement relative to the target level within an acceptable ± band. The Union targets, upper and lower bands, and weights are shown in Table J-1. The EC verified the metrics, upper and lower bands, and weights shown in the table.

Table J-1. Union's 2015 scorecard targets, lower band, upper band, and weight

Scorecard	Lower Band	2015 Target	Upper Band	Weight
Union				
Resource Acquisition	612,421,364 CCM 934 participants 7.88%	816,561,818 CCM 1,245 deep savings participants 8.88% of commercial whole building natural gas use saved	1,020,702,273 CCM 1,556 participants 9.88%	90% 5% 5%
Large Volume	154,692,013 CCM 772,381,040 CCM	206,256,017 Rate 1 CCM 1,029,841,387 Rate T2/100 CCM	257,820,021 CCM 1,287,301,734 CCM	60% 40%
Low Income	19,500,000 CCM 13,200,000 CCM	26,000,000 single family CCM 17,600,000 multi-family CCM	32,500,000 CCM 22,000,000 CCM	60% 40%
Market Transformation	25%	30% of homes built by participating builders were 20% more efficient than OBC	35%	100%

The shareholder incentive calculation in the Union tracking workbook first defines a % Achievement.

- If the achieved metric is less than the target, % achievement is calculated:

$$\% \, Achievement = \frac{(1-0.5) * achieved \; metric}{(target \; metric - lower \; band)} + 1 - \frac{(1-0.5) * target \; metric}{target \; metric - lower \; band}$$

- If the achieved metric is greater than the target, % achievement is calculated:

$$\% \, Achievement = \frac{(1.5-1) * achieved \; metric}{(upper \; band - target \; metric)} + 1.5 - \frac{(1.5-1) * upper \; band}{upper \; band - target \; metric}$$

The % Achievement is multiplied by the weight to produce % Contribution, which is summed. The summed value is used to calculated the achieved shareholder incentive using:

- If the sum of % Contribution is greater than 0.5 and less than 1, then:

$$achieved \; incentive = \left[0.8 * \left(\sum \% \, Contribution\right) - 0.4\right] * maximum \; shareholder \; incentive$$

- If the sum of % Contribution is greater than or equal to 1 and less than or equal to 1.5, then:

$$achieved \; incentive = \left[1.2 * \left(\sum \% \, Contribution\right) - 0.8\right] * maximum \; shareholder \; incentive$$

- If the sum of % Contribution is greater than 1.5, then:

$$achieved \; incentive = [1.2 * 1.5 - 0.8] * maximum \; shareholder \; incentive$$

- Otherwise the maximum shareholder incentive is zero.

DSMSI: Enbridge

The Enbridge tracking workbook includes a sheet for calculating the DSMSI based on utility-reported results. The DSMSI is calculated based on the metric achievement relative to the target level within an acceptable ± band. The Enbridge targets, upper and lower bands, and weights are shown in Table J-2. The EC verified the metrics, upper and lower bands, and weights shown in the table.

Table J-2. Enbridge's 2015 scorecard targets, lower band, upper band, and weight

Scorecard	Lower Band	2015 Target	Upper Band	Weight
Enbridge				
Resource Acquisition	758,900,000 CCM 571 participants	1,011,900,000 CCM 762 deep savings participants	1,264,900,000 CCM 952 participants	92% 8%
Low Income	18,100,000 CCM 51,600,000 CCM 30%	24,100,000 single family CCM 68,700,000 multi-family CCM 40% of Part 3 in LIBPM	30,200,000 CCM 86,000,000 CCM 50%	50% 45% 5%
Savings by Design Residential	13 builders 833 homes	18 builders enrolled 1,111 homes built by participating builders were 20% more efficient than OBC	22 builders 1,389 homes	60% 40%
Savings by Design Commercial	11 developments	18 developments enrolled	24 developments	100%
Home Labelling	No listings 2,250 ratings	5,001 total listings from committed realtors 4,500 ratings performed	10,001 listings 6,750 ratings	50% 50%

The shareholder incentive calculation in the Enbridge tracking workbook first defines a Score.

- If the achieved metric is less than or equal to the target, Score is calculated:

$$Score = 1 - \frac{0.5 * (target\ metric - achieved\ metric)}{(target\ metric - lower\ band)}$$

- If the achieved metric is greater than the target, Score is calculated:

$$Score = 1 + \frac{0.5 * (achieved\ metric - target\ metric)}{(upper\ band - target\ metric)}$$

The Score is multiplied by the weight and summed to produce the Weighted Score. The Weighted Score is used to calculated the achieved shareholder incentive using:

- If the Weighted Score is less than 0.5 then the shareholder incentive is zero.
- If the Weighted Score is greater than or equal to 0.5 and less than 1, then:

$$MIB = middle\ incentive\ band = 0.4 * maximum\ shareholder\ incentive$$

$$achieved\ incentive = MIB * \frac{(Weighted\ Score - 0.5)}{0.5}$$

- If the Weighted Score is greater than or equal to 1 and less than or equal to 1.5, then:

$$achieved\ incentive = MIB + (maximum\ shareholder\ incentive - MIB) * \frac{(Weighted\ Score - 1)}{0.5}$$

- If the Weighted Score is greater than 1.5 then the shareholder incentive is equal to the maximum shareholder incentive.

Recommendations

The EC has the following recommendation resulting from these verification activities:

- **Provide a detailed explanation for the DSMSI calculation for review by the EC and OEB.** The EC was unable to locate a source document that supports the utility calculation of DSMSI. Given the importance of the shareholder incentive, it is appropriate to have a clearly defined and detailed explanation of how it is calculated.

APPENDIX K. LRAM AND DSMSI: DETAILED CALCULATIONS

This appendix describes the detailed process used to calculate the DSMSI and LRAM for both utilities.

Union DSMSI

The metrics that affect the Union DSMSI include:

- Resource Acquisition cumulative net savings
- Low Income cumulative net savings
- Large Volume cumulative net savings
- Non-savings metrics:
  - The number of deep savings participants in the Home Reno Rebate program
  - The average percent of whole-building energy use saved by C&I customers
  - The number of homes built greater than 20% above Ontario Building Code by participating Optimum Home builders

To verify the savings metrics, the EC applied the program-level results from the previous appendices. Table K-1 shows the location of the detailed explanation for each program.

Table K-1. Union source of detailed explanation of adjustment factors

Portfolio Component	Location of Detailed Explanation
Ag and Greenhouse	APPENDIX H APPENDIX N
Commercial and Institutional Buildings	APPENDIX H APPENDIX N
Industrial	APPENDIX H APPENDIX N
Energy Savings Kit	APPENDIX E
Home Reno Rebate	APPENDIX D
Commercial and Industrial Prescriptive	APPENDIX C
Low Income Multi-family (custom projects)	APPENDIX H
Low Income Multi-family (prescriptive projects)	APPENDIX C
Home Weatherization Program	APPENDIX D
Large Volume (custom projects)	APPENDIX H APPENDIX N
Large Volume (prescriptive projects)	APPENDIX C

The analysis to produce the verified savings from the tracking savings differed by the type of project.

- For custom projects (those discussed in APPENDIX H), the appropriate CPSV adjustment factor was applied to the annual and cumulative gross tracking savings to produce annual and cumulative gross verified savings. The appropriate NTG adjustment factor, including the provisional spillover value discussed in APPENDIX N, was applied to the annual and cumulative gross verified savings to produce annual and cumulative net verified savings.

- For the home renovation projects (those discussed in APPENDIX D), the appropriate natural gas adjustment factor was applied to the annual gross tracking savings to produce annual gross verified savings. The annual gross verified savings were multiplied by the program-assumed measure life to produce cumulative gross verified savings. Both the annual gross and cumulative gross verified savings were multiplied by the complement of the program-assumed free-ridership percentage to produce annual and cumulative verified net savings.
- For the Energy Savings Kit projects (those discussed in APPENDIX E), the EC calculated the measure-level annual and cumulative gross verified savings, summed them to the technology level (such as showerheads or pipe wrap), and divided the cumulative gross verified savings by the cumulative gross tracking savings to produce a technology-level gross adjustment factor. The annual and cumulative gross verified savings were multiplied by the complement of the program-assumed free-ridership percentage to produce annual and cumulative net verified savings.
- For the remaining prescriptive projects (those discussed in APPENDIX C), the EC multiplied the annual and cumulative gross tracking savings by the appropriate adjustment factor to produce annual and cumulative gross verified savings. The annual and cumulative gross verified savings were multiplied by the complement of the program-assumed free-ridership percentage to produce annual and cumulative net verified savings.

Program-level adjustment factors were determined by first summing the gross cumulative verified and tracking savings and net cumulative verified and tracking savings across the program, then dividing the verified by the tracking result to get the adjustment factor.

Table K-3 shows the Union verified 2015 savings by scorecard and program.

For the non-savings metrics, the EC determined the verified metric as described in the previous appendices. Table K-2 shows the location of the detailed explanation for each metric and the verified value.

Table K-2. Union source of detailed explanation of final non-savings metrics and verified value

Metric	Location of Detailed Explanation	Verified Value
Number of residential deep savings participants	APPENDIX D	2,529
Percent of whole-building energy use saved	APPENDIX C	8.08%
Percent of qualifying homes by Optimum Home builders	APPENDIX I	50.3%

Table K-3. Union's verified 2015 savings by scorecard and program

Program	Draft Utility-Reported Savings*				Verification Results		Verified Savings	
	Gross Annual (m³)	Gross Cumulative (m³)	Net Annual (m³)	Net Cumulative (m³)	Gross Realization Rate†	Net-to-Gross†	Gross Cumulative (m³)	Net Cumulative (m³)
Resource Acquisition								
C&I Prescriptive	10,659,544	208,919,006	9,283,248	182,411,887	100%	87%	208,919,006	182,411,887
C&I Custom Ag and Greenhouse	41,708,475	611,477,005	19,185,899	281,279,422	97%	44%	592,368,700	262,534,051
C&I Custom Comm & Inst Buildings	16,527,002	268,582,354	7,602,421	123,547,883	89%	47%	239,199,444	112,642,330
C&I Custom Industrial	36,329,242	593,859,359	16,711,451	273,175,305	103%	43%	612,343,937	260,640,852
Energy Savings Kit	1,901,169	22,398,052	1,644,462	19,567,373	75%	88%	16,882,059	14,800,935
Home Reno Rebate	3,828,386	69,321,370	3,254,128	58,923,165	98%	85%	67,934,943	57,744,701
Total RA	**110,953,818**	**1,774,557,146**	**57,681,609**	**938,905,035**	**98%**	**51%**	**1,737,648,089**	**890,774,755†**
Large Volume								
Large Industrial-T1	12,469,705	171,240,007	5,743,536	78,919,835	154%	13%	263,624,641	33,725,518
Large Industrial-T2	83,288,363	1,002,106,837	38,382,453	462,016,235	131%	11%	1,309,850,111	147,448,803
Large Industrial-R100	11,155,712	80,624,184	5,131,627	37,087,125	147%	12%	118,331,969	13,695,699
Total LV	**106,913,780**	**1,253,971,028**	**49,257,616**	**578,023,195**	**135%**	**12%**	**1,691,806,721**	**194,870,020**
Low Income								
Low Income Multi-family	957,046	17,840,732	909,194	16,948,695	96%	95%	17,193,011	16,333,361
Home Weatherization	1,341,946	33,505,239	1,341,913	33,504,841	107%	100%	35,847,824	35,847,426
Total LI	**2,298,992**	**51,345,970**	**2,251,107**	**50,453,536**	**103%**	**98%**	**53,040,835**	**52,180,787**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
†These values are rounded.

The EC entered the appropriate metrics into the Union scorecard calculator. The resulting shareholder incentive results can be found in Table K-4. The total shareholder incentive is $7,039,894.

Table K-4. Union DSMSI results

Scorecard	DSMSI
Resource Acquisition	$4,010,638
Low Income	$2,462,534
Large Volume	$0
Market Transformation	$566,721
Total	**$7,039,894**

Enbridge DSMSI

The metrics that affect the Enbridge DSMSI include:

- Resource Acquisition cumulative net savings
- Low Income cumulative net savings
- Non-savings metrics:
    - The number of deep savings participants in the Home Energy Conservation program
    - The percentage of Part 3 participants that are also in the LIBPM program
    - The number of builders participating in the RSBD program
    - The number of homes built greater than 25% above Ontario Building Code by participating RSBD builders
    - The number of builders participating in the CSBD program
    - The number of listings represented by realtors in the Home Labelling program
    - The number of ratings in the Home Labelling program

To verify the savings metrics, the EC applied the program-level results from the previous appendices. Table K-5 shows the location of the detailed explanation for each program.

Table K-5. Enbridge source of detailed explanation of adjustment factors

Portfolio Component	Location of Detailed Explanation
Home Energy Conservation	APPENDIX D
Commercial Prescriptive	APPENDIX C
Commercial Custom	APPENDIX H APPENDIX N
RunitRight	APPENDIX F APPENDIX H APPENDIX N
Multi-family	APPENDIX H APPENDIX N
New Construction	APPENDIX H APPENDIX N
Industrial Custom	APPENDIX H APPENDIX N
Industrial Prescriptive	APPENDIX C
Industrial Agriculture	APPENDIX H APPENDIX N
Low Income Multi-family (prescriptive projects)	APPENDIX C
Low Income Multi-family (custom projects)	APPENDIX H
Low Income Single Family: Winterproofing	APPENDIX D
Low Income Single Family non-Winterproofing	APPENDIX C

The analysis to produce the verified savings from the tracking savings differed by the type of project.

- For custom projects (those discussed in APPENDIX H), the appropriate CPSV adjustment factor was applied to the annual and cumulative gross tracking savings to produce annual and cumulative gross verified savings. The appropriate NTG adjustment factor, including the provisional spillover value discussed in APPENDIX N, was applied to the annual and cumulative gross verified savings to produce annual and cumulative net verified savings.
- For the home renovation projects (those discussed in APPENDIX D), the appropriate natural gas adjustment factor was applied to the annual gross tracking savings to produce annual gross verified savings. The annual gross verified savings were multiplied by the program-assumed measure life to produce cumulative gross verified savings. Both the annual gross and cumulative gross verified savings were multiplied by the complement of the program-reported free-ridership percentage to produce annual and cumulative net verified savings.
- For the RunitRight projects (those discussed in APPENDIX F), the EC applied the gross savings verification adjustment from APPENDIX F to the annual and cumulative gross tracking savings to produce annual and cumulative gross verified savings. The appropriate NTG adjustment factor (from APPENDIX H and APPENDIX N) was applied to the annual and cumulative gross verified savings to produce annual and cumulative net verified savings.

- For the remaining prescriptive projects (those discussed in APPENDIX C), the EC calculated the verified gross annual and cumulative savings for the population of measures. The verified savings were summed into groupings corresponding to the program-reported free-ridership rate. The annual and cumulative verified net savings were produced by multiplying the verified gross savings by the complement of the program-reported free-ridership rate. The final gross savings adjustment factor was calculated by dividing the cumulative gross verified savings by the cumulative gross tracking savings.

Program-level adjustment factors were determined by first summing the gross cumulative verified and tracking savings and net cumulative verified and tracking savings across the program, then dividing the verified by the tracking result to get the adjustment factor.

Table K-7 shows the Enbridge verified 2015 savings by scorecard and program.

For the non-savings metrics, the EC determined the final metric as described in the previous appendices. Table K-6 shows the location of the detailed explanation for each metric and the verified value.

Table K-6. Enbridge source of detailed explanation of final non-savings metrics and verified value

Metric	Location of Detailed Explanation	Verified Value
Number of residential deep savings participants	APPENDIX D	5,646
Percent of Part 3 in LIBPM	APPENDIX G	65%
Number of builders in RSBD	APPENDIX I	19
Number of qualifying homes in RSBD	APPENDIX I	1,987
Number of developments in CSBD	APPENDIX I	24
Number of listings represented by Home Labelling realtors	APPENDIX I	41,650
Number of Home Labelling listings	APPENDIX I	333

Table K-7. Enbridge's verified 2015 savings by scorecard and program

Program	Draft Utility-Reported Savings*				Verification Results		Verified Savings	
	Gross Annual (m^3)	Gross Cumulative (m^3)	Net Annual (m^3)	Net Cumulative (m^3)	Gross Realization Rate**†	Net-to-Gross†	Gross Cumulative (m^3)	Net Cumulative (m^3)
Resource Acquisition								
Home Energy Conservation	7,956,225	120,488,487	6,762,791	102,415,214	100%	85%	120,488,487	102,415,214
Prescriptive Commercial	6,858,765	117,938,979	5,750,534	98,693,722	97%	86%	114,897,650	98,862,563
Custom Commercial	14,007,133	210,800,594	12,326,277	185,504,523	91%	21%	192,840,383	40,105,236
RunitRight	536,821	2,684,105	536,821	2,684,105	100%	53%	2,684,105	1,434,923
Custom Multi-family	7,363,563	152,593,766	5,890,850	122,075,013	91%	38%	139,592,777	53,699,388
C&I Custom New Construction	4,091,779	102,294,475	3,027,916	75,697,912	91%	22%	93,578,986	20,231,777
Custom Industrial	22,195,244	336,500,502	11,097,622	168,250,251	100%	36%	337,417,582	122,387,967
Prescriptive Industrial	561,521	10,826,785	398,824	7,593,008	100%	70%	10,826,785	7,593,008
Custom Industrial Ag	611,305	7,856,800	366,783	4,714,080	99%	32%	7,815,133	2,467,184
Total RA	**64,182,357**	**1,061,984,493**	**46,158,419**	**767,627,826**	**96%**	**44%**	**1,020,141,888**	**449,197,259†**
Low Income								
LI Multi-Family	3,425,023	69,505,240	3,397,177	69,226,782	101%	100%	70,147,603	70,426,062
Single Family	1,146,633	28,410,725	1,139,959	28,343,978	99%	100%	28,067,264	28,132,657
Total LI	**4,571,656**	**97,915,965**	**4,537,136**	**97,570,759**	**100%**	**100%**	**98,214,867**	**98,558,719**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.

** The gross realization rate for C&I prescriptive, single family low income, and multi-family low income includes the removal rate for some measures, which was previously included in the net-to-gross adjustment. See APPENDIX C for more detail.

†These values are rounded.

The EC entered the appropriate metrics into the Enbridge scorecard calculator. The resulting shareholder incentive results can be found in Table K-8. The total shareholder incentive is $6,228,081.

Table K-8. Enbridge DSMSI results

Scorecard	DSMSI
Resource Acquisition	$2,632,886
Low Income	$1,745,422
Residential Savings by Design	$1,076,493
Commercial Savings by Design	$418,269
Home Labelling	$616,397
Total	**$6,489,467**

Union LRAM

The inputs into the Union LRAM calculation are:

- Verified net annual energy savings by rate class and installation month using the best available information. When the installation month was in the previous year (2014), the EC assigned the savings to January.
- The annual delivery rate for each rate class.

To determine verified savings by month and rate class, the EC completed the following activities:

- **Prescriptive savings:** The EC identified the best available information for estimating energy savings, which is the currently (in 2017) approved TRM. The EC determined the prescriptive savings using the new source, summed the annual gross verified savings by month, rate class, and free rider rate, then applied the appropriate free rider rate to get annual verified net savings, and summed across the rate class to get annual verified net savings by month and rate class.
- **Custom savings:** The EC applied the measure-level CPSV and NTG ratios (which is the best available information) to the population of tracking data, then summed the verified annual savings across measures to the project level. The project-level verified annual net savings were summed by month and rate class.
- **Combined savings:** The EC summed prescriptive and custom savings by month and rate class to get the appropriate inputs to the LRAM calculation.

The EC input the summed savings by month and rate class to the utility calculator to produce the appropriate LRAM, shown in Table K-10. Table K-9 shows the results of the Union LRAM calculation by rate class.

Table K-9. Union LRAM results

Rate Class	Utility-Reported Draft LRAM	Verified LRAM
M4 Industrial	$77,105	$73,713
M5 Industrial	$38,366	$36,565
M7 Industrial	$33,512	$31,937
T1 Industrial	$2,789	$777
T2 Industrial	$1,050	$389
20 Industrial	$7,002	$6,845
100 Industrial	$5,578	$1,565
Total	**$165,411**	**$151,791**

Table K-10. Union LRAM inputs: annual net savings by rate class and install month

	Annual Savings, m^3												
Rate Class	January	February	March	April	May	June	July	August	September	October	November	December	Total
M4 Industrial	3,047,615	1,948,820	187,744	516,114	288,277	504,318	316,656	575,169	999,059	1,179,258	338,434	1,599,088	11,500,552
M5 Industrial	549,188	197,089	39,849	91,536	33,136	152,621	225,133	345,791	244,373	398,629	655,516	759,439	3,692,300
M7 Industrial	4,057,380	1,564,748	146,484	1,088,644	937,508	287,820	730,468	966,154	1,148,522	2,308,289	1,517,892		14,753,910
T1 Industrial	488,717		25,403	134,317	428,661	13,026	20,953	159,394	71,880	60,903	187,670		1,590,924
T2 Industrial	2,157,693			215,126	113,884	213,895		608,794	1,958,773	934,278	6,518,291	1,460,111	14,180,847
20 Industrial	340,326		116,932	44,372		158,512	214,125	946,951	112,483	227,511	645,161		2,806,372
100 Industrial			55,730	3,996		890,098	15,432	12,715	288,853	94,058	79,185		1,440,066
Total	10,640,920	3,710,657	572,142	2,094,103	1,801,467	2,220,290	1,522,766	3,614,968	4,823,944	5,202,927	9,942,149	3,818,638	49,964,971

Enbridge LRAM

The inputs into the Enbridge LRAM calculation are:

- Verified net annual energy savings by rate class and installation month using the best available information
- The annual delivery rate for each rate class

To determine verified savings by month and rate class, the EC completed the following activities:

- **Prescriptive savings:** The EC identified the best available information for estimating energy savings, which is the currently (in 2017) approved TRM. The EC determined the prescriptive savings using the new source, summed the annual gross verified savings by month, rate class, and free rider rate, then applied the appropriate free rider rate to get annual verified net savings, and summed across the rate class to get annual verified net savings by month and rate class.
- **Custom savings:** The EC applied the measure-level CPSV and NTG ratios (which is the best available information) to the population of tracking data, then summed the verified annual savings across measures to the project level. The project-level verified annual net savings were summed by month and rate class.
- **Combined savings:** The EC summed prescriptive and custom savings by month and rate class to get the appropriate inputs to the LRAM calculation.

The EC put the summed savings by month and rate class, shown in Table K-12 into our own calculator to produce the appropriate LRAM. Table K-11 shows the results of the Enbridge LRAM calculation by rate class.

Table K-11. Enbridge LRAM results

Rate Class	LRAM
110	$11,662
115	$2,836
135	$239
145	$834
170	$584
Total	**$16,155**

Table K-12. Enbridge LRAM inputs: annual net savings by rate class and install month

	Annual Savings, m^3												
Rate Class	January	February	March	April	May	June	July	August	September	October	November	December	Total
110			19,412			131,272	543,323	36,241		90,262	2,248,631	54,568	3,123,710
115				50,456		1,602		43,292		58,030	1,645,016	17,994	1,816,390
135											106,318	10,628	116,946
145						10,926	10,595			4,996	233,091	36,474	296,083
170							105,099	848		6,474	422,496	57,618	592,535
Total	0	0	19,412	50,456	0	143,801	659,018	80,381	0	159,763	4,655,551	177,282	5,945,664

APPENDIX L. PROGRAM SPENDING

This section reports additional program spending detail for Union and Enbridge.

Union

Table L-1. Union Resource Acquisition scorecard spending

Spending Area	Actual Spent
Residential	
Residential Incentives	$3,552,367
Residential Administration	$527,197
Residential Evaluation	$397,650
Residential Promotion Costs	$972,997
Total Residential Program	**$5,450,210**
Commercial/Industrial	
Commercial/Industrial Incentives	$7,547,776
Commercial/Industrial Administration	$2,924,084
Commercial/Industrial Evaluation	$100,200
Commercial/Industrial Promotion Costs	$796,336
Total Commercial/Industrial Program	**$11,368,397**

Table L-2. Union Large Volume scorecard spending

Spending Area	Actual Spent
Large Industrial T1/T2/R100 Incentives	$2,219,151
Large Industrial T1/T2/R100 Administration	$863,933
Large Industrial T1/T2/R100 Evaluation	$122,498
Large Industrial T1/T2/R100 Promotion Costs	$4,134
Total Large Industrial T1/T2/R100 Program	**$3,209,716**

Table L-3. Union Low Income scorecard spending

Spending Area	Actual Spent
Low Income Incentives	$5,449,462
Low Income Administration	$859,796
Low Income Evaluation	$196,171
Low Income Promotion Costs	$1,195,605
Total Low Income	**$7,701,035**

Table L-4. Union Market Transformation scorecard spending

Spending Area	Actual Spent
Optimum Home Incentives	$736,173
Optimum Home Administration	$386,703
Optimum Home Promotion Costs	$282,464
Total Optimum Home Program	**$1,405,340**

Table L-5. Union portfolio budget spending for research, evaluation, and administration

Spending Area	Residential	C&I	Low Income	Large Industrial	Market Trans-formation	Total
% of Overall	19%	39%	26%	11%	5%	100%
Research	$61,568	$128,422	$86,994	$36,258	$15,875	$329,116
Evaluation	$98,214	$204,861	$138,774	$57,840	$25,324	$525,012
Administration	$409,671	$854,517	$578,856	$241,262	$105,634	$2,189,940
Total DSM Budget	**$569,452**	**$1,187,799**	**$804,624**	**$335,359**	**$146,834**	**$3,044,068**

Enbridge

Table L-6. Enbridge program costs for Resource Acquisition

Resource Acquisition	OEB-Approved Budget	Actual Spending		
		Indirect	Direct	Total
Residential				
HEC	$1,872,720	$8,340,428	$1,021,867	$9,362,295
Residential Total	**$1,872,720**	**$8,340,428**	**$1,021,867**	**$9,362,295**
Commercial				
Comm Prescriptive		$759,387	$0	$759,387
Comm Custom		$1,647,605	$785,017	$2,432,622
RunitRight		-$12,480	$1,471,376	$1,458,896
Multi residential (Comm)		$1,485,719	$41,350	$1,527,069
New Construction (Comm)		$43,624	$125	$43,749
Commercial Total	**$8,252,370**	**$3,923,856**	**$2,297,867**	**$6,221,724**
Industrial				
Custom Industrial (excl. Agriculture)		$1,450,240	$581,814	$2,032,054
Prescriptive Industrial		$27,150	$0	$27,150
Agriculture		$96,698	$10,805	$107,502
Industrial Total	**$4,318,700**	**$1,574,088**	**$592,619**	**$2,166,706**

Table L-7. Enbridge program costs for Low Income

Low Income	OEB-Approved Budget	Actual Spending		
		Indirect	Direct	Total
Single Family - Part 9	$4,655,790	$3,765,116	$679,500	$4,444,616
Multi Residential - Part 3	$2,208,300	$1,758,240	$353,506	$2,111,746
Totals	**$6,864,090**	**$5,523,356**	**$1,033,006**	**$6,556,362**

Table L-8. Enbridge program costs for Market Transformation

Market Transformation	OEB-Approved Budget	Actual Spending		
		Indirect	Direct	Indirect
SBD Residential	$2,493,900	$1,282,840	$749,183	$2,032,022
Home Labelling	$1,428,000	$1,540	$119,700	$121,241
SBD Commercial	$969,000	$615,359	$275,105	$890,464
Totals	**$4,890,900**	**$1,899,739**	**$1,143,988**	**$3,043,727**

Table L-9. Enbridge incremental budget spend

Incremental Cost	OEB-Approved Budget	Actual Spending		
		Indirect	Direct	Total
Unallocated	$291	$0	$0	$0
Collaboration Fund	$1,000,000	$0	$53,014	$53,014
Green Button Initiative	$300,000	$0	$0	$0
Integrated Resource Planning Study	$300,000	$0	$0	$0
Potential Study Update	$50,000	$0	$0	$0
DSM IT System	$0	$0	$0	$0
Strategic Energy Management	$370,000	$179	$60,284	$60,462
Low Income New Construction	$250,000	$0	$1,101	$1,101
O-Power	$2,650,000	$0	$444,801	$444,801
Totals	**$4,920,291**	**$179**	**$559,200**	**$559,378**

APPENDIX M. COST-EFFECTIVENESS METHODOLOGY

This appendix describes the detailed process used to verify the cost-effectiveness calculations, and recalculate cost-effectiveness results based on annual verification activities.

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 M-1. 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 M-1. 2015 “Programs” as defined by the OEB, Enbridge, and Union

<table>
<tr><th colspan="2">Union</th><th colspan="2">Enbridge</th></tr>
<tr><th>Union-Defined Programs</th><th>OEB-Defined Programs</th><th>Enbridge-Defined Programs</th><th>OEB-Defined Programs</th></tr>
<tr><td rowspan="4">Residential Program

Commercial/Industrial Program</td><td>Home Reno Rebate</td><td rowspan="3">Resource Acquisition</td><td>Home Energy Conservation</td></tr>
<tr><td>Energy Savings Kit</td><td>Commercial and Industrial Prescriptive</td></tr>
<tr><td>Commercial and Industrial Prescriptive</td><td>Custom Commercial and Industrial</td></tr>
<tr><td>Commercial and Industrial Custom</td><td rowspan="2">Low Income</td><td>Home Winterproofing</td></tr>
<tr><td rowspan="2">Low-Income Program</td><td>Home Weatherization</td><td>Low income Multi-Residential – Affordable Housing</td></tr>
<tr><td>Low Income Multi-Family</td><td rowspan="4">Market Transformation</td><td>Residential Savings by Design</td></tr>
<tr><td>Large Volume Program</td><td>Large Volume</td><td>Commercial Savings by Design</td></tr>
<tr><td rowspan="2">Market Transformation</td><td rowspan="2">Optimum Home</td><td>Home Rating</td></tr>
<tr><td>Run it Right</td></tr>
</table>

To calculate cost effectiveness, the EC first built a cost-effectiveness model using the utilities’ methodology and assumptions, as detailed in their 2015 tracking /audit tool workbooks. This step had several goals, including:

- Building a comprehensive model that could easily be modified to assess the impact of changing assumptions and methodology to calculate the TRC, TRC-Plus, and PAC tests
- Ensuring consistency of cost-effectiveness calculations by regrouping both utilities in the same model[29]
- Taking a deep dive into current utility models, making sure cost-effectiveness calculations were consistent with industry best practices

The EC model was verified to confirm that the TRC and TRC-Plus results (and PAC results where available) were initially identical to the utilities’ results on a line-by-line basis and at the aggregate level.[30]

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[29] Because Union’s workbook did not include PAC calculations, we initially aligned those calculations on Enbridge’s methodology.

[30] In some cases, Union’s program costs were grouped together for several programs, and have been prorated to each program to calculate the PAC using gas savings by program. Enbridge’s overhead costs have been kept at “Program type” level (e.g. Low Income, Resource Acquisition) to ensure that the EC’s initial results are consistent with Enbridge’s PAC results by program.

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.

A series of observations are made in the results section regarding some calculations and assumptions that could be reviewed to better reflect best practices, including the discount rate, the use of a gas benefit adder for the PAC test, and water avoided costs. The impacts of alternative approaches to cost-effectiveness calculations have been calculated using the model with verified savings (i.e., after applying the realization rates and net-to-gross ratios).

Results

Table M-2 and Table M-3 show summary results for Union the TRC, TRC-Plus, and PAC tests, including the cost-benefit ratio and the net present value. Table M-4 and Table M-5 show the same information for Enbridge. While there is a general drop in cost-effectiveness results following the verification of savings, almost all OEB-defined programs still pass the cost-effectiveness threshold for both the TRC-Plus and the PAC tests. The only exceptions are the Home Reno Rebate program[31] and the RunitRight[32] program, shown in tables at the end of this section. In both cases, those programs were not cost-effective when using utility draft reported savings, before any verification-related adjustment. There are additional tables located at the end of this section with more detailed results. When using the utility definition of savings, all programs pass the threshold.

Table M-2. Union summary of cost-effectiveness ratio results

Scorecard	Draft using Utility-Reported Savings*			Final Verified Ratio		
	TRC	TRC-Plus**	PAC**	TRC	TRC-Plus	PAC
Residential Resource Acquisition	1.2	3.0	8.0	1.0	1.2	2.3
Commercial and Industrial Resource Acquisition	2.9			3.3	3.8	12.0
Low Income	1.0	1.1	0.9	1.3	1.4	1.1
Large Volume	4.7	5.4	26.3	6.0	6.9	10.2
Total Portfolio	**2.9**	**3.3**	**8.1**	**2.9**	**3.3**	**6.8**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

31 The Home Reno Rebate program is not required to be cost effective; only the utility-defined Residential program must be cost effective.

32 The RunitRight program is not required to be cost effective; only the utility-defined Resource Acquisition program must be cost effective.

Table M-3. Union summary of cost-effectiveness net present value results

<table>
<tr><th rowspan="2">Scorecard</th><th colspan="3">Draft Net Present Value (M$) using Utility-Reported Savings*</th><th colspan="3">Final Verified Net Present Value (M$)</th></tr>
<tr><th>TRC</th><th>TRC-Plus**</th><th>PAC**</th><th>TRC</th><th>TRC-Plus</th><th>PAC</th></tr>
<tr><td>Residential Resource Acquisition</td><td rowspan="2">96.7</td><td rowspan="2">120.4</td><td rowspan="2">117.9</td><td>0.4</td><td>2.6</td><td>6.8</td></tr>
<tr><td>Commercial and Industrial Resource Acquisition</td><td>105.4</td><td>128.0</td><td>124.7</td></tr>
<tr><td>Low Income</td><td>(0.02)</td><td>1.0</td><td>(1.1)</td><td>1.7</td><td>3.1</td><td>0.6</td></tr>
<tr><td>Large Volume</td><td>70.2</td><td>83.6</td><td>81.1</td><td>27.6</td><td>32.6</td><td>29.4</td></tr>
<tr><td>Total Portfolio</td><td>166.9</td><td>205.1</td><td>197.9</td><td>135.2</td><td>166.3</td><td>161.5</td></tr>
</table>

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

Table M-4. Enbridge summary of cost-effectiveness ratio results

Scorecard	Draft using Utility-Reported Savings*			Final Verified Ratio		
	TRC**	TRC-Plus	PAC	TRC	TRC-Plus	PAC
Resource Acquisition	3.3	3.8	6.0	2.3	2.7	2.7
Low Income	2.1	2.5	2.5	1.7	2.0	1.9
Total Portfolio	**3.1**	**3.6**	**5.2**	**2.2**	**2.6**	**2.5**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Enbridge only reported TRC-Plus and PAC in its filings for 2015.

Table M-5. Enbridge 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**	TRC-Plus	PAC	TRC	TRC-Plus	PAC
Resource Acquisition	123.2	149.7	120.4	50.1	61.8	40.9
Low Income	9.2	11.8	10.7	6.0	8.1	6.2
Total Portfolio	**132.4**	**161.6**	**131.1**	**56.1**	**69.9**	**47.1**

* The utility-reported values reflect the savings presented in the utility's tracking workbook, not in the draft 2015 report. The utility changed the energy savings values for some projects after submitting the 2015 report but before delivering the data for evaluation, resulting in a small change.
**These values were calculated using the utility-reported draft savings results. Enbridge only reported TRC-Plus and PAC in its filings for 2015.

As very low net-to-gross factors were applied to the Large Volume and C&I (Enbridge) custom sectors, the TRC, TRC-Plus, and PAC net values for these sectors dropped significantly.

It is interesting to note that because both savings and costs are affected by the net-to-gross factor, the impact on the TRC and TRC-Plus ratios is far less significant. In addition, a high realization rate (135%) was applied to Union's Large Volume savings, resulting in an increase of the TRC-Plus ratio, even with a net-to-gross factor of only 12%.

Cost-effectiveness framework

Enbridge and Union use divergent cost-effectiveness frameworks to calculate their 2015 results:

- **Non-energy benefit (NEB) adder:** Enbridge uses a 15% NEB adder for both the TRC and the PAC, while Union does not include the adder in their TRC calculations.[33]

[33] Union's workbook did not include PAC results. WE calculated the PAC for Union using no NEB adder.

- **Discount rate:** Union uses its weighted average cost of capital (WACC) to discount future values, while Enbridge uses a real discount rate of 4%.

It should also be noted that Enbridge applies a real discount rate to streams of current values. Enbridge notes in the cost-effectiveness workbook provided to the EC that "the Board is of the view that the gas utilities should use a discount rate (real) of 4% when screening prospective DSM programs to determine if they are cost effective for consideration [as] part of the new 2015 to 2020 multi-year DSM plan. This discount rate is consistent with that used in the electricity Conservation First framework ensuring that all possible energy conservation programs are screened in a consistent manner."

The Independent Electricity System Operator's (IESO) Conservation and Demand Management (CDM) Energy Efficiency Cost Effectiveness Guide[34] confirms the 4% discount rate in its Appendix A, but states however that "when performing a cost-effectiveness assessment, the discount rate should be applied to "real" (inflation-adjusted) streams of benefits and costs." (p.21)

It is the EC's opinion that a real discount rate should indeed be used only on real streams of benefits and costs. When working with streams of current (nominal) values, a nominal discount rate should instead be used.

Finally, the use of a NEB adder for the PAC test is questionable. The 15% adder accounts for the non-energy benefits associated with DSM programs, such as environmental, economic, and social benefits.[35] While DSM programs (mostly those aimed at low income customers) may produce some NEBs at the utility level, such as reduced arrearages, bad debt, and disconnects, the bulk of NEBs are usually at the societal level (reduced GHG and other pollutants) and the participant level (increase comfort, health and safety, etc.), both of which are outside the scope of the PAC test.

The EC did not find any clear indication in OEB decisions or other documentation that the adder should be applied to the PAC. The following excerpt seems to suggest that it should indeed be applied only to the TRC:[36]

> On October 23, 2014, the Minister of Energy amended his Conservation First directive to the OPA and made it mandatory that electricity distributor CDM programs are screened using the TRC test and "include a 15% adder to account for the non-energy benefits associated with the electricity CDM programs, such as environmental, economic, and social benefits." To effectively align natural gas DSM programs with electricity CDM programs and take into consideration government objectives outlined in the Conservation Directive to the OPA, the Board has concluded that the same approach should be used for screening DSM programs.
>
> The Board will adopt an enhanced TRC test, or the "TRC-Plus" test, which the gas utilities should use to screen all potential DSM programs when developing their multi-year DSM plans. The gas utilities should directly apply a 15% non-energy benefit adder to the benefit side of the TRC test calculation.

[34] March 2015. Conservation and Demand Management Energy Efficiency Cost Effectiveness Guide. Independent Electricity System Operator (IESO).

[35] 2015-2020 Natural Gas Framework (EB-2014-0134), p. 33

[36] 2015-2020 Natural Gas Framework (EB-2014-0134). Ontario Energy Board, p. 33. In addition, IESO's March 2015 Conservation and Demand Management Energy Efficiency Cost Effectiveness Guide clearly states that the adder is to be used only with the TRC. (pp. 31, 32)

The EC team noted that water avoided costs are based on water rates. This has been confirmed by Union: "Water avoided costs are based on average water rates from 17 municipalities across Union's service territory. This information was used as a proxy to avoided water costs. Avoided water costs and the method of estimating them were filed in Union's Board-approved 2015-2020 plan." (Union's response to EC's questions on 2015 avoided costs.)

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,[37] notably to promote conservation, and are thus a bad proxy of avoided costs.

To simulate the impact of a reduction of water avoided costs, the EC reduced water avoided costs provided by the utilities by 75%. The impact on the TRC-Plus test is slight but not negligible. There is no impact on the PAC, as only gas avoided costs are included in this second test.

To produce results that are more comparable between the two gas utilities, and more consistent with DSM cost-effectiveness best practices, the EC modified results as follows:

- Including a 15% NEB adder in Union's avoided costs for the calculation of the TRC-Plus
- Removing the 15% NEB adder for PAC calculations
- Using a 4% real discount rate (since both utilities use streams of benefits expressed in nominal dollars, the real rate was converted to a nominal rate of 5.74% using Union's inflation factor of 1.68%)
- Adjusting the water savings benefits to better reflect real avoided costs

With this new set of assumptions, Union's cost-effectiveness results are increased, while Enbridge's are decreased. All sectors and portfolios remain cost-effective for both the TRC-Plus and the PAC.

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 "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.
- **Use a consistent real discount rate of 4% for both Enbridge and Union when using "real" (inflation-adjusted) streams of benefits and costs.**
- **Explore the possibility of better defining water avoided costs.**
- **Work towards a better uniformity of cost-effectiveness methods and assumptions between the two gas utilities.** There is always a balance to be found between uniform methods and the need to account for the specific situation of each utility. The EC found, however, major discrepancies that could

[37] The City of Toronto, for example, uses a completely variable rate structure.

be reduced, such as the discount rate, the use of an NEB adder, the format of reporting results, and the allocation of administration and overhead costs by program.

Table M-6. Union Low Income TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	TRC Costs (equipment)	TRC Value (equipment)	TRC Ratio (equipment)	Program Admin Costs	TRC Ratio (program)
Utility-Reported Draft Results								
LI Multi-Family Custom	261,801	1,977,229	577,341	1,977,229	(1,399,888)	0.29	122,815	0.27
LI Multi-Family Prescriptive	589,561	456,435	1,693,096	456,435	1,236,660	3.71	276,572	2.31
Home Weatherization Program	1,341,780	3,453,109	4,927,199	3,453,109	1,474,090	1.43	629,450	1.21
LI Multi-Family Custom - Contrax	57,832	187,055	140,562	187,055	46,493	0.75	27,130	0.66
Utility-Reported Draft Total	**2,250,974**	**6,073,828**	**7,338,197**	**6,073,828**	**1,264,368**	**1.21**	**1,055,967**	**1.03**
Final Verified Results								
LI Multi-Family Custom	261,801	1,977,229	676,896	1,977,229	(1,300,333)	0.34	122,811	0.32
LI Multi-Family Prescriptive	589,643	456,499	1,997,719	456,499	1,541,219	4.38	276,602	2.73
Home Weatherization Program	1,341,765	3,453,070	6,036,321	3,453,070	2,583,250	1.75	629,424	1.48
LI Multi-Family Custom - Contrax	57,832	187,055	166,626	187,055	(20,429)	0.89	27,129	0.78
Final Verified Total	**2,251,042**	**6,073,854**	**8,877,562**	**6,073,854**	**2,803,708**	**1.46**	**1,055,967**	**1.25**

Table M-7. Union Resource Acquisition TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	TRC Costs (equipment)	TRC Value (equipment)	TRC Ratio (equipment)	Program Admin Costs	TRC Ratio (program)
Utility-Reported Draft Results								
Prescriptive	9,283,248	93,710,064	27,327,806	9,370,064	17,957,742	2.92	531,898	2.76
Agriculture & Greenhouse-Banner	1,406,652	1,464,459	3,017,406	1,464,459	1,552,947	2.06	80,596	1.95
Agriculture & Greenhouse-Contrax	17,779,246	12,334,170	38,785,681	12,334,170	26,451,511	3.14	1,018,689	2.90
Commercial & Institutional Buildings-Banner	1,324,819	4,310,368	3,695,020	4,310,368	(615,348)	0.09	75,908	0.84
Commercial & Institutional Buildings-Contrax	6,277,602	3,575,446	25,100,079	3,575,446	21,524,633	7.02	359,685	6.38
Industrial-Banner	1,287,371	1,559,799	3,265,762	1,559,799	1,705,963	2.09	73,762	2.00
Industrial-Contrax	15,424,080	11,560,886	38,455,282	11,560,886	26,894,396	3.33	883,746	3.09
Energy Savings Kit	1,644,462	139,175	9,133,806	139,175	8,994,632	65.63	310,472	20.31
Home Reno Rebate	3,254,128	12,866,720	9,071,117	12,866,720	(3,795,603)	0.71	614,375	0.67
Utility-Reported Draft Total	**57,681,609**	**57,181,085**	**157,851,959**	**57,181,085**	**100,670,874**	**2.76**	**3,949,131**	**2.58**
Final Verified Results								
Prescriptive	9,307,088	9,170,777	31,971,550	9,170,777	22,800,773	3.49	552,470	3.29
Agriculture & Greenhouse-Banner	1,346,544	1,401,880	3,247,121	1,401,880	1,845,240	2.32	79,931	2.19
Agriculture & Greenhouse-Contrax	17,019,510	11,807,111	41,348,724	11,807,111	29,541,614	3.50	1,010,281	3.23
Commercial & Institutional Buildings-Banner	1,268,208	4,126,179	4,036,407	4,126,179	(89,771)	0.98	75,281	0.96
Commercial & Institutional Buildings-Contrax	6,009,349	3,422,661	27,091,413	3,422,661	23,668,752	7.92	356,716	7.17
Industrial-Banner	1,232,360	1,493,146	3,491,739	1,493,146	1,998,593	2.34	73,153	2.23
Industrial-Contrax	14,764,984	11,066,870	39,698,891	11,066,870	28,632,021	3.59	876,452	3.32
Energy Savings Kit	1,666,803	151,348	3,969,508	151,348	3,818,160	26.23	313,261	8.54
Home Reno Rebate	3,254,128	12,866,720	10,414,786	12,866,720	(2,451,934)	0.81	611,586	0.77
Final Verified Total	**55,868,974**	**55,506,693**	**165,270,139**	**55,506,693**	**109,763,446**	**2.98**	**3,949,131**	**2.78**

Table M-8. Union Large Volume TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	TRC Costs (equipment)	TRC Value (equipment)	TRC Ratio (equipment)	Program Admin Costs	TRC Ratio (program)
Utility-Reported Draft Results								
Large Industrial-T1	5,743,536	2,813,262	13,175,552	2,813,262	10,362,290	4.68	115,020	4.50
Large Industrial-T2	38,382,453	13,967,830	69,505,342	13,967,830	55,537,512	4.98	768,645	4.72
Large Industrial-R100	5,131,627	1,305,055	6,628,785	1,305,055	5,323,730	5.08	102,766	4.71
Utility-Reported Draft Total	**49,257,616**	**18,086,146**	**89,309,678**	**18,086,146**	**71,223,532**	**4.94**	**986,431**	**4.68**
Final Verified Results								
Large Industrial-T1	1,445,698	709,008	4,737,064	709,008	4,028,056	6.68	115,810	5.74
Large Industrial-T2	9,598,272	3,540,164	26,209,242	3,540,164	22,669,079	7.40	768,884	6.08
Large Industrial-R100	1,270,020	322,986	2,236,874	322,986	1,913,888	6.93	101,737	5.27
Final Verified Total	**12,313,990**	**4,572,158**	**33,183,180**	**4,572,158**	**28,611,022**	**7.26**	**986,431**	**5.97**

Table M-9. Enbridge overall TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	Program Costs	Overhead	TRC Costs	TRC Value	TRC Ratio
Final Verified Results								
Resource Acquisition	28,335,894	23,636,918	77,654,832	3,912,353	5,639,080	33,188,351	50,105,561	2.34
Low Income	4,565,042	6,494,130	14,162,389	1,033,006	617,349	8,144,485	6,017,905	1.74

Table M-10. Enbridge Residential TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Final Verified Results							
Home Energy Conservation	6,762,791	7,790,602	17,154,904	1,021,867	8,812,469	8,342,435	1.95

Table M-11. Enbridge Commercial TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Final Verified Results							
Commercial Prescriptive	5,671,517	3,569,834	17,625,767	-	3,569,834	14,055,934	4.94
Commercial Custom	4,519,626	4,178,176	11,459,659	785,017	4,963,192	6,496,466	2.31
Run It Right	286,985	105,031	243,445	1,471,376	1,576,407	(1,332,963)	0.15
Multi-Residential	2,375,972	2,053,398	7,034,099	41,350	2,094,748	4,939,351	3.36
New Construction	884,643	2,664,670	7,599,092	125	2,664,795	4,934,298	2.85
Final Verified Total	**13,738,742**	**12,571,109**	**43,962,062**	**2,297,867**	**14,868,976**	**29,093,086**	**2.96**

Table M-12. Enbridge Industrial TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Final Verified Results							
Industrial Custom	7,161,652	2,640,877	14,786,259	10,805	2,651,681	12,134,577	5.58
Industrial Prescriptive	475,461	368,272	1,391,453	581,814	950,086	441,367	1.46
Agriculture	197,247	266,058	360,154	-	266,058	94,096	1.35
Final Verified Total	**7,834,360**	**3,275,207**	**16,537,866**	**592,619**	**3,867,826**	**12,670,040**	**4.28**

Table M-13. Enbridge Low Income TRC results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Final Verified Results							
Low Income Part 9	1,143,282	3,406,633	3,749,834	679,500	4,086,132	(336,298)	0.92
Low Income Part 3	3,421,760	3,087,497	10,412,555	353,506	3,441,003	6,971,552	3.03
Final Verified Total*	**4,565,042**	**6,494,130**	**14,162,389**	**1,033,006**	**7,527,136**	**6,635,254**	**1.88**

*This total does not include the Low Income overhead amount, which is why the results are different from the Low Income row in Table M-9.

Table M-14. Union Low Income PAC results

Program	Annual net savings (m3)	Program-level Incentives/ Promotion	Program-level general admin. costs	Portfolio Budget	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results**								
Low Income	2,251,107	6,645,067	1,055,967	804,624	6,618,986	7,701,034	(1,082,048)	0.86
Final Verified Results								
Low Income	2,251,042	6,645,067	1,055,967	804,624	8,284,628	7,701,034	583,274	1.08

**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

Table M-15. Union Resource Acquisition PAC results

Program	Annual net savings (m3)	Program-level Incentives/ Promotion	Program-level general admin. costs	Portfolio Budget	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results**								
Commercial Prescriptive	9,283,248	2,831,233	531,898	208,905	25,120,221	3,363,131	21,757,089	7.47
Commercial Custom	7,602,421	977,281	435,592	171,081	17,790,153	1,412,874	16,377,279	12.59
Small Industrial	16,711,451	2,257,424	957,508	376,065	38,912,289	3,214,932	35,697,357	12.10
Agriculture & Greenhouse	19,185,899	2,278,174	1,099,285	431,749	41,358,032	3,377,460	37,980,572	12.25
Residential	4,898,590	4,525,364	924,847	569,452	11,493,323	5,450,211	6,043,112	2.11
Utility-Reported Draft Total	**57,681,609**	**12,869,476**	**3,949,131**	**1,757,251**	**134,674,017**	**16,818,607**	**117,855,410**	**8.01**
Final Verified Results								
Commercial Prescriptive	9,307,088	2,831,233	552,470	216,985	29,874,992	3,383,704	26,491,289	8.83
Commercial Custom	7,277,557	977,281	431,997	169,668	19,318,893	1,409,278	17,909,615	13.71
Small Industrial	15,997,344	2,257,424	949,605	372,961	42,428,192	3,207,029	39,221,164	13.23
Agriculture & Greenhouse	18,366,054	2,278,174	1,090,212	428,185	44,474,009	3,368,386	41,105,623	13.20
Residential	4,920,932	4,525,364	924,847	569,452	12,254,926	5,450,211	6,804,716	2.25
Final Verified Total	**55,868,974**	**12,869,476**	**3,949,131**	**1,757,251**	**148,351,013**	**16,818,607**	**131,532,406**	**8.82**

**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

Table M-16. Union Large Volume PAC results

Program	Annual net savings (m3)	Program-level Incentives/ Promotion	Program-level general admin. costs	Portfolio Budget	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results**								
Large Industrial-T1	5,743,536	477,540	115,020	39,104	11,600,801	592,560	11,008,241	19.58
Large Industrial-T2	38,382,453	1,359,669	768,645	261,318	66,797,160	2,128,314	64,668,846	31.39
Large Industrial-R100	5,131,627	386,076	102,766	34,937	5,918,686	488,842	5,429,844	12.11
Utility-Reported Draft Total	**49,257,616**	**2,223,285**	**986,431**	**335,359**	**84,316,647**	**3,209,716**	**81,106,931**	**26.27**
Final Verified Results								
Large Industrial-T1	1,445,698	477,540	115,810	39,372	4,512,275	593,350	3,918,925	7.60
Large Industrial-T2	9,598,272	1,359,669	768,884	261,399	25,947,942	2,128,553	23,819,389	12.19
Large Industrial-R100	1,270,020	386,076	101,737	34,588	2,173,247	487,813	1,685,433	4.46
Final Verified Total	**12,313,990**	**2,223,285**	**986,431**	**335,359**	**32,633,463**	**3,209,716**	**29,423,747**	**10.17**

**These values were calculated using the utility-reported draft savings results. Union only reported TRC in its filings for 2015.

Table M-17. Enbridge Residential PAC results

Program	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results				
Home Energy Conservation	20,382,468	9,362,295	11,020,173	2.18
Final Verified Results				
Home Energy Conservation	15,833,554	9,362,295	6,471,259	1.69

Table M-18. Enbridge Commercial PAC results

Program	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results				
Commercial Prescriptive	18,785,522	759,387	18,026,134	24.74
Commercial Custom	35,425,654	3,006,848	32,418,806	11.78
Run It Right	542,289	1,458,896	(916,607)	0.37
Multi-Residential	22,201,798	1,527,069	20,674,730	14.54
New Construction	13,685,301	43,749	13,641,552	312.81
Utility-Reported Draft Total	**906,640,564**	**6,795,949**	**83,844,615**	**13.34**
Final Verified Results				
Commercial Prescriptive	13,883,037	759,387	13,123,650	18.28
Commercial Custom	9,525,149	3,006,848	6,518,301	3.17
Run It Right	243,445	1,458,896	(1,215,451)	0.17
Multi-Residential	6,396,804	1,527,069	4,869,735	4.19
New Construction	2,659,747	43,749	2,615,997	60.79
Final Verified Total	**32,708,182**	**6,795,949**	**25,912,232**	**4.81**

Table M-19. Enbridge Industrial PAC results

Program	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results				
Industrial Custom	31,091,685	2,032,054	29,059,631	15.30
Industrial Prescriptive	1,385,792	27,150	1,358,642	51.04
Agriculture	894,031	107,502	786,529	8.32
Utility-Reported Draft Total	**33,371,509**	**2,166,706**	**31,204,802**	**15.40**
Final Verified Results				
Industrial Custom	14,735,667	2,032,054	12,703,614	7.25
Industrial Prescriptive	1,230,060	27,150	1,202,910	45.31
Agriculture	360,154	107,502	252,652	3.35
Final Verified Total	**16,325,882**	**2,166,706**	**14,159,176**	**7.53**

Table M-20. Enbridge Low Income PAC results

Program	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results				
Low Income Part 9	5,178,114	4,444,616	733,498	1.17
Low Income Part 3	12,691,944	2,111,746	10,580,198	6.01
Utility-Reported Draft Total	**178,700,528**	**6,556,362**	**11,313,696**	**2.73**
Final Verified Results				
Low Income Part 9	3,731,189	4,444,616	(713,427)	0.84
Low Income Part 3	9,596,574	2,111,746	7,484,828	4.54
Final Verified Total*	**13,327,763**	**6,556,362**	**6,771,401**	**2.03**

*This total does not include the Low Income overhead amount, which is why the results are different from the Low Income row in Table M-21.

Table M-21. Enbridge overall PAC results

Program	PAC Benefits	PAC Costs	PAC Value	PAC Ratio
Utility-Reported Draft Results				
Resource Acquisition	144,394,541	23,964,031	120,430,511	6.03
Low Income	17,870,058	7,173,711	10,696,347	2.49
Utility-Reported Draft Total	**162,264,599**	**31,137,742**	**131,126,858**	**5.21**
Final Verified Results				
Resource Acquisition	64,867,618	23,964,031	40,903,587	2.71
Low Income	13,327,763	7,173,711	6,154,052	1.86
Final Verified Total	**78,195,381**	**31,137,742**	**47,057,639**	**2.51**

Table M-22. Union Low Income TRC-Plus results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	TRC Costs (equipment)	TRC Value (equipment)	TRC Ratio (equipment)	Program Admin Costs	TRC Ratio (program)
Final Verified Results								
LI Multi-Family Custom	261,801	1,977,229	778,431	1,977,229	(1,198,798)	0.39	122,811	0.37
LI Multi-Family Prescriptive	589,643	456,499	2,297,377	456,499	1,840,877	5.03	276,602	3.13
Home Weatherization Program	1,341,765	3,453,070	6,941,769	3,453,070	3,488,698	2.01	629,424	1.70
LI Multi-Family Custom - Contrax	57,832	187,055	191,620	187,055	4,565	1.02	27,129	0.89
Final Verified Total	**2,251,042**	**6,073,854**	**10,209,196**	**6,073,854**	**4,135,342**	**1.68**	**1,055,967**	**1.43**

Table M-23. Union Resource Acquisition TRC-Plus results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	TRC Costs (equipment)	TRC Value (equipment)	TRC Ratio (equipment)	Program Admin Costs	TRC Ratio (program)
Final Verified Results								
Prescriptive	9,307,088	9,170,777	36,767,282	9,170,777	27,596,505	4.01	552,470	3.78
Agriculture & Greenhouse-Banner	1,346,544	1,401,880	3,734,189	1,401,880	2,332,308	2.66	79,931	2.52
Agriculture & Greenhouse-Contrax	17,019,510	11,807,111	47,551,033	11,807,111	35,743,922	4.03	1,010,281	3.71
Commercial & Institutional Buildings-Banner	1,268,208	4,126,179	4,641,868	4,126,179	515,690	1.12	75,281	1.10
Commercial & Institutional Buildings-Contrax	6,009,349	3,422,661	31,155,125	3,422,661	27,732,464	9.1	356,716	8.24
Industrial-Banner	1,232,360	1,493,146	4,015,500	1,493,146	2,522,354	2.69	73,153	2.56
Industrial-Contrax	14,764,984	11,066,870	45,653,724	11,066,870	34,586,854	4.13	876,452	3.82
Energy Savings Kit	1,666,803	151,348	4,564,935	151,348	4,413,586	30.16	313,261	9.83
Home Reno Rebate	3,254,128	12,866,720	11,977,004	12,866,720	(889,716)	0.93	611,586	0.89
Final Verified Total	**55,868,974**	**55,506,693**	**190,060,660**	**55,506,693**	**134,553,967**	**3.42**	**3,949,131**	**3.20**

Table M-24. Union Large Volume TRC-Plus results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	TRC Costs (equipment)	TRC Value (equipment)	TRC Ratio (equipment)	Program Admin Costs	TRC Ratio (program)
Final Verified Results								
Large Industrial-T1	1,445,698	709,008	5,447,623	709,008	4,738,615	7.68	115,810	6.60
Large Industrial-T2	9,598,272	3,540,164	30,140,629	3,540,164	26,600,465	8.51	768,884	6.99
Large Industrial-R100	1,270,020	322,986	2,572,405	322,986	2,249,419	7.96	101,737	6.06
Final Verified Total	**12,313,990**	**4,572,158**	**38,160,657**	**4,572,158**	**33,588,499**	**8.35**	**986,431**	**6.87**

Table M-25. Enbridge overall TRC-Plus results

Scorecard	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	Program Costs	Overhead	TRC Costs	TRC Value	TRC Ratio
Final Verified Results								
Resource Acquisition	28,335,894	23,636,918	89,303,057	3,912,353	5,639,080	33,188,351	61,753,786	2.69
Low Income	4,565,042	6,494,130	16,286,748	1,033,006	617,349	8,144,485	8,142,263	2.00

Table M-26. Enbridge Residential TRC-Plus results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Utility-Reported Draft Results							
Home Energy Conservation	6,762,791	7,790,602	22,077,884	1,021,867	8,812,469	132,654,158	2.51
Final Verified Results							
Home Energy Conservation	6,762,791	7,790,602	19,728,139	1,021,867	8,812,469	10,915,671	2.24

Table M-27. Enbridge Commercial TRC-Plus results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Utility-Reported Draft Results							
Commercial Prescriptive	5,750,534	3,640,863	30,989,923	-	3,640,863	27,349,060	8.51
Commercial Custom	12,326,277	11,395,046	42,631,687	785,017	12,180,063	30,451,624	3.50
Run It Right	536,821	196,467	542,289	1,471,376	1,667,843	(1,125,554)	0.33
Multi-Residential	5,890,850	5,091,080	24,316,449	41,350	5,132,430	19,184,019	4.74
New Construction	3,027,916	9,120,516	39,043,342	125	9,120,641	29,922,701	4.28
Utility-Reported Draft Total	**27,532,399**	**29,443,972**	**137,523,689**	**2,297,867**	**31,741,839**	**105,781,850**	**4.33**
Final Verified Results							
Commercial Prescriptive	5,671,517	3,569,834	20,269,633	-	3,569,834	16,699,799	5.68
Commercial Custom	4,519,626	4,178,176	13,178,607	785,017	4,963,192	8,215,415	2.66
Run It Right	286,985	105,031	279,961	1,471,376	1,576,407	(1,296,446)	0.18
Multi-Residential	2,375,972	2,053,398	8,089,214	41,350	2,094,748	5,994,466	3.86
New Construction	884,643	2,664,670	8,738,956	125	2,664,795	6,074,161	3.28
Final Verified Total	**13,738,742**	**12,571,109**	**50,556,372**	**2,297,867**	**14,868,976**	**35,687,396**	**3.40**

Table M-28. Enbridge Industrial TRC-Plus results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Utility-Reported Draft Results							
Industrial Custom	11,097,622	4,092,276	33,723,828	10,805	4,103,080	29,620,748	8.22
Industrial Prescriptive	398,824	304,562	1,553,550	581,814	886,376	667,174	1.75
Agriculture	366,783	494,737	894,031	-	494,737	399,294	1.81
Utility-Reported Draft Total	**11,863,229**	**4,891,575**	**36,171,410**	**592,619**	**5,484,194**	**30,687,216**	**6.60**
Final Verified Results							
Industrial Custom	7,161,652	2,640,877	17,004,197	10,805	2,651,681	14,352,516	6.41
Industrial Prescriptive	475,461	368,272	1,600,171	581,814	950,086	650,084	1.68
Agriculture	197,247	266,058	414,177	-	266,058	148,119	1.56
Final Verified Total	**7,834,360**	**3,275,207**	**19,018,546**	**592,619**	**3,867,826**	**15,150,720**	**4.92**

Table M-29. Enbridge Low Income TRC-Plus results

Program	Annual net savings (m3)	Measure Incremental Costs	TRC-Plus Benefits	Program Costs	TRC Costs	TRC Value	TRC Ratio
Utility-Reported Draft Results							
Low Income Part 9	1,139,959	3,398,252	5,253,138	679,500	4,077,752	1,175,386	1.29
Low Income Part 3	3,397,177	3,073,287	14,695,099	353,506	3,426,793	11,268,305	4.29
Utility-Reported Draft Total	**4,537,136**	**6,471,539**	**19,948,237**	**1,033,006**	**7,504,545**	**12,443,691**	2.66
Final Verified Results							
Low Income Part 9	1,143,282	3,406,633	4,312,309	679,500	4,086,132	226,177	1.06
Low Income Part 3	3,421,760	3,087,497	11,974,438	353,506	3,441,003	8,533,435	3.48
Final Verified Total*	**4,565,042**	**6,494,130**	**16,286,748**	**1,033,006**	**7,527,136**	**8,759,612**	**2.16**

*This total does not include the Low Income overhead amount, which is why the results are different from the Low Income row in Table M-25.

APPENDIX N. SPILLOVER ESTIMATE

This appendix describes the source of the estimated value used for spillover and how it was added to the free ridership estimate to produce the NTG ratio for custom projects.[38]

A spillover study is currently being conducted on Ontario gas utilities' custom projects from 2013 and 2014; however, those results are not yet available. The OEB asked the EC to conduct secondary source research to identify an estimate that might reasonably be applied to the Ontario DSM programs as an estimate for the 2015 clearance of accounts. The EC selected a 3.4% spillover rate based on a study in Massachusetts.[39] This is the most applicable value for the Ontario DSM programs because:

- Massachusetts has a similar climate to Ontario's major population centers, so it is likely that similar measures are being implemented
- The spillover value is specifically for custom gas C&I measures, which is the same program type
- The programs in Massachusetts and Ontario are mature and in leading jurisdictions
- The Massachusetts study looked at both "like" and "unlike" spillover[40]
- The rate is within the anticipated range of results expected for spillover from custom gas C&I programs, not an extreme outlier
- The study is relatively recent, from 2014-15.

The major differences from the Ontario spillover study are as follows:

- It only *quantifies* (provides a savings estimate for) like spillover, not unlike spillover.
- The study was conducted on customers who had participated in the program 15-27 months prior, not four or five years ago. This provides for less time since the program measure for spillover to occur.

The spillover estimate was added to the measured free ridership rate from the CPSV/NTG study (APPENDIX H). Table N-1 and Table N-2 show the free ridership, spillover, and NTG adjustment factors.

The NTG adjustment factors were applied to the verified gross savings to produce verified net savings.

[38] Spillover is only added to custom projects in C&I and Large Volume, not Low Income.

[39] Tetra Tech. "2014-15 Commercial and Industrial Natural Gas Programs Free-ridership and Spillover Study" for National Grid, Eversource, Unitil, Berkshire Gas, Columbia Gas of MA, and Liberty Utilities. Revised August 10, 2015.

[40] Like spillover refers to energy efficient equipment installed by a participant due to program influence that is identical to the equipment they received through the program. Unlike spillover is installed equipment due to program influence that is different from what they received through the program.

Table N-1. Union free ridership, spillover, and NTG adjustment factors by subset

Program	Free Ridership Adjustment†	Spillover Addition	Net-to-Gross Adjustment†
C&I Custom Comm & Inst Buildings	44%	3.4%	47%
C&I Custom Ag and Greenhouse	41%	3.4%	44%
C&I Custom Industrial	39%	3.4%	43%
Large Industrial R100	8%	3.4%	12%
Large Industrial T1	9%	3.4%	13%
Large Industrial T2	8%	3.4%	11%

†These values are rounded.

Table N-2. Enbridge CPSV and NTG adjustment factors

Program	Free Ridership Adjustment†	Spillover Addition	Net-to-Gross Adjustment†
Custom Commercial	17%	3.4%	21%
C&I Custom New Construction	18%	3.4%	22%
Custom Multi-family	35%	3.4%	38%
Custom Industrial Ag	28%	3.4%	32%
Custom Industrial	33%	3.4%	36%
RunitRight	50%	3.4%	53%

†These values are rounded.

APPENDIX O. FINAL ANNUAL VERIFICATION EM&V PLAN

Below is the detailed plan for the 2015 verification. The plan was largely implemented as written; however, there was a large divergence from the original schedule.

Natural Gas Demand Side Management - Detailed Plan for 2015 Annual Verification

submitted to the Ontario Energy Board

Date: January 13, 2017

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1 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 2015. 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 (LRAM), 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 LRAM amounts.
- Recommend changes to improve input assumptions, verification procedures, and the overall verification process.

The LRAM, DSMVA, and DSMSI are based on the following metrics:

- LRAM: the verified natural gas energy savings (in annual cubic meters) by rate class (rounded to the nearest 1,000 cubic meters) 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 2015 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 LRAM and DSMSI amounts.

The remainder of this document provides the following:

- An overview of the 2015 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.

2 REPORTED METRICS TO VERIFY

To verify the LRAM and DSMSI, the EC must verify the reported utility achievements for each scorecard, as well as verify the energy savings achieved by each rate class. Table 2-1 and Table 2-2 show the 2015 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 reported 2015 achievement for each utility. Because some scorecards are a compilation of the achievements of multiple programs, Table 2-3 and Table 2-4 show the scorecard metrics and energy savings achievements by program.

Table 2-1. Union's Reported 2015 achievement, target, weight, and maximum shareholder incentive by scorecard

Scorecard	2015 Target	2015 Reported Achievement	% of Target	Weight	Maximum Shareholder Incentive (if 150% of target achieved)
Union					
Resource Acquisition	816,561,818 CCM	938,905,035 CCM	130%	90%	$5,761,833
	1,245 deep savings participants	2,537 participants	308%	5%	
	8.88% of commercial whole building natural gas use saved	8.24% saved	68%	5%	
Large Volume	206,256,017 Rate 1 CCM	78,919,835 CCM	-23%	60%	$1,862,877
	1,029,841,387 Rate T2/100 CCM	499,103,360 CCM	-3%	40%	
Low Income	26,000,000 single family CCM	33,504,841 CCM	158%	60%	$2,810,129
	17,600,000 multi-family CCM	16,948,695 CCM	93%	40%	
Market Transformation	30% of homes built by participating builders were 20% more efficient than OBC	50% of homes	306%	100%	$566,721
TOTAL					**$11,001,560**

Table 2-2. Enbridge's Reported 2015 achievement, target, weight, and maximum shareholder incentive by scorecard

Scorecard	2015 Target	2015 Reported Achievement	% of Target	Weight	Maximum Shareholder Incentive (if 150% of target achieved)
Enbridge					
Resource Acquisition	1,011,900,000 CCM	767,627,826 CCM	52%	92%	$6,482,744
	762 deep savings participants	5,646 participants	1385%	8%	
Low Income	24,100,000 single family CCM	28,343,978 CCM	135%	50%	$2,495,721
	68,700,000 multi-family CCM	69,226,782 CCM	102%	45%	
	40% of Part 3 participants enrolled	65% enrolled	224%	5%	
Residential Savings by Design (Market Transformation)	18 Builders enrolled	19 Builders enrolled	113%	20%	$1,076,493
	1,111 homes built 20% more efficient than OBC	1,987 of homes	258%	13%	
Commercial Savings by Design (Market Transformation)	18 New developments enrolled	24 developments enrolled	150%	33%	$418,269
Home Labelling (Market Transformation)	5,000 Realtor commitments	41,650 Realtor commitments	466%	17%	$616,397
	4,500 Ratings performed	336 Ratings performed	7%	17%	
TOTAL					**$11,089,624**

Table 2-3. Union 2015 reported achievement by program

Program	2015 Reported Achievement
Union Gas	
Home Reno Rebate	58,923,165 CCM 2,537 Deep savings participants
Energy Savings Kit	19,567,373 CCM
C&I Overall	8.24% of whole building natural gas use saved
Commercial Custom	678,002,610 CCM
Commercial Prescriptive	182,411,887 CCM
Large Volume Rate T1	78,919,835 CCM
Large Volume Rates T2/100	499,103,360 CCM
Low Income Weatherization	33,504,841 CCM
Low Income Multi-Residential Housing	16,948,695 CCM
Optimum Home	50% of homes built by participating builders were 20% more efficient than OBC

Table 2-4. Enbridge 2015 reported achievement by program

Program	2015 Reported Achievement
Enbridge	
Residential Home Energy Conservation	102,415,214 CCM 5,646 Deep savings participants
Commercial Custom	383,277,447 CCM
Industrial Custom	172,964,331 CCM
Commercial Prescriptive	98,693,722 CCM
Industrial Prescriptive	7,593,008 CCM
Run it Right	2,684,105 CCM
Low Income Home Winterproofing	28,343,978 CCM
Low Income Multi-Residential Housing	69,226,782 CCM

Program	2015 Reported Achievement
	65% of Part 3 participants enrolled
Residential Savings by Design	19 Builders enrolled 1,987 homes built 20% more efficient than OBC
Commercial Savings by Design	24 New developments enrolled
Home Labelling	41,650 Realtor commitments 336 Ratings performed

3 ACTIVITIES

To verify the information reported in section 2, the EC will conduct the activities outlined in Table 3-1 and Table 3-2. To prepare for the program-specific activities, the EC will request tracking data and documentation, specified in section 4. For all programs, the EC will first review the reported savings and metrics from the tracking data and compare them to the summarized information in the gas utilities' annual report to ensure consistency. We will also recreate the reported DSMVA, LRAM, and DSMSI values using the reported savings and scorecard achievements to confirm that the calculations were done correctly.

Once the program-specific verifications are completed, the EC will assemble the verified scorecard results and calculate the verified LRAM, DSMVA, and DSMSI results as necessary. We will also document any recommendations that may improve the annual verification process going forward.

Table 3-1. 2015 Annual verification activities for Union, by program

Program	Metrics	Activity
Union Gas		
Home Reno Rebate **Energy Savings Kit** **Low Income Weatherization** **Low Income Multi-Residential Housing**	Natural gas savings (CCM) Number of deep savings participants	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for a census (or the full population) of measures. Verify the number of deep savings participants by reviewing the detailed documentation for a sample of participants. Apply the results of the CPSV / NTG study, where appropriate.
Commercial Custom	Natural gas savings (CCM) Average percent of whole building energy use saved by the program	Confirm that the necessary factors (such as NTG assumptions) were applied correctly and that recommendations from previous evaluations were adopted. Apply the results of the CPSV / NTG study. Collect the annual billing information for a census of participants and compare the verified energy savings to the annual energy use to confirm the percent of whole building natural gas use saved.
Commercial Prescriptive	Natural gas savings (CCM) Average percent of whole building energy use saved by the program	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for a census of measures. Collect the annual billing information for a census of participants and compare verified energy savings to the annual energy use to confirm the percent of whole building natural gas use saved.

Program	Metrics	Activity
Large Volume	Natural gas savings (CCM)	Confirm that the necessary factors (such as NTG assumptions) were applied correctly and that recommendations from previous evaluations were adopted. Apply the results of the CPSV / NTG study.
Optimum Home	Percent of homes built by participating builders that are 20% more efficient than OEB	Review the procedure used for determining the scorecard metric to confirm whether it leads to accurate results.

Table 3-2. 2015 Annual verification activities for Enbridge, by program

Program	Metrics	Activity
Enbridge		
Residential Home Energy Conservation **Low Income Home Winterproofing** **Low Income Multi-Residential Housing**	Natural gas savings (CCM) Number of deep savings participants Percent of Part 3 participants enrolled	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for a census of measures. Verify the number of deep savings participants by reviewing the detailed documentation for a sample of participants. Review documentation to confirm the Part 3 participant low income scorecard metric. Apply the results of the CPSV / NTG study, where appropriate.
Commercial and Industrial Custom	Natural gas savings (CCM)	Confirm that the necessary factors (such as NTG assumptions) were applied correctly and that recommendations from previous evaluations were adopted. Apply the results of the CPSV / NTG study.
Commercial and Industrial Prescriptive	Natural gas savings (CCM)	Confirm that the measure-level inputs for prescriptive measures were appropriate and confirm that the savings were calculated correctly for a census of measures.
Run it Right	Natural gas savings (CCM)	Conduct a desk review of a sample of participants to verify the reasonableness of the claimed savings.
Residential Savings by Design **Commercial Savings by Design** **Home Labelling**	Builders enrolled Number of efficient homes Number of developments Number of realtor commitments Number of ratings performed	Review the procedure used for determining the scorecard metrics to confirm whether it leads to accurate results.

4 WHAT INFORMATION IS NECESSARY

DNV GL will request data and documentation in two waves. The first documentation request will address the tracking data for each program, documentation and support for prescriptive savings calculations, assumptions and adjustments (such as NTG assumptions) for custom savings projects, billing data for Union commercial customers, and an explanation for how metrics for market transformation programs are counted and tracked. The second documentation request will be significantly smaller, requesting documentation on a sample of Run it Right and Home Reno Rebate / Residential Home Energy Conservation participants.

The detailed data requested as part of the two documentation requests are shown in Table 4-1. Per the schedule outlined in section 6, the EC will send a formal documentation request for Round 1 on January 6th, with delivery due January 20th. The EC will send a formal documentation request for Round 2 on January 31st at the latest, with delivery due on February 14th.

Table 4-1. Detailed data requested for each documentation request

Documentation Request	Requested Information
Union	
Round 1: Jan 6 **Due by: Jan 20**	A copy of Year 2015 verification and evaluation studies A copy of any previous verification and evaluation studies that apply to Year 2015 savings calculations A download of the Union Year 2015 tracking data for all programs with all fields except those that include personally identifiable information such as name, address, telephone number, or account ID. 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 2015. Year 2015 whole-building billing data for all commercial program participants.
Round 2: Jan 31 **Due by: Feb 14**	Full documentation for a number (25 or more) of participants of the Home Reno Rebate program and Low Income Weatherization program. Full documentation for at least one Optimal Home to confirm that it meets program requirements. Full documentation for at least one builder participating in Optimal Home.
Enbridge	
Round 1: Jan 6 **Due by: Jan 20**	A copy of Year 2015 verification and evaluation studies A copy of any previous verification and evaluation studies that apply to Year 2015 savings calculations A download of the Enbridge Year 2015 tracking data for all programs with all fields except those that include personally identifiable information such as name, address, telephone number, or account ID. A copy of operational and quality assurance documentation associated with the tracking database A copy of the spreadsheets or other documentation

Documentation Request	Requested Information
	that confirms the reported market transformation achievements for Year 2015. Documentation that confirms the Part 3 enrollment percentage
Round 2: Jan 31 **Due by: Feb 14**	Full documentation for a number (25 or more) of participants of the Home Energy Conservation program and Low Income Weatherization program. Full documentation for at least one Residential Savings by Design home to confirm that it meets program requirements. Full documentation for at least one builder participating in Residential Savings by Design. Full documentation for at least one Commercial Savings by Design development to confirm that it meets program requirements. Full documentation for at least one builder participating in Commercial Savings by Design. Full documentation of at least one realtor commitment and subsequent ratings performed for Home Labeling.

5 OUTCOMES AND REVIEW PROCESS

The annual verification process will produce verified energy savings and scorecard achievements (by utility, scorecard, and program) for the 2015 program year. It will also produce updated LRAM, DSMVA, and DSMSI amounts that can be used in the clearance of accounts proceedings. 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 2015 program year data (such as the CPSV / NTG 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 2015 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 2015 program year. The Executive Summary will also include the verified LRAM, DSMVA, and DSMSI amounts.
- **Introduction:** This section will introduce the verification study, its objectives, and how the document reports the accomplishments.
- **Methodology:** This section will summarize the evaluation and verification activities undertaken to verify the 2015 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:** This section will report on the results of the annual verification and summarize the high-level results of additional evaluation activities. It will also report on the application of those results to the LRAM, DSMVA, and DSMSI calculations and the final outcomes.
- **Conclusions:** This section will summarize the LRAM, DSMVA, and DSMSI final results and summarize any recommendations made throughout the annual verification report, including those made in the additional evaluation reports.

