DNV·GL

ONTARIO GAS DSM EVALUATION CONTRACTOR

CPSV Participant Spillover Results

Ontario Energy Board

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GLOSSARY OF TERMS AND KEY CONCEPTS

Term	Definition
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.
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.
C&I	Commercial and Industrial
CCM	Cumulative Cubic meters (cumulative m3)
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
Confidence Interval	If the evaluation were re-done several different times, such that all possible sample combinations were selected, the calculated confidence intervals would include the true population parameter, in this case, our ratio estimate at the percentage used to define the confidence interval. When using a 90 percent confidence interval, the calculated confidence intervals would include the true population parameter in 90 percent of the selected samples. See the finite population correction about how it affects confidence intervals.
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 variable in the tracking data 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 variable in the tracking data 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.
Domain	Grouping of like projects. A domain may be defined as projects within a specific sector or a category of measure types, end uses or other.
Error Ratio	The error ratio is a measure of the strength of the association between the tracked value and the measured value and is used in statistical sampling as an estimate of the coefficient of variation (cv). An error ratio of 0.75 implies that the measured savings is typically within ± 75 percent of the tracking estimate of savings.

Term	Definition
Finite Population Correction (FPC)	The finite population correction is used when the population used to generate the sample is the same population for which the ratio will be applied. As an example, this would mean the sample was drawn for a given year, program, and utility and the ratios calculated from the sample will be applied to measures in that same year, program, and utility. FPC changes the confidence interval by reducing the population from which all possible sample combinations would be selected to the finite population used to draw the sample. The effect of the finite population correction is to reduce the estimated error and related statistics.
Free riders (FR)	Program participants who would have installed a measure on their own initiative without the influence of the program. The free ridership rate is the percentage of savings that are not attributable to the program.
Frequency of spillover observed	The observed percentage of customers who completed a gas project for which they did not receive an incentive and was attributable to the program.
Gross savings	Gross savings are changes in energy consumption and/or demand resulting from program-related activities by participants, regardless of reasons for participation
In-depth interviews (IDI)	Structured technical interviews administered by study 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.
Lifetime cumulative savings	Total natural gas savings (CCM) over the life of a DSM measure. Sometimes referred to as just “cumulative” or “lifetime.”
Maintenance (Maint.)	Repair or maintain, restore to prior efficiency
Measure – Enbridge	Measures are identified in the tracking data as a unique combination of the database fields <project code>, <project sub code>, and <ESM project ID>. Multiple measures may belong to the same project.
Measure – Union	Measure refers to a single row in the tracking data. When referring to Union programs, measure and project are used interchangeably, as the projects in the tracking data typically have only one measure each.
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 or not the program influenced a customer’s decision to undertake an energy efficiency measure.
Net-to-gross ratio (NTG)	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 (100%)
Plus/Minus (Absolute Precision (+/-)	The absolute error difference between the estimated ratio and the upper or lower confidence bound. It is a function of the standard error and the t-statistic for the desired confidence limit.
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 ID. When referring to Union programs, measure and project are used interchangeably the projects in the tracking data typically have only one measure each.
Relative Precision	Relative precision is calculated as the absolute precision divided by the estimated ratio.

Term	Definition
Segment	Segments are account groupings that are more detailed than program. For this study, the Union Custom C&I program segments include Custom Industrial and Custom Commercial and Multi-family, while the Enbridge Custom C&I program segments include Custom Industrial, Custom Commercial, and Custom Multi-Residential. For Union Large Volume and Enbridge RunitRight programs, this study does not have results for segments other than the overall program.
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 - Inside	Spillover at the same facility where program-incented measures were installed due to influence from the utility program. Inside spillover can be Like or Unlike.
Spillover - Like	Spillover measures that are similar to program-incented measures installed by the participant due to influence from the utility program. Like spillover can be Inside or Outside.
Spillover - Outside	Spillover measures at a different facility than where program-incented measures were installed due to influence from the utility program. Outside spillover can be Like or Unlike.
Spillover - Unlike	Spillover measures that are different than program-incented measures the participant installed due to influence from the utility program. Unlike spillover can be Inside or Outside.
Spillover (SO)	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."[1] Non-participant spillover is not included in this study.
Unit of Analysis – Enbridge	The level at which the data are analyzed, which is an aggregation of tracked measures by the tracking data variables 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 the tracking data variables 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).

[1] Ontario Energy Board *Demand Side Management Guidelines for Natural Gas Utilities,* EB-2008-0346, June 2011, Chapter 7.

1 Executive Summary

This document has been prepared for the Ontario Energy Board (OEB). It provides the participant spillover for the Custom Commercial and Industrial (C&I) programs in Enbridge Gas Distribution Inc.'s (Enbridge) and Union Gas Limited's (Union) natural gas demand-side management (DSM) portfolio, plus Enbridge's RunitRight program and Union's Large Volume program. The results are based on surveys of 2013 and 2014 program year participants. Table 1 through Table 4 include the attribution ratios (which were referred to as Net-to-Gross (NTG) and only included free ridership effects) in the 2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation[2] report and the participant spillover ratios from this study. To illustrate how the spillover ratios would be combined with free ridership to produce NTG ratios, the table includes a combined NTG ratio with both attribution and participant spillover included. The tables also show the absolute precision at the 90% confidence interval for the 2015 attribution, the spillover result, and the combined illustrative value. Table 1 shows Union Custom C&I, Table 2 shows Union's Large Volume, Table 3 shows Enbridge's Custom C&I, and Table 4 shows Enbridge's RunitRight results. No Participant spillover was found for Enbridge's RunitRight program.

Table 1: Union Custom Commercial and Industrial Program Participant Spillover and Illustrative Net-to-Gross Results

Sector	Domain	Ratios			+/- at 90% Confidence (FPC off)[3]		
		2015 Attr	SO	NTG	2015 Attr	SO	NTG
Custom Industrial	Greenhouse	40.40%	0.89%	41.29%	26.50%	0.56%	25.89%
	Heat Recovery	59.14%	0.89%	60.03%	15.21%	0.56%	14.99%
	Leak Repair and Hydronic Insulation	39.71%	0.89%	40.60%	17.45%	0.56%	17.26%
	Operational Improvements	10.15%	0.89%	11.04%	14.35%	0.56%	13.55%
	Controls	18.21%	0.89%	19.10%	7.92%	0.56%	7.75%
	Steam Trap	28.74%	0.89%	29.63%	19.44%	0.56%	18.76%
	Other	20.57%	0.89%	21.46%	18.47%	0.56%	18.22%
Custom Commercial and Multi-Family	Controls	78.05%	0.00%	78.05%	39.03%	0.00%	33.82%
	Other	38.02%	0.00%	38.02%	30.75%	0.00%	30.06%

[2] *2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation.* Prepared for The Ontario Energy Board by DNV GL, August 15, 2017

[3] Confidence intervals are reported without the finite population correction because the participant spillover will be applied prospectively.

Table 2: Union Large Volume Participant Spillover and Illustrative Net-to-Gross Results

Domain	Ratios			+/- at 90% Confidence (FPC off)[4]		
	2015 Attr	SO	NTG	2015 Attr	SO	NTG
Greenhouse	5.67%	0.82%	6.49%	12.33%	1.12%	11.56%
Heat Recovery	12.55%	0.82%	13.37%	12.03%	1.12%	11.61%
Leak Repair and Hydronic Insulation	6.59%	0.82%	7.41%	8.82%	1.12%	8.60%
Operational Improvements	20.65%	0.82%	21.47%	16.63%	1.12%	16.01%
Controls	0.08%	0.82%	0.90%	0.20%	1.12%	1.32%
Steam Trap	9.31%	0.82%	10.13%	11.30%	1.12%	10.91%

Table 3: Enbridge Commercial and Industrial Program Participant Spillover and Illustrative Net-to-Gross Results

Sector	Domain	Ratios			+/- at 90% Confidence (FPC off)[5]		
		2015 Attr	SO	NTG	2015 Attr	SO	NTG
Custom Industrial	Etool Ventilation	14.90%	1.45%	16.35%	21.68%	1.10%	20.78%
	Heat Recovery	55.25%	1.45%	56.70%	28.59%	1.10%	27.64%
	Other	31.04%	1.45%	32.49%	16.79%	1.10%	16.75%
Custom Commercial	Etool Boiler and Boiler Add-on	24.09%	1.36%	25.45%	15.08%	1.52%	14.98%
	Etool Ventilation	4.93%	1.36%	6.29%	4.51%	1.52%	4.77%
	Steam Trap	27.42%	1.36%	28.78%	14.18%	1.52%	12.50%
	Other	18.22%	1.36%	19.58%	17.97%	1.52%	16.99%
Custom Multi-Residential	Etool Boiler	26.18%	8.24%	34.42%	16.98%	6.35%	17.46%
	Etool Ventilation	19.70%	8.24%	27.94%	21.22%	6.35%	21.89%
	Other	97.10%	8.24%	105.34%	4.23%	6.35%	7.57%

Table 4: Enbridge RunitRight Program Participant Spillover and Illustrative Net-to-Gross Results

Domain	Ratios			+/- at 90% Confidence (FPC off)[6]		
	2015 Attr	SO	NTG	2015 Attr	SO	NTG
RunitRight	50.06%	0.00%	50.06%	19.63%	0.00%	19.23%

Based on the activities completed and results produced under this study, DNV GL offers key findings and recommendations shown in Table 5.

[4] Confidence intervals are reported without the finite population correction because they will be applied prospectively.
[5] Confidence intervals are reported without the finite population correction because they will be applied prospectively.
[6] Confidence intervals are reported without the finite population correction because they will be applied prospectively.

Table 5: Findings and Recommendations

Finding	Recommendation	Applicable Utilities and Programs
The participant spillover estimates have high statistical uncertainty. We have a high level of certainty that the incidence of spillover is low, based on our large sample size. We have less certainty of the exact magnitude of spillover per incident, both because the sample of projects that indicate spillover is low and because the magnitude of identified spillover is highly variable. Despite the uncertainty, the study provides a thorough, reasonably accurate estimate of the participant spillover occurring as a result of participation in the 2013/2014 programs.	DNV GL recommends using the reported participant spillover rates on a go forward basis as a component of the net-to-gross ratio.	All
Participant spillover for the Ontario Gas custom programs was found to be less than 2 percent with the exception of one segment, Enbridge Multi-residential.	No action recommended. Note that low participant spillover is not a negative indicator of the health of a program. It can mean that a program or programs are effective at capturing all DSM opportunities at participant facilities. It is typical for programs with the following characteristics to have low levels of participant spillover. ▪ Comprehensive programs with few energy saving options not incentivized by the program ▪ Low barriers for participation ▪ Programs for which utilities have strong relationships with customers (customers are more likely to come to the program) ▪ Low program attribution ▪ Self-Directed programs with use it or lose it incentive structures	All
Three (3) percent of informed respondents (13/224 total) were found to have some confirmed participant spillover. For most programs, spillover projects were smaller than the program incented projects that led to the spillover. When combined, these findings result in spillover ratios that are less than the frequency of participant spillover.	Finding only; no action recommended	All

Finding	Recommendation	Applicable Utilities and Programs
The frequency of confirmed and potential participant spillover does not correlate strongly with the relative magnitude of spillover. Programs and program segments with the largest program measures (Union Large Volume and Custom Industrial for both utilities) had relatively high frequencies of confirmed and potential spillover, but the size of the evaluated projects in each, combined with the program attribution of these potential spillover projects, resulted in relative participant spillover savings rate (i.e. the participant spillover ratios) that are smaller than for programs and program segments with smaller program measures such as Enbridge Multi-Residential.	Program designs that increase the likelihood of participant spillover are the first consideration in selecting programs for a participant spillover study.	All
One of the most significant measures identified by participants was one where an incentive for the measure type was not available through the program in the region it was installed. The measure found was multi-family heat reflector panels which are incented by Enbridge, but not Union.	We generally recommend focusing on increasing attribution and savings through the program rather than specifically targeting participant spillover in program design; however, this is an exception to the general recommendation. The Union program is likely to have more participant spillover in future years as a result of discontinuing measures that were previously rebated due to concerns regarding free ridership on incentivized measures. Specifically, discontinued incentives included steam trap repairs and maintenance type measures. While Union discontinued incentivizing these measures for free ridership concerns, free ridership was not 100%. Continuing to recommend these types of measures to participants implementing other measures may result in more significant participant spillover savings from the current program than were found in the study.	Union

Finding	Recommendation	Applicable Utilities and Programs
Using an open-ended survey question to gather data on participant spillover may result in less customer recall than pairing the open-ended question with a limited number of probes. For this study, there was not a clear expectation for what types of spillover would be expected, so no probes were included.	The open nature of the initial spillover question casts a wide net with the intent of identifying a wide variety of spillover. This is appropriate when the program implementation and evaluation teams do not know the most likely technologies that might be occurring as spillover. Future studies should consider starting with an open question, but add probes for the most likely participant spillover technologies, which may be identified from interviews with utility reps, evaluator experience with the programs, process evaluations, or other sources.	All
The study primarily found unlike spillover, which is most appropriately evaluated as related to a customer rather than a specific program measure.	Future participant spillover studies should use a customer-level sample design rather than a project- or measure-level sample design.	All

2 Introduction

DNV GL prepared this document for the OEB, providing the program participant spillover results for a subset of programs in Enbridge and Union natural gas demand-side management (DSM) portfolios. The outcome of the exercise produced estimates of participant spillover ratios for the programs studied. The programs included in the participant spillover study are provided in Table 6.

Table 6. Programs Included in Participant Spillover Study

Program		Participant spillover (2013/14)
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.

