FINAL REPORT

Impact Evaluation of PY2020 Custom Gas Installations in Rhode Island

RI Energy

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List of acronyms used in this report

CDA	comprehensive design approach
C&I	commercial and industrial
CI	confidence interval
EMS	energy monitoring system
HVAC	heating, ventilation, and air-conditioning
ISP	industry standard practice
M&V	measurement and verification
MA	Massachusetts
MBSS	model-based statistical sampling
PA	program administrator
PY	program year
PY2016	program year 2016
PY2017	program year 2017
PY2018	program year 2018
PY2019	program year 2019
PY2020	program year 2020
RI	Rhode Island
RR	realization rate
SEMP	strategic energy management partnership
TMY3	typical meteorological year 3

1 INTRODUCTION

This section presents the objective for DNV's Impact Evaluation of the 2020 Custom Gas Installations for RI Energy and describes the organizational format of the report.

1.1 Study purpose, objectives, and research questions

The objective of this Impact Evaluation of the Program Year 2020 (PY2020) Custom Gas Installations is to provide verification or re-estimation of energy (therms) savings for sampled Custom Gas sites through site-specific inspections, end-use monitoring, and analysis. Site-specific results were aggregated to determine realization rates for RI Energy's custom gas installations in RI. Custom gas evaluations for RI Energy starting from PY2016 are designed to be rolling/staged evaluations. The goal of this approach was to repeat M&V annually as the previous year's tracking data becomes available. The current study will consist of PY2018 as Year 1, PY2019 as Year 2, and PY2020 as Year 3.

This study:

- Achieved gross natural gas energy savings for RI custom gas projects, with targeted sampling precision of ±20% at 80% confidence when RI PY2020 results are pooled with RI PY2018 and PY2019 results

The evaluation process of PY2020 was adapted to limit the impact on customers selected for evaluation due to the ongoing COVID-19 pandemic. More information for COVID-19 evaluation adaptations can be found in Section 2.3.2. The evaluation of steam trap projects in PY2020 was also modified to align with the new steam trap evaluation approach being used in the PY2020 Custom Gas evaluation by PAs in MA. The new approach used in MA is based on the following:

- Evaluators calibrated the steam trap tool to account for all operational characteristics of the steam system
- Both implementers and evaluators use the same tool to model steam traps

The evaluators also re-evaluated PY2018 and PY2019 steam trap sites following the new steam trap evaluation approach to ensure results would align with PY2020 in the 3-year rolling results. More information about the changes to steam trap evaluations are detailed in APPENDIX E.

The objective of this program report is to document the evaluated achieved savings for the 2020 RI Custom Gas installations using a sample of projects grouped within sites based on location. DNV provides program achieved savings with a precision tolerance for regulatory reporting. The results are then used for planning future program cycles and calculating savings for 2023 installations. This program evaluation performed site-based M&V impact evaluations to quantify the achieved natural gas energy savings using 8 RI custom gas sites from projects completed in the PY2020 cycle. The results of this study were combined with the results from the PY2018 and PY2019 studies to produce updated, statewide realization rates.

1.2 Organization of report

The remainder of this report is organized as follows:

- Section 2: Methodology and Approach. The methods associated with sampling and the M&V tasks are described in this section.
- Section 3: Data Sources.
- Section 4: Analysis and Results. The results associated with the program evaluation of PY2020 and the latest rolling three-year results are presented in this section.

- Section 5: Conclusions, Recommendations, and Considerations. Conclusions and recommendations from analyzing the M&V findings are presented in this section.

2 METHODOLOGY AND APPROACH

The evaluation team's approach was consistent with the procedures and protocols developed during the previous round of custom gas impact program evaluation conducted for PY2018 and PY2019 with adaptations to the approach for evaluating steam trap projects. The change in approach for steam trap evaluations is to more closely align with the evaluation approach for Massachusetts Custom Gas programs and to account for the RI Energy steam trap tool which already adjusts for operational discrepancies. Subsequent sections of the report regarding operational adjustments will be in regards to non-steam trap sites with operational adjustments whereas steam trap sites are considered to be operationally adjusted pre-evaluation because the RI Energy steam trap tool used by the applicants are calibrated to account for operational adjustments. More details regarding the reasoning and changes to the steam trap evaluation approach is described in APPENDIX E. The evaluation consists of a randomly selected sample of projects at participating facilities. As described in the next subsections, the impact evaluation consisted of onsite visits. For virtual and some onsite visits, only non-operational observations were collected, and operational metering was performed for the remainder of the onsite visits.

2.1 Description of sampling strategy

DNV designed the PY2020 program impact evaluation sample to pool annual program evaluation results with the PY2018 and PY2019 results to produce a rolling updated result. This allowed the sampling precision to meet and exceed the targets laid out in Table 2-1.

PY2018, PY2019, and PY2020 results were pooled together to use in PY2023. In subsequent years, the realization rate will reflect the pooling of the three most recent impact results.

Based on the results achieved in the previous studies, this sample design assumed the error ratios shown in Table 2-1 for the targets listed. The sample design for this round of the study was developed assuming the results would pool with prior (and future) custom gas results. The general principle for the design is each independent program evaluation year would need to achieve a ±29% precision at an 80% confidence interval to maintain a three-year pooled result of ±20% precision at 80% confidence for gross therms savings RRs. DNV used a Model-Based Statistical Sampling (MBSS) technique to develop the sample design. The sampling unit is the sum of all projects installed in the evaluated program year for an account or location if the account serves multiple locations.

Table 2-1. Sampling targets

Annual Sampling Target	Three-Year Pooled Sampling Target	Error Ratio
±29% expected relative precision - 80% CI	±20% expected relative precision - 80% CI	0.65 (steam trap) 0.55 (non-stream trap) 0.55 (SEMP)

In PY2019, an additional category was added to the sample design after the evaluation team discovered two years' worth of projects (85 measures) was completed by a single site and compiled into three application IDs. The single SEMP randomly selected for a site evaluation was part of an RI Energy initiative called the Strategic Energy Management Partnership (SEMP[1]). In previous program evaluation years, evaluators created a randomly selected sample of measures from the SEMP site after it was selected in the sample design to limit burden on the site contacts and provide a feasible amount of field work for engineers. However, the evaluation team decided, beginning in PY2019, to categorize the initiative in a separate category due to the size of the SEMP program relative to the total portfolio and continuing partnership in the

[1] Strategic Energy Management Partnership (SEMP) is RI Energy's portfolio partnership program with a few large customers in the state. The program constitutes an assortment of multiple energy efficiency projects that are completed in these facilities in a given program year. The projects included in the portfolio range anywhere from a few measures to over 50 measures installed across multiple buildings on the campus

following program years. The SEMP category continued to be included in the current PY2020 and will continue to be included in following program years.

2.1.1 PY2020 sample frame

The initial population for this program impact evaluation was the set of custom gas projects rebated in 2020. Table 2-2 shows the distribution of all tracking records and the associated savings by RI Energy.