The EC team proposes an unusual review structure to coordinate with the CPSV / NTG study and meet an aggressive March 31, 2016 deadline. We propose to distribute an incomplete draft report that includes all of the necessary verification factors EXCEPT the final results of the CPSV / NTG study on March 10. The next two weeks (until March 24^{th}) would be used for review, comment, and addressing the comments on the annual verification report, minus the CPSV / NTG results. When the CPST / NTG results are finalized, on or just before March 31, they would be incorporated into the annual report, which would be finalized without an additional round of review.

The entire schedule is shown in section 6.

6 SCHEDULE

This section outlines the project tasks and schedule for the 2015 annual verification. The schedule is shown in Table 6-1, which lists each verification task and the start and end dates for completing that task. Bolded rows (and green-filled cells) are "super" tasks. The indented, non-bolded (and blue-filled cells) rows are sub-tasks within that super-task.

The schedule is aggressive and designed to limit interference with the CPSV / NTG study as much as possible. It is also designed to produce a final report on March 31st to meet OEB reporting requirements.

Table 6-1. Schedule of deliverables

Task	Dec	Jan	Feb	Mar
Detailed plan				
Initial tracking data review		6th	17th	
Initial data request		6th		
Initial data delivery		20th		
Identify sample for detailed review		31st		
Documentation request		31st		
Final documentation delivery			14th	
Tracking savings certification		20th		3rd
Confirm match with reporting		20th - 27th		
Assemble assumptions and adjustments		20th - 27th		
Recreate savings estimates		27th	17th	
Confirm/verify errors with utilities			17th	3rd
Documentation review				
Run it Right analysis			15th	3rd
Deep savings analysis			27th	3rd
Enbridge Part 3 analysis			27th	3rd
Market transformation analysis			15th	3rd
Union commercial percentage analysis			15th	3rd
Verified results		30th		31st
Verify DSMVA, LRAM, DSMSI calculations		30th	10th	
Assemble tracking and documentation results			17th	10th
Produce verified scorecard metrics			17th	10th
Apply CPSV / NTG results				31st
Reporting			17th	31st
Write recommendations			17th	15th
Draft results without CPSV / NTG				10th – 24th
Final results with all factors				31st
Project Management				

The EC has highlighted the tasks that require utility involvement and the dates of that involvement, in Table 6-2. There are two documentation delivery periods: one for the initial tracking data, and a follow-up period to deliver detailed documentation for a sample of measures from select programs. There are also two review periods: one for discussing any discrepancies from the tracking savings certification, and one for the overall draft report.

EAC involvement is also necessary to complete the annual assessment. The EC requests that the EAC review and comment on the draft report from March 10th through the 24th.

Table 6-2. Utility involvement during 2015 annual verification activities

Utility Involvement	Dec	Jan	Feb	Mar
Assemble and deliver initial tracking data		6th – 20th		
Assemble and deliver requested documentation		31st	14th	
Discuss discrepancies in reporting sums and certified savings			17th	3rd
Review draft report				10th - 24th

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. FINAL CPSV/NTG REPORT

Below is the final 2015 CPSV/NTG report. It does not include the spillover results.

ONTARIO GAS DSM EVALUATION CONTRACTOR

2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation

Ontario Energy Board

Date: October 12, 2017

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GLOSSARY OF TERMS AND KEY CONCEPTS

Action	**A DSM measure that generates savings through optimization, maintenance or repair of existing systems. Actions (vs. equipment) were categorized for the populations of measures based on tracking database information provided by the utilities for sample design.**
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.
Attribution	The portion of a measure that is attributable to the program being evaluated, which is the complement of free ridership (1-FR) for that program.
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
Computer-aided technical interviews (CATI)	Structured surveys administered by a third-party survey firm that require clearly defined skip logic and structured formats, CATI surveys are a lower cost data collection approach suitable for structured gathering of information from large samples of respondents
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	DNV GL identified unique customers 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 could only be identified for records for which we received contact information.
Customer - Union	DNV GL identified unique customers 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 could only be identified for records for which we received contact information.
Customer 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.
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, enduses 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.
Free riders (FR)	Program participants who would have installed a measure on their own initiative even without the program. The free ridership rate is the percentage of customers who are free riders.
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
In situ	Existing measure, conditions, and settings
Incremental cost	The difference in purchase price, 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.
In-depth interviews (IDI)	Structured technical interviews administered by evaluation engineers and market researchers either in person or more frequently, over the phone, IDIs offer more flexibility than CATIs and are best leveraged for complex projects and topics.
Industry standard practice (ISP)	Common measure implemented within the industry
Input assumptions	Assumptions such as operating characteristics and associated units of resource savings for a list of 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."
LIMF	Low Income Multifamily Program
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 assessment.
MF	Multifamily
Net savings	Net savings are changes in energy consumption or demand that are attributable to an energy efficiency program, taking into consideration whether the program influenced a customer's decision to undertake an energy efficiency measure or not.
Net-to-gross ratio (NTG)	Is an adjustment factor that reduces gross savings due to net savings, considering both free riders and spillover, the NTG ratio can be less than or greater than 1.0
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 is past 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.
Project – Union	Projects are identified in the tracking data based on project # or project ID. When referring to Union programs, measure and project are 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. 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 ration 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 are identified only for records for which we received contact information.
Spillover (SO)	Participants' adoption of energy efficiency measures due to influence by a utility's program-related information and marketing efforts. Non-participant spillover is not included in this study. Participant Spillover will be provided in a separate volume.
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 is an aggregation of tracked measures by con_acc_num, year (2015), and measure type (building shell, controls, greenhouse, heat recovery, HVAC, operational improvements, other equipment, process heat, and steam and hot water).
Unit of Analysis - Union	The level at which the data are analyzed, which is an aggregation of tracked measures by AIMS ID, year (2015), and measure type (agriculture and greenhouse, building shell, controls, cogeneration, HVAC, heat recovery, maintenance, new construction, optimization, other equipment, process heat, and steam and hot water).
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) and provides the gross savings verification – custom program savings verification (CPSV) – and net savings – free-ridership (FR) – results for a subset of programs in Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) portfolio delivered in 2015.

The overall objectives of the evaluation are to develop:

- Verified gross savings for 2015 custom commercial, industrial, low income multifamily and large volume projects
- Free-ridership savings for 2015 custom commercial, industrial and large volume projects
- A free-ridership rate for Enbridge's 2015 RunitRight program

The programs included in this study are provided in Table 1.

Table 1-1. CPSV, FR, and SO by program

Program		CPSV	FR
Union			
Custom	Large Volume	✓	✓
	Commercial & Industrial*	✓	✓
	Low Income Multi-Residential	✓	
Enbridge			
Custom	Commercial*	✓	✓
	Industrial	✓	✓
	Low Income Multi-Family	✓	
RunitRight			✓

*Custom Market-Rate Multi-Residential projects are included as a part of this program.

A spillover study of 2013-2014 programs has also been initiated; however, the results from that effort are not included in this report.

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. For the 2015 program year, as directed by the board, both utilities "rolled-over" their 2014 plans into 2015 to allow them the time necessary to redesign their programs before implementing them in 2016.

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.

[1] EB-2014-0134

- 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 (CPSV) and net-to-gross (NTG) study of the 2015 program year. This report is a result of that study.

An evaluation advisory committee (EAC) was formed to provide input and advice to the OEB on the evaluation and audit of DSM results. The EAC consists of 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.

1.2 Methodology summary

The results presented in this report are based on data collection from the following five 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
- In-Depth Interviews with a sample of participating vendors
- On-site visit to a sample of participating customer sites

The data collection with samples of participating customers and vendors included site visits and telephone interviews supporting a detailed measurement and verification (M&V) analysis, and in-depth interviews supporting assessment of free ridership. Table 2 shows the targeted and completed data collection activities and the timeframe in which they were completed.

Table 1-2. Data collection activities*

Target Group	Activity	Targeted Units of Analysis	Completed Units of Analysis	Timeframe
Enbridge				
Participating Customers	M&V Site Visit (On-site)	41	61	Jan, 2017 - Mar, 2017
	TSER Interview	38	37	Jan, 2017 - Apr, 2017
	In-Depth Interview	149	151	Jan, 2017 - Apr, 2017
Participating Vendors	In-Depth Interview	~30	20	Mar, 2017- Apr, 2017
Union				
Participating Customers	M&V Site Visit (On-site)	59	106	Jan, 2017 - Mar, 2017
	TSER Interview	22	30	Jan, 2017 - Apr, 2017
	In-Depth Interview	122	203	Jan, 2017 - Apr, 2017
Participating Vendors	In-Depth Interview	~30	15	Mar, 2017- Apr, 2017
Overall				
Participating Customers	M&V Site Visit (On-site)	100	167	Jan, 2017 - Mar, 2017
	TSER Interview	60	67	Jan, 2017 - Apr, 2017
	In-Depth Interview	271	354	Jan, 2017 - Apr, 2017
Participating Vendors	In-Depth Interview	⩽62	35	Mar, 2017- Apr, 2017

*This table reports the number of units of analysis targeted and completed as units of analysis were used to design the sample before customers and sites had been identified. Units of Analysis are a slight aggregation of utility tracking records as described in APPENDIX I.

At a high level, the gross savings verification (CPSV) and NTG study employed the following methodology:

- **Receive 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 program 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. The CPSV sample was designed as a subset of the NTG sample.
- **Collect data.** Data was collected to verify the ex ante energy savings and estimate NTG ratios.
- **Analyze the results.** The collected data was used to verify the gross savings and estimate NTG ratios 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 and net savings for the 2015 programs studied. Table 1-3 provides the results of the evaluation for Union Custom programs and Table 1-4 provides the results of the evaluation for Enbridge Custom programs and RunitRight.

Table 1-3: Union custom programs verified gross and net savings results**

Program	Claimed Savings	Gross Realization Rate	Verified Gross Savings	Net-to-Gross	Net Savings
Commercial and Industrial Custom	1,473,918,718	97.96%	1,443,912,081	40.63%	586,724,222
Custom Large Volume	1,250,879,698	135.00%	1,688,715,391	7.98%	134,835,163
Custom Low Income Multi-Family	5,920,660	89.06%	5,272,940	95.00%*	5,009,293

*Custom Low Income Multi-family NTG was not evaluated as part of this evaluation. 95% is the deemed NTG for the program.
**Ratios in this table have been rounded and are the effective overall ratios, calculated by first applying the ratios by domain and then dividing the total net savings by the total verified savings.

Table 1-4: Enbridge custom programs and RunitRight verified and net savings results**

Program	Claimed Savings	Gross Realization Rate	Verified Gross Savings	Net-to-Gross	Net Savings
Custom C&I and Market Rate Multi-residential	810,605,950	95.21%	771,756,978	27.58%	212,848,819
Custom Low Income Multi-Family	63,801,575	91.48%	58,365,681	100.00%*	58,365,681
RunitRight	2,712,210	N/A	2,712,210	50.06%	1,357,732

*Custom Low Income Multi-family NTG was not evaluated as part of this evaluation. 100% is the deemed NTG for the program. RunitRight Gross savings were not evaluated as part of this evaluation.
*Ratios in this table have been rounded and are the effective overall ratios, calculated by first applying the ratios by domain and then dividing the total net savings by the total verified savings.

1.4 Findings

Key findings from the study include:

- Free ridership for the programs is high
- Correcting for Union's "influence adjustment" (which derated gross savings pre- customer incentive for likely partial free riders) led to the high gross RR for Large Volume
- Both utilities generally produce solid ex ante engineering estimates of savings and much of the variation in gross RRs is driven by changes in operating conditions that are often hard to control for 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

1.5 Recommendations

Recommendations from the evaluation are summarized in Table 1-5 to Table 1-8. 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, see section 7.

Table 1-5: Energy savings and program performance recommendations

#	Energy Savings and Program Performance Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
ES1	The utilities should continue in their commitment to accuracy.	✓	✓				✓	✓
ES2	Evaluate free-ridership for the programs annually and consider coupling the free-ridership evaluation with process evaluation			✓		✓		
ES3	Error ratios from this report inform sample design for future evaluation.			✓	✓			✓
ES4	Align the program design with cumulative net goals	✓	✓			✓		
ES5	Do not pay incentives until after installation is complete.	✓	✓					✓
ES6	Develop policies to collaborate across electric and gas projects to avoid double-counting fuel savings and increases from energy efficiency measures.	✓	✓					✓
ES7	Consider establishing a policy to define rules around energy savings calculation for fuel switching and district heating/cooling measures.	✓	✓	✓				✓

#	Energy Savings and Program Performance Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
ES8	Consider establishing a policy that defines an eligibility floor and cap based on simple payback period for energy efficiency projects.	✓	✓			✓		✓
ES9	Consider establishing an official definition for EUL and implementing a study to define EULs for program measures	✓	✓	✓				✓
ES10	Track metrics for how long it takes from the final installation verification to the posting of incentive payments.	✓	✓				✓	
ES11	Increase transparency of "influence adjustments" and do not include in gross savings	✓				✓	✓	✓
ES12	Conduct a process evaluation to improve Large Volume influence on customer projects	✓				✓	✓	
ES13	Consider approaches to market that leverage third-party vendors.	✓	✓		✓	✓		

Table 1-6: Verification process recommendations

#	Verification Process Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
VP1	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.	✓	✓		✓			✓
VP2	The verification and utility staff should agree to a code of conduct for each role during onsite visits.	✓	✓	✓			✓	

Table 1-7: Documentation and Support recommendations

#	Documentation and Support Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DS1	Take steps to improve documentation: • 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	✓	✓			✓		✓
DS2	Ensure that incremental costs are supported by invoices or other documentation	✓	✓					✓
DS3	Increase the amount of documentation and source material for projects that have greater energy savings.	✓	✓					✓
DS4 A	Digitize and file project documentation for all projects as they are completed and paid during project closeout.	✓	✓		✓			✓
DS4 B	Until the utilities can implement an effective digital document storage process, the evaluation should allow more time for the utilities to assemble and deliver the documentation.			✓	✓			✓

#	Documentation and Support Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DS5	Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner.	✓			✓			✓
DS6	Use a consistent summary workbook.		✓		✓			✓

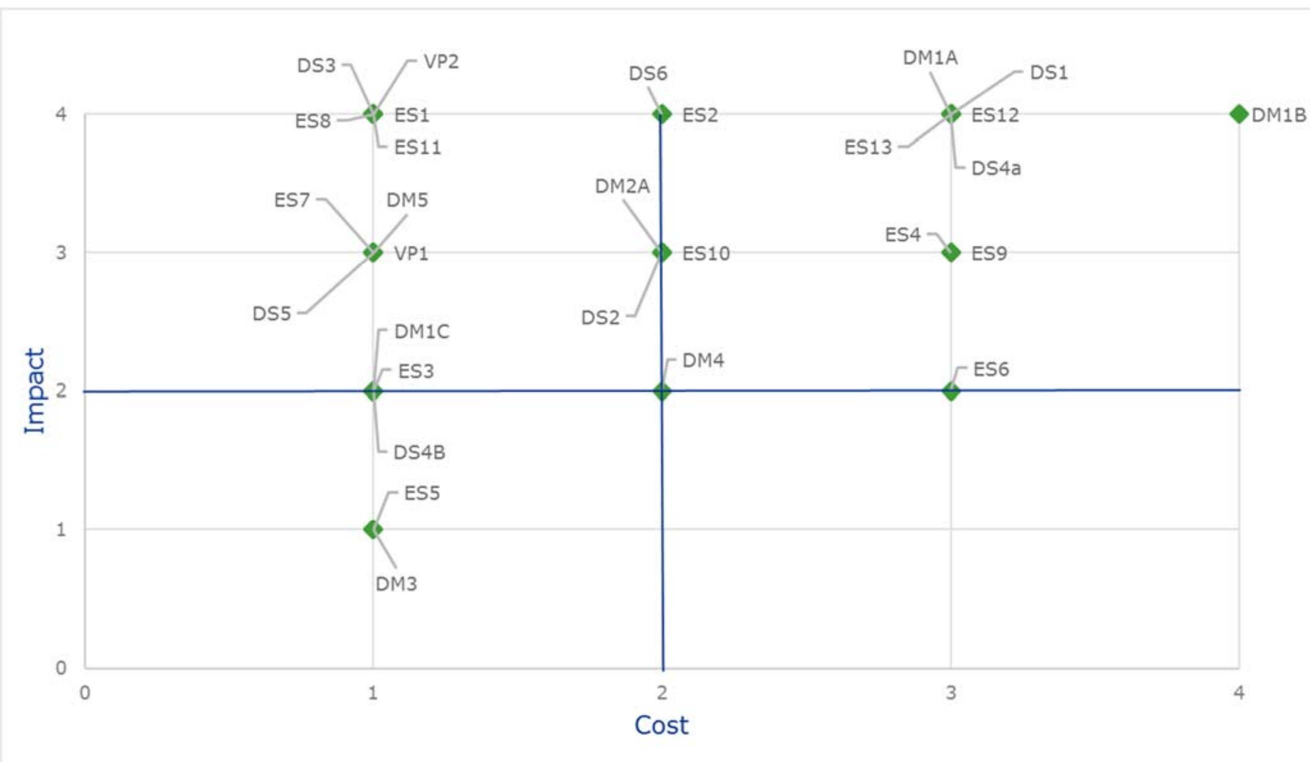
Table 1-8: Data management recommendations

#	Data Management Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DM1 A	Track contacts associated with projects in the program tracking database.	✓	✓		✓			✓
DM1 B	Strongly consider investing in relational program tracking databases.	✓	✓		✓			✓
DM1 C	Include structure for improved data integrity in the evaluator request for contact information for the 2016 and 2017 savings verification and evaluation.			✓	✓		✓	
DM2 A	Consider offering bonus incentives early in the year to combat the "hockey stick" phenomenon where a large percent of projects get closed in the fourth quarter of the year (which results in rushed QC for data).	✓	✓		✓			✓
DM3	Track and provide to evaluators dates for key milestones in the project.	✓	✓		✓			✓
DM4	Maintain a customer identifier in the database to clearly identify related sites.	✓	✓		✓		✓	

#	Data Management Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DM5	Include EUL (also remaining useful life for dual baselines), NTG, and each of the key savings types (i.e., annual and cumulative, gross and net) in the program tracking extracts provided to evaluators.	✓	✓			✓		✓

Figure 1-1 shows an approximate cost vs. impact relation ship for each of the recommendations on a 4 point scale. The upper left quadrant of the figure shows the recommendations that are relatively low cost that would have a high impact. Those in the upper right are recommendations where both cost and impact are high.

Figure 1-1: Approximate Cost vs. Impact of each recommendation



2 Introduction

This report has been prepared for the Ontario Energy Board (OEB) and provides the gross savings verification – custom program savings verification (CPSV) – and net savings – free-ridership (FR) – results for a subset of programs in Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) portfolio delivered in 2015.

The overall objectives of the evaluation are to develop:

- Verified gross savings for 2015 custom commercial, industrial, low income multifamily and large volume projects
- Free-ridership savings for 2015 custom commercial, industrial and large volume projects
- A free-ridership rate for Enbridge's 2015 RunitRight program

The programs included in this study are provided in Table 2-1.

Table 2-1. CPSV, FR, and SO by program

Program		CPSV	FR
Union			
Custom	Large Volume	✓	✓
	Commercial & Industrial*	✓	✓
	Low Income Multi-Residential	✓	
Enbridge			
Custom	Commercial*	✓	✓
	Industrial	✓	✓
	Low Income Multi-Family	✓	
RunitRight			✓

*Custom Market-Rate Multi-Residential projects are included as a part of this program.

A spillover study of 2013-2014 programs has also been initiated; however, the results from that effort are not included in this report.

2.1 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. For the 2015 program year, as directed by the board, both utilities "rolled-over" their 2014 plans into 2015 to allow them the time necessary to redesign their programs before implementing the updated plans in 2016.

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.

[2] EB-2014-0134

- 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 CPSV and net-to-gross (NTG) study of the 2015 program year. This report is a result of that study.

An evaluation advisory committee (EAC) was formed to provide input and advice to the OEB on the evaluation and audit of DSM results. The EAC consists of representatives from utility representatives, 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 than them for their involvement.

2.2 Methodology summary

The results presented in this report are based on data collection from the following five 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
- In-Depth Interviews with a sample of participating vendors
- On-site visit to a sample of participating customer sites

The data collection with samples of participating customers and vendors included site visits and telephone interviews supporting a detailed measurement and verification (M&V) analysis, and in-depth interviews supporting assessment of free ridership. Table 2-2 shows the targeted and completed data collection activities and the timeframe in which they were completed.

Table 2-2. Data collection activities*

Target Group	Activity	Targeted	Completed	Timeframe
Enbridge				
Participating Customers	M&V Site Visit (On-site)	41	61	Jan, 2017 - Mar, 2017
	TSER Interview	38	37	Jan, 2017 - Apr, 2017
	In-Depth Interview	149	151	Jan, 2017 - Apr, 2017
Participating Vendors	In-Depth Interview	~30	20	Mar, 2017- Apr, 2017
Union				
Participating Customers	M&V Site Visit (On-site)	59	106	Jan, 2017 - Mar, 2017
	TSER Interview	22	30	Jan, 2017 - Apr, 2017
	In-Depth Interview	122	203	Jan, 2017 - Apr, 2017
Participating Vendors	In-Depth Interview	~30	15	Mar, 2017- Apr, 2017
Overall				
Participating Customers	M&V Site Visit (On-site)	100	167	Jan, 2017 - Mar, 2017
	TSER Interview	60	67	Jan, 2017 - Apr, 2017
	In-Depth Interview	271	354	Jan, 2017 - Apr, 2017
Participating Vendors	In-Depth Interview	≤62	35	Mar, 2017- Apr, 2017

*This table reports the number of units of analysis targeted and completed as units of analysis were used to design the sample before customers and sites had been identified. Units of Analysis are a slight aggregation of utility tracking records as described in APPENDIX I.

At a high level, the CPSV and NTG study employed the following methodology:

- **Receive 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 program 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. The CPSV sample was designed as a subset of the NTG sample.
- **Collect data.** Data was collected to verify the ex ante energy savings and estimate NTG ratios.
- **Analyze the results.** The collected data was used to verify the gross savings and estimate NTG ratios 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 I. 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 projects that a customer contact could speak to rather than only the first selected. This means that the evaluation exceeded the targeted number of sampled units in the measure level sample design. In the expansion, weights were adjusted to eliminate potential bias from this data collection strategy by assigning a weight of one (1) to non-randomly selected units. 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 M.
- 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. More information on the verification approach is provided in APPENDIX B, APPENDIX O, and APPENDIX P. Detailed site reports for each of the sites visited or called are provided in a volume 2 and 3 of this report.
- The **NTG methodology** included data collection from participating customers and vendors. The data collection instrument outlines are provided in APPENDIX N. NTG scoring methods are provided in APPENDIX J and APPENDIX K.

2.2.1 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 2-3 describes each of the statistics provided in this report.

The relative precision of some of the ratios is low because the ratios themselves are small. Relative precision is the absolute precision (+/- quantity) divided by the estimated ratio. For example, if a ratio is 5% with absolute precision of +/-5%, the relative precision is very bad (5%/5% = 100% relative error) but in absolute terms we still are 90% confident the ratio is below 10%, which is useful information. We reported the relative precision in all cases at the 90 percent confidence level. That is, whether the relative precision is large or small, we have the same 90 percent confidence that the range defined by the point estimate +/- the absolute error captures the true unknown value. The "midpoint" estimate 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] Where a single site had two contacts, the site was used as the cluster to ensure conservative (higher) error estimates.

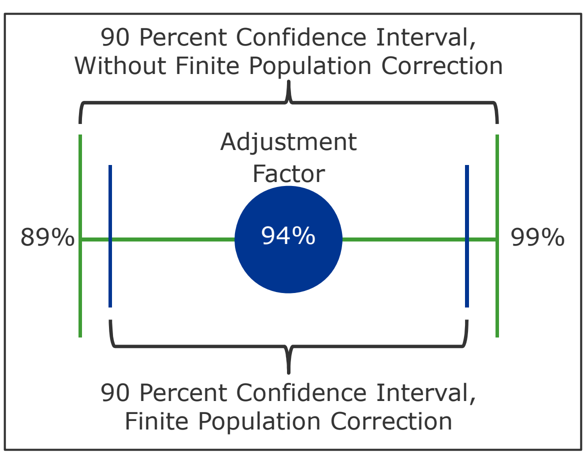
Table 2-3: Relevant statistics.

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 2-1 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)

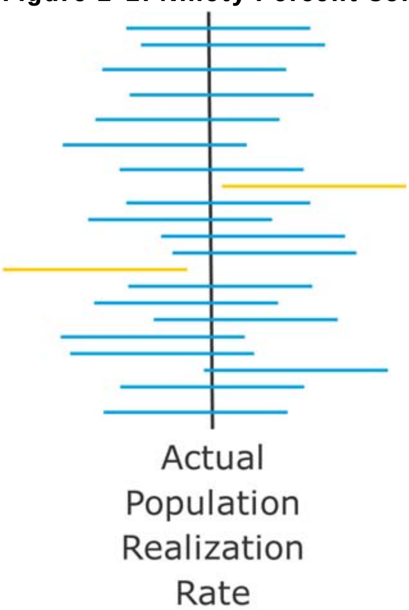
Figure 2-1: Ratio diagram example



[4] 90% is the confidence limit that we are using.

The plus/minus (±) 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 2-1, the ratio is 94% and the non-FPC 90% confidence interval is ± 5 percentage points (i.e., 94% ± 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 2-2 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 2-2. Ninety Percent Confidence Interval



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 percent confidence level. That is, whether the relative precision is large or small, we have the same 90 percent 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).

[5] The critical value for calculating the confidence interval ± 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. The critical value for the gross savings adjustment factor is determined using the degrees of freedom based on the minimum sample size for the components of the adjustment factor. The gross savings adjustment factor is a product of the installation rate and the engineering verification factor. 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.

3 Union Commercial, Industrial, and Multi-Family Programs

Through its custom program offerings, Union seeks to influence customers to adopt more energy efficient technologies and practices, or do so sooner than they would otherwise have done. The custom programs provide financial incentives, technical expertise, and guidance with respect to energy related decision-making. Union's custom programs differ from the prescriptive and direct install programs as they provide services and varying financial incentives based on overall natural gas savings realized by the customer to address customer-specific needs.

There are three program offerings covered in this section: Union Commercial and Industrial Custom and Low Income Multi-Residential Affordable Housing.

3.1 Commercial and Industrial Custom Program

Union advances 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 offering 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.

A subset of the projects in these programs is part of the multi-family or multi-residential segment (MR MF).

All projects implemented as part of these programs and claimed in 2015 are included in the CPSV and FR portions of the study.

3.2 Low-income Multi-Family Program (Union)

The Union Low Income Multi-Family (LIMF) program offers multi-family low income housing customers funding for energy audits and both custom and prescriptive incentives to encourage energy efficient upgrades and funding for energy audits. The programs also provide technical services, benchmarking, and education for housing providers, building operators and tenants about their building's energy usage and ways to achieve energy efficiency.

The target markets for both programs are social and assisted housing providers who own and operate Part 3 buildings and private multi-residential building owners that provide housing to low income households.[6]

Custom projects implemented as part of these programs and claimed in 2015 are included in the CPSV portion of the study; 12% of Union's LIMF program savings are from custom projects. An evaluation of this program's net-to-gross (NTG) was not included in this study.

3.3 CPSV results

This section summarizes the gross savings verification (CPSV) results for custom projects in the Union commercial, industrial, multifamily, and low income multi-family programs. For Union, the gross realization rate is made up of two components, the influence correction which removes Union's influence adjustments

[6] "Part 3" references buildings covered by Part 3 of the Ontario Building Code, defined as those exceeding 600 square meters in area or greater than three storeys in height; for residential energy efficiency programs, these are typically multifamily buildings.

from the tracking gross savings, and the engineering adjustment, which provides the difference (expressed as a ratio) between verified savings determined through the CPSV and tracked gross savings estimated by Union prior to applying the influence adjustment. The gross realization rate is the product of the influence correction and the engineering adjustment.

Section 3.3.1 summarizes the data collection efforts, section 3.3.2 describes and presents the influence correction, section 3.3.3 describes and presents the engineering adjustment, section 3.3.4 summarizes the reasons for the discrepancies between the ex ante and ex post gross savings estimates, and section 3.3.5 presents the gross savings realization rate.

3.3.1 Summary of CPSV data collection

Table 3-1 summarizes the CPSV data collection efforts for the Union Custom C&I, and LIMF 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 projects, the number of units of analysis, and cumulative ex ante natural gas savings (ex ante CCM). The proportion of the program in each category is also represented in Figure 3-1. The full sample design and achievement by strata can be found in 8. By collecting data on all measures at a site rather than only the first selected, the evaluation exceeded the targeted number of units despite collecting data from fewer sites. The study had a customer response rate of 64% and achieved the targeted 90/10 relative precision for the gross realization rate at the program overall level shown in Table 3-4).

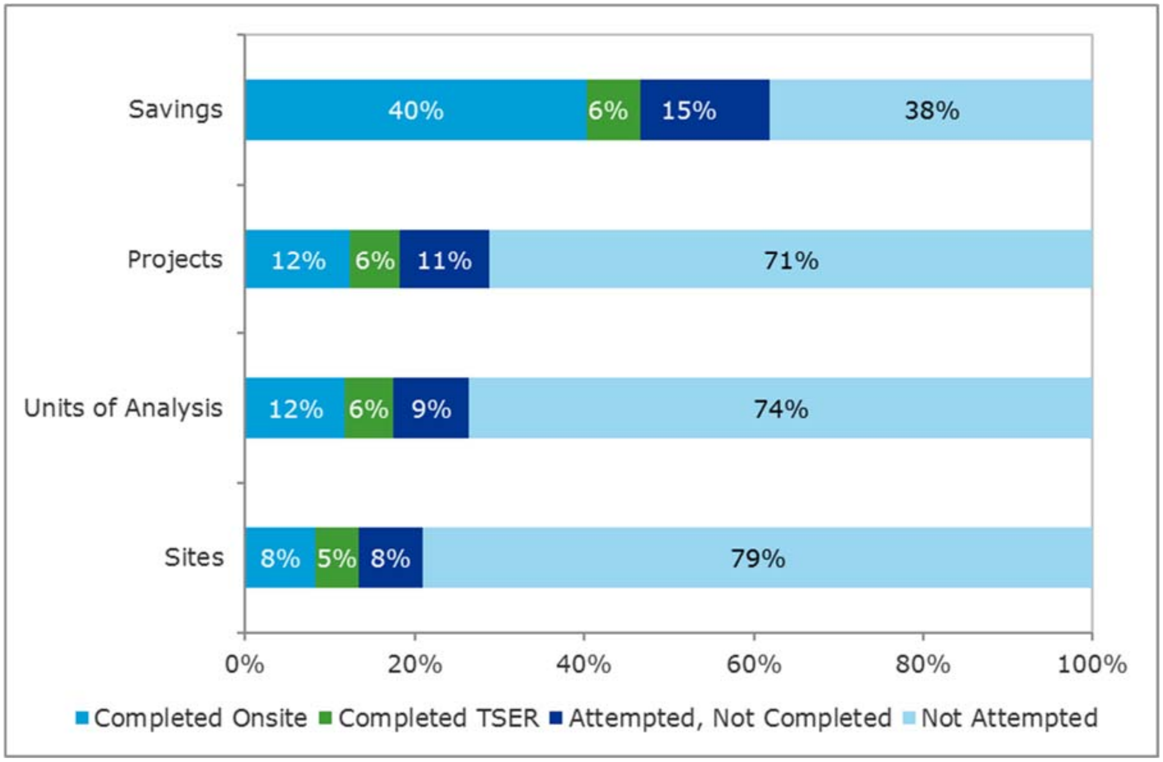
Table 3-1: Summary of CPSV data collection for Union Custom C&I, and LIMF programs*

Data Collection Category	Targeted	Completed			
	# Units of Analysis	# Sites	# Measures	# Units of Analysis	Ex Ante CCM
Completed On-Site	38	35	77	62	595,857,289
Completed TSER	22	22	37	30	93,508,182
Attempted Contact, Not Completed		32	66	47	226,355,899
Not Attempted		337	445	389	564,118,008
Total		**426**	**625**	**528**	**1,479,839,378**

* Please see the glossary for definitions of unit of analysis, site, and project.

[7] Sites, projects, or units of analysis where contact was not attempted were either not selected for contact in sampling or in the backup sample and were not contacted due to strata quotas being met.

Figure 3-1: Summary of CPSV data collection for Union Custom C&I, MF, and LIMF programs



3.3.2 Influence correction

The Union Custom C&I, MF, and LIMF programs had some corrections and adjustments that differ from other programs: the influence correction and the engineering adjustment.

The Union implementation team applied a proactive "influence factor" to some measures. The factor represents the portion of the energy savings that, in the opinion of the implementation team, was influenced by the program. In effect, it represents an anticipated free-ridership adjustment. Since the evaluation team is measuring and applying a retrospective free-ridership adjustment based on customer self-reports, the Union influence factor would double-count free-ridership for those measures. Therefore, the evaluation team removed the influence factor to produce a "true" gross savings estimate to which the NTG adjustment could be applied. Because the influence factor was not tracked for the population, we worked with Union to identify the influence factors made to the sample of projects selected for CPSV and reversed the process to calculate a true gross tracking savings. This process resulted in the influence corrections provided below.

Table 3-2 shows the influence correction by domain for the Union Custom C&I, MF, and LIMF programs. The table shows the number of units of analysis (n), influence correction 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. Note that Custom Industrial Actions and Custom Commercial & Multi-family received ratios, or influence corrections, of 103% and 101%, respectively. A ratio of 103% indicates that for these measures Union recorded 97% of the gross savings in its database. The positive (greater than 100%) adjustment was made to reported tracked savings to remove the influence factors assigned.

Table 3-2: Influence correction for Union Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Greenhouse Equipment	15	9	100%	0%	100%	100%	0%	0.00	29%
	Action	20	12	103%	4%	99%	106%	3%	0.07	12%
	Hydronic Insulation	9	9	100%	0%	100%	100%	0%	0.00	8%
	Other Equipment	36	25	100%	0%	100%	100%	0%	0.00	33%
Custom Commercial and LIMF		34	24	101%	2%	100%	103%	2%	0.05	19%
Overall		**114**	**74**	**101%**	**1%**	**100%**	**101%**	**1%**	**0.03**	**100%**

The Other category includes building shell equipment, controls, heat recovery, HVAC, operational improvements, steam separator, reverse osmosis, refractory insulation, high-efficiency iron converters, robotic arms, infrared coating, and damper motor replacement
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
Confidence intervals are mathematically correct, but in practical terms, the influence correction can only be equal to or greater than 100%.

3.3.3 Engineering adjustment

For programs with an influence adjustment, such as the Union Custom C&I, MF, and LIMF programs, the evaluation team defined an "engineering adjustment." This ratio is the difference between verified savings determined through the CPSV and tracked gross savings estimated by Union prior to applying the influence adjustment. These changes are due to differences in calculation methods, effective useful life (EUL), calculation parameters, or other engineering-related adjustments. The engineering adjustment is equivalent to the gross savings realization rate for programs that do not have an influence adjustment.

Table 3-3 shows the engineering adjustment by domain for the Union Custom C&I, MF, and LIMF programs. The table shows the number of units of analysis (n), engineering adjustment ratio (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. Overall, the engineering adjustment was 99%. The measure group with the highest adjustment was Hydronic Insulation, due to different operating conditions (temperatures and hours) reported than were documented in the ex ante calculations at four of nine sites. The measure group with the lowest adjustment was greenhouse equipment, primarily due to measure realization rates of ~80% for 4 of the 15 measures. The discrepancies found at these sites include changes to baseline and efficient conditions.

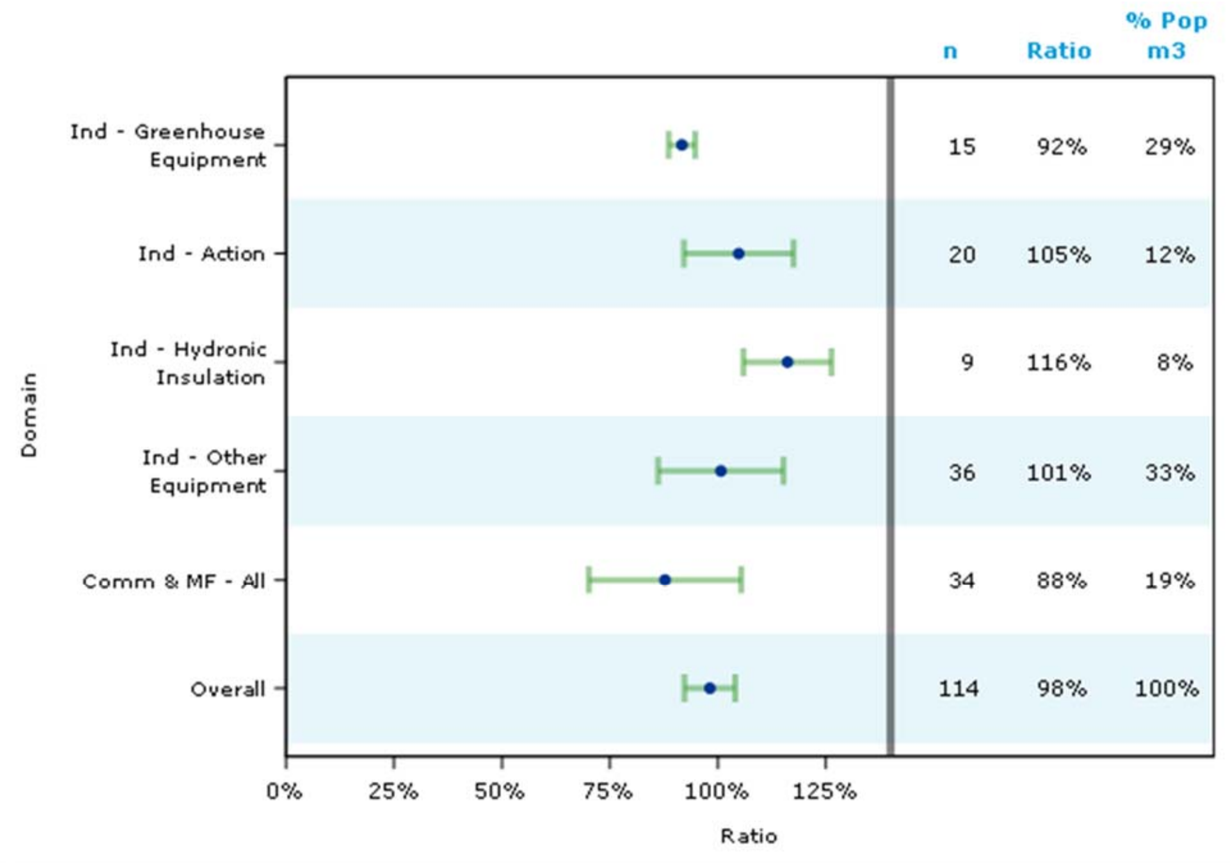
Table 3-3: Engineering adjustment for Union Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Greenhouse Equipment	15	9	92%	4%	88%	95%	4%	0.06	29%
	Action	20	12	105%	13%	92%	118%	13%	0.24	12%
	Hydronic Insulation	9	9	116%	11%	105%	127%	9%	0.15	8%
	Other Equipment	36	25	101%	15%	86%	116%	15%	0.43	33%
Custom Commercial and Multi-family		34	24	88%	18%	70%	106%	21%	0.59	19%
Overall		**114**	**74**	**98%**	**6%**	**92%**	**105%**	**6%**	**0.33**	**100%**

The Other Equipment category includes building shell equipment controls, heat recovery, HVAC, operational improvements, steam separator, reverse osmosis, refractory insulation, high-efficiency iron converters, robotic arms, infrared coating, and damper motor replacement.
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.

Figure 3-2 also shows the engineering adjustment by domain. The figure shows the ratio point estimate as a blue dot on the horizontal axis and the confidence interval as hashmarks connected by a green line. The number of units of analysis, numeric ratio, and percent of program savings represented by each domain are shown to the right of the plot. Industrial greenhouse equipment and hydronic insulation are the only domains that are statistically significantly different from 100%.

Figure 3-2: Engineering adjustment for Union Custom C&I, and LIMF programs



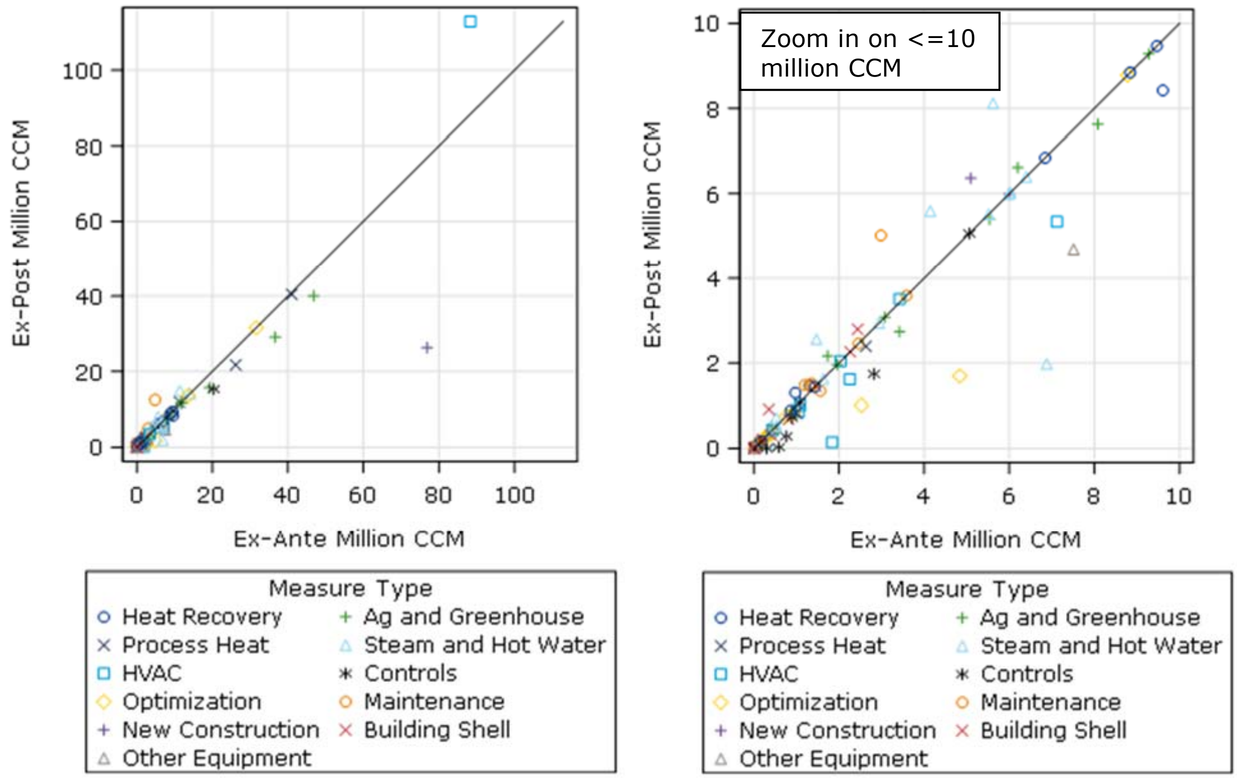
3.3.4 Discrepancy summary

This section presents detailed results for the reasons for and magnitude of the various discrepancies between ex ante and ex-post savings. First we will look at the cumulative savings, then the two key components of cumulative savings: annual savings and the EUL. See APPENDIX Q for additional detail**.**

Figure 3-3 plots the ex post cumulative savings (with influence corrected) against the ex ante cumulative savings (with influence corrected) for each measure in the sample. The plot on the left shows the full set of measures, while the plot on the right is focused in on the cluster of measures with less than 10 million CCM in both ex ante and ex post. The diagonal line represents a 100% engineering adjustment, or the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post savings were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

Most projects had similar ex post and ex ante savings. The largest two sites had large discrepancies. The largest was a thermal oxidator project that had a realization rate of 127% (upper right) due to operating conditions differences in the ex ante and ex post cases. The second was a new construction project with a 55% realization rate: in this case the code used for the ex ante baseline was outdated at the time that building permits were applied for.

Figure 3-3. Ex post versus ex ante cumulative savings (CCM) with influence corrected - Union C&I and MF, by measure type

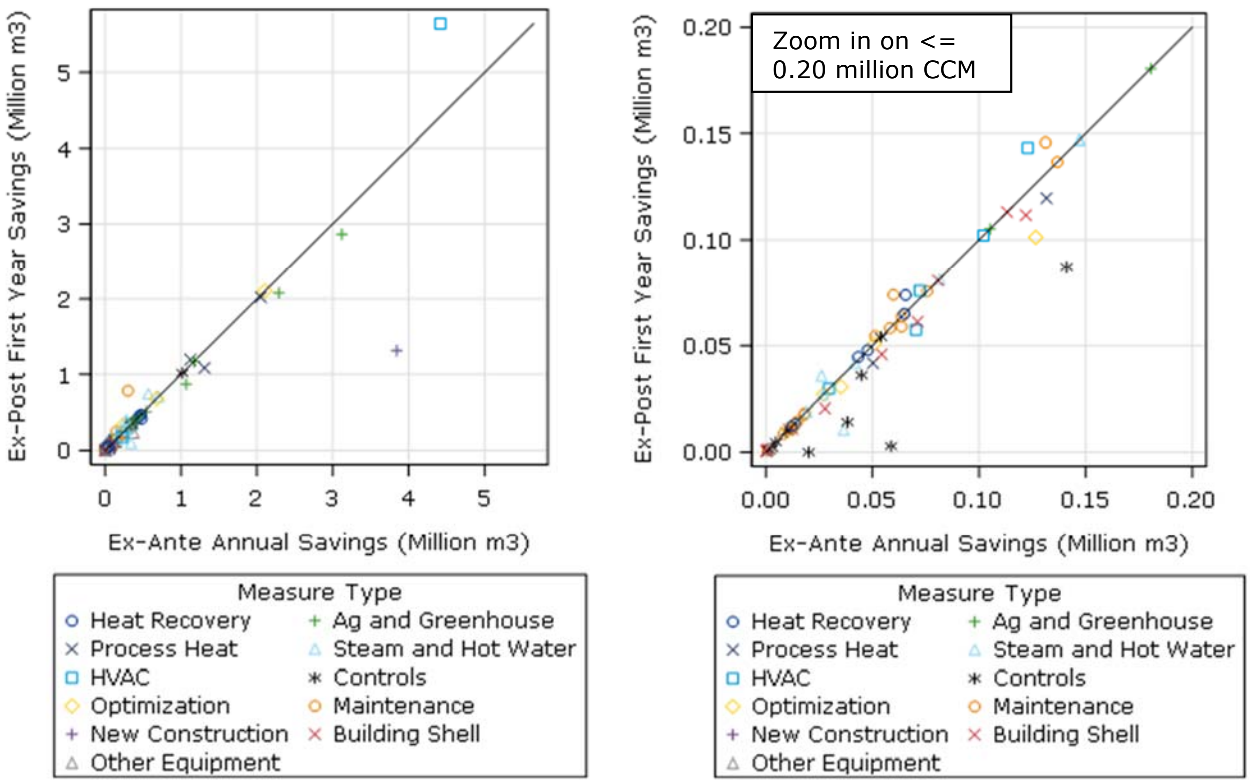


3.3.4.1 First-year savings discrepancies

Figure 3-4 plots the ex post annual savings (with influence corrected) against the ex ante annual savings (with influence corrected) for each measure in the sample. The plot on the left shows the full set of measures, while the plot on the right is focused in on the cluster of measures with less than 0.20 million cubic meters (m^3) in both ex ante and ex post. The diagonal line represents a 100% engineering adjustment, or the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post savings were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

The plot on the left shows a very similar pattern to that of the cumulative savings because the two largest projects and adjustments were each due to discrepancies in annual savings. The plot on the right shows some differences because annual savings were adjusted for several controls projects. There was no pattern to the discrepancies in this case: one was a difference in baseline between ex ante and ex post, one involved additional data provided to the verifier and one lowered production after the program measure was implemented.

Figure 3-4: Ex post versus ex ante annual savings with influence corrected - Union C&I, by measure type

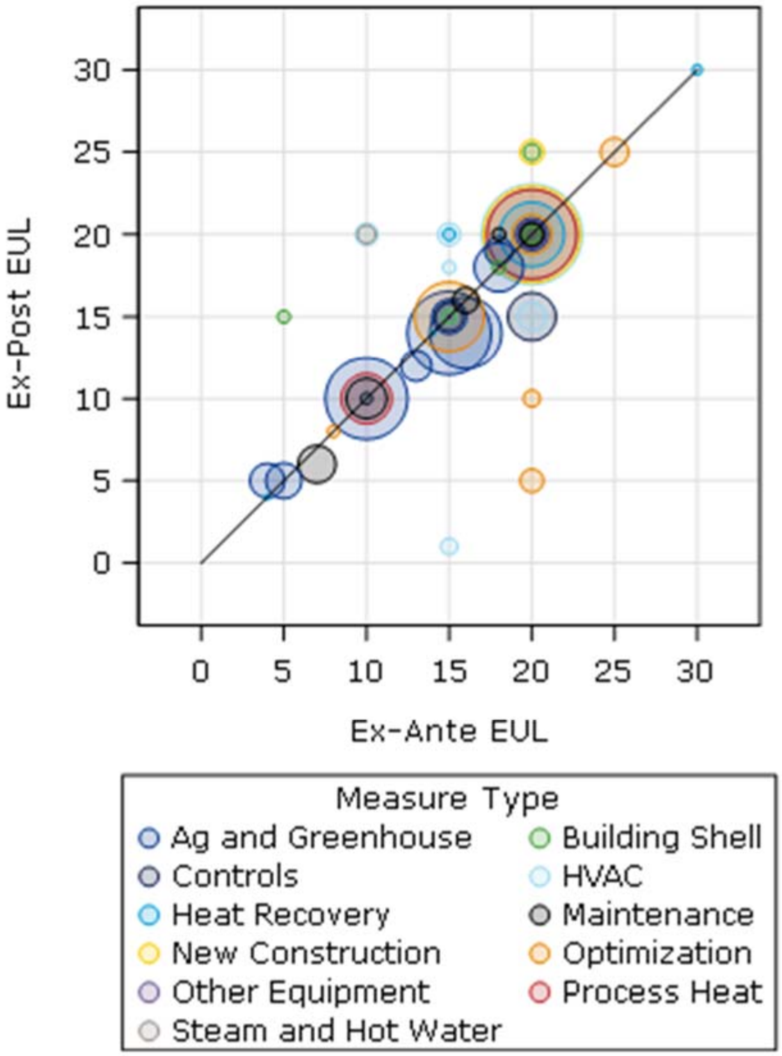


3.3.4.2 Measure life discrepancies

One of the primary discrepancies is a change in EUL between ex ante and ex post. Figure 3-5 plots the ex post EUL against the ex ante EUL for each measure in the sample. Because EULs tend to be discrete numbers, the size of the bubbles in the plot indicate show the relative amount of ex ante savings for the measures at each plotted point (e.g., the larger the bubble, the more savings at that point). The diagonal line represents the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post EUL were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

The plot shows that most EULs had equal ex post and ex ante EULs. The projects with the greatest differences tended to be small to medium sized and differences in EUL went both ways. Some projects had greater EULs in the ex post than the ex ante and vice versa. The overall weighted average EUL adjustment for the program was 99.8%.

Figure 3-5: Ex post versus ex ante effective useful life - Union C&I and MF, by measure type



3.3.5 Gross realization rate

For the Union programs, the gross realization rate is the product of the influence correction and the engineering adjustment. Table 3-4 shows the engineering adjustment by domain for the Union Custom C&I, MF, and LIMF programs. The table shows the number of units of analysis (n), engineering adjustment ratio (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 and LIMF programs overall had a 100% gross realization rate, which means that the overall ex post savings are equivalent to the overall ex ante savings, within rounding errors. The Action domain has a gross realization rate pf 108%, the result of an influence correction of 103% and an engineering adjustment of 105%. Likewise, Custom Commercial, and LIMF result in a ratio of 97%, the result of a 101% influence correction and 95% engineering adjustment.

Table 3-4: Gross realization rate for Union Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Greenhouse Equipment	15	9	92%	4%	88%	95%	4%	0.06	29%
	Action	20	12	108%	14%	94%	122%	13%	0.25	12%
	Hydronic Insulation	9	9	116%	11%	105%	127%	9%	0.15	8%
	Other Equipment	36	25	101%	15%	86%	116%	15%	0.43	33%
Custom Commercial and LIMF		34	24	89%	18%	71%	108%	21%	0.59	19%
Overall		**114**	**74**	**99%**	**6%**	**92%**	**105%**	**7%**	**0.34**	**100%**

The Other Equipment category includes building shell equipment controls, heat recovery, HVAC, operational improvements, steam separator, reverse osmosis, refractory insulation, high-efficiency iron converters, robotic arms, infrared coating, and damper motor replacement.
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

Table 3-5 shows the influence correction and engineering adjustments that were multiplied to calculate the gross realization rates.

Table 3-5: Gross realization rate components for Union Custom C&I and LIMF programs

Sector	Domain	Influence correction	Engineering Adjustment	Gross Realization Rate
Custom Industrial	Greenhouse Equipment	100%	92%	92%
	Action	103%	105%	108%
	Hydronic Insulation	100%	116%	116%
	Other Equipment	100%	101%	101%
Custom Commercial and LIMF		101%	88%	89%
Overall		**101%**	**98%**	**99%**

3.4 NTG ratio

This section summarizes the free-ridership results for the Union Custom C&I, MF, and LIMF programs. Section 3.4.1 summarizes the data collection efforts, section 3.4.2 presents the net savings realization rate, and section 3.4.3 describes the sources of program attribution.

3.4.1 Summary of participant data collected

Table 3-6 summarizes the NTG ratio data collection efforts for the Union Custom C&I, MF, and LIMF programs. The table shows the portion of the program that:

- Completed an in-depth interview through the NTG battery
- Did not respond to an evaluation attempt at contact

- Was not contacted by the evaluation team.[8]

The data collected is represented as the cumulative ex ante natural gas savings, number of projects, units of analysis, and sites. The portion of the program in each category is also represented in Figure 3-6. The full sample design and achievement by strata can be found in 8. The sample design for the NTG study included attempting an NTG interview with all sites in the CPSV sample plus additional sites. Not all sites in the CPSV sample responded to the NTG interview.

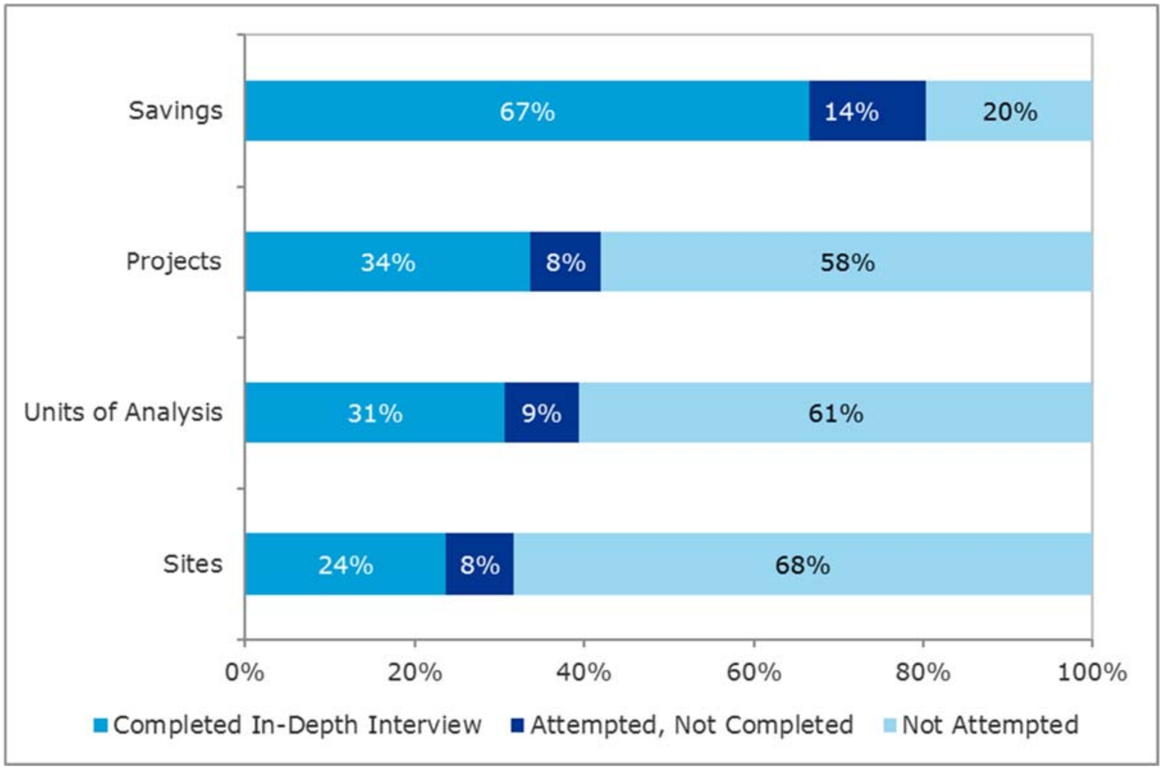
By collecting data on all measures at a site rather than only the first selected, the evaluation exceeded the targeted number of units. The number of completed sites exceed the targeted number of units due to single contacts having multiple sites in the sample/backup. Despite collecting NTG data for 67% of savings in the programs with a customer response rate of 73%, the study did not achieve the targeted 90/10 relative precision for the NTG ratio at the program overall level (shown in Table 3-7). The achieved relative precision was 12%. Relative precision is relative to the ratio result, which for sampling purposes was assumed as 50%. The achieved absolute precision (+/-) of 5% would have met the 90/10 relative precision target had the NTG ratio been at or above the assumed ratio.

Table 3-6: Summary of NTG data collection for Union Custom C&I programs

Data Collection Category	Targeted	Completed			
	# Units of Analysis	# Sites	# Measures	# Units of Analysis	Ex Ante CCM
Completed In-Depth Interview	90	92	198	150	980,275,237
Attempted Contact, Not Completed		31	49	43	204,588,592
Not Attempted		266	341	298	289,054,889
Total		**389**	**588**	**491**	**1,473,918,718**

[8] Sites, projects, or units of analysis where contact was not attempted were either not selected for contact in sampling or in the backup sample and were not contacted due to strata quotas being met.

Figure 3-6: Summary of NTG data collection for Union Custom C&I, MF, and LIMF programs



3.4.2 Free-ridership

Free-ridership is the sole contributor to the NTG ratio. The evaluation team is also conducting a study of the spillover savings attributable to the program; spillover results will be presented in a later report. Free-ridership is calculated from self-reported responses to survey questions as outlined in APPENDIX C.

Table 3-7 shows the NTG ratio by domain for the Union Custom C&I programs. The table also shows the number of units of analysis (n), 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.

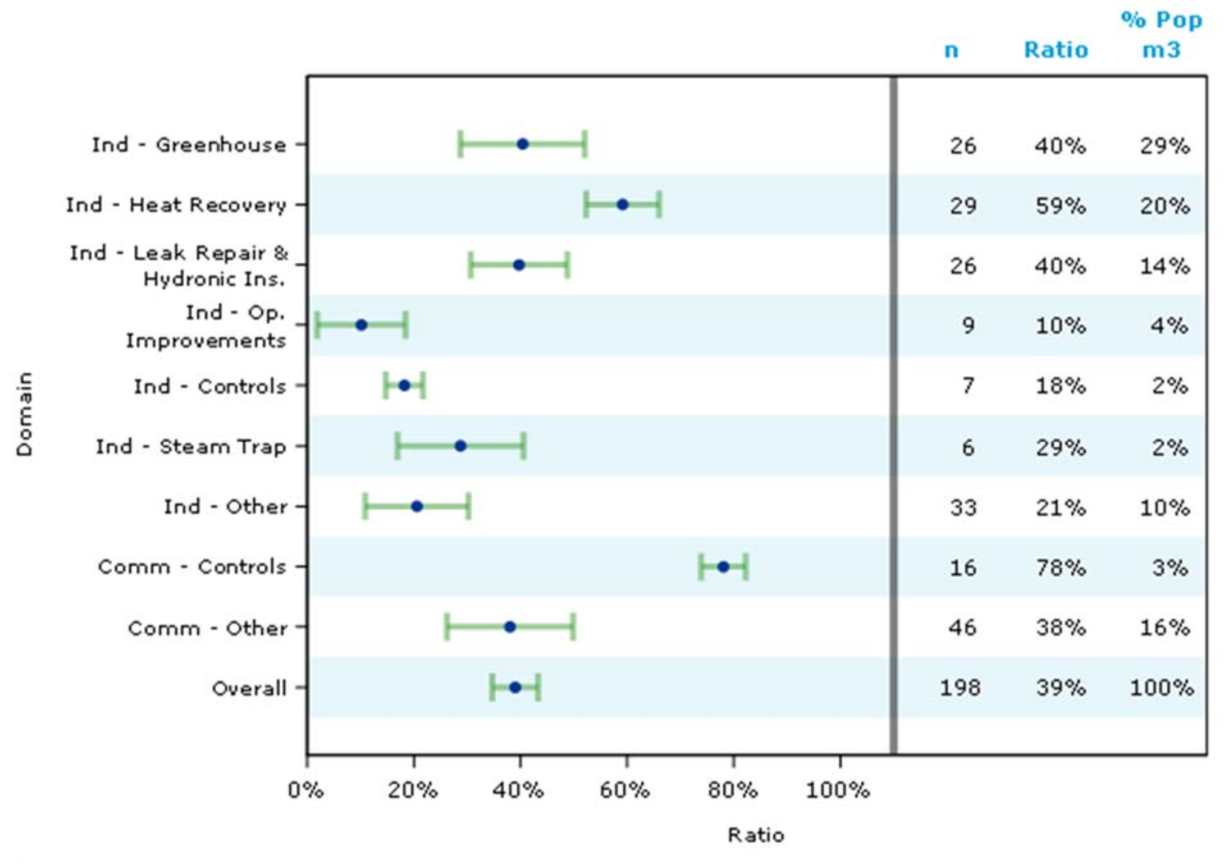
Table 3-7: NTG ratio for Union Custom C&I programs

Sector	Domain	n		NTG Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Meas	Clusts		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Greenhouse	26	17	40%	12%	28%	52%	30%	0.70	29%
	Heat Recovery	29	21	59%	7%	52%	66%	12%	0.32	20%
	Leak Repair and Hydronic Insulation	26	21	40%	9%	30%	49%	24%	0.63	14%
	Operational Improvements	9	7	10%	9%	1%	19%	85%	1.16	4%
	Controls	7	7	18%	4%	14%	22%	21%	0.29	2%
	Steam Trap	6	6	29%	12%	17%	41%	42%	0.52	2%
	Other	33	23	21%	10%	11%	31%	49%	1.37	10%
Custom Commercial	Controls	16	6	78%	5%	74%	83%	6%	0.07	3%
	Other	46	23	38%	12%	26%	50%	32%	0.90	16%
Overall		**198**	**112**	**39%**	**5%**	**34%**	**44%**	**12%**	**0.76**	**100%**

The Industrial Other category includes: building shell, HVAC, steam separator, reverse osmosis, refractory insulation, boiler, high-efficiency iron converters, robotic arms, duct insulation, infrared coating, and damper motor replacement.
The Commercial Other category includes: building shell, heat recovery, HVAC, hydronic insulation, leak repair, operational improvements, steam traps, high-efficiency washer, domestic hot water upgrade, air handling unit maintenance, and geothermal heating.
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
*Overall ratio in this table is the sample weighted average and is not used in calculating net savings for the programs.

Figure 3-7 also shows the NTG ratio by domain. The figure shows the ratio point estimate as a blue dot on the horizontal axis and the confidence interval as hashmarks connected by a green line. The number of units of analysis, the numeric ratio, and the percent of program savings represented by each domain are shown to the right of the plot. The confidence intervals for all but the two lowest and two highest performing measures overlap the program overall ratio of 39%.

Figure 3-7: NTG ratio for Union Custom C&I and MF programs



3.4.3 Sources of attribution

As described in APPENDIX K, the NTG ratio is a combination of responses regarding the program's influence on the timing, quantity, and efficiency of the measure installed. This section details the program's effect on each of those sources of attribution and indicates where the program is creating the greatest transformation.

Table 3-8 represents the possible combinations of timing, efficiency, and quantity attribution. A "yes" in the timing, efficiency, or quantity column indicates partial or full attribution for that source. A "no" indicates no attribution for that source. For example, the row that has Yes for timing, efficiency, and quantity reports the portion of the program that indicated that the program had at least partial influence on the timing, efficiency, and quantity for that measure. For some measures, efficiency or quantity may not be applicable questions; for the purposes of this table, the not applicable measures are included as "no" on the non-applicable dimension.

The table also shows the number of customers, measures, and savings that fall into each combination. The portion of the program that falls into each combination of timing, efficiency, and quantity attribution is represented by the number of responses, and the percent of cumulative savings represented by that category.

The table shows that the majority program participation (58% of savings) at least partially influenced by the program. Of the three ways the program can influence program performance, timing is the most common, affecting approximately 49% of the program savings.

Table 3-8. Overview of the sources of attribution for Union Custom C&I programs

Attribution						
Timing	Efficiency	Quantity	Customers*	Units of Analysis	Projects	Percent Savings
Yes	Yes	Yes	11	20	31	14%
Yes	Yes	No	*	*	*	9%
Yes	No	Yes	16	34	44	14%
Yes	No	No	19	25	34	13%
No	Yes	Yes	*	*	*	<1%
No	Yes	No	5	6	6	6%
No	No	Yes	7	7	13	3%
No	No	No	41	55	66	41%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

3.4.3.1 Timing

Respondents answered a sequence of questions that addresses the timing of the equipment installation. First, respondents answered the likelihood of installing the same type of equipment at the same time without the program (DAT1a). Respondents who answered "Later" specified the number of months later in the next question (DAT1b).[9]

Timing was the component most strongly affected by the program. The program affected the timing of projects that account for approximately half of the energy savings. Fifty-two customers accounting for 51% of program savings said they would have installed their measure(s) at the same time. Projects accounting for approximately 17% of savings received full attribution by answering that they never would have installed the measure (13% of savings) or would have delayed the project by 48 months or more (4% of savings). The remaining 33% of savings received partial timing attribution (Table 3-9).

[9] See APPENDIX K for the detailed scoring algorithm.

Table 3-9. Determining the acceleration period, Union Custom C&I programs

DAT1a. Without the utility, how different would the timing have been?						
DAT1b. Approximately how many months later?						
DAT1a	**DAT1b**	**Customers***	**Units of Analysis**	**Projects**	**Percent Savings**	**Timing Attribution**
Same Time	N/A	52	69	87	50%	0%
Earlier	N/A	0	0	0	0%	0%
Later	Months < 48	24	43	57	25%	ER baseline credit** for months accelerated
	Months >= 48	*	6	10	4%	100%+ ER baseline credit
	Don't Know/ Refused	8	12	16	7%	ER baseline credit for avg. of DAT1b
Never	N/A	12	20	28	13%	100%
Don't Know/ Refused	N/A	0	0	0	0%	ER baseline credit for avg. of DAT1a

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.
**ER baseline credit reflects credit for a vs. in situ equipment baseline savings during the acceleration period.

3.4.3.2 Efficiency

Respondents answered a sequence of questions that addresses the program's effects on the efficiency level of the installed equipment. First, respondents answered the likelihood of installing the same level of efficiency without the program (DAT2a). Respondents who answered that they would have installed a less efficient option answered a follow-up question (DAT2b) to specify the level of efficiency they would have installed.

The program had less effect on efficiency than timing, affecting approximately one-third (29%) of the program savings (Table 3-10). Approximately one-third (36%) of program savings received zero attribution because the respondents indicated they would have installed the same level of efficiency without the program. Another third (35%) of savings were from measures for which efficiency levels is not applicable such as operational improvements, leak repairs or steam trap replacements.

Table 3-10. Determining efficiency attribution, Union Custom C&I programs

DAT2a. Without the utility, would you have installed the same, higher, or lower efficiency?						
DAT2b. Without the utility, what efficiency would you have installed?						
DAT2a	**DAT2b**	**Customers***	**Units of Analysis**	**Projects**	**Percent Savings**	**Efficiency Attribution**
Same	N/A/ Skipped	35	44	63	36%	0%
Lower	Standard Efficiency	9	17	25	10%	100%
	Between Standard and High	*	*	6	11%	50%
	Don't Know/ Refused	*	7	9	8%	Average of DAT2b
Higher	N/A/ Skipped	0	0	0	0%	0%
Don't Know/Refused	N/A Skipped	*	*	*	<1%	Average of DAT2a
Not Applicable	N/A	47	77	94	35%	Not Asked

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

3.4.3.3 Quantity

Respondents answered a sequence of questions that addresses the program’s effects on the amount of equipment installed. First, respondents answered the likelihood of installing the same amount of equipment (or capacity for measures for which number is not relevant, such as chillers) without the program (DAT3a). Respondents who answered that they would have installed a less or more equipment answered a follow-up question (DAT3b) to specify how the program changed the amount that they installed.

The program had about the same level of effect on quantity as efficiency, affecting approximately one-third (29%) of the program savings (Table 3-11). Approximately two-thirds (66%) of program savings received zero attribution because the respondents indicated they would have installed the same amount without the program.

Table 3-11. Determining quantity/size attribution, Union Custom C&I programs

DAT3a. Without the utility, how different would the quantity/size have been?						
DAT3b. By what percentage did you change the amount installed because of utility?						
DAT3a	**DAT3b**	**Customers***	**Units of Analysis**	**Projects**	**Percent Savings**	**Quantity Attribution**
Same	N/A	58	84	107	66%	0%
Less	Value < 100%	10	14	29	10%	Value < 50%
	Value ≥ 100%	*	*	*	<1%	Value > 50%
	Don't Know/Refused	6	19	22	4%	Average of DAT3a
More	Value < 100%	0	0	0	0%	Value < 100%
	Value ≥ 100%	0	0	0	0%	Value = 100%
	Don't Know/ Refused	0	0	0	0%	Average of DAT3a
None	N/A	11	22	29	16%	100%
Don't Know/ Refused	N/A	*	*	*	<1%	Average of DAT3
Not Applicable	N/A	7	9	9	4%	Not Asked

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

3.5 Gross and net savings

This section reports the evaluation-verified gross savings in section 3.5.1 and the net savings (including only free-ridership) in section 3.5.2.

3.5.1 Verified gross savings

The program-level gross savings are determined by multiplying tracked savings by the gross realization rate within each primary reporting domain. Table shows the primary domains, tracked savings, gross realization rate (RR), and final verified gross savings. Dividing the overall verified gross savings by the overall tracking savings results in a program-level gross realization rate of 99%.

Table 3-12: Verified gross savings for Union Custom C&I and LIMF programs

Sector	Applied Domain	Cumulative Tracked Savings (m3)	Gross RR	Verified Cumulative Gross Savings (m3)
Custom Industrial	Greenhouse Equipment	428,140,859	91.68%	392,519,540
	Action	177,687,651	107.57%	191,138,606
	Hydronic Insulation	112,443,825	116.13%	130,581,014
	Other Equipment	487,064,029	100.70%	490,473,477
	Total	**1,205,336,364**	**99.95%**	**1,204,712,637**
Custom Commercial and Multi-Family		268,582,354	89.06%	239,199,444
Low Income Multi-Family		5,920,660	89.06%	5,272,940

APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
*Custom Commercial, Market Rate Multi-Family, and Low Income Multi-Family use the combined domain of Customer Commercial and LIMF.

3.5.2 Net savings

Program-level net savings are determined by multiplying the verified savings by the NTG ratio within each primary reporting domain. Table 3-13 shows the primary domains, tracking savings, verified savings, NTG ratio, and the final net savings. Dividing the overall net savings by the overall verified savings results in a program-level NTG ratio of 40%. This is slightly higher than that reported in Table 3-7 due to domain level application of ratios.

Table 3-13: Net savings for Union Custom C&I and LIMF programs

Sector	Applied Domain	Verified Cumulative Gross Savings (m3)	NTG	Net Cumulative Savings (m3)
Custom Industrial	Greenhouse	392,519,540	40.40%	158,577,894
	Heat Recovery	303,555,269	59.14%	179,522,586
	Leak Repair and Hydronic Insulation	226,857,406	39.71%	90,085,076
	Operational Improvements	57,328,381	10.15%	5,818,831
	Controls	34,273,847	18.21%	6,241,267
	Steam Trap	34,875,943	28.74%	10,023,346
	Other	155,302,251	20.57%	31,945,673
	Total	**1,204,712,637**	**40.03%**	**482,214,673**
Custom Commercial and Multi-Family	Controls	33,889,383	78.05%	26,450,663
	Other	205,310,062	38.02%	78,058,885
	Total	**239,199,444**	**43.69%**	**104,509,549**
Low Income Multi-Family		5,272,940	95.00%	5,009,293

The Industrial Other category includes: building shell, HVAC, steam separator, reverse osmosis, refractory insulation, boiler, high-efficiency iron converters, robotic arms, duct insulation, infrared coating, and damper motor replacement.
The Commercial Other category includes: building shell, heat recovery, HVAC, hydronic insulation, leak repair, operational improvements, steam traps, high-efficiency washer, domestic hot water upgrade, air handling unit maintenance, and geothermal heating.
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
*In 2015, all of the Market Rate Multi-Family measures have the Custom Commercial other domain applied based on the measure mix.
**The Low Income Multi-Family NTG ratio is deemed.

4 Union Large Volume

Union encourages the adoption of energy efficient equipment, technologies, and actions via its Large Volume program, which applies to customers in Rate 1 (2015 only) and Rate T2/Rate 100.

The 2015 program uses a direct access budget mechanism for the customer incentive budget process for Rate T2/Rate 100 customers. 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 incentive approach for Rate T1 customers remains unchanged from the aggregate pool approach offered in 2014.

The Large Volume program is the only "direct access" program offered in Ontario. It is similar in concept, though not in funding mechanism design, to the standard custom programs offered by the two gas utilities.

Custom projects implemented as part of this program and claimed in 2015 are included in the both the CPSV and FR portions of the study. While most of the Large Volume are custom projects that fall within the scope of this evaluation, a small percent of savings (<1%) come from prescriptive projects.[10]

4.1 CPSV results

This section summarizes the gross savings verification (CPSV) results for the Union Large Volume program. For Union, the gross realization rate is made up of two components, the influence correction which removes Union's influence adjustments from the tracking gross savings, and the engineering adjustment, which provides the difference (expressed as a ratio) between verified savings determined through the CPSV and tracked gross savings estimated by Union prior to applying the influence adjustment.

Section 4.1.1 summarizes the data collection efforts, section 4.1.2 describes and presents the influence correction, section 4.1.3 describes and presents the engineering adjustment, section 4.1.4 summarizes the reasons for the discrepancies between the ex ante and ex post gross savings estimates, and section 4.1.5 presents the gross savings realization rate.

4.1.1 Summary of CPSV data collection

Table 4-1 summarizes the CPSV data collection efforts for the Union Large Volume program. 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.[11]

The data collected is represented as the number of sites, the number of projects, the number of units of analysis, and cumulative ex ante natural gas savings. The proportion of the program in each category is also represented in Figure 8. The full sample design and achievement by strata can be found in 8. By collecting data on all measures at a site rather than only the first selected, the evaluation exceeded the targeted

[10] Union Gas provided the savings from and counts of prescriptive projects that were claimed as part of the Large Volume program via email May 31, 2016.

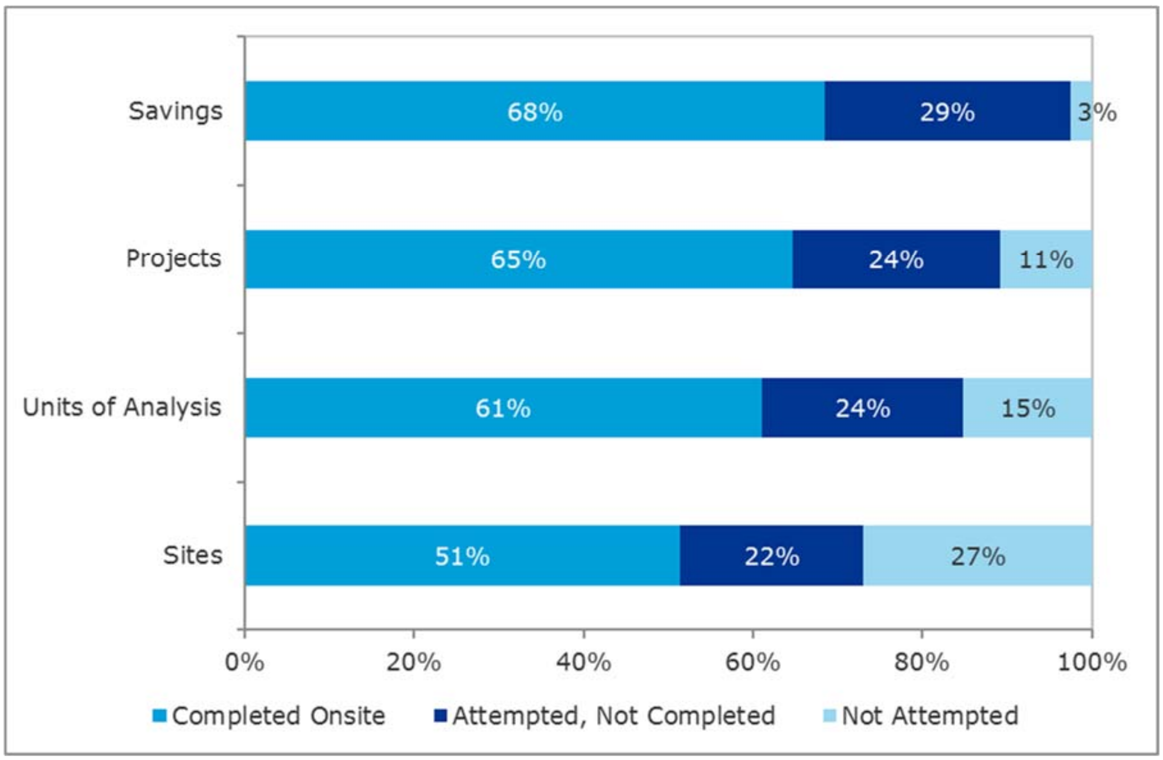
[11] Sites, projects, or units of analysis were not contacted due to strata quotas being met.

number of units despite collecting data from less sites than targeted units. The study did not achieve the targeted 90/10 relative precision for the gross realization rate at the program overall level (shown in Table 4-4). Two primary reasons for the lower than anticipated precision were a large number of influence adjustments that reduced the efficiency of the size based stratification and a lower number of customers in the sample than the data provided for sampling indicated (many customers had multiple AIMs IDs). The customer response rate was 73%.