The overall objectives of the study were to develop participant spillover ratios based on surveys with a sample of participants in the 2013 and 2014 program years for the Custom Commercial, Industrial, Large Volume and RunitRight programs. Once determined, the spillover results can be combined with free ridership to yield net-to-gross (NTG). The statistical error estimates (+/-, error ratios, relative precision and confidence intervals) provided in this report are appropriate and allow for application of the results to future program years of the same or similar programs.

This effort is the final stage in the DNV GL's scope of work delivered December 14, 2016.[7] It follows the submission of the CPSV/Free-ridership final report.[8]

[7] *Measurement of NTG Factors and Custom Savings Verification for Ontario's Natural Gas Custom Commercial and Industrial DSM Scope of Work*. Prepared for The Ontario Energy Board by DNV GL, December 14th, 2016.

[8] *2015 Natural Gas Demand Side Management Custom Savings Verification and Free-ridership Evaluation.* Prepared for The Ontario Energy Board by DNV GL, August 15, 2017

3 METHOD SUMMARY

The results presented in this report are based on data collected from five primary sources, supplemented with secondary source information.

1. Union and Enbridge program tracking databases (2013-2016 program years)
2. Union and Enbridge project contact information
3. Participant Spillover screener surveys completed as in-depth interviews during the 2015 CPSV evaluation, for customers with participation in 2013-2014.
4. Participant Spillover screener surveys completed as CATI interviews for a sample of customers who participated in 2013-2014 but were not included in the 2015 CPSV evaluation.
5. Follow-up in-depth interviews with participant spillover screener respondents who showed evidence of gas participant spillover

At a high level, the participant spillover study employed the following methodology:

- **Sample Design.** The sample design employed a stratified random sample that targeted 10% relative precision with 90% confidence at the program level.
- **Participant Spillover Screener.** The study started with a survey of a sample of 2013-2014 program participants to determine which participants had performed additional energy-saving actions as a result of their experience with the program(s). These projects are referred to as *potential gas participant spillover projects*.
- **Compare with Tracking Databases.** The tracking data was used to:
  - Verify that customer-reported non-incentivized projects did not receive an incentive
  - Check for program incentives for projects where the customer was unsure about whether an incentive was received.
  - Identify like versus unlike participant spillover.
- **In-depth Interviews.** An engineer called the participants back to gather the information required to estimate savings for confirmed participant spillover projects.
- **Calculate Project-Level Savings.** The engineer who performed the in-depth interviews estimated savings for each participant spillover project.
- **Impute values for respondents with partial information.** An analyst calculated and employed "average fill factors" (described in Appendix A) to estimate participant spillover savings for customers who answered "don't know" to one or more of the key questions. This imputation technique, or "filling," is not intended to represent the true response for the customer; rather, it is meant to limit the bias of the program-level estimate, and to make best use of the information we have.
- **Develop program-level participant spillover factors.** An analyst expanded the results to the population using ratio estimation to produce final participant spillover ratios.
- **Report the results.** The final step is this report.

Table 7 shows the targeted and completed data collection activities and the timeframe in which they were completed.

Table 7: Data collection activities

Target Group	Activity	Targeted Units of Analysis	Targeted Customers	Completed Units of Analysis	Complete and Informed Customers	Timeframe
Union						
Participating Customers	Spillover Screener	238	N/A	299	121	Feb-Oct, 2017
	In-Depth Interview	N/A	8	13	6	Nov, 2017, April 2018
Enbridge						
Participating Customers	Spillover Screener	246	N/A	214	105[9]	Feb-Oct, 2017
	In-Depth Interview	N/A	5	13	3	Nov, 2017, April 2018
Overall						
Participating Customers	Spillover Screener	484[10]	N/A	513	224[11]	Feb-Oct, 2017
	In-Depth Interview	N/A	13	26	9	Nov, 2017, April 2018

The following sections provide summaries of results by program. All precision and error statistics are reported with no finite population correction, i.e. the errors are those that are appropriate for consideration when applying results to future program years.

[9] Two customers had projects in both the RunitRight and Enbridge Custom C&I sample. They are each counted once in this number.

[10] Three customers had projects in the CATI sample frame for both Union and Enbridge.

[11] Two customers had projects in both the Union and Enbridge Custom C&I sample. They are each counted once in this number.

Union Custom Commercial and Industrial

This section presents the results of the participant spillover study for Union Custom Commercial (including Market Rate Multi-Family) and Industrial programs.

3.1 Sample

The respondents and projects included in each stage of the study process are shown in Figure 1 for Union Custom Industrial and Figure 2 for Union Custom Commercial and Market Rate Multi-Family. We did not call customers who were not randomly selected into the sample or backup sample of requested contact information. In Figure 1 and Figure 2, the sum of each row equals the number of "yes" responses (right-most boxes) on the row above. The boxes with a coloured border include the final status for customers who are included in the results.

- Boxes with green dashed borders are those respondents with clear evidence of participant spillover. Those that did not complete an engineering IDI had participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.
- Boxes with yellow dot-dashed borders are those respondents with a non-zero chance of participant spillover based on their survey responses. These had participant spillover savings estimated using a "net fill" as described in APPENDIX A.
- Boxes with red solid borders are those respondents that did not have any participant spillover based on their survey responses.

Figure 1 and Figure 2 also show the frequency of spillover observed. The formula used to calculate this frequency is shown in the bubble referencing the labels in the boxes to the left.

Seven of the boxes are labeled with letters in the corners. These include:

A. **Completed Screener** – This is the number of customers who provided at least some data for the study.

B. **Don't know if project done after participation** -These customers were considered uninformed and dropped from the analysis.

C. **Don't Know (if project received incentive) / had many, but did not respond to follow up** – These customers knew that they did a project after participating in the program, but could not provide enough detail to determine if it saved gas or received an incentive. Some of these customers had done more projects (eight or more) than could be reasonably collected by CATI, but did not respond to a follow-up attempt to gather additional data. These customers had participant spillover savings estimated using a "net fill" described in APPENDIX A.

D. **Attributable –** These customers reported that the non-incented gas project they completed was not "very likely" to have been done without the prior interactions with the program.

E. **Attributable Don't Know –** These customers reported that they completed a gas project without an incentive, but were unable to say whether or not the project was "very likely" to have happened without the program. These customers had their participant spillover savings estimated using a "gross SO fill" and "attribution fill" as described in APPENDIX A.

F. **Responded to follow up call -** These customers installed projects that were confirmed to be participant spillover and provided our engineers with sufficient information to quantify the savings of their project(s).

G. **Did not respond to follow up call -** These customers had installed projects that were confirmed to be participant spillover, but did not respond to follow-up attempts for information that would allow the savings to be estimated. These customers had their participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.

Figure 1. Summary of data collection for the Union Custom Industrial program

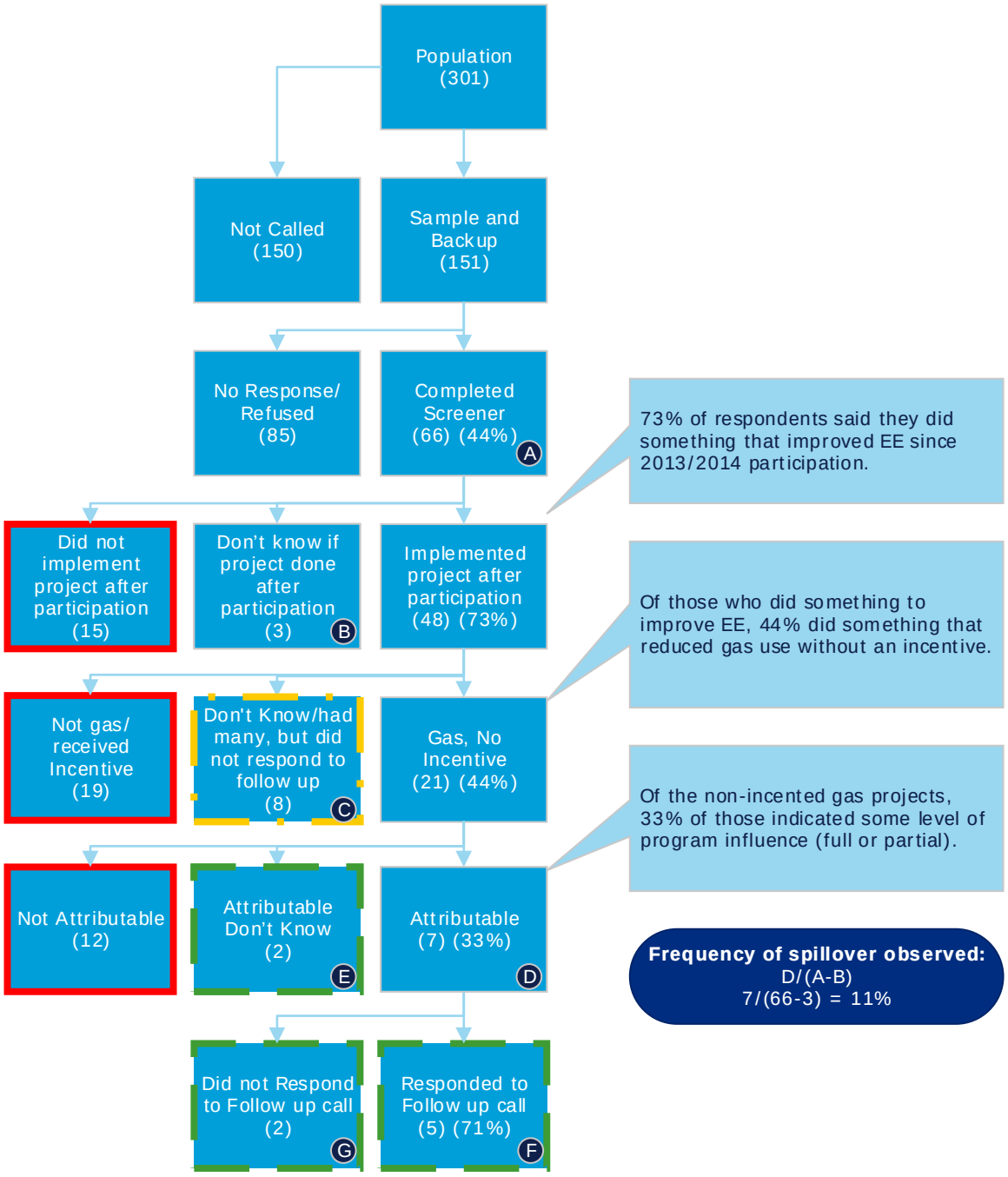
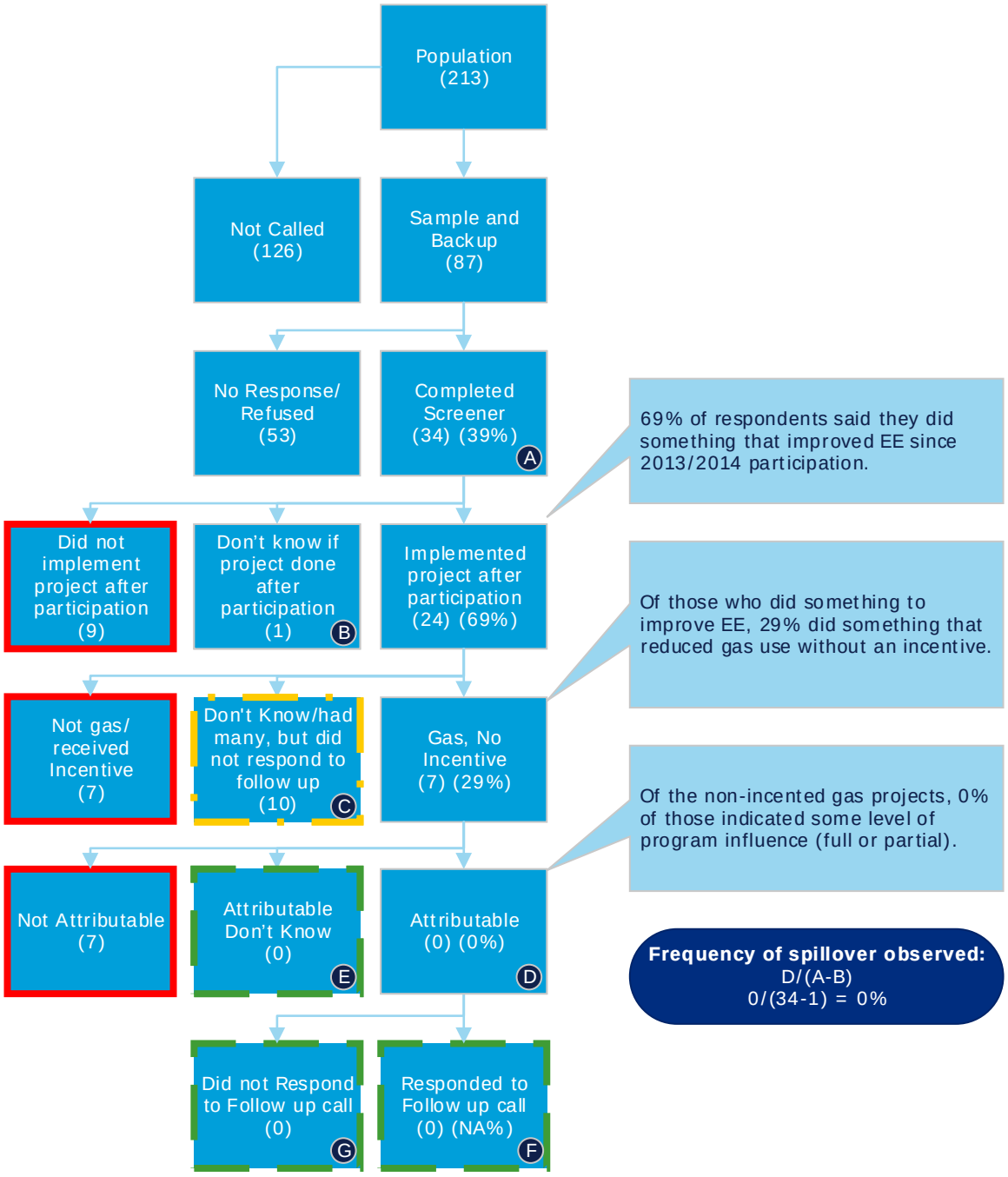


Figure 2. Summary of data collection for the Union Custom Commercial and Multi-family program



3.2 Results

Table 8 shows the participant spillover results for Union Custom Commercial and Industrial Programs. The ”n customers” are the number of customers included in the analysis, equal to box A minus box B in the figures, because customers in box B above were treated as uninformed respondents and dropped from the analysis.