Table 2-2. PY2020 population distribution of custom gas accounts

Distribution	Number of Accounts	Gas Savings (Therms)	% Savings
Custom Design Approach (CDA)	3	21,437	1.6%
Custom-Prescriptive	2	4,345	0.3%
Less than 1,000 therms savings	7	2,896	0.2%
C&I Custom General (Sampling Population Frame)	77	1,280,693	97.8%
Grand Total	89	1,309,370	100%

Custom Design Approach (CDA) projects, Custom-Prescriptive projects, and sites that save less than 1,000 therms are not included in the population frame that is used for sampling. Though CDA projects are kept in the population totals, they were originally removed from the sample to study the projects as a separate effort during the evaluation years RI results were combined with MA results. Custom-Prescriptive projects are held within the custom offering, but their review is not representative of the custom program, so they are included in the population savings but not included for selection of sites for evaluation. The same is true for sites that are less than 1,000 therms of savings except the reason for exclusion from evaluation. RI Energy and DNV agree the savings for smaller sites are typically less rigorous and an evaluation of larger savings projects are more appropriate for evaluation. Examples of low savings sites include steam trap projects that retrofit or replace less than 10 steam traps or pipe insulation projects that retrofit small quantities of insulation. Steam trap projects represent 57% of the total savings in the sampling population frame. Table 2-3 shows the selected sample frame after dropping the small sites, dropping CDA projects, and removing prescriptive measures.

Table 2-3. PY2020 adjusted (final) project sample frame

Accounts	Tracking Savings (Therms)
77	1,280,693

2.1.2 PY2020 sample design

Table 2-4 shows the selected sample for this project. DNV estimated that eight sampled sites would give reliable precisions to achieve the required annual and three-year rolling program target per Table 2-1. An annual target of ±29% precision at 80% confidence interval was set for the individual program year, and, when combined with the other two program years in the three-year rolling sample, a target of ±11.7% precision at 80% confidence was estimated to result if all planned sites were completed in the current program year. The number of sites determined to reach the precision and confidence interval was estimated accounting for a reduced sampling error from splitting operational vs. non-operational data and using historical operational data to account for operational data not collected during the PY2020 year. The minimum recommended sites per stratum resulted in a sample of eight sites for this evaluation round in PY2020. The 3-year estimated

precision exceeds targets due to annual minimum threshold precision goals. PY2019 was an exceptionally good year for precision targets, but PY2019 results will eventually drop out of the 3-year rolling evaluation in PY2022. Therefore, DNV plans to meet a minimum annual precision threshold in PY2020 to safeguard against missing 3 year rolling targets in the future by not reducing the number of PY2020 evaluated sites just because past study performance was exceptional.The study also achieved reliable statistical precision targets at an 80% confidence interval, as shown in Table 2-4.

Table 2-4. PY2020 project sample

Accounts	Savings	Error Ratio	Sample (n)		Expected Relative Precision @ 80% CI
			Designed	Completed	
77	1,280,693	0.65 (steam trap) 0.55 (non-stream trap)	8	3 Non-Op, Non-ST 5 Op[2]	±29%

Non-Op: Sites with Non-Operational adjustment factors; Op: Sites with Operational and Non-Operation adjustment factors; Non-ST: non-steam trap; ST: steam trap;

2.1.2.1 Strategic Energy Management Partnership (SEMP) category addition

Strategic Energy Management Partnership (SEMP) is RI Energy's portfolio partnership program with a few large customers in the state. The program constitutes an assortment of multiple-measure energy efficiency projects that are completed in these facilities in a given program year. The total savings from all the measures are entered into RI Energy's tracking system under a single application or two applications, sometimes as a parent/child combination.

In PY2019, the SEMP population was roughly half of the portfolio savings, and one site accounted for most SEMP savings. Evaluating these large projects could possibly become very expensive and burdensome for customers. DNV has previously sub-sampled within large sites to reduce workload outside of the traditional sampling/expansion method, but the error associated with outside sampling is not included within the program statistics at the project end. Therefore, DNV and RI Energy chose to create a subcategory within the population for SEMP projects during traditional sampling/expansion but at a more refined level than just using site ID (measure, building, application ID level, etc.). The sampling method is similar to how DNV stratifies and samples steam trap and non-steam trap projects with the added step of breaking site IDs into smaller parts and sending for sub-sampling. The sub-sampling can continue for several cycles until an appropriate workload is agreed upon by RI Energy and DNV.

Specifically, DNV proposed and implemented a three-stage process.

- Stage 1 is to identify SEMP projects and categorize them in their separate categories (steam trap, non-steam trap, SEMP) as they are claimed in tracking savings by creating site IDs as traditionally done. This is the standard first step of sampling. The team identified which SEMP projects are chosen by using the Model-Based Statistical Sampling (MBSS) process, which leads to Stage 2.
- Stage 2 will require project files to disaggregate sampled SEMP projects. The team provided the sampling at measure level to choose from the list of items completed in the SEMP claimed savings.
- Stage 3 is a fallback from Stage 2 chosen sites if the sites are a much larger burden on evaluators and customers than need be. A second disaggregation would then occur, if needed, at a unit chosen during Stage 3 to break work

[2] Includes 1 non-steam trap site with operational adjustments and 4 steam trap sites (pre-evaluation operational adjustments)

down further into a manageable task. DNV did not find a need to complete Stage 2 or 3 for the PY2020 cycle as discussed below.

What resulted from this process are representative sub-samples for site IDs identified within the SEMP category. Site independence was not an issue from sub-sampling SEMP projects as the sites are grouped per Stage 1, which is sufficient to avoid site interdependency. Stage 1 sampled at the site level, where Stage 2 and Stage 3 sampling rolls up to Stage 1 results. Stage 2 and 3 therefore keeps interdependency within the site level, and Stage 1 expands results back to the population level at the site level as traditionally completed.

After following the three-stage process for PY2020, DNV found the SEMP category did not represent as large of a portion of program savings as found in PY2019. The burden of work from chosen SEMP sites was within reason after the first sampling round. Therefore, following the steps laid out above, DNV recommends evaluating the SEMP sites and all included measures as listed in the sample. In PY2020, one SEMP site (2020RIG019N) was included in the sample for evaluation.

The sample for PY2020 is found in APPENDIX A.

2.1.3 Rolling sample design

The expected precision from the PY2020 sample design was combined with the achieved PY2018 and PY2019 study results to produce a combined precision for the overall program. DNV noted that the savings for PY2020 were significantly lower than the previous two program years. Table 2-5 provides the combined expected precision based on this sample design.

Table 2-5. PY2018, PY2019, and PY2020 combined expected precision at 80% confidence interval

Program Year	Accounts (N)	Therms Savings	Error Ratio	Sample (n)		RP @80% CI
				Design	Achieved	Design
PY2018	87	2,350,739	0.40 (non-ST) 0.65 (ST)	8	4 non-OP non-ST 2 OP non-ST 2 ST	±21.0%
PY2019	91	1,944,204	0.55 (non-ST) 0.65 (ST) 0.55 (SS)	10	2 non-OP non-ST 4 OP non-ST 3 ST 1 non-OP combined	±35.0%
PY2020	77	1,280,693	0.55 (non-ST) 0.65 (ST) 0.55 (SS)	8	3 non-OP non-ST 1 OP non-ST 4 ST	±29%
PYs (2018, 2019, & 2020)	255	5,575,636	N/A	26	26	±11.7%

ST = Steam Trap; SS = SEMP Site; OP = Operational, combined = Combined steam trap and non-steam trap, N/A = Did not calculate. *=Recalculated under new approach for steam trap evaluations

2.1.4 PY2020 final sample disposition

Two primary sites were dropped from the study sample and were replaced by a secondary site. The sites were removed and replaced due to the non-responsiveness of the site contacts. The energy savings measures were HVAC controls, refrigerated case night covers, refrigerated case glass doors, and replacement/repair of steam traps. The sites were replaced by the next sites on the priority list.