Table 4-1: Summary of CPSV data collection for Union Large Volume

Data Collection Category	Targeted	Completed			
	# Units of Analysis	# Sites	# Measures	# Units of Analysis	Ex Ante CCM
Completed On-Site	21	19	77	44	856,320,533
Attempted Contact, Not Completed		8	29	17	362,135,793
Not Attempted		10	13	11	32,423,372
Total		**37**	**119**	**72**	**1,250,879,698**

Figure 4-1: Summary of CPSV data collection for Union Large Volume



4.1.2 Influence correction

The Union Large Volume program has some corrections and adjustments that differ from other programs: the influence correction and the engineering adjustment.

The Union Large Volume implementation team applied a proactive "influence factor" to some measures. The factor represents the portion of the energy savings that, in the opinion of the implementation team, was influenced by the program. In effect, it represents an anticipated free-ridership adjustment. Since the evaluation team is measuring and applying a retrospective free-ridership adjustment based on customer self-reports, the Union influence factor would double-count free-ridership for those measures. Therefore, the evaluation team removed the influence factor to produce a "true" gross savings estimate to which the NTG adjustment could be applied.

Table 4-2 shows the influence correction by domain for the Union Large Volume program. The table shows the number of units of analysis (n), influence correction ratio (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. Actions (including steam traps and repairs to steam leaks and heat recovery systems) were more likely to have an influence adjustment than equipment. A ratio of 306% indicates that for these measures Union recorded 32.7% of the gross savings in its database. The positive (greater than 100%) adjustment was made to reported tracked savings to remove the influence factors assigned.

Table 4-2: Influence correction for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Equipment	24	18	108%	3%	106%	111%	2%	0.06	68%
Action	53	18	306%	131%	175%	438%	43%	1.04	32%
Overall*	**77**	**36**	**174%**	**43%**	**131%**	**217%**	**25%**	**0.88**	**100%**

Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
Confidence intervals are restricted to greater than 100% as all influence corrections were removing reductions in ex ante savings.
*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

4.1.3 Engineering adjustment

For programs with an influence adjustment, such as the Union Large Volume program, the evaluation team defined an "engineering adjustment." This ratio is the difference between verified savings determined through the CPSV and tracked gross savings estimated by Union prior to applying the influence adjustment. These changes are due to differences in calculation methods, EUL, calculation parameters, or other engineering-related adjustments. The engineering adjustment is equivalent to the gross savings realization rate for programs that do not have an influence adjustment.

Table 4-3 shows the engineering adjustment by domain for the Union Large Volume program. The table shows the number of units of analysis (n), the engineering adjustment 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 low realization rate for actions (57%) was primarily the result of changes to EUL due to customer reported maintenance schedules, plant shut downs and RUL of existing equipment limiting the life of the implemented measure. The realization rate for the equipment domain was influenced by large adjustments to two projects.[12]

[12] One project had an ex post EUL of 10 where the ex ante was 1 and another project had an inverted calculation in the ex ante documentation which led to an ex post adjustment of 725%.

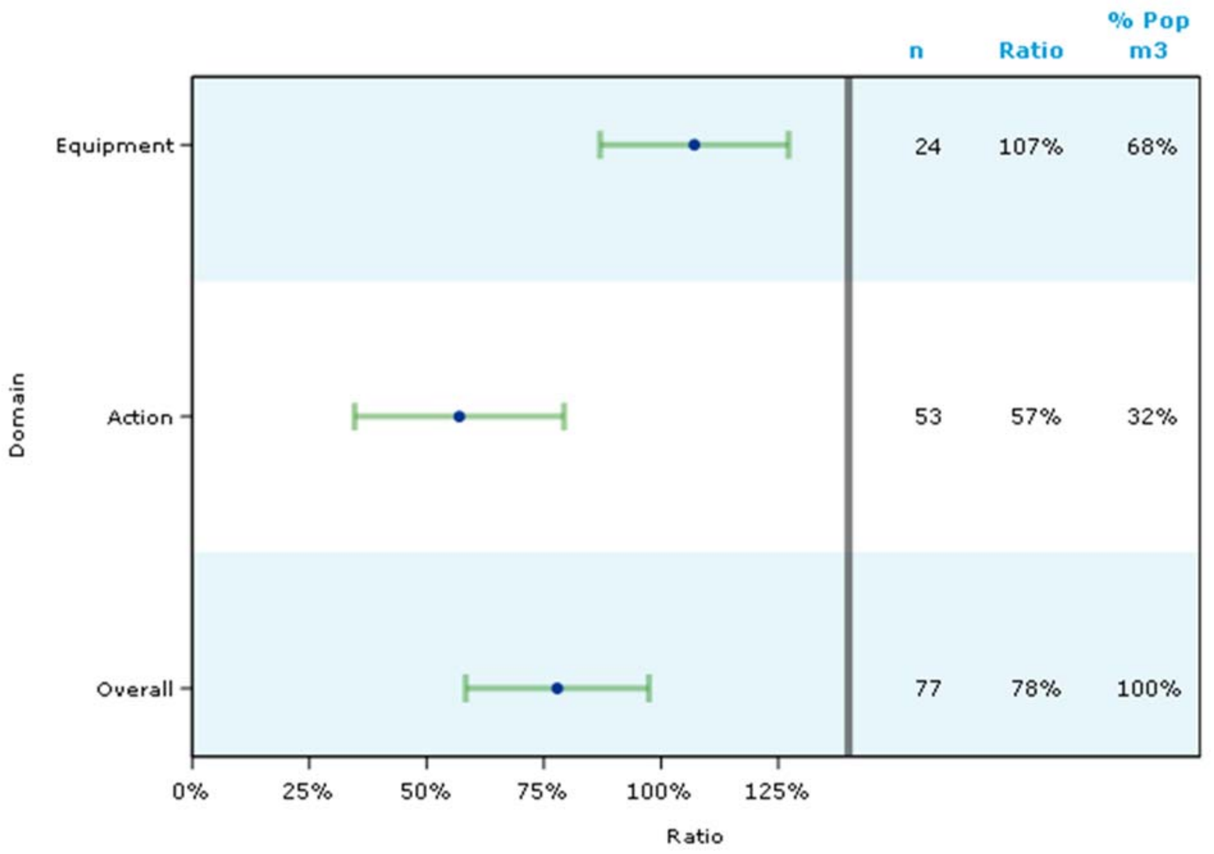
Table 4-3: Engineering adjustment for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Equipment	24	18	107%	21%	87%	128%	19%	0.47	68%
Action	53	18	57%	23%	34%	80%	40%	0.97	32%
Overall*	**77**	**36**	**78%**	**20%**	**58%**	**98%**	**26%**	**0.91**	**100%**

APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

Figure 4-2 also shows the engineering adjustment by domain. The figure shows the ratio point estimate as a blue dot on the horizontal axis and the confidence interval as hashmarks connected by a green line. The number of units of analysis, the numeric ratio, and the percent of program savings represented by each domain are shown to the right of the plot. The confidence bounds indicate that we are 90% confident that the realization rate for overall and for the actions domain are less than 100%.

Figure 4-2: Engineering adjustment for Union Large Volume



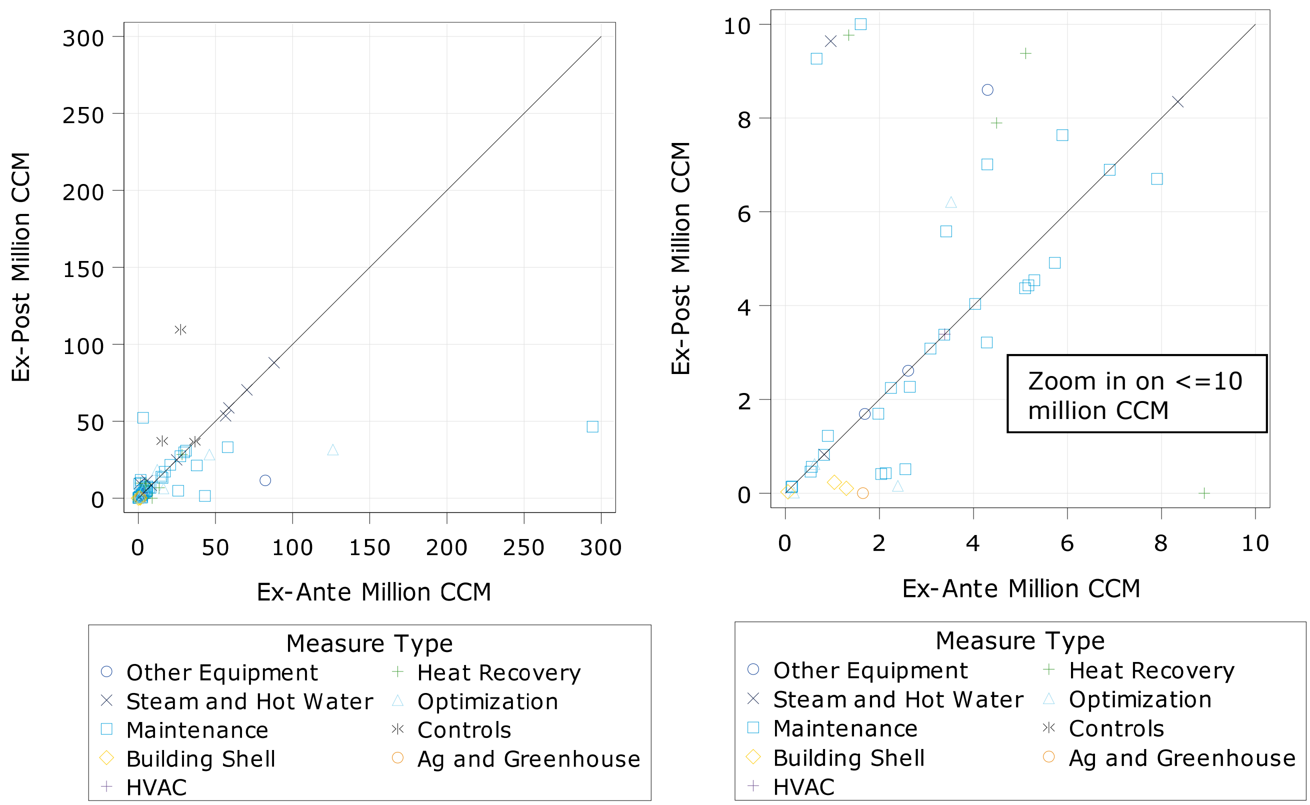
4.1.4 Discrepancy summary

This section presents detailed results for the reasons for and magnitude of the various discrepancies between ex ante and ex-post savings. First we will look at the cumulative savings, then the two key components of cumulative savings: annual savings and the EUL. See APPENDIX Q for additional detail.

Figure 4-3 plots the ex post cumulative savings (with influence corrected) against the ex ante cumulative savings (with influence corrected) for each measure in the sample. The plot on the left shows the full set of measures, while the plot on the right is focused in on the cluster of measures with less than 10 million CCM in both ex ante and ex post. The diagonal line represents a 100% engineering adjustment, or the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post savings were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

The figure shows that most ex post savings were close to ex ante, but there was a lot of variability. The cyan squares are maintenance projects.[13] Maintenance projects had more variation in their realization rates than other projects as reflected in the scatter plots. The largest project in the sample (point on the bottom right of the plot) had a downward adjustment to savings due to a data entry error in the program tracking database.

Figure 4-3. Ex post versus ex ante cumulative savings (CCM) with influence corrected- Union Large Volume, by measure type



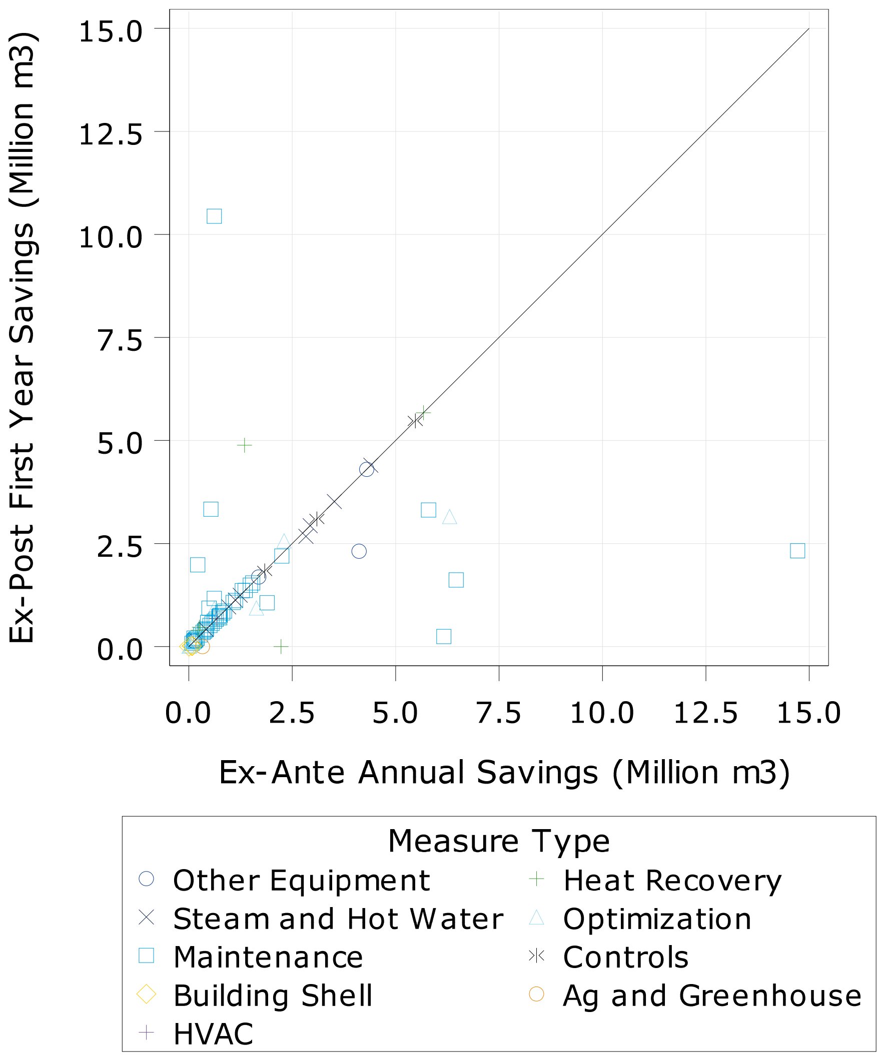
[13] Maintenance measures were a major subset of the action domain reported on in section 4.1.3 .

4.1.4.1 First-year savings discrepancies

Figure 4-4 plots the ex post annual savings (with influence corrected) against the ex ante annual savings (with influence corrected) for each measure in the sample. The plot shows the full set of measures The diagonal line represents a 100% engineering adjustment, or the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post savings were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

Most of the large adjustments to annual savings were for maintenance projects (cyan squares). One optimization project (sky blue triangle) and one heat recovery project (green plus sign) also had significant annual savings adjustments.

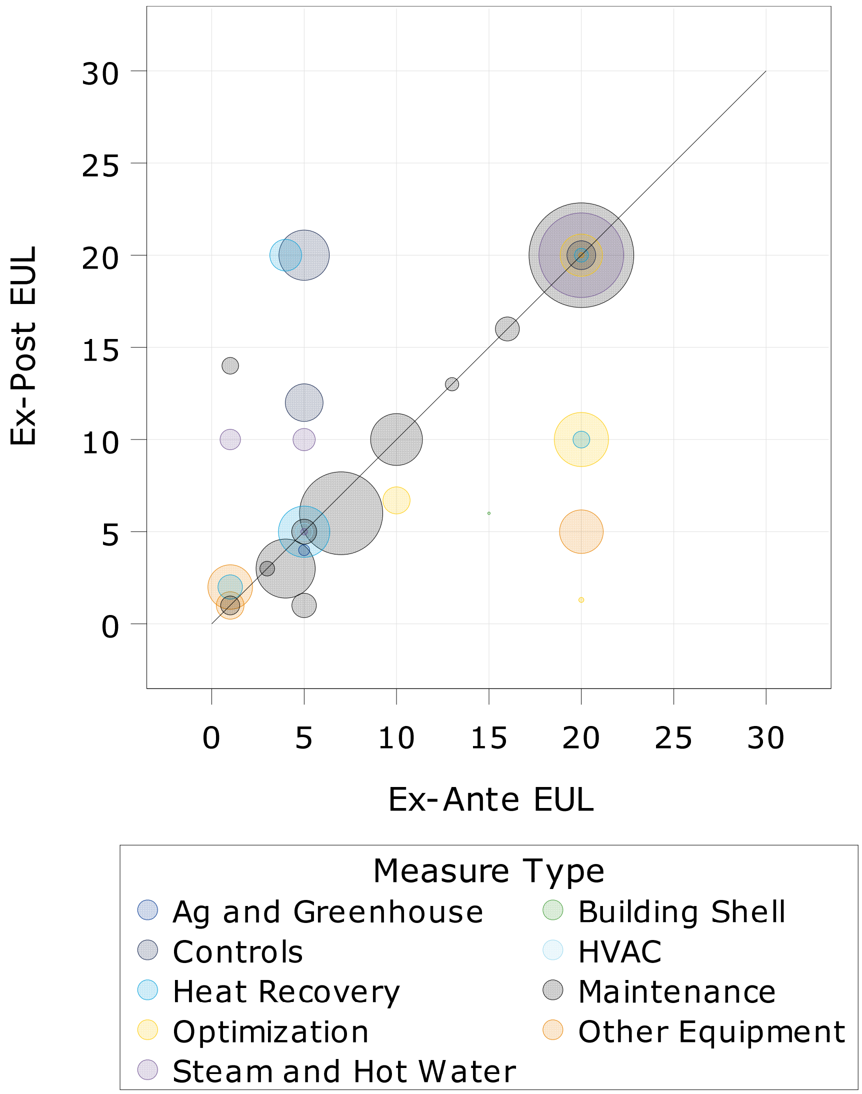
Figure 4-4: Ex post versus ex ante annual savings with influence corrected - Union Large Volume, by measure type



4.1.4.2 Measure-life discrepancies

One of the primary discrepancies is a change in EUL between ex ante and ex post. Figure 4-5 plots the ex post EUL against the ex ante EUL for each measure in the sample. Because EULs tend to be discrete numbers, the size of the bubbles in the plot indicate show the relative amount of ex ante savings for the measures at each plotted point (e.g., the larger the bubble, the more savings at that point). The diagonal line represents the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post EUL were greater than ex ante, while points below the line indicate where ex post were less than ex ante. The figure shows that several significant saving measures had large adjustments to EUL in both directions; overall, the weighted average ratio of ex post to ex ante for Large Volume EULs was 94.8%.

Figure 4-5: Ex post versus ex ante effective useful life - Union Large Volume, by measure type



4.1.5 Gross realization rate

For the Union Large Volume program, the gross realization rate is the product of the influence correction and the engineering adjustment.

Table 4-4 shows the gross realization rate by domain for the Union Large Volume program. The table shows the number of units of analysis (n), the gross 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.

Table 4-4: Gross realization rate for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Equipment	24	18	116%	22%	94%	138%	19%	0.47	68%
Action	53	18	175%	102%	72%	277%	59%	1.43	32%
Overall*	**77**	**36**	**135%**	**48%**	**87%**	**184%**	**36%**	**1.27**	**100%**

APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

Table 4-5 shows the influence correction and engineering adjustments that were multiplied to calculate the gross realization rates.

Table 4-5: Gross realization rate components for Union Large Volume

Domain	Influence correction	Engineering Adjustment	Gross Realization Rate
Equipment	108%	107%	116%
Action	306%	57%	175%
Overall*	**174%**	**78%**	**135%**

*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

4.2 NTG ratio

This section summarizes the free ridership results for the Union Large Volume program. Section 4.2.1 summarizes the data collection efforts, section 4.2.2 presents the net savings realization rate, and section 4.2.3 describes the sources of program attribution.

4.2.1 Summary of participant data collected

Table 4-6 summarizes the NTG ratio data collection efforts for the Union Large Volume program. The table shows the portion of the program that:

- Completed an in-depth interview through the NTG battery
- Did not respond to an evaluation attempt at contact
- Was not contacted by the evaluation team[14]

The data collected is represented as the cumulative ex ante natural gas savings, the number of projects, the units of analysis, and sites. The portion of the program in each category is also represented in Figure 4-6. The full sample design and achievement by strata can be found in APPENDIX A. The sample design for the NTG study included attempting an NTG interview with all sites in the CPSV sample plus additional sites. Not all sites in the CPSV sample responded to the NTG interview.

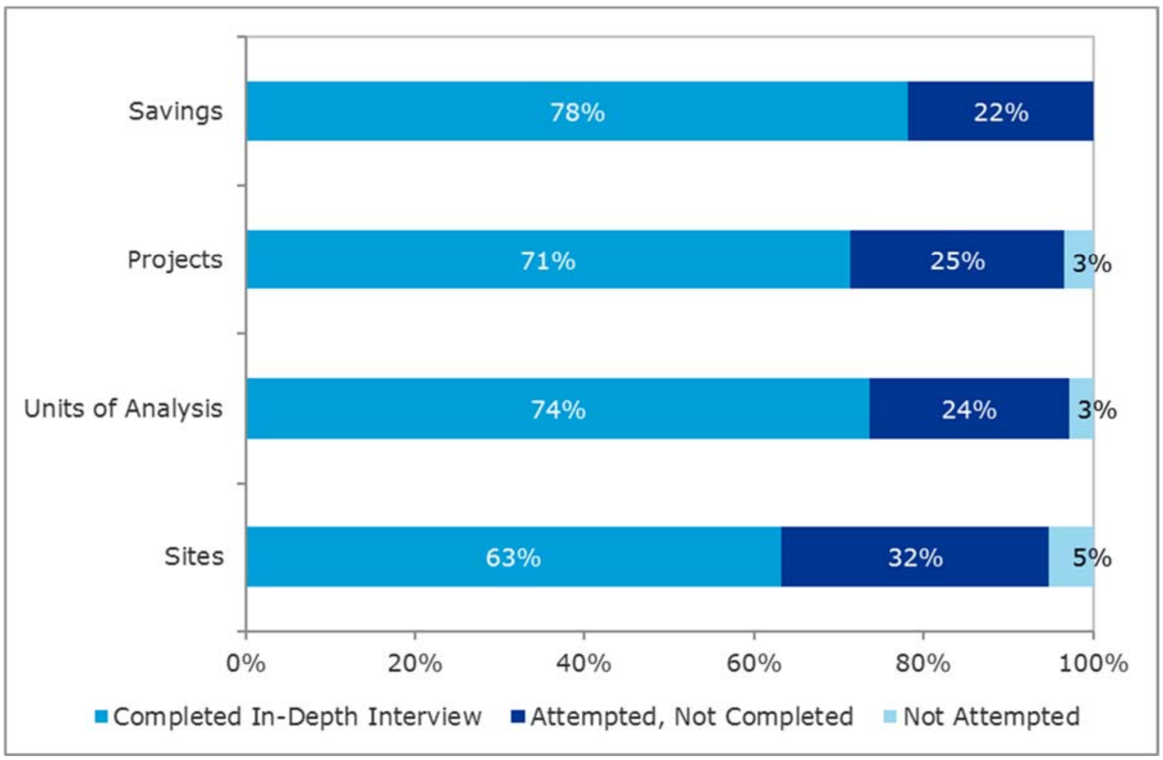
[14] Sites, projects, or units of analysis where contact was not attempted were either not selected for contact in sampling or in the backup sample and were not contacted due to strata quotas being met.

By collecting data on all measures at a site rather than only the first selected, the evaluation exceeded the targeted number of units despite collecting data from less sites than targeted units. The study had a customer response rate of 66% and did not achieve the targeted 90/10 relative precision for the NTG ratio at the program overall level (shown in Table 4-7). Relative precision is relative to the ratio result, which for sampling purposes was assumed as 50%. The achieved absolute precision (+/-) of 2% was very good and would have met the 90/10 relative precision target had the NTG ratio been at or above the assumed ratio.

Table 4-6: Summary of NTG data collection for Union Large Volume

Data Collection Category	Targeted	Completed			
	# Units of Analysis	# Sites	# Measures	# Units of Analysis	Ex Ante CCM
Completed In-Depth Interview	32	24	85	53	977,256,930
Attempted Contact, Not Completed		12	30	17	271,898,668
Not Attempted		2	4	2	1,724,100
Total		**38**	**119**	**72**	**1,250,879,698**

Figure 4-6: Summary of NTG data collection for Union Large Volume



4.2.2 Free-ridership

Free-ridership is the sole contributor to the NTG ratio. The evaluation team is also conducting a study of the spillover savings attributable to the program; those results will be presented in a later report. The free-ridership is calculated from self-reported responses to survey questions as outlined in APPENDIX K.

Union's Large Volume program overall had 8% attribution, or 92% free-ridership. Steam traps were the highest performing measure in the program with 21% attribution.

Table 4-7 shows the NTG ratio by domain for the Union Large Volume program. The table shows the number of units of analysis (n), NTG ratio (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 Large Volume program overall had 8% attribution, or 92% free-ridership. Steam traps were the highest performing measure in the program with 21% attribution.

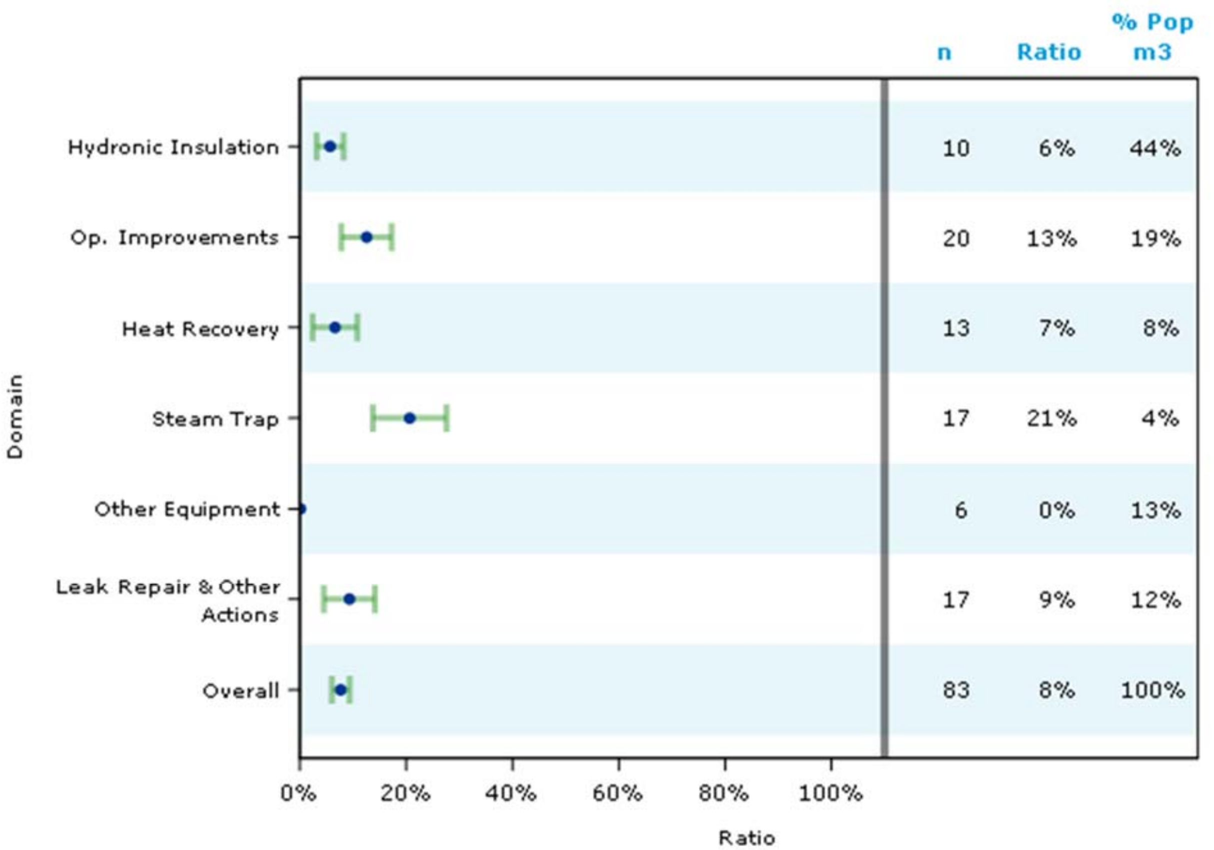
Table 4-7: NTG ratio for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Hydronic Insulation	10	7	6%	3%	3%	9%	51%	0.70	44%
Operational Improvements	20	12	13%	5%	7%	18%	41%	0.79	19%
Heat Recovery	13	10	7%	5%	2%	11%	70%	1.20	8%
Steam Trap	17	11	21%	7%	13%	28%	35%	0.65	4%
Other Equipment	6	6	0%	0%	0%	0%	146%	1.77	13%
Leak Repair and Other Actions	17	11	9%	5%	4%	14%	56%	1.02	12%
Overall*	**83**	**41**	**8%**	**2%**	**6%**	**10%**	**27%**	**1.02**	**100%**

The Other Equipment category includes building shell, steam turbine blades, burner management system, replace flue gas analyzers, infrared polyethylene, and cogeneration transformers.
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
*Overall ratio in this table is the sample weighted average and is not used in calculating net savings for the programs.

Figure 4-7 also shows the NTG ratio by domain. The figure shows the ratio point estimate as a blue dot on the horizontal axis and the confidence interval as hashmarks connected by a green line. The number of units of analysis, the numeric ratio, and the percent of program savings represented by each domain are shown to the right of the plot.

Figure 4-7: NTG ratio for Union Large Volume



4.2.3 Sources of attribution

As outlined in APPENDIX K, the NTG ratio is a combination of responses regarding the program's influence on the timing, quantity, and efficiency of the measure installed. This section details the program's effect on each of those sources of attribution and indicates where the program is creating the greatest transformation.

Table 4-8 represents the possible combinations of timing, efficiency, and quantity attribution. A "yes" in the timing, efficiency, or quantity column indicates partial or full attribution for that source. A "no" indicates no attribution for that source. For example, the row that has "yes" for timing, efficiency, and quantity reports the portion of the program that indicated that the program had at least partial influence on the timing, efficiency, and quantity for that measure. For some measures, efficiency or quantity may not be applicable questions; for the purposes of this table, the not applicable measures are included as "no" on the non-applicable dimension.

The table also shows the number of customers, measures, and savings that fall into each combination. The portion of the program that falls into each combination of timing, efficiency, and quantity attribution is represented by the number of responses, the cumulative savings in CCM, and the percent of cumulative savings represented by that category.

The table shows that a quarter of program participation (~24% of savings) was at least partially influenced by the program. Of the three ways the program can influence, timing is the most common, affecting approximately 23% of the program savings (sum of the first four rows). Quantity/size affects approximately 14% of the program savings (sum of the rows with quantity equals "yes"), and the program influenced the efficiency levels of less than 1% of the savings in the Large Volume program.

Table 4-8. Overview of the sources of attribution for Union Large Volume

Attribution						
Timing	Efficiency	Quantity	Customers*	Units of Analysis	Projects	Percent Savings
Yes	Yes	Yes	*	*	*	<1%
Yes	Yes	No	0	0	0	0%
Yes	No	Yes	*	6	15	13%
Yes	No	No	7	10	13	11%
No	Yes	Yes	0	0	0	0%
No	Yes	No	0	0	0	0%
No	No	Yes	*	*	*	1%
No	No	No	19	34	54	75%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

4.2.3.1 Timing component

Respondents answered a sequence of questions that addresses the timing of the equipment installation. First, respondents answered the likelihood of installing the same type of equipment at the same time without the program (DAT1a). Respondents who answered "Later" specified the number of months later in the next question (DAT1b).[15]

Timing was the component most strongly affected by the program. The program affected the timing of projects that account for approximately one-fourth of program savings. Twenty out of 33 surveyed customers accounting for 76% of program savings said they would have installed their measure(s) at the same time. The rest indicated some amount of program acceleration, mostly between 1 and 48 months (Table 4-9).

[15] See APPENDIX K for the detailed scoring algorithm.

Table 4-9. Determining the Acceleration period, Union Large Volume

DAT1a. Without the utility, how different would the timing have been? DAT1b. Approximately how many months later?						
DAT1a	**DAT1b**	**Customers***	**Units of Analysis**	**Projects**	**Percent Savings**	**Timing Attribution**
Same Time	N/A	20	35	55	76%	0%
Earlier	N/A	0	0	0	0%	0%
Later	Months < 48	10	15	27	19%	ER baseline credit** for months accelerated
	Months ≥ 48	*	*	*	<1%	100%+ ER baseline credit
	Don't Know/ Refused	*	*	*	5%	ER baseline credit for avg. of DAT1b
Never	N/A	*	*	*	<1%	100%
Don't Know/ Refused	N/A	0	0	0	0%	ER baseline credit for avg. of DAT1a

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.
**ER baseline credit reflects credit for a vs. in situ equipment baseline savings during the acceleration period.

4.2.3.2 Efficiency Component

Respondents answered a sequence of questions that addresses the program's effects on the efficiency level of the installed equipment. First, respondents answered the likelihood of installing the same level of efficiency without the program (DAT2a). Respondents who answered that they would have installed a less efficient option answered a follow-up question (DAT2b) to specify the level of efficiency they would have installed.

Respondents reported that program had very little effect on efficiency level (Table 4-10) of the measures implemented. In part, this is because most (58%) of program savings were from measures for which efficiency levels is not applicable such as operational improvements, leak repairs or steam trap replacements. Almost all remaining survey respondents said the program had no effect on the efficiency level of the equipment installed.

Table 4-10. Determining Efficiency Attribution, Union Large Volume

DAT2a. Without the utility, would you have installed the same, higher, or lower efficiency? DAT2b. Without the utility, what efficiency would you have installed?						
DAT2a	**DAT2b**	**Customers***	**Units of Analysis**	**Projects**	**Percent Savings**	**Efficiency Attribution**
Same	N/A/Skipped	15	19	24	42%	0%
Lower	Standard Efficiency	*	*	*	<1%	100%
	Between Standard and High	0	0	0	0%	50%
	Don't Know/ Refused	0	0	0	0%	Average of DAT2b
Higher	N/A/Skipped	0	0	0	0%	0%
Don't Know/ Refused	N/A/Skipped	0	0	0	0%	Average of DAT2a
Not Applicable	N/A	17	32	59	58%	Not Asked

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

4.2.3.3 Quantity Component

Respondents answered a sequence of questions that addresses the program's effects on the amount of equipment installed. First, respondents answered the likelihood of installing the same amount of equipment (or capacity for measures for which number is not relevant, such as chillers) without the program (DAT3a). Respondents who answered that they would have installed a less or more equipment answered a follow-up question (DAT3b) to specify how the program changed the amount that they installed.

The program had little effect on the quantity of measures installed. Twenty-one customers accounting for 84% of the program savings said they would have purchased the same amount of equipment without the program (Table 4-11).

Table 4-11. Determining quantity/size attribution, Union Large Volume

DAT3a. Without the utility, how different would the quantity/size have been?						
DAT3b. By what percentage did you change the amount installed because of utility?						
DAT3a	**DAT3b**	**Customers***	**Units of Analysis**	**Projects**	**Percent Savings**	**Quantity Attribution**
Same	N/A	21	43	66	84%	0%
Less	Value < 100%	*	6	15	9%	Value < 50%
	Value ≥ 100%	0	0	0	0%	Value > 50%
	Don't Know/Refused	*	*	*	5%	Average of DAT3a
More	Value < 100%	0	0	0	0%	Value < 100%
	Value ≥ 100%	0	0	0	0%	Value = 100%
	Don't Know/ Refused	0	0	0	0%	Average of DAT3a
None	N/A	*	*	*	<1%	100%
Don't Know/ Refused	N/A	0	0	0	0%	Average of DAT3
Not Applicable	N/A	*	*	*	1%	Not Asked

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

4.3 Gross and net savings

This section reports the evaluation-verified gross savings in section 4.3.1 and the net savings (including only free-ridership) in section 4.3.2.

4.3.1 Verified gross savings

The program-level gross savings are determined by multiplying the tracking savings by the gross realization rate within each primary reporting domain. Table 4-12shows the primary domains, the tracking savings for that domain, the gross realization rate, and the final verified gross savings for that domain. Dividing the overall verified gross savings by the overall tracking savings results in a program-level gross realization rate of 135%.

Table 4-12: Verified gross savings for Union Large Volume

Domain	Cumulative Tracked Savings (m^3)	Gross RR	Verified Cumulative Gross Savings (m^3)
Equipment	846,481,549	116.08%	982,595,782
Action	404,398,149	174.61%	706,119,609
Overall	**1,250,879,698**	**135.00%**	**1,688,715,391**

4.3.2 Net savings

The program-level net savings are determined by multiplying the verified savings by the NTG ratio within each primary reporting domain. Table 4-13 shows the primary domains, the tracking savings for that domain, the verified savings, the NTG ratio, and the final net savings for that domain. Dividing the overall net savings by the overall verified savings results in a program-level NTG ratio of 8%.

Table 4-13: Net savings for Union Large Volume

Domain	Verified Cumulative Gross Savings (m^3)	NTG	Net Cumulative Savings (m^3)
Hydronic Insulation	635,631,096	5.67%	36,040,283
Heat Recovery	134,997,398	6.59%	8,896,329
Operational Improvements	375,172,128	12.55%	47,084,102
Steam Trap	89,234,963	20.65%	18,427,020
Other Equipment	260,286,951	9.31%	24,232,715
Leak Repair and Other Actions	193,392,855	0.08%	154,714
Overall	**1,688,715,391**	**7.98%**	**134,835,163**

The Other Equipment category includes building shell, steam turbine blades, burner management system, replace flue gas analyzers, infrared polyethylene, and cogeneration transformers

APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.

5 Enbridge Commercial, Industrial, and Multi-Residential Programs

Enbridge's custom program offerings encourage commercial and industrial customers to reduce their energy consumption by providing financial incentives, technical expertise, and guidance for energy related decision-making. They differ from the prescriptive and direct install programs as they provide services and varying financial incentives based on overall natural gas savings realized by the customer to address customer-specific needs.

There are three programs covered in this section: Enbridge Commercial Custom, Enbridge Industrial Custom Solutions, and Low Income Multi-Residential Affordable Housing.

5.1 Commercial Custom and Industrial Custom Solutions (Enbridge)

The goal of the Enbridge Commercial Custom offer is 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 Enbridge Industrial Custom Solutions offer is designed to capture energy savings within the industrial sector by supporting customers through a continuous improvement approach. Industrial Energy Solutions Consultants (ESCs) assist customers with the adoption of energy efficient technologies by overcoming financial, knowledge or technical barriers.

A subset of the measures[16] in the commercial program is part of the multi-family or multi-residential segment.

All measures implemented as part of these programs and claimed in 2015 are included in the CPSV and FR results in the next sections.

5.2 Low-income Multi-Residential Affordable Housing (Enbridge)

This program offers multi-family low-income housing customers incentives to encourage energy efficient upgrades and funding for energy audits. The program also provides technical services, benchmarking, and education for housing providers, building operators, and tenants about their building's energy usage and ways to achieve energy efficiency. Eligible measures include boilers, ventilation systems, building envelope, window upgrades, in-suite water conservation measures (faucet aerators and showerheads), and heat reflector panels.

The target markets for this program are social and assisted housing providers who own and operate Part 3 buildings and private multi-residential building owners that provide housing to low-income households.[17] In addition, Enbridge targets shelters and supportive housing.

[16] Throughout the report we will refer to unique combinations of Enbridge project codes and project sub-codes and measures.

[17] "Part 3" references buildings covered by Part 3 of the Ontario Building Code, defined as those exceeding 600 square meters in area or greater than three storeys in height; for residential energy efficiency programs, these are typically multifamily buildings.

Custom measures implemented as part of these programs and claimed in 2015 are included in the CPSV results; 4% of the Enbridge low income multi-family (LI MF) program savings are from custom measures. We did not include measures implemented as part of this program in the NTG evaluation.

5.3 CPSV results

This section summarizes the gross savings verification (CPSV) energy savings verification results for the Enbridge C&I, MR MF and LIMF Programs. Section 5.3.1 summarizes the data collection efforts, section 5.3.2 presents the gross savings realization rate, and section 5.3.3 summarizes the reasons for the discrepancies between the ex ante and ex post gross savings estimates, and.

5.3.1 Summary of CPSV data collection

Table 5-1 summarizes the CPSV data collection efforts for the Enbridge C&I and LIMF Programs. This includes the number of targeted sites and measures that:

- Had completed on-site visits
- Had completed telephone supported engineering reviews (TSER)
- Did not respond to an evaluation attempt at contact
- Were not contacted by the evaluation team[18]

The data collected is represented as the number of sites, the number of measures, the number of units of analysis, and cumulative ex ante natural gas savings. The proportion of the program in each category is also represented in Figure 5-1. The full sample design and achievement by strata can be found in 8. By collecting data on all measures at a site rather than only the first selected, the evaluation exceeded the targeted number of units despite collecting data from fewer sites and TSER units than targeted. The study had a 57% customer response rate and achieved the targeted 90/10 relative precision for the gross realization rate at the overall program level (shown in Table 5-2).

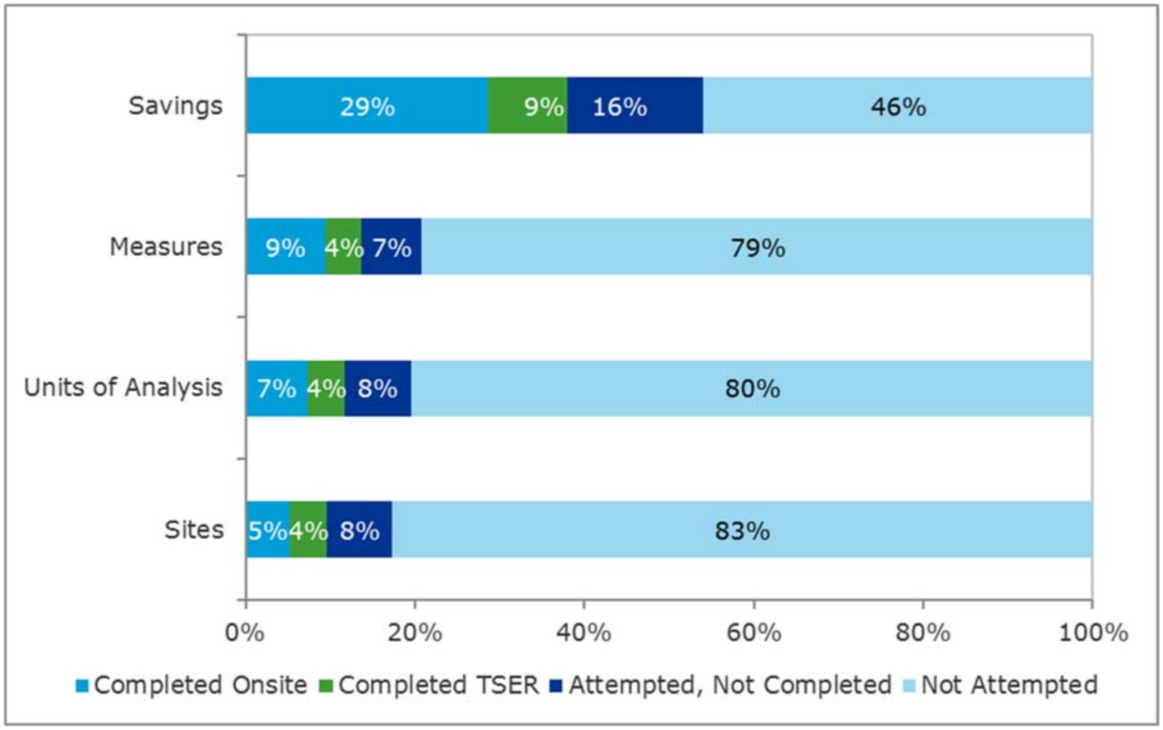
Table 5-1: Summary of CPSV data collection for Enbridge Custom C&I, MF, and LIMF programs*

Data Collection Category	Targeted	Completed			
	# Units of Analysis	# Sites	# Measures	# Units of Analysis	Ex Ante CCM
Completed On-Site	40	37	88	61	250,801,165
Completed TSER	38	31	39	37	81,376,035
Attempted Contact, Not Completed		54	66	65	140,499,585
Not Attempted		584	734	670	401,730,740
Total		**706**	**927**	**833**	**874,407,525**

* Please see the glossary for definitions of unit of analysis, site, and measure.

[18] Sites, projects, or units of analysis where contact was not attempted were either not selected for contact in sampling or in the backup sample and were not contacted due to strata quotas being met.

Figure 5-1: Summary of CPSV data collection for Enbridge Custom C&I and LIMF programs



5.3.2 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 5-2 shows the gross savings realization rate by domain for the Enbridge Custom C&I, MF, and LIMF offerings. 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 LIMF programs overall had a sample weighted 92% gross realization rate. These domains were found to have variation in engineering adjustment ratios ranging from 87% to 125%, resulting in an overall engineering correction ratio of 91%. The largest domain for these programs is the combined Custom Commercial and Multi-residential programs, which include all commercial measures as well as all MRMF and LIMF measures. The 88% realization rate is driven by 11 measures with RRs less than 75%. The discrepancies in these measures were mostly due to documentation that did not match what the verifier found onsite, a lack of pre-/post-usage data, differences in billing and simulation results, and EUL changes. The high realization rate for steam traps is primarily due to a change in EUL from 5 years to 6. Relative precision for the programs overall was 10% at 90% confidence.

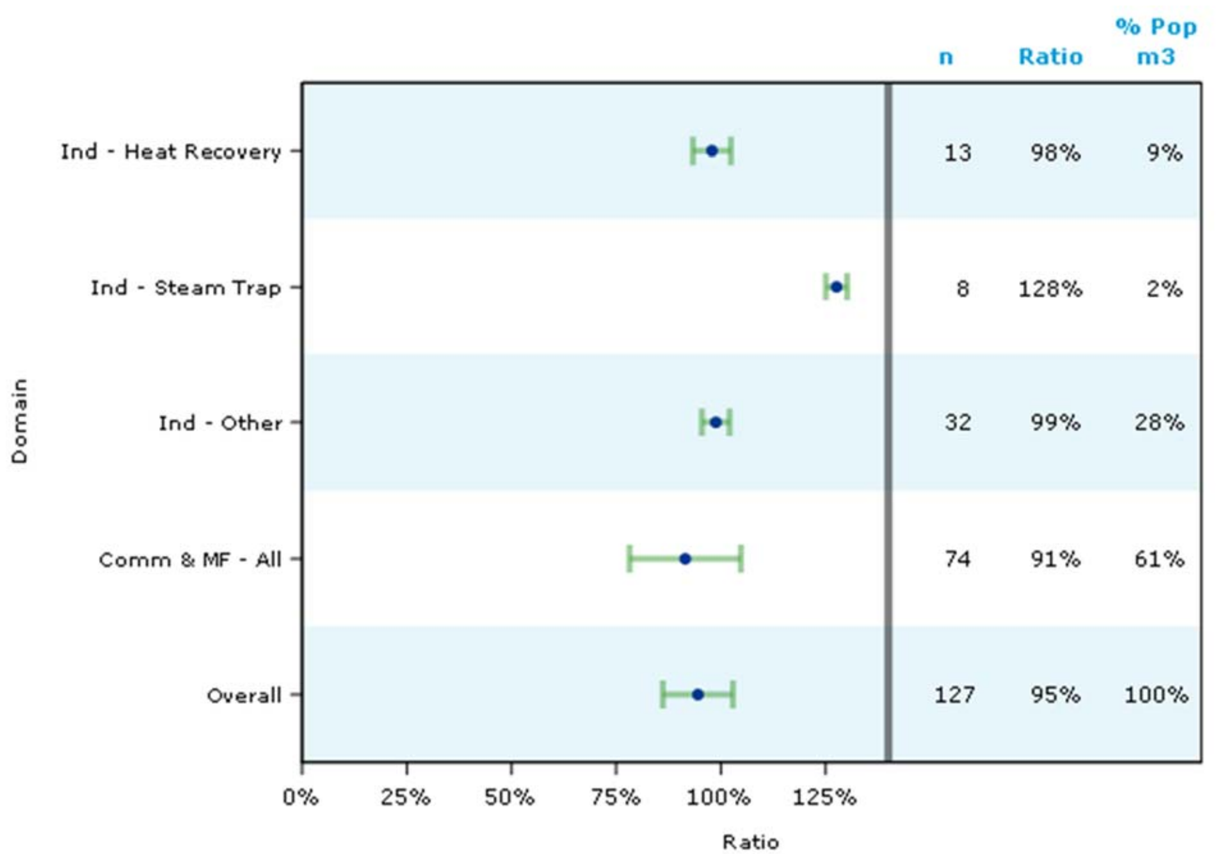
Table 5-2: Gross savings realization rate for Enbridge Custom C&I, and LIMF offerings

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Meas	Custs		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Heat Recovery	13	10	98%	5%	93%	103%	5%	0.09	9%
	Steam Trap	8	8	128%	3%	125%	131%	2%	0.04	2%
	Other	32	25	99%	4%	95%	103%	4%	0.11	28%
Custom Commercial and LIMF		74	41	91%	14%	78%	105%	15%	0.57	61%
Overall*		**127**	**82**	**95%**	**9%**	**86%**	**103%**	**9%**	**0.51**	**100%**

Other industrial: controls, Etools boiler, Etools boiler add-on, Etools insulation, Etools ventilation, other (low temperature spray washer chemical, increase mechanical dewatering, furnace burner tune-up, infrared heater and programable thermostat, low temp catalytic oxidizer, air curtain, and industrial roll-up doors, water heater)
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
*Overall ratio in this table is the sample weighted average and is not used in calculating gross savings for the programs.

Figure 5-2 also shows the gross savings realization rate by domain. The figure shows the ratio point estimate as a blue dot on the horizontal axis and the confidence interval as hashmarks connected by a green line. The number of units of analysis, the numeric ratio, and the percent of program savings represented by each domain are shown to the right of the plot.

Figure 5-2: Engineering adjustment for Enbridge Custom C&I, MF, and LIMF programs



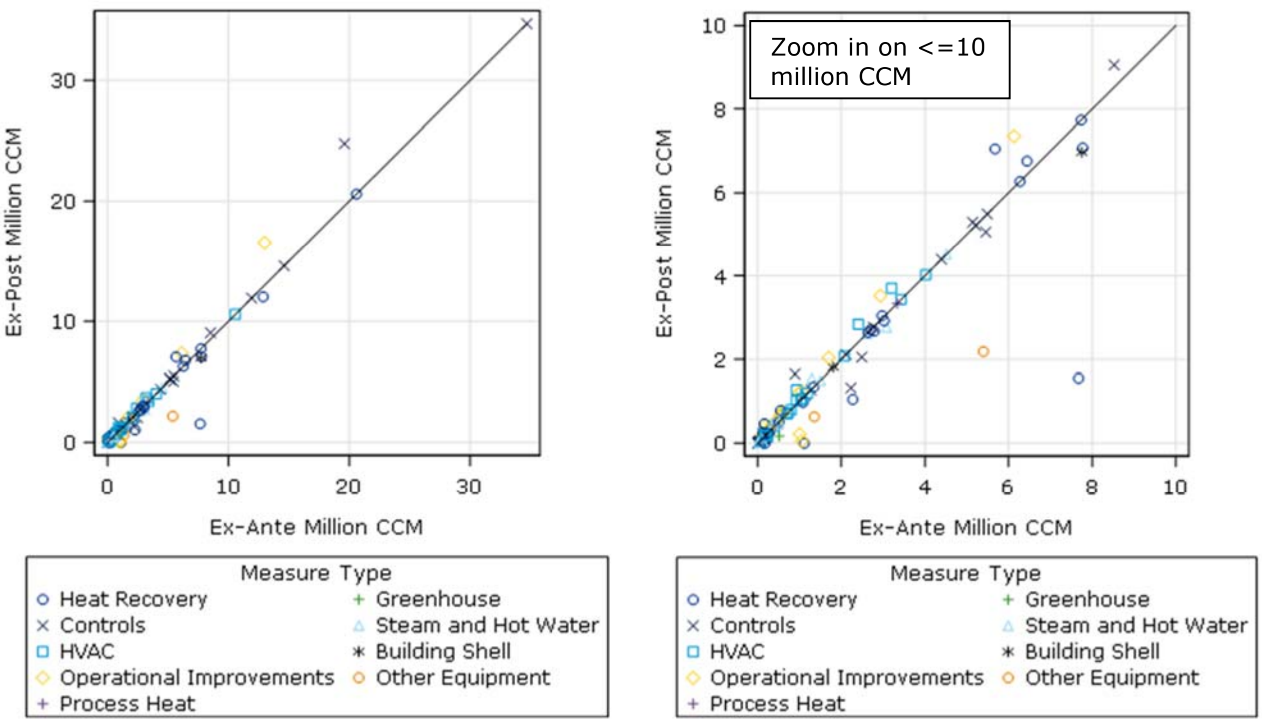
5.3.3 Discrepancy summary

This section presents detailed results for the reasons for and magnitude of the various discrepancies between ex ante and ex-post savings. First we will look at the cumulative savings, then the two key components of cumulative savings: annual savings and the EUL. See APPENDIX Q for additional detail.

Figure 5-3 plots the ex post cumulative savings against the ex ante cumulative savings for each measure in the sample. The plot on the left shows the full set of measures, while the plot on the right is focused in on the cluster of measures with less than 10 million CCM in both ex ante and ex post. The diagonal line represents a 100% engineering adjustment, or the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post savings were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

Most measures had similar ex post and ex ante savings. Heat recovery measures tended to have the largest adjustments. Two heat recovery measures resulted in large negative discrepancies, the largest of which was due to the site contact providing updated measured gas use. Two other large heat recovery measures had positive adjustments (each due to different operating conditions for found in the ex post verification.

Figure 5-3: Ex post versus ex ante cumulative savings (CCM) - Enbridge C&I and MF, by measure type

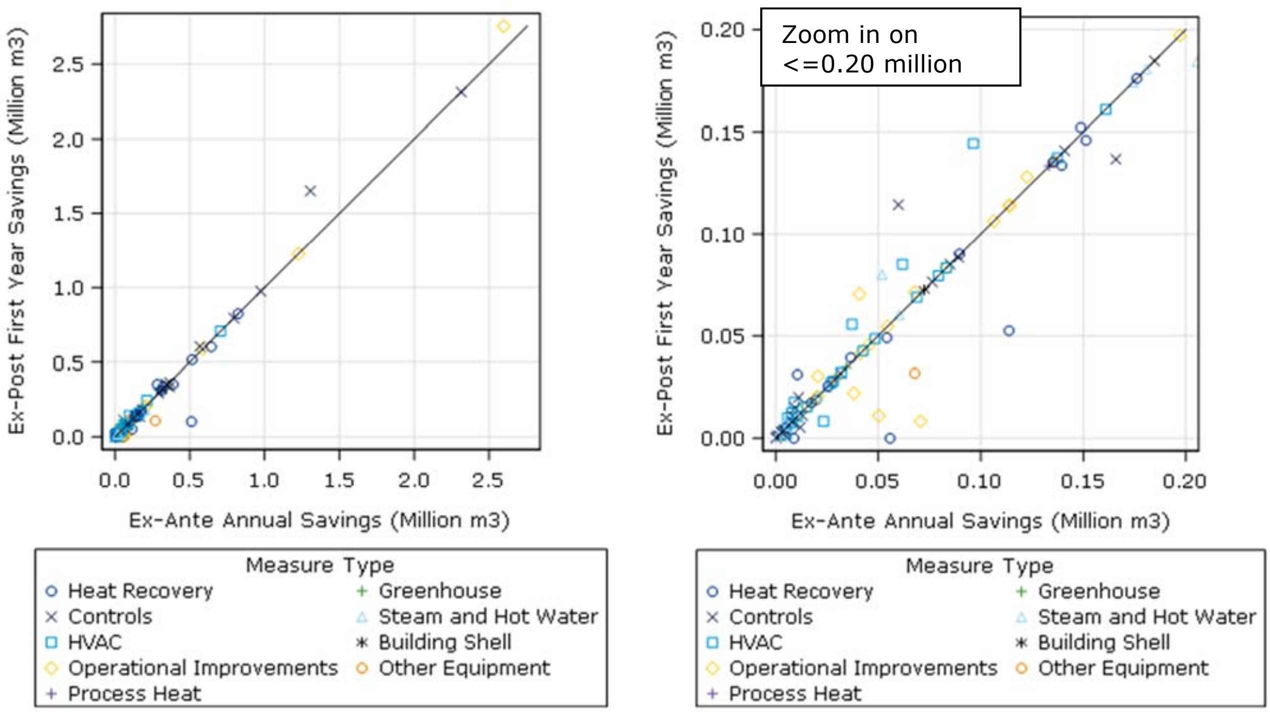


5.3.3.1 First-year savings discrepancies

Figure 5-4 plots the ex post annual savings against the ex ante annual savings for each measure in the sample. The plot on the left shows the full set of measures, while the plot on the right is focused in on the cluster of measures with less than 0.20 million m^3 in both ex ante and ex post. The diagonal line represents a 100% engineering adjustment, or the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post savings were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

Like the cumulative savings, most measures had similar ex post and ex ante savings. At the high level the pattern is consistent in terms of types of measures with large adjustment.

Figure 5-4. Ex post versus ex ante annual savings - Enbridge C&I and MF, by measure type

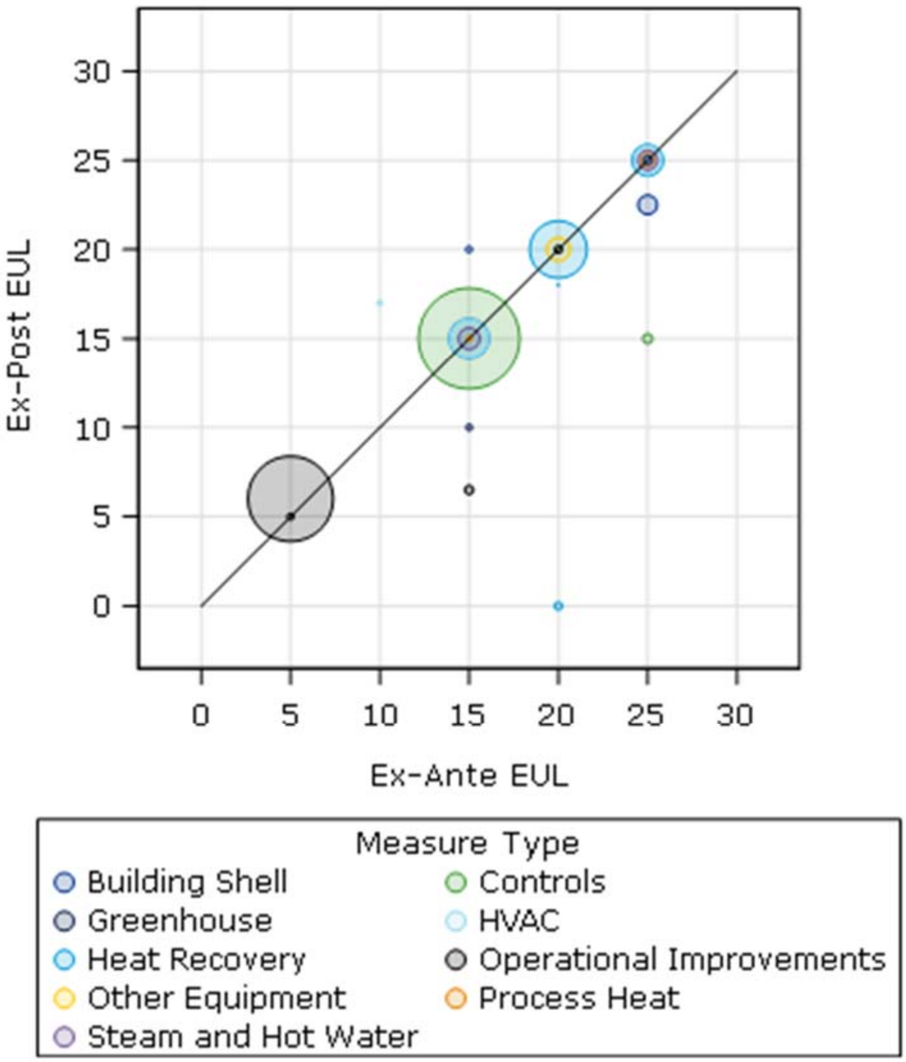


5.3.3.2 Measure life discrepancies

One of the primary discrepancies is a change in EUL between ex ante and ex post. Figure 5-5 plots the ex post EUL against the ex ante EUL for each measure in the sample. Because EULs tend to be discrete numbers, the size of the bubbles in the plot indicate show the relative amount of ex ante savings for the measures at each plotted point (e.g., the larger the bubble, the more savings at that point). The diagonal line represents the plotted value if ex post equals ex ante. Points above the line indicate measures where ex post EUL were greater than ex ante, while points below the line indicate where ex post were less than ex ante.

The plot shows that most savings had equal ex post and ex ante EULs. The greatest differences represented relatively small savings.

Figure 5-5: Ex post versus ex ante effective useful life - Enbridge C&I and MF


Ex-Post EUL
Ex-Ante EUL
0
5
10
15
20
25
30
Measure Type
Building Shell
Controls
Greenhouse
HVAC
Heat Recovery
Operational Improvements
Other Equipment
Process Heat
Steam and Hot Water

5.4 NTG ratio

This section summarizes the free-ridership results for the Enbridge Custom C&I program. Section 5.4.1 summarizes the data collection efforts, section 5.4.2 presents the net savings realization rate, and section 5.4.3 describes the sources of program attribution.

5.4.1 Summary of participant data collected

Table 5-3 summarizes the NTG ratio data collection efforts for the Enbridge Custom C&I program. The table shows the portion of the program that:

- Completed an in-depth interview through the NTG battery
- Did not respond to an evaluation attempt at contact
- Was not contacted by the evaluation team[19]

The data collected is represented as the cumulative ex ante natural gas savings, the number of measures, the units of analysis, and sites. The portion of the program in each category is also represented in Figure 5-6. The full sample design and achievement by strata can be found in 8. The sample design for the NTG study included attempting an NTG interview with all sites in the CPSV sample plus additional sites. Not all sites in the CPSV sample responded to the NTG interview.

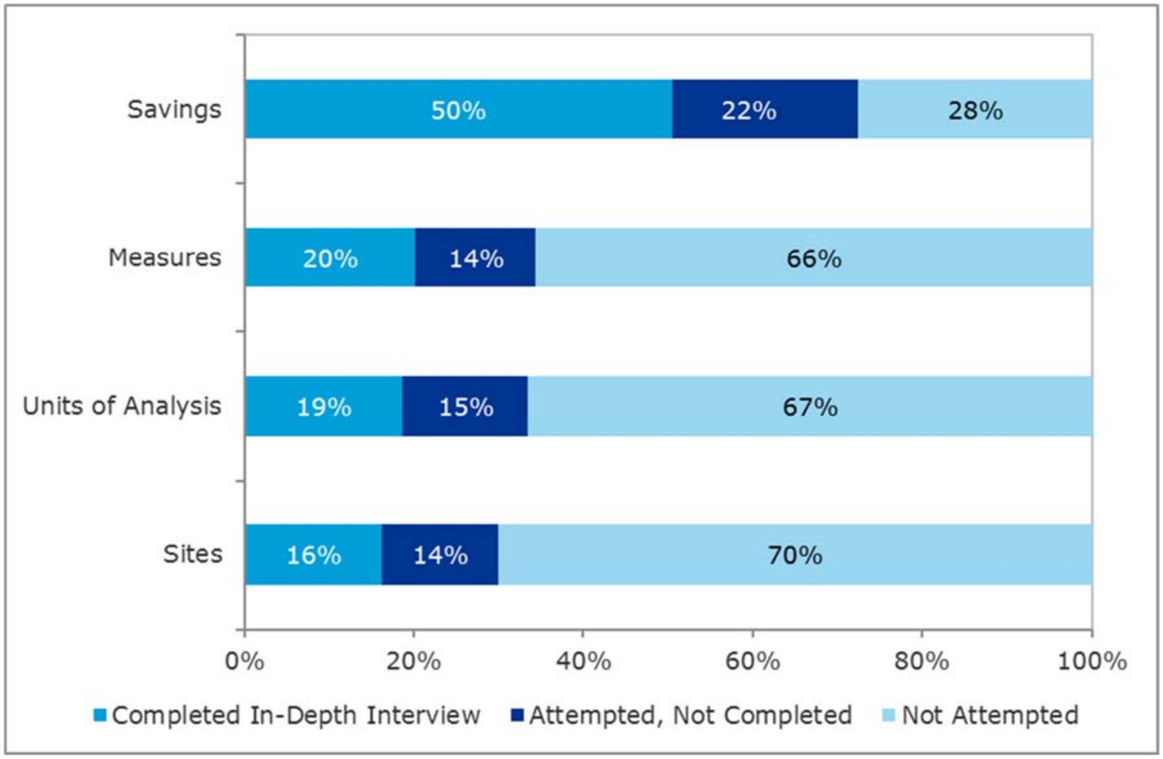
By collecting data on all measures at a site rather than only the first selected, the evaluation fell one short of the targeted number of units despite collecting data from 50% fewer sites than targeted. The study had a 52% customer response rate and achieved a NTG ratio with absolute precision of +/-5% and relative precision of 16% at 90% confidence (shown in Table 5-4). Relative precision is relative to the ratio result, which for sampling purposes was assumed as 50%. The achieved absolute precision (+/-) of 5% would have met the 90/10 relative precision target had the NTG ratio been at or above the assumed ratio.

Table 5-3: Summary of NTG data collection for Enbridge Custom C&I and LIMF programs

Data Collection Category	Targeted	Completed			
	# Units of Analysis	# Sites	# Measures	# Units of Analysis	Ex Ante CCM
Completed In-Depth Interview	151	100	162	135	408,890,043
Attempted Contact, Not Completed		84	114	107	178,062,737
Not Attempted		431	527	481	223,653,170
Total		**615**	**803**	**723**	**810,605,950**

[19] Sites, projects, or units of analysis where contact was not attempted were either not selected for contact in sampling or in the backup sample and were not contacted due to strata quotas being met.

Figure 5-6: Summary of NTG data collection for Enbridge Custom C&I programs



5.4.2 Free-ridership

Free-ridership is the sole contributor to the NTG ratio. The evaluation team is also conducting a study of the spillover savings attributable to the program; those results will be presented in a later report. The free-ridership is calculated from self-reported responses to survey questions as outlined in APPENDIX J.

Table 5-4 shows the NTG ratio by domain for the Enbridge Custom C&I programs. The table shows the number of units of analysis (n), NTG ratio (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 programs overall had 29% attribution, or 71% free-ridership. Ventilation measures showed the lowest attribution (4-19% in each sector) while multi-residential other (non-boiler, non-ventilation) showed the highest attribution at 97%. Industrial Heat Recovery measures were the only other domain over 50% attribution at 56%.

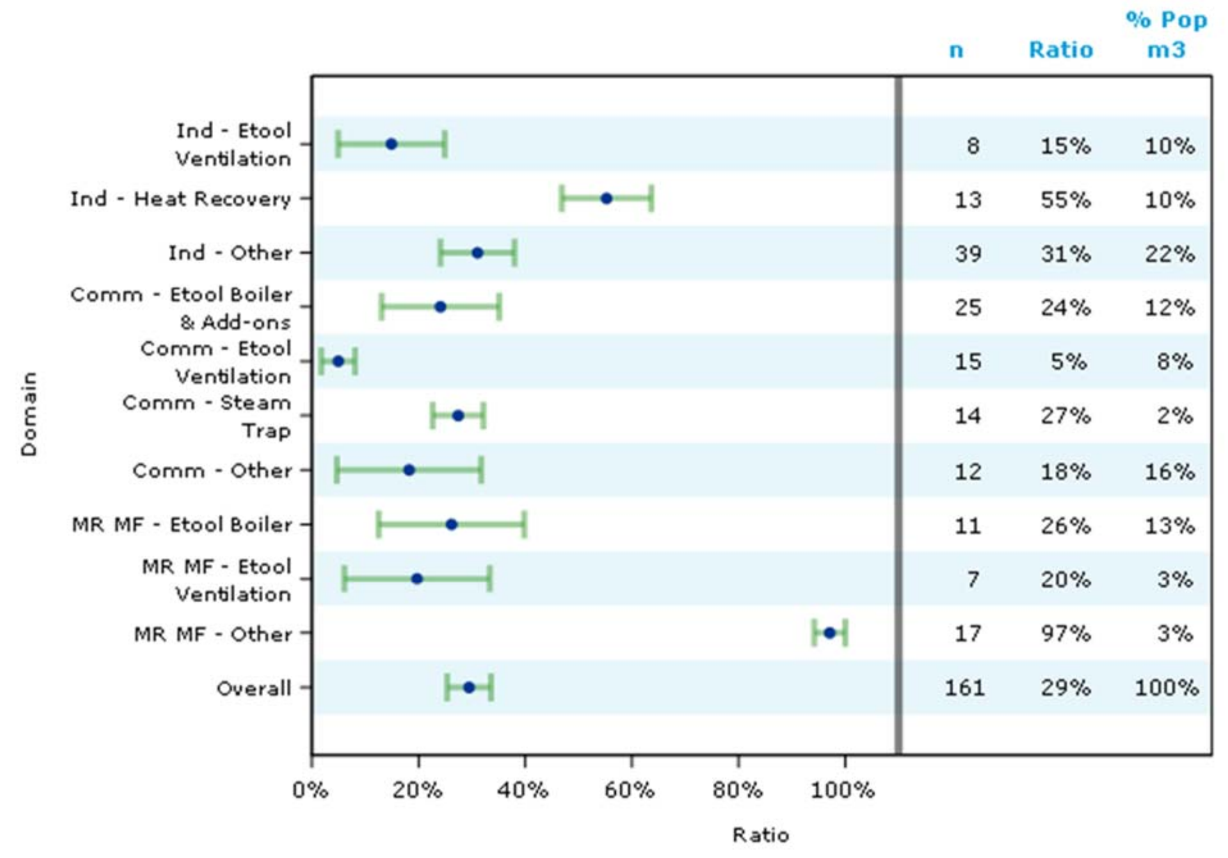
Table 5-4: NTG ratio for Enbridge Custom C&I programs

Sector	Domain	n		NTG Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Meas.	Custs.		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Etools Ventilation	8	7	15%	10%	5%	25%	70%	0.95	10%
	Heat Recovery	13	10	55%	9%	46%	64%	16%	0.27	10%
	Other	39	34	31%	7%	24%	38%	24%	0.81	22%
Custom Commercial	Etools Boiler and Boiler Add-on	25	20	24%	11%	13%	35%	47%	1.22	12%
	Etools Ventilation	15	15	5%	4%	1%	8%	72%	1.58	8%
	Steam Trap	14	6	27%	5%	22%	33%	19%	0.23	2%
	Other	12	8	18%	14%	4%	32%	76%	1.14	16%
Custom Multi-Residential	Etools Boiler	11	8	26%	14%	12%	40%	54%	0.80	13%
	Etools Ventilation	7	7	20%	14%	6%	34%	71%	0.97	3%
	Other	17	7	97%	3%	94%	100%	3%	0.05	3%
Overall*		**161**	**112**	**29%**	**4%**	**25%**	**34%**	**15%**	**0.97**	**100%**

Other Industrial: Controls, Etools boiler, Etools boiler add-on, Etools insulation, steam trap, other (increase mechanical dewatering, VFD, infrared heater and programmable thermostat, low temp catalytic oxidizer, air curtain, industrial roll-up doors, evaporator system, water heater, reduce powder paint curing oven exhaust, dock seal, aquathermat heating system, insulated panels, greenhouse double polyethylene walls)
Other Commercial: Etools insulation, controls, other (dock seal, building shell, steam chiller, high speed door, boiler – hydronic high-efficiency)
Other Multi-res: Etools boiler add-on, Etools insulation, heat reflector panels
APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.
*Overall ratio in this table is the sample weighted average and is not used in calculating net savings for the programs.

Figure 5-7 also shows the NTG ratio by domain. The figure shows the ratio point estimate as a blue dot on the horizontal axis and the confidence interval as hashmarks connected by a green line. The number of units of analysis, the numeric ratio, and the percent of program savings represented by each domain are shown to the right of the plot.

Figure 5-7: NTG ratio for Enbridge Custom C&I programs



5.4.3 Sources of attribution

As outlined in APPENDIX K, the NTG ratio is an estimate of a program's influence on the timing, quantity, and efficiency of the measure installed. This section details the program's effect on each of those sources of attribution and indicates where the program is creating the greatest transformation.

Table 5-5 represents the possible combinations of timing, efficiency, and quantity attribution. A "yes" in the timing, efficiency, or quantity column indicates partial or full attribution for that source. A "no" indicates no attribution for that source. For example, the row that has Yes for timing, efficiency, and quantity reports the portion of the program that indicated that the program had at least partial influence on the timing, efficiency, and quantity for that measure. For some measures, efficiency or quantity may not be applicable questions; for the purposes of this table, the not applicable measures are included as "no" on the non-applicable dimension.

The table also shows the portion of the program that falls into each combination of timing, efficiency, and quantity attribution represented by the number of responses and the percent of cumulative savings represented by that category.

The table shows that approximately two-thirds (63%) of program savings were at least partially influenced by the program. Of the three aspects relating to savings that the program can influence, timing is the most common, affecting approximately 57% of the program savings. Quantity affects approximately 20% of the program savings, and the program influenced efficiency levels of equipment accounting for approximately 13% of program savings.

Table 5-5. Overview of the sources of attribution for Enbridge Custom C&I programs

Attribution						
Timing	Efficiency	Quantity	Customers*	Units of Analysis	Measures	Percent Savings
Yes	Yes	Yes	0	0	0	0%
Yes	Yes	No	7	8	8	8%
Yes	No	Yes	18	27	33	20%
Yes	No	No	28	34	49	30%
No	Yes	Yes	*	*	*	<1%
No	Yes	No	*	5	5	6%
No	No	Yes	5	5	5	<1%
No	No	No	42	54	60	36%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

5.4.3.1 Timing component

Respondents answered a sequence of questions that addresses the timing of the equipment installation. First, respondents answered the likelihood of installing the same type of equipment at the same time without the program (DAT1a). Respondents who answered "Later" specified the number of months later in the next question (DAT1b). [20]

Timing was the component most strongly affected by the program. The program affected the timing of measures that account for more than half of program savings. Forty-eight out of 100 surveyed customers accounting for 43% of program savings said they would have installed their measure(s) at the same time. The rest indicated some amount of program acceleration, mostly between 1 and 48 months (Table 5-6).

Table 5-6. Determining the Acceleration period, Enbridge Custom C&I programs

DAT1a. Without the utility, how different would the timing have been?						
DAT1b. Approximately how many months later?						
DAT1a	DAT1b	Customers *	Units of Analysis	Measures	Percent Savings	Timing Attribution
Same Time	N/A	48	66	72	43%	0%
Earlier	N/A	0	0	0	0%	0%
Later	Months < 48	33	44	59	35%	ER baseline credit** for months accelerated
	Months ≥ 48	*	*	*	1%	100%+ ER baseline credit
	Don't Know/ Refused	5	5	5	2%	ER baseline credit for avg. of DAT1b
Never	N/A	9	15	21	14%	100%
Don't Know/ Refused	N/A	*	*	*	0%	ER baseline credit for avg. of DAT1a

[20] See APPENDIX K for the detailed scoring algorithm.

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.
**ER baseline credit reflects credit for a vs. in situ equipment baseline savings during the acceleration period.

5.4.3.2 Efficiency Component

Respondents answered a sequence of questions that addresses the program's effects on the efficiency level of the installed equipment. First, respondents indicated the likelihood of installing the same level of efficiency without the program (DAT2a). Respondents who answered that they would have installed a less efficient option answered a follow-up question (DAT2b) to specify the level of efficiency they would have installed.

The program had limited effect on efficiency (Table 5-7). Most (54%) of program savings were from measures for which efficiency levels is not applicable such as operational improvements, leak repairs or steam trap replacements. Most of the remaining survey respondents said the program had no effect on the efficiency level of the equipment installed. Respondents who indicated the program increased the efficiency level of their measures accounted for approximately 13% of program savings. Most of these indicated that the program moved them from an efficiency level already above standard efficiency to an even higher level of efficiency. The relatively low program influence on efficiency can be an indicator that measures included in the program, though above current code requirements, are standard on the market.

Table 5-7. Determining Efficiency Attribution, Enbridge Custom C&I programs

DAT2a. Without the utility, would you have installed the same, higher, or lower efficiency?						
DAT2b. Without the utility, what efficiency would you have installed?						
DAT2a	DAT2b	Customers *	Units of Analysis	Measure s	Percent Savings	Efficiency Attribution
Same	N/A/Skipped	31	37	41	33%	0%
Lower	Standard Efficiency	*	*	*	<1%	100%
	Between Standard and High	6	6	6	10%	50%
	Don't Know/Refused	5	6	6	3%	Average of DAT2b
Higher	N/A/Skipped	0	0	0	0%	0%
Don't Know/Refused	N/A Skipped	*	*	*	<1%	Average of DAT2a
Not Applicable	N/A	57	83	106	54%	Not Asked

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

5.4.3.3 Quantity Component

Respondents answered a sequence of questions that addresses the program's effects on the amount of equipment installed. First, respondents indicated the likelihood of installing the same amount of equipment (or capacity for measures for which number is not relevant, such as heat exchangers) without the program (DAT3a). Respondents who answered that they would have installed less or more equipment answered a follow-up question (DAT3b) to specify how the program changed the amount that they installed.

The program had limited effect on the quantity of measures installed. Sixty-five of the 96 customers, who accounted for 82% of program savings, said they would have purchased the same amount of equipment without the program (Table 5-8). Most of the remaining customers (12% of savings) received full attribution because they indicated they would not have installed any measures without the program.