Table 8: 2013-2014 Participant spillover results for Union Custom Commercial and Industrial programs

Domain	n		SO Ratio	90% Confidence Interval (FPC off)				Error Ratio	% Program Savings
	Unit of Analysis	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	127	63	0.89%	0.56%	0.33%	1.45%	63.36%	3.87	86.29%
Custom Comm & MF	69	33	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	13.71%

The study found evidence of inside, outside (one project), and unlike participant spillover in the custom industrial segment. The strongest evidence was for inside unlike participant spillover. The evidence for like participant spillover was minimal, consisting only of customers who indicated they did something, but did not tell us what. We identified five industrial customers with quantifiable participant spillover projects: an energy curtain, pipe insulation, unit heaters, a process boiler, and a residential furnace. Three customers indicated that they did not go through the programs because the project was “too small” to bother with tracking the information required for the paperwork. One customer indicated that he was unaware of the incentive for the measure at the time. The fifth customer did not indicate why the project was not done through the program.

While we found a relatively high frequency of spillover for the custom industrial segment, the projects completed were small relative to the size of the projects the same participants completed through the program. This resulted in a low spillover rate, which is calculated as the spillover energy savings divided by the original tracking savings. This finding indicates that the program is doing a good job of capturing the major gas saving projects at participating sites through program participation.

We found no participant spillover for the commercial and multifamily programs. Seven of the 33 informed customers indicated that they did a non-incented gas project. All seven said they were “very likely” to complete the project had they not participated in Union programs previously.

Because the study produced only five quantified cases of spillover, we did not attempt to produce separate participant spillover rates in the like/unlike and inside/outside categories.

4 Union Large Volume

This section presents the results of the participant spillover study for Union Large Volume programs.

4.1 Sample

The respondents and projects included in each stage of the study process are shown in Figure 3. We did not call customers who were not randomly selected into the sample or backup sample of requested contact information. In Figure 3, the sum of each row equals the number of "yes" responses (right-most boxes) on the row above. The boxes with a coloured border include the final status for customers who are included in the results.

- Boxes with green dashed borders are those respondents with clear evidence of participant spillover. Those that did not complete an engineering IDI had participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.
- Boxes with yellow dot-dashed borders are those respondents with a non-zero chance of participant spillover based on their survey responses. These had participant spillover savings estimated using a "net fill" as described in APPENDIX A.
- Boxes with red solid borders are those respondents that did not have any participant spillover based on their survey responses.

Figure 3 also show the frequency of spillover observed. The formula used to calculate this frequency is shown in the bubble referencing the labels in the boxes to the left.

Seven of the boxes are labeled with letters in the corners. These include:

A. **Completed Screener** – This is the number of customers who provided at least some data for the study.

B. **Don't know if project done after participation** -These customers were considered uninformed and dropped from the analysis.

C. **Don't Know (if project received incentive) / had many, but did not respond to follow up** – These customers knew that they did a project after participating in the program, but could not provide enough detail to determine if it saved gas or received an incentive. Some of these customers had done more projects (eight or more) than could be reasonably collected by CATI, but did not respond to a follow-up attempt to gather additional data. These customers had participant spillover savings estimated using a "net fill" described in APPENDIX A.

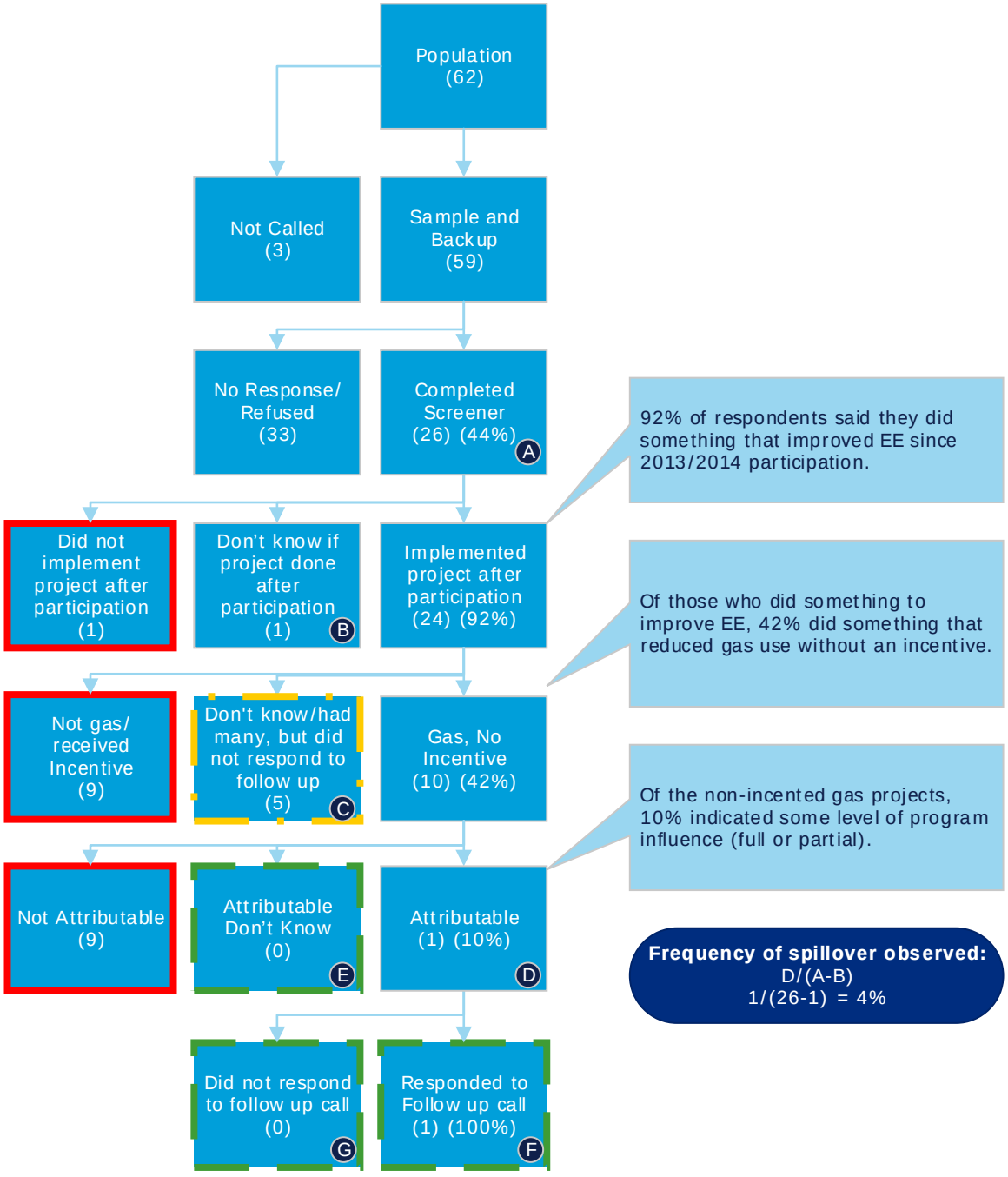
D. **Attributable –** These customers reported that the non-incented gas project they completed was not "very likely" to have been done without the prior interactions with the program.

E. **Attributable Don't Know –** These customers reported that they completed a gas project without an incentive, but were unable to say whether or not the project was "very likely" to have happened without the program. These customers had their participant spillover savings estimated using a "gross SO fill" and "attribution fill" as described in APPENDIX A.

F. **Responded to follow up call -** These customers installed projects that were confirmed to be participant spillover and provided our engineers with sufficient information to quantify the savings of their project(s).

G. **Did not respond to follow up call -** These customers had installed projects that were confirmed to be participant spillover, but did not respond to follow-up attempts for information that would allow the savings to be estimated. These customers had their participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.

Figure 3. Summary of data collection for Union Large Volume program



4.2 Results

Table 8 shows the participant spillover results for Union Large Volume programs. The ”n customers” are the number of customers included in the analysis, equal to box A minus box B in the figures, because customers in box B above were treated as uninformed respondents and dropped from the analysis.

Table 9: 2013-2014 participant spillover results for Union Large Volume programs

Domain	n		SO Ratio	90% Confidence Interval (FPC off)				Error Ratio	% Program Savings
	Unit of Analysis	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Large Volume	103	25	0.82%	1.12%	0.00%	1.94%	136.28%	6.69	100.00%

The study found evidence of inside and unlike participant spillover. The evidence for like participant spillover was minimal, consisting only of customers who indicated they did something, but did not tell us what. No respondent indicated any potential outside participant spillover. The directly quantifiable projects were relatively large optimization projects (like and inside participant spillover) installed at one facility. The customer indicated that they did not go through the program because the money available from the program was not worth the effort for these projects.

The frequency of spillover found for Large Volume was low at 4%. While a relatively high proportion of customers reported completing gas saving projects outside of the program, only one out of 10 indicated that the projects were anything other than “very likely” to be completed without the program.

Because we had only one quantifiable instance of participant spillover, we did not attempt to produce separate participant spillover rates in the like/unlike and inside/outside categories.

5 Enbridge Custom Commercial and Industrial

This section presents the results of the participant spillover study for Enbridge Custom Commercial, Multi-Residential, and Industrial programs.

5.1 Sample

The respondents and projects included in each stage of the study process are shown in Figure 4 for Enbridge Custom Industrial, Figure 5 for Enbridge Custom Commercial, and Figure 6 for Enbridge Custom Multi-Residential. We did not call customers who were not randomly selected into the sample or backup sample of requested contact information. In Figure 4 through Figure 6, the sum of each row equals the number of "yes" responses (right-most boxes) on the row above. The boxes with a coloured border include the final status for customers who are included in the results.

- Boxes with green dashed borders are those respondents with clear evidence of participant spillover. Those that did not complete an engineering IDI had participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.
- Boxes with yellow dot-dashed borders are those respondents with a non-zero chance of participant spillover based on their survey responses. These had participant spillover savings estimated using a "net fill" as described in APPENDIX A.
- Boxes with red solid borders are those respondents that did not have any participant spillover based on their survey responses.

Figure 4 through Figure 6 also show the frequency of spillover observed. The formula used to calculate this frequency is shown in the bubble referencing the labels in the boxes to the left.

Seven of the boxes are labeled with letters in the corners. These include:

A. **Completed Screener** – This is the number of customers who provided at least some data for the study.

B. **Don't know if project done after participation** -These customers were considered uninformed and dropped from the analysis.

C. **Don't Know (if project received incentive) / had many, but did not respond to follow up** – These customers knew that they did a project after participating in the program, but could not provide enough detail to determine if it saved gas or received an incentive. Some of these customers had done more projects (eight or more) than could be reasonably collected by CATI, but did not respond to a follow-up attempt to gather additional data. These customers had participant spillover savings estimated using a "net fill" described in APPENDIX A.

D. **Attributable –** These customers reported that the non-incented gas project they completed was not "very likely" to have been done without the prior interactions with the program.

E. **Attributable Don't Know –** These customers reported that they completed a gas project without an incentive, but were unable to say whether or not the project was "very likely" to have happened without the program. These customers had their participant spillover savings estimated using a "gross SO fill" and "attribution fill" as described in APPENDIX A.

F. **Responded to follow up call -** These customers installed projects that were confirmed to be participant spillover and provided our engineers with sufficient information to quantify the savings of their project(s).

G. **Did not respond to follow up call -** These customers had installed projects that were confirmed to be participant spillover, but did not respond to follow-up attempts for information that would allow the savings to be estimated. These customers had their participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.