The final (achieved) sample includes eight sites, which can be found in Table 2-6 which summarizes the eight sites for which M&V activities were completed. The summary includes the site ID, the verified measure description, tracking savings, and site RR.

2.2 Site M&V planning

The site evaluation (M&V) plan played an important role in establishing approved field methods and ensuring that the ultimate objectives for each site evaluation were met. The M&V plan for each evaluated site provided detailed information on the procedures for accomplishing those objectives.

DNV submitted full individual M&V plans for each evaluated site. These plans were reviewed by RI Energy. Each site plan included the following sections:

- **Project description** – A description of how the project saves energy.
- **Tracking savings** – A short description of how the tracking savings were estimated and their source, including:
  - Analysis method was used.
  - Identification of the key baseline assumptions.
  - Identification of the key proposed assumptions.
  - Evaluator assessment of tracking savings methods or assumptions, including program-reported baseline.
- **COVID-19 impacts** – A description, if any, of impacts from the current health emergency.
  - Suggested site evaluation method taking into account COVID-19 Impacts.
  - Reasoning for the chosen site evaluation method.
- **Project (site) evaluation** – A short description of the methods to be used to evaluate the project, including, but not limited to:
  - Methods for verifying the measure installation and current operation.
  - Methods for observing and/or assessing building use and occupancy.
  - Identification of the tracking and expected evaluator baseline of each measure.
  - The data to be collected by DNV; where several similar items have been installed or are being controlled, the site evaluation plan described and justified the sampling rate of the equipment to be monitored.
  - Site staff interview questions (to understand the baseline operation and determine if any changes in the operation of the impacted system occurred after the project was installed).
  - The data provided or to be provided by the site (e.g., EMS trends, production, pre-metering) and/or RI Energy.

- The expected site evaluation analysis method to be used, including any deviations from the implementer savings estimation method. In general, the same methodology used to estimate tracking savings was used to estimate evaluated savings. DNV presented an alternative methodology only if the tracking methodology was flawed, unfeasible, or a more accurate methodology that utilized post-installation data was available.
- Key parameters that are determined through the site evaluation preparation to compare to those used in the original savings estimate.
- Measurement verification equipment to install on select equipment and quantity of devices intended for installation.

DNV updated the M&V plan, responding to RI Energy comments, and in most of the cases, submitted a revised M&V plan before the site visit. For some sites, the initial visit was scheduled within a couple of days or less, and RI Energy reviewers did not have the chance to approve the entire M&V plan before the site visit. For those sites, DNV evaluators emailed the plan for a quick review and response specifically for the tasks to be conducted onsite and the metering approach.

2.3 Data collection

DNV performed a site contact interview and scheduled a site visit to perform the tasks described in the site M&V plan. Data collection occurred from January 2022 to May 2022.

2.3.1 Customer outreach

Using the information provided in the project files, project engineers reached out to customer site contacts. During this initial outreach, the engineers discussed the purpose of the site evaluation, the scope of measures installed, availability of onsite trend/EMS/production data, any other applicable parameters relevant to the site evaluation, impact from a COVID-19 health emergency, and confirmed that the site would allow DNV to conduct the site visits. The site-specific M&V planning effort did not commence until the customer site contacted indicated they would accommodate the ex-post virtual or onsite evaluation process. After the customer outreach discussion, if the engineer determined significant barriers were preventing M&V of substantial parts of the completed project, the site was flagged for review and, if warranted, replaced with a backup site.

The agreed-upon communication protocol memo for RI Energy is found in APPENDIX C.

2.3.2 Site evaluation type determination

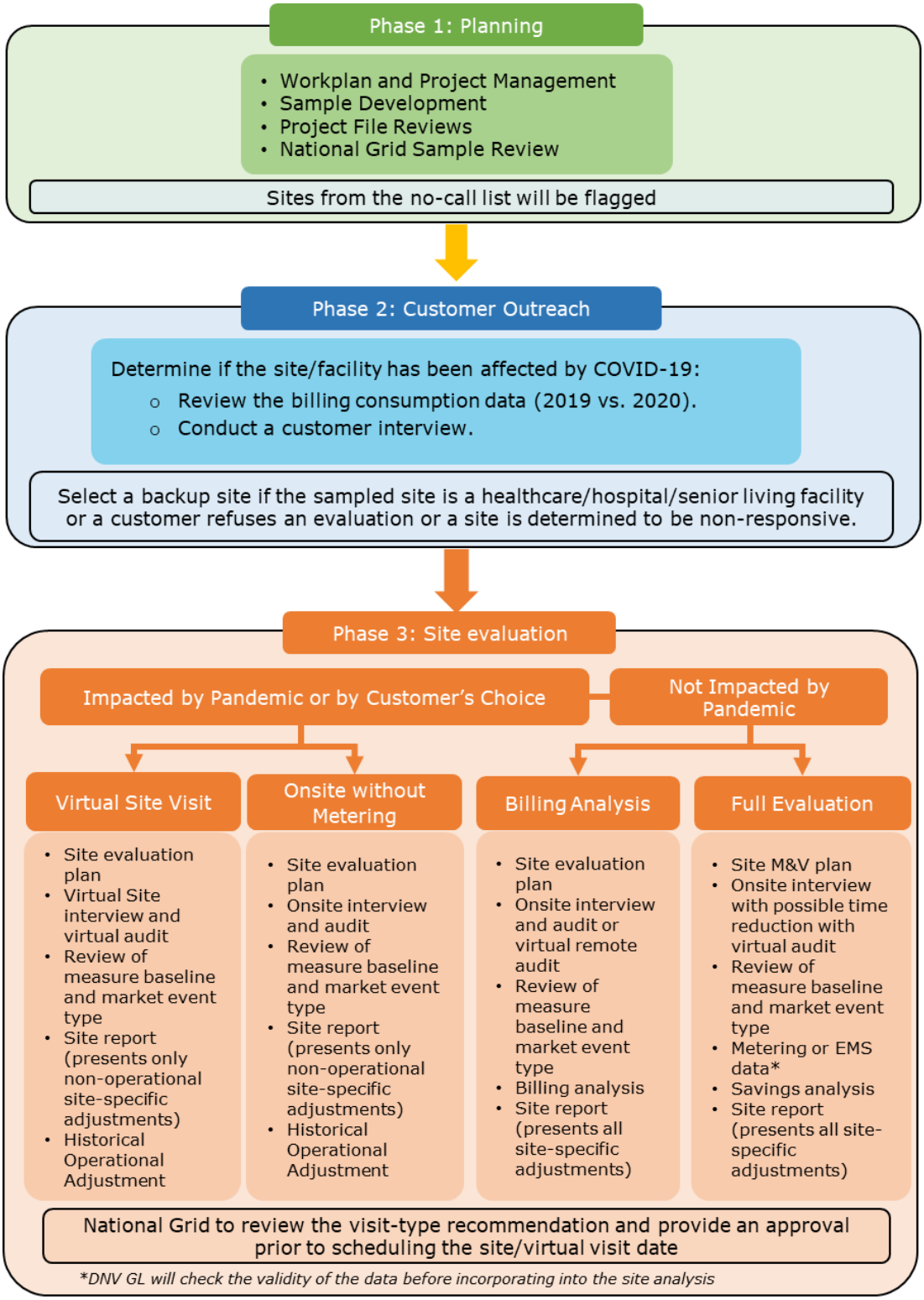
DNV conducted one of four types of site evaluations for each site. The deciding factors were: whether the site was a steam trap category site; COVID-19 gas consumption impact; general COVID-19 impacts including changes to the site's operation, production level, facility health policies, site contacts long-term absence or physical presence onsite; and site contact willingness for a physical visit from engineers. The following conditions were applied to the site evaluation type:

- Base Method – Virtual Site Visit: The site was recruited for virtual visits due to the restrictions on having an in-person visit. Evaluators collected only non-operational impacts for this option.
- Add-On 1 – Onsite Site Visit with only non-operational impacts: The site was open for an onsite visit, but the COVID-19 pandemic impacts the installed measure's operation, and little meaningful data would be obtained by performing onsite metering. Evaluators collected only non-operational impacts for this option. This option was also used for steam trap evaluations with the consideration that all operational impacts would be already accounted for in the steam trap tool calibration.

- Add-On 2 – Billing Analysis: In this case, the engineer determined the measures installed were best analyzed by billing analysis. This option was possible if the site was open for an onsite or virtual visit and the customer operation was not impacted by the COVID-19 pandemic. Billing analysis does not allow for savings determination across measures and only delivers results at the site level.
- Add-On 3 – Onsite Visit with both non-operational and operational impacts: The site was open to an onsite visit, and the customer was not impacted by the COVID-19 pandemic. Evaluators collected both non-operational and operational impacts using M&V.

Evaluators suggested a virtual site visit depending upon the site contact's willingness for a physical visit to the site. A backup site was selected when the customer refused a site visit or a virtual visit. Figure 2-1 shows the decision tree graphically. A virtual visit was conducted for non-operational sites, and an onsite visit was conducted for both non-operational and operational metering sites if the customer permitted. The onsite site visits were used to verify the non-operational and operational adjustment factors. In the absence of metered or trend data (i.e., non-operational sites), operational adjustment factors are based on historical results (operational data collected in PY2018 and PY2019, and operational data collected in PY2020) as discussed in Section 2.7.2.

Figure 2-1. Summary of M&V flow through sampling to site evaluation to determine site evaluation type



As Table 2-6 lists the site level information of data types collected and the type of site visit .

Table 2-6. Site-level information for the type of visit and data collected

Site ID	Type of Site Visit	Data Collected				Type of Adjustment
		Site Interview	Equipment Verification	Trend Data	M&V Data	
2020RIG002N	Onsite	X	X	N/A	N/A	Non-Operational
2020RIG082N	Onsite	X	X	-	X	Operational
2020RIG019N	Onsite	X	X	X	N/A	Non-Operational
2020RIG058S	Onsite	X	X	N/A	N/A	ST
2020RIG004S	Virtual	X	-	N/A	N/A	ST
2020RIG033S	Onsite	X	X	N/A	N/A	ST
2020RIG064S	Onsite	X	X	N/A	N/A	ST
2020RIG009N	Onsite	X	X	X	N/A	Non-Operational

ST: Steam Trap sites have operational adjustments that come from the calibrated steam trap tool

2.3.3 Site visit

Each initial site visit consisted of the confirmation of the COVID-19 health emergency impacts; site verification of installed equipment; a discussion with facility personnel regarding the baseline characteristics of the measure; if called for, the installation of measurement equipment; the collection of available trend data; and/or the creation of a plan to gather trend data coinciding with the measurement period. Trend data beyond the measurement period was also requested and used to improve the accuracy of measure savings estimates.

A second site visit to retrieve meters was scheduled for sites where evaluators installed meters during the initial visit. For 2020RIG064S, the site was initially evaluated as an on-site with Add-on 3 (includes M&V) before the decision was made to change the steam trap evaluation approach. The evaluators returned to the site to collect the installed meters but the metered data was not used. Operational adjustments were already accounted for in the calibration of the steam trap tool.

2.3.4 M&V plan update

DNV submitted an updated site M&V plan to RI Energy after the completion of the initial site visit. This updated plan included the following information, based on the site visit:

- Any deviations from the plan that occurred during the visit or were expected to occur; deviations included cases where a portion of the proposed M&V plan was not feasible for unforeseen reasons.
- Provides a summary of the information to be collected, information that will not be available for analysis purposes, and lists tasks to complete on the return for meter pickup.

The update was intended to keep RI Energy current on the status of the site evaluation and communicate any anticipated or resulting deviations from the plan.

2.4 Site analysis

As previously shown In Table 2-6, the evaluation team evaluated only one project with operations adjustments (traditionally called full site evaluations) from metered data. For the one operationally adjusted project, the analysis generated evaluated savings estimates for all measures installed at the sampled site. Results were normalized to typical production or weather data. For weather-dependent measures that result in savings, the site analysis involves normalizing the models to weather data using Typical Meteorological Year 3 (TMY3) data from the closest representative weather station to each site.

For the remaining three non-steam trap sites, engineers did not complete a full site evaluation at two sites due to COVID impacts, limiting the program representativeness of the operational aspects from their site evaluations. Operational data was not collected for the two non-steam trap sites as the pandemic impacted site energy usage at those facilities. Sites were affected by the pandemic due to a reduction in personnel or occupants at the locations, reduced manufacturing, or changes to HVAC needs from pandemic-related logistical changes. One non-steam trap site was not metered due to visiting the site past the heating season window and a change in HVAC needs due to pandemic. All sites that did not have an analysis completed were still included in the final project realization rate using the operational and non-operational adjustments described in detail in Section 2.7.2 due to evaluators and RI Energy's wanting to include the non-operational information.

2.4.1 Steam trap analysis

Four steam trap sites were evaluated with operational adjustments that came from the steam trap tool which is already calibrated with operational data from a previous impact evaluation/tool calibration. The steam trap sites were evaluated using the approach outlined in APPENDIX E. The evaluators conducted a desk review of the savings calculation methodology and determined if the applicant used the RI Energy Steam Trap Tool. The evaluators determined the four steam trap sites used the correct tool. For the purposes expanding to 3-year rolling results, the evaluators conducted the steam trap analysis using the new approach for PY2018 and PY2019 steam trap sites in addition to the current program year.

2.5 Site reporting

For the four non-steam trap sites, DNV submitted draft site reports to RI Energy, who provided comments or questions to the engineer who led the site analysis. The engineer responded to comments and questions until a final agreement was reached on the analysis approach, the results, and the report itself. Each site report contains the following sections:

- Project summary and results – Provides a brief description of how the evaluated measures at the site save energy and a high-level summary of why the site evaluation results may differ from the tracking estimates. The site results are also presented in this section. A description of COVID impact and site evaluation type is included to describe what data was included and if an M&V based operational analysis was completed during the site evaluation.
- Evaluated measures – Describes the evaluated measures, including, but not limited to:
  - Applicant baseline and proposed conditions
  - Applicant savings calculation methods
  - Evaluator assessment of the applicant savings calculation methods
  - Measure verification results and methods for verifying measures
  - The data collected by DNV, summarized in graphical or tabular form for each data point
  - The data provided by the site and/or RI Energy, with key data summarized in graphical or tabular form

- Site evaluation baseline used
- The site evaluation analysis method used, identifying any deviations from the original savings estimation method
- Key savings parameters determined through the site evaluation, and a comparison to those used in the original savings estimate
- A summary of the evaluated savings calculated and the primary drivers for differences between the tracking savings estimates and site evaluation savings estimates

An internal quality assurance lead reviewed a select amount of site reports. This review determined if the reports complied with the requirements for this deliverable and if the document communicates information clearly and consistently.