Table 5-8. Determining quantity/size attribution, Enbridge Custom C&I programs

DAT3a. Without the utility, how different would the quantity/size have been?						
DAT3b. By what percentage did you change the amount installed because of utility?						
DAT3a	**DAT3b**	**Customers***	**Units of Analysis**	**Measures**	**Percent Savings**	**Quantity Attribution**
Same	N/A	65	94	117	82%	0%
Less	Value < 100%	9	11	11	4%	Value < 50%
	Value ≥ 100%	*	*	*	<1%	Value > 50%
	Don't Know/Refused	*	*	*	<1%	Average of DAT3a
More	Value < 100%	0	0	0	0%	Value < 100%
	Value ≥ 100%	0	0	0	0%	Value = 100%
	Don't Know/ Refused	0	0	0	0%	Average of DAT3a
None	N/A	10	16	19	11%	100%
Don't Know/ Refused	N/A	*	*	*	<1%	Average of DAT3
Not Applicable	N/A	7	9	10	2%	Not Asked

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

5.5 Gross and net savings

This section reports the evaluation-verified gross savings in section 5.5.1 and the net savings (including only free-ridership) in section 5.5.2.

5.5.1 Verified gross savings

Program-level gross savings are determined by multiplying the tracking savings by the gross realization rate within each primary reporting domain. Table 5-9 shows the primary domains, the tracking savings for that domain, the gross realization rate, and the final verified gross savings for that domain. Dividing the overall verified gross savings by the overall tracking savings results in a program-level gross realization rate of 92%.

Table 5-9: Verified gross savings for Enbridge Custom C&I and LIMF programs

Sector	Applied Domain	Cumulative Tracked Savings (m3)	Gross RR	Verified Cumulative Gross Savings (m3)
Custom Industrial	Heat Recovery	82,143,555	97.86%	80,385,683
	Steam Trap	20,222,930	127.62%	25,808,503
	Other	241,990,817	98.78%	239,038,529
	Total	**344,357,302**	**100.25%**	**345,232,715**
Custom Commercial and Multi-Residential		466,248,648	91.48%	426,524,263
Low Income Multi-Residential		63,801,575	91.48%	58,365,681

5.5.2 Net savings

Program-level net savings are determined by multiplying the verified gross savings by the NTG ratio within each primary reporting domain. Table 5-10 shows the primary domains, tracking savings, verified savings, NTG ratio, and the final net savings for that domain.

Table 5-10: Net savings for Enbridge Custom C&I programs

Sector	Applied Domain	Verified Cumulative Gross Savings (m3)	NTG	Net Cumulative Savings (m3)
Custom Industrial	Etool Ventilation	83,670,201	14.90%	12,466,860
	Heat Recovery	80,385,683	55.25%	44,413,090
	Other	181,176,831	31.04%	56,237,288
	Total	**345,232,715**	**32.77%**	**113,117,238**
Custom Commercial	Etool Boiler and Boiler Add-on	90,295,668	24.09%	21,752,226
	Etool Ventilation	61,235,559	4.93%	3,018,913
	Steam Trap	13,597,779	27.42%	3,728,511
	Other	121,290,363	18.22%	22,099,104
	Total	**286,419,369**	**17.67%**	**50,598,755**
Market Rate Multi-Residential	Etool Boiler	98,725,211	26.18%	25,846,260
	Etool Ventilation	21,825,719	19.70%	4,299,667
	Other	19,553,964	97.10%	18,986,899
	Total	**140,104,894**	**35.07%**	**49,132,826**
Low Income Multi-Residential*		58,365,681	100.00%	58,365,681

The Other Industrial category includes: Controls, Etools boiler, Etools boiler add-on, Etools insulation, steam trap, other (increase mechanical dewatering, VFD, infrared heater and programmable thermostat, low temp catalytic oxidizer, air curtain, industrial roll-up doors, evaporator system, water heater, reduce powder paint curing oven exhaust, dock seal, aquathermal heating system, insulated panels, and greenhouse double polyethylene walls)
The Other Commercial category includes: Etools insulation, controls, other (dock seal, building shell, steam chiller, high speed door, boiler – hydronic high-efficiency)
The Other Multi-residential category includes: Etools boiler add-on, Etools insulation, and heat reflector panels.
*The Enbridge Low Income Multi-Residential NTG ratio is deemed at 100%.

6 Enbridge RunitRight

Through its program RunitRight, Enbridge provides customers with an energy assessment, technical and implementation assistance and performance monitoring. RiR participation starts with EGD working with the customer utilizing investigation agents to identify low cost/no cost re-commissioning measures that could be implemented to achieve a minimum of 5% gas savings followed with energy monitoring to monitor impact of operational improvement and facilitate improved energy management. The FR portion will evaluate measures implemented in 2014 and claimed in 2015. Run it Right is not part of the CPSV scope for the verification of 2015 measures and is the only program with non-custom measures included in the scope of the evaluation.

6.1 CPSV results

The gross savings for the RunitRight program were not verified as part of this study.

6.2 NTG ratio

This section summarizes the free ridership results for the Enbridge RunitRight program. Section 6.2.1 summarizes the data collection efforts, section 6.2.2 presents the net savings realization rate, and section 6.2.3 describes the sources of program attribution.

6.2.1 Summary of participant data collected

Table 6-1 summarizes the net-to-gross ratio data collection efforts for the Enbridge RunitRight program. The table shows the portion of the program that:

- Completed an in-depth interview through the NTG battery
- Did not respond to an evaluation attempt at contact
- Was not contacted by the evaluation team.[21]

The data collected is represented as the cumulative ex ante natural gas savings, the number of measures, the units of analysis, and number of sites. The portion of the program in each category is also represented in Figure 6-1. See section 6.3.1 for more detail. The full sample design and achievement by strata can be found in APPENDIX A.

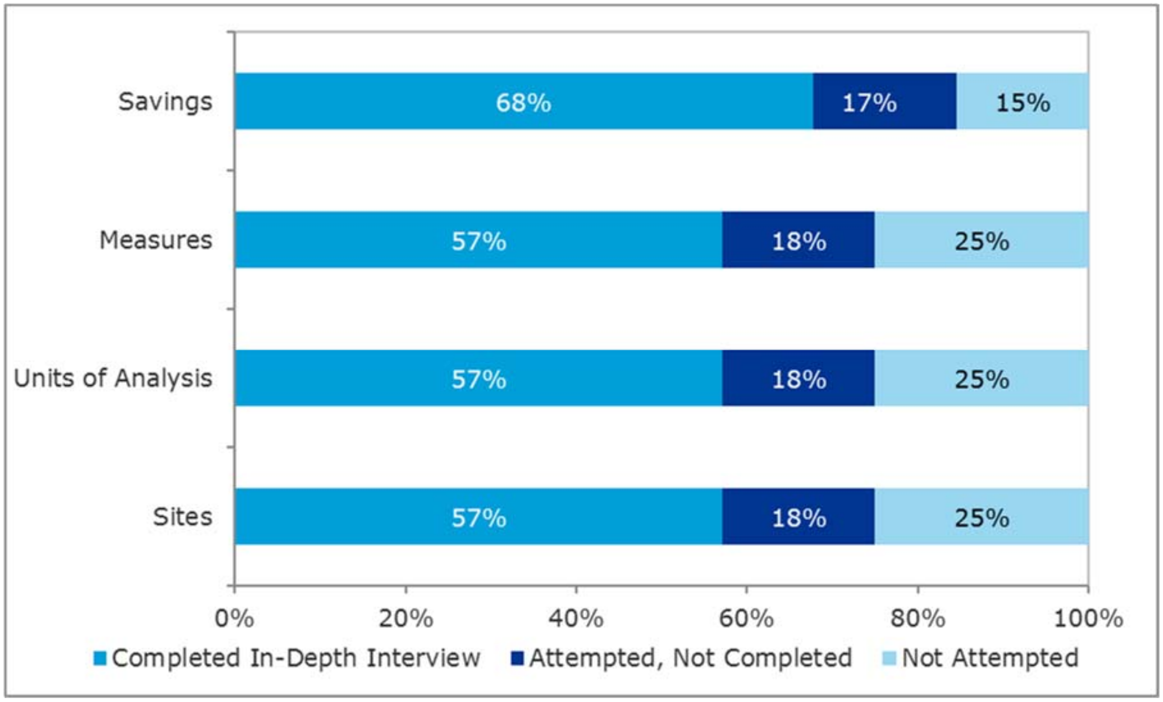
The study had a 58% customer response rate, reached the sample targets in two of three strata, and achieved a NTG ratio with absolute precision of +/-14% and relative precision of 27% at 90% confidence (shown in Table 6-2).

[21] Sites, measures, or units of analysis where contact was not attempted were either not selected for contact in sampling or in the backup sample and were not contacted due to strata quotas being met.

Table 6-1: Summary of NTG data collection for Enbridge RunitRight

Data Collection Category	Targeted	Completed			
	# Units of Analysis	# Sites	# Measures	# Units of Analysis	Ex Ante CCM
Completed In-Depth Interview	16	16	16	16	2,508,665
Attempted Contact, Not Completed		5	5	5	627,615
Not Attempted		7	7	7	569,850
Total		**28**	**28**	**28**	**3,706,130**

Figure 6-1: Summary of NTG data collection for Enbridge RunitRight



6.2.2 Free-ridership

Free-ridership is the sole contributor to the NTG ratio. The evaluation team is also conducting a study of the spillover savings attributable to the program; those results will be presented in a later report. The free-ridership is calculated from self-reported responses to survey questions as outlined in APPENDIX K**.**

Table 6-2 shows the NTG ratio by domain for the Enbridge RunitRight program. The table shows the number of units of analysis (n), NTG 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 RunitRight program overall had 50% attribution, or 50% free-ridership.

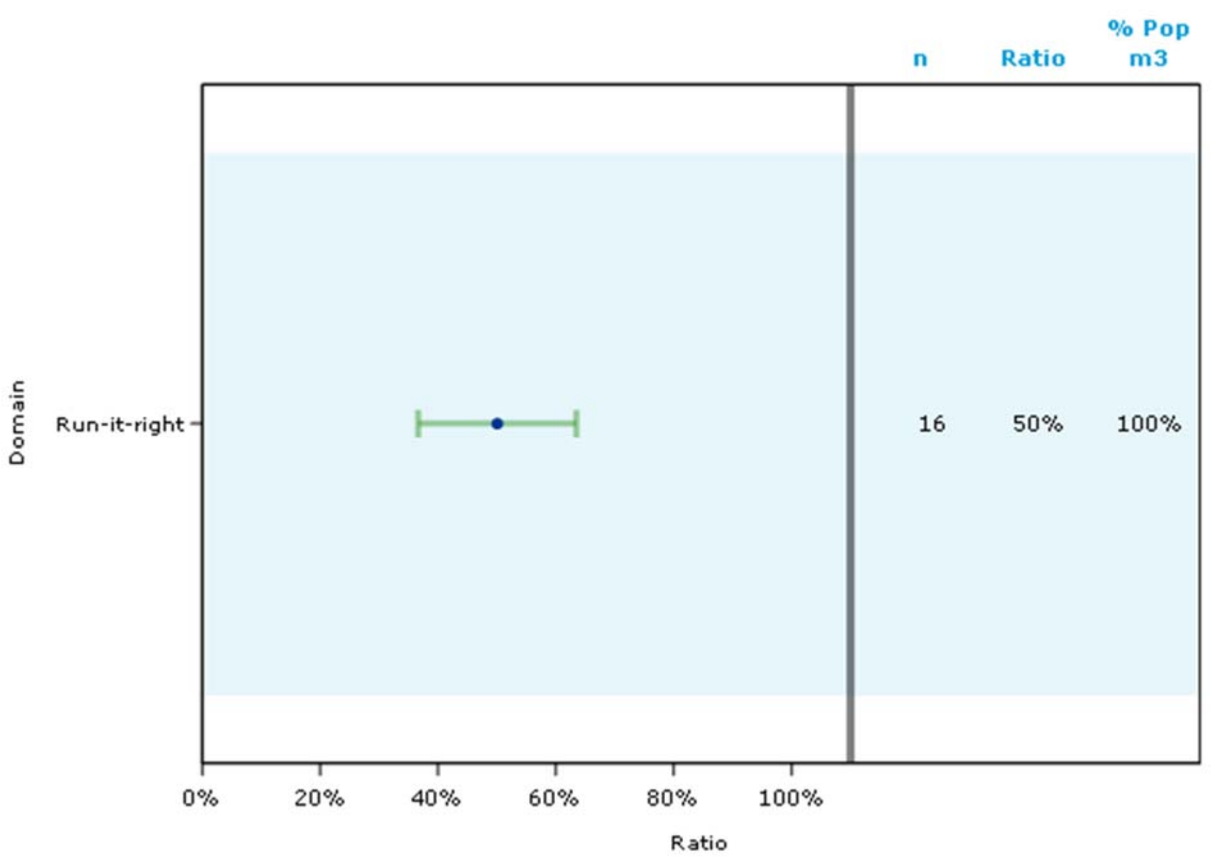
Table 6-2: NTG ratio for Enbridge RunitRight

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Customers		+ / -	Lower Bound	Upper Bound	Relative Precision		
RunitRight	16	10	50%	14%	36%	64%	27%	0.47	100%

APPENDIX M describes the criteria used for determining the domains used for ratio application and reporting.
Clusters reported in this table are unique customers per stratum: one customer may be in multiple strata, so the count of clusters is greater than the number of customers contacted.

Figure 6-2 also shows the NTG ratio for this program. The figure shows the ratio point estimate as a blue dot on the horizontal axis and the confidence interval as hashmarks connected by a green line. The number of units of analysis, numeric ratio, and percent of program savings represented by each domain are shown to the right of the plot. Attribution for the RunitRight program is higher than most of Enbridge's custom offerings, with the exceptions of Heat Recovery and Multi-Residential Other.

Figure 6-2: NTG ratio for Enbridge RunitRight



6.2.3 Sources of attribution

As outlined in APPENDIX K, the NTG ratio is a combination of responses regarding the program's influence on the timing, quantity, and efficiency of the measure implemented. Since most measures in the RunitRight program are a result of low cost/no cost operational improvements and re-commissioning which does not have its own inherent efficiency, the efficiency question was not asked for the participants of this program.

This section details the program's effect on each of those sources of attribution and indicates where the program is creating the greatest transformation.

Table 6-3 represents the possible combinations of timing and quantity attribution. A "yes" in the timing or quantity column indicates partial or full attribution for that source. A "no" indicates no attribution for that source. For example, the row that has Yes for timing and quantity reports the portion of the program that indicated that the program had at least partial influence on the timing and quantity for that measure.

The table also shows the number of customers, measures, and savings that fall into each combination. The portion of the program that falls into each combination of timing and quantity attribution is represented by the number of responses and the percent of cumulative savings represented by that category.

The table shows that all program participation was at least partially influenced by the program. The program affected the timing of all measures. It had a limited effect on quantity, influencing measures that accounted for approximately 7% of program savings.

Table 6-3. Overview of the sources of attribution for Enbridge RunitRight

Attribution					
Timing	**Quantity**	**Customers***	**Units of Analysis**	**Measures**	**Percent Savings**
Yes	**Yes**	*	*	*	7%
Yes	No	6	15	15	93%
No	**Yes**	0	0	0	0%
No	No	0	0	0	0%

A * refers to a category with fewer than 5 participants. These are not shown for customer privacy reasons.
A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.

6.2.3.1 Timing component

Respondents answered a sequence of questions that addresses the timing of the energy saving activities. First, respondents answered the likelihood of performing the energy saving activities at the same time without the program (DAT1a). Respondents who answered "Later" specified the number of months later in the next question (DAT1b). [22]

Timing was the component most strongly affected by the program. No customers indicated they would have completed the energy saving activities at the same time. Customers indicated that measures accounting for over a quarter of savings would not have been completed for four or more years and measures accounting for nearly an additional 59% of savings would have been completed within four years. The rest indicated that they didn't know when the measure would have been completed or refused to answer the question (Table 6-4).

Table 6-4. Determining the Acceleration period, Enbridge RunitRight

DAT1a. Without the utility, how different would the timing have been?						
DAT1b. Approximately how many months later?						
DAT1a	**DAT1b**	**Customers***	**Units of Analysis**	**Measures**	**Percent Savings**	**Timing Attribution**
Same Time	N/A	0	0	0	0%	0%
Earlier	N/A	0	0	0	0%	0%
Later	Months < 48	*	7	7	59%	ER baseline** credit for months accelerated
	Months ≥ 48	*	6	6	26%	100%+ ER baseline credit
	Don't Know/ Refused	*	*	*	7%	ER baseline credit for avg. of DAT1b
Never	N/A	0	0	0	0%	100%
Don't Know/ Refused	N/A	*	*	*	9%	ER baseline credit for avg. of DAT1a

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*A customer may appear multiple times if their responses varied by measures, resulting in a total greater than the number of customers interviewed.
**ER baseline credit reflects credit for a vs. in situ equipment baseline savings during the acceleration period.

6.2.3.2 Quantity Component

Respondents answered a sequence of questions that addresses the program's effects on the extent of energy savings activities taken. First, respondents answered the likelihood of performing the same amount of energy saving activities without the program (DAT3a). Respondents who answered that they would have done more answered a follow-up question (DAT3b) to specify how the program changed the amount of activity that they performed.

The program had a small effect on quantity. Respondents indicated that they would have performed the same amount of activity in measures that accounted for almost all (93%) of the program savings. For confidentiality reasons this table is not provided.

[22] See APPENDIX K for the detailed scoring algorithm.

6.3 Gross and net savings

The RunitRight program was not included in the CPSV portion of the study. This section reports the net savings (including only free-ridership) in section 6.3.1.

6.3.1 Net savings

The program-level net savings are determined by multiplying the verified savings by the NTG ratio within each primary reporting domain. Table 6-5 shows the tracking savings, NTG ratio, and final net savings. Dividing the overall net savings by the overall verified savings results in a program-level NTG ratio of 50%.

Table 6-5: Net savings for Enbridge RunitRight

Domain	Cumulative Tracking Savings (m^3)	NTG	Net Cumulative Savings (m^3)
RunitRight	2,712,210	50.06%	1,357,732

7 Findings and recommendations

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). Details of the findings, recommendations and outcomes follow the tables.

Table 7-1: Energy savings and program performance recommendations

#	Energy Savings and Program Performance Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
ES1	The utilities should continue in their commitment to accuracy.	✓	✓				✓	✓
ES2	Evaluate free-ridership for the programs annually and couple the free-ridership evaluation with process evaluation			✓		✓		
ES3	Error ratios from this report inform sample design for future evaluation.			✓	✓			✓
ES4	Align the program design with cumulative net goals	✓	✓			✓		
ES5	Do not pay incentives until after installation is complete.	✓	✓					✓
ES6	Develop policies to collaborate across electric and gas projects to avoid double-counting fuel savings and increases from energy efficiency measures.	✓	✓					✓
ES7	Consider establishing a policy to define rules around energy savings calculation for fuel switching and district heating/cooling measures.	✓	✓	✓				✓
ES8	Consider establishing a policy that defines an eligibility floor and cap based on simple payback period for energy efficiency projects.	✓	✓			✓		✓
ES9	Consider establishing an official definition for EUL and implementing a study to define EULs for program measures	✓	✓	✓				✓

#	Energy Savings and Program Performance Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
ES10	Track metrics for how long it takes from the final installation verification to the posting of incentive payments.	✓	✓				✓	
ES11	Increase transparency of "influence adjustments" and do not include in gross savings	✓				✓	✓	✓
ES12	Conduct a process evaluation to improve Large Volume influence on customer projects	✓				✓	✓	
ES13	Consider approaches to market that leverage third-party vendors.	✓	✓		✓	✓		

Table 7-2: Verification process recommendations

#	Verification Process Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
VP1	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.	✓	✓		✓			✓
VP2	The verification and utility staff should agree to a code of conduct for each role during onsite visits.	✓	✓	✓			✓	

Table 7-3: Documentation and Support recommendations

#	Documentation and Support Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DS1	Take steps to improve documentation: • 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	✓	✓			✓		✓
DS2	Ensure that incremental costs are supported by invoices or other documentation	✓	✓					✓
DS3	Increase the amount of documentation and source material for projects that have greater energy savings.	✓	✓					✓
DS4 A	Digitize and file project documentation for all projects as they are completed and paid during project closeout.	✓	✓		✓			✓
DS4 B	Until the utilities can implement an effective digital document storage process, the evaluation should allow more time for the utilities to assemble and deliver the documentation.			✓	✓			✓

#	Documentation and Support Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DS5	Consider providing more training or adding quality control steps to ensure the summary workbook front page is completed and stored in a consistent manner.	✓			✓			✓
DS6	Use a consistent summary workbook.		✓		✓			✓

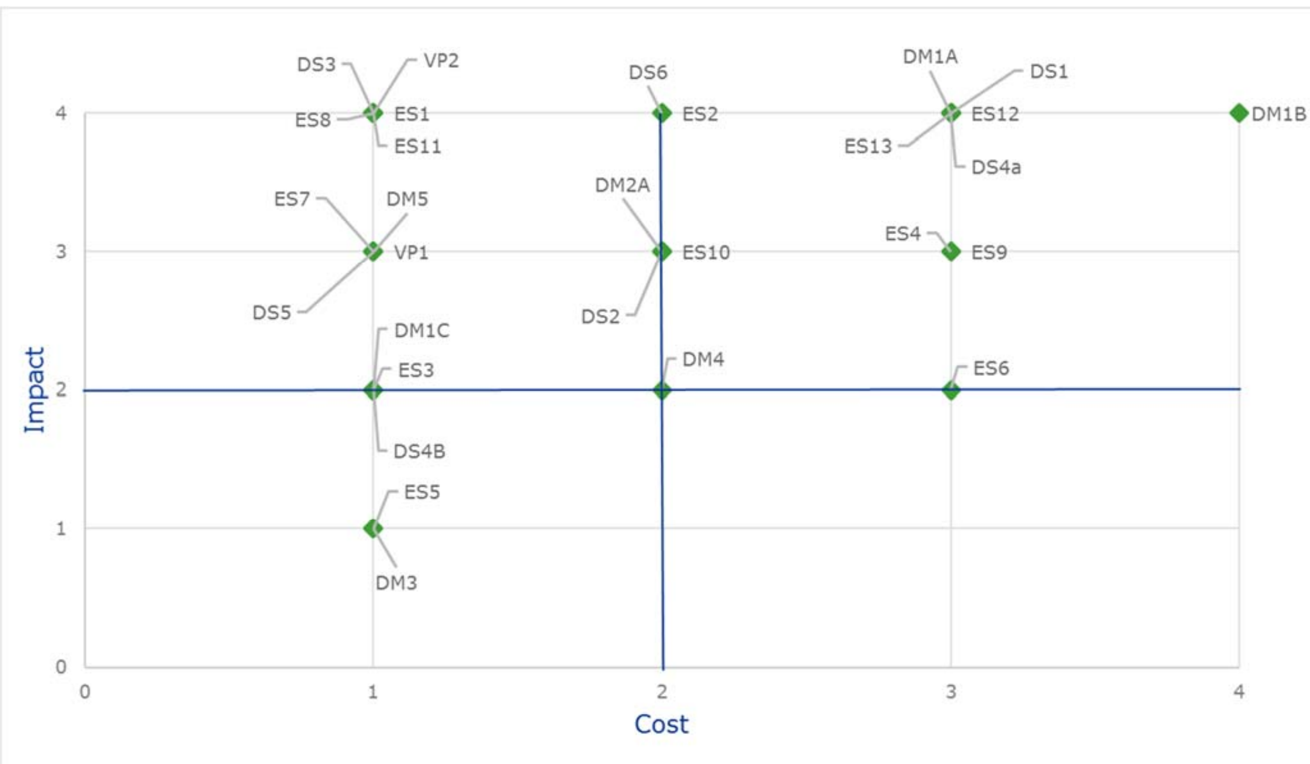
Table 7-4: Data management recommendations

#	Data Management Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DM1 A	Track contacts associated with projects in the program tracking database.	✓	✓		✓			✓
DM1 B	Strongly consider investing in relational program tracking databases.	✓	✓		✓			✓
DM1 C	Include structure for improved data integrity in the evaluator request for contact information for the 2016 and 2017 savings verification and evaluation.			✓	✓		✓	
DM2 A	Consider offering bonus incentives early in the year to combat the "hockey stick" phenomenon where a large percent of projects get closed in the fourth quarter of the year (which results in rushed QC for data).	✓	✓		✓			✓
DM3	Track and provide to evaluators dates for key milestones in the project.	✓	✓		✓			✓
DM4	Maintain a customer identifier in the database to clearly identify related sites.	✓	✓		✓		✓	

#	Data Management Recommendation	Applies to			Primary Outcome			
		Union	Enbridge	Evaluation	Reduce Costs	Increase Savings	Increase Customer Satisfaction	Decrease Risk
DM5	Include EUL (also remaining useful life for dual baselines), NTG, and each of the key savings types (i.e., annual and cumulative, gross and net) in the program tracking extracts provided to evaluators.	✓	✓			✓		✓

Figure 1-1 shows an approximate cost vs. impact relation ship for each of the recommendations on a 4-point scale. The upper left quadrant of the figure shows the recommendations that are relatively low cost that would have a high impact. Those in the upper right are recommendations where both cost and impact are high.

Figure 7-1: Approximate Cost vs. Impact of each recommendation



7.1 Energy savings and program performance

ES1. 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 understandings of their customers' building and process systems. We had numerous opportunities to interact with these engineers on phone calls and site visits, and have grown to respect their knowledge and engagement with the types of systems that matter to their customers.

Both utilities showed a commitment to finding accurate savings. 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 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.

ES2. Finding: Free-ridership in the utilities' programs is high

Recommendation: With high free-ridership and rapidly changing programs, consistent evaluation of free-ridership annually and free-ridership evaluation coupled with process evaluation will help identify specific ways for each program to manage and reduce free-ridership.

Outcome: Effective free-ridership management will allow the programs to increase their net savings significantly in future years.

ES3. Finding: Relative precision targets were exceeded for some programs and not met for others.

Recommendation: Error ratios from the results provided in this report should be used to inform sample design for future evaluation years.

Outcome: Better defined error ratios for the measures in the programs will allow more efficient sample design for future evaluations, improving precisions and reducing costs.

ES4. Finding: Attribution for the programs came primarily through acceleration rather than changes in efficiency or quantity/size. This is partly due to the measures that dominate the programs: controls, maintenance, and optimisation. These measures do not have varying efficiencies, so the programs are either affecting the number of units implemented or accelerating the measure. Acceleration is less valuable to programs that are seeking to meet cumulative net goals. Acceleration periods tend to be considerably shorter than the estimated useful life (EUL) of a measure and thus the partial attribution that results is low relative to cumulative gross savings.

Recommendation: To align the programs with cumulative net goals, the utilities should seek to:

- continue promoting long life measures and consider discontinuing promotion of short lived measures
- proactively upsell equipment purchases from standard to efficient products
- target hard to reach customers who have not participated in the past
- promote EE measures with low market penetration (such as heat reflector panels)

- motivate customers to increase the scope of their projects, some options include multi-measure bonuses or escalating incentive structures that pay more for doing more

Outcome 1: Focusing on proactive sales rather than reactive will help the net-to-gross (NTG) ratio.

Outcome 2: Effective free-ridership management will allow the program to increase net savings significantly in future years.

ES5. **Finding:** A handful (<5) of respondents indicated that all or part of their incentivized project had not yet been installed over a year after the incentive was paid.

Recommendation: Do not pay incentives until after installation is complete.

Outcome: Cost-effectiveness of the program will increase as it avoids paying for savings that do not materialize.

ES6. **Finding:** Some customers receive incentives from their electric provider and natural gas utility to complete the same EE measure. Both providers may claim the same changes in energy use, resulting in overlap when aggregated across fuels at the provincial level.

Recommendation: Develop policies to collaborate across electric and gas projects to avoid double-counting fuel savings and increases from energy efficiency measures.

Outcome: More accurate energy and carbon savings estimates across the province.

ES7. **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.

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

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

ES8. **Finding:** Projects with very long and very short simple payback periods often have low NTG ratios. However, from a customer service standpoint, it may be difficult for utilities to deny incentives to customers unless they have pre-established rules to point to.

Recommendation: Consider establishing a policy that defines an eligibility floor and cap based on simple payback period for energy efficiency projects.

Outcome: The rule will give utilities a guideline to restrict the program to projects that are more likely to result in net savings. It will also allow the utilities to reject potentially poor projects without a large effect on customer satisfaction.

ES9. **Finding:** Members of the EAC and evaluation team have different understandings of the definition of some evaluation inputs.

Recommendation: Consider establishing an official definition for EUL and implementing a study to define EUL for all measures, especially steam traps, pipe leaks, steam leaks, condensate leaks, and pipe insulation.

Outcome: The study will improve the accuracy of lifetime savings estimates.

ES10. Finding: A handful (<5) of sites reported unhappiness with delays in receiving their incentive payment (5 months).

Recommendation: Track metrics for how long it takes from the final installation verification to the posting of incentive payments. Consider holding program managers accountable to these metrics by considering them during performance reviews, building in performance bonuses if all payments are posted within one month, and/or implementing a penalty if it takes greater than three months to post any payments.

Outcome: Improved customer satisfaction.

ES11. Finding: Influence adjustments were made to projects that adjusted the gross savings for "net" or program influence reasons. Accounting of which projects had these adjustments was not maintained by the program and the adjustments were included in different places in project calculation workbooks, making their identification challenging. In addition, the program NTG was also applied to these projects, effectively double discounting savings in scorecards.

Recommendation: If the utility chooses to continue making influence adjustments to the savings upon which it calculates savings, these adjustments should be made more transparent and not included in 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.

ES12. Finding: Union's Large Volume program has a very high amount of free-ridership.

Recommendation: This evaluation did not include a process evaluation. Union should consider conducting a process evaluation focused on how to reduce the rate of free-ridership. Three options that the Union might consider are:

- Eliminate measure types with high free-ridership (Union indicated that most maintenance type measures were eliminated in 2016).
- Use an application process that includes a committee review that can reject free riders. This option is hard for utilities to manage as it can affect customer satisfaction negatively
- Clear payback criteria such as initial payback must be longer that X years and the incentive paid must reduce payback below Y years. This has the advantage of being a rule that account representatives can explain when talking to customers.
- Non-energy benefits of projects that large industrial customers gravitate to are often large compared to energy saving benefits, so simple payback criteria will not eliminate all free rider projects. Awareness of this issue should be promoted among the implementation team.

Outcome: Effective free-ridership management may allow the program to increase its net savings significantly in future years.

ES13. Finding: Vendor attribution did not increase overall program attribution significantly. Of the vendors that customers cited as influences, few indicated that either program had much effect on the projects.

Recommendation: The utilities should consider approaches to market that leverage third-party vendors. A process evaluation that includes vendor interviews might uncover opportunities.

Outcome: Effective leveraging of vendors could both increase NTG ratios and increase program uptake.

7.2 Verification processes

VP1. 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 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 states: 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 states: 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.

VP2. Finding: Verification engineers and verification forms caused confusion with site contacts and the length of visits also led to a handful of customer complaints. Utility staff at a handful of sites responded to questions in place of participating customers and in one case interfered with data collection.

Recommendation: The verification and utility staff should agree to a code of conduct for each role. The teams should receive clear direction as to the dos and don'ts of all parties involved in site visits, including both verification engineers and utility staff should they attend the visit. Open lines of communication between the site team and utility staff should be maintained to reduce misunderstandings and ensure that the teams are on the same page as to each other's role.

In general, the following should be part of standard verification practices:

- Ensure site engineer reviews final site report for accuracy post-audit.
- Align data collection forms with site report structure to reduce communication and transcription errors.
- Ensure data appropriate to determining EUL is collected while on-site (i.e., make EUL determination a primary, rather than secondary focus).
- Request specific documentation or data from systems prior to site visit (allowing for adequate time for site contact to obtain).

Outcome: Improved data collection and customer satisfaction.

7.3 Documentation and support

DS1. Finding: 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
- Energy intensity changes presented without providing the data to justify it
- 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
- Scanned documents that were unreadable
- Input adjustments that approximate other effects, but are not explained
- Insufficient access to customer data (by customers) for confidentiality reasons.
- 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
- Etools files not provided for many industrial boiler & boiler add-on projects

Recommendation: Several steps could be taken to improve data quality:

- 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.

DS2. Finding: Invoices were not always included with documentation, and we saw a handful (<5) of cases where utility program staff were overclaiming incremental costs. This did not appear to be systemic, but higher incremental costs enable payment of a larger incentive.

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.

DS3. **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%.

DS4. **Finding:** Enbridge did not maintain complete digital project files prior to the evaluation request. Union appeared to have digital documentation that was not completely assembled prior to evaluation.

Recommendation A: Digitize and file project documentation for all projects as they are completed and paid during project closeout. PDF and Excel files associated with a project should be stored in a way that allows them to be easily found and associated with a specific project and/or customer. The best practice is to include a document repository as part of the program tracking system with a separate folder for each project.

Recommendation B: Until the utilities can implement an effective digital document storage process, the evaluation should allow more time for the utilities to assemble and deliver the documentation.

Outcome: In our experience, DSM programs that store complete and well-organized digital records experience less evaluation risk. In other words, their gross savings adjustments are closer to 100%. This happens for three reasons:

- Digitization facilitates internal review of project documentation, providing additional opportunities to identify missing information and errors
- Assembly during project closeout improves the comprehensiveness of the documentation because less time has elapsed than if it was assembled for evaluation, so less information is lost or forgotten

Easy retrieval makes it more likely that the complete file is sent to the evaluation team, reducing the information gap between implementation and evaluation.

DS5. **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. 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.

DS6. **Finding:** The 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.

7.4 Data management

DM1. **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 put significant burden on utility staff. When contact information was provided, there were significant data integrity issues including contacts listed in the wrong places, partial addresses, and incorrect or missing phone numbers and email addresses.

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.

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. This allows programs to easily clarify aspects of projects during implementation and to provide accurate, timely, and usable contact information to evaluators and verifiers. 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 B: 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 C: For 2016 (and perhaps 2017), we do not anticipate that contact information will have been entered into the program tracking databases. When the evaluation requests contact information for the 2016 and 2017 savings verification and evaluation, the contact request spreadsheet will be updated 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).

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.

DM2. Finding: Both utilities have indicated that inputting and/or extracting data necessary for annual reporting and evaluation requires significant effort.

Recommendation A: Consider offering bonus incentives early in the year to combat the "hockey stick" phenomenon where a large percent of projects get closed in the fourth quarter of the year.

Outcome: Reduced burden on program staff, more consistency in meeting annual filing deadlines.

Recommendation B: See recommendation DM1B. The utilities should consider investing in a new database.

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

DM3. 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 "installation 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.

DM4. Finding: Customers with multiple sites are not tracked in the program tracking database. A few property management groups had many sites selected in the sample, but it was not clear from project tracking or the provided contact information that the sites were related. Property management firms were the most significant but not the only customer type where this was true.

Recommendation: Maintain a customer identifier in the database to clearly identify related sites. This is easiest to deploy in a relational database see recommendation DM1B.

Outcome: Reduced evaluation costs and reduced customer burden. In some cases, a failure to identify related sites can result in multiple calls to the same customer, which a customer identifier would avoid. In addition, tracking related sites could improve program implementation by increasing awareness of connected opportunities.

DM5. Finding: EUL and cumulative gross savings were not provided in the standard program tracking database extracts. The evaluation team backed out the missing information from the fields provided.

Recommendation: Include EUL (also remaining useful life for dual baselines), NTG, and each of the key savings types (i.e., annual and cumulative, gross and net) in the program tracking database.

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.

8 APPENDICES

APPENDIX A. FINAL SAMPLE ACHIEVEMENT

The tables below (Table 8-1 to Table 8-7) show the achieved sample for each stratum in the sample designs. The tables are specific to a program group and show the categorical stratification (grouping) and size strata (larger numbers are bigger projects). Sampling was done at the unit of analysis level which was a slight aggregation of the measures in the data base. The target column shows the number of units we attempted to complete. "Normal completes" were randomly selected and received a full sample weight, while "extra completes" were non-random measures that we collected data on while collecting data for a selected unit. "Extra completes" were unit weighted (given a weight of 1) so that they only represent themselves in the sample expansion. The strata status indicates whether additional units were not attempted in a strata (open) or we attempted to contact all units (closed). Percent of frame cumulative savings is the percent of total savings in the sample frame (population studied) in each category.

Table 8-1: CPSV Sample Achievement for Union Custom C&I and LIMF programs

Grouping			Max CCM Savings	Units of Analysis					Percent of Frame CCM Savings				Strata Status
					Complete			Frame Total	Strata %	% Complete			
				Target	Total	Normal	Extra			Total	Normal	Extra	
Commercial	Action	On-site	19,910,861	3	3	3	0	7	3%	<1%	<1%	0%	Closed
			31,595,400	1	1	1	0	1	2%	2%	2%	0%	Closed
		TSER	6,237,000	3	4	4	0	13	1%	<1%	<1%	0%	Open
	Equipment	On-site	2,419,140	3	7	4	3	104	1%	<1%	<1%	<1%	Open
			20,369,040	3	3	3	0	4	3%	2%	2%	0%	Closed
			76,886,900	1	1	1	0	1	5%	5%	5%	0%	Closed
		TSER	2,453,080	3	5	4	1	42	1%	<1%	<1%	<1%	Open
	Multi-family	On-site	1,008,360	1	0	0	0	5	<1%	0%	0%	0%	Open
			5,093,140	1	1	1	0	1	<1%	<1%	<1%	0%	Closed
		TSER	44,260	1	0	0	0	1	<1%	0%	0%	0%	Closed
Industrial	Action	On-site	14,670,829	6	8	8	0	21	5%	2%	2%	0%	Open
		TSER	20,817,671	3	5	4	1	44	7%	1%	1%	<1%	Open
	Equipment	On-site	6,027,660	6	21	6	15	104	12%	3%	<1%	3%	Open
			20,887,330	5	9	6	3	22	16%	6%	4%	2%	Open
			67,233,620	5	5	4	1	9	23%	12%	9%	3%	Open
			88,336,980	1	1	1	0	1	6%	6%	6%	0%	Closed
		TSER	2,082,190	4	7	2	5	91	3%	<1%	<1%	<1%	Open
			11,662,800	4	5	4	1	19	5%	2%	1%	<1%	Open
			41,029,840	1	1	1	0	1	3%	3%	3%	0%	Closed
Low Income	Multi-family	On-site	20,865	1	1	1	0	1	<1%	<1%	<1%	0%	Closed
			1,433,430	1	1	1	0	1	<1%	<1%	<1%	0%	Closed
		TSER	621,180	3	3	3	0	35	<1%	<1%	<1%	0%	Open

Table 8-2: CPSV Sample Achievement for Union Large Volume

Grouping			Max CCM Savings	Units of Analysis					Percent of Frame CCM Savings				Strata Status
				Target	Complete			Frame Total	Strata %	% Complete			
					Total	Normal	Extra			Total	Normal	Extra	
Large Volume	Action	On-site	13,696,893	4	17	17	0	28	10%	7%	7%	0%	Closed
			60,858,260	3	6	6	0	6	17%	17%	17%	0%	Closed
			63,059,180	1	1	1	0	1	5%	5%	5%	0%	Closed
	Equipment	On-site	19,498,030	4	13	10	3	25	9%	6%	4%	2%	Open
			36,699,320	3	3	3	0	5	11%	7%	7%	0%	Closed
			63,342,400	3	2	2	0	4	16%	9%	9%	0%	Closed
			179,561,960	3	2	2	0	3	31%	17%	17%	0%	Closed

Table 8-3: CPSV Sample Achievement for Enbridge Custom C&I and LIMF programs

Grouping			Max CCM Savings	Units of Analysis					Percent of Frame CCM Savings				Strata Status
				Target	Complete			Frame Total	Strata %	% Complete			
					Total	Normal	Extra			Total	Normal	Extra	
Commercial	Action	On-site	568,750	2	2	2	0	2	<1%	<1%	<1%	0%	Closed
			10,213,885	1	1	1	0	1	1%	1%	1%	0%	Closed
		TSER	531,630	4	2	2	0	24	<1%	<1%	<1%	0%	Open
	Equipment	On-site	2,231,300	4	8	4	4	50	2%	<1%	<1%	<1%	Open
			7,735,530	4	7	7	0	8	4%	3%	3%	0%	Closed
			9,501,060	1	0	0	0	1	1%	0%	0%	0%	Closed
		TSER	1,594,225	5	3	3	0	265	10%	<1%	<1%	0%	Open
			11,081,850	5	3	3	0	28	17%	3%	3%	0%	Open
	Multi-Residential	On-site	2,702,600	5	7	4	3	53	3%	<1%	<1%	<1%	Open
		TSER	1,032,930	4	5	2	3	139	6%	<1%	<1%	<1%	Open
			4,357,525	4	7	5	2	36	9%	2%	1%	<1%	Open
Industrial	Action	On-site	424,835	3	3	3	0	8	<1%	<1%	<1%	0%	Open
			1,059,870	3	3	3	0	4	<1%	<1%	<1%	0%	Closed
			12,988,135	1	1	1	0	1	1%	1%	1%	0%	Closed
		TSER	799,210	3	3	3	0	7	<1%	<1%	<1%	0%	Open
			2,935,575	1	1	1	0	1	<1%	<1%	<1%	0%	Closed
	Equipment	On-site	2,716,060	4	12	4	8	47	5%	1%	<1%	1%	Open
			6,197,900	4	7	6	1	13	6%	3%	3%	<1%	Open
			19,604,220	4	6	6	0	7	9%	8%	8%	0%	Closed
			49,314,000	3	2	2	0	3	12%	8%	8%	0%	Closed
		TSER	3,332,925	5	5	4	1	24	3%	<1%	<1%	<1%	Open
			20,592,275	1	1	1	0	1	2%	2%	2%	0%	Closed
Low Income	Multi-Residential	On-site	1,922,580	2	2	2	0	6	<1%	<1%	<1%	0%	Open
		TSER	3,548,480	6	7	5	2	104	7%	<1%	<1%	<1%	Open

Table 8-4: NTG Sample Achievement for Union Custom C&I programs

Grouping			Max CCM Savings	Units of Analysis					Percent of Frame CCM Savings				Strata Status
				Target	Complete			Frame Total	Strata %	% Complete			
					Total	Normal	Extra			Total	Normal	Extra	
Commercial	Action	On-site	19,910,861	4	6	6	0	7	3%	3%	3%	0%	Closed
			31,595,400	1	1	1	0	1	2%	2%	2%	0%	Closed
		TSER	6,237,000	6	4	4	0	13	1%	<1%	<1%	0%	Open
	Equipment	On-site	2,419,140	9	20	14	6	104	1%	<1%	<1%	<1%	Open
			20,369,040	4	4	4	0	4	3%	3%	3%	0%	Closed
			76,886,900	1	1	1	0	1	5%	5%	5%	0%	Closed
		TSER	2,453,080	5	7	6	1	42	1%	<1%	<1%	<1%	Open
	Multi-family	On-site	1,008,360	2	1	1	0	5	<1%	<1%	<1%	0%	Open
			5,093,140	1	1	1	0	1	<1%	<1%	<1%	0%	Closed
		TSER	44,260	1	0	0	0	1	<1%	0%	0%	0%	Closed
Industrial	Action	On-site	14,670,829	7	12	12	0	21	5%	4%	4%	0%	Open
		TSER	20,817,671	4	6	5	1	44	7%	1%	1%	<1%	Open
	Equipment	On-site	6,027,660	13	45	20	25	104	12%	6%	3%	3%	Open
			20,887,330	12	17	17	0	22	16%	14%	14%	0%	Closed
			67,233,620	9	7	7	0	9	24%	16%	16%	0%	Closed
			88,336,980	1	1	1	0	1	6%	6%	6%	0%	Closed
		TSER	2,082,190	5	10	4	6	91	3%	<1%	<1%	<1%	Open
			11,662,800	4	6	5	1	19	5%	2%	1%	<1%	Open
			41,029,840	1	1	1	0	1	3%	3%	3%	0%	Closed

Table 8-5: NTG Sample Achievement for Union Large Volume

Grouping			Max CCM Savings	Units of Analysis					Percent of Frame CCM Savings				Strata Status
				Target	Complete			Frame Total	Strata %	% Complete			
					Total	Normal	Extra			Total	Normal	Extra	
Large Volume	Action	On-site	13,696,893	5	22	22	0	28	10%	9%	9%	0%	Closed
			60,858,260	4	5	5	0	6	17%	16%	16%	0%	Closed
			63,059,180	1	1	1	0	1	5%	5%	5%	0%	Closed
	Equipment	On-site	19,498,030	10	15	14	1	25	9%	6%	6%	<1%	Open
			36,699,320	5	4	4	0	5	11%	9%	9%	0%	Closed
			63,342,400	4	4	4	0	4	16%	16%	16%	0%	Closed
			179,561,960	3	2	2	0	3	31%	17%	17%	0%	Closed

Table 8-6: NTG Sample Achievement for Enbridge Custom C&I programs

Grouping			Max CCM Savings	Units of Analysis					Percent of Frame CCM Savings				Strata Status
				Target	Complete			Frame Total	Strata %	% Complete			
					Total	Normal	Extra			Total	Normal	Extra	
Commercial	Action	On-site	568,750	2	2	2	0	2	<1%	<1%	<1%	0%	Closed
Commercial	Action	On-site	10,213,885	1	1	1	0	1	1%	1%	1%	0%	Closed
Commercial	Action	TSER	531,630	4	3	2	1	24	<1%	<1%	<1%	<1%	Open
Commercial	Equipment	On-site	2,231,300	13	18	17	1	50	2%	1%	1%	<1%	Open
Commercial	Equipment	On-site	7,735,530	8	8	8	0	8	4%	4%	4%	0%	Closed
Commercial	Equipment	On-site	9,501,060	1	1	1	0	1	1%	1%	1%	0%	Closed
Commercial	Equipment	TSER	1,594,225	17	14	11	3	265	11%	<1%	<1%	<1%	Open
Commercial	Equipment	TSER	11,081,850	17	9	9	0	28	18%	5%	5%	0%	Open
Commercial	Multi-Residential	On-site	2,702,600	8	13	9	4	53	3%	<1%	<1%	<1%	Open
Commercial	Multi-Residential	TSER	1,032,930	10	7	6	1	139	7%	<1%	<1%	<1%	Open
Commercial	Multi-Residential	TSER	4,357,525	9	7	6	1	36	9%	2%	2%	<1%	Open
Industrial	Action	On-site	424,835	4	3	3	0	8	<1%	<1%	<1%	0%	Closed
Industrial	Action	On-site	1,059,870	3	1	1	0	4	<1%	<1%	<1%	0%	Closed
Industrial	Action	On-site	12,988,135	1	1	1	0	1	2%	2%	2%	0%	Closed
Industrial	Action	TSER	799,210	3	4	4	0	7	<1%	<1%	<1%	0%	Open
Industrial	Action	TSER	2,935,575	1	1	1	0	1	<1%	<1%	<1%	0%	Closed
Industrial	Equipment	On-site	2,716,060	7	15	9	6	47	6%	2%	1%	1%	Open
Industrial	Equipment	On-site	6,197,900	7	9	9	0	13	6%	4%	4%	0%	Closed
Industrial	Equipment	On-site	19,604,220	7	6	6	0	7	9%	8%	8%	0%	Closed
Industrial	Equipment	On-site	49,314,000	3	3	3	0	3	13%	13%	13%	0%	Closed
Industrial	Equipment	TSER	3,332,925	5	8	6	2	24	3%	1%	<1%	<1%	Open
Industrial	Equipment	TSER	20,592,275	1	1	1	0	1	3%	3%	3%	0%	Closed

Table 8-7: NTG Sample Achievement for Enbridge RunitRight

Grouping			Max CCM Savings	Units of Analysis					Percent of Frame CCM Savings				Strata Status
				Target	Complete			Frame Total	Strata %	% Complete			
					Total	Normal	Extra			Total	Normal	Extra	
Run-it-right	Action	IDI	170,060	8	9	9	0	19	14%	20%	20%	0%	Open
Run-it-right	Action	IDI	208,725	5	3	3	0	5	34%	21%	21%	0%	Closed
Run-it-right	Action	IDI	700,715	4	4	4	0	4	52%	52%	52%	0%	Closed

APPENDIX B. SPECIFIC TOPIC METHODS

General topics

Multiple topics came up during the evaluation that required methodological decisions. These included:

- Codifying and clarifying standard or best practices for:
- Baselines
- EULs
- Determination of industry standard practice for measures and sectors that lack a known, researched standard and code requirements for key equipment (e.g.: greenhouses)
- Whether to use a dual baseline for early replacement measures.

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.

Measure categories and baseline selection

Table 8-8shows 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.

Table 8-8 General Baseline Appropriateness Guidelines

Measure Type	Gross Savings, based on remaining useful life from facility contact and documentation		Examples	Net Savings, based on acceleration period identified in the NTG surveys.	
	Early Replacement Baseline	Normal Replacement Baseline		Net: Acceleration Period Baseline	Net: Post Acceleration-Period Baseline
Replace on Burnout (ROB) and Existing Equipment More Efficient than Code	NA	In-Situ (must use the original specified rating as brand new non-degraded equipment, or a comparable brand with new theoretical baseline)	Unique measures where no code/Industry Standard Practice (ISP) exists; Drum Dryers	NA	In-Situ (must use the original specified rating as brand new non-degraded equipment, or a comparable brand with new theoretical baseline)
Replace on Burnout (ROB) and Existing Equipment Less Efficient than Code	NA	Code/Standard Market Efficiency	Replacing a 40-year-old boiler; Replacing anything beyond its EUL	NA	Code/Standard Market Efficiency
New Construction/Load (NC)/ Capacity Expansion (CE)	NA	Code/Standard Market Efficiency	New boiler for new space or system (80 commercial or 82% Industrial/Agricultural; specify the minimum). Any new construction or natural gas load adding/increasing.	NA	Code/Standard Market Efficiency
Retrofit Add On (REA)	In-Situ	In-Situ (unless the retrofit triggers code[23])	Boiler controls; HVAC controls; Flue gas controls; VFDs; Heat recovery; Addition of boiler economizer (such new HX, not replaced HX); Insulation (where truly no prior insulation existed, or the insulation is added on new pipes/tanks/equipment less than 1 year old; for the latter, ISP/code for NC would be valid measure type and not REA.	In-Situ (unless the retrofit triggers code)	In-Situ (unless the retrofit triggers code)
Normal Replacement (NR) and Existing Equipment **More** Efficient than Code	In-Situ	In-Situ (must use the original specified rating as brand new non-degraded equipment, or a comparable brand with new theoretical baseline)	Similar examples as ROB, except the equipment was past EUL but in good operating condition; Greenhouse components –Example: A site originally had double-layer polyethylene walls (that degraded) and 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-Situ	In-Situ (must use the original specified rating as brand new non-degraded equipment, or a comparable brand with new theoretical baseline)
Normal Replacement (NR) and Existing Equipment **Less** Efficient than Code	In-Situ	Code/Standard Market Eff.	Similar to ROB, except the equipment was past EUL but in good operating condition; Regenerative Thermal Oxidizer (RTO) – required to meet local air quality emissions requirements, that a recuperative or direct-fired oxidizer cannot achieve. Greenhouse components such as single layer heat curtains, which might be ISP, but ex ante is using no heat curtain as the baseline.	In-Situ	Code/Standard Market Eff.

[23] Larger retrofits often require related systems or spaces to be brought up to code as part of the project

Measure Type	Gross Savings, based on remaining useful life from facility contact and documentation		Examples	Net Savings, based on acceleration period identified in the NTG surveys.	
	Early Replacement Baseline	Normal Replacement Baseline		Net: Acceleration Period Baseline	Net: Post Acceleration-Period Baseline
Maintenance (Including Repair or Maintain to Code or Restoration to Prior Efficiency Level)	In-Situ	In-Situ	Maintenance allowed in the 2015 program: pipe insulation of existing pipes. Re-tube boilers to rated efficiency levels; Repair heat exchanger; Replace heat exchanger oil; Rewind motors; Repair or Replace faulty/leaking valves, pipes, ductwork, etc.; Descale or clean boiler tubes; Clean gas burners; Re-pipe condensate return lines. Typically allowed maintenance: steam trap repairs, boiler tune-ups.	In-Situ	In-Situ
System Optimization (OPT)	In-Situ	In-Situ	VALID SYSTEM OPTIMIZATION: Revamp Process Control Strategy; De-bottlenecking to increase production and m^3/widget; Modifying the sequence of processes.	In-Situ	In-Situ

Estimated useful life

The EUL of the new measure applied to the following categories of measures:

- Replace on Burnout
- New Construction (NC)/Capacity Expansion (CE)
- Normal Replacement (NR)
- Early Replacement (ER)

We based EULs on those found in the OEB Measure Life Guide,[24] when present and reasonable. When EULs were not present in the OEB Measure Life Guide, we EULs on those used in other North American jurisdictions. In rare cases, manufacturer information may 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).

[24] Union Gas Limited, Enbridge Gas Distribution Inc. (2016, December 21). EB-2016-0246 Joint Summary Table of Measures Assumptions. Toronto.

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.

The list of questions included:

1. What was the age of the pre-existing equipment? (In years)
2. Was the pre-existing equipment fully functional, fully functioning but with significant problems, or non-functional?

   At the time the pre-existing equipment was replaced,

3. How often was maintenance required and of what type? How often was major non-scheduled maintenance required and of what type?
4. Can you provide recent/historical maintenance records?
5. How often did the old equipment fail (downtime for the past year), and how was this (downtime) compared to previous years?
6. How satisfactory was the performance of the old equipment?
7. How long would the old equipment have met the technical and performance needs of the facility?
8. How many years do you think the old equipment would have lasted (without major repairs which may have led to replacement)?

In a limited number of cases RUL of existing equipment could not be determined based on site contact provided information or project documentation. In these cases, a default RUL was required. The default RUL for existing equipment was one-third the EUL for new equipment of the same type (consistent with the CA DEER approach). The default applied if:

- the existing equipment was older than the EUL of new equipment of the same type as existing, AND
- existing equipment was fully functional AND
- the information provided by the site contact was insufficient to make a reasonable RUL determination

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.

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 teams 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 utilities concern with free ridership and represented a proactive way of addressing it.

Inclusion of the influence factors created a dilemma for the evaluation team. Gross savings are not discounted for program influence and are meant to represent the savings that are happening at customer sites relative to those sites not installing efficient measures or taking efficient actions. Inclusion of an influence factor in gross savings muddies this interpretation. Further the inclusion of the influence factor in gross savings complicates the analysis of evaluated net savings and the NTG ratio. When asking customers about their projects, customers will not be thinking of the portion the program claimed, they will instead be considering the project as a whole. To correctly estimate net savings for the project the evaluation needed to adjust gross savings to remove the influence factors.

Steam traps

The CPSV team used a six (6) year EUL for these measures. 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).[25]

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.

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

[25] Massachusetts 2013 Prescriptive Gas impact Evaluation. Prepared by DNVGL for Massachusetts Gas Program Administrators and Massachusetts Energy Advisory Council, June 2015.

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 to 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.

Enbridge topics

Enbridge specific topics that required significant decisions during the verification included evaluation approach to boilers and steam traps.

Boilers

For the 2015 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.

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, 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. FREE-RIDERSHIP SURVEY RESPONSES

Union Commercial, Industrial and Multi-Family Programs

This section presents the Union Commercial and Industrial self-reported responses from the timing, efficiency, and quantity attribution battery where customers were asked "Why do you say that?". Table 8-9, Table 8-10, and Table 8-11.

A "yes" in the timing, efficiency, or quantity column indicates partial or full attribution for that source based on the scored questions (not the responses here). A "no" indicates no attribution for that source. For example, in the first table a "yes" in the timing column indicates that the respondent answered the question DAT1a and DAT1b with responses that credited the program with accelerating the project. A "no" in the timing column indicates that the respondent did not credit the program with accelerating the project. A "no" for timing does not preclude the same respondent indicating the program affected the efficiency or quantity/size of the same project.

Additionally, following the specific timing, efficiency and quantity questions, customers were asked to summarize the program's effect on the timing, efficiency and amount of the project installed (Dat4). These responses are presented in Table 8-12 with the scored level of attribution: full, partial, or none.

None of the responses provided below were used in the direct scoring of surveys. For respondent confidentiality these responses are isolated from other responses from the interview and do not reflect the full story the respondent conveyed. The responses are provided here to provide insight into how customers describe their decision making on the project relative to the program. See APPENDIX J and APPENDIX K for details on how attribution was scored.

Table 8-9: Timing Verbatim Responses Union Custom C&I programs

Timing	Dat1a_O. Why do you say that?
Yes	***** would've happened more piecemeal but would've happened; ***** had to be done immediately
Yes	2 more years.
Yes	At some point in time we would have learned the value of this and done it.
Yes	Because without the incentive other projects would have become a higher priority.
Yes	Didn't know about the associated energy savings, but once the Union Gas rep showed us savings calculations we did it right away. Hope we would have done this anyways down the road.
Yes	Everything boils down to economics, what it costs us to do, what the paybacks are.
Yes	Funding.
Yes	Funding was tight.
Yes	He never thought of this before.
Yes	He wouldn't have known about it. They would have kept going through the plant a piece at the time.
Yes	Highly likely that there was a 0% chance that we would have done anything.
Yes	If we didn't have incentives, we would only do this work every 2 years (instead of every year).
Yes	Incentive helps us make the decisions faster and invest in new tech sooner with more confidence.
Yes	Incentives allowed for us to complete the project sooner than if we had to wait for the budget.
Yes	It depends on how energy costs go. It was 3 years pushing it.
Yes	It depends on what portion of the production process run as to whether it would have been viable to do.
Yes	It's one of those things that you put on a list and OK, we'll do it sometime, but it might be 5 years or 3 years. Hard to say.
Yes	May have done it the next year without incentives. Hard to say if upper management would have approved.
Yes	Once you commit to this infrastructure, you're committed. So it’s a conversation about rate of return for shareholder purposes; if we said we wanted to do this and didn’t incorporate a potential grant then the IRR isn’t there.
Yes	The payback was too long.
Yes	The program did affect it a little bit, and made me do it a little sooner.
Yes	Realized inefficiency due to existing seals, but utilities encouraged us to do the work right away.
Yes	Some sections would have been done later due to cost.
Yes	They do things that save money.
Yes	They weren't going to be making the ROI at that point in time. Would have had a harder time selling to the board.
Yes	Utilities encouraged us to do the work, otherwise would not have identified the opportunity.
Yes	We were not aware of the steam traps.
Yes	We would have gone ahead with the less efficient design we already had in place.
Yes	Without the program we would have likely only fixed large leaks. Small leaks would have been fixed later.
Yes	Would have done some at the same time, but would have taken longer to complete the remainder.
Yes	It all depends on the payback.
Yes	Their assistance enabled us to get the calculations and get that info to the production department and would’ve been much harder to get numbers to justify the project.
Yes	We would have broken it up into smaller projects without the program. On as-needed basis.
Yes	Finances would've been harder to come by.
Yes	If payback was more than 2 years they wouldn't have done it.
Yes	It went with the same project as *****, but might have been even longer maybe a couple of years.
Yes	It would take us forever; we will always be *****, would never get them all done.
Yes	Payback wouldn't have worked out.
Yes	Probably would never have done it; if so, maybe a couple of years.
Yes	The program prompted us to think about things that we wouldn’t have thought about otherwise.
Yes	It would have taken longer to get approval.
Yes	The program educated them about the opportunity for savings; so they did this sooner than they would've otherwise.
Yes	The rebates help the ROI and increases the chances the ***** will approve; they would've done this eventually.
Yes	They will wait to replace something until they really have to unless it's a health and safety issue.
Yes	They would've had to do these eventually.
Yes	Tough question - It's possible that we just would have done nothing at all. Maybe fewer if we did.

Timing	Dat1a_O. Why do you say that?
Yes	Without the incentive same time, without the program never because they told us to do it.
Yes	Without the incentive the payback would've been longer, so it would've take a longer time.
Yes	We would have done it anyway, but taken thru 2020; some of it was insulated with insulation ***** years old.
Yes	We would have gone with standard *****.
Yes	We would have had to replace anyway.
Yes	We would have taken 2 years instead of 1, so it would double the time.
Yes	We wouldn't have even done it; been working 5 years with issues and still had no plans to replace it. Reviews of steam losses with Union gas helped us push it forward.
Yes	No comment.
No	***** were overdue for replacement - needed to be done regardless.
No	All of the overlap from the rest of construction.
No	As a company, they're looking at energy efficiency. They seek these opportunities. The incentive was not high enough to drive this.
No	At the beginning, it was more important as we got more of an incentive, but now it's as important because people already understand the value of this type of project. By 2015 we were already set, so it didn't affect time frame; in 2008-11 it was important.
No	Because of the window of opportunity (seasonal availability and had to do it then).
No	Because the project was going ahead. We needed the building built. It might have impacted what equipment was being installed in the building.
No	Cheaper, easier decision, still easy to pursue in absence of incentive and program support.
No	Company felt this was a necessary project, so incentive had little influence.
No	Decision driven by equipment failure. Also I'm an energy guy, so we were motivated irrespective of Union Gas program. Incentive helps a bit to convince CFO but would have happened anyway.
No	Dictated by size of project.
No	Did this work before we knew it qualified for incentives.
No	Driven by the need *****.
No	He needed the boiler.
No	High ROI (under 1 year).
No	High maintenance and I had to change the unit.
No	I don't run my business based on a rebate program that is peanuts to my business.
No	I don't think it would have made a difference.
No	If we would have known about the program, we probably would have done it earlier.
No	Incentives were mostly an afterthought and icing on the cake financially.
No	It neither sped up nor hindered the progress. That's a positive comment. Some programs do hold us up like when you need pre-approval and it drags on. That impedes the speed of the project.
No	It was needed.
No	It's just the way things fell into place, step by step, when we were installing.
No	Large energy waste if we didn't recover the heat from new larger ***** unit.
No	No significant factor on timing.
No	Only because there was the ability to get that ***** down. We knew there was big savings in gas for us.
No	Projects were already on the radar and needed done.
No	Safety hazard that needed to be resolved.
No	That's what was happening with our construction schedule.
No	We needed to do those changes anyways. But, it was good that we had incentives on the side. But, when you've got to do it, you've got to do it.
No	We planned to do this work regardless (need for expansion).
No	We planned to do this work regardless (need for insulation).
No	We were moving forward before learning of the rebate.
No	We would have still installed it, but most likely gone with a somewhat cheaper option that would have saved less energy. For example, we decided to go with the ***** versus the *****.
No	The incentive wasn't a game changer, it had to be done.
No	It was the right time of the year to do this and the business needed it, they've been growing a bit.
No	The project was small enough that rebate didn't impact timing.
No	Replacing failed equipment so it needed to be done quickly.
No	The earlier *measure* was broken.
No	The owner wanted it done quickly.

Timing	Dat1a_O. Why do you say that?
No	The project had its own merits, so if it was to move forward it probably wouldn’t affect timing.
No	We can only shutdown the plant during 2 specific times a year.
No	We had to address the leaks immediately; ***** so they're just wasting money if they left it leaking.
No	We needed to do this during the summer, a very short window.
No	We were at a point between ***** and the manpower was available to do these projects; already had the budget approved to address the equipment failure because they had been thinking of doing this for some time.
No	This was an installation that helped the plant, *****, so it would've happened regardless.
No	Very attractive on own merits.
No	Very likely, the time frame the same; would have done the project anyway; it wasn't - we get a rebate if we upgrade, but we need to upgrade, and hey- we can get a rebate.
No	Very likely; same timing.
No	You need the program to prompt us to think about EE; we have an enormous utility bill.
No	No comment.

Table 8-10: Efficiency Verbatim Responses for Union Custom C&I programs

Efficiency	Dat2a_O. Why do you say that?
Yes	***** would have dropped out. ***** may have been harder to justify.
Yes	Cost reasons.
Yes	I would have put up the same amount of *measure*, but would have chosen a less efficient product.
Yes	If there were not incentives, than we likely would have not been able to afford the more efficient options.
Yes	We had a less efficient design in place.
Yes	Standard efficiency for the industry that would still support our overall budget.
Yes	The program recommended the highest R-value insulation available and rebates are tied to energy savings so greater efficiency leads to a higher rebate.
Yes	We didn't know of the insulation opportunity and savings.
Yes	We wouldn't have had the knowledge about available higher efficiency options.
Yes	It could have easily affected the technology. We were *****, so may have gone for *****.
Yes	We just would have went with a cheaper, less efficient version, like we did years ago.
Yes	Possibly less but just as likely that we would have done nothing at all.
Yes	The program incentives allowed us to install more measures, greater efficiency.
Yes	The rebates allow us to purchase better equipment.
Yes	We would do ***** just to code.
Yes	Would have been a less efficient *measure*; the old *measure* was 40 years old.
No	Because I don't think we could have gone any higher with the efficiency. It's pretty efficient.
No	After analyzing different options, it seemed like the best option for our operation.
No	We would not have been able to do *****, but we checked them every couple of years.
No	Considered going with more efficient option, but savings did not appear to be worth the extra money.
No	Decision driven by equipment failure. Also I'm an energy guy, so we were motivated irrespective of Union Gas program. Incentive helps a bit to convince CFO but would have happened anyway.
No	I would have kept fixing the leaks for the next 18 months then would have to replace it.
No	High ROI (under 1 year).
No	I'm looking at the long term on my bill.
No	If we are doing the work, we try to replace with best technology available because we've found it often saves us money in the long run and is better ***** (i.e. ***** is clearer and provides *****).
No	Incentives were mostly an afterthought and icing on the cake.
No	It all comes back to I need to do what I think I need to do to give me the best ROI. If I rely on some government program then we are all in trouble.
No	It is the highest. If I decided to go with doing the insulation of the pipe it would have been the same efficiency.
No	It was either install it or not. We wouldn't have considered different efficiencies.
No	It's a guess. It's possible.
No	The program did not affect our planning or decisions whatsoever. They were driven by ***** requirements.
No	There's not that many choices.
No	We decided that's what we wanted to do, and they ok'ed it.
No	We liked what we did, because we saw it at other *****.
No	We had a set ***** in mind.
No	We try to get the most energy efficient options available anyways - if incentive is only 1% of project cost we are going with the same equipment regardless.
No	We were going for ***** anyways. The incentive just helped us along.
No	We would have gotten the same boiler.
No	You don't know what you don't know.
No	The efficiency of ***** was part of the engineering design so they wouldn't have changed it.
No	It's based on the programming, so nothing different.
No	The payback would've worked out without rebates.
No	Same efficiency - we have standards that we have to follow.
No	Same efficiency as it was the best available at that time.
No	We needed the efficiency that we installed.
No	We prioritize energy savings.
No	We would've gone with the same ***** from the same manufacturer - they've been buying from the same manufacturer for years.

Efficiency	Dat2a_O. Why do you say that?
No	The vendor ***** recommends an insulation value, after a certain amount adding more insulation doesn't get more savings.
No	We would have still picked the most efficient option.

Table 8-11: Quantity Verbatim Responses for Union Custom C&I programs

Quantity	Dat3a_O. Why do you say that?
Yes	Because without the incentive other projects would have become a higher priority.
Yes	We didn't know of the opportunity and savings.
Yes	We had another plan in place.
Yes	If a steam trap was on the border of needing to be replaced, we may have not completed it without the incentive.
Yes	It was such a minor project.
Yes	It would have been none.
Yes	We may have done less of the dock seals without the incentives.
Yes	We may have not replaced all the steam traps at the same time.
Yes	We only had a few large leaks and lots of small leaks. We would have only fixed large leaks without incentives.
Yes	We were not aware of the steam traps.
Yes	We may not have done as much testing as we did. But, it would have been close.
Yes	We needed to do it with utility incentive support or not at all.
Yes	We wouldn't have *****. With the additional savings. It led to the next project *****.
Yes	It would have been spread over numerous years.
Yes	We would not have identified the opportunity without help from Union Gas.
Yes	Because the project is not scalable.
Yes	It comes down to spending (the incentives).
Yes	We definitely would not have done everything we did without the rebates.
Yes	If it was a proactive replacement, maybe half.
Yes	The original design was no insulation.
Yes	Out of the *****, we would have done half.
Yes	Possibly less, but just as likely that we would have done nothing at all.
Yes	The rebates allow us to do more.
Yes	The rebates allowed us to install more measures.
Yes	The incentive improved the payback and allowed us to replace more valves.
Yes	There were areas with no doors and garage doors that would have been just left open.
Yes	There would have been nothing.
Yes	We wouldn't have installed energy saving *****; there was a lot that went into the construction of the ***** so hard to say what wouldn't have been done.
Yes	We would have done 20% less; incentive helps us get more $ for this year.
Yes	We would have done 25% of what we did.
Yes	We would have done fewer building. We do 2 or 3 per year, so we would have done half. Maybe 1 to code and 1 with insulation.
Yes	We would have had no ***** without the program; *****.
Yes	We would have only done 25% of what we did; would not have targeted the most important ones; *****, just the ones we could visually locate, the others no.
Yes	No comment.
No	***** had enough justification on their own. Auxiliary equipment would have changed.
No	*****, same scale.
No	The amount of work was need based.
No	Cheaper, easier decision, still easy to pursue in absence of incentive and program support.
No	The current condition was a safety hazard. We needed to complete this amount to fix it.
No	The decision was driven by equipment failure. Also, I'm an energy guy, so we were motivated irrespective of the Union Gas program. Incentive helps a bit to convince CFO but would have happened anyway.
No	We did this work before we knew it qualified for incentives.
No	Didn't present management with smaller options.
No	He would have kept going through the plant piecemeal, eventually getting to the whole thing. This is accounted for in timing.
No	High ROI (under 1 year).
No	I don't rely on rebates to make these decisions. I base the decision on the return on investment.
No	I would use the source I used to calculate what I needed and install it.
No	If we did the work, we would have done it the same way.
No	The incentive doesn't make any difference.

Quantity	Dat3a_O. Why do you say that?
No	The incentives were mostly an afterthought and icing on the cake.
No	It was a ***** replacement.
No	It would be very difficult to do anything else. It's all or nothing. You can't do part.
No	It's a very large building. We had to install the proper equipment in it.
No	It's just a matter of the size of the *****. There's nothing that I could change.
No	Just based on this project requirements. There was only one way to do it. There weren't options.
No	We knew what we wanted.
No	NA for this project, set amount required for this application regardless
No	No difference.
No	Same - Energy savings were large enough to make it worth it, even without incentives.
No	Scope of projects already determined years prior.
No	The program did not influence our decisions.
No	The size of the ***** was decided based on the needs of the process.
No	The incentive did not affect the amount of equipment that would have been installed.
No	There is a certain amount needed *****. That can't change.
No	We had a specific size that we needed. The new one has more throughput.
No	We had an engineering study completed in order to identify exactly the size of the unit we needed.
No	To leave some pipe uninsulated would not have made sense.
No	We didn't want to leave any pipe exposed.
No	We just replaced what needed to be replaced.
No	We needed a certain size *****.
No	We needed to conduct this amount of work, regardless of the incentives.
No	We upgrade a whole suite of controls; so we needed to do all for it to function properly.
No	We were moving forward before learning of the rebate.
No	We would have done it. We had to do it. The incentive is a great thing. We welcome that. But, the incentive is not going to change the scope of the work.
No	It would have been spread over numerous years.
No	We would have still done the same amount, just may have taken a little longer to get completed.
No	The amount of the incentive didn't drive the quantity, it was marginal, so they would've installed the same amount.
No	The capacity wouldn't have changed.
No	It doesn't make sense to do a portion.
No	We might've chosen not to do as many steam traps right away, some were just leaking as opposed to failing outright.
No	We need the same size to keep up with customer demands for our product.
No	The quantity was not an issue here; we didn't have an ***** and we wanted one to increase efficiency.
No	The quantity was not relevant; we needed to replace the fans.
No	The quantity wasn't the issue here.
No	We replaced one washer.
No	It was required.
No	The same amount but we would have done it less frequently.
No	The same scale.
No	The option with the most savings was to go with the ***** smaller *****; incentives made no difference here.
No	We have all sorts of other systems that fit with the ***** - heating/cooling, irrigation, etc. - that we had to get the amount of ***** we did.
No	We needed the quantity that we went with.
No	We needed to address all of the leaks with or without the rebate.
No	We needed to replace the failed insulation, no more no less.
No	Ultimately the same amount, but it would have taken us much longer to get through the queue.
No	We would have installed a lower quality.
No	It wouldn’t really have an effect.
No	No comment.

Table 8-12: Dat4 Verbatim Responses for Union Custom C&I programs

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
Full	We had to do it right away; it was designed to incorporate a lot of ee tools.
Full	I'd say it definitely would have impacted whether we did it. And, the quality of product that went into it.
Full	It had a positive impact on the end result. / It allowed us to select a higher efficiency unit that is cheaper to run.
Full	It had a large effect, probably wouldn't have done this work without program/incentives.
Full	Nothing at all.
Full	The program affected the timing; the grant was coming, so we could do the project right away; otherwise it would have been delayed. would have gone standard efficiency; lots of planning and design went into maximizing efficiency and product quality.
Full	The rebate influenced the timing of the project. We likely wouldn't have done it otherwise.
Full	The only reason I did it was because of the program, so I wouldn't have done it.
Full	The program affected the timing, size, and materials selection of the project because they are involved in the annual planning phases.
Full	The program made it all work. It's a lot easier to put together a big project all at once than small little ones over time. The money savings allowed it to be a larger up front project.
Full	The program provided technical support and incentives that helped the project move forward.
Full	The program provided technical support and incentives that were essential to the project moving forward.
Full	The program slowed down the process due to the length of the process (i.e. application), but allowed us to install more efficient equipment. It did not have an effect on the amount of equipment installed.
Full	They were very polite and very easy to deal with. In going forward, we are going to bring them in right at the forefront. Union Gas's program wasn't the reason for doing the project. We didn't do the project just because we saved the gas. That was a very nice spin-off of the project.
Full	Very helpful. Audit helped us to recognize steam traps and fix them.
Full	We wouldn't have done this without the program.
Full	Without the program this project would have likely not been implemented.
Full	The program was a large influence in helping to coordinate moving forward with the project.
Full	Union Gas was highly influential in the project because their visit and suggestion led to the initiation of the project. Once discovered, the project would have proceeded at the same time with or without the incentive but not at all without their involvement.
Full	We would have built a standard *****, with no upgrades; we would not have ventured down this path without the program. We used engineering services to see if it was going to work; we did trials up front; we stepped forward in increments.
Full	We would have done nothing at all.
Full	Without the rebates, we would have done it, just would have went with a cheaper, less efficient version.
Full	We would have installed roofing just to meet code, not beyond.
Full	We need the program to even prompt us to think about energy efficiency.
Full	No comment.
Partial	Definitely with Union it made the decision easier. Sometimes financially it's not doable at the time. It makes it easier, but in this case it was already in the plan.
Partial	We didn't know about the energy savings from this project, but we would have been doing it for years if we had known (with or without the incentives since it has such a high ROI).
Partial	Due to the incentive, it moved the program forward for us; re controls and other equipment, it assisted us in upgrading those controllers.
Partial	We would have kept going through the plant a piece at a time.
Partial	I would have put up the same amount of ***** area, but would have chosen a less efficient product; Program did affect it a little bit, and made me do it a little sooner, maybe a year later without the program.
Partial	Incentives are nice, but we would do this work anyways due to the energy savings and safety. It does help us get the work done more quickly.
Partial	It had a payback involved in it. So, it was a deciding factor in deciding whether to proceed or not and the timing of when to proceed. And, if it saved on capital funds. Because if we were able to get a grant then that would speed up implantation.
Partial	It made it sooner and more. No effect on energy efficiency level per se.
Partial	It was a lot easier to do the project when they did it when they offered the rebate. Otherwise, it would have been another 6 months or a year.

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
Partial	Medium to large effect, we probably wouldn't have done this work or done less dock seals without program.
Partial	Program had an effect on timing since incentives helped get the project approved quickly by upper management. The program had little effect on efficiency or quantity (for this project - larger projects like a boiler this would likely have a greater effect).
Partial	The program impacted the timing of the project but not the quantity or efficiency.
Partial	The program impacted the timing, efficiency, and quantity.
Partial	The program impacted timing, quantity, and efficiency; their projects are entirely dependent on payback.
Partial	The program incentives influenced timing, efficiency, and quantity of what was installed.
Partial	Program is not as important is it used to be in 2008-2011.
Partial	The project would have been delayed 12 months and absence of program could have easily affected the technology. We were *****, so we may have gone for plain *****
Partial	We would have installed the same amount of square meters (or linear meters) or I just wouldn't have done it at all.
Partial	The program had little effect on the timing. No impact on efficiency for this project, but helped us get more efficient boilers in the past. Incentives helped us do more steam traps than we likely would have been able to do at one time.
Partial	The program helped us complete the work sooner/more frequently than otherwise possible and also helped us afford to complete more. Little effect on efficiency.
Partial	The program made it all work. It's a lot easier to put together a big project all at once than small little ones over time. The money savings allowed it to be a larger up front project.
Partial	They were part of bringing the awareness of that project to us, it helped us with cost justification and calculations and made us aware of the technology.
Partial	Union Gas incentives probably helped upper management approve this work, otherwise would have tried to get it approved the next year.
Partial	What we did was just identified if we could get an increase in productivity with our ***** then we could take our other ***** off line.
Partial	We would have kept repairing the cracked *****, removing sections, etc… and then would have replaced it in 1-2 years.
Partial	We would have only fixed large leaks without incentives.
Partial	Lower efficiency is not an option, but would not have been able to do it with the level of frequency and intensity.
Partial	The program did not influence timing or efficiency, but it did influence the quantity of valves installed.
Partial	The program had an influence on the timing of the project and the quantity (for steam traps), but no impact on the efficiency level.
Partial	The program impacted the timing, not quantity or efficiency.
Partial	The program influenced the timing but not the efficiency or the amount.
Partial	The program prompted us to think about it; maybe would have done half over several years.
Partial	The same amount but we would have done it less frequently; with the program we were doing it annually, without the program, we would have done it every 2-3 years instead.
Partial	The same time, same size/scale, some components such as ***** and ***** would have dropped out.
Partial	The incentives were a nice bonus; had no impact on timing, quantity, or efficiency.
Partial	The program's largest effect was the assistance in assessing the situation. As far as the rebate program goes, it made it easier to convince the project going forward. Incentive wise it's a moderate effect.
Partial	The Union incentive had a significant effect on size and effectiveness. Without the incentive, it may have proceeded but it would've been harder to justify and smaller in scope.
Partial	We would have done half as many *****
Partial	We would have done it anyway, but would have done less than half of what we did and it would have taken through 2020; audits helped identify what we needed.
Partial	We would have only done 25% of the quantity, only the ones that we could see.
None	We could have done it later, but it would have been awkward, looked bad, and potentially damaged the building.
None	Essentially, Union makes us aware that the incentive programs are available. They haven't really pushed them in any one direction WRT any specific projects.
None	Everything was in line and turned out very well for us and for Union Gas. Because I had to change the unit, I would do it anyway. Since I had the incentive it was faster for us to go ahead and purchase the unit.
None	Everything went smooth. I am thankful for the incentive. There was nothing else we could have done to better the efficiency.