Figure 4. Summary of data collection for Enbridge Custom Industrial program

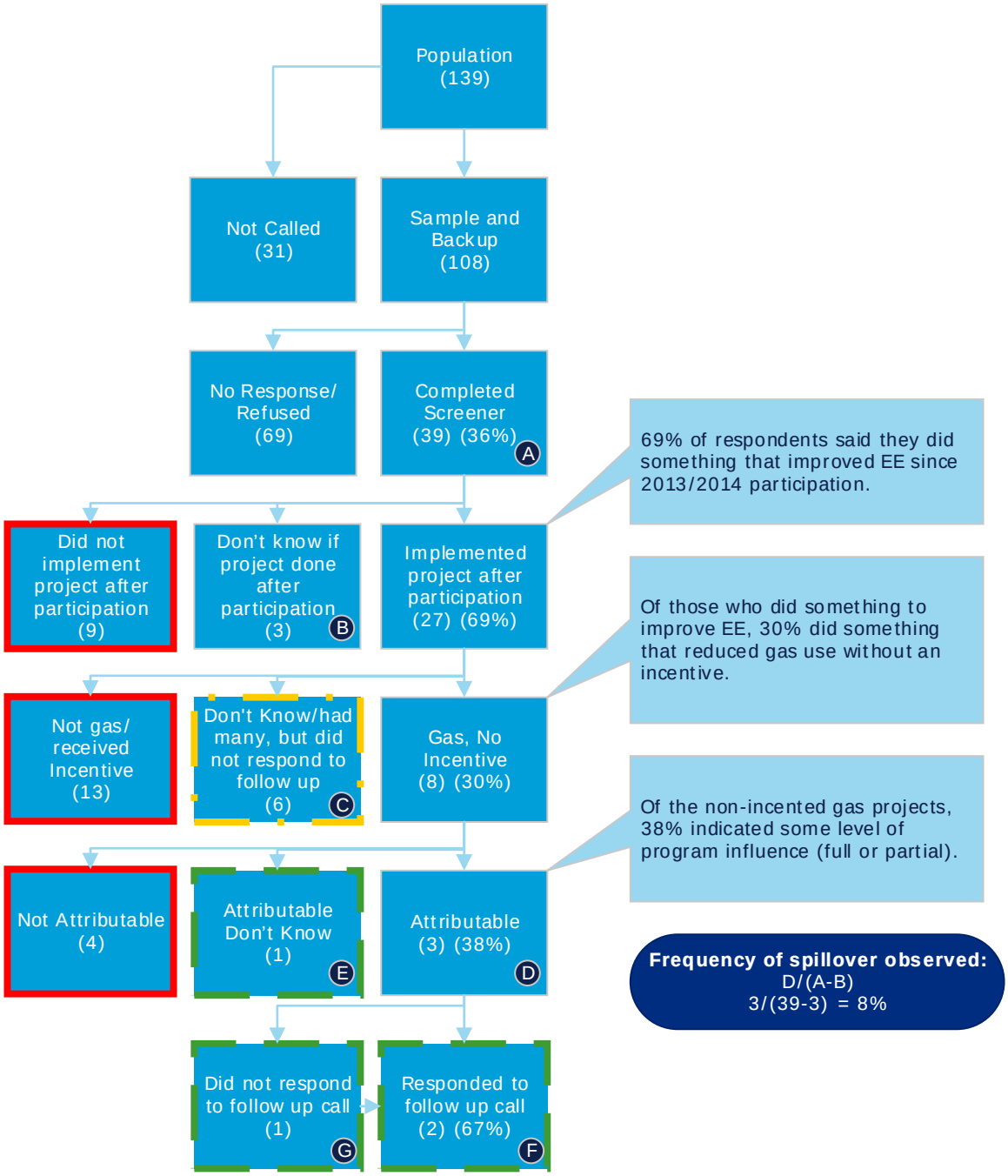


Figure 5. Summary of data collection for Enbridge Custom Commercial program

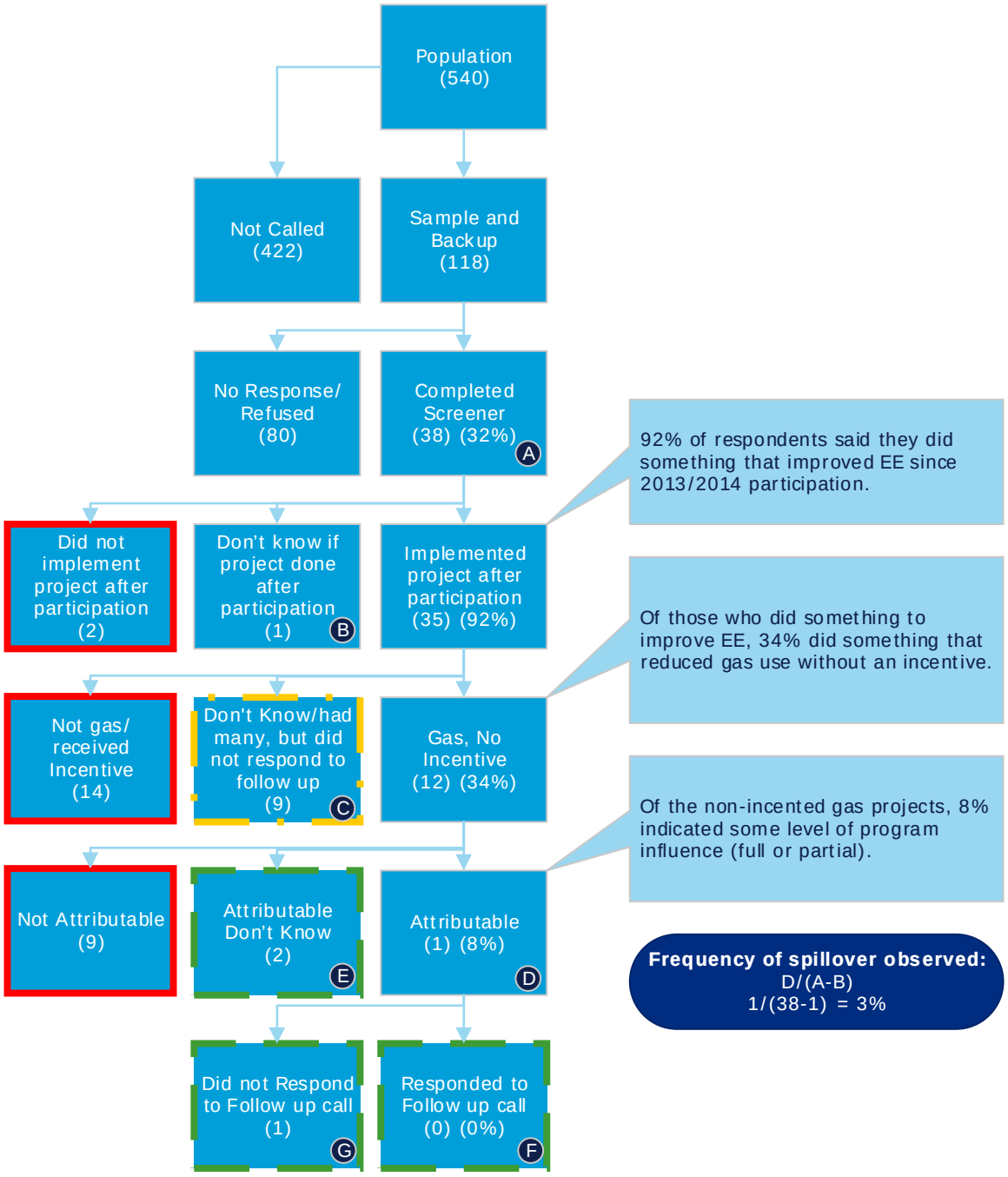
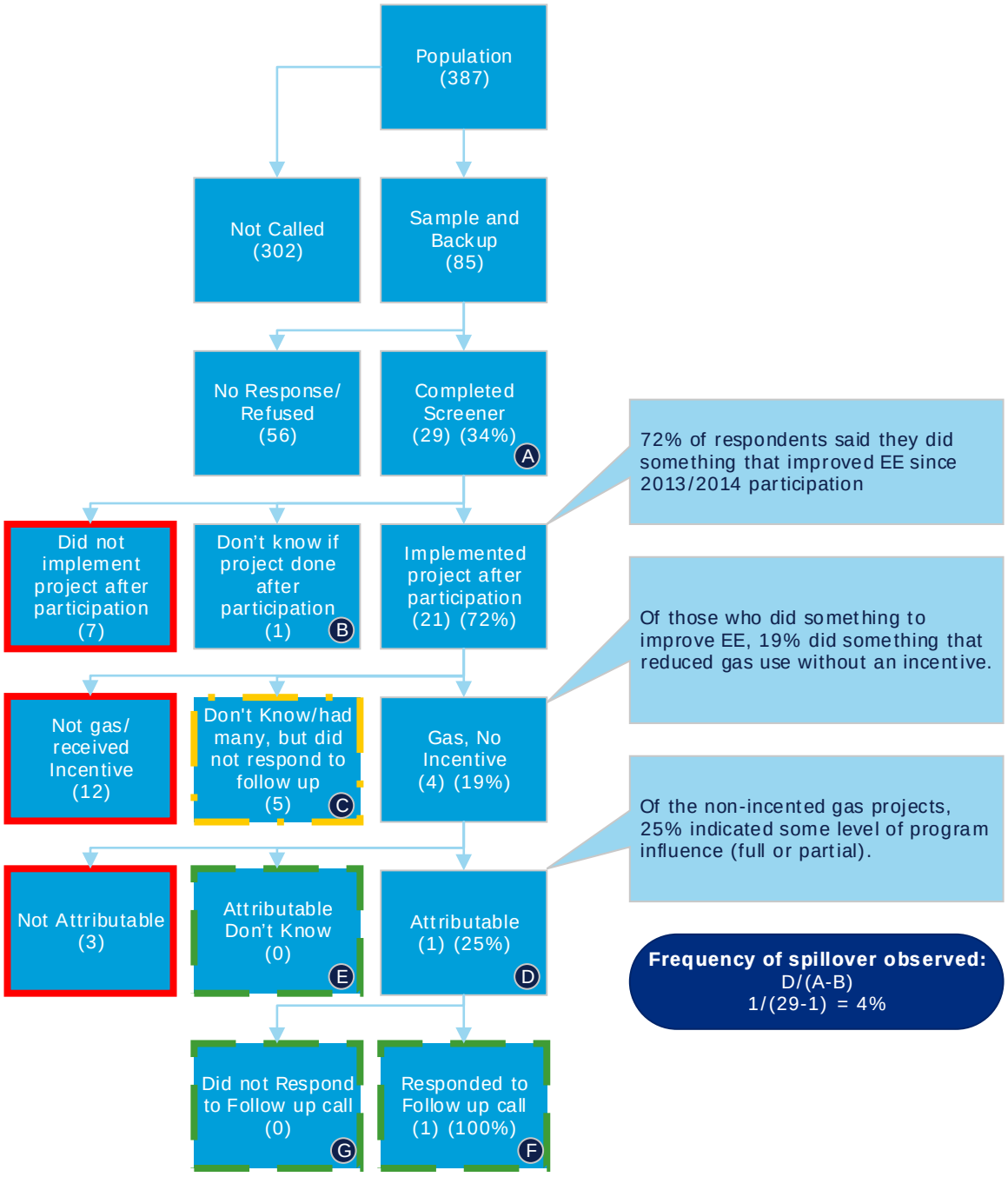


Figure 6. Summary of data collection for Enbridge Custom Multi-Residential program



5.2 Results

Table 10 shows the participant spillover results for Enbridge Custom Commercial and Industrial programs. The "n customers" are the number of customers included in the analysis, equal to box A minus box B in the figures, because customers in box B above were treated as uninformed respondents and dropped from the analysis.

Table 10: 2013-2014 participant spillover results for Enbridge Custom Commercial, Industrial, and Multi-Residential programs

Domain	n		SO Ratio	90% Confidence Interval (FPC off)				Error Ratio	% Program Savings
	Unit of Analysis	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Custom Industrial	69	36	1.45%	1.10%	0.35%	2.55%	75.68%	3.45	43.39%
Custom Commercial	76	37	1.36%	1.52%	0.00%	2.88%	112.33%	5.25	31.28%
Custom Multi-Res	58	28	8.24%	6.35%	1.89%	14.59%	77.09%	2.89	25.33%

The study found confirmed projects with inside, outside, like, and unlike participant spillover. We quantified the participant spillover savings for two industrial projects and one multi-residential project.

The frequency of spillover for the industrial segment (8%) was higher than that found for the commercial (3%) or multi-residential (4%) segments.

The industrial projects we were able to quantify included the installation of a baghouse and steam trap replacement. In one case the customer indicated that they applied for an incentive, but their application was rejected. The other project did not provide the reason that they did not complete the project through the program. The two projects we were able to quantify for the industrial segment were small relative to the measures these customers completed through the program, which indicates that the program is doing a good job of capturing the larger projects completed by participants.

The multi-residential project was installation of heat reflector panels at several dozen apartment buildings in 2015/16 (unlike, outside). The customer was prompted to complete these participant spillover projects through experience with other projects in the Enbridge program. In 2015, the customer also completed multiple heat reflector projects through the Enbridge program. The customer did not go through the Enbridge program for the participant spillover projects because they were completed at sites with gas service from Union Gas. These sites are ineligible for the Enbridge program and the customer indicated that Union does not incent this measure.

Because the study produced only three quantified cases of spillover, we did not attempt to produce separate participant spillover rates in the like/unlike and inside/outside categories.

6 Enbridge RunitRight

This section presents the results of the participant spillover study for the Enbridge RunitRight program.

6.1 Sample

The respondents and projects included in each stage of the study process are shown in Figure 7. We did not call customers who were not randomly selected into the sample or backup sample of requested contact information. In Figure 7, the sum of each row equals the number of "yes" responses (right-most boxes) on the row above. The boxes with a coloured border include the final status for customers who are included in the results.

- Boxes with green dashed borders are those respondents with clear evidence of participant spillover. Those that did not complete an engineering IDI had participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.
- Boxes with yellow dot-dashed borders are those respondents with a non-zero chance of participant spillover based on their survey responses. These had participant spillover savings estimated using a "net fill" as described in APPENDIX A.
- Boxes with red solid borders are those respondents that did not have any participant spillover based on their survey responses.

Figure 7 also show the frequency of spillover observed. The formula used to calculate this frequency is shown in the bubble referencing the labels in the boxes to the left.

Seven of the boxes are labeled with letters in the corners. These include:

A. **Completed Screener** – This is the number of customers who provided at least some data for the study.

B. **Don't know if project done after participation** -These customers were considered uninformed and dropped from the analysis.

C. **Don't Know (if project received incentive) / had many, but did not respond to follow up** – These customers knew that they did a project after participating in the program, but could not provide enough detail to determine if it saved gas or received an incentive. Some of these customers had done more projects (eight or more) than could be reasonably collected by CATI, but did not respond to a follow-up attempt to gather additional data. These customers had participant spillover savings estimated using a "net fill" described in APPENDIX A.