2.5.1 Steam trap memo

For the four steam trap sites, the evaluators summarized the results of the steam trap reviews in a steam trap memo which can be found in APPENDIX F. The memo includes the following:

- Applicant savings calculation methods
- Whether the RI Energy Steam Trap Tool was used or a proprietary calculator
- Identification of sites that need to be recalculated using the RI Energy Steam Trap Tool
- Major discrepancies found through the onsite or virtual visit
- A summary of the evaluated savings calculated and the primary drivers for differences between the tracking savings estimates and site evaluation savings estimates

An internal quality assurance lead reviewed the memo which highlighted the findings from all steam trap sites. In PY2020, the steam trap memo also includes the results and summaries for PY2018 and PY2019 sites.

2.5.2 Measure event type and baseline review

A review of event measure types and baselines for each measure installed at sites in the sample selected for the program evaluation were completed for this study. DNV selected a measure baseline event type from stakeholder agreed-upon categories based on a preponderance of evidence presented in the project file, the data gathered during the site contact interview, and information gathered during the site visit. RI Energy classified measures into two event types: 1) new construction measures, which include both new buildings and replace on failure or planned new measure purchases, and 2) retrofit measures which include single baseline, early replacement, and add-on. New construction and retrofit event types were found in the PY2020 program evaluation. The evaluation team reclassified EMS and insulation measures as add-ons.

Table 2-7 shows the measure event types used in RI Energy tracking information and site evaluations. Sites 2020RIG019N is part of the SEMP category and had adjustments to baseline classification for some measures. The evaluator agrees with the applicant's baseline for measures M2 and M4 (replacement pipework with above-code insulation). The pre-existing pipework and insulation were in poor condition and were between 31 and 40 years old at the time of measure implementation, which is equal to or greater than the equipment estimated useful life (EUL) of 31 years determined by the evaluators based on background research. Because the existing pipework had exceeded or equalled its EUL, this measure is new construction. However, the evaluator disagrees with the baseline for measure M3, retrofit. Measure M3 is based on

the same physical hardware installed as part of measure M2/M4, and therefore the evaluator also classifies it as new construction.

Table 2-7. Measure event type in RI Energy tracking information and site evaluations

Site ID	Measure Type	RI Energy Application#	Tracking Event Type	Site Evaluation Event Type
2020RIG002N	Insulation	7576109	Retrofit	Retrofit
2020RIG082N	Process Pipe Insulation	11160436	Retrofit	Add-On
2020RIG019N	HVAC Controls	10731883	Retrofit	Retrofit
	HVAC Controls	11388357	New Construction	New Construction
	Process Pipe Insulation	11701603	Retrofit	New Construction
	Heating Plant Efficiency	11954010	New Construction	New Construction
2020RIG058S	Steam Traps	11371101	Retrofit	Retrofit
2020RIG004S	Steam Traps	9241027	Retrofit	Retrofit
2020RIG033S	Steam Traps	11016913	Retrofit	Retrofit
2020RIG064S	Steam Traps	11510840	Retrofit	Retrofit
2020RIG009N	HVAC Controls	9624593	Retrofit	Add-on

After the measure event type was selected, the evaluator selected the evaluated baseline for the event type. Measures classified as retrofit (and add-on) used pre-existing conditions as a baseline. Measures classified as new construction used ISP or code as the baseline. The evaluation team completed an independent review of the baseline for each sampled project. Using site data project documentation and interviews at the facility, DNV assessed the reasonableness of the baseline for each sampled project.

2.6 Non-operational site collected data

With the ongoing COVID-19 health emergency, the Team decided to implement a two-tiered data collection approach such as the approach used in PY2018 and PY2019. Evaluators and RI Energy understood there would be sites incapable of accepting evaluators at the location, sites that may not have full occupancy, sites with reduced production capacity, and sites with reduced or increased energy usage due to the previous scenarios or others. Refer to the site evaluation type decision tree, found in Figure 2-1, to understand when sites received non-operational vs. operational adjustment factors.

Non-operational data was collected for all eight sites in PY2020. From the total of eight sites evaluated, four were evaluated using the new Steam Trap evaluation methodology. Only non-operational data was collected for three of the non-steam trap sites. Non-operational and operational data was collected for the remaining one site.

The evaluation team conducted an in-depth review of the baseline, methodology, administrative tracking/documentation, quantity, and technology adjustment factors for each evaluated measure. The non-operational data collection focused on measure-specific assessments of the following criterion:

- Measure event type classifications (retrofit, add-on, lost opportunity, etc.)
- Applicant baseline source
- Applicant and evaluator measure life
- Evaluator assessment of the baseline (pre-existing single/dual, ISP, unique)
- Assessment of baseline change impact on the measure savings
- Savings calculation method used by the applicant
- Most applicable savings calculation method, per evaluator
- Applicant key assumptions quality
- Assessment of methodology change impact on the measure savings
- Availability of native tracking savings calculations in electronic form
- Tracking savings source (applicant, equipment vendor/contractor, RI Energy implementer, independent TA consultant)
- Assessment of quantity of items installed
- Verify the unit(s) is/are installed and if there are any discrepancies for installed quantities
- Does the installed technology match the applicant claimed technology or serve the same function?
- Does the applicant analysis consider interactivity with other end-uses, equipment, or fuel types?
- Were the applicant savings calculations normalized?
- Evaluator assessment of the quality of the applicant's savings estimations

The results for steam trap sites were documented and reported in a desk review format, then summarized into a steam trap memo encompassing the major findings for all four steam trap sites. The results of the non-operational data-only sites were documented and reported in a final site report as per full site evaluation standard procedure. Discrepancies were documented in the final site reports and used in the program savings expansion. Operational adjustment factors were imputed for all sites where only non-operational data was collected from prior years of program evaluations and the current operational data collected (PY2018, PY2019, and PY2020 operational collected sites). More information on the imputed historical adjustments can be found in Section 2.7.2.

2.7 Sample expansion

2.7.1 Site weight calculation

Weights are calculated similarly to previous rounds of custom gas program evaluations and are determined by taking the total number of observations in the stratum and dividing by the number of evaluated observations. Operational adjustments use the same weights as non-operational adjustments; however, the final realization rate and error calculations are based on imputed values for the portion of population savings not represented by operational adjustment sample sites. Initially, PY2020 operational adjustments are calculated and then combined with PY2018 and PY2019 operational adjustments using the methodology found in APPENDIX B. The methodology is similar to combining results from the three-year rolling sample with only operational adjustment calculations; however, APPENDIX B contains the specific algorithm followed to calculate imputed historical results.

2.7.2 Operational and non-operational sample with imputed historical adjustments

The operational and non-operational sample estimation approach accounts for the difference within the program year of 2020 from two results: operational and non-operational adjustment factors. RI Energy and DNV chose to keep the integrity of the randomly selected sample by collecting as much information from each site if a minimum amount of information was collected to verify measure installation. That minimum included a site contact interview and measure verification from either a site visit or virtual visit.