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
None	Had to do it. Original controls were 11 years old and had reached the end of the equipment life. Were wasting a lot of energy. No effect by program on timing, efficiency, size/scope.
None	I think it was a bonus for the overall project that this incentive was available. It probably influenced the decisions on some of the smaller, gas-fired equipment that we use in the building. It might have contributed to *****.
None	Incentives didn't have large impact. Main goal was to reduce heat output. ROI was high enough that we would have done anyways.
None	Incentives were nice but didn't have a huge impact since we realized the potential savings from this project.
None	It made no difference.
None	It would have been a very similar project. But, the incentive helps our decision to go forward and install the components. The timing wouldn't have changed.
None	It's great. It didn't effect the timing, efficiency, or amount.
None	Made it easier to make the case to my CFO but would have happened anyway.
None	No effect on timing, efficiency, or quantity, since we did this work before learning about incentives.
None	No effect.
None	No influence on timing, quantity, or efficiency.
None	Not much influence.
None	Nothing in particular.
None	The program had no impact on timing, efficiency, or quantity.
None	Safety was the main driver, not the program, although the incentives were appreciated.
None	The fact that there's an incentive program provides incentives for doing the project, but it's not the major factor. It helps push this project along.
None	The program didn't really effect the timing, efficiency, or amount, but incentives did help.
None	The program had little effect on the timing, efficiency, and amount of work conducted for this project since it was all need based. Other projects they have influence quantity though (i.e. when installing insulation).
None	The project was designed. Went on time. We got good results from the project. And we are thankful that we got the incentive from Union Gas for the project.
None	The timing was good because everything got completed on time. We didn't know the savings until about 7 months later, when we hit winter. The incentive was a great help.
None	There was no effect.
None	There was some effect. There are a few things we might not have done, or the utility support sped the decision. E.g. the ***** and the *****. Would have likely done anyway but taken longer to analyze and decide.
None	Utility helped define the minimum efficiency for project and helped improve ROI to get easy approvals from corporate
None	We were moving forward before learning of the rebate.
None	While the incentives were appreciated, they were not large enough to have much effect on what we installed (timing, efficiency, or amount).
None	While we appreciated the incentive, we would have installed the energy curtain anyways to save on natural gas so the program didn't really influence our decision.
None	Incentives were a bonus that fit in with their maintenance schedule; program had no influence on timing, quantity, or efficiency
None	No impact on the timing and efficiency. The incentives were a nice bonus; always looking for way to get energy savings.
None	No impact on timing, quantity, or efficiency.
None	No program attribution. The program did not impact timing, quantity or efficiency.
None	The program didn't have an influence on anything.
None	The program had no influence on timing, quantity, or efficiency.
None	The program impacted efficiency of equipment; no impact on timing or quantity.
None	We would have done the same exact thing that we did. You could get a less efficient deck design but we wouldn't have picked that.
None	We would have done exactly what we did; the rebate is a bonus on the end; we're making decision based on best payback and most EE; if there's a rebate, great. If not, we wouldn't do something less efficient because it doesn't make business sense.
None	No comment.

Union Large Volume

This section presents the Union Large Volume self-reported responses from the timing, efficiency, and quantity attribution battery where customers were asked "Why do you say that?". These responses along with whether a response received some timing, efficiency, or quantity credit are presented inTable 8-13, Table 8-14, and Table 8-15.

A "yes" in the timing, efficiency, or quantity column indicates partial or full attribution for that source based on the scored questions (not the responses here). A "no" indicates no attribution for that source. For example in the first table a "yes" in the timing column indicates that the respondent answered the question DAT1a and DAT1b with responses that credited the program with accelerating the project. A "no" in the timing column indicates that the respondend did not credit the program with accelerating the project. A "no" for timing does not preclude the same respondant indicating the program affected the efficiency or quantity/size of the same project.

Additionally, following the specific timing, efficiency and quantity questions, customers were asked to summarize the program's effect on the timing, efficiency and amount of the project installed (Dat4). These responses are presented in Table 8-16 with the scored level of attribution: full, partial, or none.

None of the responses provided below were used in the direct scoring of surveys. For respondent confidentiality these responses are isolated from other responses from the interview and do not reflect the full story the respondent conveyed. The responses are provided here to provide insight into how customers describe their decision making on the project relative to the program. See APPENDIX J and APPENDIX K for details on how attribution was scored.

Table 8-13: Timing Verbatim Responses for Union Large Volume

Timing	Dat1a_O. Why do you say that?
Yes	By being aware of everything it helped to speed things up.
Yes	Do a yearly steam trap analysis and would have discovered the failed traps then.
Yes	I think because the effective cost of the work was less with the incentive from Union Gas.
Yes	It helped to move it ahead faster, with the funding.
Yes	It was creating a *****, one was very fouled, so it had to be done regardless, the 2nd was borderline, and would have been cleaned the next year if it hadn't been last year.
Yes	Survey by Union Gas identified the issues, but this would've happened eventually anyway.
Yes	It was a good project & made sense to do at some point in time. ***** would have given it more priority.
Yes	No comment.
No	Already identified and approved as part of infrastructure maintenance - incentives were a bonus.
No	Company has recognized the need for this due to potential energy savings/ ROI.
No	Decision driven by needs at the site, not incentives.
No	Installation was staggered as it was. They chipped away at it. Had to stagger anyway due to their production schedule and constraints.
No	It would have had no impact. We would have implemented the project with or without the program rebate.
No	It's a larger project. So, the relative effect of the rebate is not as great.
No	Needed to be replaced. Incentives were too small to have an effect (incentive less than 1% of project cost).
No	Only the one window of time for spring maintenance projects.
No	The incentive is appreciated. But, I can't delay such a large maintenance item.
No	The project was feasible on its own merits and management expected them to implement it.
No	These issues are important to the continuing operation of the plant and they are addressed as quickly as they can be.
No	Timing determined by turnaround cycle.
No	We planned to do it regardless of the program.
No	Because of equipment age (turnaround). incentive helpful to engineering group, but small compared to whole project. Incentive less than 1% of project cost.
No	Because of equipment age. incentive helpful to engineering group, but small compared to whole project. Incentive less than 5% of project cost.
No	Because won't have another ***** until ****, so take advantage of that opportunity or lose out on it.
No	It needed to be replaced.
No	The program had no influence on these projects. These were maintenance issues that needed to be done regardless and met payback requirements without incentives.
No	Repairs, so they had to happen.
No	It was part of a larger project.
No	We had to do the one as it was failing, the 2nd would have been done in the next couple of years if we didn't do it at this time, it would have failed in 2-3 years.
No	No comment.

Table 8-14: Efficiency Verbatim Responses for Union Large Volume

Efficiency	Dat2a_O. Why do you say that?
Yes	Because they made us aware of the potential energy savings of going with what we did. And, they actively lobbied us for it.
Yes	No comment.
No	As a ***** manufacturer, we understand going with higher efficiency product will save us money in the long run. Plus already had scope approved by president/director.
No	Energy savings justify on its own.
No	Engineering standards.
No	More efficient units like the one we got would pay for themselves, even without the incentive.
No	It needed to be replaced. Incentives were too small to have an effect in this case (for other projects incentives have helped us afford more efficient equipment, but depends on ROI).
No	We picked this ***** because it was the best operational decision. It's just good business practice to install the highest efficiency that we could install.
No	We would have selected same product.
No	We needed the amount of insulation and the type that we installed.
No	We had to do the one, the 2nd would have been done in the next couple of years if we didn't do it at this time, it would have failed in 2-3 years.
No	Would have gone ahead with same ***** project anyway.
No	No comment.

Table 8-15: Quantity Verbatim Responses for Union Large Volume

Quantity	Dat3a_O. Why do you say that?
Yes	We would have gone with an option that did not increase the efficiency of the system.
Yes	One ***** needed to be replaced due to corrosion, but the rebate allowed us to do the 2nd one at the same time.
Yes	Would be influenced.
Yes	No comment.
No	*Measure* needed to be replaced anyway. Maintenance ***** needed to be done anyway, and was already scheduled.
No	Already identified and approved as part of infrastructure maintenance - incentives were a bonus.
No	Certain constraints in terms of safety standards.
No	Decision driven by needs at the site, not incentives.
No	Maintenance standards.
No	NA - only 1 was needed.
No	Needed to be replaced anyway.
No	Needed to be replaced. Incentives were too small to have an effect (incentives less than 1% of project cost).
No	The program is beneficial; it puts money back into their pocket. Like sprinkles on cake (extra $).
No	The simplicity of the project. What we were implementing was just standard practice. There was nothing we would have done that was out of the ordinary.
No	There wasn't really an option to do only part of it.
No	It was based on engineering standards, not on program incentives.
No	We had a pretty good idea of what we were going to do. We spent a lot of time determining the scope of the work. At the time we are thinking, it is not guaranteed that we will get the rebates. So, it is a bit of an educated guess.
No	We had to install the amount we did. The incentive contribution was not material.
No	We needed the insulation they installed, and we wouldn't have changed this.
No	We needed to replace ***** failed steam traps anyway, would just have been delayed.
No	Only one choice.
No	Repairs are necessary.
No	Same amount but this would've had to happen over a period of time / piecemeal.
No	This was what we needed, and we incorporate the program in our planning process.
No	It was new construction/***** project, one window of opportunity.
No	We would have been installed anyway on own merits.
No	No comment.

Table 8-16: Dat4 Verbatim Responses for Union Large Volume

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
Full	The program provides commitment to the project. Gets it done.
Full	They were instrumental in helping us to identify the potential energy savings, which expanded the project's scope. But, resulted in a long-term cost benefit to our organization. The program was very helpful in convincing the powers that be that the more expensive option was the best one to pursue.
Full	Would not have installed absent the program. Would have kept as-is.
Full	No comment.
Partial	Incentives helped motivate staff to get going. The project was done slightly earlier and on a larger scale than it would have been absent the program.
Partial	It improved the timing because of the availability of the rebate. The efficiency and the scope would have remained the same. We couldn't have done less work than we did.
Partial	Program provides commitment to project. Gets it done.
Partial	The timing, the program made it happen sooner. So, we gained the savings sooner.
Partial	Very likely to install same equipment, 36 months later, same efficiency, same quantity.
Partial	Very likely to install same equipment, would have been delayed 18 months.
Partial	We would have done less and less frequently. We would have likely done it, but 6 months later when we have downtime, on a smaller scale. We would do 75% and not replace ***** until they were closer to end of life because of program education we understand ***** efficiency.
Partial	Its hard to say, would have done half as many 2 years later. We would have wasted more fuel, traps are something we observe; years of patching up equipment. Now it's maintenance annually due to program ed.
Partial	One ***** needed to be replaced due to corrosion, but we did the 2nd one at the same time because of the rebate, but it had some RUL.
Partial	The program influenced timing and quantity.
Partial	The program accelerated the installation by 12 months and caused a larger amount of steam traps (half of those that were incented) to be replaced.
Partial	The program accelerated the installation some, and caused a larger amount of pipe insulation to be replaced but the respondent didn't know by how much for either.
Partial	We would have been somewhat likely to do it, because we knew what we were doing. It wasn't a good thing to do, but would have been 6 months later because we didn't know how much fuel we were wasting, but in keeping with same scale/efficiency.
Partial	We would have done the same thing; rebate was influential in getting us to do the *****; incentive pushed the 2nd project to this year, instead of the next year; utility rebate makes the payback better.
None	As mentioned before, the utility mainly just provided the incentive quote/estimate, but did not have much effect on anything else.
None	Honestly, we were set on doing this as an infrastructure improvement and would have done it all the same without the incentives.
None	Incentives can help for certain projects, but when they are relatively small they don't impact our timing, efficiency, or amount. Still helps, but doesn't sway us.
None	It had no effect. It's a good program that helps people make better business decisions in terms of installing the best, efficient materials and equipment and, therefore, making better business decisions.
None	It triggered an awareness that there were many more projects that we could implement. It put us in that frame of thought and helped encourage us.
None	It would have affected if and how soon the project got approved.
None	No effect on timing, efficiency or size/scope of what they installed. Would have done anyway.
None	No effect. Decision driven by needs at the site, not incentives
None	No effect. Would have been same timing, efficiency level and size/scope.
None	Program had little effect on the decision to do this work, because it was necessary for the safety/continuing operation of the facility. Also little effect on efficiency and quantity, due to engineering and maintenance standards respectively.
None	Project was very likely to be implemented without the Union Gas program, at the same time, efficiency level and size/scope.
None	The program had essentially no effect on this work at all (timing, efficiency, or amount). This was work we planned to do regardless.
None	The project would have been done at the same time, efficiency level and size absent the program.
None	Very likely to install same equipment, same time, same efficiency, same quantity.

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
None	No effect on the timing, efficiency level, or size/scope.
None	No influence.
None	The program is always there, so you look for ways to recoup your money. But without the program we would still do these repairs.
None	It wouldn't have affected it. Would have happened anyways.
None	No comment.

Enbridge Commercial, Industrial and Multi-Residential Programs

This section presents the Enbridge Commercial, Industrial and Multi-Residential self-reported responses from the timing, efficiency, and quantity attribution battery where customers were asked "Why do you say that?". These responses along with whether a response received some timing, efficiency, or quantity credit are presented in None of the responses provided below were used in the direct scoring of surveys. For respondent confidentiality these responses are isolated from other responses from the interview and do not reflect the full story the respondent conveyed. The responses are provided here to provide insight into how customers describe their decision making on the project relative to the program. See APPENDIX J and APPENDIX K for details on how attribution was scored.

Table 8-17, Table 8-18, and Table 8-19.

A "yes" in the timing, efficiency, or quantity column indicates partial or full attribution for that source based on the scored questions (not the responses here). A "no" indicates no attribution for that source. For example in the first table a "yes" in the timing column indicates that the respondent answered the question DAT1a and DAT1b with responses that credited the program with accelerating the project. A "no" in the timing column indicates that the respondend did not credit the program with accelerating the project. A "no" for timing does not preclude the same respondant indicating the program affected the efficiency or quantity/size of the same project.

Additionally, following the specific timing, efficiency and quantity questions, customers were asked to summarize the program's effect on the timing, efficiency and amount of the project installed (Dat4). These responses are presented in Table 8-20 with the scored level of attribution: full, partial, or none.

None of the responses provided below were used in the direct scoring of surveys. For respondent confidentiality these responses are isolated from other responses from the interview and do not reflect the full story the respondent conveyed. The responses are provided here to provide insight into how customers describe their decision making on the project relative to the program. See APPENDIX J and APPENDIX K for details on how attribution was scored.

Table 8-17: Timing Verbatim Responses for Enbridge Custom C&I programs

Timing	Dat1a_O. Why do you say that?
Yes	*****: delayed a year w/o rebate – it still would have gone, but maybe 60%chance it was done that year/40% chance next year; *****: would have to do something at some point...maybe delayed, it would not go to ruin but it could be neglected longer.
Yes	Because having a stronger business case will give us better payback and the project will become more viable and more likely to get approved and funded.
Yes	I don't know for this specific project - but incentives frequently expedite getting projects approved.
Yes	It is easy to justify in the project budget.
Yes	Enbridge's program created the business case for us.
Yes	Eventually we would have gotten to it, such a large saver.
Yes	I would have added ***** instead of doing the *****. But, I would still have had to add *****.
Yes	The incentive matters.
Yes	Incentives are included in our budget forecasting.
Yes	Incentives helped the director approve the project. We may have been delayed it without incentives.
Yes	Incentives made it easy to get approved (brought it within 2.5 yr ROI). May have got pushed back without incentives because more convincing would have been necessary.
Yes	It would have been much later if not never.
Yes	It wouldn't have had the payback. It would have been beyond our guideline.
Yes	It's the business case. The incentives shore it up. Without that funding, it throws off the numbers, we need to secure more internal funding.
Yes	Just because of the ROI. The incentives made it happen. They put it over the edge.
Yes	Likely would not have done it without incentives due to maintenance costs/hassle to keep them clean.
Yes	Money.
Yes	Our location is closing, so it would never have happened.
Yes	Probably a little bit later because general awareness of incentive was lower. Enbridge turned them on to other incentives.
Yes	The *process* for ***** relatively expensive for the expected ROI. As a result, upper management would not likely see value without the incentive.
Yes	The incentive helps focus people's attention in terms of getting the job done. They help us in highlighting these measures as opportunities.
Yes	The incentive raised the profile of the project in comparison to its size.
Yes	The math showed them the savings to get the ***** installed. Enbridge helped with the math.
Yes	The program is not just an incentive thing. The thing for me that is equally important is the parternship in terms of identifying and vetting different project ideas.
Yes	They incentivized the steam trap audit as well.
Yes	They now do this every year. This is an odd question.
Yes	They were still considering energy savings and wanted to be proactive. They like the incentive. If there weren't an incentive, they would do another project first.
Yes	They would do it every three years, but not every year.
Yes	They would have done them piecemeal over time.
Yes	Upper management would have likely not approved a project like this that is not viewed as an immediate priority.
Yes	We had to do it. But, the incentive helped us to do it faster.
Yes	We wouldn't have been able to justify the payback without the incentive.
Yes	Without incentives the project would not have been approved/ we wouldn't have done the project.
Yes	It would have been pushed off.
Yes	We would have had to wait until next summer to get it in the budget.
Yes	We would have likely still replaced one at the same time, and then the second one at a later date.
Yes	We would have replaced on equipment burnout.
Yes	We would have taken longer to be aware of the savings opportunity. Plus the incentive was relatively large and a significant motivator.
Yes	We would have taken longer to get appropriate resources and funding in place.
Yes	We wouldn't have had technical or financial support.
Yes	It's not a small project *****, so it takes time, lots of operations, keep the plant running all the time, started 2011, ended 2015, rebate accelerated the project by one year.
Yes	The rebate helped the payback work out.
Yes	The rebate reduced payback so they could install measures sooner.

Timing	Dat1a_O. Why do you say that?
Yes	The rebate helped the payback allowing them to do the project sooner.
Yes	Tough to say; they have tight ROI metrics.
Yes	It would have taken longer to convince them to do.
Yes	It would've been replaced eventually, but they don't typically become aware until an audit or something breaks down.
Yes	No comment.
No	***** replacement was due
No	***** was a regular maintenance item. ***** were something they wanted for growing reasons.
No	Aiming to meet internal efficiency goals.
No	Because of our business model. We work in *****. We only have a short window to ***** because of the weather.
No	The incentive is a very small percentage from the project cost.
No	The unit was old and needed to be replaced.
No	Because we were going to change the boilers whether there was any incentive or not.
No	The Enbridge program was not a factor.
No	End of useful life, savings with gas when replaced.
No	The equipment had failed and we needed a replacement. The decision was driven largely by the larger Toronto Hydro incentive. The small Enbridge incentive relative to the large total project cost wasn't a big motivator.
No	The equipment needed replacement.
No	I think that moment when you are trying to decide, knowing that there is some extra funding pushes you to do it. Enbridge's involvement had more to do with whether we would do it or not do it than the with timing of doing it.
No	I would still implement it. It's more of an operational savings. We are going to get savings with the Enbridge program or not.
No	The idea came from us and our president.
No	It's the business case. The incentives shore it up. Without that funding, it throws off the numbers, we need to secure more internal funding.
No	Leaks needed to be fixed, it's very expensive for the company to continue operating "as is/was".
No	Motive was for improved plant conditions, only found out about incentives after we were set on doing project.
No	It needed doing.
No	We needed to get this work done for energy efficiency purposes.
No	Once we discovered the need we like to move on them, given the circumstances.
No	Refused.
No	Similar time because we have a 5 year plan on spending on this type of project.
No	Simply because the payback was justifiable.
No	That was the time when we were able to identify it. The program being in place just helped us move along.
No	The Hydro Incentive was bigger. The Enbridge incentive was great. It made the ROI that much better. It was a bonus. But, it was the Hydro one that made the case for this project.
No	The boilers were falling apart. Try to submit early in the year when people aren't busy, timing for tender is very important.
No	The drivers for the projects didn't have much overlap with the Enbridge reps; they provide only a very small portion of total funding; they're not at the table.
No	The incentive makes it a real no brainer, but it's a decent business case without it. The decision is weather driven, so we do it every year but could do it every other year without the incentives.
No	They needed to be done.
No	They were a pile of rust.
No	This one would probably have happened at this time, though in a smaller way.
No	This was a construction project which was scheduled for other reasons.
No	Timing was coordinated by the energy office.
No	We had planned to do this replacement per our schedule.
No	We had to change the equipment. Enbridge just helped us with installing energy efficient equipment.
No	We had to have the ***** shut down at the time we made the installation. Those shutdowns aren't very frequent. We had a scheduled outage. And, the equipment was here. So, that's when we installed it.
No	We had to replace the *****.
No	The maintenance had to be done.
No	It didn’t affect timing.

Timing	Dat1a_O. Why do you say that?
No	We had to address safety issues.
No	It had to be done during shutdown.
No	it was a quick, small project; no capital investment involved.
No	leverage *****
No	One of the boilers was failing critically.
No	The project was under the 1-year ROI, but the rebate made the ROI lower.
No	The rebates were not a factor in the timing. We were going to do these projects with or without the incentives.
No	The rebates were not a factor in the timing; We were going to do this project with or without the incentives.
No	The system was broken. We had to replace.
No	We planned these projects well before they knew the rebates existed.
No	To improve process efficiency.
No	No comment.

Table 8-18: Efficiency Verbatim Responses for Enbridge Custom C&I programs

Efficiency	Dat2a_O. Why do you say that?
Yes	Incentive changed the cost/benefit calculation.
Yes	Incentives helped get a more efficient unit approved. *****, so may have gone with unit of a similar efficiency - hard to say.
Yes	Might have gone less efficient. Hard to know.
Yes	The program incentive helps improve PP.
Yes	The incentive helps to install a higher efficiency equipment.
Yes	We would have gone with a lower efficiency.
Yes	We would have replaced like for like without the rebates.
Yes	I don’t know for this specific project, but possibly less efficient equipment if that was the only way they could get it approved.
Yes	We would have installed more than standard but not quite high-efficiency.
Yes	The rebates allowed them to pursue more efficient equipment.
No	Again, the decision wasn't driven by the Enbridge incentive.
No	Consultant recommendation.
No	Enbridge is just a small player in the financing and decision making for these projects.
No	Enbridge's involvement is mainly to do with verifying what they did. No influence on efficiency.
No	Energy savings is important to us
No	If we are going to do it, we'll do it right. The goal was to increase efficiency.
No	If we were to do the *****, we would have done it in the most efficient way possible.
No	We installed the equipment suggested by our vendor. Incentives did not influence the choice.
No	Just energy savings after the fact. I am very conscious of the environmental energy cost, its just second nature to my training, how are we going to be better.
No	***** driven
No	The ***** requirements were the driver for getting the *****.
No	The big ***** was supposed to be more efficient.
No	The equipment we selected meets our own internal high standard and yields payback over time.
No	We don't care about the rebates.
No	We wanted to install the best and latest technology.
No	We bought a used unit that became available. We did not custom buy it.
No	We needed a ***** that would be faster because of the increased usage.
No	We put the best possible solution at the time in place.
No	We try to install the most EE boiler money can buy, we know that in the long run you save on operating cost.
No	We try to update our equipment with like for like, efficient alternatives regardless (this is why we consult energy experts first).
No	We wanted to use the equipment we used.
No	Without incentives the project would not have been approved/ we wouldn't have done the project.
No	We would have replaced it with the same efficiency levels.
No	It wouldn't make sense to spend the money without getting the savings.
No	Just ***** installation and some ***** to control it.
No	There was only one option other than *****, which is ***** and that's what we did.
No	We had a good idea of what we wanted based on previous experience. We wanted to save money by increasing energy efficiency.
No	We knew what we needed.
No	No comment.

Table 8-19: Quantity Verbatim Responses for Enbridge Custom C&I programs

Quantity	Dat3a_O. Why do you say that?
Yes	Because the program helps offset the difference in the price cost.
Yes	Because we would have less incentive. So, the payback would have been less. So, there would have been less money to be spent.
Yes	Enbridge made us aware of the type of equipment that was available.
Yes	Enbridge's incentives and assistance in annual planning is critical for the implementation of most non-mission critical projects.
Yes	If there is no incentive, then we might go for less.
Yes	If you can get incentives to do something, then you will do a better job just because of the cost reduction.
Yes	It all come backs to it being one system. You are either installing it or not.
Yes	May have only installed 1 or 2 *****.
Yes	Not immediate priority due to lower ROI.
Yes	Only one *action* was necessary to recover heat.
Yes	Same reason, budget would have had a smaller scope. We may not have adjusted the dampers.
Yes	The cost savings with the program.
Yes	The incentive made it cost effective enough that we could get approval from our finance team.
Yes	They might do however many steam traps they could afford, which is often not much.
Yes	They would have done one of the ***** boilers.
Yes	They would not have done this project otherwise.
Yes	We needed it.
Yes	We would have gone with like-for-like replacement of the old system, which was smaller.
Yes	We wouldn't have been focused on identifying the traps that needed replacing.
Yes	Without the proper ROI we would have had to come up with some other design or something to get it approved. But, I don't know what that would be.
Yes	Without incentives, the project would not have been approved/ we wouldn't have done the project.
Yes	We would have likely replaced the seal/bumper on one door, then another later on.
Yes	We would have probably not done any without incentives.
Yes	We would have still done both since we were focusing on renovating non-critical office area.
Yes	We wouldn't have been aware of the value and need.
Yes	We would have just done one *measure* instead of two.
Yes	No comment.
No	All units were at the end of the useful life.
No	Amount was needed for significant improvement.
No	The audit service provided by the utility was very helpful. But the incentives did not impact the choice.
No	Basically, we don't get to see incentive money, it goes back to ***** and might be used somewhere else.
No	Enbridge is just a small player in the financing and decision making for these projects.
No	Engineer and vendor recommendation.
No	The equipment needed replacement.
No	Every site needed a new *****
No	The extent would have been the same.
No	It had to be compatible, but increased efficiency was part of 5 year goal.
No	I don't think the incentive had any bearing on whether we were going to do this project.
No	It all come backs to it's one system. You are either installing it or not.
No	It had merits on it own. It had its own justification, even without Enbridge's rebate.
No	It was a comprehensive project for all mechanicals by design.
No	It's because of the financials.
No	It's just a maintenance thing they had to fix.
No	It's was the option we needed to save money.
No	Just have 1 heater.
No	Leaks needed to be fixed. It would be expensive for the company to not repair.
No	Likely would have done less, and only completed a few of the ***** one year and more the next.
No	We might have gone with a smaller system.
No	We needed to replace them all at once to get a better price from the vendor.
No	There was no influence on size or quantity of boilers installed.
No	I'm not certain, but I believe only one needed to be replaced.

Quantity	Dat3a_O. Why do you say that?
No	No influence on sizing.
No	Not scalable; had to control all ***** fans.
No	We only need one unit.
No	We only needed to replace the one.
No	The project needed to be done together because of co-location of *****.
No	The quantity was based on ***** advice based on square feet. We would install as many as they advised since they had most experience with them. Not dependent upon the incentive.
No	The repair had to be done to address safety concerns.
No	The ***** was more influential.
No	The ***** requirements was the driver for getting the EE points.
No	The equipment was sized based on the amount of *process*.
No	The equipment we selected to meet our own internal high standard and yields payback over time.
No	The incentive was just a bonus. We had to do this.
No	The size we went with fills the need.
No	They go based on the building size.
No	They sized it for the building.
No	They wanted to try it, which is what they did.
No	They were a system. Replace all at once.
No	They were sized for the building.
No	They would do the audit and replacement the same, just less often.
No	Vendor.
No	We needed it.
No	You can't do less because of the type of work we do. You can't do a portion and not do the other portion.
No	Because the units that were being replaced all work well together hand-in-hand so it was advantageous to do a whole replacement instead of partial. More practical and cost efficient.
No	The decision wasn't driven by the Enbridge incentive.
No	Just a longer period of time.
No	We needed the size for health and safety.
No	Not scalable.
No	The same process, both buildings.
No	The same size either way.
No	The same, with controls, you can't say do more/less, you have to do it.
No	Still gone after at the same time because of internal drivers, good business case.
No	The failing boilers needed to be replaced.
No	The project would have been the same without Enbridge support as the old system was broken.
No	We needed to redo the ductwork system, so nothing would've changed without rebates.
No	We needed what we got; the rebate had no impact on this.
No	We were only looking to install one VFD.
No	It would've gotten replaced but later, as they failed.
No	No comment.

Table 8-20: Dat4 Verbatim Responses for Enbridge Custom C&I programs

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
Full	Enbridge's incentives and assistance in annual planning is critical for the implementation of most non-mission critical projects.
Full	It helps with the timing. Some of the projects would never happen at all if it wasn't for the analysis. The efficiency is improved as well. The analysis helps determine how to make the project a better option. They help with the overall outcome by providing the technical support and some of the fi.
Full	The program had large impact on timing and amount. Very likely this work would have not been approved without incentives.
Full	Program had little effect on timing or efficiency for ***** project (because it was a HUGE energy waste and had a very high ROI = needed to be done), but had large impact on ***** - made this project feasible.
Full	The funding made the project viable. Without the funding we wouldn't have been able to do it.
Full	The incentive and the program through Enbridge allowed us to get a program completed that we probably wouldn't have without their help. They helped us simplify the project and implement it in a timely manner.
Full	The incentives had a very large effect. If we didn't have them, the ROI would have been over 3 years and the project would have never been approved.
Full	They originated the project, the business case. They helped with the assessment which helped accelerate the process of approval with the incentives and a faster ROI.
Full	They provided evidence that this was a good thing to do, and they put their money where their mouth is.
Full	We would have installed a standard efficiency boiler otherwise.
Full	When I give them the number of exhaust fans that I have. And, I give them the ***** units that I have, they did the calculations to balance the system. / When I learned that there is an incentive then I can spend a little more money than what I planned to. With the incentives, we could install a *****.
Full	With the incentives and the individual help from Enbridge it helped us reach the proper ROI and make the project a reality.
Full	Without incentives, we would most likely not have done this work, so large effect on timing and amount.
Full	Without the timing, it would have been delayed indefinitely.
Full	We would have installed all ***** boilers at the same efficiency.
Full	No comment.
Partial	Absent the program and incentive, the controls projects would have been implemented eventually, about 12 months later. The program had no impact on the efficiency level or size dimension.
Partial	Big influence. The incentive is a great help to the corp. Without the incentive, they would not move the project forward that soon.
Partial	By having the incentive, it does increase our ability to save money sooner rather than later. And, it increases our ability to get it done sooner.
Partial	I suspect this work would have taken longer to get approved and we may have had to settle for a less efficient unit without incentives.
Partial	Certainly, a relevant bonus to us, we got 5% back, but again, overall, project would have proceeded regardless
Partial	Enbridge's incentives and assistance in annual planning is critical for the implementation of most non-mission critical projects.
Partial	Hard to say for a lot of these (since hypothetical), but incentives helped get this work approved. Without incentives, we may have done it later, or only 1 maybe 2 of the economizers at this time.
Partial	I think Enbridge's program for subsidizing steam trap studies and replacement of faulty traps ensures that we do it on a regular basis and a higher frequency than we otherwise would.
Partial	If we didn't have the assistance the project would not have been completed to the extent that it was. And, it would have been much later that we got the job done. We would have not experienced the improvements in production.
Partial	Incentives helped bring down ROI which made it easier to get approved. We would have likely done a less thorough job and later without incentives, since the bottom line is critical here.
Partial	It helped us install it a year early.
Partial	It improved the business case and made the decision process easier. Also, it invites more rigor for measurement and verification which makes it easier for us.
Partial	Program incentives helped us afford a more efficient option, but didn't impact timing/quantity since all units were overdue for replacements.
Partial	Program incentives helped us complete both ***** at the same time. Otherwise would have done work in two stages.

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
Partial	Sped up installation, improved efficiency, and had no effect on quantity for this one site.
Partial	The Enbridge rep made them aware of the incentive for the VFD measure and got the process started. The VFDs were installed 24 months before they would have been absent the program. No effect on the efficiency level or size/scope.
Partial	The incentive and help with calculations of paybacks were important. Easier to make the business case and sell it to VP level to get funded. It clarifies the driving factors and provides outside proof that it will save money.
Partial	The incentive program helps in specifying energy efficient equipment. Also, the coordinator helped in answering questions for optimum energy equipment. Also, to help in reducing the cost of the project.
Partial	The incentives helped them to implement the project in 2015. Else they would have replaced it on burnout, perhaps a few years later.
Partial	The key was our Enbridge contact making us aware of the incentives. Then our consultant ***** identified the failed traps and the quantitative savings opportunity. We would have done fewer traps and significantly later without the program's role.
Partial	The program definitely helped us to create the business case. Without Enbridge's help we would not have looked in depth at the ***** project. They helped during the assessment which helped create the business case for the payback. And, they helped direct us to manufacturers to help replace the equipment. The incentives helped us move forward faster on the process of approval. And, the money helped us to do more. And, giving us the incentives gives us a lot of visibility.
Partial	The program has very significant influence on the timing and efficiency of the projects but it promotes the selection of the smaller or easier projects as opposed to larger or more complicated projects.
Partial	The program helps in specifying the equipment. So, the program helps in offsetting some costs for us.
Partial	The program incentives helped us increase the project scope and improve overall ***** efficiency, but did not have much effect on the timing.
Partial	The program was the main driver in the maintenance manager initially becoming a steam trap champion.
Partial	The timing was okay. We got our incentive as soon as we finished the project. So, it gave us incentive to finish it quicker rather than later. We are satisfied with it. We are happy with the program.
Partial	There was a small effect by the program on the timing of installation. The measure would still have been installed, but about 12 months later.
Partial	They had key inputs in helping ***** upsize to bigger more efficient equipment.
Partial	They helped us do the audit every year rather than every three years.
Partial	They raised the profile of the project as they have done for other projects like boilers.
Partial	We would have done one boiler to see how it went otherwise.
Partial	Without the incentive, we would have had to wait until the next year at least.
Partial	Without the program incentives, we may have not done this work as soon or as thorough.
Partial	We would have installed them two years later at a lower efficiency level.
Partial	We would probably have done these piecemeal over time.
Partial	We would still have gone after the same projects because of internal drivers, good business case.
Partial	All or nothing, same upfront costs, let’s not waste time doing half and half again; it may have affected repairs if I didn’t have enough $.
Partial	It influenced the timing, but that's it.
Partial	The program had an influence on the timing due to incentive.
Partial	The program impacted timing and efficiency.
Partial	The program influenced timing, nothing else.
Partial	The program only influenced timing.
Partial	The program rebates influenced the timing, nothing else.
Partial	The insulation before was deteriorating so we had to put it back; with the rebate we could put in something more efficient to capture everything; controls would have done the same efficiency/quantity.
Partial	We would have replaced *measure* with the same *measure* instead of spending $ modifying the piping to install *measure*, but that would only be good for 2-3 years.
None	It was nice to have that money, it wasn’t what pushed it to do it. Aged equipment needed replacement.
None	We were already set on doing this project before we became aware of incentives, so the program did not have an impact on timing or efficiency. Quantity only based on advice of product specialist.
None	Audit service provided by the utility was very helpful. But the incentives did not impact the choice, size, efficiency or timing of the project.
None	Enbridge did not have influence. Rebates were nice to have but not the driving force.

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
None	Enbridge didn't have as much impact on this project as the Toronto Hydro incentive. Enbridge's was an additional incentive that we could go for. But, it was just a bonus. We received a larger incentive from Toronto Hydro. Don't get me wrong. We love the Enbridge program. But, the Toronto Hydro incentive was more influential.
None	Enbridge incentives were good but did not impact the scope or timing of the project.
None	Enbridge reps; they're not at the table; we remember there's money there and we always apply for it because we want to apply it forward; but you're not even a 5% share; 100% goes back into other projects.
None	Enbridge's incentive on the project didn't have much effect on the timing. It was an expensive project. So, the incentive was a smaller portion of the total cost than with other projects. So , it was nice. But, the project was going to go ahead with or without incentives.
None	Enbridge's support allowed us to make a decision to move ahead quickly. Their technical support helped us make the decision. And, the financial support also helped expedite the decision.
None	I just plan it the year before. I've got a budget. You get a rebate. But, because I have to tell them the year before, I have to tell them about the project. You tell them everything that is going to happen the year before. It makes it easier to do the project because there is an incentive.
None	Incentives helped, but we would have done the project the same without it.
None	Incentives were helpful to get work approved, but we would have done mostly the same since we had it on radar with our internal 5 year energy savings plan.
None	It didn't affect the timing. It didn't affect the scope. It stood on its own merits. So, it was a bonus that we got a rebate check at the end. But, we still would have pursued this anyways.
None	Makes the decision a no brainer i.e. much easier to do.
None	Minimal effect on timing, efficiency, and amount installed for this project, since we had planned to replace this anyways since it was at the end of its expect life.
None	No effect.
None	No impact. We know that there's incentive money coming, but if we have to replace, we just go ahead and do it.
None	None.
None	Not a huge effect.
None	Not much effect, since it needed to happen right away due to failed equipment and since larger ***** Toronto Hydro incentive was the big driver. Still, every piece played a part in overall financing and decision making.
None	Program had no influence on timing, quantity, or efficiency.
None	Program incentives didn't effect timing, efficiency, and amount installed since the leaks needed to be repaired.
None	Rebates were nice but didn't make a difference.
None	Since we knew about the incentives before we started planning, the program might have increased the efficiency level of what we installed. Not sure, though. In terms of timing and what we did, we were doing the whole thing regardless.
None	The Enbridge program was icing on the cake for us. We would still have implemented the program regardless of the Enbridge program. The operational savings and the energy savings had more impact than the incentive and rebate.
None	The owners tend to take rebates into account.
None	The program had no effect on the project, and it would have gone forward at the same time, efficiency level and size absent the program.
None	The program had no effect on this project; it had to be done to address safety issues. No effect on timing, efficiency or size from the program.
None	The program just really didn't have an effect on whether we would do it or not. The timing was good and it made it get approved.
None	There was no impact on this boiler project. It was just another thing to go and get because it was available. The impact on Project 1 was more.
None	These projects were well on their way before they became aware of the rebates.
None	This project had to be done at the time that it was (during shutdown) and the program had no impact on the efficiency level or size dimension. The company would have installed the same technology regardless.
None	This project we would have done otherwise.
None	To get the incentive, audits and repairs have to follow a specified methodology, so it's high as well. The program's existence tightens up our process.

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
None	When we planned to replace the door we knew we had to replace the door. Our general manager said to contact Enbridge to see if there is an incentive that we could get. They came over and looked at our plan. They told us there is an incentive and this is what it is going to be. The Enbridge incentive gave us a boost to do it. It went through faster.
None	We would have done these anyhow.
None	Installation had to happen, rebate was a nice bonus.
None	No influence on timing, quantity, or efficiency.
None	No program influence on timing, quantity, or efficiency.
None	The program did not have any influence on the timing, efficiency or quantity.
None	The program really just was a bonus for us (a surprise because we didn't know Enbridge was going to supply a credit).
None	We would have done the same; it’s a pure opportunity for savings; it's a mandate for every project we do, there has to be an energy component.
None	No comment.

RunitRight

This section presents the Enbridge RunitRight self-reported responses from the timing, efficiency and quantity attribution battery where customers were asked “Why do you say that?”. These responses along with whether a response received some timing or quantity credit are presented in Table 8-21 and Table 8-22.

A “yes” in the timing or quantity column indicates partial or full attribution for that source based on the scored questions (not the responses here). A “no” indicates no attribution for that source. For example in the first table a “yes” in the timing column indicates that the respondent answered the question DAT1a and DAT1b with responses that credited the program with accelerating the project. A “no” in the timing column indicates that the respondend did not credit the program with accelerating the project. A “no” for timing does not preclude the same respondant indicating the program affected the efficiency or quantity/size of the same project.

Additionally, following the specific timing, efficiency and quantity questions, customers were asked to summarize the program’s effect on the timing, efficiency and amount of the project installed (Dat4). These responses are presented in Table 8-23 with the scored level of attribution: full, partial, or none.

None of the responses provided below were used in the direct scoring of surveys. For respondent confidentiality these responses are isolated from other responses from the interview and do not reflect the full story the respondent conveyed. The responses are provided here to provide insight into how customers describe their decision making on the project relative to the program. See APPENDIX J and APPENDIX K for details on how attribution was scored.

Table 8-21: Timing Verbatim Responses for Enbridge RunitRight

Timing	Dat1a_O. Why do you say that?
Yes	We have a strong commitment to energy efficiency so the program's financial incentive helped accelerate the timeline of the gas projects by decreasing their cost and their payback periods.
Yes	Later or never. Some of the work we were aware needed to be done, but incentives allowed us to expedite work. Some things identified may have been overlooked/never done.
Yes	The rebate helped accelerate the project timeline.

Table 8-22: Quantity Verbatim Responses for Enbridge RunitRight

Quantity	Dat3a_O. Why do you say that?
Yes	Our internal efficiency audits are likely not as thorough as Enbridge's report.
Yes	No comment.
No	No comment.

Table 8-23: Dat4 Verbatim Responses for Enbridge RunitRight

Attribution	Dat4. Summarize the program's effect on the timing, efficiency, and amount that you installed.
Full	Helped identify the projects earlier and provided the motivation to act on them earlier.
Partial	Only affected the timing of the projects by helping to make them happen sooner.
Partial	The program helped expedite work and helped us complete a more extensive project overall. Also helped us identify/plan for future capital projects.
Partial	The ***** program accelerated the timeline for the gas projects.
Partial	The program has very significant influence on the timing and efficiency of the projects but it promotes the selection of the smaller or easier projects as opposed to larger or more complicated projects.
Partial	Unsure how program would have affected timing but it didn't affect the extensiveness or size of the projects.

APPENDIX D. GROSS RR RESULTS FOR ADDITIONAL DOMAINS

These results are not applied to calculate savings totals. The results in this section are different aggregations of the data that provide additional information to the programs and stakeholders. In the tables, results with less than 5 completes or absolute precision (+/-) greater than 20% are not shown, but the categories remain in the table to provide context for the results that can be reported.

The final table in each section has the application domain (same domain as in the body of the report) with non-finite population (non-FPC) corrected errors. Non-FPC errors provide a more appropriate estimate of error for projecting future program performance.

Overall ratios in these tables are the sample weighted average and not used in calculating verified gross savings for the programs.

Union Commercial, Industrial and Multi-Family Programs

Table 8-24: Targeted Sample Domain for Union Custom C&I and LIMF programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Overall	**114**	**74**	**98%**	**6%**	**92%**	**105%**	**6%**	**0.33**	**100%**

Table 8-25: Simple vs. Complex Engineering adjustment for Union Custom C&I and LIMF programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Complex	56	42	87%	7%	81%	94%	8%	0.29	67%
Simple	58	39	117%	12%	105%	129%	10%	0.38	33%
Overall	**114**	**74**	**98%**	**6%**	**92%**	**105%**	**6%**	**0.33**	**100%**

Table 8-26: Program and Simple vs. Complex Engineering adjustment for Union Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Complex	42	30	90%	7%	83%	97%	8%	0.26	54%
	Simple	38	25	116%	13%	103%	129%	11%	0.33	27%
Custom Commercial	Complex	11	9	68%	17%	51%	86%	26%	0.41	12%
	Simple	17	12	127%	35%	92%	163%	28%	0.53	5%
Multi-residential	Complex	3	3	124%	2%	122%	126%	2%	0.01	1%
	Simple	3	2	100%	0%	100%	100%	0%	0.00	0%
Overall		**114**	**114**	**98%**	**6%**	**92%**	**105%**	**6%**	**0.33**	**100%**

Table 8-27: Detailed Measures for Union Custom C&I and LIMF programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Hydronic Insulation	9	9	116%	11%	105%	127%	9%	0.15	8%
Heat Recovery	13	10	106%	10%	96%	117%	10%	0.17	20%
Greenhouse	15	9	92%	4%	88%	95%	4%	0.06	29%
Operational Improvements	9	7	90%	10%	80%	99%	11%	0.15	4%
Leak Repair	7	4	130%	32%	98%	162%	25%	0.21	6%
HVAC	10	10	85%	41%	44%	125%	48%	0.83	11%
Steam Trap	9	8	85%	1%	84%	86%	1%	0.02	3%
Other Action	2	1	191%	0%	0%	0%	0%	0.00	3%
Controls	10	9	82%	9%	74%	91%	11%	0.17	5%
Building Shell	8	6	99%	12%	87%	112%	12%	0.15	2%
Other Equipment	16	12	83%	18%	65%	101%	22%	0.42	9%
Other Multi-family	6	5	121%	8%	114%	129%	6%	0.07	1%
Overall	**114**	**74**	**98%**	**6%**	**92%**	**105%**	**6%**	**0.33**	**100%**

Table 8-28: Program and Detailed Measures for Union Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Meas.	Clusts.		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Building Shell	8	6	89%	8%	81%	97%	9%	0.11	2%
	Controls	4	4	88%	20%	68%	108%	23%	0.19	2%
	Greenhouse	15	9	97%	3%	94%	100%	3%	0.05	29%
	Heat Recovery	13	10	105%	10%	95%	114%	9%	0.16	20%
	HVAC	5	5	93%	12%	81%	106%	13%	0.14	2%
	Hydronic Insulation	9	9	116%	11%	105%	127%	9%	0.15	8%
	Leak Repair	7	4	121%	30%	92%	151%	24%	0.21	6%
	Operational Improvements	9	7	96%	8%	88%	105%	9%	0.12	4%
	Steam Trap	3	3	100%	1%	99%	101%	1%	0.00	2%
	Other Equipment	7	5	70%	25%	45%	95%	35%	0.37	6%
Custom Commercial	Controls	6	5	98%	4%	93%	102%	4%	0.05	3%
	HVAC	5	5	59%	25%	34%	84%	42%	0.44	9%
	Steam Trap	6	5	99%	3%	97%	102%	3%	0.03	1%
	Other Action	2	1	173%	0%	0%	0%	0%	0.00	3%
	Other Equipment	9	7	90%	11%	79%	101%	12%	0.17	2%
Multi-Family	Other	9	7	90%	11%	79%	101%	12%	0.17	2%
Overall		**114**	**114**	**98%**	**6%**	**92%**	**105%**	**6%**	**0.33**	**100%**

Table 8-29: Applied Domains with non-FPC Errors for Union Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Greenhouse Equipment	15	9	92%	5%	87%	97%	6%	0.09	29%
	Action	20	12	108%	20%	88%	127%	18%	0.35	12%
	Hydronic Insulation	9	9	116%	15%	101%	131%	13%	0.21	8%
	Other Equipment	36	25	101%	20%	81%	120%	19%	0.57	33%
Custom Commercial and LIMF		34	24	89%	30%	59%	120%	34%	0.98	19%
Overall		**114**	**74**	**99%**	**9%**	**89%**	**108%**	**10%**	**0.49**	**100%**

Union Large Volume

Table 8-30: Simple vs. Complex Engineering adjustment for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Complex	55	24	102%	20%	82%	122%	20%	0.57	49%
Simple	22	15	57%	23%	33%	80%	41%	0.91	51%
Overall	**77**	**36**	**78%**	**20%**	**58%**	**98%**	**26%**	**0.91**	**100%**

Table 8-31: Detailed Measures for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Hydronic Insulation	6	5	99%	2%	97%	100%	2%	0.02	44%
Heat Recovery	13	10	140%	57%	83%	196%	41%	0.70	8%
Operational Improvements	15	10	56%	12%	45%	68%	21%	0.36	19%
Leak Repair	18	11	46%	24%	23%	70%	51%	0.93	7%
Steam Trap	14	9	62%	34%	28%	96%	54%	0.88	4%
Other Action	3	3	96%	28%	67%	124%	30%	0.18	5%
Other Equipment	8	7	122%	109%	13%	232%	89%	1.22	13%
Overall	**77**	**36**	**78%**	**20%**	**58%**	**98%**	**26%**	**0.91**	**100%**

Table 8-32: Applied Domains with non-FPC Errors for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Equipment	24	18	116%	36%	80%	152%	31%	0.76	68%
Action	53	18	175%	176%	-1%	350%	101%	2.45	32%
Overall	**77**	**36**	**135%**	**81%**	**54%**	**217%**	**60%**	**2.13**	**100%**

Enbridge Commercial, Industrial and Multi-Residential Programs

Table 8-33: Targeted Sampling Domains for Enbridge Custom C&I and LIMF programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	53	41	100%	3%	97%	103%	3%	0.12	39%
Custom Commercial and LIMF	74	41	91%	14%	78%	105%	15%	0.57	61%
Overall	**127**	**82**	**95%**	**9%**	**86%**	**103%**	**9%**	**0.51**	**100%**

Table 8-34: Simple vs. Complex Engineering adjustment for Enbridge Custom C&I and LIMF programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Complex	64	41	100%	3%	97%	103%	3%	0.12	41%
Simple	63	45	92%	14%	78%	106%	15%	0.61	59%
Overall	**127**	**82**	**95%**	**9%**	**86%**	**103%**	**9%**	**0.51**	**100%**

Table 8-35: Program and Simple vs. Complex Engineering adjustment for Enbridge Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Simple	37	26	100%	4%	96%	104%	4%	0.11	33%
	Complex	16	16	102%	2%	101%	104%	2%	0.04	7%
Custom Commercial	Simple	22	14	82%	27%	56%	109%	33%	0.69	30%
	Complex	14	9	100%	7%	93%	107%	7%	0.11	6%
Multi-residential	Simple	25	15	104%	4%	100%	108%	4%	0.09	22%
	Complex	13	6	99%	2%	97%	101%	2%	0.02	2%
Overall		**127**	**82**	**95%**	**9%**	**86%**	**103%**	**9%**	**0.51**	**100%**

Table 8-36: Detailed Measures for Enbridge Custom C&I and LIMF programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Heat Recovery	13	10	98%	5%	93%	103%	5%	0.09	9%
Etools Boiler	18	12	104%	3%	101%	107%	3%	0.06	25%
Etools Ventilation	16	15	100%	3%	96%	103%	4%	0.08	21%
Steam Trap	21	13	124%	2%	122%	126%	1%	0.03	4%
Etools Boiler Add-on	8	7	101%	15%	86%	116%	15%	0.20	3%
Other Equipment	29	23	74%	27%	47%	101%	37%	1.03	34%
Other Action	3	3	20%	16%	4%	36%	80%	0.47	0%
Other Multi-Residential	19	9	101%	2%	99%	103%	2%	0.03	4%
Overall	**127**	**82**	**95%**	**9%**	**86%**	**103%**	**9%**	**0.51**	**100%**

Table 8-37: Program and Detailed Measures for Enbridge Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Etools Ventilation	4	3	106%	8%	97%	114%	8%	0.05	10%
	Heat Recovery	12	9	99%	5%	94%	104%	5%	0.08	9%
	Steam Trap	8	8	106%	3%	104%	109%	2%	0.04	2%
	Other Action	3	3	32%	25%	8%	57%	76%	0.45	0%
	Other Equipment	25	19	94%	6%	88%	99%	6%	0.15	18%
Custom Commercial	Etools Boiler	3	3	100%	0%	100%	100%	0%	0.00	8%
	Etools Boiler Add-on	8	7	106%	13%	94%	119%	12%	0.16	3%
	Etools Ventilation	8	8	97%	7%	90%	104%	8%	0.11	8%
	Steam Trap	13	5	100%	0%	100%	100%	0%	0.00	2%
	Other Equipment	4	4	52%	70%	-18%	122%	135%	1.15	16%
Multi-residential	Etools Boiler	15	9	107%	4%	103%	110%	3%	0.06	17%
	Etools Ventilation	4	4	93%	11%	82%	104%	12%	0.10	4%
	Other Multi-Residential	19	9	100%	1%	99%	101%	1%	0.02	4%
Overall		**127**	**82**	**95%**	**9%**	**86%**	**103%**	**9%**	**0.51**	**100%**

Table 8-38: Applied Domains with non-FPC Errors for Enbridge Custom C&I and LIMF programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Heat Recovery	13	10	98%	8%	90%	106%	8%	0.14	9%
	Steam Trap	8	8	128%	5%	123%	132%	4%	0.05	2%
	Other	32	25	99%	7%	92%	106%	7%	0.20	28%
Custom Commercial and Multi-residential		74	41	91%	15%	77%	106%	16%	0.61	61%
Overall		**127**	**82**	**95%**	**10%**	**85%**	**104%**	**10%**	**0.55**	**100%**

APPENDIX E. NTG Results for Additional Domains

These results are not applied to calculate savings totals. The results in this section are different aggregations of the data that provide additional information to the programs and stakeholders. In the tables, results with less than 5 completes or absolute precision (+/-) greater than 20% are not shown, but the categories remain in the table to provide context for the results that can be reported.

The final table in each section has the application domain (same domain as in the body of the report) with non-finite population (non-FPC) corrected errors. Non-FPC errors provide a more appropriate estimate of error for projecting future program performance.

Overall ratios in these tables are the sample weighted average and not used in calculating net savings for the programs.

Union Commercial, Industrial and Multi-Family Programs

Table 8-39: Targeted Sample Domain for Union Custom C&I programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	136	84	38%	5%	33%	43%	13%	0.74	82%
Custom Commercial	62	28	43%	11%	32%	54%	26%	0.80	18%
Overall	**198**	**112**	**39%**	**5%**	**34%**	**44%**	**12%**	**0.76**	**100%**

Table 8-40: Net-to-Gross Category for Union Custom C&I programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Equipment	147	85	41%	5%	36%	46%	12%	0.67	80%
Action	49	26	35%	12%	22%	47%	35%	1.06	19%
Multi-family	*	*	*	0%	*	*	0%	0.00	1%
Overall	**198**	**112**	**39%**	**5%**	**34%**	**44%**	**12%**	**0.76**	**100%**

Table 8-41: Program and Net-to-Gross Category for Union Custom C&I programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Equipment	107	67	42%	5%	36%	47%	13%	0.64	70%
	Action	29	17	24%	12%	11%	36%	52%	1.23	12%
Custom Commercial	Equipment	40	18	33%	4%	29%	37%	11%	0.27	11%
	Action	*	*	*	21%	*	*	36%	0.58	7%
Multi-family	Multi-family	*	*	*	0%	*	*	0%	0.00	1%
Overall		**198**	**112**	**39%**	**5%**	**34%**	**44%**	**12%**	**0.76**	**100%**

Table 8-42: Detailed Measures for Union Custom C&I programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Hydronic Insulation	12	12	42%	13%	29%	55%	31%	0.60	8%
Heat Recovery	29	21	59%	7%	52%	66%	12%	0.32	20%
Greenhouse	26	17	40%	12%	28%	52%	30%	0.70	29%
Operational Improvements	9	7	10%	9%	1%	19%	85%	1.16	4%
Leak Repair	14	9	37%	16%	21%	52%	42%	0.68	6%
HVAC	21	17	33%	17%	16%	51%	52%	1.23	11%
Steam Trap	14	12	38%	11%	27%	48%	28%	0.55	3%
Other Action	*	*	*	23%	*	*	62%	0.52	3%
Controls	23	13	45%	9%	36%	54%	20%	0.40	5%
Building Shell	*	*	*	20%	*	*	38%	0.66	2%
Other Equipment	28	19	18%	9%	10%	27%	47%	1.17	9%
Other Multi-family	*	*	*	0%	*	*	0%	0.00	1%
Overall	**198**	**112**	**39%**	**5%**	**34%**	**44%**	**12%**	**0.76**	**100%**

Table 8-43: Program and Detailed Measures for Union Custom C&I programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Meas.	Clusts		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Greenhouse	26	17	40%	12%	28%	52%	30%	0.70	29%
	Heat Recovery	29	21	59%	7%	52%	66%	12%	0.32	20%
	Hydronic Insulation	12	12	42%	13%	29%	55%	31%	0.60	8%
	Leak Repair	14	9	37%	16%	21%	52%	42%	0.68	6%
	Operational Improvements	9	7	10%	9%	1%	19%	85%	1.16	4%
	Building Shell	*	*	*	20%	*	*	38%	0.66	2%
	Controls	7	7	18%	4%	14%	22%	21%	0.29	2%
	Steam Trap	6	6	29%	12%	17%	41%	42%	0.52	2%
	HVAC	*	*	*	21%	*	*	95%	1.64	2%
	Other	10	8	7%	8%	-1%	15%	108%	1.61	6%
Custom Commercial	HVAC	10	7	46%	19%	27%	65%	41%	0.56	9%
	Controls	16	6	78%	5%	74%	83%	6%	0.07	3%
	Steam Trap	8	6	54%	16%	38%	69%	29%	0.35	1%
	Other Action	*	*	*	23%	*	*	62%	0.52	3%
	Other Equipment	18	11	38%	8%	30%	46%	20%	0.37	2%
Multi-Family	Other	*	*	*	0%	*	*	0%	0.00	1%
Overall		**198**	**112**	**39%**	**5%**	**34%**	**44%**	**12%**	**0.76**	**100%**

Table 8-44: Applied Domains with non-FPC Errors for Union Custom C&I programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Greenhouse	26	17	38%	27%	11%	65%	71%	1.68	29%
	Heat Recovery	29	21	58%	17%	41%	74%	29%	0.76	20%
	Leak Repair and Hydronic Insulation	26	21	35%	19%	17%	54%	53%	1.41	14%
	Operational Improvements	9	7	12%	15%	-3%	27%	123%	1.68	4%
	Controls	7	7	19%	8%	11%	26%	41%	0.56	2%
	Steam Trap	6	6	29%	21%	8%	50%	73%	0.89	2%
	Other	33	23	21%	19%	2%	40%	90%	2.51	10%
Custom Commercial	Controls	16	6	78%	39%	39%	117%	50%	0.61	3%
	Other	46	23	42%	32%	10%	75%	76%	2.13	16%
Overall		**198**	**112**	**38%**	**10%**	**28%**	**49%**	**27%**	**1.70**	**100%**

Union Large Volume

Table 8-45: Net-to-Gross Category for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Equipment	26	21	5%	2%	3%	7%	37%	0.98	68%
Action	57	20	12%	4%	8%	16%	34%	0.89	32%
Overall	**83**	**41**	**8%**	**2%**	**6%**	**10%**	**27%**	**1.02**	**100%**

Table 8-46: Detailed Measures for Union Large Volume

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Hydronic Insulation	10	7	6%	3%	3%	9%	51%	0.70	44%
Heat Recovery	13	10	7%	5%	2%	11%	70%	1.20	8%
Operational Improvements	20	12	13%	5%	7%	18%	41%	0.79	19%
Leak Repair	14	8	12%	6%	5%	18%	55%	0.82	7%
Steam Trap	17	11	21%	7%	13%	28%	35%	0.65	4%
Other Equipment	6	6	0%	0%	0%	0%	146%	1.77	13%
Other Action	*	*	*	0%	*	*	0%	0.00	5%
Overall	**83**	**41**	**8%**	**2%**	**6%**	**10%**	**27%**	**1.02**	**100%**

Table 8-47: Applied Domains with non-FPC Errors for Union Custom C&I programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Customers		+ / -	Lower Bound	Upper Bound	Relative Precision		
Hydronic Insulation	10	7	6%	12%	-7%	18%	217%	2.95	44%
Operational Improvements	20	12	17%	11%	6%	29%	67%	1.28	19%
Heat Recovery	13	10	11%	15%	-5%	26%	144%	2.48	8%
Leak Repair and Other Actions	17	11	7%	9%	-2%	15%	127%	2.33	12%
Steam Trap	17	11	21%	17%	4%	38%	83%	1.52	4%
Other Equipment	6	6	0%	0%	0%	0%	235%	2.86	13%
Overall	**83**	**41**	**11%**	**6%**	**5%**	**17%**	**58%**	**2.21**	**100%**

Enbridge Commercial, Industrial and Multi-Residential Programs

Table 8-48: Targeted Sample Domain for Enbridge Custom C&I programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	60	50	32%	5%	27%	37%	15%	0.65	42%
Custom Commercial	101	62	27%	7%	20%	35%	26%	1.20	58%
Overall	**161**	**112**	**29%**	**4%**	**25%**	**34%**	**15%**	**0.97**	**100%**

Table 8-49: Net-to-Gross Category for Enbridge Custom C&I programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Equipment	102	79	26%	4%	21%	30%	16%	0.87	76%
Action	24	16	25%	13%	12%	37%	51%	1.17	5%
Multi-Residential	35	17	44%	14%	30%	58%	31%	0.74	19%
Overall	**161**	**112**	**29%**	**4%**	**25%**	**34%**	**15%**	**0.97**	**100%**

Table 8-50: Program and Net-to-Gross Category for Enbridge Custom C&I programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Equipment	50	40	33%	5%	28%	38%	15%	0.56	40%
	Action	10	10	*	22%	*	*	96%	1.65	3%
Custom Commercial	Equipment	52	39	17%	7%	10%	24%	40%	1.47	37%
	Action	14	6	27%	5%	22%	33%	19%	0.23	2%
Multi-Residential	Multi-Residential	35	17	44%	14%	30%	58%	31%	0.74	19%
Overall		**161**	**112**	**29%**	**4%**	**25%**	**34%**	**15%**	**0.97**	**100%**

Table 8-51: Detailed Measures for Enbridge Custom C&I programs

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Heat Recovery	13	10	55%	9%	46%	64%	16%	0.27	10%
Etools Ventilation	30	29	12%	5%	7%	17%	43%	1.36	22%
Etools Boiler	24	19	27%	10%	17%	36%	36%	0.90	21%
Steam Trap	24	16	25%	13%	12%	37%	51%	1.17	4%
Etools Boiler Add-on	11	9	14%	4%	10%	18%	29%	0.46	3%
Other Equipment	42	33	28%	7%	21%	35%	25%	0.83	36%
Other Multi-Residential	17	7	97%	3%	94%	100%	3%	0.05	3%
Overall	**161**	**112**	**29%**	**4%**	**25%**	**34%**	**15%**	**0.97**	**100%**

Table 8-52: Program and Detailed Measures for Enbridge Custom C&I programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Clusters		+ / -	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Etools Ventilation	8	7	15%	10%	5%	25%	70%	0.95	10%
	Heat Recovery	13	10	55%	9%	46%	64%	16%	0.27	10%
	Steam Trap	*	*	*	22%	*	*	96%	1.65	2%
	Other Equipment	29	24	33%	7%	25%	40%	23%	0.65	19%
Custom Commercial	Etools Ventilation	15	15	5%	4%	1%	8%	72%	1.58	8%
	Etools Boiler	13	11	27%	15%	12%	41%	54%	0.99	8%
	Boiler Add-on	11	9	14%	4%	10%	18%	29%	0.46	3%
	Steam Trap	14	6	27%	5%	22%	33%	19%	0.23	2%
	Other	13	9	18%	12%	5%	30%	70%	1.13	17%
Multi-Residential	Etools Boiler	11	8	26%	14%	12%	40%	54%	0.80	13%
	Etools Ventilation	7	7	20%	14%	6%	34%	71%	0.97	3%
	Other	17	7	97%	3%	94%	100%	3%	0.05	3%
Overall		**161**	**112**	**29%**	**4%**	**25%**	**34%**	**15%**	**0.97**	**100%**

Table 8-53: Applied Domains with non-FPC Errors for Enbridge Custom C&I programs

Sector	Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
		Measures	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	Etool Ventilation	8	7	15%	22%	-7%	37%	146%	1.98	10%
	Heat Recovery	13	10	55%	30%	25%	85%	54%	0.93	10%
	Other	39	34	31%	18%	14%	49%	56%	1.95	22%
Custom Commercial	Etool Ventilation	15	15	5%	5%	0%	9%	91%	2.01	8%
	Etool Boiler and Boiler Add-on	25	20	23%	14%	9%	37%	61%	1.57	12%
	Steam Trap	14	6	27%	14%	13%	42%	52%	0.63	2%
	Other	12	8	21%	20%	1%	42%	97%	1.45	16%
Multi-Residential	Etool Boiler	11	8	27%	16%	10%	43%	61%	0.90	13%
	Etool Ventilation	7	7	20%	21%	-2%	41%	108%	1.47	3%
	Other	17	7	97%	4%	93%	101%	4%	0.06	3%
Overall		**161**	**112**	**29%**	**9%**	**21%**	**38%**	**29%**	**1.87**	**100%**

RunitRight

Table 8-54: Net-to-Gross Category for Enbridge RunitRight

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Clusters		+/-	Lower Bound	Upper Bound	Relative Precision		
Action	16	10	50%	14%	36%	64%	27%	0.47	100%
Overall	**16**	**10**	**50%**	**14%**	**36%**	**64%**	**27%**	**0.47**	**100%**

Table 8-55: Applied Domains with non-FPC Errors for Enbridge RunitRight

Domain	n		Ratio	90% Confidence Interval				Error Ratio	% Program Savings
	Measures	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
RunitRight	16	10	50%	20%	30%	70%	39%	0.68	100%

APPENDIX F. SECONDARY ATTRIBUTION Results

These results are not applied to calculate savings totals. This secondary attribution approach is lower rigour than the primary approach and provides a sense of the incremental effect that historical program efforts have on projects today. This score is not intended for application in determining program net savings.

Union Commercial, Industrial and Multi-Family Programs

Table 8-56: Secondary Attribution for Union Custom C&I programs

Sector	Domain	n		Secondary Attr Ratio	Ratio	Ratio Difference	% Program Savings
		Measures	Clusters				
Custom Industrial	Greenhouse	26	17	46%	40%	6%	29%
	Heat Recovery	29	21	61%	59%	2%	20%
	Leak Repair and Hydronic Insulation	26	21	54%	40%	14%	14%
	Operational Improvements	9	7	10%	10%	0%	4%
	Controls	7	7	51%	18%	32%	2%
	Steam Trap	6	6	35%	29%	7%	2%
	Other	33	23	21%	21%	0%	10%
Custom Commercial	Controls	16	6	92%	78%	14%	3%
	Other	46	23	45%	38%	7%	16%
Overall		**198**	**112**	**45%**	**39%**	**6%**	**100%**

Union Large Volume

Table 8-57: Secondary Attribution for Union Large Volume

Domain	n		Secondary Attr Ratio	Ratio	Ratio Difference	% Program Savings
	Measures	Clusters				
Hydronic Insulation	10	7	6%	6%	0%	44%
Operational Improvements	20	12	21%	13%	8%	19%
Heat Recovery	13	10	15%	7%	9%	8%
Steam Trap	17	11	21%	21%	1%	4%
Other Equipment	6	6	1%	0%	1%	13%
Leak Repair and Other Actions	17	11	17%	9%	8%	12%
Overall	**83**	**41**	**12%**	**8%**	**4%**	**100%**

Enbridge Commercial, Industrial and Multi-Residential Programs

Table 8-58: Secondary Attribution for Enbridge Custom C&I programs

Sector	Domain	n		Secondary Attr Ratio	Ratio	Ratio Difference	% Program Savings
		Measures	Clusters				
Custom Industrial	Etools Ventilation	8	7	15%	15%	0%	10%
	Heat Recovery	13	10	61%	55%	6%	10%
	Other	39	34	39%	31%	8%	22%
Custom Commercial	Etools Ventilation	15	15	35%	5%	31%	8%
	Steam Trap	14	6	61%	27%	33%	2%
	Etools Boiler and Boiler Add-on	25	20	27%	24%	3%	12%
	Other	12	8	24%	18%	6%	16%
Multi-Residential	Etools Boiler	11	8	30%	26%	4%	13%
	Etools Ventilation	7	7	60%	20%	41%	3%
	Other	17	7	99%	97%	1%	3%
Overall		**161**	**112**	**39%**	**29%**	**9%**	**100%**

RunitRight

Table 8-59: Secondary Attribution for Enbridge RunitRight

Domain	n		Secondary Attr Ratio	Ratio	Ratio Difference	% Program Savings
	Measures	Clusters				
RunitRight	16	10	60%	50%	10%	100%
Overall	**16**	**10**	**60%**	**50%**	**10%**	**100%**

APPENDIX G. VENDOR ATTRIBUTION

The NTG ratio includes two components, a participant score and a vendor score. APPENDIX K provides details of how vendor interviews are triggered and how vendor scores are used.

Union Commercial, Industrial and Multi-Family Programs

Table 8-60 shows that of the 51 measures that we attempted to contact the vendor, we completed 24 via 14 vendor interviews.

Table 8-60: Vendor Interviews for Union Custom C&I programs

Vendor Involvement	Attribution	Customers		Measures		Percent Savings
		N	n	N	n	
Vendor not involved in decision		38	N/A	85	N/A	48%
Vendor not important		11		26		16%
Vendor important	100% Direct Attribution	18		36		14%
	<100% Direct Attribution	31	14	51	24	23%
Total		**98**	**14**	**198**	**24**	**100%**

Table 8-61 shows a comparison of attribution with and without vendors. The table shows that vendor scores increased attribution by 3% overall, with the greatest effect being a 12% increased for controls.

Table 8-61: Attribution with and without Vendors for Union Commercial, Industrial and Multi-Family Programs

Sector	Domain	n		Ratio with Vendor	Ratio without Vendor	Ratio Difference	% Program Savings
		Measures	Clusters				
Custom Industrial	Greenhouse	26	17	40%	40%	0%	29%
	Heat Recovery	29	21	59%	59%	0%	20%
	Leak Repair and Hydronic Insulation	26	21	40%	36%	4%	14%
	Operational Improvements	9	7	10%	6%	4%	4%
	Controls	7	7	18%	6%	12%	2%
	Steam Trap	6	6	29%	27%	2%	2%
	Other	33	23	21%	18%	3%	10%
Custom Commercial	Controls	16	6	78%	78%	0%	3%
	Other	46	23	38%	31%	7%	16%
Overall		**198**	**112**	**39%**	**36%**	**3%**	**100%**

Union Large Volume

Table 8-62 shows that we attempted to contact five vendors and were only able to complete one.

Table 8-62: Vendor Interviews for Union Large Volume

Vendor Involvement	Attribution	Customers	
		N	n
Vendor not involved in decision		16	N/A
Vendor not important		2	
Vendor important	100% Direct Attribution	11	
	<100% Direct Attribution	5	1
Total		**34**	**1**

For confidentiality reasons, the number of measures and percent of savings cannot be reported for this program.

Table 8-63 shows that vendor attribution did not increase overall attribution for this program.

Table 8-63: Attribution with and without Vendors for Union Large Volume

Domain	n		Ratio with Vendor	Ratio without Vendor	Ratio Difference	% Program Savings
	Measures	Clusters				
Hydronic Insulation	10	7	6%	6%	0%	44%
Operational Improvements	20	12	13%	13%	0%	19%
Leak Repair and Other Actions	17	11	9%	9%	0%	12%
Heat Recovery	13	10	7%	7%	0%	8%
Steam Trap	17	11	21%	21%	0%	4%
Other Equipment	6	6	0.1%	0.1%	0%	13%
Overall	**83**	**41**	**8%**	**8%**	**0%**	**100%**

Enbridge Commercial, Industrial and Multi-Residential Programs

Table 8-64 shows that of the 49 measures that we attempted to contact the vendor, we completed 23 via 19 vendor interviews.

Table 8-64: Vendor Interviews for Enbridge Custom C&I programs

Vendor Involvement	Attribution	Customers		Measures		Percent Savings
		N	n	N	n	
Vendor not involved in decision		27	N/A	50	N/A	31%
Vendor not important		6		9		9%
Vendor important	100% Direct Attribution	29		54		30%
	<100% Direct Attribution	37	19	49	23	30%
Total		**99**	**19**	**162**	**23**	**100%**

Table 8-65 shows that vendor attribution increased overall program attribution by 2%. The greatest increases were for Multi-residential boilers and ventilation.

Table 8-65: Attribution with and without Vendors for Enbridge Custom C&I programs

Sector	Domain	n		Ratio with Vendor	Ratio without Vendor	Ratio Difference	% Program Savings
		Measures	Clusters				
Custom Industrial	Etools Ventilation	8	7	15%	15%	0%	10%
	Heat Recovery	13	10	55%	55%	0%	10%
	Other	39	34	31%	30%	1%	22%
Custom Commercial	Etools Ventilation	15	15	5%	5%	0%	8%
	Steam Trap	14	6	27%	27%	0%	2%
	Etools Boiler and Boiler Add-on	25	20	24%	22%	2%	12%
	Other	12	8	18%	16%	2%	16%
Multi-Residential	Etools Boiler	11	8	26%	19%	7%	13%
	Etools Ventilation	7	7	20%	11%	8%	3%
	Other	17	7	97%	97%	0%	3%
Overall		**161**	**112**	**29%**	**28%**	**2%**	**100%**

RunitRight

Table 8-66 shows that we attempted to contact two vendors and were only able to complete one.

Table 8-66: Vendor Interviews for Enbridge RunitRight

Vendor Involvement	Attribution	Customers	
		N	n
Vendor not involved in decision		3	N/A
Vendor not important		1	
Vendor important	100% Direct Attribution	1	
	<100% Direct Attribution	2	1
Total		**7**	**1**

For confidentiality reasons, the number of measures and percent of savings cannot be reported for this program.

Table 8-67 shows that vendor attribution did not increase overall attribution for this program.

Table 8-67: Attribution with and without Vendors for Enbridge RunitRight

Domain	n		Ratio with Vendor	Ratio without Vendor	Ratio Difference	% Program Savings
	Measures	Clusters				
RunitRight	16	10	50%	50%	0%	100%
Overall	**16**	**10**	**50%**	**50%**	**0%**	**100%**

APPENDIX H. MAPPING OF REPORTING DOMAINS TO TRACKING CATEGORIES

A map of reporting domains to tracking database records and categorization will be provided to each utility in Excel format to facilitate adding the ratio results to their internal data.

APPENDIX I. SAMPLING PROCESS

This appendix provides detail on the:

- High-level process used in sampling
- exploration of tracking data
- definition of the unit of analysis
- stratification decisions
- 2015 FR and CPSV sample design
- 2013/14 Spillover Sample design
- Sample and backup sample selection

High-level process

A sample is a collection of data items such as those collected through surveys, metering or on-site observation. A sample design is required when a sample does not include the entire target population. Most sample designs are driven by cost constraints (including schedule constraints), desired precision or both. The sampling process described here ensures that all bases are covered, ensuring optimal precision around estimates of interest for the data collected. The process we followed is detailed below. All numbers and observations and goals described were operating assumptions used at the beginning of the process:

1. **Identify Goals, Methods and Constraints**: for sampling, the goals consist of identifying the primary and secondary estimates of interest: what quantitative results are most important. Defining the data collection methodology –the process used to gather the data for the analysis – and the estimation method – the approach used to calculate the primary estimate of interest – is critical for defining elements of the design. Cost and schedule constraints surrounding the data collection and analysis then determine an upper bound for the sample size.

   - **Goals**: For this study the primary estimate of interest is the NTG ratio for each program. The NTG ratio is the parameter that we are targeting for 90/10 precision for each program.

     As will be described later in the methodology memo, we calculate the NTG ratio as

     NTG = (1-FR)*(1+SO).

     Since spillover tends to be small, this formulation is mathematically very close to the simpler formula indicated in the recent Ontario evaluations

     NTG = 1-FR + SO.

     We prefer the multiplicative formula as a more complete expression of the relationship between free ridership and spillover.

     Previous work in Ontario indicates that free ridership is on the order of 10% to 60% across program segments, 50% overall on a savings-weighted basis. Spillover is on the order of 5%. Because spillover is generally small, the precision of the full NTG will in most cases be close to that of the net-of-free rider factor, even with a modest spillover sample size.

   - **Methods and Constraints:** We are using two data collection methods, each of which have different costs associated. Due to cost constraints we must limit our use of on-sites to those projects where it will make the most difference in the estimate. These will be deployed on the largest and most complex projects as identified based on tracking data descriptions. TSERs will be used to collect the balance of the data that we do not have the funds to collect with On-sites. For smaller and simpler projects where the decisions made are more straight forward, TSER verification provides accurate data at a reasonable cost.

Define the unit of analysis: The unit of analysis is the level at which final estimates will be made. Some studies have multiple units of analysis: process evaluation results may be based on respondent level estimates, while impact evaluation results may be based on measure or project level estimates. Sampling units do not need to be the same as the unit of analysis, but identifying both early is crucial.

We are using the same definition for our sampling unit. Most customers have no more than three projects in a given year, and most projects are of only one or two measure types, so that we will be able to inquire about all of these in a single survey or interview of reasonable length.

We plan to ask each sampled customer about attribution for all of the customer's measures. Only a handful of customers have more than three (unit of analysis level) measures in 2016, with a maximum of six.

For customers with large numbers of projects and measures, we will ask about groups of measures or projects. The groupings will depend on details of the types of measures and savings magnitudes.

Identify the target population: The target population is the universe of items that inferences and estimates are desired for. In the initial scope of the NTG study, the primary target population was defined as future programs of the same type. Having future program years as the target population has two implications for the sample design. First, the applicable error associated with our estimates is the non-finite population corrected error (described in our discussion of sample size below) which requires larger sample sizes for a given precision. Second, analysis by sub-domains such as measure types within the programs becomes more important. The measure mix in programs changes from year to year and typically NTG varies more across measure types than within. For more accurate estimates of net savings for future program years, applying measure type NTG ratios will be preferred to program as a whole NTG ratios. At this time the question of prospective vs. retrospective application of NTG results is unresolved. The final sample design is expected to result in precision levels sufficient for either application of the results.