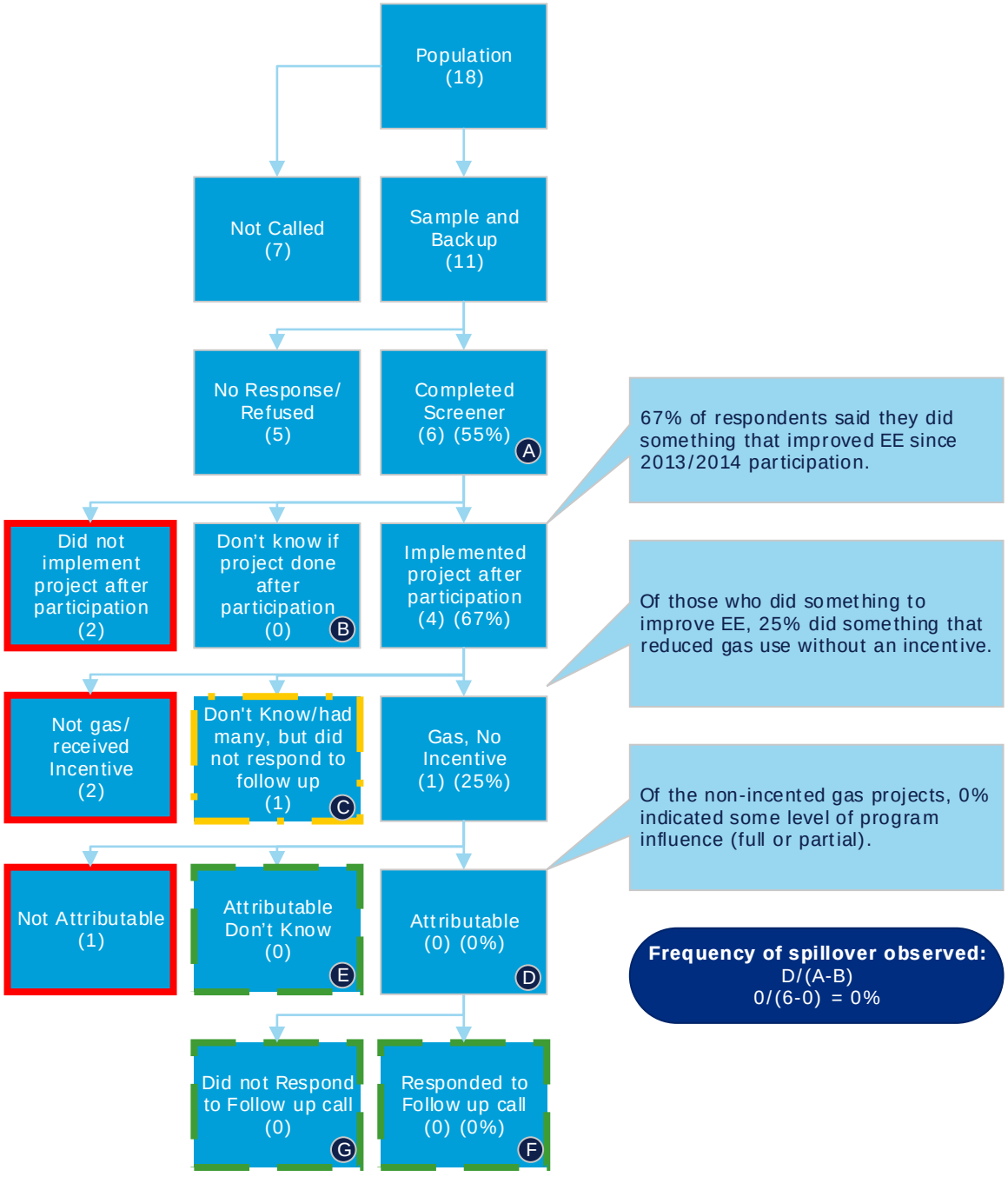
D. **Attributable –** These customers reported that the non-incented gas project they completed was not "very likely" to have been done without the prior interactions with the program.

E. **Attributable Don't Know –** These customers reported that they completed a gas project without an incentive, but were unable to say whether or not the project was "very likely" to have happened without the program. These customers had their participant spillover savings estimated using a "gross SO fill" and "attribution fill" as described in APPENDIX A.

F. **Responded to follow up call -** These customers installed projects that were confirmed to be participant spillover and provided our engineers with sufficient information to quantify the savings of their project(s).

G. **Did not respond to follow up call -** These customers had installed projects that were confirmed to be participant spillover, but did not respond to follow-up attempts for information that would allow the savings to be estimated. These customers had their participant spillover savings estimated using a "gross SO fill" as described in APPENDIX A.

Figure 7. Summary of data collection for the Enbridge RunitRight program



6.2 Results

Table 11 shows the participant spillover results for Enbridge RunitRight program. The ”n customers” are the number of customers included in the analysis, equal to box A minus box B in the figures, because customers in box B above were treated as uninformed respondents and dropped from the analysis.

Table 11: 2013-2014 participant spillover results for the Enbridge RunitRight program

Domain	n		SO Ratio	90% Confidence Interval (FPC off)				Error Ratio	% Program Savings
	Unit of Analysis	Customers		+/-	Lower Bound	Upper Bound	Relative Precision		
Run-it-Right	11	6	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	100.00%

The study did not find any participant spillover from the RunitRight program. Only six customers responded to the survey. One customer did more projects (8 or more) than could reasonably be collected with a CATI, but did not respond to follow-up attempts to collect detailed project information and determine program attribution. Another customer indicated they did a non-incented gas project., but it was not attributable, as the respondent said they were “very likely” to do the same project had they not participated in RunitRight previously.

APPENDIX A. PARTICIPANT SPILLOVER METHODOLOGY

The participant spillover analysis provides estimates of participant spillover for each program segment. The study was designed to support separate estimates for inside-like, inside-unlike, outside-like, and outside-unlike participant spillover; however, the data collected was not sufficient to accurately estimate each of these participant spillover types separately.

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."[12] As in many jurisdictions, Ontario's Demand-Side Management Guidelines recognize the importance of spillover in determining program benefits, and also require "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 approach provides a high level of rigour to address each of these issues.

- We confirm that the actions tentatively identified as spillover were not already counted by another program by cross-checking tracking databases. 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 participant spillover measure. Employee turnover can also complicate this.
- *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 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 participant 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 participant spillover attribution.
- *Estimating the energy savings for the participant spillover measures* - Because participant spillover measures occurred outside the program, evaluators do not have access to the same information

[12] Ontario Energy Board *Demand Side Management Guidelines for Natural Gas Utilities,* EB-2008-0346, June 2011, Chapter 7.

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.

Understanding energy-related standard practices

The first objective of the survey was 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. Before doing that, we collected some information about the company or organization's energy-related decision-making process. We asked 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.

By getting the respondent to think about the project decision-making process, these questions should improve customer recall about energy efficiency projects they have completed. It should also 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 collected this information about participant energy practices, we asked the participants whether their company/organization had installed any energy-efficient projects after the installation of the tracked project. If the participants reported no subsequent actions, we terminated the survey since there is no participant spillover to be measured. If they did identify subsequent projects, we then collected some basic information about the project, including:

- The approximate year of the project
- The geographic location of the project (e.g. city or complete address)
- The types of energy-efficient measures installed or energy-efficient O&M practices implemented
- Whether the tracked project and the subsequent project were in the same facility or not (needed for the calculation of inside vs. outside participant spillover)
- If they received incentives (if so, from whom)

Because this information was collected by CATI program surveyors who do not have an energy background, or at the end of the CPSV/NTG interview, we did not try to collect detailed information about the energy-efficient project. The goal was to have information just detailed enough to allow the evaluators to make a reasonable match with any projects in the program tracking data.

Calculating program attribution for candidate participant spillover actions

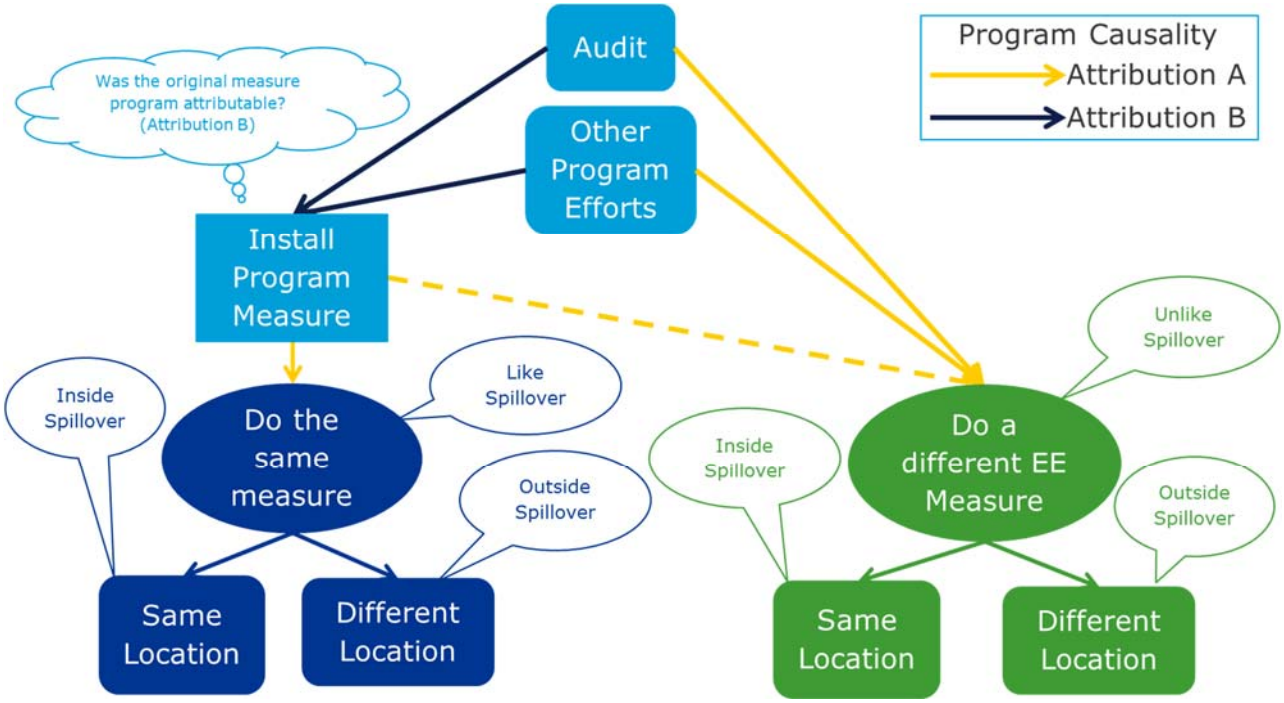
The next stage of the survey focused on program attribution. Our method awards participant spillover energy savings if two criteria are met:

1. The potential participant spillover project is at least partially attributable to the participant's experience with the program in implementing the earlier tracked project (Attribution Factor A).
2. For like participant spillover, the original tracked project is at least partially attributable to the program (Attribution Factor B). For unlike participant spillover, Attribution B would theoretically apply if the

respondent indicates that the original program measure (separate from other program efforts) was a factor in their decision.[13] However capturing and parsing this information was not feasible, so we did not apply attribution B to any unlike spillover cases.

Figure 8 shows how program causality ties to different types of participant spillover. Attribution B applies to like participant spillover in all cases, while for unlike participant spillover Attribution B only applies to the participant spillover if the original program measure was part of the program influence that led to the participant spillover measure being implemented.

Figure 8. Program influence on Participant spillover by Type



If a measure met these two criteria, we assigned it participant spillover savings according to the following formula:

(Participant 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 was asked in the CATI survey, while Attribution B was only planned to be asked in the engineering follow up IDI. If Attribution A was zero, we did not follow up with an IDI. Attribution B was asked of one customer with like spillover and resulted in an attribution factor B of 100%.[14]

To determine Attribution Factor B, we used the FR question battery described in the SOW Appendix C.

For Attribution factor A, we used a scoring method that was triggered from the question:

[13] In this study Attribution B did not affect the results.

[14] *Measurement of NTG Factors and Custom Savings Verification For Ontario's Natural Gas Custom Commercial and Industrial DSM Scope of Work*. Prepared for The Ontario Energy Board by DNV GL, December 14th, 2016.

On a 1 to 4 scale, where '1' is "Not likely at all" and '4' is "Very Likely", how likely would you say your organization would have been to perform that project without having previously worked with or had contact with the <Utility program>?

The scoring method is shown in Table 12.

If the participant said they were very likely to have made the additional energy efficiency improvement without the program, then we moved to the next potential participant spillover measure (if multiple) or ended the survey since there was no participant spillover to be measured. If the potential unlike participant spillover measure is fully or partially attributable, then a follow up question was administered as part of the engineering interview to assess whether Attribution B was applicable. In this study, there were no cases of unlike participant spillover where Attribution B was found to be applicable.

Table 12: Program Attribution for Subsequent Measures (Attribution A)

S3b. On a 1 to 4 scale, where '1' is "Not likely at all" and '4' is "Very Likely", how likely would you say your organization would have been to perform that project without having previously worked with or had contact with the <Utility program>?		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
-98	Don't Know/Refused	Weighted average of scored respondents

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 are a source of program influence by reducing payback periods; therefore, we want to measure things like acceleration effects. However, with participant spillover, the influence is less tangible and more likely to be a general positive experience with a new energy-efficient technology and the energy savings it produces. We believe that using a Likert scale question (such as in Table 12) better captures the less tangible character of this type of influence.

The question above, which was used in this study, refers to broad program effects rather than the specific earlier measure, making the causal tie between Attribution A and B tenuous. The original question for Attribution A was "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?". This phrasing keeps the causal link between the two attribution factors, but does not provide for utility attribution on the spillover measure through avenues separate from the original measure. In future work, we would not apply Attribution B if the Attribution A question uses the same wording; however, since Attribution B was only applied once and that one value was 100%, it did not affect this study's results.