Operational adjustment factors were not collected from a site for two reasons: 1) the location was affected at the time of the site evaluation by COVID-19 restriction measures that reduced occupancy or energy consumption or 2) meter installation, trend data collection, or physical access by evaluators to the installed measure for direct observation was impossible from the COVID-19 restriction regulations or customer comfort with site work.

The methodology in APPENDIX B is used to calculate the realization rates for both sample components of the 2020 program year. The overall 2020 program year realization rate is shown and discussed in detail in Section 4.1.

Table 2-8 shows the adjustment factors used by evaluators to categorize discrepancies from tracking data and how those factors are categorized within PY2018, PY2019, and PY2020. Non-operational adjustment factors include factors that are obtained during a desk review, site contact interview, and primary site visit. Operational adjustments require metering or trend data collected for analysis which is obtained during logger installation or delivered after the initial site visit.

Table 2-8. Adjustment factors for site evaluation

	Adjustment Factors						
Ratio Name:	Non-Operational Adjustments					Operational Adjustments	
Obtain During:	In-depth desk review			1st site visit (onsite or virtual)		Logger Installation	
Factor:	Baseline	Methodology	Tracking & Admin	Technology	Quantity	Operational	HVAC Interactive

Operational adjustment results were used from PY2018, PY2019, and PY2020. The historical adjustment is essentially extrapolating results from the operational adjustment factors from the most recent three years available at the time of the evaluation (inclusive of the current evaluation year) to calculate a combined operational realization rate. Table 2-9 details the sites used from each program year that were used to calculate the imputed historical operational adjustment for PY2020. The total number of operational adjusted sites from each program year are included, along with the total number of sites the

program year contained. Four out of eight sites in PY2020 were steam trap sites so they did not qualify for operational adjustments in the current evaluation cycle. The four steam trap sites were considered to be operationally adjusted pre-evaluation. For PY2018, four out of eight sites had operational adjustments and for PY2019, three out of ten sampled sites had operational adjustments, as shown below.

Table 2-9. Sites used for imputed historical operational adjustment calculations

Program Year	Site IDs	Number of Sites in Imputed Ops Adjustments	Number of Sites in Program Year
PY2018	2018RIG78, 2018RIG26, 2018RIG27, 2018RIG43	4	8
PY2019	2019RIG065N, 2019RIG057N, 2019RIG138N	3	10
PY2020	2020RIG082N	1	8

3 DATA SOURCES

To support the findings of the study, the team used the following data sources:

- PY2020 tracking data provided by RI Energy
- PY2020 parent/child tracking data provided by RI Energy
- PY2018 and PY2019 tracking data
- PY2018 and PY2019 program impact evaluation results
- Re-evaluated steam trap sites from PY2018 and PY2019 to adhere to the updated steam trap evaluation methodology
- Project files, which typically include one or more of the following: original applications, offer letter, BCR screenings, invoices, minimum requirements documents, technical assistance studies, applicant savings calculations that match claimed savings, and post-installation reports
- Onsite observations and data collection including inspection and verifications of equipment, nameplate data, staff interviews, vendor interviews, spot measurements of various parameters including kW, longer-term measurements, and combustion efficiency
- Metered and/or EMS trend data from operational adjusted sites that participated in the study

4 ANALYSIS AND RESULTS

The RI PY2020 study achieved the target precisions for that individual year's projects as well as for the combinination of the latest three years (PY2018, PY2019, and PY2020). PY2018 program impact evaluation results were finalized in June 2020 and PY2019 impact evaluations were finalized in December 2021. DNV collected operational data for one out of eight PY2020 sites and non-operational data for all eight sites. Trend data, metered data, or a combination of both were collected for the one operationally adjusted non-steam trap site. One steam trap site was conducted as a full M&V site including metering data but the metered data was not used due to the change in steam trap evaluation approach shown in APPENDIX E. Operational data was not collected for the remaining 3 non-steam trap sites as the pandemic impacted site energy usage at those facilities or DNV was not able to meter the site within the required temperature window. Sites were affected by the pandemic due to a reduction in personnel or occupants at the locations, reduced manufacturing, or changes to HVAC needs from pandemic-related logistical changes. One non-steam trap site was not metered due to visiting the site past the heating season window and a change in HVAC needs due to pandemic. The four evaluated steam trap sites are considered to be operationally adjusted because the steam trap evaluation approach uses the RI Energy steam trap tool (STT) which calculates savings based on vetted operational and billing data sets. Both sets of non-operational and operational adjustment factors in PY2020 were then combined to calculate the overall site RR for operational adjusted sites.

The following subsections provide more details on the PY2020 results.

4.1 PY2020 results

This section provides an overview of the results from comparing PY2020 tracking and evaluated results.

4.1.1 Site-level results

Error! Reference source not found. illustrates the comparison of reported (x-axis) and evaluated (y-axis) annual natural gas savings for each of the eight sites included in the program evaluation sample for PY2020. The figure shows three categories which include steam trap sites, non-steam trap sites with operational adjustments, and non-steam trap sites without operational adjustments. APPENDIX A summarizes the eight sites for which M&V activities were completed, with statistics such as the site ID, the verified measure description, tracking savings, and RR. APPENDIX F summarizes the results of PY2020 steam trap sites and also includes revisited PY2019 and PY2018 steam trap site results under the new steam trap evaluation approach. The new steam trap evaluation approach is discussed further in APPENDIX E.

4.1.1.1 Non-operational adjustment results

Non-operational adjustments contain baseline, methodology, tracking/admin, technology, and quantity adjustment factors. Baseline, methodology, and tracking/admin factors are completed from review of project files, tracking data, and preferably a site contact interview. Technology and quantity adjustments are verified and obtained during the first site-visit or through a virtual visit. The team was able to collect information from non-operational adjustments on all 4 of the sampled non-steam trap sites. Table 4-1 shows how the savings change from tracking as adjustments are tabulated; adjustments were applied in the same order for each site. For example, no gas savings (therms) change was made for 2020RIG009N for baseline adjustments from tracking, so the total therm savings remains constant (24,037 therms for tracking and 24,037 therms for baseline). However, a therm savings reduction was made from a methodology adjustment, so the change is found as 25,479 therms in the Methodology column in Table 4-1. Similarly, in the example of steam trap site 2020RIG058S, no non-ops adjustments were made so the therms savings remains constant (1,775 therms for tracking and 1,775 therms for quantity).

Table 4-1. PY2020 site-level verified savings after non-operational adjustments

Site ID	Tracking Savings (therms)	Verified Savings After Non-Operational Adjustments				
		Baseline	Methodology	Tracking/Admin	Technology	Quantity
2020RIG002N	11,780	11,780	11,780	11,780	11,780	11,780
2020RIG082N	5,012	5,012	4,876	4,876	4,876	4,876
2020RIG019N	23,754	10,713	8,519	8,519	8,519	8,519
2020RIG058S	1,775	1,775	1,775	1,775	1,775	1,775
2020RIG004S	49,822	49,822	49,822	49,822	49,822	49,822
2020RIG033S	29,192	29,192	29,192	29,192	29,192	29,192
2020RIG064S	13,749	13,749	13,749	13,749	13,749	13,749
2020RIG009N	24,037	24,037	25,479	11,698	11,698	11,698

For 2020RIG082N, evaluators found that there were pre-project errors related to parameters used in the calculation of the process pipe insulation measure that resulted in lesser savings compared to the tracking savings value. The evaluators found discrepancies among the applicant description of equipment. This lead to finding discrepancies among assumed process and facility ambient temperatures used in the applicant calculation which was classified as a methodology error.