Establish the Sample Frame: The sample frame refers to the list or mechanism from which the sample is drawn. A perfect frame will match the target population exactly.

Since the target populations of this study are the future programs, we will not have a perfect sample frame; however, if the program designs remain relatively stable, using past program participants as the sample frame will provide a good list from which to draw our sample.

Determine sample size: Sample size refers to the number of items that are selected from the sample frame in order to draw inferences and create estimates about the target population. In stratified designs, sample sizes are determined for each stratum.

Critical to the sample size determination is the error ratio for each sampling cell with respect to the ratio to the estimated. The error ratio for ratio estimation is the equivalent of the coefficient of variation for estimation of a population mean. Our experience with conducting similar NTG studies of commercial-industrial customers is that the error ratio for the free rider rate is between 0.7 and 0.8 within reasonably defined sampling cells.

In determining these sample sizes, the number of customers in the full population is also important for two reasons. First, if we are trying to estimate a parameter for a finite population, the sample size required is reduced by the Finite Population Correction or FPC. Second, we need to consider the number of completed surveys we can realistically complete given likely response rates.

Use of the FPC is appropriate when the parameter of interest represents a particular population. This situation applies when we are determining the free ridership factor or spillover rate for a particular program and time frame. When we determine these factors for all future theoretical projects, it is arguably more appropriate to treat the sample drawn from recent participants as coming from an essentially infinite population. Thus, for projection to future years we generally recommend against applying the FPC.

Stratification: Stratification is the partitioning of a target population. Stratification is discussed in depth in the sample design section in the body of the Scope of Work.

Sample Selection: Sample selection refers to the process of obtaining the sample of units from the sample frame. If all units on the sample frame are selected then the design is referred to as a census or certainty sample. Otherwise units may be selected either randomly or non-randomly, depending on the evaluation goals, constraints and amount of acceptable bias. The sample selection process is a critical feature of the sample design and has a direct impact on the expected precision and bias of estimates. The optimal sample selection process for a particular project can vary greatly.

Unit and Item non-response Unit and item nonresponse are potential sources of bias, depending on the nonresponse mechanism and the level of nonresponse encountered. Unit nonresponse refers to the absence of information from an entire sampled unit. Item nonresponse refers to the situation where some data are collected, but not all, from a sampled unit. The nonresponse mechanism refers to the process that is causing the nonresponse. If the probability of responding depends on the data items being sought then the nonresponse mechanism is said to be non-ignorable. Otherwise it is called an ignorable nonresponse mechanism. Nonresponse bias tends to be greater when the nonresponse mechanism is non-ignorable and as levels of item nonresponse increase.

There are various ways to address nonresponse in a sample. For example, weight adjustments are often used to account for unit nonresponse and item imputation techniques are often used to account for item nonresponse.

If nonresponse levels are low and the response mechanism is thought to be ignorable then one could ignore nonresponse and simply create estimates among the respondents.

We recommend treating unit nonresponse as ignorable for this study since it does not depend on the data items being sought. Instead, it depends on the willingness of the decision maker at the participating business agreeing to respond to the survey.

For item nonresponse in the scored portion of the surveys we recommend treating the nonresponse as non-ignorable if all three of the T, E, Q portions of the free ridership sequence contain non-response. Otherwise we plan to treat the item nonresponse as ignorable and will impute the average response for the missing item from among scored units of the same measure type and utility. The exception to this rule is when we find conflicting responses in our QC of the data collection that indicates the nonresponse is non-ignorable. For non-ignorable item nonresponse we will drop the unit from the analysis.

Expansion Sample expansion refers to the process of extrapolating results from a sample back to the target population of interest. Often times this is done using a sample weight. The weight is a numeric quantity associated with each responding unit and conceptually represents the amount of the target population the responding unit represents during the analysis. The sample weight is some function of the total number of units on the sample frame.

The sample weight for our analysis will be built from the inverse probability of selection, incorporating additional adjustment factors to account for nonresponse and coverage errors. The sample weight will be utilized along with the "size" of the unit (energy savings) to expand results using ratio estimation, as described in the ratio estimation appendix of this work plan.

Domains of interest: Often times, estimates for an entire target population are of interest, but so are estimates for various subgroups. Subgroups may or may not overlap. Identifying the population domains of interest is another critically important design feature because it affects the decisions being made about other design features, such as the desired sample size, stratification variables and primary and secondary estimates of interest.

Explore the tracking data

We explored the tracking data provided by Union and Enbridge to determine data availability, the number and types of measures installed, and the size and quantity of projects. We explored the Union and Enbridge datasets separately.

Enbridge custom participant data

The custom program participant data files provided by Enbridge included custom C&I energy efficiency projects claimed during the 2013-2015 program years and custom Low Income Multi-Family projects claimed in 2015 (Table 8-68). The records in the tracking data are per installed measure, so there may be multiple rows per project if more than one measure is installed, and there may also be more than one project per account. There are 124 accounts that appear in both the 2015 program year and the 2013/14 program years.

Table 8-68. Enbridge Custom C&I and Multi-Residential program participation metrics by year

Program Year	Accounts	Gas Savings (m^3)
2013	680	53,030,333
2014	573	46,195,015
2015	706	51,330,067

The Enbridge custom project tracking data includes measure level savings specific to a measure, site and date. As part of defining the unit of analysis, we used the tracking data variables *Market Type, load type name*, *end use*, and *technology* to categorize measures into measure types that would be meaningful for data collection and expansion, shown in Table 8-69.

Table 8-69. Enbridge participation metrics by measure, 2013-2015

Measure Type	2013-2014 (SO)		2015 (CPSV/FR)	
	Accounts	Gas Savings (m^3)	Accounts	Gas Savings (m^3)
HVAC	636	32,807,840	380	19,105,965
Controls	337	17,821,495	175	13,868,059
Other Equipment	121	25,151,192	10	2,153,339
Operational Improvements	119	9,672,787	55	7,811,661
Heat Recovery	16	1,092,519	29	4,398,419
Steam and Hot Water	175	3,376,999	86	1,825,048
Process Heat	14	4,786,413	3	73,078
Building Shell	38	1,833,941	89	1,794,104
Greenhouse	10	2,682,162	3	300,394

Enbridge RunitRight participation data

For RunitRight, the program tracking data includes projects claimed in the 2014-2015 program years. These projects were all completed in 2013-2014; savings for a project in the program do not get claimed until after one year of site metering is complete.

Table 8-70. Enbridge RunitRight program participation metrics by year claimed

Program Year	Accounts	Gas Savings (m^3)
2014	45	625,088
2015	28	542,442

The RunitRight program has only one measure type. It also has several projects with negative savings. Negative savings (increases in energy use) are possible results from retro-commissioning projects, sometimes due to calculation method (billing analysis based savings without weather, occupancy adjustment or production adjustment) or due to actual increases in energy use. Negative saving measures need to be handled carefully in ratio estimation: high FR on large negative savings projects can result in overall program FR <0, which is not a valid result.[26] Our recommended approach to the problem is to produce and apply ratios with separate domains for positive and negative savings projects.

Union custom participant data

The participant data files provided by Union included energy efficiency projects claimed during the 2013-2015 program years. The records in the tracking data are per installed measure, so there may be multiple rows per project if more than one measure is installed, and there may also be more than one project per account. There are 67 accounts that appear in both the 2015 program year and the 2013/14 program years.

[26] Free ridership on negative savings results in more program savings, rather than less.

Table 8-71. Union participation metrics by year

Program Year	Accounts	Gas Savings (m^3)
2013	352	369,438,742
2014	392	285,752,549
2015	462	201,620,726

We used the *project type*, *equipment type*, and *project category* variables in the tracking data to categorize measures. Our first step was to distill the combined information from the three fields into measure types that would be meaningful for data collection and expansion, shown in Table 8-72. The largest measure types (by cumulative savings) were maintenance, steam and hot water, and optimization.

Table 8-72. Union participation metrics by measure, 2013-2015

Measure Type	2013-2014		2015	
	Accounts	Gas Savings (m^3)	Accounts	Gas Savings (m^3)
Maintenance	222	255,847,232	79	37,181,863
Steam and Hot Water	161	119,657,223	91	39,229,635
Optimization	91	94,790,733	28	16,936,421
Ag and Greenhouse	149	64,895,560	73	31,875,980
Heat Recovery	86	38,174,741	52	19,797,904
Other Equipment	56	27,104,377	13	20,653,141
Controls	78	16,785,704	128	13,267,526
HVAC	48	14,885,291	49	8,829,742
Process Heat	25	13,242,538	10	4,536,172
Building Shell	152	5,599,318	68	3,597,883
New Construction	19	3,714,489	5	4,589,777
Cogeneration	4	494,085	1	1,124,682

Define the unit of analysis

Following data exploration, we defined the unit of analysis, which established the level at which data will be analyzed but not the level at which it will be collected, which is the sampling unit. We further discuss this distinction and how the sampling unit is defined in the Task 2.5 section.

The definition of the unit of analysis is one of the most important and least discussed aspects of DSM program evaluation. Consider the following four dimensions: end -use, measure type, equipment or "action," and calculation approach. The program tracking databases include the first three dimensions and do not have an identifier for the fourth (though there may be a way to proxy it). Our example assumes that calculation type can be defined at a high level with reasonable accuracy based on existing database fields for the 2015 program year. Table 8-73 shows six measures performed at a site in a year through a program. Each of these categories could be considered a possible unit of analysis.

Table 8-73: Example dimensions used to define a unit of analysis

Measure ID	Enduse	Measure Type	Equipment or Action	Calc Type
M1	Process Heat	Boiler	Action	Complex
M2	Process Heat	Boiler	Equipment	Complex
M3	Space Heat	Boiler	Action	Simple
M4	Space Heat	Boiler	Equipment	Simple
M5	Space Heat	Furnace	Action	Simple
M6	Space Heat	Furnace	Equipment	Simple

- **The end use** can be important in decision making because lowering the cost per unit produced is a different decision than lowering the cost of heating a facility or office, for example. It can also be used as a proxy for the complexity of the calculation, as process-related end uses tend to have more complex and site-specific calculation approaches. End use can be used in surveys by listing the measure types that fall into the category; however, this is not ideal for NTG as the program's influence on decision making may differ by measure type, affecting the attribution response.
- **Measure type** is important for surveys to aid participant recall by providing a concrete, simple description of what equipment was altered or installed. This aggregation is less appropriate for CPSV where the calculation method may differ.
- **Equipment or Action** is a very important distinction for NTG. Continuous improvement actions, such as maintenance, operations, and optimization, have fewer barriers to implementation than equipment purchases due to lower total cost, shorter term planning horizons and often fewer approvals. Businesses typically have separate budgets for capital and operating expenses. Purchases of new or replacement equipment falls under a capital budget, while actions are usually part of the operating budget or performed by salaried employees. Capital budgets typically have long term planning and allocation, while an operating budget is by nature more flexible to conditions in a given year. The ability of programs to affect equipment and action decision making is necessarily different as well. For the unit of analysis, actions were put into three categories: maintenance, operational improvement, and optimization.
- **Calculation type** is important for CPSV. Simple, commonly implemented measures in custom programs do not require the same depth of data collection to verify calculations and inputs as more complex measures. Simple measures also use standardized calculation approaches that reduce variance. Evaluators tend to find fewer adjustments and, even when adjustments are found, the adjustment often affects all measures of a calculation approach similarly.

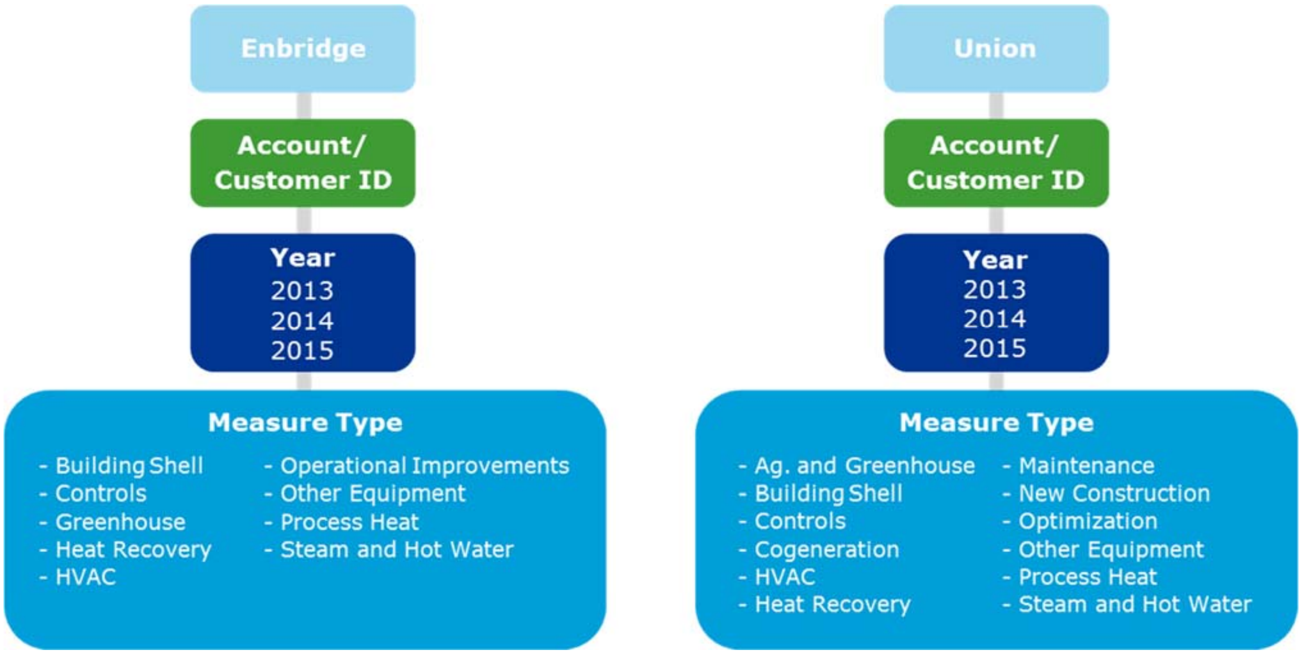
In the example shown in Table 8-73, aggregating across any of the four listed dimensions is a trade-off of accuracy for increased precision, reduced customer burden and reduced evaluation costs. Not aggregating makes the same trade-off, but in reverse.

We aggregated across elements that are likely to have a lesser effect on decision making (such as type of insulation) and did not aggregate across distinctions that are likely to play a larger role in how decisions were made (such as process vs space heat).

The unit of analysis for the evaluation, presented in Figure 8-1, aggregates the data to the utility, account, year, and measure type. For Union, aggregating the tracking data to the unit of analysis reduced the number of records from 744 to 597 records for 2015 and from 1,468 to 1,091 records for 2013 to 2014. For

Enbridge, the number of records for 2015 decreased from 955 to 858 records and for 2013 to 2014 decreased from 1,648 to 1,511 records.

Figure 8-1: Unit of analysis



For this evaluation, the unit of analysis and the sampling units are defined differently. While a unit of analysis separates units of different accounts/sites, program years or measure types, the sampling unit is specific to the customer. As an example, one Enbridge customer may have installed a new boiler in 2013 and insulation in 2014, which is two different units of analysis. Since they were installed by the same customer, however, they belong to one sampling unit. In the analysis phase, weights will be developed for each unit of analysis (account-measure type-year), but for the standard error calculation, data collected from a single customer (sample unit) will be a treated as a cluster rather than evaluated as if they are independent observations.

Once aggregated to the unit of analysis, Union had an average of 1.5 units of analysis per account in 2013 and 2014 and 1.3 units per account in 2015[27] while Enbridge has an average of 1.2 units per account in 2013, 2014, and in 2015. In general, Union accounts tended to have more units of analysis per account than Enbridge accounts. Only 26 Union accounts have 5 units and none had more than 5. For Enbridge, 9 accounts have 4 units and no accounts have more than 4. This will facilitate data collection, since it's reasonable to ask about 3-4 units.

At this time we are unable to comment on the number of units per customer, because some customers will likely have multiple accounts. Customers will be defined by their contact information which will be requested along with the documentation request following submission of the scope of work.

[27] We are assuming a 1:1 account to customer ratio for sampling. For the analysis, customer will be defined by contact information (phone number primarily), which is not included in the provided tracking data.

Stratify the NTG and CPSV data

There is a balance between having too many and too few strata.[28] In sample designs, more strata allow the design to control representativeness and estimated precision along more dimensions. Having more strata does not hurt overall precision, but it can increase the sample sizes required. Each stratification level serves to improve efficiency, improve representativeness, or both.

There are four populations across which the evaluation findings will be completely separate from one another.[29] These populations are defined by having separate program designs. The divisions between these populations are hard lines; none of the reported ratio results will include a mix of information across these populations. We can think of this as four evaluations using a common methodology and data collection effort:

- Union Large Volume
- Union Custom C&I
- Enbridge Custom C&I
- Enbridge RunitRight

Within the stratification segments (see **Figure** 8-2 and Figure 8-3) we categorize measures to improve the efficiency and representativeness of the sample. [30] The stratification for the 2015 data collection effort balances the needs of two studies, with the CPSV sample a subset of the NTG sample. Each has differing measure categorization priorities. [31]

- For NTG the measure categorization most predictive of free ridership rates is whether the project is installation of efficient equipment or whether the project was an action taken with existing equipment, regardless of whether that action is maintenance or an optimization that leads to energy savings.
- For CPSV the measure categorization most predictive of verification rates is a simple calculation versus one that is complex. Simple projects that follow consistent approaches and vary less from site to site typically have verification rates with lower variance than more complex projects that require more site-specific knowledge and truly custom calculations. Stratifying by rigour allows us to assign a lower ER (0.3) to the simple project strata and higher to the more complex strata (0.4 ER) which provides better sample allocation. Simple strata projects will receive a TSER verification, while complex strata projects will receive an on-site verification.

The final stratification level segments projects by the magnitude of energy savings resulting from that project. Large projects represent a greater portion of the population, so sampling them at increased rates will result in greater precision with fewer verification visits or calls. Smaller projects must also be sampled to ensure representativeness. DNV GL used cumulative savings as a measure of size for the 2015 sample designs and annual savings as a measure of size for 2013/14 sample designs. Cumulative savings were not

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[28] DNV GL agrees with the approaches described in “Sampling Methodology for Custom C&I Programs” which was prepared by Navigant for the TEC in 2012 and used to inform previous CPSV sample designs. Our sample design approach is consistent with the approaches recommended and follows the recommended seven step process (pages 17-23).
Dan Violette, Ph.D. & Brad Rogers, M.S., MBA, Navigant Consulting, Inc. “A Sampling Methodology for Custom C&I Programs,” Prepared for: Sub-Committee of the Technical Evaluation Committee. November 12, 2012 (Revised October 28, 2014).

[29] For the CPSV, LI MF will be reported with MR MF either together with Custom C&I or as a separate Multi-Family domain, depending on final sample sizes and precisions.

[30] Page 14 in the Navigant report provides an explanation of the rationale for stratification.

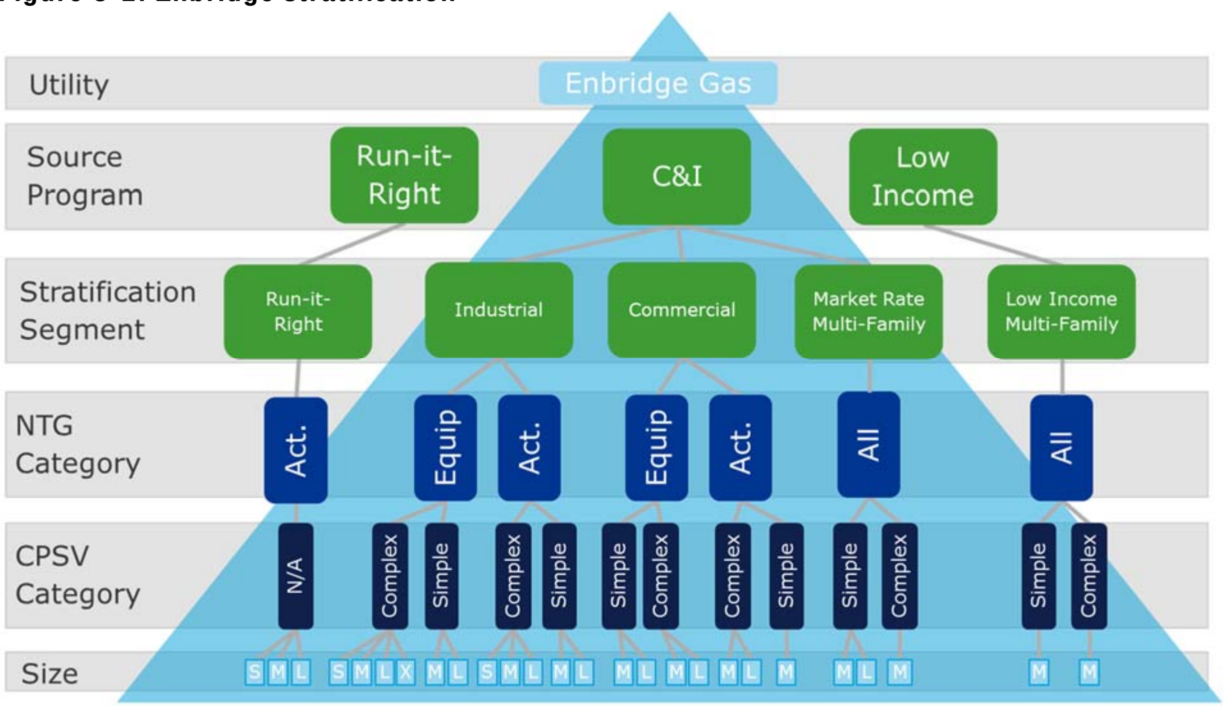
[31] The current stratification plan has more aggregated program segment categories than were described in the original proposal. When developing the proposal sample design, we did not have access to the data or savings amounts specific to measure types.

provided for 2013/14.[32] In terms of sample allocation, using annual savings will select longer life measures at a lower rate than would occur if cumulative savings are used.

It is important to note that the stratification used for sampling and expansion does not need to correspond directly to the level of reporting. For example, while we have chosen to use broad categories of customer segments in our stratification, this does not preclude reporting by more disaggregate customer segments.

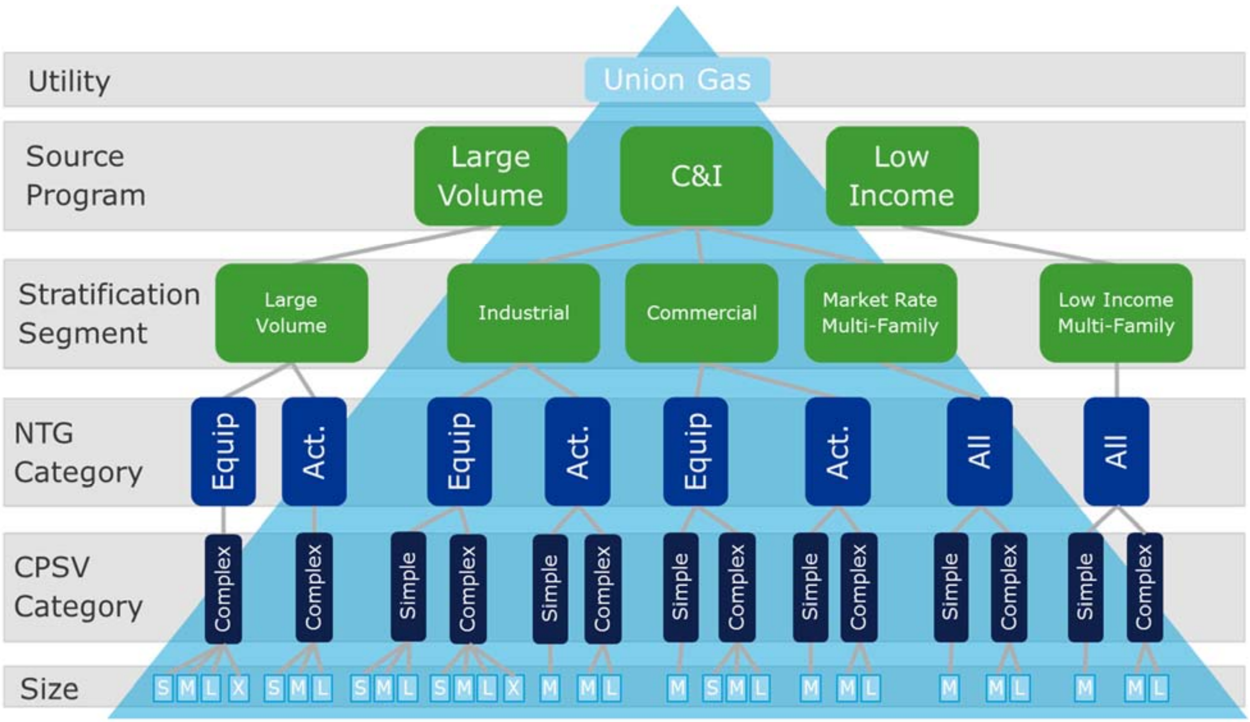
Figure 8-2 and Figure 8-3 show the CPSV and NTG stratification for Enbridge and Union respectively.

Figure 8-2: Enbridge stratification



32 The August 4, 2016 data provided by Enbridge included cumulative savings for 2015, but not 2013 and 2014.

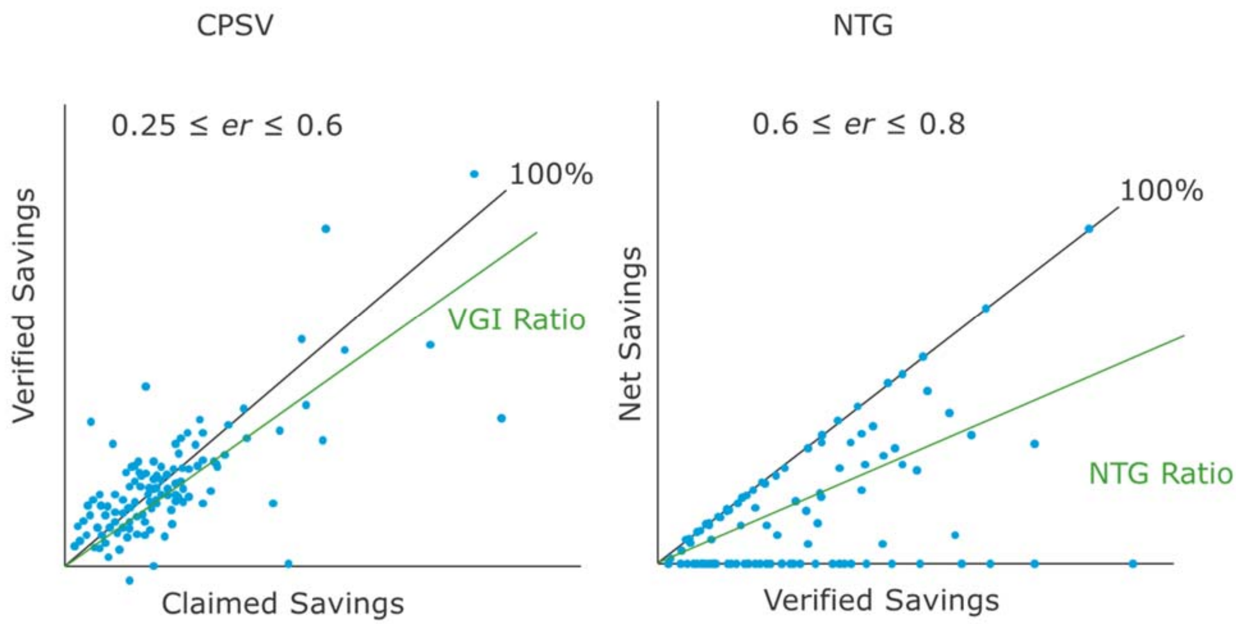
Figure 8-3: Union stratification



Design the 2015 samples

Critical to the sample size determination is the error ratio for each sampling cell with respect to the ratio to be estimated. The error ratio for ratio estimation is the equivalent of the coefficient of variation for estimation of a population mean. Free ridership is measured as a percentage between 0 and 100%, with clustering of responses on the extremes. The clustering of responses at 0 and 100% means that the error ratio for NTG studies is generally higher than that for engineering verification, where most of the estimates cluster reasonably close to the tracking savings estimates. Figure 27 shows the expected clustering of results for the two study types.

Figure 8-4: Error ratio example-plots



Our experience with conducting similar studies of commercial-industrial customers is that the error ratio for NTG factors is between 0.6 and 0.8 within reasonably defined sampling cells. SO typically has an error ratio higher than that of FR. Our sample design assumes an ER of 0.6 for FR and 0.8 for SO.

Including the Equipment vs. Action level of stratification allows us to use a 0.6 ER assumption for FR, rather than the 0.7 ER assumption that we would use without.

The CPSV sample of the 2015 program year will target a subset of sites selected for the FR portion of the study. CPSV error ratios are typically lower than those for FR. We are using error ratios ranging from 0.3 to 0.4 for the CPSV portion of the study. Including a stratification level based on assumed complexity allows us to vary these ERs to better allocate our sample. Specifically, we used an error ratio of 0.4 for "complex" Commercial and Industrial strata, 0.35 for "complex" Multi-Family strata, and 0.3 for the less complex TSER strata.

The error ratios for CPSV are based on previous CPSV efforts for the utilities that have achieved or come close to achieving 90/10 precision at the program level using an error ratio assumption of 0.35. Using an error ratio from a study performed by a different firm working for different clients (even though they are the same programs) is a risk. We are mitigating this risk by using a unit of analysis smaller than site-level in our sample design, but collecting data on all projects at the site from the same program year. This approach provides an additional margin of error for the evaluation by collecting more data than is projected by the sample design approach.[33] The cost of the additional data collection is low since engineers will already be on the phone or on-site with the customer.

[33] Sampling at the sub-site level allows us to use measure characteristics more effectively in sampling and expansion. Over-collected data (units of analysis that were not selected randomly) will be given a weight of one (representing themselves alone) to ensure the final results are not biased by collecting additional data from multiple measure sites.

2015 Enbridge stratification

The 2015 Enbridge stratification is presented in **Figure** 8-2. The final stratification includes 4 evaluation programs, two NTG categories, two CPSV categories and up to three size categories optimized for sampling efficiency. In total, there are 26 Strata.

Table 8-74 shows the 2015 Enbridge sample design in table form with the expected relative precisions and sample for targeted programs shown for each portion of the study. Data collection for FR will be completed through IDI, while the CPSV group indicates strata that will have on-site data collection (complex) or TSER (simple) for gross savings verification.

Table 8-74: 2015 Enbridge CPSV and FR sample design

				Sample Frame		FR Sample Design		CPSV Sample Design	
Stratification Segment	NTG Group	CPSV Group	Size Strata	N	m3	n	Rel. Prec.	n	Rel. Prec.
Industrial	Action	Complex	3	13	18,898,127	8	10%	7	10%
		Simple	2	8	4,964,165	4		4	
	Equipment	Complex	4	70	276,569,945	24		15	
		Simple	2	25	43,925,065	6		6	
Commercial	Action	Complex	2	3	10,988,780	3	10%	3	10%
		Simple	1	24	3,875,430	4		4	
	Equipment	Complex	3	59	61,573,901	22		9	
		Simple	2	293	236,656,958	34		10	
Market Rate Multi-Family	All	Complex	1	53	23,584,650	8		5	
		Simple	2	175	129,568,929	19		8	
Low Income	All	Complex	1	6	5,125,020	0	N/A	2	
		Simple	1	104	58,676,555	0		6	
RunitRight	Optimization	IDI	3	28	2,712,210	17	10%	0	N/A
Total				**861**		**149**		**79**	

Table 8-75 shows the anticipated relative precisions for less aggregated program segments. We expect that the final relative precisions will be close to 90/10 for these segments as well as the targeted programs above.

Table 8-75: Enbridge expected precisions by program segment

Stratification Segment	Sample Frame		NTG		CPSV	
	N	Savings	n	Relative Precision	n	Relative Precision
Industrial	118	22,806,549	41	9%	30	9%
Commercial	376	18,098,912	64	10%	27	12%
MR MF + LI MF	336	10,424,606			21	13%
MR MF	237	7,363,563	27	20%		
RunitRight	28	542,442	18	10%		

Table 8-76 provides the detailed sample design.

Table 8-76: Detailed 2015 Enbridge CPSV and FR sample design

Strata	Utility	Program	NTG Category	CPSV Category	Measures in Frame	FR Measure Target	CPSV Measure Target	Cumulative Gas Savings in Frame (m3)	Fraction of Frame Total Reported Cumulative Savings (m3)
211101	Enbridge	Industrial	Action	Complex	8	4	3	2,231,087	0.3%
211102	Enbridge	Industrial	Action	Complex	4	3	3	3,678,905	0.4%
211103	Enbridge	Industrial	Action	Complex	1	1	1	12,988,135	1.5%
211201	Enbridge	Industrial	Action	Simple	7	3	3	2,028,590	0.2%
211202	Enbridge	Industrial	Action	Simple	1	1	1	2,935,575	0.3%
212101	Enbridge	Industrial	Equipment	Complex	47	7	4	44,621,995	5.1%
212102	Enbridge	Industrial	Equipment	Complex	13	7	4	52,578,105	6.0%
212103	Enbridge	Industrial	Equipment	Complex	7	7	4	76,310,125	8.7%
212104	Enbridge	Industrial	Equipment	Complex	3	3	3	103,059,720	11.7%
212201	Enbridge	Industrial	Equipment	Simple	24	5	5	23,332,790	2.7%
212202	Enbridge	Industrial	Equipment	Simple	1	1	1	20,592,275	2.3%
221101	Enbridge	Commercial	Action	Complex	2	2	2	774,895	<0.1%
221102	Enbridge	Commercial	Action	Complex	1	1	1	10,213,885	1.2%
221201	Enbridge	Commercial	Action	Simple	24	4	4	3,875,430	0.4%
222101	Enbridge	Commercial	Equipment	Complex	50	13	4	20,106,586	2.3%
222102	Enbridge	Commercial	Equipment	Complex	8	8	4	31,966,255	3.6%
222103	Enbridge	Commercial	Equipment	Complex	1	1	1	9,501,060	1.1%
222201	Enbridge	Commercial	Equipment	Simple	265	17	5	88,190,023	10.1%
222202	Enbridge	Commercial	Equipment	Simple	28	17	5	148,466,935	16.9%
224101	Enbridge	Commercial	Multi-Residential	Complex	53	8	5	23,584,650	2.7%
224201	Enbridge	Commercial	Multi-Residential	Simple	139	10	4	53,999,911	6.2%
224202	Enbridge	Commercial	Multi-Residential	Simple	36	9	4	75,569,018	8.6%
241301	Enbridge	Run-it-right	Action	N/A	19	8	0	373,925	<0.1%
241302	Enbridge	Run-it-right	Action	N/A	5	5	0	923,845	0.1%
241303	Enbridge	Run-it-right	Action	N/A	4	4	0	1,414,440	0.2%
254101	Enbridge	Low Income	N/A	Complex	6	0	2	5,125,020	0.6%
254201	Enbridge	Low Income	N/A	Simple	104	0	6	58,676,555	6.7%

2015 Union stratification

The Union stratification is shown in Figure 8-3. The final stratification includes 4 evaluation programs, two NTG categories, two CPSV categories and up to three size categories optimized for sampling efficiency. In total, there are 30 strata.

Table 8-77 shows the 2015 Union sample design in table form with the expected relative precisions and sample for targeted programs shown for each portion of the study. Data collection for FR will all be completed through IDI, while the CPSV group indicates strata that will be have on-site data collection (complex) or TSER (simple) for gross savings verification.

Table 8-77: 2015 Union CPSV and FR sample design

Stratification Segment	NTG Group	CPSV Group	Size Strata	Sample Frame		FR Sample Design		CPSV Sample Design	
				N	m3	n	Rel. Prec.	n	Rel. Prec.
Industrial	Action	Complex	1	21	75,487,148	7	10 %	6	10 %
		Simple	1	44	102,200,503	4		3	
	Equipment	Complex	4	136	862,582,429	35		17	
		Simple	3	111	165,066,284	10		9	
Commercial	Action	Complex	2	8	81,635,903	5	10 %	4	
		Simple	1	13	22,029,892	6		3	
	Equipment	Complex	3	109	142,631,725	14		7	
		Simple	1	42	14,831,059	5		3	
Market Rate Multi-Family	All	Complex	2	6	7,409,515	3		2	
		Simple	1	1	44,260	1		1	
Low Income Multi-Family	All	Complex	2	2	1,454,295	0	N/A	2	
		Simple	1	35	4,466,365	0		3	
Large Volume	Action	Complex	3	35	404,398,149	10	10 %	8	10 %
	Equipment	Complex	4	37	846,481,549	22		13	
Total				**579**		**115**		**75**	

Table 8-78 shows the anticipated relative precisions for less aggregated program segments. We expect that the final relative precisions will be close to 90/10 for these segments as well as the targeted programs above.

Table 8-78: 2015 anticipated precisions by program segment

Program Segment	Sample Frame		NTG		CPSV	
	N	Savings	n	Relative Precision	n	Relative Precision
Industrial	310	78,037,717	61	10%	38	10%
Commercial	171	16,132,513	33	10%	19	11%
Large Volume	72	106,719,551	31	10%	23	10%
MR MF+LI MF	44	730,945			11	13%
MR MF	7	394,489	5	18%		

Table 8-79 provides the detailed sample design.

Table 8-79: Detailed 2015 Union CPSV and FR sample design

Strata	Utility	Program	NTG Category	CPSV Category	Measures in Frame	FR Measure Target	CPSV Measure Target	Cumulative Gas Savings in Frame (m3)	Fraction of Frame Total Reported Cumulative Savings (m3)
111101	Union	Industrial	Action	Complex	21	7	6	75,487,148	2.8%
111201	Union	Industrial	Action	Simple	44	4	3	102,200,503	3.7%
112101	Union	Industrial	Equipment	Complex	104	13	6	183,932,142	6.7%
112102	Union	Industrial	Equipment	Complex	22	12	5	242,844,358	8.9%
112103	Union	Industrial	Equipment	Complex	9	9	5	347,468,949	12.7%
112104	Union	Industrial	Equipment	Complex	1	1	1	88,336,980	3.2%
112201	Union	Industrial	Equipment	Simple	91	5	4	50,638,424	1.9%
112202	Union	Industrial	Equipment	Simple	19	4	4	73,398,020	2.7%
112203	Union	Industrial	Equipment	Simple	1	1	1	41,029,840	1.5%
121101	Union	Commercial	Action	Complex	7	4	3	50,040,503	1.8%
121102	Union	Commercial	Action	Complex	1	1	1	31,595,400	1.2%
121201	Union	Commercial	Action	Simple	13	6	3	22,029,892	0.8%
122101	Union	Commercial	Equipment	Complex	104	9	3	20,998,185	0.8%
122102	Union	Commercial	Equipment	Complex	4	4	3	44,746,640	1.6%
122103	Union	Commercial	Equipment	Complex	1	1	1	76,886,900	2.8%
122201	Union	Commercial	Equipment	Simple	42	5	3	14,831,059	0.5%
123101	Union	Commercial	Multi-family	Complex	5	2	1	2,316,375	<0.1%
123102	Union	Commercial	Multi-family	Complex	1	1	1	5,093,140	0.2%
123201	Union	Commercial	Multi-family	Simple	1	1	1	44,260	<0.1%
131101	Union	Large Volume	Action	Complex	28	5	4	126,323,149	4.6%
131102	Union	Large Volume	Action	Complex	6	4	3	215,015,820	7.9%
131103	Union	Large Volume	Action	Complex	1	1	1	63,059,180	2.3%
132101	Union	Large Volume	Equipment	Complex	25	10	4	114,682,330	4.2%
132102	Union	Large Volume	Equipment	Complex	5	5	3	137,740,059	5.0%
132103	Union	Large Volume	Equipment	Complex	4	4	3	200,140,680	7.3%
132104	Union	Large Volume	Equipment	Complex	3	3	3	393,918,480	14.4%
153101	Union	Low Income	N/A	Complex	1	0	1	20,865	<0.1%
153102	Union	Low Income	N/A	Complex	1	0	1	1,433,430	<0.1%
153201	Union	Low Income	N/A	Simple	35	0	3	4,466,365	0.2%

Design the spillover samples

The sample design for spillover omits the CPSV category, but is otherwise consistent with the sample design for the 2015 FR and CPSV evaluation task. For spillover, the ER used was 0.8; 90/10 precision was targeted.

2013/14 Enbridge stratification

The 2013/14 Enbridge stratification is presented in Figure 8-5. The final stratification includes 4 evaluation programs, two NTG categories, two CPSV categories and up to three size categories optimized for sampling efficiency. In total, there are 28 strata.

Figure 8-5: 2013/14 Enbridge stratification

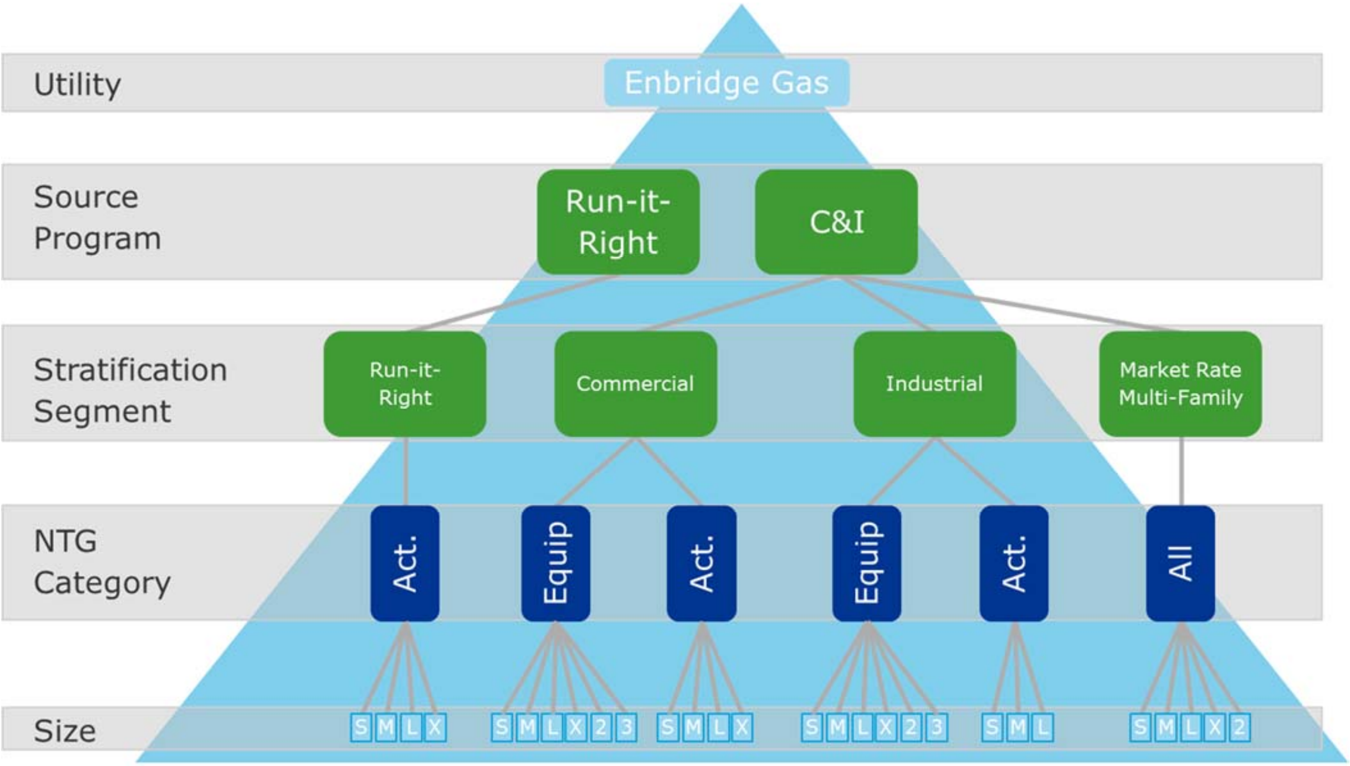


Table 8-80 shows the number of accounts and savings in the sample frame and the targeted spillover sample size for each grouping.

Table 8-80: 2013/14 Enbridge spillover sample design

Stratification Segment	NTG Group	Size Strata	Sample Frame		SO Sample Design	
			N	m3	n	Rel. Prec.
Industrial	Action	3	40	5,067,923	20	10%
	Equipment	6	191	41,899,589	50	
Commercial	Action	4	79	4,604,864	25	10%
	Equipment	6	603	27,240,429	60	
MR MF	All	5	553	20,412,543	65	
RunitRight	Action	4	45	625,088	26	10%
Total			**1,511**		**246**	

2013/14 Union stratification

The Union stratification is presented in Figure 8-6. In total, there are 35 strata.

Figure 8-6: 2013/14 Union stratification

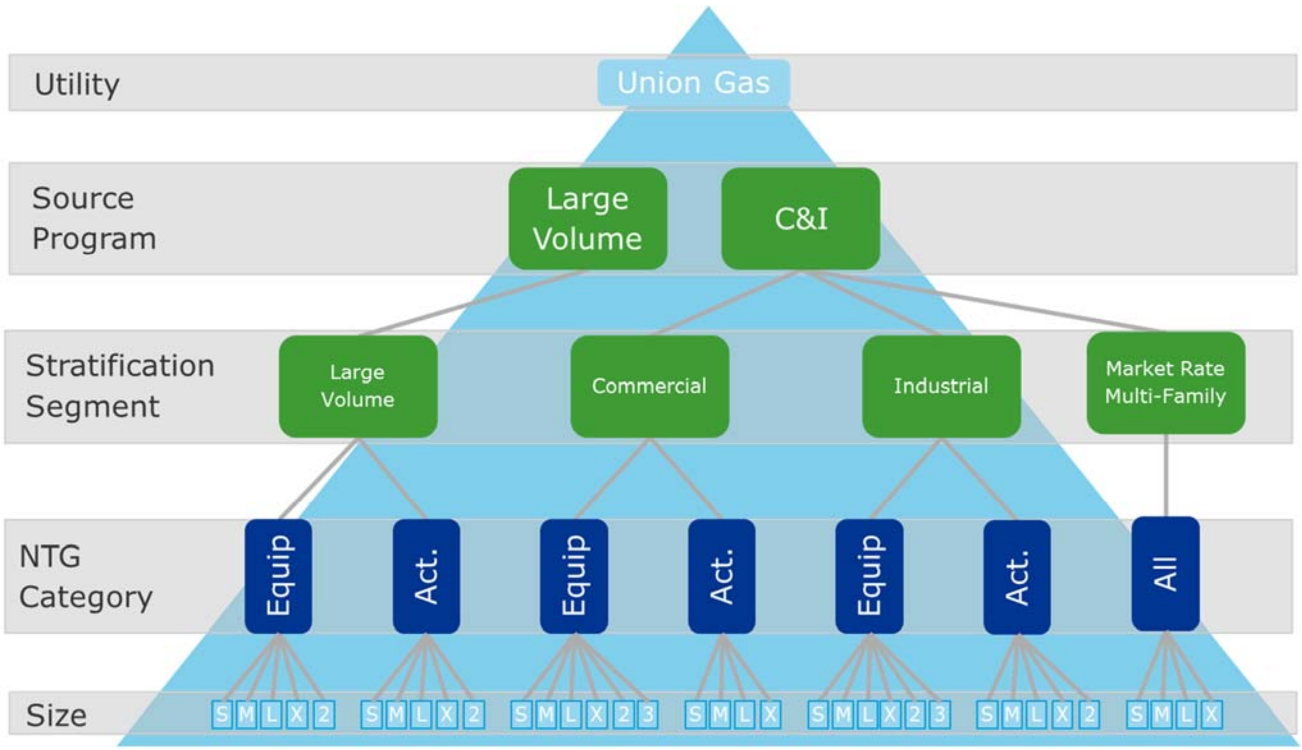


Table 8-81 shows the number of accounts and savings in the sample frame and the targeted spillover sample size for each grouping.

Table 8-81: Union spillover sample design

Utility	Stratification Segment	NTG Group	Size Strata	Sample Frame		SO Sample Design	
				N	m3	n	Rel. Prec.
Union	Industrial	Action	5	167	64,448,800	38	10%
		Equipment	6	412	107,347,726	57	
	Commercial	Action	4	74	9,687,715	24	10%
		Equipment	5	190	15,744,760	40	
	MR MF	All	2	38	564,428	8	
	Large Volume	Action	5	130	317,638,812	38	10%
		Equipment	5	94	139,759,050	33	
	Total			**1,105**		**238**	

Prepare the sample and backup sample

Once we have completed the final sample design, we will submit a data request to the utilities. The specific types of information we will be requesting are outlined in Table 8-82. The decision maker may not necessarily be located at the site where the project occurred and may be the same for multiple projects at multiple sites. The technical expert is someone who will be able to answer questions regarding the specific engineering specifications of the equipment. Program energy advisors are the primary Account Manager or Energy Solutions Consultant that worked with the customer on the sampled projects. Vendors are the third-party firms that were involved in the sale or design of the equipment, or the sale and performance of the O&M services.

Table 8-82: Information to be requested

Requested Information	Project Year	
	2013/14	2015
Site Address	√	√
Project Documentation	√	√
Decision Maker Contact Information: ▪ Full Name ▪ Role ▪ Mailing Address ▪ Email Address ▪ Direct Business Phone Number	√	√
Technical Expert Contact Information: ▪ Full Name ▪ Role ▪ Mailing Address ▪ Email Address ▪ Direct Business Phone Number	√	√
Program Energy Advisor Information: ▪ Full Name ▪ Email Address ▪ Direct Business Phone Number		√
Vendor Contact Information: ▪ Full Name ▪ Role ▪ Mailing Address ▪ Email Address ▪ Direct Business Phone Number	√	√

For the 2015 NTG sample we will request documentation and contact information for 50% more projects that are in the primary sample. This corresponds to a minimum 66% response rate. If response rates are lower than 66% in specific stratum, we will request documentation and contact information for additional projects in the stratum.

For the 2013/14 spillover sample, we will request contact information for three times the number of sampled projects. This corresponds to a minimum 33% response rate. We will not request project documentation for the spillover sample until we have identified the sites that require follow up engineering interviews. To protect respondent confidentiality, we will request documentation for more sites than will receive follow up calls. Overall this staging of requests will reduce the amount of project documentation that the utilities need to provide, while ensuring efficient data collection.

Backup sample will only be contacted if needed to meet targeted number of completes.

Once we have received the requested contact information, we will identify instances where a contact was involved in multiple projects, even across sites. While the projects are conducted at the site level, the decision maker, technical expert, or vendor may have been involved in projects at multiple sites. For example, multiple participating sites for the same retail chain may have one energy manager from the corporate office but the technical expert may be site specific. Using this contact information and considering cross-site involvement, we will assemble the CATI and the IDI sample frame.

APPENDIX J. LCNS Methodology

Life Cycle Net Savings (LCNS) is a methodology for determining the FR component of NTG by estimating program effect over the life of the program measure. In this appendix, the terms FR and attribution are used interchangeably as complements of one another. This appendix does not include spillover.

Notation:

VGS_S = Verified Gross Savings based on ISP or code efficiency equipment baseline (annual)

VGS_E = Verified Gross Savings based on pre-existing equipment baseline (annual)

VGS_L = Verified Gross Lifetime Savings

$Y_{V.EUL}$ = Verified Estimated Useful Life (Years) of installed efficient equipment

$Y_{V.RUL}$ = Verified Remaining Useful Life (Years) of replaced equipment[34]

Y_A = Years Accelerated

Y_R = Remaining Useful Life of pre-existing equipment

A_E = Efficiency Attribution

A_Q = Quantity (size) Attribution

F_E = Efficiency free ridership

F_Q = Quantity (size) free ridership

SPA = Simple Program Attribution (function of efficiency and quantity free ridership, not timing)

NS_L = Net Lifetime Savings

NS_A = Net Acceleration Period Savings

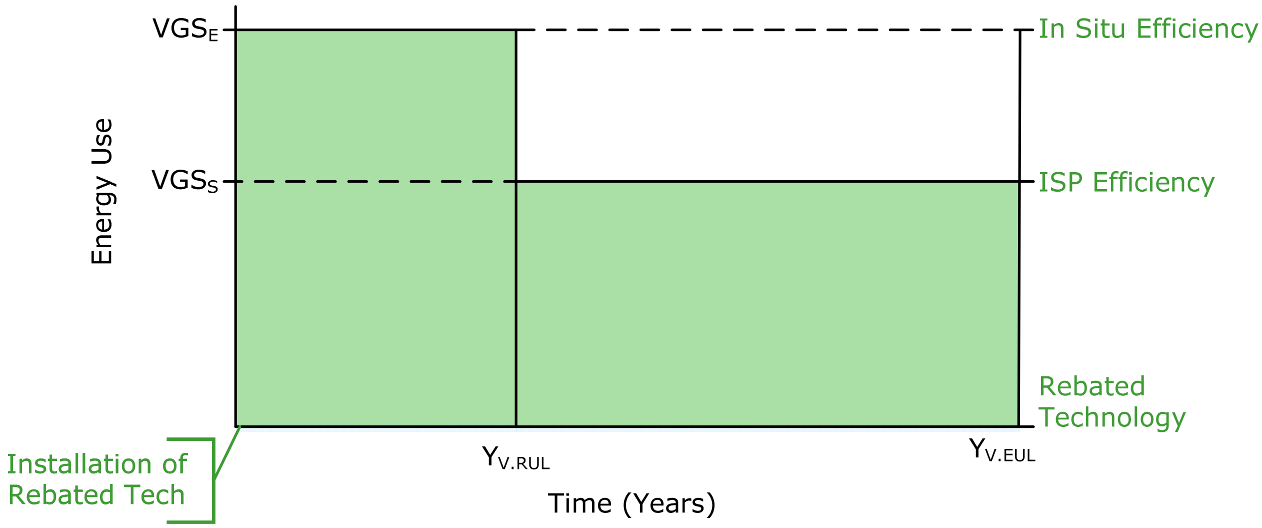
NS_P = Net Post-Acceleration Period Savings

Verified lifetime savings

First we consider the verified savings that make up the denominator in the NTG ratio. Figure 8-7 shows the verified lifetime savings for a measure.

[34] RUL of existing equipment is also applicable as defining the estimated useful life for some retrofit add-on measures

Figure 8-7: Verified lifetime savings for a measure



Verified lifetime savings are calculated as the difference in energy use of the incentivized measure and the energy use of the in-situ measure for the remaining useful life of the in-situ measure plus the verified savings of the ISP or code baseline measure for rest of the (verified) life of the new measure.

$$VGS_L = VGS_E \times Y_{V.RUL} + VGS_S \times Y_{V.EUL}$$

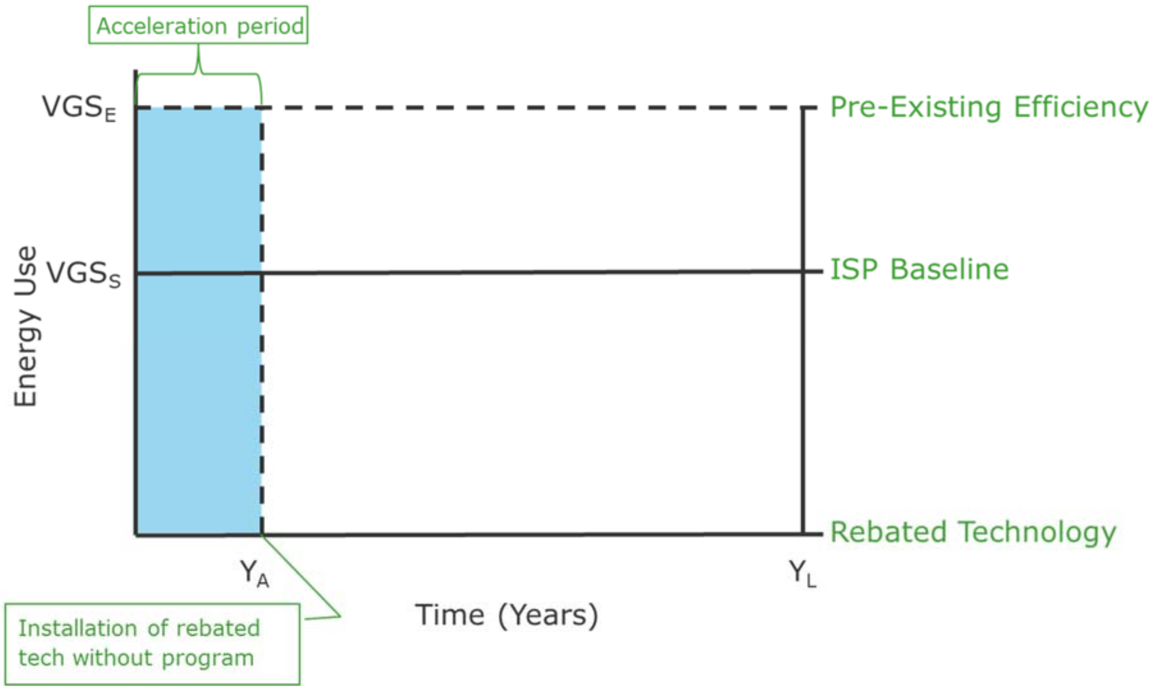
Timing

The treatment of timing is how LCNS differs from other estimation approaches for attribution. In LCNS the response to the question "when would you have performed the measure without the program" defines the number of years that the program accelerated (advanced) the measure. This period is referred to as the "acceleration period" and shown as the distance from the origin to Y_A along the x-axis.

During the acceleration period, the customer would not have installed a new measure (efficient or standard). Instead the appropriate baseline equipment for this time period is the pre-existing equipment that they had been using. This section shows how this difference in baseline affects the net savings estimate for the measure relative to the gross savings.

During the acceleration period (Y_A), the attributable savings are calculated as the difference in energy use of the incentivized equipment and the energy use of the replaced equipment (a pre-existing efficiency baseline). As a result, during the acceleration period the net savings (blue box up to VGS_E) may be higher than the verified gross savings (VGS_s) if the efficiency of the pre-existing equipment was less than the standard program baseline. Savings during the acceleration period are, by definition, attributable. Figure 8-8 shows the attributable savings in the acceleration period for an accelerated measure.

Figure 8-8: Acceleration Period Savings



Acceleration period savings are calculated as:

$$NS_A = VGS_E \times Y_A$$

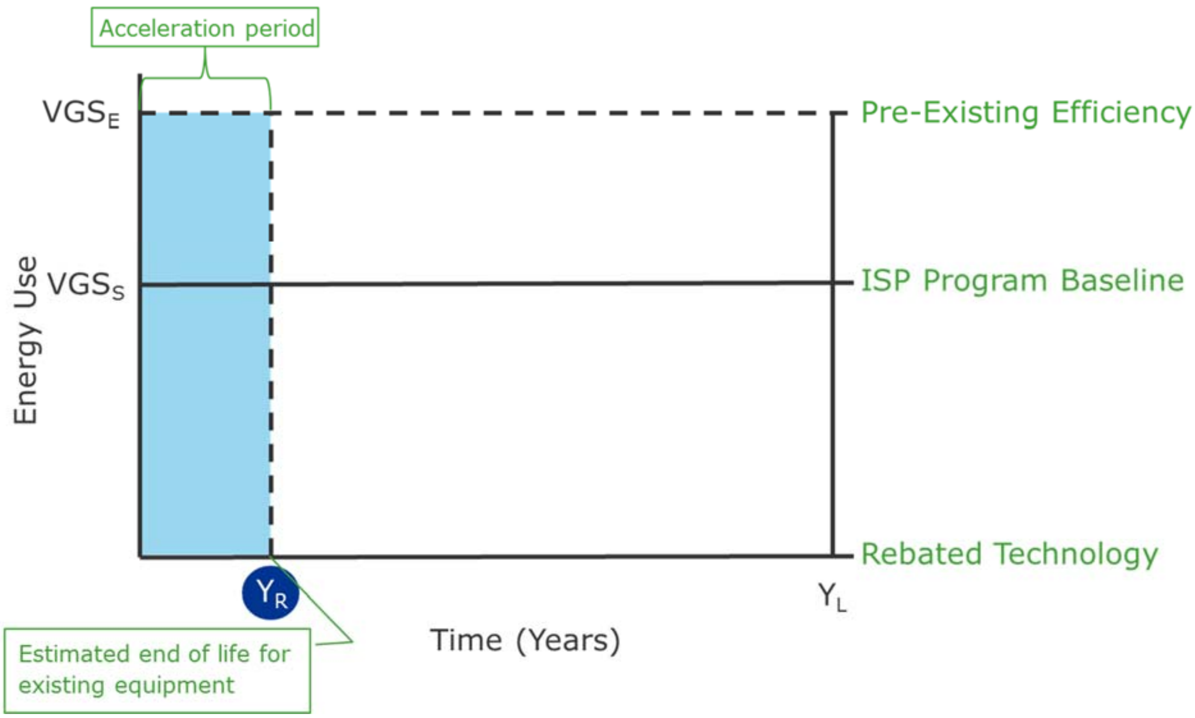
Special Case: "Never"

Some respondents will indicate that they would "never" have replaced the existing equipment. A customer "Never" would have installed the project if they:

1. respond to initial timing question by saying they never would have installed it without the program
2. respond to second timing question by saying they would have installed it more than four years later without the program
3. respond to the initial quantity question by saying they would not have replaced any of the units without the program

For these measures, the acceleration period is defined by the remaining useful life of the pre-existing measure (Y_R) and the applicable baseline is versus pre-existing efficiency (VGS_E) as shown in Figure 8-9.

Figure 8-9: Acceleration period savings for "never" cases



Acceleration period savings for "Never" would have installed measures are calculated as:

$$NS_A = VGS_E \times Y_R$$

Efficiency and quantity

In the post-acceleration period attribution is based on the program effect on the efficiency and quantity of what was installed.

Efficiency attribution, A_E, measures the effect the program had on the *efficiency* of the equipment installed. The efficiency attribution measures the proportion of savings attributable to the program for increasing the efficiency of the equipment above what would have been installed otherwise.

Quantity attribution, A_Q, measures the effect the program had on the *size or amount* of the equipment installed. The quantity attribution measures the proportion of savings attributable to the program for increasing or decreasing the quantity of equipment above or below what would have been installed otherwise.

The Simple Program Attribution (SPA) is the fraction of annual verified gross savings that are attributable to the program and is a function of the efficiency free-ridership (f_E) and the quantity free-ridership (f_Q).

The free-ridership values for efficiency and quantity are calculated from the attribution factors. The complement of attribution is free-ridership. Attribution measures the portion of the savings that result because of the actions of the program. Free-ridership measures the portion of the savings that would have happened in the absence of the program. The free-ridership equivalents of the attribution factors are used to determine program net savings.

$$f_E = 1 - A_E$$

$$f_Q = 1 - A_Q$$

The fraction of verified gross savings that would have occurred without the program is the product of the fraction of units that would have been installed without the program, and the fractional unit savings that these units would have had without the program.

$$f_{QE} = f_Q f_E$$

For example, if two-thirds as many units would have been installed without the program (f_Q = 2/3), and the savings per unit would have been only half as much (f_E = 1/2), the portion of the savings that would have occurred without the program would be

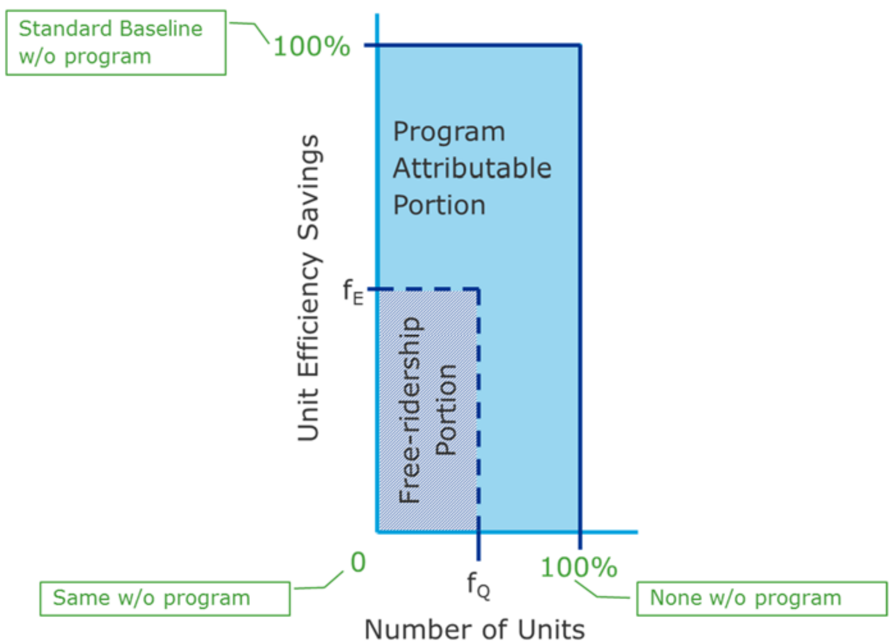
$$f_{QE} = (2/3) \times (1/2) = 1/3.$$

The SPA is the complement of this free rider portion.

$$SPA = 1\text{-}f_{QE} = 1\text{-} f_Q\, f_E$$

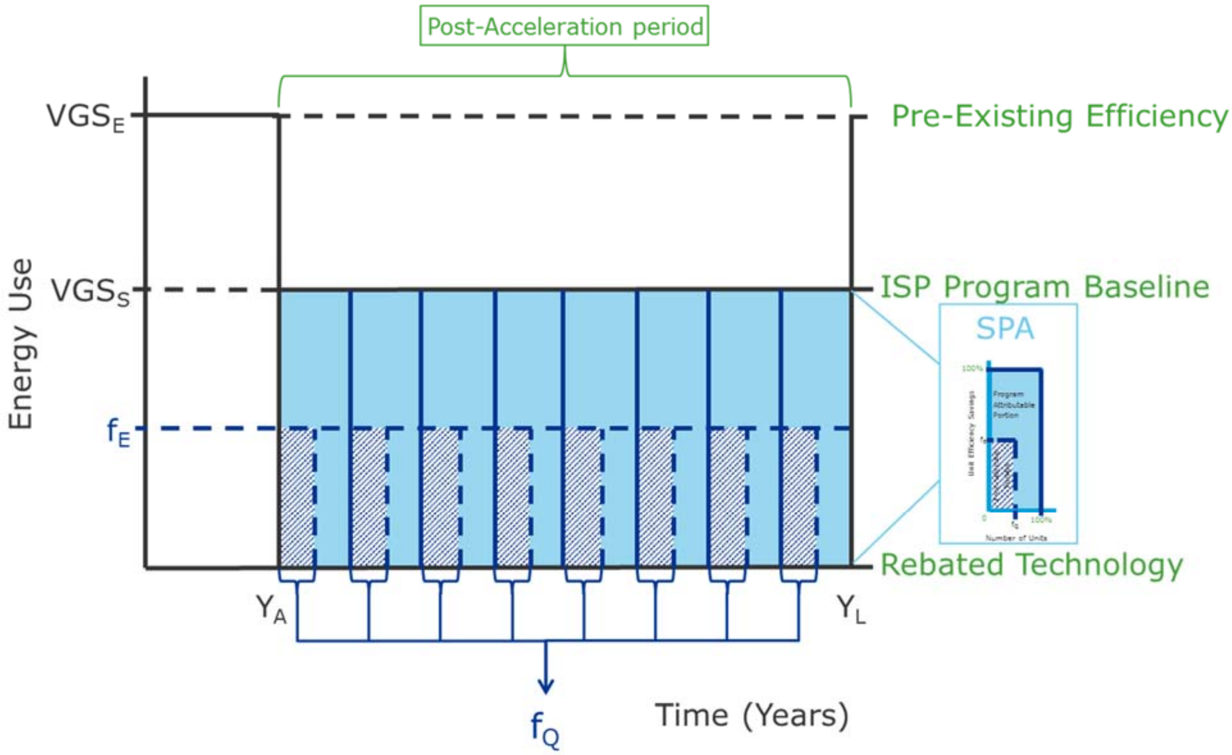
The relationship is illustrated in Figure 8-10.

Figure 8-10: Graphical derivation of the SPA equation



SPA is the attribution of each year savings in the post-acceleration period. Figure 8-11 shows the program attributable and free-ridership portions of each year's savings in the post-acceleration period. The blue rectangles represent SPA as discussed and shown from above. The height of the SPA box is equivalent to the baseline used for verified savings. The grey "missing pieces" are the free ridership for each year's savings. Because attribution is three dimensional and this is a two-dimension document, we are representing both years and quantity on the x-axis. Years are denoted by the dark blue vertical lines, while the quantity FR (f_Q) is shown as the width of the grey box.

Figure 8-11: Post-acceleration period attributable savings



The net savings in the post-acceleration period are calculated as:

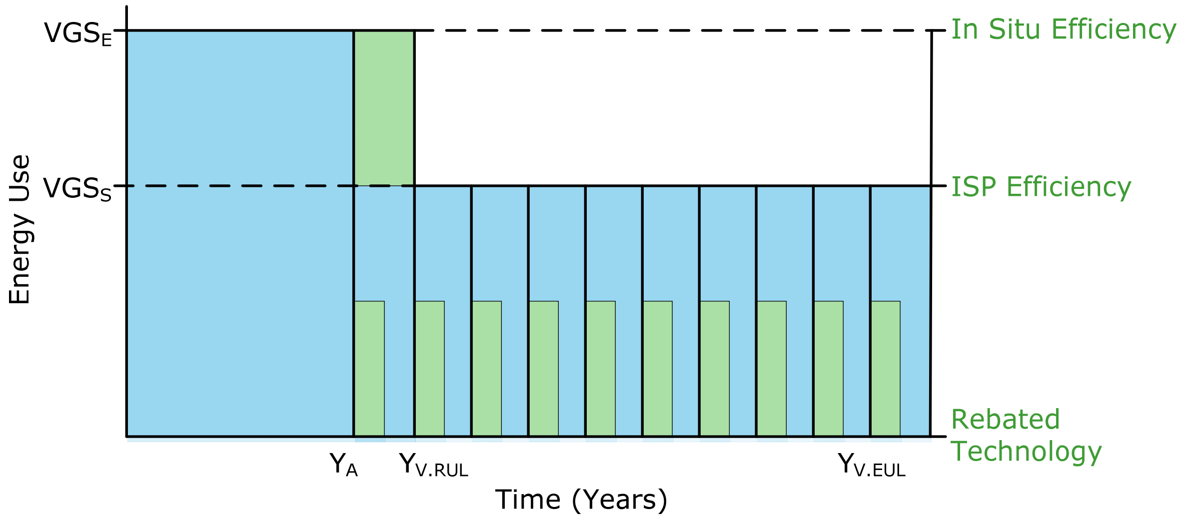
$$NS_P = VGS_S \times SPA \times (Y_L - Y_A)$$

Note that for the special case discussed relating to acceleration period savings, "Never", SPA= 100%.

Calculating attribution

Figure 8-12 shows the attributable savings across the lifetime of the measure NS_L (blue) overlaid on the verified gross lifetime savings VGS_L (green). The figure shows that with the effect of the dual baseline verification included in the net savings estimate and in the verified savings estimate that net savings will always be less than or equal to gross savings.

Figure 8-12: Attributable vs. verified gross savings for a measure



The formula for each individual measure's estimate of lifetime net savings is:

$$NS_L = NS_A + NS_P$$

or

$$NS_L = VGS_E \times Y_A + VGS_S \times (SPA) \times (Y_{V.EUL} - Y_A)$$

The formula for each individual measure's attribution is:

$$Attr = \frac{NS_L}{VGS_L}$$

or

$$Attr = \frac{VGS_E \times Y_A + VGS_S \times (SPA) \times (Y_{V.EUL} - Y_A)}{VGS_E \times Y_{V.RUL} + VGS_S \times (Y_{V.EUL} - Y_{V.RUL})}$$

Four years is the time horizon beyond which we assume the respondent cannot answer with certainty. Anything beyond four years (Y_A>=4) is treated as a "never would have installed" response (100% attributable), rather than an accelerated measure.

Special Case: FR Sampled Projects not sampled for CPSV

The sample for the CPSV portion of the study is a subset of the free ridership sample. This means that for projects included in the FR study, but not included in CPSV we will not be calculating verified savings. For expansion of the NTG ratio and for calculating post-acceleration period savings we will use the final ratio application domain level Gross RR to estimate verified savings for measures not in the CPSV.

For acceleration period savings, we will use the A/P ratio of accelerated projects in the CPSV to estimate the pre-existing baseline savings. The A/P ratio refers to the ratio between the annual Acceleration Period Savings and the annual Post-Acceleration Period Net Savings. It is always one or larger. Like the application of Gross RR, the A/P ratio will be estimated at the application domain level for use in estimating net savings for the FR-only sampled measures.

APPENDIX K. DETERMINING ATTRIBUTION PARAMETERS

The attribution factors defined in the previous section are determined from the participant responses gathered during the survey. This section provides an overview of the survey data and how it is used to determine each attribution factor. It also includes more detailed sections for each factor that show exactly how all survey responses are handled.

General procedure

This section provides an overview of the attribution factors and how they are determined.

- Timing attribution, A_T: The timing attribution is determined from the acceleration period, Y_A, which is in turn provided directly by the respondent and the verified savings versus existing equipment provided by the evaluation engineers. There is no timing attribution effect for values of Y_A greater than four; in those instances, we assume that the measure would never have been installed without the influence of the program.
- Efficiency attribution, A_E: The efficiency attribution is based on the answers to questions DAT2a and DAT2b which ask about the efficiency level that would have been installed in absence of the program. Respondents who indicate that they would have installed a lesser-efficient piece of equipment in the absence of the program are asked what efficiency they would have installed instead. An efficiency attribution value is assigned based on the response. Standard efficiency based on program definitions will be used to bracket the finer cut as defined in the project documentation provided by the utilities.
- Quantity attribution, A_Q: The quantity attribution is based on the percentage change in quantity caused by the program, ΔQ, which is in turn provided directly by the respondent. The timing section next shows the attribution assignment based on responses to DAT3a and DAT3b.

The next few sections deal with determining the timing, efficiency, and quantity attributions on a more detailed level.

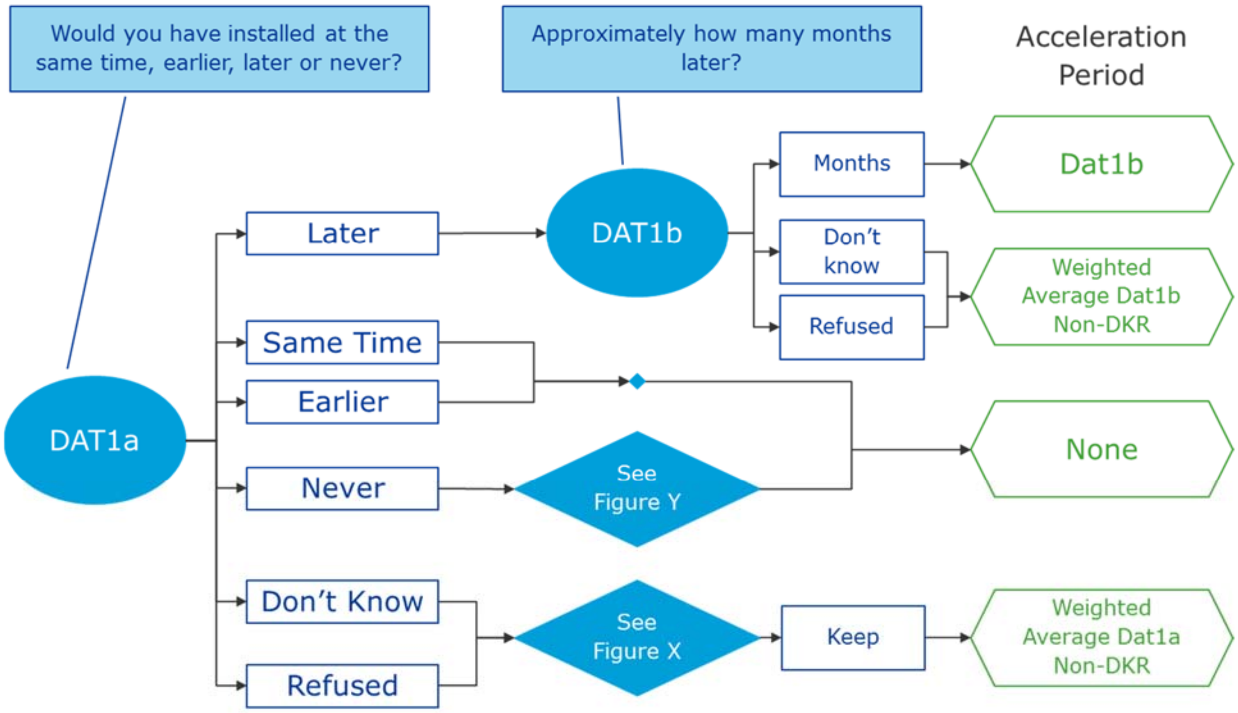
Timing

The timing attribution, A_T, is determined from the first set of attribution survey questions. These questions are used to determine if the program accelerated implementation of a measure or caused it to be implemented before it would have been without the program. The two relevant questions are labelled DAT1a and DAT1b.

- DAT1a: “Without < the program>, would you have <installed, preformed> <measure> at the same time, earlier, later, or never?”
    - DAT1a_O: “Why do you say that?”
- DAT1b: “Approximately how many months later?” (DAT1b is only asked if DAT1a is “Later.”)

Note that these questions ask about the timing of installing equipment, not installation of efficient equipment in particular. For example, if the measure was replacement of a high-efficiency boiler, the question asks when the boiler would have been replaced without the program. Engineers conducting the interviews are trained to ensure clarity for these questions. Figure 8-13 shows a decision tree for DAT1a and DAT1b.

Figure 8-13: Decision tree for the acceleration period



The measure is considered accelerated if the respondent indicates that the measure would have been installed less than four years later without the influence of the program. The acceleration period is determined based on the answer to DAT1b. If the respondent is unable to answer DAT1b, the measure is assigned the average acceleration period across all accelerated measures in the same measure group.

If the respondent answers DAT1a with Earlier or Same Time then there is no acceleration period. If the respondent answers DAT1a with Never and the Quantity and Efficiency sections apply to the measure then the survey skips to the next section and there is no acceleration period. If the respondent answers DAT1a with Don't Know or Refused but does provide answers to inform the Quantity and Efficiency Attributions then the measure is assigned the average Acceleration Attribution for all measures in the same primary domain.[35]

[35] The primary domain is the domain that the attribution factor will be applied to in calculating the final net savings for the programs.