Avoiding double counting of energy savings

Once a participant identified a subsequent project that is attributable – e.g. one where Attribution Factor A (and Attribution Factor B where applicable) are both greater than zero -- we then conducted some additional checks to ensure that the subsequent project is not also a tracked project. Some of these checks occurred in the survey itself. For example, we asked the participants if they recalled receiving financial incentives from an energy efficiency program for the subsequent projects. For measures where the customer said they did

not receive an incentive or did not know, we also examined the program tracking data to make sure that the subsequent project was not in the tracking program data for future years. For example, when we interviewed a 2013 participant and they identified a subsequent project in 2014, we looked at the 2014-2016 program tracking data to see if we could find that project. We looked at all three program years in case their memory of the project timing was faulty. If we found the subsequent project in program tracking data, we removed that project as a candidate for participant spillover energy savings since the savings for that project had already been claimed by the program. When the customer indicated that an incentive was provided for a project we did not attempt to verify this in the program databases because we do not have non-gas utility program data and the gas utility data provided did not contain the information necessary for the search. There is also a high probability of false negatives (ie there is a high likelihood that we would not find an incentive that is in the database due to challenges using search parameters such as customer names and addresses). This false negative risk also affects our search for incentives when the customer indicated they did not receive one, but in those cases there are at least two independent sources of information that are not in conflict.

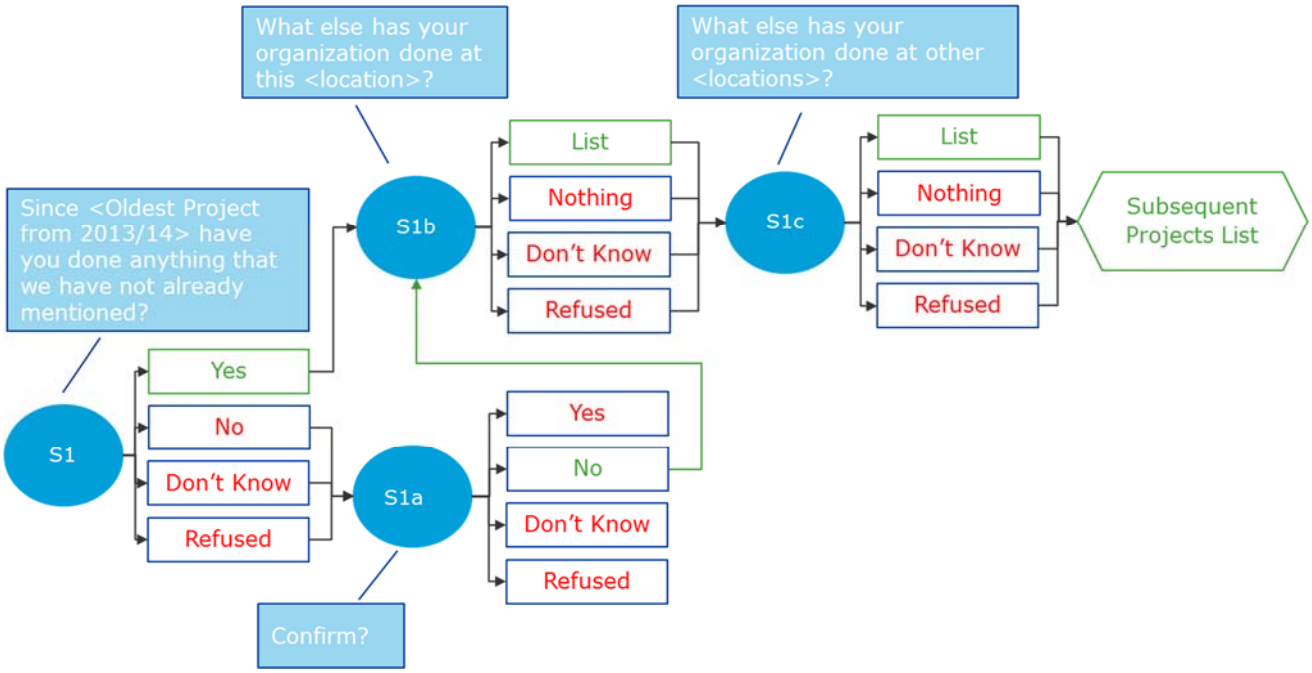
Estimating energy savings for participant spillover measures

Once a project was identified as having participant spillover energy savings, meaning it was program attributable and we could not locate it in the program tracking data, the final step was to estimate its energy savings. To estimate the energy savings for participant spillover measures, we had engineers conduct follow-up interviews with the persons identified in the CATI surveys as being most familiar with the participant spillover projects. The engineers had some basic project information collected from the CATI survey as well as some information about deemed savings algorithms for that measure, which allowed them to prepare the types of questions they needed to ask before the interview (e.g., about baseline measures, hours-of-use, etc.). Once they conducted the interview and collected the necessary information, they calculated the first-year savings and EUL (estimated useful life) for the measure. If a deemed savings algorithm existed for the measure, they used it as a default. If none existed, they used their best professional judgment to estimate the energy savings.

Participant spillover decision trees

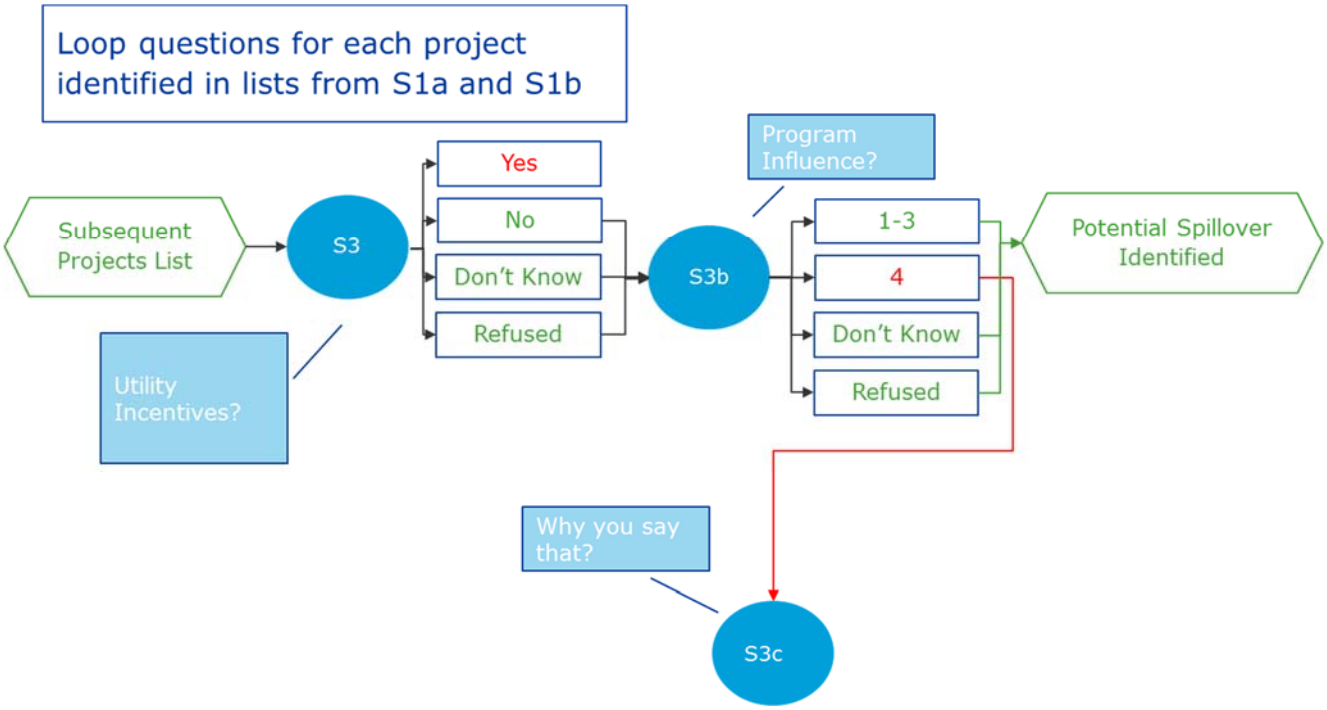
The initial participant IDI and participant CATI each included a participant spillover module that produced a list of potential participant spillover projects for each participant. The first part of the module (Figure 9) generated a list of changes to energy using equipment at the same location as the original measure and another list of changes to equipment at other locations.

Figure 9. Participant spillover Module Part 1: Identify Subsequent Projects



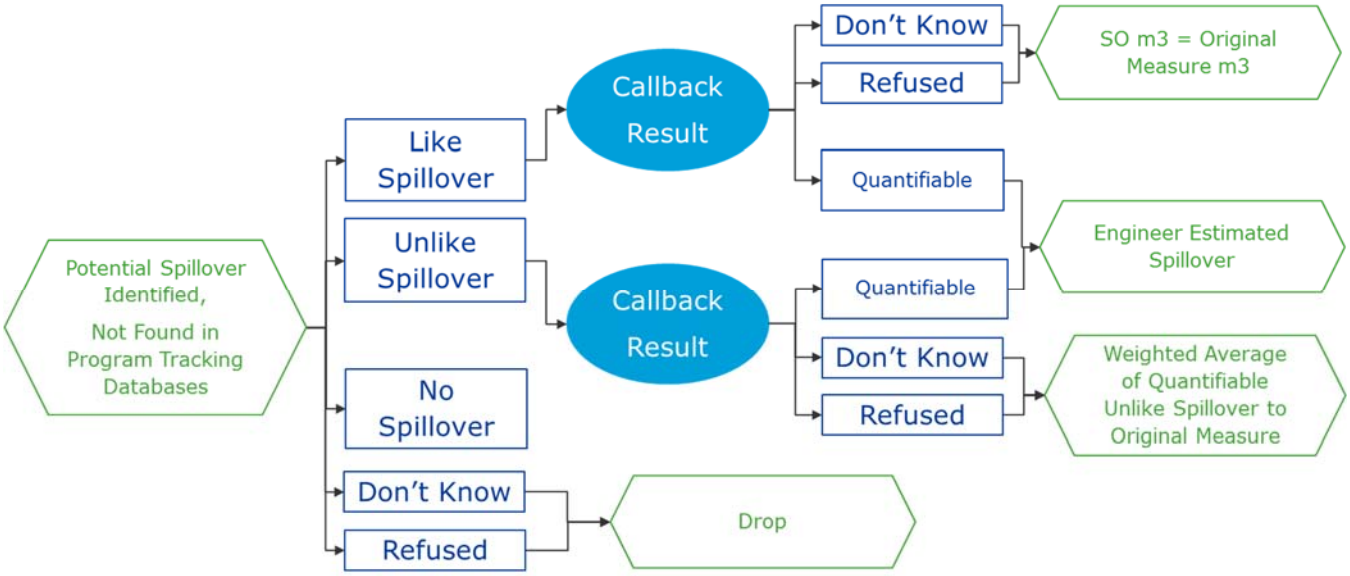
The second part of the module (Figure 10) looped through the list of subsequent projects to eliminate projects that received utility incentives or were non-gas and to establish program influence. The projects identified as program influenced are referred to as potential participant spillover and received a follow-up engineering interview to quantify savings. Question S3b is the question described in Table 12.

Figure 10. Participant spillover Module Part 2: Subsequent Project loop



Potential participant spillover projects that were not found in program tracking databases received a call from a DNV GL engineer (Figure 11). If the customer refused the interview or the engineer was not able to find a contact who could answer technical questions, the participant spillover was quantified in one of two ways. Where the project was like participant spillover, we used the savings of the original program measure as the basis for the savings estimate. This was done for one measure. Where the project was unlike participant spillover, we used the average of other customers with unlike participant spillover for the estimate.

Figure 11. Participant spillover callback high-level process



Details of the average fill process

The final participant spillover results are based on 224 customer contacts that found evidence of spillover for 62 customers (27%).[15] The study found definitive evidence of attributable participant spillover for 13 customers (6%)[16] and quantifiable participant spillover for nine customers.[17] One of the features of the analysis was the process by which we imputed responses and estimated participant spillover savings for customers where we had some evidence of potential participant spillover, but did not have enough information to calculate participant spillover directly. The process of imputing the responses to substitute for the "Don't Know" response is called filling.

In this section, we discuss the process of utilizing averages to fill responses where customers answered "don't know" to a key question. We begin with an overview of the fill process, including how many customers received fills and how many responses were used to calculate the fill averages. We conducted fills at the customer level to avoid double counting: the final dataset had a many-to-many relationship[18] of program measures to potential participant spillover projects, making project level fills impractical.

Three fill factors were calculated and used in this study:

[15] Green and yellow boxes in figure below.

[16] Bottom two green boxes (also 4th box down in column 3) in figure below

[17] Bottom box in column 3 in figure below.

[18] A single customer with more than one program measure and more than one potential spillover measure.

- **Gross SO fill** – the relationship between the participant spillover savings estimated and the program tracking savings
- **Attribution fill** – the average of program influence on potential participant spillover measures
- **Net SO fill** – the relationship between the average net participant spillover savings estimated and the program tracking savings

For customers requiring fills, or customers that showed evidence of participant spillover but did not provide a key piece of information, we filled with averages appropriate to what was known about the customer, as described below. Figure 12 shows a visual explanation of how survey responses were categorized.[19]

In Figure 12, the sum of each row equals the number of "yes" responses (right most boxes) on the row above. The boxes with a coloured border include the final status for customers who are included in the results.

- Boxes with green dashed borders are those respondents with clear evidence of participant spillover. Those that did not complete an engineering IDI had participant spillover savings estimated using a "gross SO fill" as described below.
- Boxes with yellow dot-dashed borders are those respondents with a non-zero chance of participant spillover based on their survey responses. These had participant spillover savings estimated using a "net fill" as described below.
- Boxes with red solid borders are those respondents that did not have any participant spillover based on their survey responses.