For 2020RIG019N, evaluators found the most substantial deviation was the reclassification of some measures from retrofit to new construction which contributed to the decrease in project savings. One measure, M3 claimed savings for increasing condensate return, however the baseline for new construction steam distribution is for pipework to return condensate, therefore there are no savings for this measure after the baseline reclassification. There were also adjustments made to the calculation methodology which differed from the client and pre-project errors identified during the evaluation.

For 2020RIG009N, the applicant did not reference the correct cell to report project savings which resulted in a large decrease in savings due to tracking error. The evaluators also deemed the applicant methodology not appropriate as the applicant didn't consider unoccupied discharge air temperature was reduced due to the proposed temperature setback.

No non-operational adjustments were made to the steam trap sites as all sites were found to have used the RI Energy Steam Trap Tool and adhere to the criteria outlined in the updated steam trap evaluation approach. All other sites either do not contain non-operational adjustment factor discrepancies, or the discrepancies affected <1% of tracking savings. Forthcoming sections present the descriptions of the general discrepancies for all sampled sites in operational adjustment factors.

4.1.1.2 Operational adjustment results

The results from a full site evaluation include all adjustment factors found in the non-operational adjustment factors while also including the additional operational adjustments (Operation and HVAC-interactive adjustments). These factors are obtained after logger pickup and after analyzing long-term data (trend data is categorized in these adjustments). In the case of steam trap sites, the RI Energy Steam Trap Tool is calibrated to account for operational adjustments so no additional operational adjustments are applied to avoid the potential of double-counting operational effects. Table 5-2 in APPENDIX E shows a summary of steam trap evaluation results for PY2020 steam trap sites. Table 4-2 shows the operational

adjustments after non-operational adjustment factors are considered from Table 4-1. Of the four non-steam trap sites, one was evaluated for operational adjustment factors. The other three sites either had COVID-impacted energy usage or metering was not possible with COVID restrictions from a site facility mandate. The three sites where operational adjustments were not calculated are listed as 'N/A.'

Table 4-2. Non-Steam Trap PY2020 site-level unweighted operational savings after operational adjustments

Site ID	Savings After Non-Operational Adjustments (therms)	Savings After Operational Adjustments	
		Operation	Interactive
2020RIG002N	11,780	N/A	N/A
2020RIG082N	4,876	5,173	5,173
2020RIG019N	8,519	N/A	N/A
2020RIG009N	11,698	N/A	N/A

There were no interactive savings adjustments found for the one evaluated site. All adjustments were found within operation adjustment factors. All adjustments are operational that require metered data or observable changes.

2019RIG082N has increased savings due to discrepancies in heater efficiency relative to what was claimed in the applicant estimations. Overall, the operational adjustment for that site resulted in higher savings than the tracking value.

4.1.1.3 PY2020 combined operational and non-operational results with historical operational adjustments

Our sampling took into account sites that would only get non-operational adjustments and sites that would get non-operational adjustments and operational adjustments. The sampling approach was designed due to the current health emergency where site operation may be atypical, or site customer managment may not want external visitors to their location (resulting in not getting M&V data on every site). Results are tabulated using the methodology described in Section 2.7.2. Table 4-3 shows the non-steam trap historical operation adjustments for PY2018-PY2020.

Table 4-3. Non-steam trap historical operation adjustment and impact on PY2020

Program Year of Operational Adjustment	# of Sites w/ Ops Adj	Population Savings (therm)	Operational Realization Rate (%)		PY2020 Operational RR w/ Historical Ops Adjustment (Non-Traps)
PY2018 OpsAdj	4	2,350,739	91.6%		
PY2019 OpsAdj	3	1,944,204	59.2%	>	85.7%
PY2020 OpsAdj	1	1,280,693	106%		

The historical operational adjustment is calculated after operational/non-operational realization rates and standard errors are calculated in a program year as shown in Table 4-3. The historical adjustment is essentially extrapolating results from the operational adjustment factors from the most recent three years available at the time of the evaluation (inclusive of the current evaluation year) to calculate a combined operational realization rate. The historical operational adjustment is calculated from the most recent three years available at the time of the evaluation (inclusive of the current evaluation year). The expansion methodology is discussed further in APPENDIX B. In order to align the prior year results with the current steam trap evaluation methodology, the evaluators re-evaluated PY2018 and PY2019 steam trap sites using the new steam trap evaluation methodology. The new methodology removes operational adjustments from the evaluation because the sites are considered to be operationally adjusted pre-evaluation. The combination of the PY2020 operational adjustment and the PY2018-19 historical operational adjustment form the PY2020 operational realization rate with the historical operations adjustment found in Table 4-4 under 'Operational RR'. The non-operational and operational adjustments are then combined as explained below.

Table 4-4 presents the discrepancy change percentage of non-operational and operational adjustment factors from tracking and the resulting weighted therms totals for the two adjustment classifications (non-operational and operational). The non-operational realization rate is calculated with weighted tracking savings as the denominator. This realization rate is used to calculate the non-operational realization rate and precisions. In this table, the operational realization rate contains all operational adjustment factors for the sites where operational adjustments were collected. For the case on steam trap sites, the realization rates are shown but the operational adjustments are considered to be pre-evaluation because the steam trap calculator is pre-calibrated to account for operational adjustments. This realization rate here is used in the expansion process to compute the overall operations realization rate using the historical adjustment factor. This realization rate is the final site-level realization rate for operational adjustment collected sites. The final site-level realization rate for non-operational only adjustment sites is the realization rate found in the non-operational adjustment column. In the right-most columns, historical operational adjustments were applied at the program level. The historical operational adjustments are then used to determine the overall PY2020 realization rates with steam trap and non-steam trap results combined. See Section 4.1.2 for specific non-operational and operational discrepancy percentages when compared with tracking individually that combine to achieve the site level realization rate in Table 4-7.

Table 4-4. PY2020 Combined Realization Rate

		After Non-Operational Adjustments		After Site Specific Operational Adjustments		PY2020 Operational RR w/ Historical Ops Adjustment*	PY2020 Custom Gas RR
Site ID	Weighted Tracking Savings (therms)	Weighted Evaluated Savings (therms)	Site Level Realization Rate from Tracking (%)	Weighted Evaluated Savings (therms)	Site Level Realization Rate from Operational (%)		
2020RIG002N	206,150	206,150	100%	206,150	N/A	N/A	N/A
2020RIG082N	87,710	85,330	97%	90,528	103%		
2020RIG019N	106,893	38,336	36%	38,336	N/A		
2020RIG009N	108,167	52,641	49%	52,641	N/A		
Non-Trap Total	**508,920**	**382,457**	**75%**	**387,654**	**N/A**	**85.7%**	**64%**
2020RIG058S	24,850	24,850	100%	24,850	N/A	N/A	N/A
2020RIG004S	124,555	124,555	100%	124,555	N/A		
2020RIG033S	72,980	72,980	100%	72,980	N/A		
2020RIG064S	192,486	192,486	100%	192,486	N/A		
Trap Site Total	**414,871**	**414,871**	**100%**	**414,871**	**N/A**	**100%**	**100%**
	Non-Operational RR		89.2%	**PY2020 Overall Operational RR**		93.8%	
						PY2020 Custom Gas Combined RR for ST and Non-ST	84.5%

*Imputed historical adjustment was done at the population level rather than the individual site level

The realization rate for PY2020 RI Custom Gas installations is 84.5%. The realization rate is calculated using previous program year cycle operational adjustments (PY2018 and PY2019) combined with ops adjustment for 2020 sites where

appropriate, to provide more results, since operational adjustments were not collected from all PY2020 sites. 2020RIG082N was the only non-steam trap site with operational adjustments.