Table 8-83: Timing attribution assignments

Coarse Cut (DAT1a) (Would you have implemented the measure at the same time absent the program)	Finer Cut (DAT1b)	Acceleration period
Same time	NA	None
Earlier	NA	None
Later	0 < years <4	A_T=DAT1b Acceleration period equals response to DAT1b
	4<= years	Equivalent to "Never" $A_T=A_R$ Acceleration period equals remaining useful life of replaced equipment, SPA=100%
	Don't know/refused	Weighted average of "later" cases for primary domain, 0 < years <4
Never	NA	$A_T=A_R$ Acceleration period equals remaining useful life of replaced equipment, SPA=100%
Don't know/refused	NA	Weighted average of all respondents for primary domain

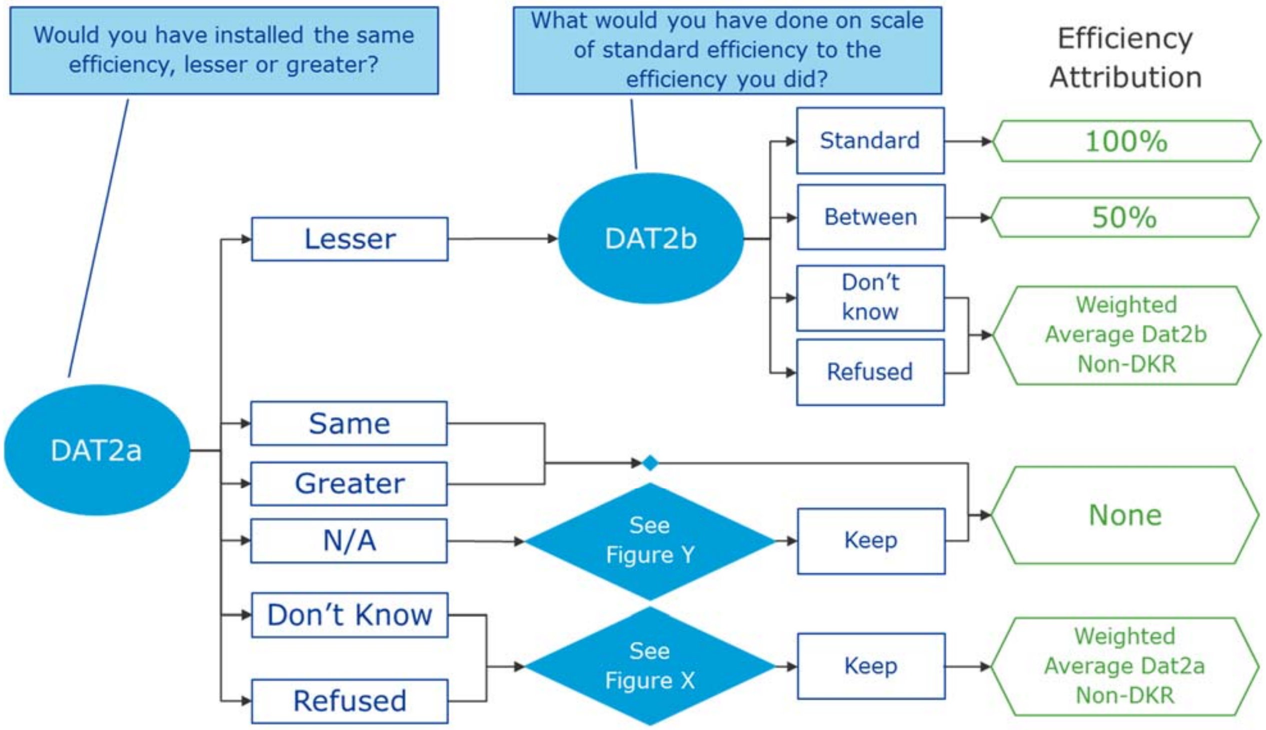
Efficiency

Efficiency Attribution, A_E, gives the program credit for increasing the efficiency of a measure above what would have been installed in the absence of the program. The two relevant questions are DAT2a and DAT2b.

- DAT2a: "Without <the program>, would you have installed the same efficiency as what you installed, lower efficiency, or higher efficiency?"
- DAT2b: "Without <the program>, would you have installed <measure> that was "standard efficiency on the market at that time," or "between standard efficiency and the efficiency that you installed?" (DAT2b is only asked if DAT2a is "Lesser.")

The program receives nonzero Efficiency Attribution if the respondent indicates that they would have installed a less efficient measure without the influence of the program. The magnitude of the Efficiency Attribution is determined based on the answer to DAT2b, as shown in Table 8-84. Figure 8-14 shows the corresponding decision tree for DAT2a and DAT2b.

Figure 8-14: Decision tree for efficiency attribution



If the respondent answers DAT2a with Greater or Same then the survey skips to the next section and there is zero Efficiency Attribution. If efficiency is not applicable to this measure but quantity is applicable and the measure would have been installed anyway then the survey skips to the next section and the Efficiency Attribution will not affect the Simple Program Attribution. If the respondent answers DAT2a with Don't Know or Refused but does provide answers to inform the Quantity Attribution and Acceleration Period then the measure is assigned the average Efficiency Attribution for all measures in the same measure group.

Table 8-84: Efficiency attribution assignments

Coarse Cut (DAT2a) (what efficiency would have been implemented absent the program)	Finer Cut (DAT2b)	Efficiency Attribution
Same	NA	0%
Lower	Standard efficiency or according to code	100%
	Between standard efficiency and the efficiency that was installed	50%
	Don't know/refused	Weighted average of above cases for primary domain
Greater	NA	0%
Don't know/refused	NA	Weighted average of all respondents for primary domain

Quantity

Quantity Attribution, A_Q, gives the program credit for increasing the quantity of a measure above what would have been installed in the absence of the program. The two relevant questions are DAT3a and DAT3b.

- DAT3a: "Without <the program>, how different would the <number/size> of the <equipment type> have been? Would you say you would have installed the same amount, less, more, or not have installed anything?"
- DAT3b: "By what percentage did you change the amount of <equipment type> installed because of <the program>?" (DAT3b is only asked if DAT3a is "Less" or "More.")

The program receives nonzero Quantity Attribution if the respondent indicates that they would have installed less of the measure or a smaller measure without the influence of the program (for example: "I would have replaced as many doors"_. The program also receives nonzero Quantity Attribution if the respondent indicates that they would have installed more of the measure or a larger measure without the influence of the program (for example: "I would have installed a bigger furnace, but I through the program I learned it was unnecessary"). The latter case covers situations where the program effect was in "right sizing" the measure. The magnitude of the Quantity Attribution is determined based on the answer to DAT3b, as shown in Table 8-85. Figure 8-15 shows a decision tree for DAT3a and DAT3b.

Figure 8-15: Decision tree for quantity attribution

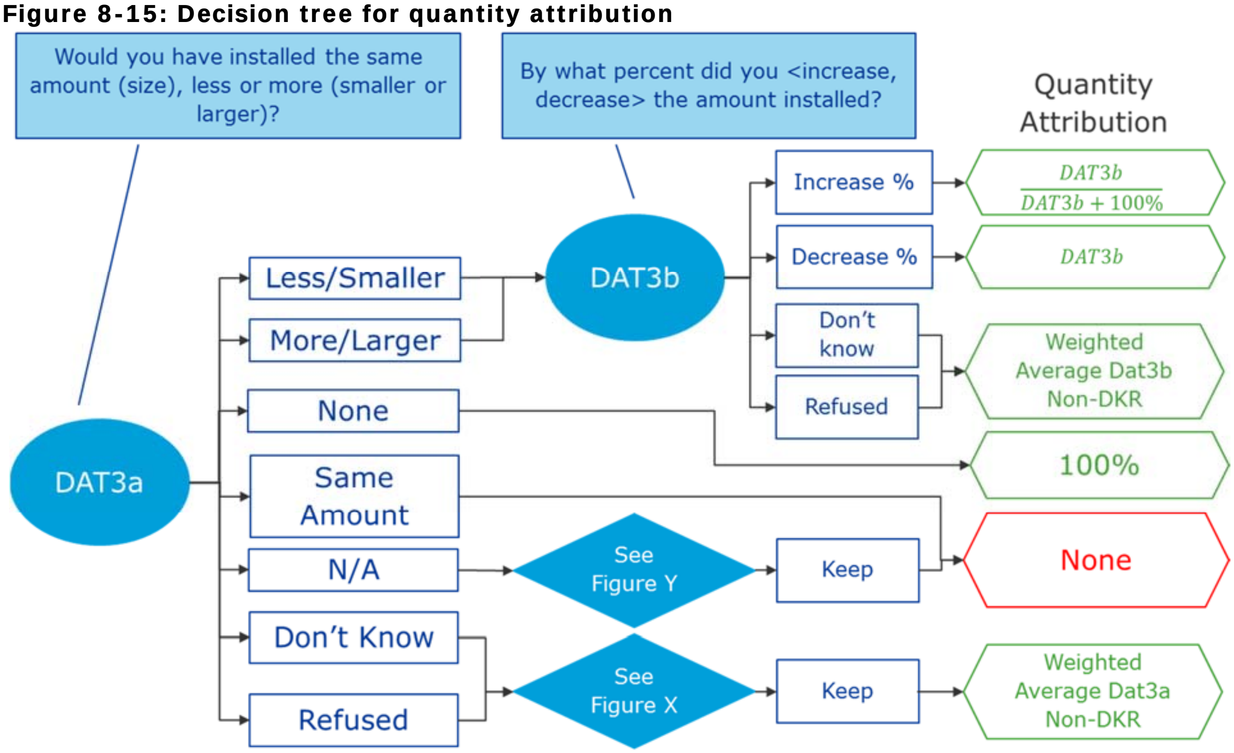


Table 8-85: Quantity attribution assignments

Coarse Cut (DAT3a) (How much equipment would have been replaced absent the program)	Finer Cut (DAT3b)	Quantity Attribution
Same	N/A	0%
Less/Smaller	ΔQ	AQ = ΔQ / (ΔQ + 100%)
	Don't know/refused	Weighted average of "less" cases for primary domain
More/Larger (right sizing)	ΔQ	AQ = ΔQ
	Don't know/refused	Weighted average of "more" cases for primary domain
None	N/A	100%
Don't know/refused	N/A	Weighted average of all respondents for primary domain

If the respondent would have installed a smaller measure without the program then the Quantity Attribution is calculated as:

A_Q = Inc / (Inc + 100%)

where

Inc = percentage change in quantity because of the program.

If the respondent would have installed a larger measure without the program, then the Quantity Attribution is calculated as:

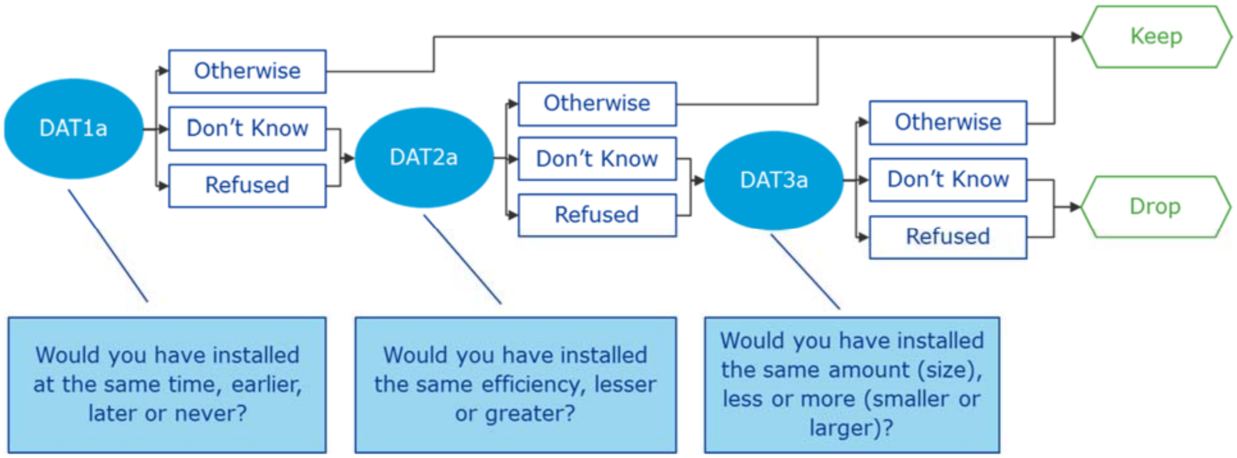
A_Q = Inc.

If the respondent answers DAT3a with Same Amount or None then the survey skips to the next section and there is zero Quantity Attribution. If quantity is not applicable to this measure but efficiency is applicable and the measure would have been installed anyway then the survey skips to the next section and the Quantity Attribution will not affect the Simple Program Attribution. If the respondent answers DAT3a or DAT3b with Don't Know or Refused but does provide answers to inform the Efficiency Attribution and Acceleration Period then the measure is assigned the average Quantity Effect for all measures in the same measure group.

What if they "Don't Know" or "Refuse?"

Some respondents are unable or unwilling to answer the relevant questions in the survey attribution sequence. If a participant is unable or unwilling to answer *all* of the attribution questions then the participant is dropped from the attribution analysis. However, the respondent information will still be included as part of the installation rate and the VGI. Figure 8-16 shows a decision tree that indicates the relationship between the question responses and how they affect the attribution. If a measure goes to the "Keep" decision then the ultimate resolution of each effect is shown in the previous tables.

Figure 8-16: NTG case retention decision tree for don't know / refused

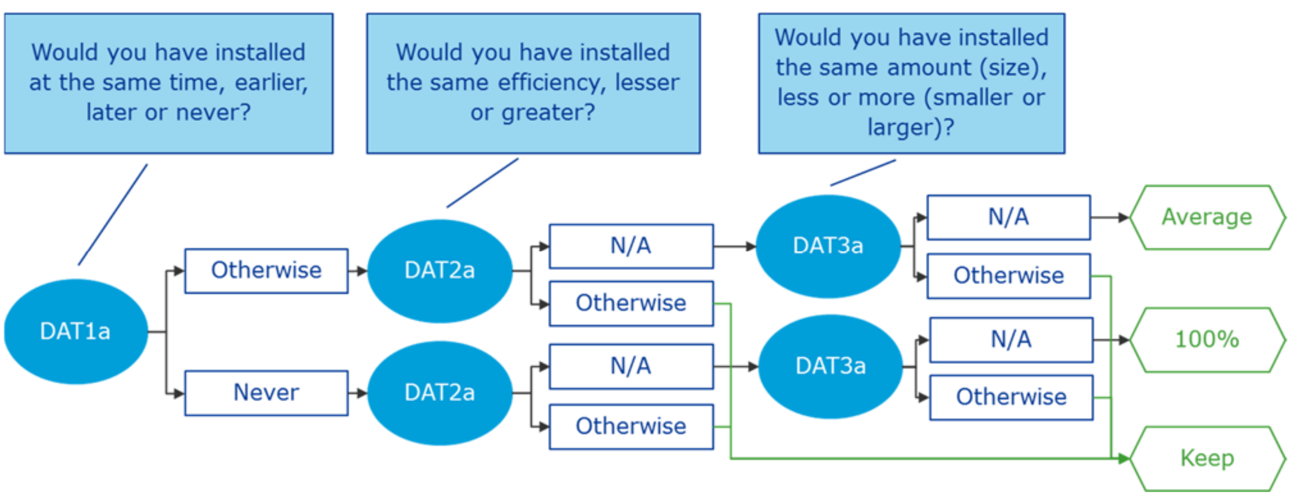


When efficiency and quantity don't apply

Quantity and efficiency questions do not apply to all measures. Efficiency questions do not apply if the equipment type is inherently an efficiency improvement; that is, the "standard efficiency" baseline would be not to install anything. Variable frequency drives (VFDs) or heat recovery systems are examples. Quantity questions do not apply when varying quantity or size does not make sense in the context of the measure.

Figure 8-17 shows a decision tree that indicates the relationship between the question responses and how they affect attribution. If a respondent indicates that a measure would never have been installed without the program and the DAT2a and DAT3a questions do not apply then the attribution is 100%. If the respondent would have installed the project at the same time, earlier, or later and the DAT2a and DAT3a questions do not apply then the measure is assigned the average savings-weighted attribution across all measures in that measure group.

Figure 8-17: Decision tree for not applicable



Example Attribution Calculations

Table 8-86 provides several examples of how survey responses are translated into an NTG ratio. The examples in the table show primarily early replacement (on the gross savings) measures, but the non-ER measures would work the same way. E and Q are the attribution portions, not free ridership (i.e. 0% in column Q means 100% free ridership for quantity/ size).

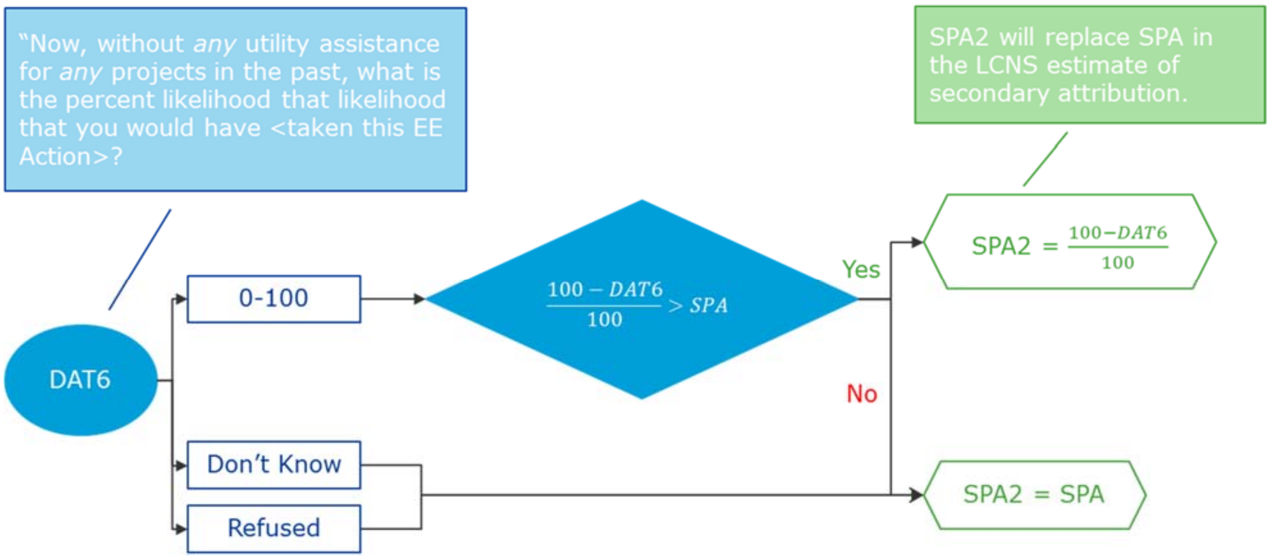
Table 8-86: Attribution Examples

Example	DAT1a	DAT1b	DAT2a	DAT2b	DAT3a	DAT3b	VGS_E	VGS_S	$Y_{V.RUL}$	$Y_{V.EUL}$	VGS_L	Y_A	E	Q	SPA	NS_L	NTG
Accl only	Later	Two Years	Same		Same		100	50	3	10	650	2	0%	0%	0%	200	**31%**
"Never" for timing	Never		Same		Same		100	50	3	10	650	3	0%	0%	100%	650	**100%**
No attribution	Same		Same		Same		100	50	3	10	650	0	0%	0%	0%	0	**0%**
Accl with partial efficiency	Later	Two Years	Less	Between	Same		100	50	3	10	650	2	50%	0%	50%	400	**62%**
"Never" with partial eff.	Never		Less	Between	Same		100	50	3	10	650	3	50%	0%	100%	650	**100%**
Partial eff. only	Same		Less	Between	Same		100	50	3	10	650	0	50%	0%	50%	250	**38%**
Accl with partial eff. and partial quantity	Later	Two Years	Less	Between	Less	Half	100	50	3	10	650	2	50%	50%	75%	500	**77%**
"Never" with partial eff. and partial quantity	Never		Less	Between	Less	Half	100	50	3	10	650	3	50%	50%	100%	650	**100%**
Partial efficiency and partial quantity	Same		Less	Between	Less	Half	100	50	3	10	650	0	50%	50%	75%	375	**58%**
"None" is equal to "Never"	Same		Same		None		100	50	3	10	650	3	100%	0%	100%	650	**100%**
Full eff. credit, no accel. or quantity (ER)	Same		Less	Standard	Same		100	50	3	10	650	0	0%	100%	100%	500	**77%**
Full eff. credit, no accel. or quantity (non-ER)	Same		Less	Standard	Same		0	50	0	10	500	0	0%	100%	100%	500	**100%**

Secondary attribution

Secondary attribution, the longer-term effect of the program on participant decision making will be assessed based on a single question (DAT6). DAT6 asks the respondent about the likelihood of the project given all program assistance for all projects since the programs were started. The greater of the score from DAT6 and the primary SPA will be used as the SPA in calculating the secondary attribution. Secondary attribution is an estimate of LCNS attribution based on all program efforts, not just program efforts focused on this project. This secondary attribution approach is lower rigour than the primary approach and provides a sense of the incremental effect that historical program efforts have on projects today. This score is not intended for application in determining program net savings.

Figure 8-18: Secondary attribution scoring

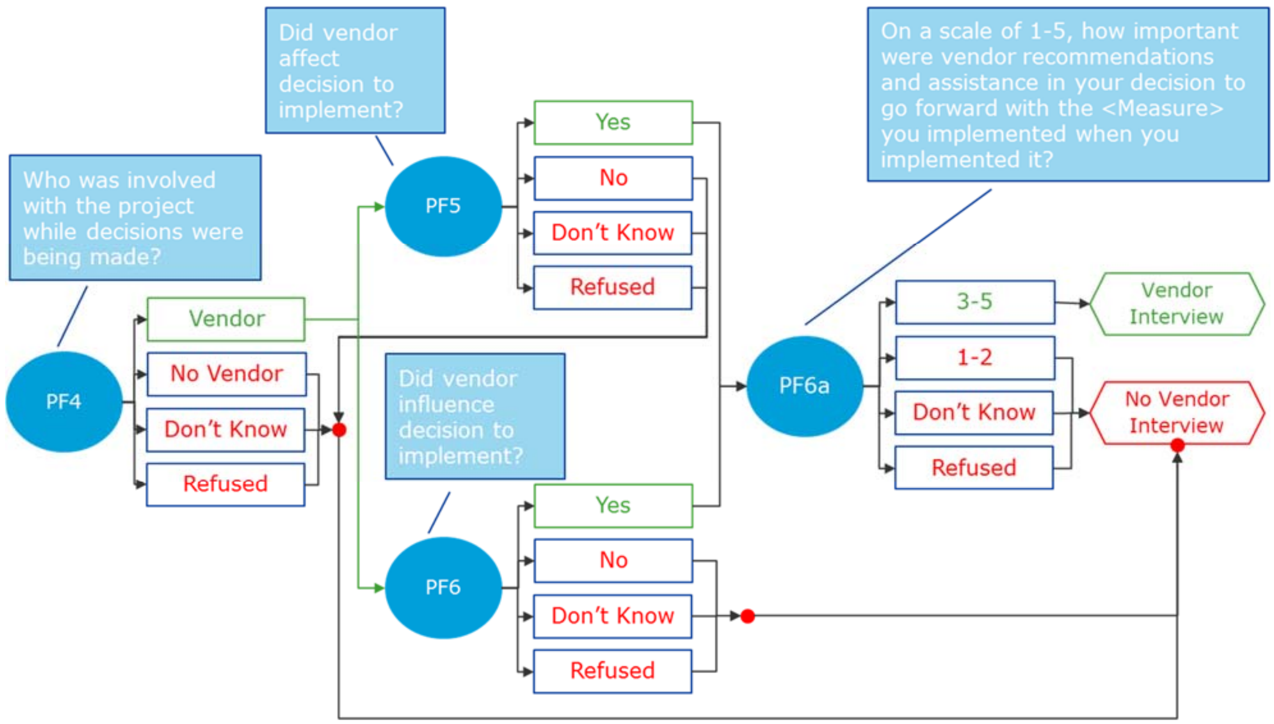


Incorporating vendor effect

DNV GL will take two steps to determine when a vendor survey is necessary to supplement the participant survey. They are:

1. When we request project documentation and site contact information for each sampled project we will also ask the utilities to provide vendor contact information for projects with vendor involvement.
2. Each survey completed with a participant is reviewed to determine the effect the supplier had on the participant's decision to install a given measure relative to the program's effect. If a participant indicates that the program did not influence their decision to install high-efficiency equipment but the vendor did have substantial influence, then we will complete a survey with the vendor. The decision tree is shown in Figure 8-19.

Figure 8-19. Decision tree to trigger vendor interview



For measures with both participant surveys and vendor surveys, the analysis will produce two separate attribution values. The first reflects the influence that the program had on the participant's decision to install the measure. The second reflects the influence that the program had on the vendor's business practices and therefore their ability to sell the measure. We choose the higher of the two values as the final program attribution for that measure. That is, if either the vendor or the customer indicates that the program influenced the decision to install the measure, we conclude that the program influenced the decision. In the event that a vendor interview is triggered, but is either not completed or results in an inconclusive vendor score, vendor attribution for the measure will be the average attribution of all completed vendors within the evaluation program.

The vendor attribution scoring method will be included with the vender interview guide.

Quality control by interviewers and analysts

Each of the components of attribution, Timing (DAT1a/ DAT1a_O/DAT1b), Efficiency (DAT2a/DAT2a_O/DAT2b) and Quantity (DAT3a/ DAT3a_O/DAT3b), have a question sequence that follows the same pattern:

DATXa.	What would you have done without the program?
DATXa_O.	Why do you say that?
DATXb.	<If DATXa=program effect> How different would the project have been?

Quality control for each component of attribution consists of comparing the final component attribution score (t, e, q) to the open-ended response for the "DATXa_O. Why do you say that?" question.

Interviewers are trained to probe if the response to the open-ended question is inconsistent with the scored response to DATXa.

During the analysis phase, the analyst will put measures into three bins: full attribution, partial attribution and full free rider for each component. The analyst works bin at a time to compare each verbatim open ended response to the score for the attribution component. Assessing verbatim responses by bin reduces analyst error and speeds the review. If an open-ended response appears inconsistent with the score received, the case is elevated to PM review.

Overall attribution scores are compared to the DAT0 score and assesses for consistency. A high attribution score from the TEQ questions should usually correspond to a "somewhat unlikely" or" very unlikely" to implement response to DAT0. Inconsistent scores are referred to PM review.

Overall attribution scores are also assessed for consistency with the DAT4 verbatim, by bins as described for the QC of the component scores. Inconsistent scores are referred to PM (Ben Jones) review.

Non-Zero attribution scores are also assessed for consistency with the responses to PF8 and PF9. Any non-zero score that also has a response of "after making decision" or "after installing" is considered inconsistent and referred to PM (Ben Jones) review.

The overall attribution score will also be compared to DAT6 (the secondary attribution question). In theory, DAT6 should be equal to or greater to the overall attribution score for all measures, but because the question is a scalar 1-10 and the primary attribution is scored by asking about influence on specific aspects of the project inconsistencies are expected. For QC, all instances where the secondary attribution is more than 20% lower than overall primary attribution will trigger a PM review.

Quality control PM Review

Analysts are instructed to have a low bar ("when in doubt flag for review"), most of the measures flagged for PM review result in no change. For each site that has a measure flagged for PM review, the PM (Ben Jones) will review the full survey, including all measures and responses. The PM may also follow up with the interviewer to better understand the combination of responses. If the PM determines that the flagged score (whether of a component or overall) is not clearly contradicted by the overall story told by the respondent throughout the interview, the PM makes no change. If the flagged score is clearly contradicted (approximately 1% of cases in DNV GL's experience), the PM decides among three options:

- drop the measure from the sample (for very muddled responses, much more common with CATI than IDI)
- replace the inconsistent response with a "Don't Know" (effectively using the average if it is clear that there should be some attribution for the component, but unclear how much)
- adjust the flagged score to more accurately reflect the intent of the respondent (employed in cases where there is overwhelming evidence of intent, for instance the open-ended response says clearly what the score should be)

For all adjusted scores, project sponsor (Tammy Kuiken) approval is required.

APPENDIX L. Spillover Methodology

The spillover portion of the study includes participant spillover only. The participant spillover analysis will provide separate estimates of spillover for inside-like, inside-unlike, outside-like, and outside-unlike spillover. Each of the estimates will be generated based on ratio estimation relative to the program measure savings. Some spillover data was collected as part of the combined CPSV/NTG data collection. Spillover results will be provided in a separate volume.

Spillover "refers to effects of customers that adopt energy efficiency measures because they are influenced by a utility's program-related information and marketing efforts, but do not actually participate in the program."[36] As in many jurisdictions, Ontario's Demand-Side Management Guidelines recognize the importance of spillover in determining program benefits and requires "comprehensive and convincing empirical evidence" to support any program spillover claim.

Key challenges to providing convincing quantified evidence of spillover for a particular customer include:

- Determining that a particular subsequent action was due to the influence of the program
- Confirming that the action was not taken as part of the original or another program, hence already counted by the program
- Quantifying the savings associated with confirmed spillover actions.

DNV GL's proposed approach provides a high level of rigor to address each of these issues.

- We determine program influence using participant surveys that start with the framing used for our free ridership questions. This framing helps ensure more meaningful responses to questions of the influence of the experience with the program in implementing the original measure on subsequent actions. As for the free rider surveys, obtaining the right respondents is also essential to obtaining meaningful responses to these questions.
- We confirm that the actions tentatively identified as spillover were not already counted by another program by cross-checking tracking data bases. Also critical to separation of spillover from program-claimed savings is understanding what savings if any are claimed by the programs for facilitation support such as opportunity identification, feasibility studies, audits, and related continuous improvement program engagement.
- We quantify the savings for confirmed spillover actions by collecting engineering specifications and calculating associated savings. This approach gives more accurate results than asking customers to estimate the magnitude of spillover savings relative to the original measure.

Thus, our participant spillover methodology addresses the following key issues:

- *Locating the right decision-maker* - Large commercial and industrial companies have multiple decision-makers and it is often difficult to find someone who is familiar with both the tracked program-influenced measure and the spillover measure. Employee turnover can also complicate this. Our approaches to ensure appropriate respondents are discussed above.
- *Avoiding double-counting* – Companies that received financial incentives from an energy efficiency program for one measure are likely to seek these incentives for future measures. Hence it is important

[36] Ontario Energy Board Demand Side Management Guidelines for Natural Gas Utilities, EB-2008-0346, June 2011, Chapter 7.

to get the program's latest tracking data to make sure that a potential participant spillover measure did not receive program support.

- *Estimating program attribution for potential spillover measures* - A common way of assessing participant spillover is to ask how much the participant's experience with the tracked program-influenced measure influenced their decision to implement measures that are candidates for spillover attribution. It is difficult to turn this "fuzzy" assessment of program influence into a more concrete attribution factor necessary for attributing a certain quantity of m^3 from the spillover measure to the program.
- *Estimating the energy savings for the participant spillover measures.* Because spillover measures occurred outside the program, evaluators do not have access to the same information about the size, type, and quantity of the implemented energy-efficient measures that they would find in a program tracking database.

Our approach to these issues is described in more detail below. This approach is based on one we used successfully in Wisconsin C&I programs over many years.

Understanding energy-related standard practices

The first objective of the survey will be to find out whether the participant's company or organization had installed any energy-efficient equipment or made any energy-efficient changes in operation or maintenance (O&M) procedures after the implementation of the tracked project. But before doing that we will collect some information about the company or organization's energy-related decision-making process. We will ask the participants a series of questions about:

- Who in their company makes decisions about equipment replacement and retrofit projects;
- What information sources are used in making these decisions; and
- Possible barriers to energy efficiency implementation.

This information will be valuable for a number of different reasons. First, it should help program implementers devise strategies for increasing program awareness and mitigating barriers to project implementation, especially for participants who did not identify any subsequent energy-efficient projects after the tracked project. Second, by shedding light on the project decision-making process, it should help the evaluators make better judgments about assigning program attribution to a given project. Finally, it should make the survey appear less peremptory for those who did not report any new energy-efficient projects after the tracked projects, since otherwise their survey would be terminated fairly quickly.

After we collect this information about participant energy practices, we will ask the participants whether their company/organization had installed any energy-efficient projects after the installation of the tracked project. If the participants report no subsequent actions, we will terminate the survey since there is no participant spillover to be measured. If they do identify subsequent projects, then we will collect some basic information about the project including:

- The approximate year of the project;
- The geographic location of the project (e.g. city);
- The types of energy-efficient measures installed or energy-efficient O&M practices implemented; and
- Whether the tracked project and the subsequent project were in the same facility or not (needed for the calculation of inside vs. outside spillover).

Because this information will be collected by CATI program surveyors who do not have an energy background, we will not ask them to try to collect too detailed information about the energy-efficient project.

It just needs to be detailed enough to allow the evaluators to make a reasonable match with any projects in the program tracking data.

Calculating program attribution for candidate spillover actions

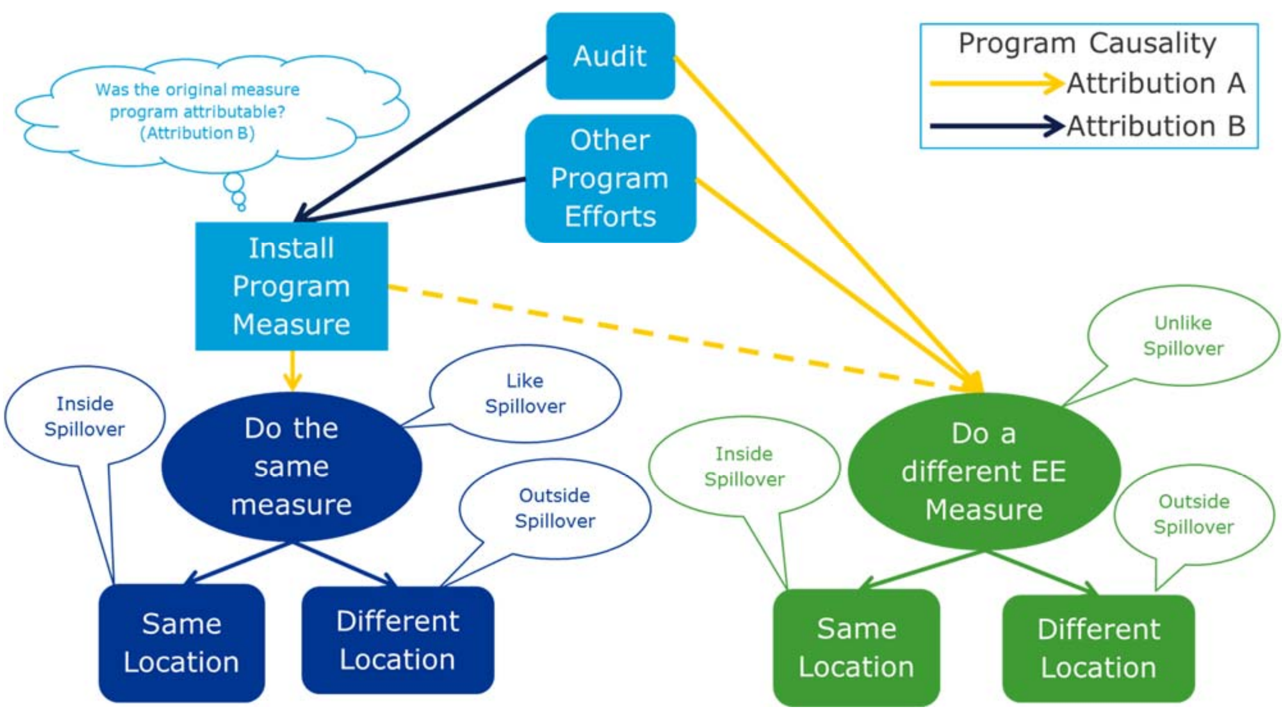
The next stage of the survey will focus on program attribution. Our method only awards spillover energy savings if two criteria are met:

ES1. The potential spillover project is at least partially attributable to the participant's experience with the program in implementing the earlier tracked project (Attribution Factor A).

For like spillover, the original tracked project is at least partially attributable to the program (Attribution Factor B). For unlike spillover, Attribution B will apply if the respondent indicates that the original program measure (separate from other program efforts) was a factor in their decision.

Figure 8-20 shows how program causality ties to different types of spillover. Attribution B applies to like spillover in all cases, while for unlike spillover attribution B applies to the spillover only if the original program measure was part of the program influence that led to the spillover measure being implemented.

Figure 8-20: Program influence on spillover by type



If a measure met these two criteria, we assign it spillover savings according to the following formula:

(Spillover Savings) = (the measure's savings) X (Attribution Factor A) X (Attribution Factor B).

We apply both Attribution Factor A and Attribution Factor B because if the program had no influence on the original tracked project, the program should not get credit for any additional measure installations resulting from that tracked project. To reduce respondent fatigue, Attribution Factor A will be asked in the CATI survey, while Attribution B will only be asked in the Engineering follow up IDI. If Attribution A is zero we will not conduct a follow up interview.

To determine attribution factor B we will use the FR question battery already described in this SOW. For Attribution factor A we will use a scoring method that will be triggered off the question, "If you had not made the earlier energy-efficiency improvements I just listed, how likely would you have been to make this additional energy efficiency improvement?" The scoring method, which we used in Wisconsin for many years, is shown in Table 8-87. If the participant said they were very likely to have made the additional energy efficiency improvement without the program, then we will terminate the survey since there will be no participant spillover to be measured. If the subsequent measure is fully or partially attributable, then for unlike spillover a follow up question will be administered to assess whether Attribution B is applicable.

Table 8-87: Program Attribution for Subsequent Measures

If had not made tracked program-influenced energy efficiency improvement, reported likelihood of making subsequent energy efficiency improvement		Assigned Attribution Factor A
1	Not likely at all	1.00
2	Not very likely	0.90
3	Somewhat likely	0.55
4	Very likely	0.00

The reason we use a different method for Attribution Factor A than for Attribution Factor B is that the character of influence is different. For the program's influence on the tracked project (Attribution Factor B) financial incentives usually account for much of the influence in terms of reducing payback periods and therefore we want to measure things like acceleration effects. However, with participant spillover the influence is less tangible and more likely to be general positive experience with a new energy-efficient technology and the energy savings it produces. We believe that using a Likert scale question will better capture the less tangible character of this type of influence.

Avoiding double counting of energy savings

Once a participant has identified a subsequent project that is attributable – e.g. one where Attribution Factor A and Attribution Factor B are both greater than zero -- then we will conduct some additional checks to insure that the subsequent project is not also a tracked project. Some of these checks will occur in the survey itself. For example, we will ask the participants if they recall receiving financial incentives from an energy efficiency program for the subsequent projects. We will also examine the program tracking data to make sure that the subsequent project is not in the tracking program data for future years. For example, if we interview a 2013 participant and they identify a subsequent project in 2014 we will look at the 2014-2015 program tracking data (we will look at both program years in case their memory of the project timing was faulty) to see if we can find that project. If we do find the subsequent project in program tracking data, then we will remove that project as a candidate for spillover energy savings since the savings for that project has already been claimed by the program.

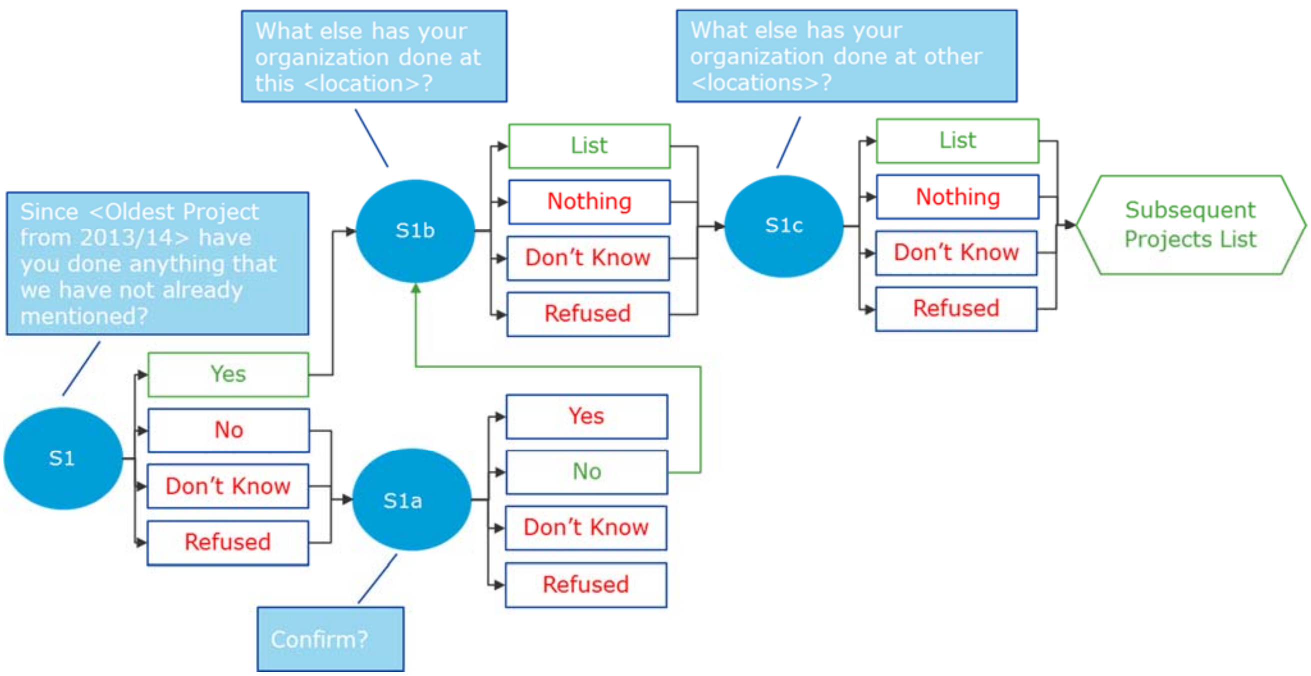
Estimating energy savings for participant spillover measures

Once a project has been identified as having spillover energy savings (it is program attributable and we could not locate it in the program tracking data) the final step will be to estimate its energy savings. To estimate the annual energy savings for participant spillover measures, we plan to have engineers conduct follow-up interviews with the persons identified in the CATI surveys as being most familiar with the spillover projects. The engineers will have some basic project information collected from the CATI survey as well as some information about deemed savings algorithms for that measure which will allow them to prepare ahead of time the types of questions they will need to ask (e.g., about baseline measures, hours-of-use, etc.). Once they have conducted the interview and collected the necessary information they will calculate the first-year savings and EUL for the measure. If a deemed savings algorithm exists for that measure they will use that as a default. If none exists then they will use their best professional judgment to estimate the energy savings. This process will work equally well for both like and unlike spillover.

Spillover decision trees

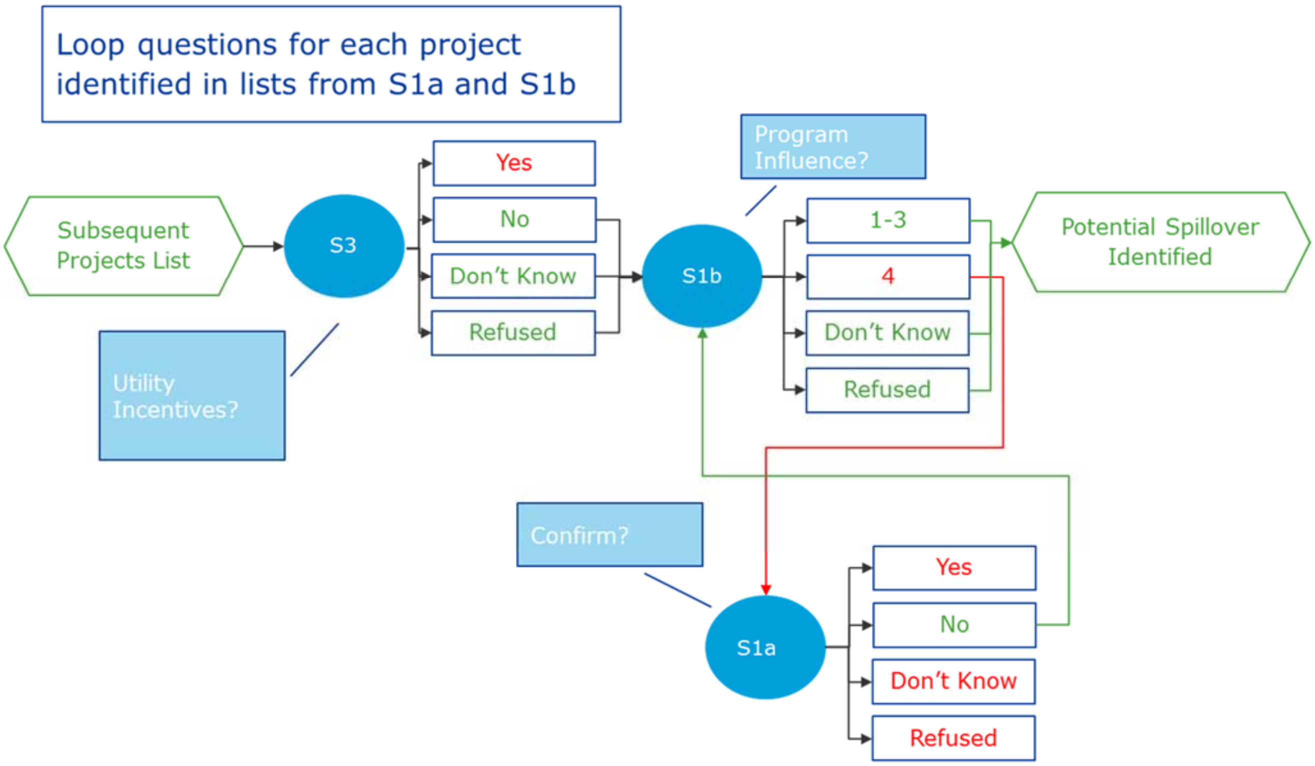
The initial participant IDI and participant CATI each include a spillover module that produces a list of potential spillover projects for each participant. The first part of the module (Figure 8-21) generates a list of changes to energy using equipment at the same location as the original measure and another list of changes to equipment at other locations.

Figure 8-21. Spillover module Part 1: identify subsequent projects



The second part of the module (Figure 8-22) loops through the list of subsequent projects to eliminate projects that received utility incentives and to establish program influence. The projects identified that were program influenced are referred to as potential spillover and will receive a follow up engineering interview to quantify savings.

Figure 8-22. Spillover module Part 2: subsequent project loop



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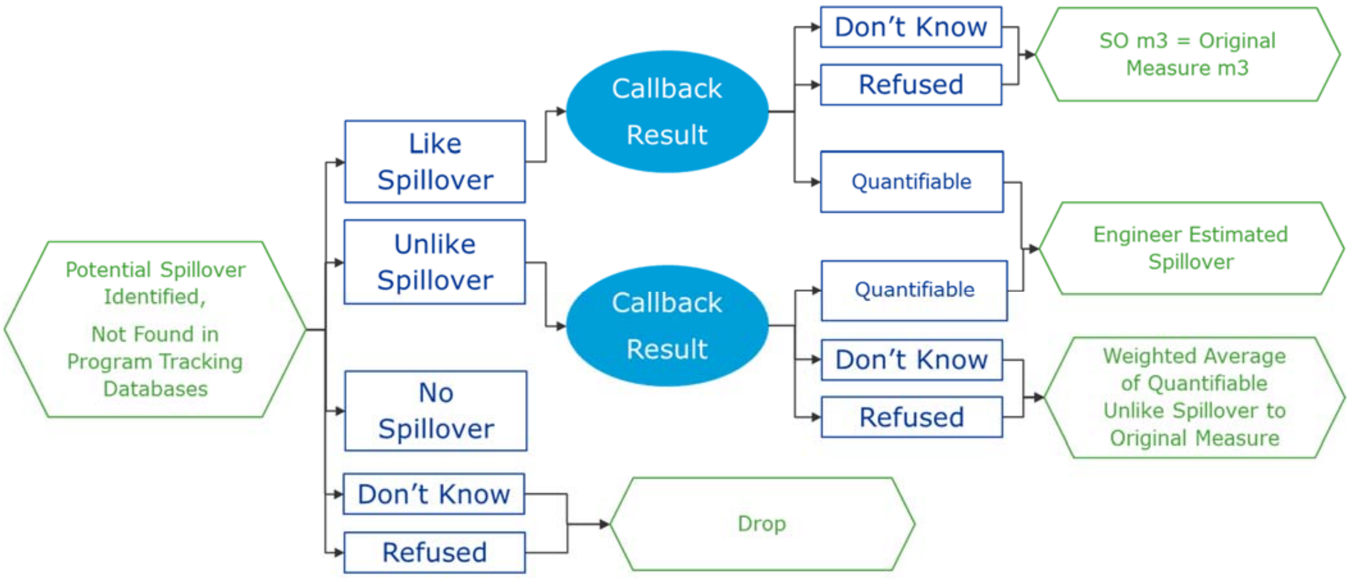
Potential spillover projects that are not found in program tracking databases will receive a call from a DNV GL engineer. If the customer refuses the interview or the evaluation engineer is not able to find a contact who can answer technical questions, the spillover will be quantified in one of two ways (Figure 8-23). If the project is like spillover we will use the savings of the original program measure as the basis for the savings estimate. If the project is unlike spillover we will use the average of other sites with unlike spillover for the estimate.

Figure 8-23. Spillover callback high-level process



APPENDIX M. 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 2 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 2: 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 project needs to be set to 1 in order to use the data collected without biasing the result. Our sample design targets 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 measures in a single IDI or site visit. This maximizes the data collected on each customer contact, but requires special handling to ensure that extra data collected does not bias the sample. To eliminate the potential bias of over representing multiple measure sites, we first identify units that were completed as an add-on when another measure was selected for a site.

For each stratum in our sample design the units are randomly ordered for selection in a list. If seven units are targeted for the stratum then the first seven units on the list are the primary sample and the rest of the list comprises the full backup sample (when we request project documentation we will restrict the backup sample for the request in order to reduce burden on utility staff). If a site has two measures in different strata and one is selected in the primary sample, we will request documents on both measures and ask about both, regardless of whether the second measure is in the primary or backup sample in its stratum. After collecting data on both measures we will assess whether the second measure was selected in its stratum based on how far down the list we had to go to complete our target. If the second measure's spot on the list was selected, then the measure will be counted as a normal complete and included in the stratum's N/n weight calculation. If the measure's spot on the list did not come up, the data collected for the measure will be used, but the measure will not be included in the N/n weight for its strata. Instead it will be given a weight of 1 so that it represents itself and no other measures. For variance estimates, the measure will remain in its sampled stratum.

Table 8-88 provides an example. Both site A and Site B were had measures in Stratum X selected in the sample. Each responded to our interview. Both sites also had a measure in Stratum Y. The evaluation completed data collection for both measures for each site. Due to where each of the sites' second measures were on the original priority list in stratum Y, the second measure for each site received different weights despite being in the same stratum.

Table 8-88: Determining non-randomly selected measures

Strata	Priority	Site	Measure	Survey Status	Selection Type	Weight
X	1	**A**	**A1**	**Complete**	**Random**	**3 / 2**
X	2	**B**	**B1**	**Complete**	**Random**	**3 / 2**
X	3	C	C1	live		
Y	1	D	D1	Complete	Random	8/3
Y	2	E	E1	Refused		
Y	3	**A**	**A2**	**Complete**	**Random**	**8 / 3**
Y	4	F	F1	Complete	Random	8/3
Y	5	G	G1	live		
Y	6	**B**	**B2**	**Complete**	**Not Random**	**1 / 1**
Y	7	H	H1	live		
Y	8	I	I1	live		
Y	9	J	J1	live		

The measures in Stratum X each were selected randomly. Measure A1 was first on the priority list and measure B1 was second. Because both A1 and B1 were completed and the target was 2 for the strata, site C was not called. Because site C was not called, measure C1 had a final survey status of "live." In the case of stratum X, there were 3 measures and 2 were completed. This resulted in a sample weight of 3/2 for each of the two completed measures.

In stratum Y four measures were completed. In this example the target for the stratum was achieved prior to calling site G. The evaluation attempted data collection for the first 4 measures on the list. Site E refused the survey or otherwise did not respond. Sites D, A, F and G completed the survey, but B did not come up in the priority list until after site G (the first "live" site in the list). In this case measure B2 was not selected randomly and needs to be treated as a special case. Measure B2 is removed from the stratum Y weight calculation, so the three measures that were completed receive a weight of 8/3 (once measure B3 is removed there are eight measures in the frame, and 3 completed measures). Measure B2 receives a weight of 1.

Ratio estimation

The calculation of the adjustment factors for tracking system gross and net savings uses appropriate case weights corresponding to the sampling rate as discussed above. The energy saving estimates (tracking savings, installed savings, verified savings or net savings) of the sampled units (measures, projects, sites) are present in both the numerator and the denominator of the ratios, when combined with the sample weights the ratio estimation method produces unbiased, savings weighted adjustment factors.

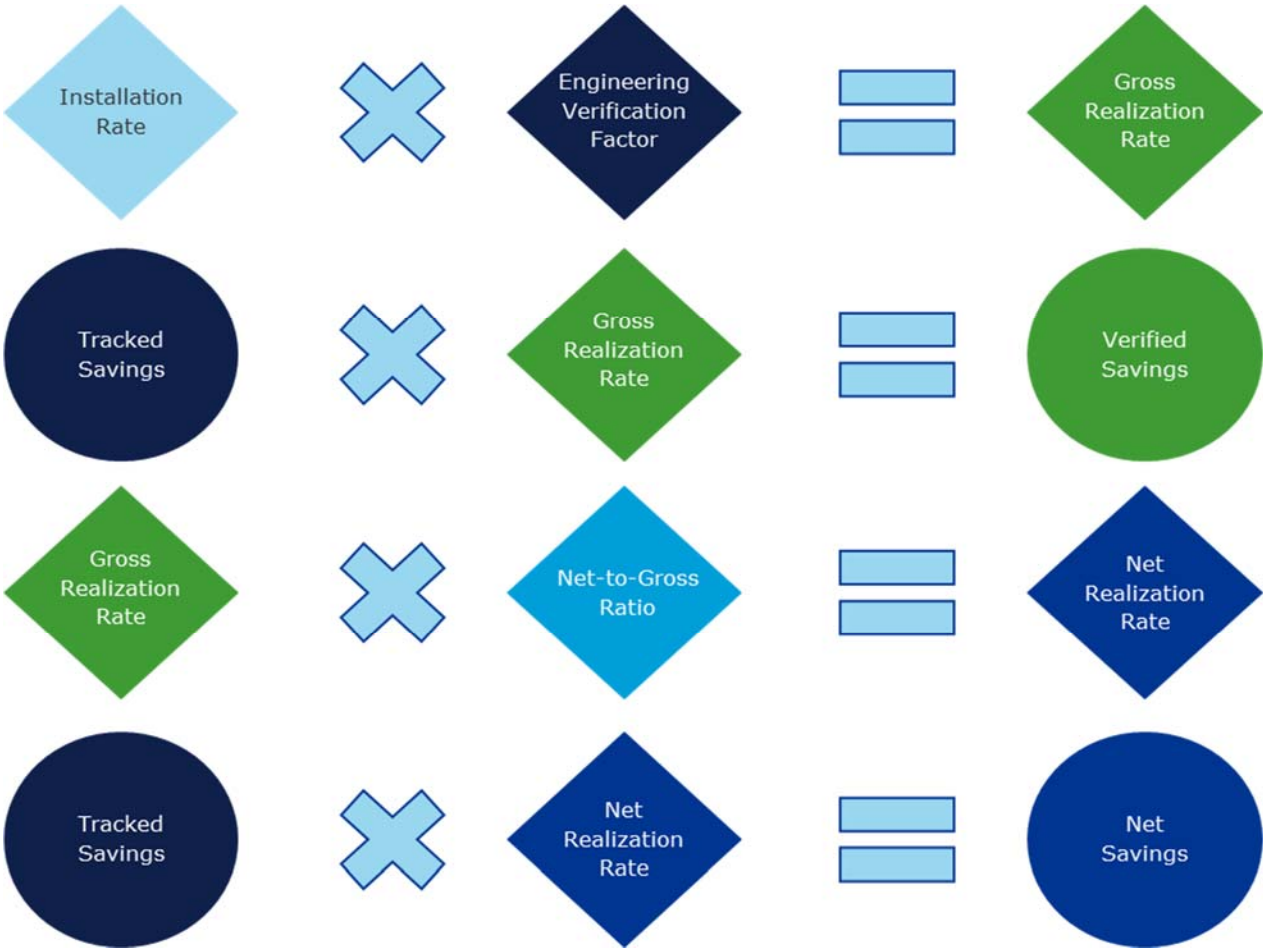
Collecting data on verified and net savings for the same set of measures provides a more accurate estimate of net savings. Integrating the two allows the evaluation to calculate net savings for a measure as a function of verified savings rather than tracking savings. This means that projects carry the weight of their specific verified savings in the net-to-gross ratio rather than tracking savings or a broader estimate of verified savings. Large verification adjustments can have a large effect on the relative weight of specific projects in the NTG.

For an individual measure:

- Installed savings are a function of the tracking savings. When the measure is installed the installed savings equal tracking savings and when the measure is not installed, then installed savings are zero.
- Verified savings are calculated independent of the tracking savings by evaluation engineers using the best available methods and information.
- Net savings are a function of verified savings. Attribution for the measure multiplied times verified savings plus spillover savings associated with the measure.

Individual measure results are expanded to the estimate population savings (circles) using ratios (diamonds), as shown in Figure 8-24. Ratios are applied for each of the primary reporting domains and then summed to calculate the total for the program overall.

Figure 8-24: 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_{Ij} = tracking estimate of gross savings for measure *j*, adjusted for non-installation

G_{Vj} = engineer verified estimate of gross savings for measure *j*,

N_{Vj} = Net 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

W_{Nj} = weighting factor for measure j used to expand the FR sample to the full population

The installation rate R_I is calculated using the CPSV sample as

$$R_I = \frac{\sum_{j\varepsilon A} G_{Ij} w_{Vj}}{\sum_{j\varepsilon A} G_{Tj} w_{Vj}}$$

The Engineering Adjustment R_E is calculated from the CPSV sample as

$$R_E = \frac{\sum_{j\varepsilon V} G_{Ej} w_{Vj}}{\sum_{j\varepsilon V} G_{Ij} w_{Vj}}$$

The Attribution ratio R_A is calculated from the FR sample as[37]

$$R_A = \frac{\sum_{j\varepsilon N} N_{Vj} w_{Nj}}{\sum_{j\varepsilon N} G_{Vj} w_{Nj}}$$

The procedure used for calculating ratio estimation by domains provides the correct standard error of the estimate for each domain and overall. The procedure also takes into account defined clusters of observations (customers) and stratification. The standard error is calculated using two methods.

The first method recognizes the sample as drawn from a finite population: the measures completed within the analysis period with associated energy impacts in the program-tracking database. This calculation uses the Finite Population Correction (FPC) factor. This factor is a reduction to the calculated variance that accounts for the fact that a relatively large fraction of the population of interest has been observed directly and is not subject to uncertainty. It is appropriate to apply precision statistics, such as confidence intervals, based on the standard error calculated in this manner when quantifying the results of the program during the study period only. The FPC factor reduces the calculated sampling error around the estimate more for smaller populations than for large.

The second calculation treats the population of interest as essentially infinite. Thus, the measures completed to date and the sample selected from them is regarded as random instances of a virtually infinite number of measures that could have been completed under the program. In this case, the FPC is not included. It is appropriate to apply standard errors calculated in this manner when applying the verification factors developed from this study to tracked savings from other years to estimate verified savings in those years.

The Gross RR, R_V, is calculated by chaining together the installation rate and the calculation adjustment:

$$R_V = R_I R_E = \left[\frac{\sum_{j\varepsilon V} G_{Ij} w_{Vj}}{\sum_{j\varepsilon V} G_{Tj} w_{Vj}}\right]\left[\frac{\sum_{j\varepsilon V} G_{Cj} w_{Vj}}{\sum_{j\varepsilon V} G_{Ij} w_{Vj}}\right]$$

This is an example of a chained ratio estimator using a nested sample. The standard error for the chained ratio is approximated by the formula:

$$SE(AB) \cong AB\sqrt{\left[\left(\frac{SE(A)}{A}\right)^2 + \left(\frac{SE(B)}{B}\right)^2\right]}$$

(This formula overstates the standard error, because it ignores the correlation between the numerator of R_I and the denominator of R_E, which reduces the variance of the product.)

[37] For the net-to-gross ratio, the verified gross savings for measures in the FR only sample (G_{Vj}) were estimated based on the gross RRs found for measures of the same measure type in the CPSV sample.

Likewise, the Net RR, R_N, is calculated by chaining together the gross realization rate and the net-to-gross ratio:

$$R_N = R_V R_A$$

The same standard error approximation formula allows (an over-estimate of) the standard errors of each of the realization rates to be calculated from the two separate standard errors.

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 8-89 shows the reported, installed and verified savings and NTG for Example Customer A's four measures reported in the program tracking database.

Table 8-89: 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 8-90 shows the verified gross and net savings for Example Customer A.

Table 8-90: 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 8-91 shows the un-weighted customer and commercial sector savings results.

Table 8-91: 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 4 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 8-92: Example industrial sector measure-type-level weighted savings

			Reported m3		Installed m3		Verified m3		Net m3	
Customer	Measure Type	Weight	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 weighted installed m^3 / 3,627,000 weighted reported m^3 = 100% installation rate
- 3,380,500 weighted verified gross m^3 / 3,627,000 weighted installed m^3= 93.2% eng. verification factor
- 1,235,500 weighted net m^3 / 3,380,500 weighted verified gross m^3 = 36.5% attribution adjustment.

The verified gross RR is the product of the installation rate and the engineering verification factor, or 100% 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% times 36.5% = 34.018% 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

Ratio 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 8-93 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% 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 8-93: Example of ratios applied overall vs. by domains

	A	B	C	D		
Measure Type	Population m3	Sample Weighted m3	Gross RR	Net RR	Verified Gross Savings (A*C)	Net Savings (A*D)
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 and net savings for the programs.

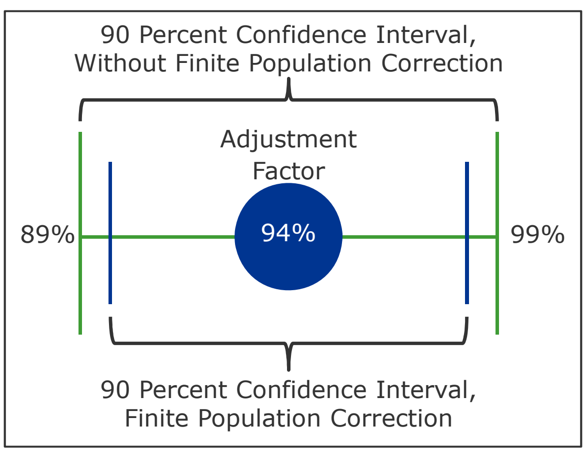
Table 8-94: Relevant statistics.

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%[38] 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)
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 51 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 8-25: Ratio diagram example



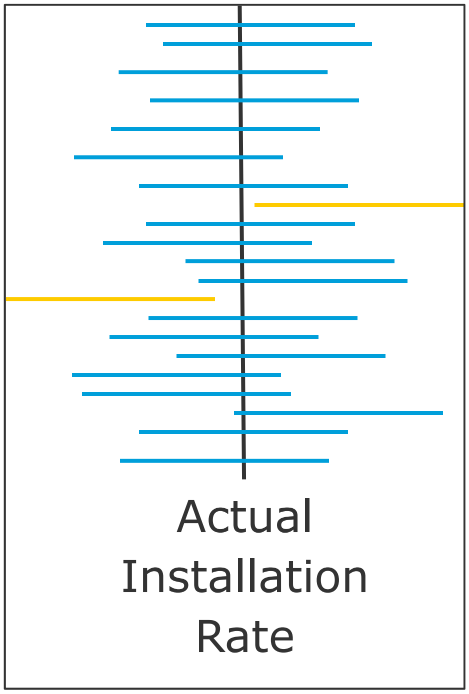
The plus/minus (±) error (%) indicated at the 90% confidence interval is the absolute difference between the estimated percentage and the upper or lower confidence bound. For example, in Figure 51, the ratio is 94% and the non-FPC 90% confidence interval is ± 5 percentage points (i.e., 94% ± 5%).[39] Another way of

[38] 90% is the confidence limit that we are using.

[39] The critical value for calculating the confidence interval ± 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. The critical value for the gross savings adjustment factor is determined using the degrees 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 8-26 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

Figure 8-26. 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.

For determining which ratios to report and apply we will 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.

freedom based on the minimum sample size for the components of the adjustment factor. The gross savings adjustment factor is a product of the installation rate and the engineering verification factor. 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.

Reporting domains will be defined as combinations of the following categorizations where sample sizes and precisions allow:

- Stratification segments
- NTG Category (for FR and SO)
- CPSV Category (for Gross results)
- Measure types (shown in later tables)

Table 8-95 and Table 8-97 present the maximum number of reporting domains for the NTG results and Table 8-98 and Table 8-99 present the maximum number of reporting domains for the CPSV results.

There will be cases where some of the groups defined by a categorization have sufficient precision, while others do not. In these cases, we will combine the groups that do not meet reporting thresholds into an "other" group. For example, we may have sufficient precision to report separate ratios for Enbridge Commercial Controls, Heat Recovery and HVAC, but not enough to report the ratios for the other six measure types. In this case, we will report the three groups that we have sufficient precision for and group the rest into a "Balance of commercial/Other" group. Table 8-96 provides an example of how the Enbridge NTG domains presented in Table 8-95 could potentially be collapsed during ratio estimation.

No results will be reported that blend Union and Enbridge samples. Large Volume and RunitRight will also not be combined with other programs segments due to their different designs.

For application of CPSV results our initial list of application domains will be within stratification segment with separate domains for each CPSV category and measure type (as shown in the tables below). Those domains that meet the pre-defined precision and sample size criteria, described above, will have results applied at this level. For the rest of the list we will combine domains in the most logical manner appropriate to the ratio in order to achieve combinations that meet criteria and where possible are a meaningful grouping of measures. For example, we will combine CPSV categories within measure types and combine measure types within CPSV categories as is most reasonable given the estimation approaches used (i.e. if there is little difference in simple vs complex measures in the calculation method for building shell measures we would combine the simple and complex building shell first rather than simple building shell into a "simple-other" domain).

For application of NTG results the same process will be used as for CPSV, but with the NTG category substituting for the CPSV category.

Table 8-95. Enbridge NTG domains

Utility	Program	NTG Category	Measure Type
Enbridge	Commercial	Action	Operational Improvements
Enbridge	Commercial	Equipment	Building Shell
Enbridge	Commercial	Equipment	Controls
Enbridge	Commercial	Equipment	HVAC
Enbridge	Commercial	Equipment	Heat Recovery
Enbridge	Commercial	Equipment	Steam and Hot Water
Enbridge	Industrial	Action	Operational Improvements
Enbridge	Industrial	Equipment	Building Shell
Enbridge	Industrial	Equipment	Controls
Enbridge	Industrial	Equipment	Greenhouse
Enbridge	Industrial	Equipment	HVAC
Enbridge	Industrial	Equipment	Heat Recovery
Enbridge	Industrial	Equipment	Other Equipment
Enbridge	Industrial	Equipment	Process Heat
Enbridge	Industrial	Equipment	Steam and Hot Water
Enbridge	Multi-Residential	All	Controls
Enbridge	Multi-Residential	All	HVAC
Enbridge	Multi-Residential	All	Heat Recovery
Enbridge	Multi-Residential	All	Operational Improvements
Enbridge	Multi-Residential	All	Steam and Hot Water
Enbridge	RunitRight	Action	RunitRight

Table 8-96. Example of potential Enbridge NTG domain collapsing

Utility	Program	NTG Category	Measure Type
Enbridge	Commercial & Multi-Residential	Equipment	Controls
Enbridge	Commercial & Multi-Residential	Equipment	HVAC
Enbridge	Commercial & Multi-Residential	Equipment	Steam and Hot Water
Enbridge	Commercial	Equipment	Other Commercial Equipment
Enbridge	Industrial	Action	Operational Improvements
Enbridge	Industrial	Equipment	Controls
Enbridge	Industrial	Equipment	Heat Recovery
Enbridge	Industrial	Equipment	Other Industrial Equipment
Enbridge	Multi-Residential	All	Multi-Residential Other
Enbridge	RunitRight	Action	RunitRight

Table 8-97. Union NTG domains

Utility	Program	NTG Category	Measure Type
Union	Commercial	Action	Controls
Union	Commercial	Action	Maintenance
Union	Commercial	Action	Optimization
Union	Commercial	Action	Steam and Hot Water
Union	Commercial	Equipment	Building Shell
Union	Commercial	Equipment	Controls
Union	Commercial	Equipment	HVAC
Union	Commercial	Equipment	Heat Recovery
Union	Commercial	Equipment	New Construction
Union	Commercial	Equipment	Other Equipment
Union	Commercial	Equipment	Steam and Hot Water
Union	Industrial	Action	Controls
Union	Industrial	Action	HVAC
Union	Industrial	Action	Maintenance
Union	Industrial	Action	Optimization
Union	Industrial	Action	Steam and Hot Water
Union	Industrial	Equipment	Ag and Greenhouse
Union	Industrial	Equipment	Building Shell
Union	Industrial	Equipment	Controls
Union	Industrial	Equipment	HVAC
Union	Industrial	Equipment	Heat Recovery
Union	Industrial	Equipment	Other Equipment
Union	Industrial	Equipment	Process Heat
Union	Industrial	Equipment	Steam and Hot Water
Union	Large Volume	Action	HVAC
Union	Large Volume	Action	Heat Recovery
Union	Large Volume	Action	Maintenance
Union	Large Volume	Action	Optimization
Union	Large Volume	Action	Other Equipment
Union	Large Volume	Equipment	Ag and Greenhouse
Union	Large Volume	Equipment	Building Shell
Union	Large Volume	Equipment	Controls
Union	Large Volume	Equipment	HVAC
Union	Large Volume	Equipment	Heat Recovery
Union	Large Volume	Equipment	New Construction
Union	Large Volume	Equipment	Other Equipment
Union	Large Volume	Equipment	Steam and Hot Water
Union	Multi-Family	All	Controls
Union	Multi-Family	All	New Construction
Union	Multi-Family	All	Steam and Hot Water

Table 8-98. Enbridge CPSV domains

Utility	Program	CPSV Category	Measure Type
Enbridge	Commercial	Complex	Building Shell
Enbridge	Commercial	Complex	Controls
Enbridge	Commercial	Complex	HVAC
Enbridge	Commercial	Complex	Heat Recovery
Enbridge	Commercial	Complex	Operational Improvements
Enbridge	Commercial	Complex	Steam and Hot Water
Enbridge	Commercial	Simple	Building Shell
Enbridge	Commercial	Simple	Controls
Enbridge	Commercial	Simple	HVAC
Enbridge	Commercial	Simple	Heat Recovery
Enbridge	Commercial	Simple	Operational Improvements
Enbridge	Commercial	Simple	Steam and Hot Water
Enbridge	Industrial	Complex	Building Shell
Enbridge	Industrial	Complex	Controls
Enbridge	Industrial	Complex	Greenhouse
Enbridge	Industrial	Complex	HVAC
Enbridge	Industrial	Complex	Heat Recovery
Enbridge	Industrial	Complex	Operational Improvements
Enbridge	Industrial	Complex	Other Equipment
Enbridge	Industrial	Complex	Steam and Hot Water
Enbridge	Industrial	Simple	Building Shell
Enbridge	Industrial	Simple	Greenhouse
Enbridge	Industrial	Simple	HVAC
Enbridge	Industrial	Simple	Heat Recovery
Enbridge	Industrial	Simple	Operational Improvements
Enbridge	Industrial	Simple	Other Equipment
Enbridge	Industrial	Simple	Process Heat
Enbridge	Industrial	Simple	Steam and Hot Water
Enbridge	Multi-Residential	Complex	Controls
Enbridge	Multi-Residential	Complex	HVAC
Enbridge	Multi-Residential	Complex	Heat Recovery
Enbridge	Multi-Residential	Complex	Steam and Hot Water
Enbridge	Multi-Residential	Simple	Controls
Enbridge	Multi-Residential	Simple	HVAC
Enbridge	Multi-Residential	Simple	Heat Recovery
Enbridge	Multi-Residential	Simple	Operational Improvements
Enbridge	Multi-Residential	Simple	Steam and Hot Water

Table 8-99. Union CPSV domains

Utility	Program	CPSV Category	Measure Type
Union	Commercial	Complex	Building Shell
Union	Commercial	Complex	Controls
Union	Commercial	Complex	HVAC
Union	Commercial	Complex	Heat Recovery
Union	Commercial	Complex	Maintenance
Union	Commercial	Complex	New Construction
Union	Commercial	Complex	Optimization
Union	Commercial	Complex	Other Equipment
Union	Commercial	Complex	Steam and Hot Water
Union	Commercial	Simple	Building Shell
Union	Commercial	Simple	Controls
Union	Commercial	Simple	HVAC
Union	Commercial	Simple	Heat Recovery
Union	Commercial	Simple	Maintenance
Union	Commercial	Simple	Optimization
Union	Commercial	Simple	Other Equipment
Union	Commercial	Simple	Steam and Hot Water
Union	Industrial	Complex	Ag and Greenhouse
Union	Industrial	Complex	Building Shell
Union	Industrial	Complex	Controls
Union	Industrial	Complex	HVAC
Union	Industrial	Complex	Heat Recovery
Union	Industrial	Complex	Maintenance
Union	Industrial	Complex	Optimization
Union	Industrial	Complex	Other Equipment
Union	Industrial	Complex	Process Heat
Union	Industrial	Complex	Steam and Hot Water
Union	Industrial	Simple	Ag and Greenhouse
Union	Industrial	Simple	Building Shell
Union	Industrial	Simple	Controls
Union	Industrial	Simple	HVAC
Union	Industrial	Simple	Heat Recovery
Union	Industrial	Simple	Maintenance
Union	Industrial	Simple	Optimization
Union	Industrial	Simple	Process Heat
Union	Industrial	Simple	Steam and Hot Water
Union	Large Volume	Complex	Ag and Greenhouse
Union	Large Volume	Complex	Building Shell
Union	Large Volume	Complex	Controls
Union	Large Volume	Complex	HVAC
Union	Large Volume	Complex	Heat Recovery
Union	Large Volume	Complex	Maintenance
Union	Large Volume	Complex	New Construction
Union	Large Volume	Complex	Optimization
Union	Large Volume	Complex	Other Equipment
Union	Large Volume	Complex	Steam and Hot Water
Union	Multi-family	Complex	Controls
Union	Multi-family	Complex	Heat Recovery
Union	Multi-family	Complex	New Construction
Union	Multi-family	Complex	Other Equipment
Union	Multi-family	Simple	Building Shell
Union	Multi-family	Simple	Controls
Union	Multi-family	Simple	HVAC
Union	Multi-family	Simple	Steam and Hot Water

APPENDIX N. DATA COLLECTION INSTRUMENTS

The embedded documents below are the interview guides used for participant and vendor data collection for the NTG portion of the evaluation.

Participant IDI

Vendor IDI

APPENDIX O. FREE-RIDERSHIP SURVEY DATA QUALITY CONTROL

This appendix includes summaries of survey questions used to QC the attribution results. The QC process involves comparison of scored question responses to question responses in the same interview. Interviews with potentially conflicting responses are reviewed by the PM, who reads the entire interview before determining if an adjustment to a score is required. In total, 29 measure free ridership scores were adjusted through this process and five measures were dropped. Table 8-100 provides the count of measures adjusted for each utility and whether the adjustment increased (Inc) or decreased (Dec) attribution for that measure.

Table 8-100. PM Quality Assurance Adjustments.