The figure also shows the *frequency of spillover observed*, or the observed percentage of customers who completed a gas project for which they did not receive an incentive and was attributable to the program. The formula used to calculate this frequency is shown in the bubble referencing the labels in the boxes to the left.

Seven of the boxes are labeled with letters in the corners. These include:

A. **Completed Screener** – This is the number of customers who provided at least some data for the study.

B. **Don't know if project done after participation** -These customers were considered uninformed and dropped from the analysis.

C. **Don't Know (if project received incentive) / had many, but did not respond to follow up** – These customers knew that they did a project after participating in the program, but could not provide enough detail to determine if it saved gas or received an incentive. Some of these customers had done more projects (eight or more) than could be reasonably collected by CATI, but did not respond to a follow-up attempt to gather additional data. These customers had participant spillover savings estimated using a "net fill" as described below.

D. **Attributable –** These customers reported that the non-incented gas project they completed was not "very likely" to have been done without the prior interactions with the program.

[19] The totals reported below only count customers who were sampled in two programs once. There two customers who were sampled for projects in both Union and Enbridge programs and another two who had projects in both Enbridge Custom C&I and RunitRight.

E. **Attributable Don't Know –** These customers reported that they completed a gas project without an incentive, but were unable to say whether or not the project was "very likely" to have happened without the program. These customers had their participant spillover savings estimated using a "gross SO fill" and "attribution fill" as described below.

F. **Responded to follow up call -** These customers installed projects that were confirmed to be participant spillover and provided our engineers with sufficient information to quantify the savings of their project(s).

G. **Did not respond to follow up call -** These customers had installed projects that were confirmed to be participant spillover, but did not respond to follow-up attempts for information that would allow the savings to be estimated. These customers had their participant spillover savings estimated using a "gross SO fill" as described below.

In Figure 12 we can see that the study completed surveys with 234 customers (box A), 13 of which confirmed that they completed gas saving projects, did not receive an incentive and credited the program with influencing their decision to implement these projects (box D). We can also see that 44 customers (box C) did something to save energy, but could not confirm that it saved gas and did not receive an incentive. Five customers (box E) completed a gas saving project without an incentive, but could not say whether the program had any influence. The frequency of confirmed spillover was six (6) percent.

Figure 12. Survey Response Category Tree for Overall Participant Spillover Study[20]

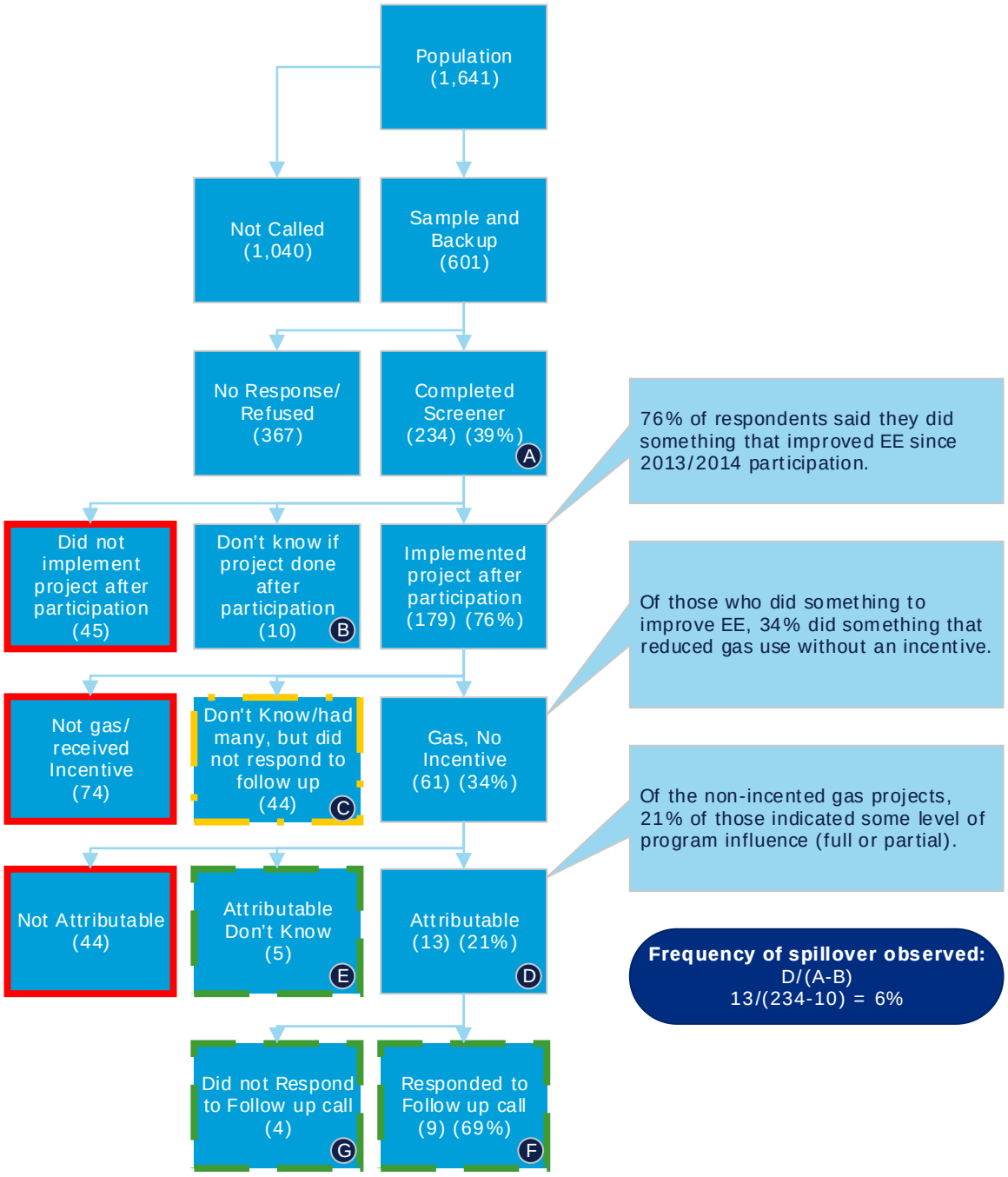


Table 13 shows the same information, and adds the breakdown of which response categories were included in the weighted average that was used to calculate each fill and which response categories received fills. The number of customers shown is the number for the study as a whole, including all four utility programs.

[20] The totals reported in this figure are lower than the sum of the figures reported in the body of the report. This is due to overlap of customers across utilities, programs and segments in the samples, sample frames and population. In this figure, the sum of the boxes in the second row from the bottom is 62, not the 61 that the "Gas, no incentive" box implies. One customer that was in both the Union and Enbridge samples had different outcomes from each program and is included twice in the figure in this row.

References to the corresponding boxes in Figure 12 are included in the first column. Box A is the sum of the "total cust." column below, while box D is the sum of boxes F and G.

Table 13. Customer Responses and Fill Approach[21]

	Did Something?	Did non-incented gas savings project?	Attribution of Potential Participant spillover	Gross Participant spillover	Final Participant spillover	Included in Fill for			Total Cust.
						Gross SO	Attribution	Net Part. Spillover	
	No				Zero				45
	Yes	No			Zero			Yes	74
	Yes	Yes	Zero		Zero		Yes	Yes	44
F	Yes	Yes	Non-Zero	Quantified	Known from Customer		Yes	Yes	9
G	Yes	Yes	Non-Zero	Don't Know	Fill with Gross SO	Yes	Yes	Yes	4
E	Yes	Yes	Don't Know		Fill with Gross SO and Attribution			Yes	5
C	Yes	Don't Know			Fill with Net Spillover				44
B	Don't Know				Dropped				10

DNV GL tested the sensitivity of the results to following the described fill process by using an alternate analysis. Customers requiring a fill of any type were dropped from the alternate analysis. Including the fill process increased the estimates of participant spillover for Union Industrial from 0.57% to 0.89%, increased Enbridge Industrial from 0.58% to 1.45%, increased Enbridge Commercial from 0% to 1.36%, and increased Enbridge Multi-Residential from 8.07% to 8.24%.

More detail on each fill is included below.

Gross SO Fill

Nine customers indicated that Union or Enbridge's program had an influence on a participant spillover project,[22] but we were unable to collect enough information to quantify the magnitude of savings that resulted from the project. In each of these cases, we estimated the gross participant spillover for the project using a "gross SO fill" multiplier. We calculated the multiplier as the ratio of gross participant spillover CCM to tracking CCM from the customers who completed the engineering interview. In the example in Table 14, the "gross SO multiplier" is calculated as 5,000 CCM / 18,000 CCM = 0.2778. We used responses from five Union Custom C&I customers to calculate a savings-weighted average fill for two Union Custom C&I customers requiring a fill. We used three Enbridge Custom C&I customers to calculate a savings-weighted average fill for two Enbridge Custom C&I customers requiring a fill.

[21] The sum of the table is 225, not the 224 found in box A in Figure 12. One customer that was in both the Union and Enbridge samples had different outcomes from each program and is included twice in the table.

[22] Sum of rows 5 and 6 in Table 13 and box E and G in Figure 12

Table 14: Example calculation of a gross SO multiplier

Program Measures	Example Tracking Savings (CCM)	Gross SO Fill multiplier	Unlike Participant spillover Measure	Unlike Participant spillover Measure Savings (CCM)
Program Meas 1	7,000		SO Measure A	3,000
Program Meas 2	10,000		SO Measure B	2,000
Program Meas 3	1,000		NONE	0
Customer total	18,000	**0.2778**		5,000

The Gross SO fill process provided a scaled magnitude of savings relative to the program project savings that the customer with unknown participant spillover savings completed through the program. In the example provided in Table 15, gross participant spillover is estimated for the customer using the gross SO fill multiplier as 24,000 CCM X 0.2778 = 6,667 CCM.

Table 15: Example application of a gross SO multiplier

Program Measures	Example Tracking Savings (CCM)	SO Fill multiplier (from above)	Measure	Unlike Participant spillover Measure Savings (CCM)
Program Meas 4	6,000		SO Measure C	?
Program Meas 5	18,000		SO Measure D	?
Customer total	24,000	0.2778		**6,667**

Each of the customers with only a gross SO fill value has known attribution that is then multiplied by the Gross SO value to calculate a net SO value.

Table 16 shows the number of customers requiring only a gross SO fill[23] for each segment (n Customers Requiring Fill). The table also shows the number of customers with known gross SO that were included in calculating each gross SO fill multiplier (n Customers in Fill Average) as well as the level of calculation (Fill Program/ Segment) and multipliers that resulted (Gross SO fill multiplier).

[23] Additional customers required a gross fill and an attribution fill as shown later in Table 18.

Table 16: Customers requiring only Gross SO fill

Utility	Reporting Program	n Customers Requiring Fill	Fill Program / Segment	n Customers in Fill Average	Gross SO fill multiplier
Union	Custom Industrial	2	Union All Custom	5	0.0745
	Custom Commercial	0			
	Multi-Family	0			
	Large Volume	0	Union Large Volume	1	0.2254
Enbridge	Custom Industrial	1	Enbridge All Custom	3	0.2589
	Custom Commercial	1			
	Multi-Residential	0			
	RunitRight	0	RunitRight	N/A	N/A

Our plan included an alternative approach for estimating the unlike participant spillover savings that were filled by the gross SO fill process. The alternative was to base the savings on known projects in the program of the same or similar project type. We investigated this option, but did not pursue it because similar projects in the program data were not found or had a very wide range of savings magnitudes. The projects in all cases were of unknown size or number and included:

- Pipe insulation
- Water recovery
- Air handling unit
- Sealing roof vents

We tested alternate values for the gross SO fill to determine the sensitivity of the results to this fill. None of the tests were a real alternative, so we are not reporting the specific results of these tests. The gross SO fill had no effect on Enbridge Multi-residential, Enbridge RunitRight, Union Comm & MF or Union Large Volume results. The gross SO fill multiplier has a significant effect on Enbridge Commercial, Enbridge Industrial, and Union Industrial results.

We had one like participant spillover project completed in addition to two unlike projects for a customer who did not respond to the engineering interview (the Enbridge Industrial customer). In this case the customer received the gross SO fill for program measures that were not “like” the like participant spillover measures. For the like participant spillover measure, gross SO was set equal to the program measure savings (as planned in the study methodology).

Attribution Fill

Five customers who had a potential SO project did not know how likely they were to install the participant spillover project without the prior program participation. These customers received the same “gross SO fill multiplier” fill as the four above and also received the program “attribution fill” (for the potential participant spillover, not the program measure, Attribution A) using a weighted average program attribution from the 58 (see below) customers who provided this information.

We used a savings weighted average of program attribution for potential participant spillover, including all customers who answered the attribution question and had attribution between zero and 100% inclusive.

This is consistent with the approach DNV GL used in filling missing values for determining free ridership. In the FR study this average was calculated across measures, while for the spillover study we had to modify the approach to accommodate unlike spillover, which is related to customer experiences with the program and not a specific measure. The approach we used is described below.

Calculating an appropriately weighted average of attribution scores for participant spillover proved problematic: attribution was asked for each non-incented gas project that a customer reported, but we do not have information on the size of projects that were not reported as attributable because we did not follow up with an engineering IDI. Unlike participant spillover also does not have a clear causal relationship with a specific program project. To address this problem, we:

1. aggregated measure level Attribution A scores to the customer level for customers with more than one score
2. calculated the program savings weighted average of known customer Attribution A scores (rows 3-5 inTable 17).

The customer aggregation step was done using a simple average of the maximum attribution for a customer. We selected the maximum because, without knowing the size of the measures, an average risked inadvertently disadvantaging the programs. The maximum avoided this risk and the decision ultimately had little effect on the overall results (discussed below). An example of the customer level aggregation is provided in Table 17.