<table>
<tr><th colspan="3" rowspan="2">PM Quality Assurance Status</th><th colspan="3">Union</th><th colspan="3">Enbridge</th><th colspan="3">Overall</th></tr>
<tr><th>Inc</th><th>Dec</th><th>Total</th><th>Inc</th><th>Dec</th><th>Total</th><th>Inc</th><th>Dec</th><th>Total</th></tr>
<tr><td colspan="3">Total Measures Completed from FR IDIs</td><td></td><td></td><td>281</td><td></td><td></td><td>177</td><td></td><td></td><td>458</td></tr>
<tr><td colspan="3">Not Adjusted</td><td></td><td></td><td>260</td><td></td><td></td><td>164</td><td></td><td></td><td>424</td></tr>
<tr><td rowspan="8">PM Adjustments from QA</td><td colspan="2">Dropped</td><td></td><td></td><td>4</td><td></td><td></td><td>1</td><td></td><td></td><td>5</td></tr>
<tr><td rowspan="3">Assign DNK Attribution, but unclear amount.</td><td>Timing</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Efficiency</td><td>3</td><td>0</td><td>3</td><td>7</td><td>0</td><td>7</td><td>10</td><td>0</td><td>10</td></tr>
<tr><td>Quantity/Size</td><td>2</td><td>0</td><td>2</td><td>1</td><td>0</td><td>1</td><td>3</td><td>0</td><td>3</td></tr>
<tr><td rowspan="3">Adjust Score Attribution Clear based on open, conflicted with scored response</td><td>Timing</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>2</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>Efficiency</td><td>3</td><td>1</td><td>4</td><td>1</td><td>0</td><td>1</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>Quantity/Size</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td></td><td>1</td><td>1</td></tr>
<tr><td colspan="2">Gross Baseline Efficiency Adjustment</td><td>3</td><td>2</td><td>5</td><td>0</td><td>1</td><td>1</td><td>3</td><td>3</td><td>6</td></tr>
</table>

The attribution results used to create the following tables also include the vendor component of attribution. Consequently, the attribution bin may be higher than reported by the customer alone. This section includes the following tables:

- PF8 responses by overall attribution bin
- PF9 responses by overall attribution bin.
- Dat0 responses versus overall attribution bin
- Dat6 responses versus overall attribution bin
- Dat6 responses versus overall spa bin

Union Commercial and Industrial Programs

Table 8-101. PF8 and Attribution Bin, Union Custom C&I programs*

PF8. For the project, did you become aware of utility program incentives and services…?					
Attribution Bin	**PF8**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Before starting the project	16	31	43	18%
	As soon as you began exploring equipment options	*	*	*	<1%
	While exploring equipment options, but before making equipment decision	*	*	*	5%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	*	*	*	<1%
	Don't Know/ Refused	0	0	0	0%
Partial	Before starting the project	26	46	64	23%
	As soon as you began exploring equipment options	6	7	10	4%
	While exploring equipment options, but before making equipment decision	*	*	*	<1%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	*	7	9%
None	Before starting the project	26	35	45	27%
	As soon as you began exploring equipment options	*	*	5	5%
	While exploring equipment options, but before making equipment decision	*	*	*	2%
	After making an equipment decision	5	6	6	3%
	After installing the equipment	*	5	5	4%
	Don't Know/ Refused	*	*	*	<1%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-102. PF9 and Attribution Bin, Union Custom C&I programs*

PF9. When did the utility first get involved in this project? Was it…					
Attribution Bin	**PF9**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Before starting the project	12	24	31	15%
	As soon as you began exploring equipment options	*	7	13	3%
	While exploring equipment options, but before making equipment decision	*	*	*	5%
	After making an equipment decision	*	*	*	<1%
	After installing the equipment	*	*	*	<1%
	Don't Know/ Refused	0	0	0	0%
Partial	Before starting the project	16	30	42	16%
	As soon as you began exploring equipment options	12	20	32	12%
	While exploring equipment options, but before making equipment decision	5	5	5	8%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	*	*	1%
None	Before starting the project	13	19	25	20%
	As soon as you began exploring equipment options	7	8	11	5%
	While exploring equipment options, but before making equipment decision	*	5	5	2%
	After making an equipment decision	8	9	9	5%
	After installing the equipment	*	7	9	7%
	Don't Know/ Refused	6	6	6	<1%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-103. Dat0 and Attribution Bin, Union Custom C&I programs*

DAT0. Without the program, would you say the likelihood of [installing / performing] the project was...?					
Attribution Bin	**Dat0**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Very likely	*	*	6	2%
	Somewhat likely	*	*	5	3%
	Not very likely	6	7	8	3%
	Very unlikely	10	21	30	14%
	Don't Know/ Refused	0	0	0	0%
Partial	Very likely	12	13	15	11%
	Somewhat likely	17	19	25	13%
	Not very likely	7	20	34	11%
	Very unlikely	*	*	*	1%
	Don't Know/ Refused	*	*	6	1%
None	Very likely	33	41	46	30%
	Somewhat likely	9	10	16	11%
	Not very likely	*	*	*	<1%
	Very unlikely	0	0	0	0%
	Don't Know/ Refused	*	*	*	<1%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-104. Dat6 and Attribution Bin, Union Custom C&I programs*

Dat6. Without any utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
Attribution Bin	Dat6	Customers	Units of Analysis	Measures	Percent Savings
Full	0%	8	18	25	15%
	1% to 25%	6	8	12	<1%
	26% to 50%	*	*	*	2%
	51% to 75%	*	*	*	2%
	76% to 99%	0	0	0	0%
	100%	*	*	5	3%
	Don't Know/ Refused	*	*	*	<1%
Partial	0%	*	*	*	<1%
	1% to 25%	*	*	*	<1%
	26% to 50%	*	*	*	3%
	51% to 75%	*	*	*	3%
	76% to 99%	*	*	7	3%
	100%	31	41	49	32%
	Don't Know/ Refused	*	*	*	<1%
None	0%	*	*	*	<1%
	1% to 25%	9	12	26	12%
	26% to 50%	6	19	21	9%
	51% to 75%	*	*	8	2%
	76% to 99%	6	6	6	3%
	100%	11	15	19	11%
	Don't Know/ Refused	*	*	*	<1%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-105. Dat6 and SPA Bin, Union Custom C&I programs

Dat6. Without any utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
SPA Bin	**Dat6**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	0%	8	18	25	15%
	1% to 25%	6	8	12	<1%
	26% to 50%	*	*	*	2%
	51% to 75%	*	*	*	2%
	76% to 99%	0	0	0	0%
	100%	*	*	5	3%
	Don't Know/ Refused	*	*	*	<1%
Partial	0%	*	*	*	<1%
	1% to 25%	7	8	15	5%
	26% to 50%	*	*	*	3%
	51% to 75%	*	5	5	3%
	76% to 99%	6	6	9	3%
	100%	38	53	63	40%
	Don't Know/ Refused	*	*	*	<1%
None	0%	0	0	0	0%
	1% to 25%	5	5	12	7%
	26% to 50%	6	19	21	9%
	51% to 75%	*	*	7	2%
	76% to 99%	*	*	*	3%
	100%	*	*	5	3%
	Don't Know/ Refused	0	0	0	0%

Union Large Volume

Table 8-106. PF8 and Attribution Bin, Union Large Volume*

PF8. For the project, did you become aware of utility program incentives and services…?					
Attribution Bin	**PF8**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Before starting the project	*	*	*	<1%
	As soon as you began exploring equipment options	*	*	*	<1%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
Partial	Before starting the project	9	16	28	24%
	As soon as you began exploring equipment options	0	0	0	0%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
None	Before starting the project	12	21	37	64%
	As soon as you began exploring equipment options	*	*	*	<1%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	*	*	*	<1%
	After installing the equipment	*	6	9	9%
	Don't Know/ Refused	*	*	5	2%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-107. PF9 and Attribution Bin, Union Large Volume*

PF9. When did the utility first get involved in this project? Was it…					
Attribution Bin	PF9	Customers	Units of Analysis	Measures	Percent Savings
Full	Before starting the project	*	*	*	<1%
	As soon as you began exploring equipment options	0	0	0	0%
	While exploring equipment options, but before making equipment decision	*	*	*	<1%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
Partial	Before starting the project	6	12	24	21%
	As soon as you began exploring equipment options	*	*	*	2%
	While exploring equipment options, but before making equipment decision	*	*	*	1%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
None	Before starting the project	6	14	21	46%
	As soon as you began exploring equipment options	7	7	10	8%
	While exploring equipment options, but before making equipment decision	*	*	*	2%
	After making an equipment decision	*	*	8	9%
	After installing the equipment	*	6	9	9%
	Don't Know/ Refused	*	*	*	1%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-108. Dat0 and Attribution Bin, Union Large Volume*

DAT0. Without the program, would you say the likelihood of [installing / performing] the project was...?					
Attribution Bin	Dat0	Customers	Units of Analysis	Measures	Percent Savings
Full	Very likely	0	0	0	0%
	Somewhat likely	*	*	*	<1%
	Not very likely	*	*	*	<1%
	Very unlikely	*	*	*	<1%
	Don't Know/ Refused	0	0	0	0%
Partial	Very likely	*	6	14	11%
	Somewhat likely	*	8	12	9%
	Not very likely	*	*	*	3%
	Very unlikely	*	*	*	1%
	Don't Know/ Refused	0	0	0	0%
None	Very likely	19	31	51	70%
	Somewhat likely	*	*	*	5%
	Not very likely	0	0	0	0%
	Very unlikely	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-109. Dat6 and Attribution Bin, Union Large Volume*

Dat6. Without any utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
Attribution Bin	**Dat6**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	0%	0	0	0	0%
	1% to 25%	*	*	*	<1%
	26% to 50%	*	*	*	<1%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	*	*	*	<1%
	Don't Know/ Refused	0	0	0	0%
Partial	0%	0	0	0	0%
	1% to 25%	*	*	*	3%
	26% to 50%	0	0	0	0%
	51% to 75%	0	0	0	0%
	76% to 99%	*	*	6	7%
	100%	16	29	46	64%
	Don't Know/ Refused	0	0	0	0%
None	0%	0	0	0	0%
	1% to 25%	0	0	0	0%
	26% to 50%	*	*	*	<1%
	51% to 75%	*	*	*	4%
	76% to 99%	*	*	*	3%
	100%	6	9	19	17%
	Don't Know/ Refused	0	0	0	0%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-110. Dat6 and SPA Bin, Union Large Volume*

Dat6. Without any utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
SPA Bin	**Dat6**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	0%	0	0	0	0%
	1% to 25%	*	*	*	<1%
	26% to 50%	*	*	*	<1%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	*	*	*	<1%
	Don't Know/ Refused	0	0	0	0%
Partial	0%	0	0	0	0%
	1% to 25%	*	*	*	3%
	26% to 50%	0	0	0	0%
	51% to 75%	*	*	*	4%
	76% to 99%	*	5	7	9%
	100%	18	34	54	69%
	Don't Know/ Refused	0	0	0	0%
None	0%	0	0	0	0%
	1% to 25%	0	0	0	0%
	26% to 50%	*	*	*	<1%
	51% to 75%	0	0	0	0%
	76% to 99%	*	*	*	<1%
	100%	*	*	11	13%
	Don't Know/ Refused	0	0	0	0%

Enbridge Commercial and Industrial Programs

Table 8-111. PF8 and Attribution Bin, Enbridge Custom C&I programs*

PF8. For the project, did you become aware of utility program incentives and services…?					
Attribution Bin	**PF8**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Before starting the project	11	16	22	12%
	As soon as you began exploring equipment options	*	*	*	<1%
	While exploring equipment options, but before making equipment decision	*	*	*	<1%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	*	*	4%
Partial	Before starting the project	33	47	60	31%
	As soon as you began exploring equipment options	8	9	11	14%
	While exploring equipment options, but before making equipment decision	*	*	*	<1%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	*	*	1%
None	Before starting the project	31	42	47	28%
	As soon as you began exploring equipment options	6	7	8	3%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	*	*	*	2%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	*	*	3%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-112. PF9 and Attribution Bin, Enbridge Custom C&I programs*

PF9. When did the utility first get involved in this project? Was it…					
Attribution Bin	**PF9**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Before starting the project	7	12	17	9%
	As soon as you began exploring equipment options	*	*	*	1%
	While exploring equipment options, but before making equipment decision	*	*	*	1%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	5	5	5%
Partial	Before starting the project	15	21	22	19%
	As soon as you began exploring equipment options	10	12	13	10%
	While exploring equipment options, but before making equipment decision	*	*	12	3%
	After making an equipment decision	*	*	*	4%
	After installing the equipment	*	*	*	3%
	Don't Know/ Refused	15	21	26	9%
None	Before starting the project	8	11	13	7%
	As soon as you began exploring equipment options	7	8	8	5%
	While exploring equipment options, but before making equipment decision	7	8	8	9%
	After making an equipment decision	9	11	12	6%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	12	16	19	8%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-113. Dat0 and Attribution Bin, Enbridge Custom C&I programs*

DAT0. Without the program, would you say the likelihood of [installing / performing] the project was...?					
Attribution Bin	**Dat0**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Very likely	*	*	*	<1%
	Somewhat likely	*	*	*	3%
	Not very likely	7	12	15	9%
	Very unlikely	6	6	6	5%
	Don't Know/ Refused	0	0	0	0%
Partial	Very likely	13	16	17	10%
	Somewhat likely	19	22	31	27%
	Not very likely	14	20	25	10%
	Very unlikely	*	*	*	<1%
	Don't Know/ Refused	*	*	*	<1%
None	Very likely	33	40	46	28%
	Somewhat likely	10	14	14	8%
	Not very likely	0	0	0	0%
	Very unlikely	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-114. Dat6 and Attribution Bin, Enbridge Custom C&I programs*

Dat6. Without *any* utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
Attribution Bin	Dat6	Customers	Units of Analysis	Measures	Percent Savings
Full	0%	5	10	12	9%
	1% to 25%	*	*	*	2%
	26% to 50%	*	*	7	5%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	*	*	*	1%
	Don't Know/ Refused	0	0	0	0%
Partial	0%	0	0	0	0%
	1% to 25%	0	0	0	0%
	26% to 50%	*	*	*	<1%
	51% to 75%	*	*	*	3%
	76% to 99%	5	7	7	3%
	100%	31	37	41	29%
	Don't Know/ Refused	*	5	7	<1%
None	0%	*	*	*	<1%
	1% to 25%	*	5	5	2%
	26% to 50%	12	18	23	12%
	51% to 75%	5	7	7	5%
	76% to 99%	9	10	18	6%
	100%	13	16	18	18%
	Don't Know/ Refused	*	*	*	3%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-115. Dat6 and SPA Bin, Enbridge Custom C&I programs*

Dat6. Without any utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
SPA Bin	**Dat6**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	0%	5	10	12	9%
	1% to 25%	*	*	*	2%
	26% to 50%	*	*	7	5%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	*	*	*	1%
	Don't Know/ Refused	0	0	0	0%
Partial	0%	*	*	*	<1%
	1% to 25%	*	*	*	2%
	26% to 50%	10	14	19	10%
	51% to 75%	*	5	5	5%
	76% to 99%	8	11	19	6%
	100%	39	47	53	42%
	Don't Know/ Refused	*	5	7	<1%
None	0%	0	0	0	0%
	1% to 25%	*	*	*	<1%
	26% to 50%	6	6	6	3%
	51% to 75%	*	5	5	4%
	76% to 99%	5	6	6	3%
	100%	*	6	6	5%
	Don't Know/ Refused	*	*	*	3%

RunitRight

Table 8-116. PF8 and Attribution Bin, RunItRight*

PF8. For the project, did you become aware of utility program incentives and services...?					
Attribution Bin	**PF8**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Before starting the project	*	6	6	26%
	As soon as you began exploring equipment options	0	0	0	0%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
Partial	Before starting the project	5	9	9	66%
	As soon as you began exploring equipment options	0	0	0	0%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	*	*	9%
None	Before starting the project	0	0	0	0%
	As soon as you began exploring equipment options	0	0	0	0%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-117. PF9 and Attribution Bin, RunItRight*

PF9. When did the utility first get involved in this project? Was it…					
Attribution Bin	**PF9**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Before starting the project	*	6	6	26%
	As soon as you began exploring equipment options	0	0	0	0%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
Partial	Before starting the project	*	*	*	27%
	As soon as you began exploring equipment options	*	*	*	19%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	*	5	5	28%
None	Before starting the project	0	0	0	0%
	As soon as you began exploring equipment options	0	0	0	0%
	While exploring equipment options, but before making equipment decision	0	0	0	0%
	After making an equipment decision	0	0	0	0%
	After installing the equipment	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-118. Dat0 and Attribution Bin, RunItRight*

DAT0. Without the program, would you say the likelihood of [installing / performing] the project was...?					
Attribution Bin	**Dat0**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	Very likely	0	0	0	0%
	Somewhat likely	0	0	0	0%
	Not very likely	*	6	6	26%
	Very unlikely	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
Partial	Very likely	*	5	5	48%
	Somewhat likely	*	*	*	7%
	Not very likely	*	*	*	19%
	Very unlikely	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
None	Very likely	0	0	0	0%
	Somewhat likely	0	0	0	0%
	Not very likely	0	0	0	0%
	Very unlikely	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-119. Dat6 and Attribution Bin, RunItRight*

Dat6. Without any utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
Attribution Bin	**Dat6**	**Customers**	**Units of Analysis**	**Measures**	**Percent Savings**
Full	0%	0	0	0	0%
	1% to 25%	0	0	0	0%
	26% to 50%	*	6	6	26%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
Partial	0%	0	0	0	0%
	1% to 25%	0	0	0	0%
	26% to 50%	0	0	0	0%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
None	0%	0	0	0	0%
	1% to 25%	*	*	*	7%
	26% to 50%	*	*	*	12%
	51% to 75%	0	0	0	0%
	76% to 99%	*	*	*	7%
	100%	*	5	5	48%
	Don't Know/ Refused	0	0	0	0%

For confidentiality reasons the numbers of customers, units of analysis and measures less than 5 are not displayed.
*Attribution includes both a customer and a vendor component when the customer indicated that the vendor was influential in their decision. Consequently, the attribution bin may be higher for a measure than indicated by the customer.

Table 8-120. Dat6 and SPA Bin, RunItRight*

Dat6. Without any utility assistance for this or any other projects in the past, what is the percent likelihood that you would have done this project? (0% means no chance and 100% means definitely completed without assistance)					
SPA Bin	Dat6	Customers	Units of Analysis	Measures	Percent Savings
Full	0%	0	0	0	0%
	1% to 25%	0	0	0	0%
	26% to 50%	*	6	6	26%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%
Partial	0%	0	0	0	0%
	1% to 25%	0	0	0	0%
	26% to 50%	*	*	*	12%
	51% to 75%	0	0	0	0%
	76% to 99%	*	*	*	7%
	100%	*	5	5	48%
	Don't Know/ Refused	0	0	0	0%
None	0%	0	0	0	0%
	1% to 25%	*	*	*	7%
	26% to 50%	0	0	0	0%
	51% to 75%	0	0	0	0%
	76% to 99%	0	0	0	0%
	100%	0	0	0	0%
	Don't Know/ Refused	0	0	0	0%

APPENDIX P. CPSV Details

CPSV data collection

Data collection for the TSER sample will be completed via the IDI as described above. Prior to the TSER IDI the interviewing engineer will review project documents and calculations to identify the specific CPSV questions to include in the interview. Following the interview the engineer will complete the TSER verification report, embedded below. Verification reports completed by DNV GL engineers will be reviewed by an Itron engineer and verification reports completed by Itron engineers will be reviewed by a DNV GL engineer.

On-site sample customers will not have engineering questions asked during the IDI. Instead these customers will be asked permission for a follow up site visit. Customers who agree to the site visit will receive a follow up call from Stantec to schedule the visit. Utility staff will be informed of the scheduled visit and invited to attend. Following the on-site visit, the Stantec engineer will complete the on-site verification report, embedded below. An Itron engineer will review the report.

Appendix F has the template forms that each of the data collection approaches will use for the CPSV.

Completed verification reports will be compiled into a draft report to be reviewed by the OEB and EAC. The steps in the CPSV review process are shown in Table 8-121.

Table 8-121: CPSV steps

Step	Activity
1	NTG/CPSV Evaluation Team reviews project files provided by utilities ▪ Missing or incomplete documentation will be requested from utilities following review (final opportunity for utilities to provide new information).
2	NTG/CPSV Evaluation Team conducts IDI with customers ▪ Collects required CPSV data for TSER sample projects
3	NTG/CPSV Evaluation Team schedules site visits with on-site sample customers, informs utility
4	NTG/CPSV Evaluation Team conducts customer site visit ▪ Collects required CPSV data for On-site sample projects
5	NTG/CPSV Evaluation Team drafts project verification reports ▪ Contacts utility staff/customer to clarify any site/operational details if needed.
6	EC Team conducts internal review of individual project verification reports ▪ Itron reviews projects verified by Stantec and DNV GL ▪ DNV GL reviews projects verified by Itron
7	EC Team shares draft report, including all site verification reports, with OEB for quality control, redacted as necessary.
8	EC Team (OEB team) shares final draft report with EAC, redacted as necessary
9	EAC provides written comments on final draft report
10	EC Team/OEB hold EAC meeting to discuss comments
11	EC Team finalizes report

Gross realization rate

The gross RR is developed through data collected during the CPSV effort, which will verify program-achieved gross savings for measures at a sample of sites. The two components are the installation rate and the engineering verification factor.

- The installation rate is derived through the participant survey data collection, which confirms that the reported equipment / measure or something like it was installed at the facility. The resulting analysis value is binary; any similar project to the one reported is considered installed. At the individual measure level, the installation rate is either 100% or 0%.
- 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 "substantially similar" 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.

To get the evaluation-verified savings for each evaluated measure, the CPSV effort will verify savings based on the applicable standard program baseline and measure life based on the best available information. The formula for estimating measure level verified savings is shown here:

$$VGS_L = VY_L \times VGS_S$$

Where:

VGS_L – Verified Gross Savings versus standard efficiency equipment on the market (lifetime)

VY_L – Verified Estimated Useful Life of the equipment/action

VGS_S – Verified Gross Savings versus standard efficiency equipment on the market (annual)

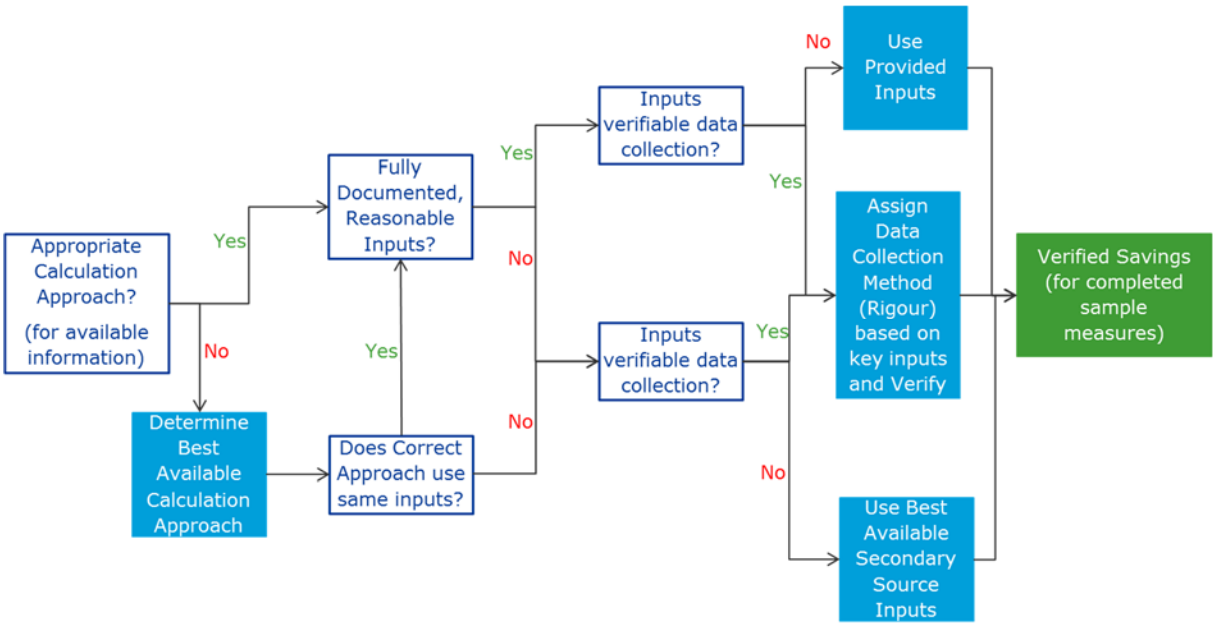
In the Life-Cycle Net Savings (LCNS) method used for this evaluation, the CPSV will also produce a verified savings estimate for accelerated measures using the pre-existing equipment as the baseline (VGS_E). Whether or not the measure is accelerated depends on the responses to the attribution survey and will be discussed later. The "versus existing" verified savings will be used in estimating net savings and will not be included in the verified gross savings. The LCNS methodology is further explained in Appendix B.

The CPSV will produce verified values for three required inputs in the Life-Cycle Net Savings (LCNS) attribution:

- **VGS_S** – Verified Gross Savings versus standard efficiency equipment on the market
- **VY_L** – Verified Estimated Useful Life of the equipment/action
- **VGS_E** – Verified Gross Savings versus existing equipment configuration at the time of installation/action: for a sub-set of measures that are accelerated

CPSV site reports will be completed by assigned evaluation engineers and reviewed by an experienced evaluation engineer at another partner firm. Each review will follow the same basic process shown in Figure 8-27.

Figure 8-27: CPSV high-level process



After the initial review and savings calculation, an engineer from a partner firm on the EC team (either DNV GL or Itron) will review the site report, approach, calculation, and verified savings. Following this review the verified savings, verified estimated useful life, reasons for deviation and other pertinent information will be compiled into a single dataset at the unit of analysis level for expansion and integration with the FR analysis.

CPSV rigour levels

The CPSV plan calls for two types of data collection: telephone-supported engineering review (TSER) and on-site. There are adjustments that might entail more or less work at each site. Table 7 details likely engineering effort levels for the standard, increased, and decreased levels. The levels of effort are averages. Some sites may require substantially more effort, while some sites may entail less effort.

Based on the tracking data we have identified the simplest projects as a level of stratification and will used TSER interviews to verify the projects at these sites. The more complex on-site sample will also have varying degrees of effort requirements in order to allow more effort at more complex sites.

Table 8: M&V Description for Proposed Engineering Effort Levels

Effort Level	Description
Telephone-supported engineering review (TSER)	Lower rigour projects. Application desk review, telephone interviews, possible revised engineering calculations; primarily for qualitative assessment.
Standard On-site	Simpler projects. Detailed application review, on-site verification, collection of data on key parameters, revised engineering calculations, billing data analysis, and possible spot measurements.
Higher Rigour On-site	Small, medium and large scale projects that may or may not require monitoring or metering. Detailed application review, on-site verification, collection of data on key parameters, revised engineering calculations, billing data analysis, and possible spot measurements / short term post monitoring.
Very High Rigour On-site	Largest and most complex projects. Detailed application review, on-site verification, collection of data on key parameters, billing/interval data analysis, calibrated simulation models, spot measurements, long-term post monitoring, pre-verification and short-term measurement. May require larger teams, including senior staff and multiple site visits.

Most site-specific impact evaluation efforts for Standard On-site points will fall into the category of lower rigor level of effort. However, there are exceptions and adjustments that might entail more or less work at each site. During the file review adjustments of this sort should be noted and the sites will be reviewed by the engineering team lead (Phani Pagadala) to determine which level of rigour is required. Up to 20 sites (primarily Large Volume) will receive higher rigour on-sites and up to two sites will receive very high rigour on-sites to establish the relative value of increased rigour levels in future evaluation.

Each site will be assigned a single point of contact (POC) for the purposes of communications with the customer, the utility and within CPSV itself. The POC will be a more senior engineering team member who is experienced in the energy efficiency field (preferably a registered professional engineer) and will be responsible for co-ordinating the work of their team, tracking progress on each project review, becoming intimately familiar with the documentation and technical requirements of the work to be performed, ensuring that quality control procedures are implemented, and reporting on project review progress and any issues to the engineering team lead (Phani Pagadala).

Higher rigour sites could involve the addition of elements such as:

- A fully specified regression analysis of consumption information from utility bills with inclusion/adjustment for changes and background variables over the time period of the analysis that could potentially be correlated with the gross energy savings being measured.
- Twelve (12) months post-retrofit consumption data are required.
- Twelve (12) months pre-retrofit consumption data are required, unless program design does not allow pre-retrofit billing data, such as in new construction. In these cases, well-matched control groups and post-retrofit consumption analysis is allowable.

- Sampling must be adequate (in general, a minimum of six data points will be required) for a valid regression-based estimate.
- Building energy simulation models that are calibrated as described in IPMVP Option D requirements. If appropriate, evaluators may alternatively use an engineering model with calibration.
- Retrofit isolation engineering models as described in IPMVP Option B requirements.

APPENDIX Q. CPSV DISCREPANCY DETAILS

This appendix includes additional information about the magnitude of and reasons for gross savings adjustments, by program. Sections are broken up into "Annual savings Adjustments," which refer to adjustments that do not relate to measure life, and "Measure Life Savings Adjustments" which relate only to measure life but do not affect annual savings. Attempts are made to identify the level of control the program has over each type of adjustment and provide context and opportunities for improvement. Table 8-122 and Table 8-123 show the "Reasons for Discrepancies" which are used throughout this appendix.

Table 8-122: Descriptions of Annual savings Adjustments

Reason for Discrepancy	Level of Program Control	Description	Explanation	Recommendation (where possible, do the following:)
Measured Usage	Low	Customer provided metered or measured data that differs from what the program used.	This usually stems from the evaluation having a longer metering period to work with than the ex ante engineering team.	Attempt to use a longer post-installation data collection period if possible.
Efficient Equipment Operating Conditions	Low	On-site conditions differed from that claimed by documentation.	These can reflect a change in the operation of the facility since the measure was installed, but also can be due to information that was either not communicated or communicated differently to program engineering staff.	Document any observations or assumptions made with emails, on-site forms, photos, and conversation notes. When evaluators don't have evidence of a value, they have to determine their own value.
Operating Hours	Low	Customer reported different operating hours from those reported in ex ante documentation, but no other operational changes.		
Change to Calculation Method	Medium	Evaluator used a different calculation method.	This stems from the lack of a live calculation tool or the choice to use a different tool (often because the ex ante tool is not able to accommodate all the information obtained on-site).	Maintain and provide live calculation tools with practical instructions on their use and supporting documentation for their methods and assumptions. Seek to avoid using calculation methods which use too many assumptions or rely on theoretical assumptions rather than metered data.
Baseline	Medium	Customer stated or the evaluator determined that a different baseline should be used.	This happens when the program does not clearly document their baseline sources, and a different site contact has different ideas about the baseline, or the evaluator that the baseline is not industry standard practice. In other cases, the appropriate code may be misidentified.	Follow the policy decisions made during EAC evaluation discussions. Document any observations or assumptions made with emails, on-site forms, photos, and conversation notes. Include documentation of permit dates (such as email from customer or copy of paperwork etc.).
Efficient Equipment Specifications	High	Equipment specifications differed from ex ante documentation.	This can occur when there was a misunderstanding of how the equipment operated or the meaning of a specification, such as input vs. output boiler efficiency.	Collect photographs, invoices, and cut sheets to document the sources of equipment specifications.
Data Entry Error	High	Tracking savings or calculation tool contained an error.	This most often reflects tracking savings not matching documentation, but can also be a mistake in recording some building characteristic.	Check tracking savings against documentation before finalizing, particularly for large projects.

Table 8-123: Descriptions of Measure Life Savings Adjustments

Reason for Discrepancy	Level of Program Control	Description	Explanation	Recommendation (where possible, do the following:)
RUL limitation	Medium	The EUL is limited by the RUL of the existing equipment.	Evaluation determined that the equipment in question will not be reused after the host equipment reaches its RUL.	Provide evidence that add-on equipment can be reused after host equipment is removed. Provide a program estimate of RUL.
No Savings	Medium	The existing equipment had reached the end of its useful life and was replaced with Industry Standard Practice equipment.	Sometimes the customer says that equipment replaced through the program had only a few months of useful life remaining, and that they considered the equipment installed to be "standard efficiency."	Document the source of post-ER baseline equipment, as well as a sourced estimate for RUL.
Reported Maintenance Schedule	Medium	Customer reported that they perform maintenance at a scheduled frequency.	If a customer does specific maintenance, for example, every three years, then a rebate for that maintenance activity cannot have a measure life longer than this.	Document customer maintenance practices.
Customer reported replacement schedule	Medium	Customer reported that they replace equipment on a set schedule.	Some facilities replace furnaces, boilers, and other equipment on a recurring schedule. The measure life or RUL cannot be longer than this.	Document customer replacement practices, or the reasons why the equipment in question is an exception.
Lack of Ex Ante Doc	High	Program did not include any evidence or reasoning behind the EUL selection.	In the absence of a clear OEB Measure Life Guide category or justification for another value, the evaluators determined measure life independently.	Provide justification for the measure life selected, especially when the category selected is unclear or one does not exist.
Average of Measures	High	Project included multiple measures with different measure lives.	When multiple measures are used in a single project, evaluation will combine the measure lives as a savings-weighted average or another appropriate value depending on the situation.	Use and document a savings-weighted average of measure lives, or other appropriate value.
Added post-ER period	High	Dual baseline project, with post-early replacement not claimed by program.	The program claimed only early replacement or post-early replacement savings, multiplying this value by the EUL.	Calculate dual baseline savings and document the reasons for selecting the chosen baselines.
Steam Trap	High	Adjustment made to steam traps EUL in the OEB Measure Life Guide.	The two utilities used a different EUL value for steam traps, which is a common installed measure. Evaluation performed research and selected a value to use across programs.	Use the evaluation-selected value, or provide steam-trap-specific (site, trap type, and application specific) evidence for another value.

The following sections provide results in detail for each program. All adjustments shown in this section are unweighted. Adjustments in tables are absolute values, and are the total of positive and negative adjustments. Values shown in figures are identified with regard to the magnitude of positive or negative adjustments (greater or less than 100%). Union’s influence adjustments are removed from ex ante results, so the adjustments shown here do not include their removal.

Enbridge Commercial, Industrial and Multi-Family

Annual savings adjustments

The absolute value of total annual savings adjustments for the Enbridge Commercial, Industrial, and Multi-family programs are 1,793,030 m^3 of natural gas, or 6% of the total first year sample tracking savings of 30,679,909 m^3.

This section shows annual savings only, which is an attempt to isolate the effects of gross savings adjustments outside of measure life. Annual savings can occur during the early replacement or post-early replacement periods, depending on the situation. Ex-post annual savings are typically better comparable with the program's ex ante savings estimate than other first year metrics such as average annual savings, early replacement period savings, or post-early replacement period savings.

Table 8-124 shows the percent of total annual savings adjustments associated with each Reason for Adjustment. The table also indicates the level of control that the program has over that discrepancy through improved calculations or improved documentation, as discussed in Table 8-122. For example, "Measured Usage" represents 24% of first year discrepancies, and the program has a limited ("Low") ability to prevent this kind of adjustment. 92% of first year discrepancies fall into the "Low" category.

Table 8-124: Summary of annual savings adjustments (m^3 Natural Gas)

Reason For Adjustment	Percent of First Year Discrepancy	Level of Program Control	Percent of First Year Discrepancy
Measured Usage	24%	Low	92%
Efficient Equipment Operating Conditions	30%		
Operating Hours	38%		
Change to Calculation Method	0%	Medium	2%
Baseline	2%		
Efficient Equipment Specifications	6%	High	6%
Data Entry Error	0%		
Overall	**100%**		**100%**

Figure 8-28 distributes the annual savings adjustments by realization rate bin, showing the positive and negative impacts of each adjustment on first year program savings. For example, focusing on projects with 40-60% realization rates, about 2/3 of the savings adjustments resulted from Operating Hours changes and about 1/3 from Efficient Equipment Operating Conditions changes. Overall, about 15% of total annual savings adjustments result from projects in the 40-60% gross savings realization rate bin.

Figure 8-28: Annual savings Adjustments by Magnitude of Adjustment (m^3 Natural Gas)

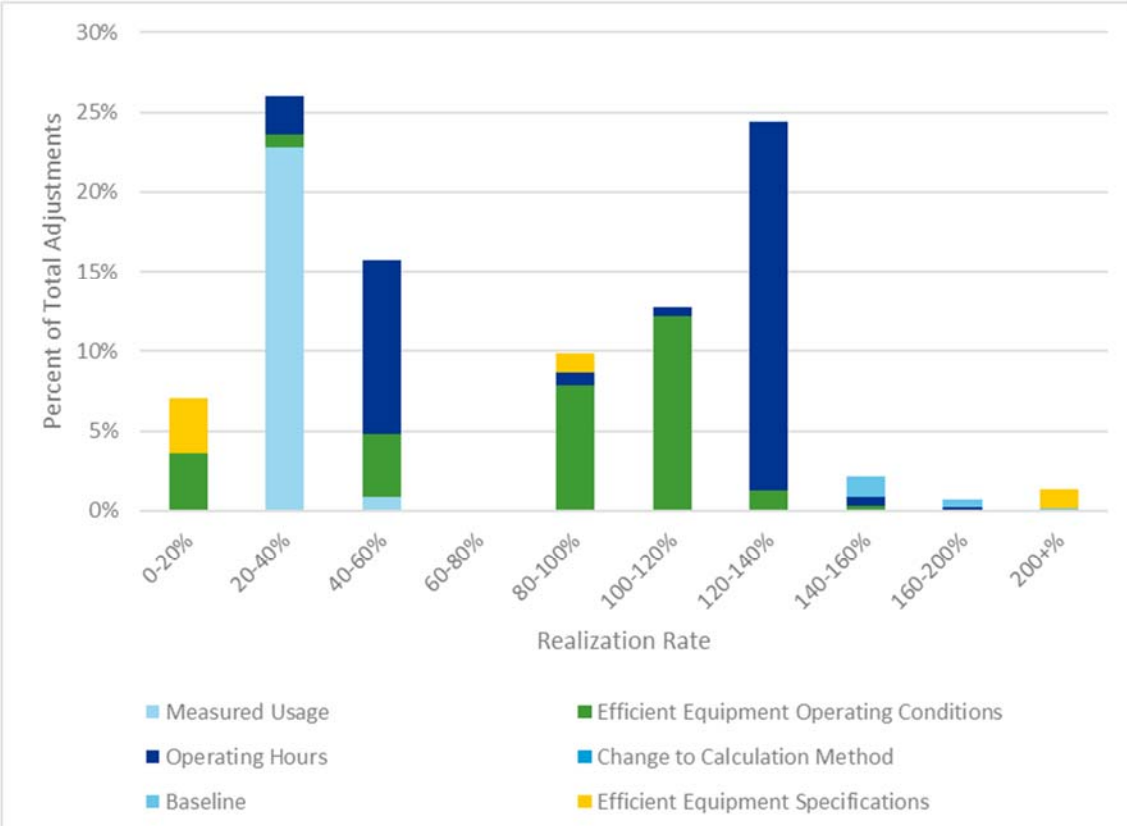
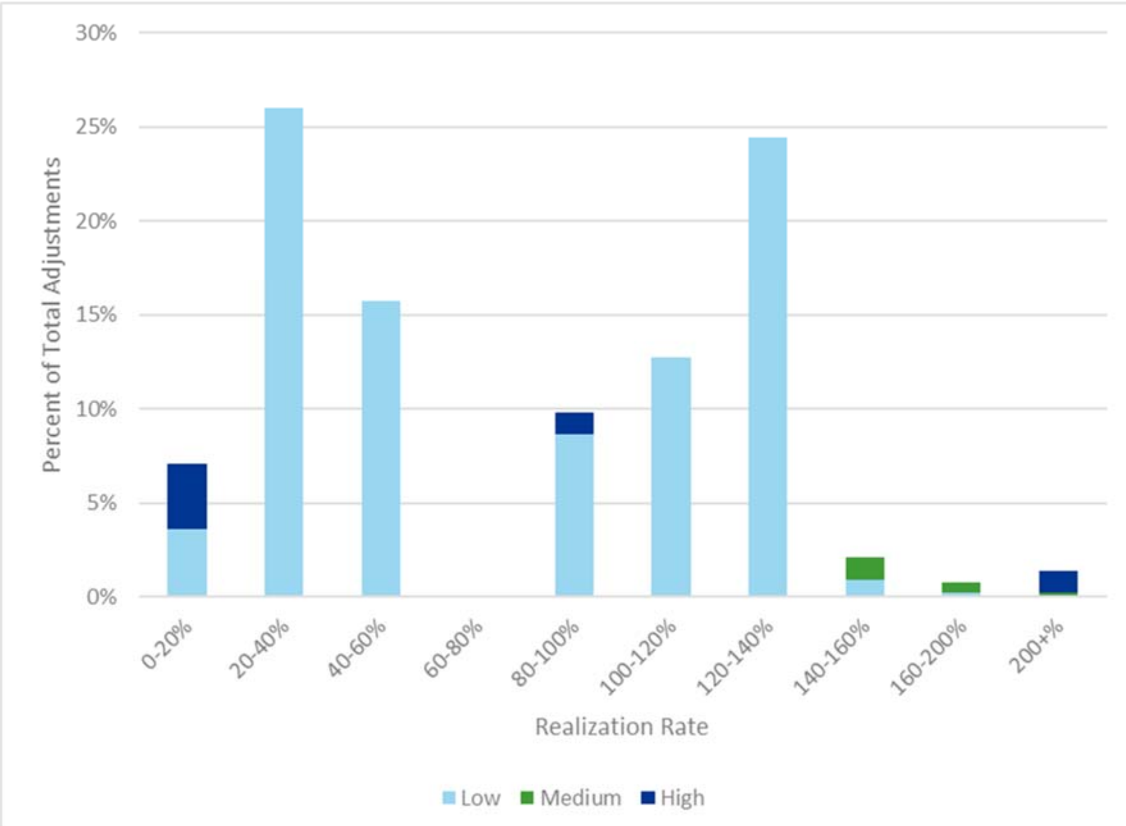


Figure 8-29 shows the level of program control over the adjustments shown in Figure 8-28. For example, the program has a "Low" level of control over all the adjustments which resulted in first year gross savings realization rates of 40-60%.

Figure 8-29: Program Control Over Annual savings Adjustments by Magnitude of Adjustment (m^3 Natural Gas)



Measure life adjustments

The absolute value of the total measure life-driven cumulative savings adjustments for Enbridge are 10,983,754 CCM of natural gas, or 2% of the total cumulative sample tracking savings of 471,326,160 CCM. These are cumulative lifetime savings[40] and should not be compared to annual savings adjustments.

Table 8-125 shows the percent of total measure life-driven adjustments associated with each specific Reason for Adjustment. The table also indicates the level of control that the program has over that discrepancy through improved calculations or improved documentation, as discussed in Table 8-123. For example, “RUL Limitation” represents 25% of measure life adjustments, and the program has a moderate (“Medium”) ability to prevent this kind of adjustment. Thirty-five percent of measure life adjustments fall into the “Medium” category. The program likely has a high degree of control over almost two-thirds of the EUL adjustments, which indicates that better documentation of EULs could significantly reduce the risk of adjustments in the future.

Note that the measure life adjustments shown here are inexact. Because they result from changes to both RUL and EUL, there is no way to directly compare the impacts of measure life changes on savings in

[40] To provide comparable values, the cumulative savings adjustments are calculated as ex ante annual savings times ex post EUL minus ex ante annual savings times ex ante EUL.

isolation from other effects. This section is an attempt to isolate those effects to the extent possible, in order to provide useful information for program planning.

Table 8-125: Summary of Measure Life Driven of Annual savings Adjustments (CCM Natural Gas)

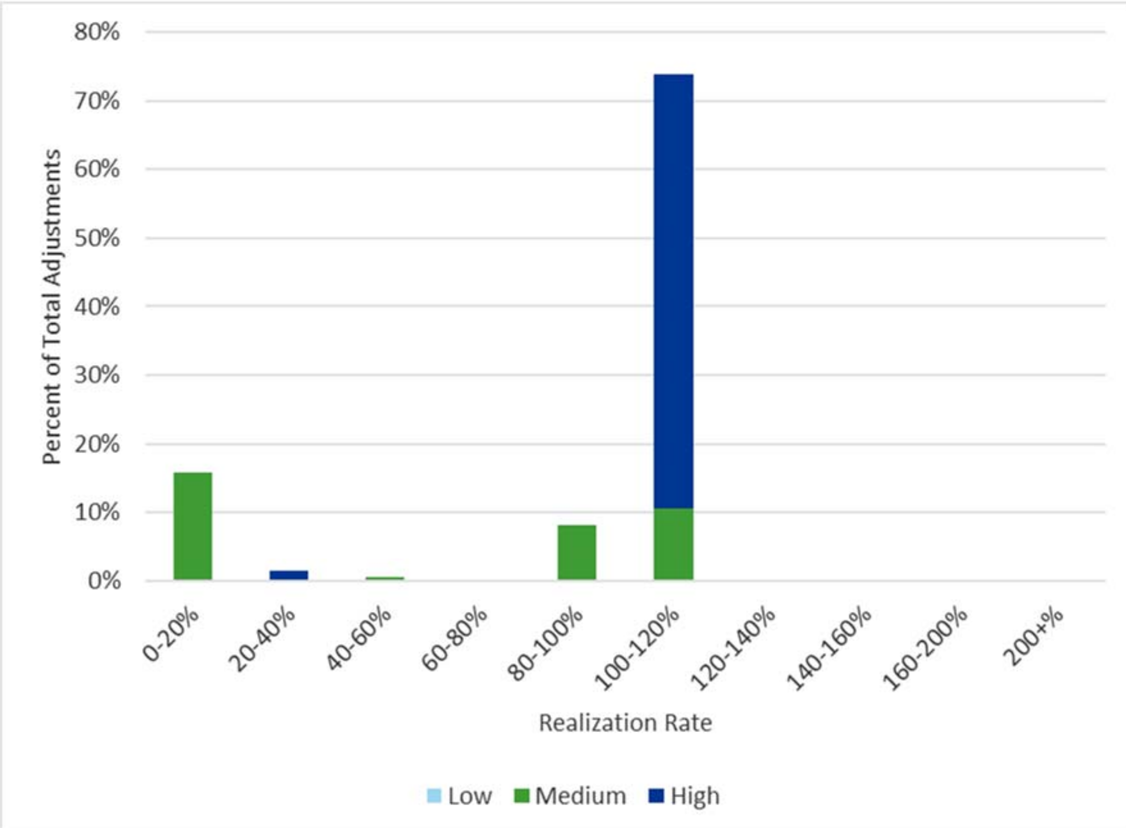
Reason For Adjustment	Percent of Measure Life Driven Adjustments	Level of Program Control	Percent of Measure Life Driven Adjustments
RUL limitation	25%	Medium	35%
No Savings	10%		
Reported Maintenance Schedule	0%		
Customer Reported Replacement Schedule	0%		
Lack of Ex Ante Doc	48%	High	65%
Average of Measures	7%		
Added post-ER period	2%		
Steam Trap	8%		
Overall	**100%**		**100%**

Figure 8-30 distributes the measure life adjustments by realization rate bin, showing the positive and negative impacts of each kind of adjustment on cumulative savings overall. For example, focusing on projects with 100-120% measure life driven adjustments, about 2/3 of the savings adjustments result from a Lack of Ex Ante Documentation, with the rest stemming from RUL Limitations, Average of Measures, and No Savings adjustments. Overall, about 72% of total measure life savings adjustments result from projects in the 100-120% adjustment bin. In other words, most EUL adjustments for this program resulted in small increases.

Figure 8-30: EUL Adjustments by Magnitude of Adjustment (CCM Natural Gas)

Figure 8-31 shows the level of program control over the adjustments shown in Figure 8-30. For example, the program has a "High" level of control over most reasons which resulted in adjustments of 100-120%.

Figure 8-31: Program Control Over Measure Life Driven Savings Adjustments by Magnitude of Adjustment (CCM Natural Gas)



Union Commercial, Industrial and Multi-Family

Annual savings adjustments

The total absolute value of the annual savings adjustments (engineering adjustment) for Union Custom Programs are 2,652,557 m^3 of natural gas, or 3% of the total first year sample tracking savings of 85,649,059 m^3. The engineering adjustment represents the differences in ex post and ex ante savings that are not a result of the influence correction. These changes are due to differences in calculation methods, EUL, calculation parameters, or other engineering-related adjustments.

Table 8-126 shows the percent of total annual savings adjustments associated with each Reason for Adjustment. The table also indicates the level of control that the program has over that discrepancy through improved calculations or improved documentation, as discussed in Table 8-122. For example, "Efficient Equipment Operating Conditions" represents 75% of first year discrepancies, and the program has a limited ("Low") ability to prevent this kind of adjustment. The table shows that 90% of adjustments to Union' Custom programs were issues that the program likely has a low ability to control.

Table 8-126: Summary of Annual savings Adjustments

Reason For Adjustment	Percent of First Year Discrepancy	Level of Program Control	Percent of First Year Discrepancy
Measured Usage	0%	Low	90%
Efficient Equipment Operating Conditions	75%		
Operating Hours	15%		
Change to Calculation Method	3%	Medium	4%
Baseline	1%		
Efficient Equipment Specifications	1%	High	6%
Data Entry Error	4%		
Overall	**100%**		**100%**

Figure 8-32 distributes the annual savings adjustments by realization rate bin, showing the positive and negative impacts of each adjustment on first year program savings. Overall, adjustments were mostly because of changes to Efficient Equipment Operating Conditions and Operating Hours.

Figure 8-32: Annual savings Adjustments by Magnitude of Adjustment (m^3 Natural Gas)

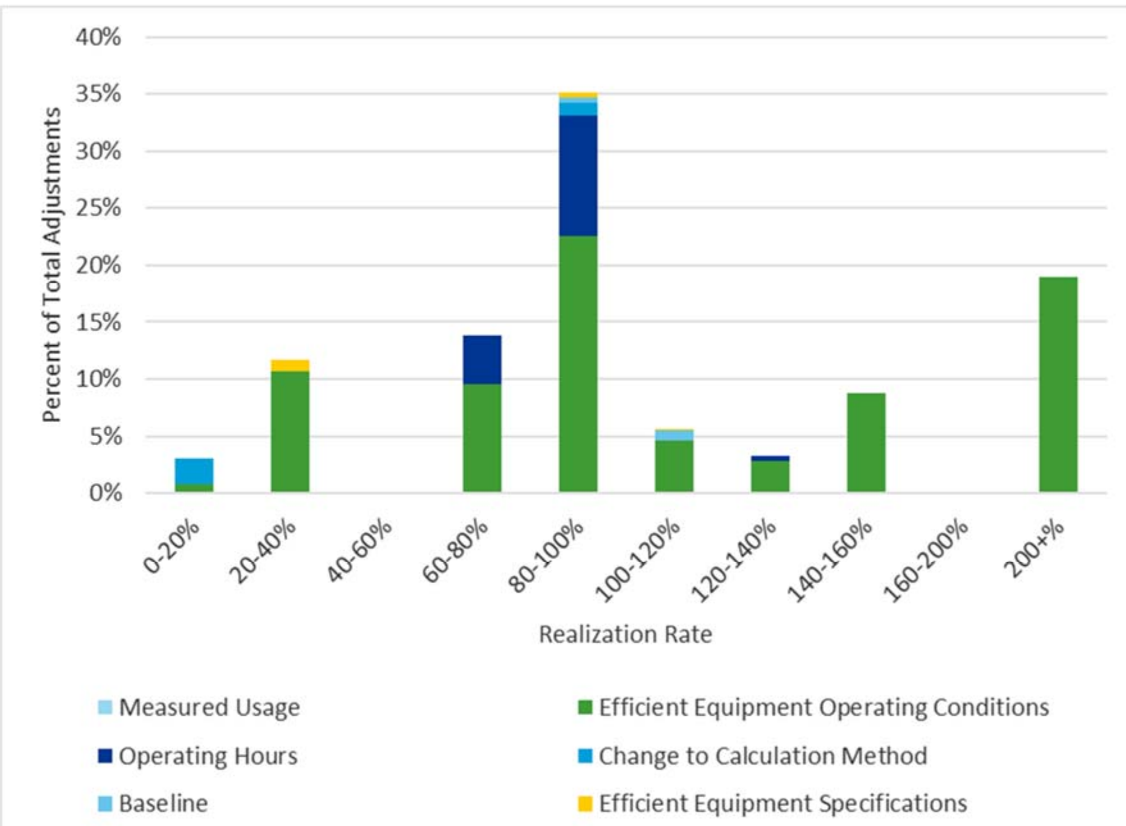
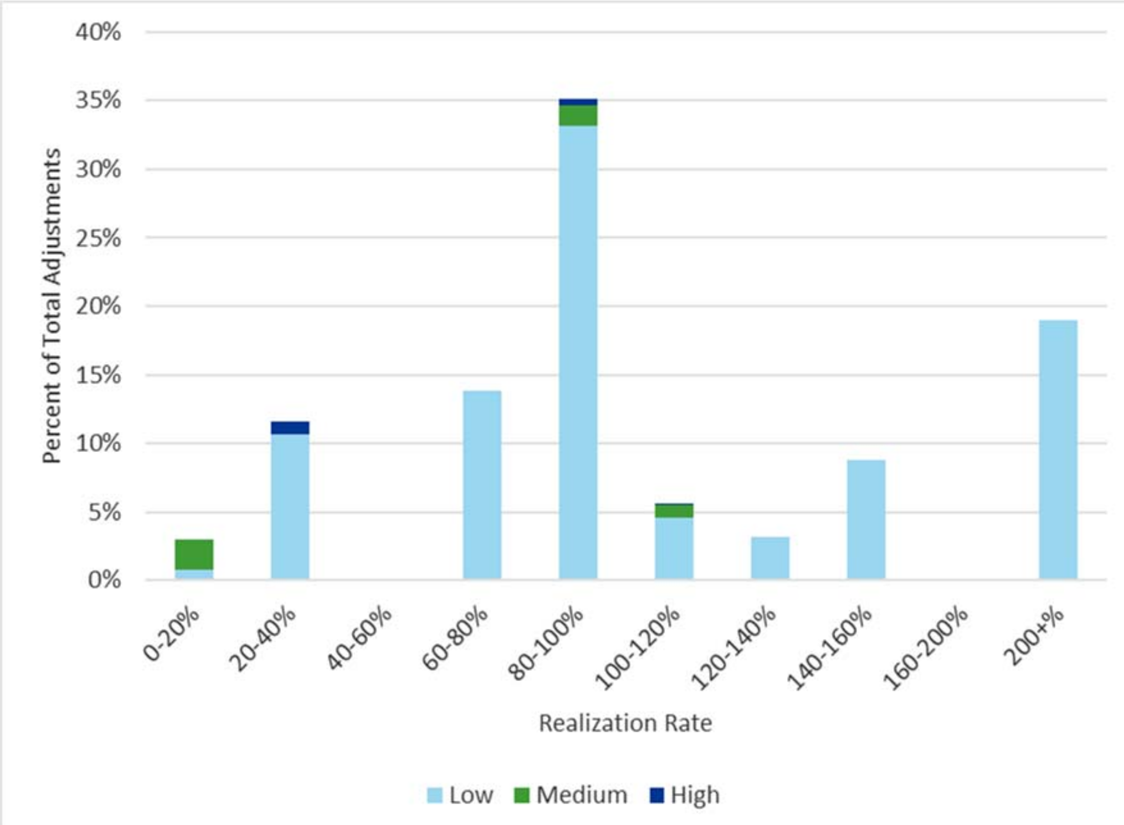


Figure 8-33 shows the level of program control over the adjustments shown in Figure 8-32. Almost all first-year savings discrepancies were in categories that the program has a low degree of control over.

Figure 8-33: Program Control Over Annual savings Adjustments by Magnitude of Adjustment (m^3 Natural Gas)



Measure life adjustments

Total absolute value measure life driven cumulative savings adjustments for Union Custom Programs are 31,801,957 CCM of natural gas, or 2% of the total cumulative sample tracking savings of 1,277,857,163 CCM. These are cumulative lifetime savings[41] and should not be compared to annual savings adjustments.

Table 8-127 shows the percent of total measure life-driven adjustments associated with each specific Reason for Adjustment. The table also indicates the level of control that the program has over that discrepancy through improved calculations or improved documentation, as discussed in Table 8-123. The table shows that 85% of EUL adjustments were due to categories that the program has a high degree of control over. However, this effect is likely overstated because weighting EUL adjustments by ex ante savings may overstate some changes. For example, many Union sites received significant EUL adjustments for early replacement projects that installed ISP technologies. Although the total EUL was greatly increased, the post-ER savings were zero. Using the ex post savings to weight those measures would likely result in a different distribution.

Note that measure life adjustments shown here are inexact. Because they result from changes to both RUL and EUL, there is no way to directly compare the impacts of measure life changes on savings in isolation

[41] To provide comparable values, the cumulative savings adjustments are calculated as ex ante annual savings times ex post EUL minus ex ante annual savings times ex ante EUL.

from other effects. This section is an attempt to isolate those effects to the extent possible, in order to provide useful information for program planning.

Table 8-127: Summary of Measure Life Driven of Annual savings Adjustments (CCM Natural Gas)

Reason For Adjustment	Percent of Measure Life Driven Adjustments	Level of Program Control	Percent of Measure Life Driven Adjustments
RUL limitation	15%	Medium	15%
No Savings	0%		
Reported Maintenance Schedule	0%		
Customer Reported Replacement Schedule	0%		
Lack of Ex Ante Doc	34%	High	85%
Average of Measures	0%		
Added post-ER period	49%		
Steam Trap	1%		
Overall	**100%**		**100.0%**

Figure 8-34 distributes the measure life adjustments by realization rate bin, showing the positive and negative impacts of each kind of adjustment on cumulative savings overall. The figure shows that most of the EUL adjustments were small and positive, while a few were strongly negative.

Figure 8-34: Measure Life Driven Savings Adjustments by Magnitude of Adjustment (CCM Natural Gas)

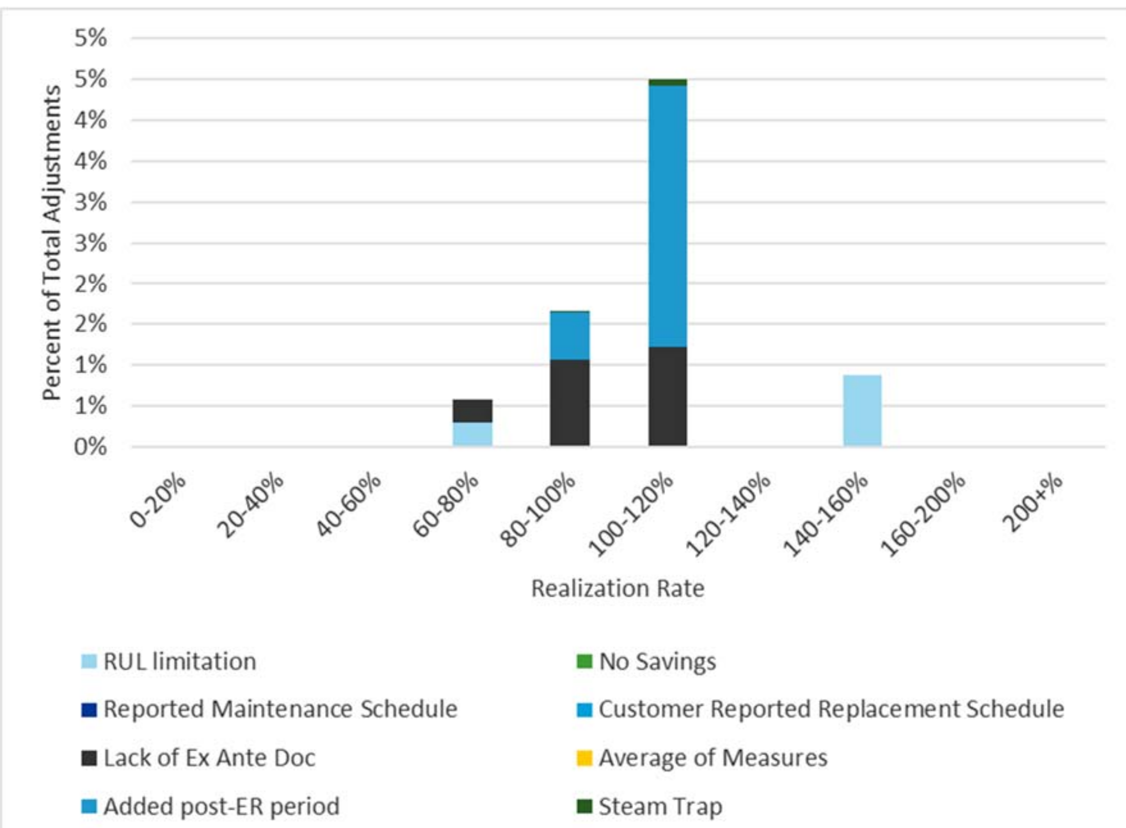
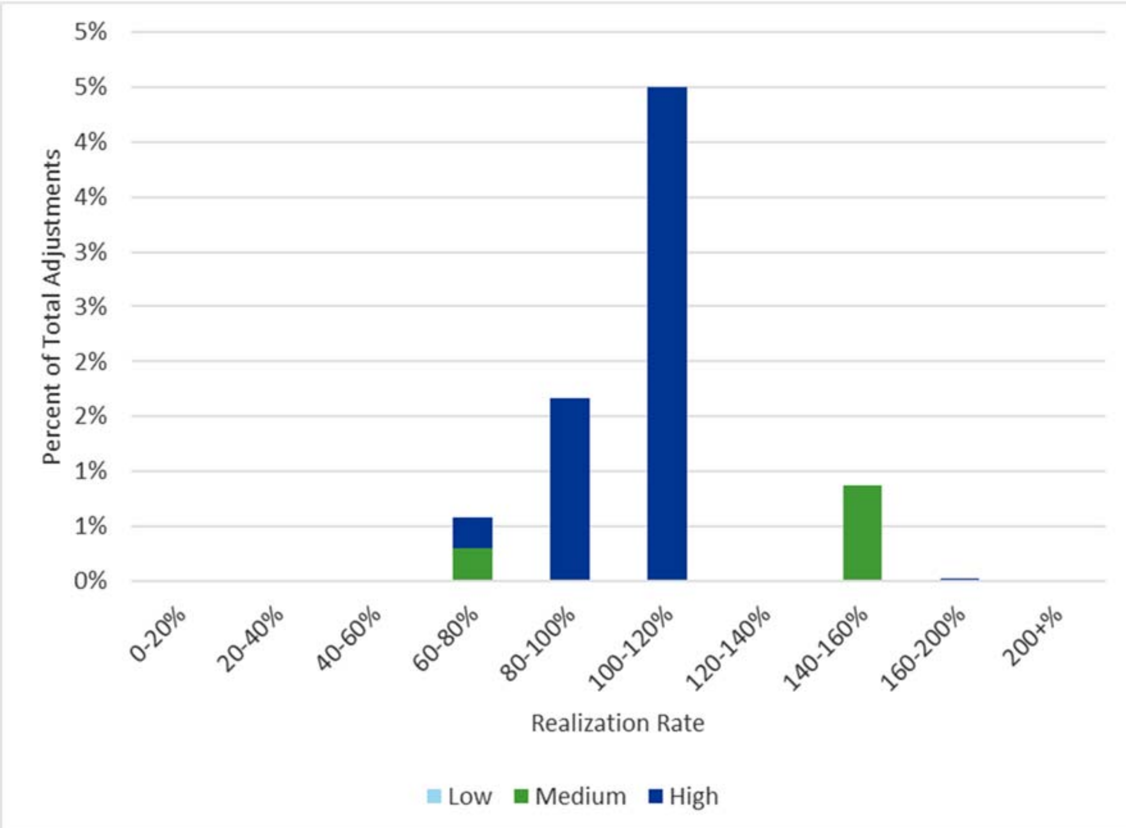


Figure 8-35 shows the level of program control over the adjustments shown in Figure 8-34. For example, the program has a "High" level of control over most reasons which resulted in adjustments of 100-120%.

Figure 8-35: Program Control Over Measure Life Driven Savings Adjustments by Magnitude of Adjustment (CCM Natural Gas)



Union Large Volume

Annual savings adjustments

Total absolute value annual savings adjustments (engineering adjustment) for Union Large Volume are 54,809,839 m^3 of natural gas, or 74% of the total first year sample tracking savings of 73,711,036 m^3. The engineering adjustment represents the differences in ex post and ex ante savings that are not a result of the influence correction.

Table 8-128 shows the percent of total annual savings adjustments associated with each Reason for Adjustment. The table also indicates the level of control that the program has over that discrepancy through improved calculations or improved documentation, as discussed in Table 8-122. For example, "Efficient Equipment Operating Conditions" represents 57% of first year discrepancies, and the program has a limited ("Low") ability to prevent this kind of adjustment. The table shows that discrepancies classified as data entry errors had a significant effect on adjustments. Seven sites had adjustments of this type, with three of them being caused by transfer of values from the project workbook to the tracking database. These are separate from the Influence Adjustments applied by Union to some projects, which are removed from ex ante savings and not considered here.

Table 8-128: Summary of Annual savings Adjustments

Reason For Adjustment	Percent of First Year Discrepancy	Level of Program Control	Percent of First Year Discrepancy
Measured Usage	5%	Low	66%
Efficient Equipment Operating Conditions	57%		
Operating Hours	4%		
Change to Calculation Method	0%	Medium	1%
Baseline	1%		
Efficient Equipment Specifications	0%	High	33%
Data Entry Error	33%		
Overall	**100%**		**100%**

Figure 8-36 distributes the annual savings adjustments by realization rate bin, showing the positive and negative impacts of each adjustment on first year program savings. The figure shows that most of the annual savings adjustments were large and positive.

Figure 8-36: Annual savings Adjustments by Magnitude of Adjustment (m³ Natural Gas)

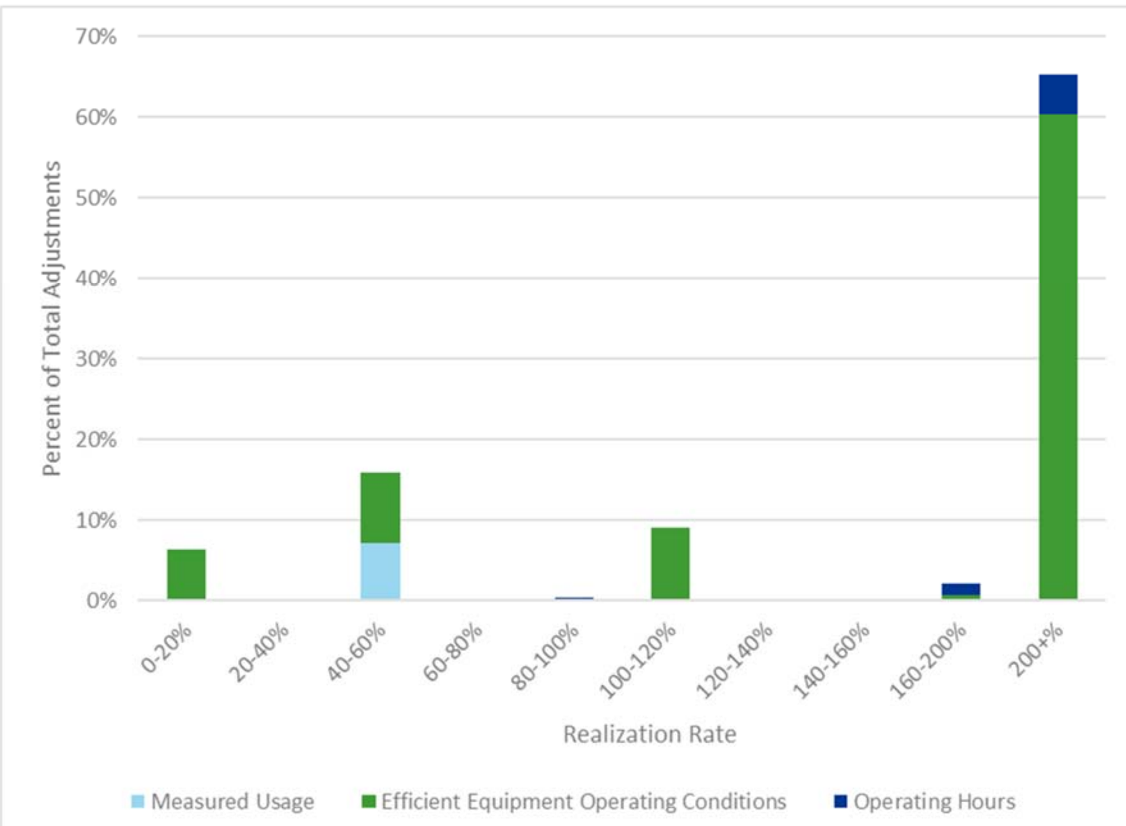
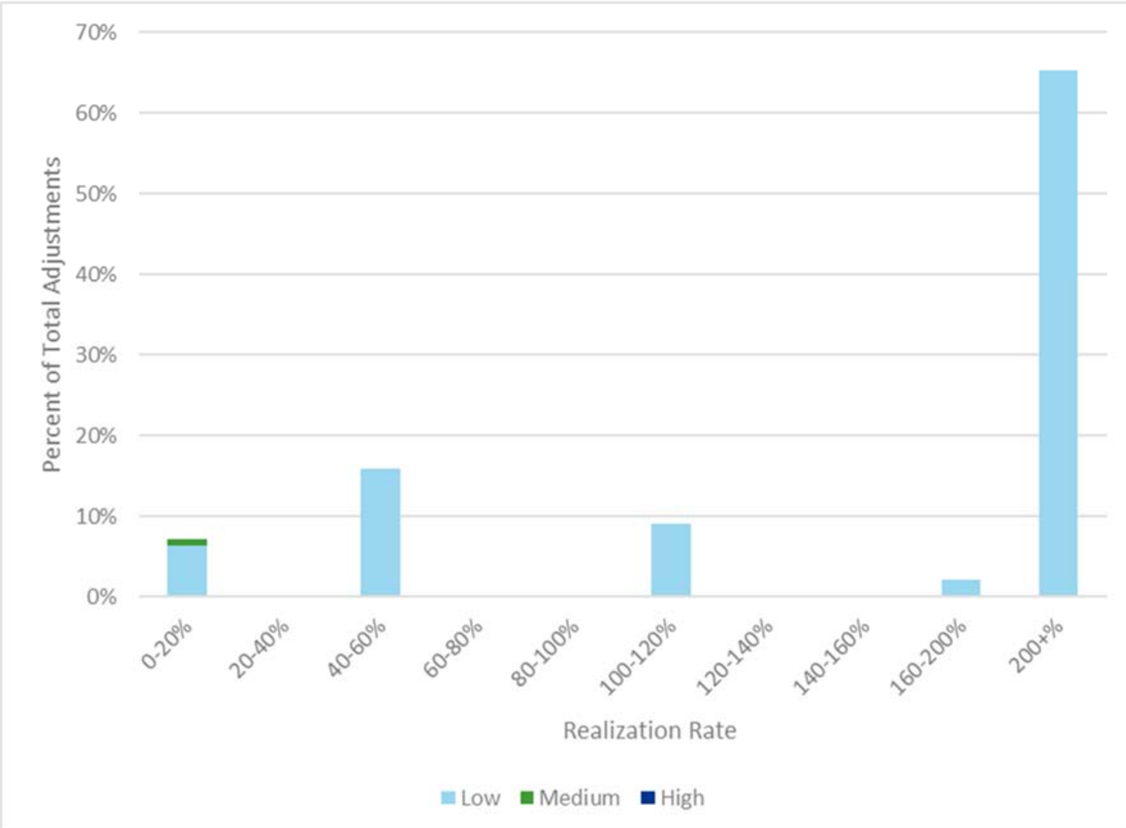


Figure 8-37 shows the level of program control over the adjustments shown in Figure 8-36. As with previous programs, almost all annual savings discrepancies are in areas the program has low control over.

Figure 8-37: Program Control Over Annual savings Adjustments by Magnitude of Adjustment (m^3 Natural Gas)



Measure life adjustments

Total measure life driven cumulative savings adjustments for Union Large Volume are 384,999,510 CCM of natural gas, or 45% of the total first year sample tracking savings of 856,320,533 CCM. These are cumulative lifetime savings[42] and should not be compared to annual savings adjustments.

Table 8-129 shows the percent of total measure life-driven adjustments associated with each specific Reason for Adjustment. The table also indicates the level of control that the program has over that discrepancy through improved calculations or improved documentation, as discussed in Table 8-123. The table shows that 65% of the adjustments made to measure life for the Large Volume program are in areas of high program control. However, this effect is likely overstated because weighting EUL adjustments by ex ante savings may overstate some changes. For example, many Union sites received significant EUL adjustments for early replacement projects that installed ISP technologies. Although the total EUL was greatly increased, the post-ER savings were zero. Using the ex post savings to weight those measures would likely result in a different distribution.

Note that measure life adjustments shown here are inexact. Because they result from changes to both RUL and EUL, there is no way to directly compare the impacts of measure life changes on savings in isolation

[42] To provide comparable values, the cumulative savings adjustments are calculated as ex ante annual savings times ex post EUL minus ex ante annual savings times ex ante EUL.

from other effects. This section is an attempt to isolate those effects to the extent possible, in order to provide useful information for program planning.

Table 8-129: Summary of measure-life-driven annual savings adjustments (CCM natural gas)

Reason for Adjustment	Percent of Measure Life Driven Adjustments	Level of Program Control	Percent of Measure Life Driven Adjustments
RUL limitation	10%	Medium	35%
No Savings	9%		
Reported Maintenance Schedule	<1%		
Customer Reported Replacement Schedule	16%		
Lack of Ex Ante Doc	10%	High	65%
Average of Measures	0%		
Added post-ER period	54%		
Steam Trap	<1%		
Overall	**100%**		**100%**

Figure 8-38 distributes the measure life adjustments by realization rate bin, showing the positive and negative impacts of each kind of adjustment on cumulative savings overall. The figure shows that most of the EUL adjustments were small and positive while a few were extremely positive or extremely negative.

Figure 8-38: Measure-life-driven savings adjustments by magnitude of adjustment (CCM natural gas)

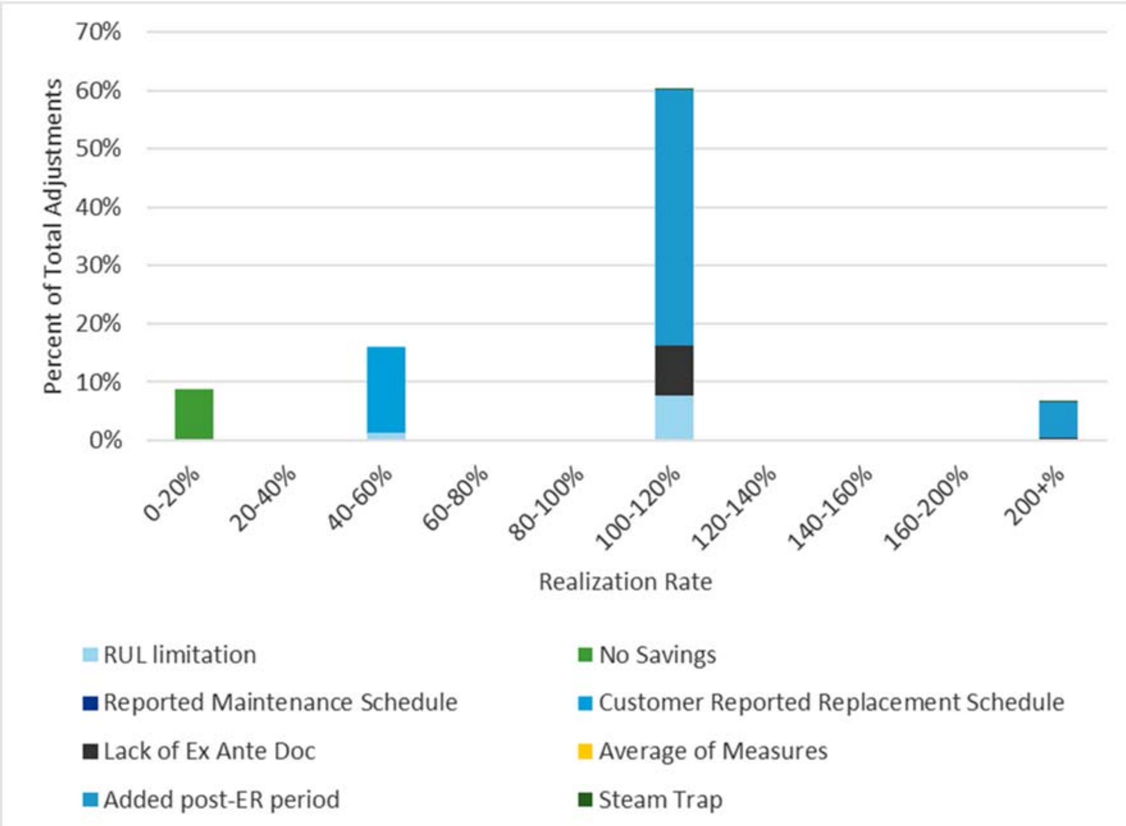
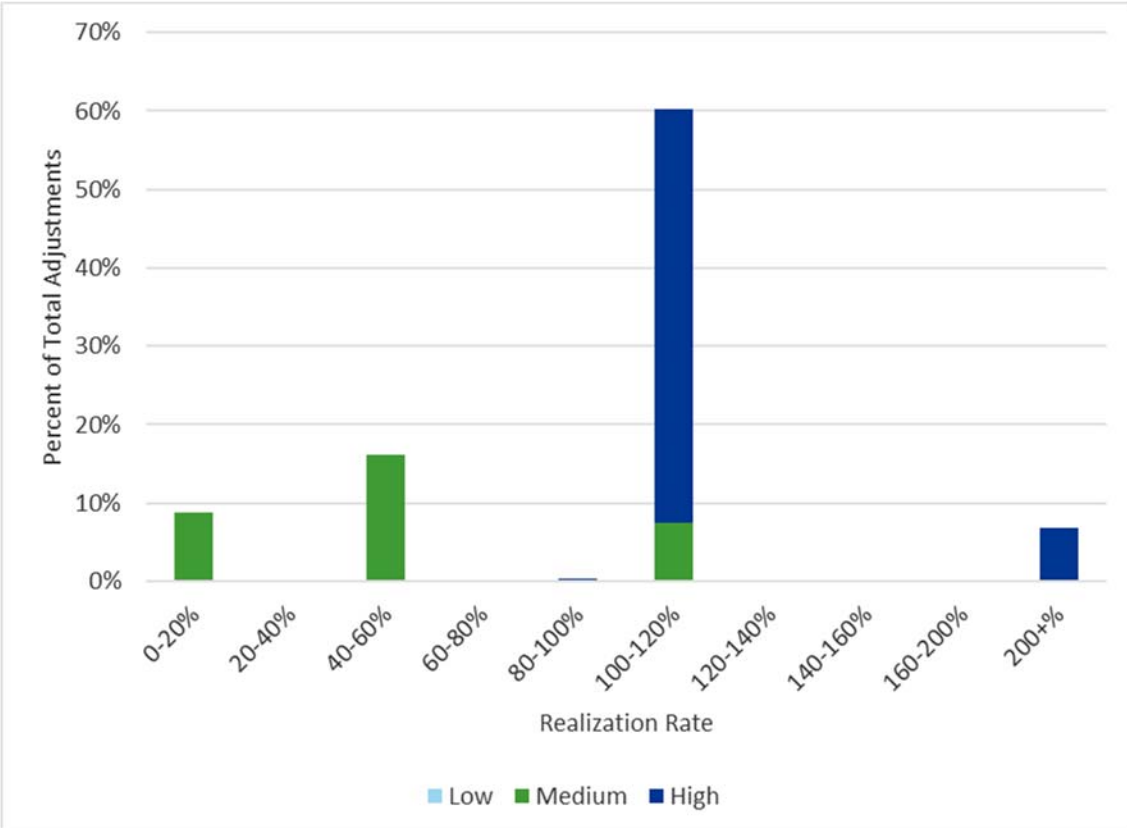


Figure 8-39 shows the level of program control over the adjustments shown in Figure 8-38. For example, the program has a "High" level of control over most reasons which resulted in adjustments of 100-120%.

Figure 8-39: Program control over measure-life-driven savings adjustments by magnitude of adjustment (CCM Natural Gas)



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