Table 17: Aggregation of Attribution A to Customer Level

Measure	Unlike Participant Spillover Measure Savings	Likelihood of implementing without prior program participation	Assigned Attribution A
SO Measure F	?	Very Likely	0%
SO Measure G	?	Not Likely at all	100%
SO Measure H	?	Somewhat Likely	55%
Customer Aggregated Attribution			100%

We investigated the effect of this decision by looking at the final participant spillover results using an average and comparing the two results. For Union Industrial, the result using an average was 0.32%, while using the max was 0.89%. For Enbridge Commercial, the result using an average was 0.65%, while using the max was 1.36%. None of the other results were affected. Customers with zero reported attribution for one potential participant spillover measure and “don’t know” for another received the attribution fill. Three of those filled had one measure with no attribution and another measure with “don’t know.”

Table 18 shows the number of customers requiring both a gross SO and attribution fill for each segment (n Customers Requiring Fill). The table also shows the number of customers with known attribution that were included in calculating each average attribution score (n Customers in Fill Average) as well as the level of calculation (Fill Program/ Segment) and fill values that resulted (Attribution A fill value). The gross fill multipliers are provided from above (Gross SO fill multiplier) as they were also used to estimate participant spillover for these customers.

Table 18: Customers Requiring Attribution Fill and Gross SO fill

Utility	Reporting Program	n Customers Requiring Fill	Attribution of potential Participant spillover			Applicable Gross SO fill multiplier
			Fill Program / Segment	n Customers in Fill Average	Attribution A fill value	
Union	Custom Industrial	2	Custom Industrial	19	23.58%	0.0745
	Custom Commercial	0	Custom Commercial	5	0.00%	
	Multi-Family	0	Multi-Family	2	0.00%	
	Large Volume	0	Large Volume	10	7.29%	0.2254
Enbridge	Custom Industrial	1	Custom Industrial	7	23.05%	0.2589
	Custom Commercial	2	Custom Commercial	10	20.86%	
	Multi-Residential	0	Multi-Residential	4	75.99%	
	RunitRight	0	RunitRight	1	0.00%	N/A

Net Participant Spillover Fill

Forty-four customers required a fill of net participant spillover. These customers indicated that they had done additional energy saving projects following their participation in 2013/14 programs, but did not know what or whether they received an incentive. Twenty of these customers had too many additional energy saving projects for the CATI screener to reasonably collect (eight or more) and follow-up attempts to contact the customer were unsuccessful. An additional 24 customers indicated that they had done something but that they did not know how many projects had been performed, which ended the interview. These customers received an average fill based on 136 customers, which included all the customers that were filled in the gross SO and attribution fill tables above, all the customers that were used to develop the fills above, and all the customers who did something, but received an incentive or did a non-gas project (lines 2-6 in Table 13). Again, aggregation to the customer level was required before taking the average. In this case the information requiring aggregation was “did the customer complete at least one gas project without an incentive.”

Table 19: Customers Requiring Net Participant Spillover Fill

Utility	Reporting Program	n Customers Requiring Fill	Net Participant Spillover		
			Fill Program / Segment	n Customers in Fill Average (max per customer)	Fill Factor
Union	Custom Industrial	8	Custom Commercial	40	1.01%
	Custom Commercial	8	Custom Industrial	12	0.00%
	Multi-Family	2	Multi-Family	2	0.00%
	Large Volume	5	Large Volume	19	0.83%
Enbridge	Custom Industrial	6	Custom Industrial	21	1.81%
	Custom Commercial	9	Custom Commercial	26	1.43%
	Multi-Residential	5	Multi-Residential	16	9.27%
	RunitRight	1	RunitRight	3	0.00%

Averages and association of participant spillover savings to program participation

The study encountered multiple situations of many-to-many relationships between participant spillover or potential participant spillover measures and program measures for the same customer. That is, a customer had multiple measures in 2013/2014 and also identified multiple potential participant spillover measures which did not tie back to individual 2013/2014 measures (unlike participant spillover). For unlike participant spillover, tying the potential participant spillover back to a single measure does not make sense: the experience with the program drives the participant spillover. For this reason, we proportionally associated unlike participant spillover savings with all program measures completed by a customer. We had one Enbridge customer with like participant spillover confirmed by attribution A who did not respond to the engineering interview. This customer had other unlike participant spillover measures. For this customer, we assumed the like spillover measure was the same magnitude for the program measure (like multiplier of 1) that was “like” the participant spillover measure. All other measures were filled using the program “gross SO fill” multiplier.

Table 20: Example Treatment of Like Participant Spillover for Customer with Like and Unlike Participant Spillover.

Program Measure	Like / Unlike	Gross SO Fill Multiplier	Like multiplier	Example Tracking Savings	Example Gross SO Savings
Measure A	Like	0.00	1.00	5,000	5,000
Measure B	Unlike	0.39	0.00	10,000	3,900
Measure C	Unlike	0.39	0.00	3,000	1,170

APPENDIX B. FINAL SAMPLE ACHIEVEMENT

The tables below (Table 21 to Table 24) 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 database. 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. Percent of frame cumulative savings is the percent of total savings in the sample frame (population studied) in each category.

Table 21: Participant Spillover Sample Achievement for Union Custom C&I Programs

Grouping		Size	Units of Analysis					Percent of Frame CCM Savings			
			Target	Complete			Frame Total	Strata %	% Completed		
				Total	Normal	Extra			Total	Normal	Extra
Commercial	Action	1	6	16	10	6	50	<1%	<1%	<1%	<1%
		2	6	8	8	0	12	<1%	<1%	0%	<1%
		3	6	0	0	0	6	<1%	0%	0%	0%
		4	6	2	2	0	6	3%	<1%	0%	<1%
	Equipment	1	9	19	9	10	135	1%	<1%	<1%	<1%
		2	9	3	3	0	26	1%	<1%	0%	<1%
		3	8	2	2	0	14	2%	<1%	0%	<1%
		4	8	8	8	0	9	2%	1%	0%	1%
		5	6	2	2	0	6	2%	<1%	0%	<1%
	Multi-family	1	7	9	9	0	37	<1%	<1%	0%	<1%
		2	1	0	0	0	1	<1%	0%	0%	0%
Industrial	Action	1	8	23	7	16	108	5%	1%	<1%	<1%
		2	8	4	3	1	28	5%	<1%	<1%	<1%
		3	8	3	3	0	16	5%	<1%	0%	<1%
		4	7	2	2	0	8	5%	1%	0%	1%
		5	7	2	2	0	7	13%	2%	0%	2%
	Equipment	1	10	54	10	44	269	7%	2%	<1%	<1%
		2	10	19	7	12	66	6%	2%	1%	<1%
		3	10	9	7	2	35	7%	2%	<1%	2%
		4	9	8	8	0	21	8%	3%	0%	3%
		5	9	1	1	0	12	11%	<1%	0%	<1%
		6	9	2	2	0	9	15%	4%	0%	4%

Table 22: Participant Spillover Sample Achievement for Union Large Volume

Grouping	Size	Units of Analysis					Percent of Frame CCM Savings			
		Target	Complete			Frame Total	Strata %	% Completed		
			Total	Normal	Extra			Total	Normal	Extra
Action	1	8	41	12	29	80	11%	6%	3%	3%
	2	8	8	7	1	20	13%	5%	<1%	5%
	3	7	4	4	0	13	10%	3%	0%	3%
	4	7	6	6	0	9	15%	9%	0%	9%
	5	8	6	6	0	8	21%	15%	0%	15%
Equipment	1	6	18	9	9	58	3%	<1%	<1%	<1%
	2	6	5	5	0	12	2%	1%	0%	1%
	3	5	6	6	0	8	4%	3%	0%	3%
	4	5	2	2	0	5	4%	1%	0%	1%
	5	11	7	7	0	11	18%	12%	0%	12%

Table 23: Participant Spillover Sample Achievement for Enbridge Custom C&I Programs

Grouping		Size	Units of Analysis					Percent of Frame CCM Savings			
			Target	Complete			Frame Total	Strata %	% Completed		
				Total	Normal	Extra			Total	Normal	Extra
Commercial	Action	1	7	3	3	0	47	<1%	<1%	0%	<1%
		2	6	5	5	0	17	<1%	<1%	0%	<1%
		3	6	2	2	0	9	<1%	<1%	0%	<1%
		4	6	3	3	0	6	2%	1%	0%	1%
	Equipment	1	12	16	9	7	358	3%	<1%	<1%	<1%
		2	11	12	10	2	115	4%	<1%	<1%	<1%
		3	11	19	13	6	66	4%	2%	<1%	1%
		4	11	8	8	0	40	5%	2%	0%	2%
		5	11	6	5	1	20	6%	1%	<1%	1%
		6	4	2	2	0	4	4%	2%	0%	2%
Multi-Residential		1	13	14	9	5	289	3%	<1%	<1%	<1%
		2	13	14	10	4	109	4%	<1%	<1%	<1%
		3	13	13	9	4	73	4%	<1%	<1%	<1%
		4	13	13	11	2	51	4%	1%	<1%	<1%
		5	12	4	4	0	30	5%	<1%	0%	<1%
		6	1	0	0	0	1	<1%	0%	0%	0%
Industrial	Action	1	8	8	8	0	26	<1%	<1%	0%	<1%
		2	8	4	4	0	10	1%	<1%	0%	<1%
		3	4	3	3	0	4	3%	2%	0%	2%
	Equipment	1	8	20	6	14	98	3%	<1%	<1%	<1%
		2	8	7	6	1	34	4%	<1%	<1%	<1%
		3	8	11	10	1	23	5%	2%	<1%	2%
		4	8	10	10	0	16	6%	4%	0%	4%
		5	8	2	2	0	10	6%	1%	0%	1%
		6	10	4	4	0	10	18%	5%	0%	5%

Table 24: Participant Spillover Sample Achievement for Enbridge RunitRight

Grouping	Size	Units of Analysis					Percent of Frame CCM Savings			
		Target	Complete			Frame Total	Strata %	% Completed		
			Total	Normal	Extra			Total	Normal	Extra
Action	1	7	5	5	0	26	-34%	-4%	0%	-4%
	2	5	2	2	0	5	17%	8%	0%	8%
	3	5	2	2	0	5	24%	10%	0%	10%
	4	9	2	2	0	9	93%	21%	0%	21%

APPENDIX C. DATA COLLECTION INSTRUMENT

The embedded documents below are the interview guides used for CATI and In-Depth Interviews for the participant spillover study. Participant spillover questions were also included in the interview guide used for 2015 CPSV/NTG (provided as an appendix to that report)

Spillover Survey CATI Final.docx

Spillover Follow up IDI Guide Final.docx

APPENDIX D. SITE SPECIFIC PARTICIPANT SPILLOVER SUMMARY

This appendix contains the summary results from the participant spillover surveys and calculations. It contains only the results from those participants who completed participant spillover projects with energy savings which were attributable to the programs.

Table 25: Summary of Project-Specific Participant Spillover Results

Utility	Program / Segment	Cust ID	Participant Spillover Project		
			Description	Calculation Method	Lifetime Savings (CCM)
Enbridge	Custom Industrial	A	Baghouse Installation	Customer provided the weight of production increase at the same level of energy consumption and the dollar value following the baghouse installation. Literature review provided the energy per weight required for efficiently producing this particular metal oxide; this is the savings because the customer stated that additional production occurred with the same amount of total energy (a reduction in per unit energy use). Energy savings value is consistent with the cost savings (20% of the dollar value).	1,160,050
		B	Steam Trap Replacement	Customer estimated that 3-4 low pressure steam traps were repaired, plus leaks at one other place. We estimated the savings based on default values in the Illinois TRM, which allows for reasonable savings estimates with a minimum of input information.	60,285
	Multi-Residential	C	Heat Reflector Panels at many sites[24]	Contractor provided m3 savings estimates for most buildings which was based on 10% of space heat consumption (consistent with EGD's approach in 2015). They also provided the number of apartments for each building. For buildings without an estimate, we used the average m3/apartment of those with estimates to calculate the annual savings.	5,832,960
Union	Custom Industrial	D	Greenhouse Energy Curtains	Onsite contact provided the size of greenhouse and material for the curtain. We used Virtual Grower to calculate the baseline and installed case to derive the savings.	8,007,630

[24] Precise number of sites not reported to preserve respondent confidentiality.

Utility	Program / Segment	Cust ID	Participant Spillover Project		
			Description	Calculation Method	Lifetime Savings (CCM)
		E	Pipe Insulation	Customer provided the steam pressure, length of pipe and pipe diameter. We used the 3E Plus calculator to estimate savings.	289,726
		F	Unit heater replacements. Convective space heaters units in non-insulated spaces were replaced with higher efficiency units near the end of their EUL.	Onsite contact could not find records or details. Estimated heating load based on building area and compared usage for baseline vs. efficient heater efficiencies.	175,302
		G	Process Boiler	Customer stated the boiler size, load and operating hours for the boiler. Assumed improvement from 80 to 85% efficiency.	830,954
		H	Furnace	Customer noted that a residential furnace was added. Estimated load using heating degree days and design temperatures for the customer's location. Furnace size assumed for a 2,000 sq ft house. Assumed base case heating system based on code (90%), efficient case at 95%. EUL of 18 years from EPA for residential furnaces.	4,466
	Large Volume	I	Boiler Optimization	Customer provided internal calculation results.	36,158,661
			Process Optimization		1,070,430
			Process Optimization		4,268,042
			Process Optimization		3,501,983
			Process Optimization		967,833
			Process Optimization		1,087,530
			Process Optimization		16,200,092
			Heat Exchanger Upgrade		820,777

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.