4.1.2 Discrepancy results

For each of the eight sites included in the PY2020 study, the site engineers identified factors that led to differences between the program-reported (tracking) savings and the evaluated savings. The factors are classified into seven categories: baseline, methodology, tracking/administrative, technology, quantity, HVAC interaction, and operational. A more discrete breakdown of possible differences and how they are categorized is presented below in Table 4-5.

Table 4-5. Possible discrepancy factors and their mapping to major categories

Major Discrepancy Category	Discrepancy Definition or Examples
Baseline	Change in the baseline of the post-retrofit condition
Methodology	Accuracy/appropriateness of Analysis Methodology Calculation changes Non-metered data input updates
Tracking/Admin	Accuracy of Tracking Savings Errors during claimed savings input Savings changed but not changed in tracking savings
Technology	Differences in proposed vs. installed technology or measure type
Quantity	Quantity of installed equipment is different
Operational	Boiler combustion efficiency Difference in equipment hours of operation Different equipment load profile Inaccurate pre-project characterization Steam operating pressure difference System optimization or programming not implemented Faulty or improperly installed equipment Operating temperature differences
HVAC Interaction	Interactive effects

The evaluation team used the site-specific, non-operational sampling weights and the sum of site-specific impacts of each discrepancy category to calculate the impact of adjustment factors for differences between the program tracking and evaluated results at the population level. Table 4-6 below presents the discrepancy factors and their impacts. There were no quantity or interactive adjustments discrepancies found in the sample. Most discrepancies are operational, with site-specific comparisons found in Table 4-7.

Table 4-6. PY2020 weighted discrepancy factors between tracking and evaluated results

Adjustment Factor	Site Counts	Impact on RR	Impact (%)
Baseline	1		-10.3%
Methodology	2		0.7%
Tracking/Admin	1		-10.9%
Technology	1		0.0%
Quantity	0		0.0%
Operational*	1		0.2%
Interactive*	0		0.0%
Historical Operations Adjustment			4.7%
Total			-15.5%

*Only for the 1 non-steam trap site with a full site evaluation completed.

Adjustment percentages found in Table 4-7 are the magnitude of changes from tracking for each site and are reported at the site level. The combination of non-operational and operational discrepancies sums to the change from tracking to evaluated (realization rate). The percentages are the total adjustments for operational and non-operational adjustments when compared to site-level savings. These percentages are not inclusive of historical operational adjustments which are applied through the expansion process outlined in APPENDIX B.

Table 4-7. Non-operational and operational weighted discrepancies – PY2020

Site ID	Tracking Savings (therms)	Evaluated Savings (therms)	Site Level Discrepancies		Combined Ops/Non-Ops Realization Rate (%)
			Non-Operational	Operational	
2020RIG002N	11,780	11,780	0.0%	N/A	100.0%
2020RIG082N	5,012	5,173	-2.7%	5.9%	103.2%
2020RIG019N	23,754	8,519	-64.1%	N/A	35.9%
2020RIG058S	1,775	1,775	0.0%	N/A	100.0%
2020RIG004S	49,822	49,822	0.0%	N/A	100.0%
2020RIG033S	29,192	29,192	0.0%	N/A	100.0%
2020RIG064S	13,749	13,749	0.0%	N/A	100.0%
2020RIG009N	24,037	11,698	-51.3%	N/A	48.7%

Section 3 of each site report presents detailed information on site-specific differences, which is included in APPENDIX D.

4.2 Combined three-year rolling results (PY2018, PY2019, and PY2020)

The evaluators calculated the gross RR and precisions using the results from PY2018, PY2019, and PY2020. The results are summarized in Table 4-8. The PY2020 results have operational adjustments that are imputed using operational

adjustments from PY2018, PY2019, and a portion of the PY2020 sample. The imputed historical adjustments improved the overall relative precision. For each program year, the evaluators calculated one RR which combines the steam trap and non-steam trap site results.

Table 4-8. Three-year rolling plan results and statistics

Parameter	PY2018	PY2019	PY2020	PYs 2018+2019+2020
Tracking Savings (therms)	2,350,739	1,944,204	1,280,693	5,575,636
Non-Operational Sample Size	8	10	4	26
Operational Sample Size[3]	4	3	1	8
Realization Rate (RR)	84.0%	80.78%	84.5%	83.0%
Relative Precision @ 80% CI (%)	±27.0%	±48.3%	±8.9%	±16.2%

The PY2020 individual year results meet the design precision targets proposed and presented above, in Section 2.1.2 and 2.1.3, for a standalone evaluation program year cycle at 84.5% RR and ±8.9% precision. The relative precision of the overall 3 year rolling sample RR (±16.2%) also meets the design precision targets proposed and presented above, in Section 2.1.2 and 2.1.3, after combining the current evaluation program year (2020) and the prior two years of results (2018 and 2019).

The original sample was designed to estimate the overall realization rate of the program by combining results from three program year evaluation studies (PYs 2018, 2019, and 2020) to achieve the agreed-upon precision targets of ±20% relative precision at 80% confidence for a custom gas study. In this case, the precision target was achieved by combining results from PY2018, PY2019, and PY2020 (based on the methodology discussed in Section 2). As stated in Section 2, the PY2018 and PY2019 steam trap sites were re-evaluated under the same methodology as PY2020 steam trap sites. Table 4-8 shows the individual PY2018, PY2019, and PY2020 results along with the combined three-year rolling program evaluation for PY2018, PY2019, and PY2020. Table 4-9 shows the non-operational and operational realization rates that are used to calculate the three-year rolling realization rate. PY2020 includes imputed historical operation data from PY2018 and the sites that received operational adjustments for PY2019.

Table 4-9. RRs used to calculate three-year rolling RR

Program Year	Tracking Savings (therms)	Non-Operational RR	Operational RR	Combined RR
PY2018 Non-Trap	1,991,871	88.6%	91.6%	81.1%
PY2019 Non-Trap *	1,649,362	98.3%	78.7%	77.3%
PY2020 Non-Trap*	556,583	75.2%	85.7%	64%

[3] The minimum sample size of each of the inner samples (sites with operational adjustments) dictates the overall sample size of the year for combined results.

PY2018 ST	358,868	100%	100%	100%
PY2019 ST	294,842	100%	100%	100%
PY2020 ST	724,110	100%	100%	100%
3-Year Rolling	5,575,636	92.9%	89.3%	83.0%

Non-Trap = Non-steam trap site, ST = Steam Trap Site *PY2019 and PY2020 include imputed historical adjustments (operational results from PY2018, and PY2019)

5 CONCLUSIONS, RECOMMENDATIONS, AND CONSIDERATIONS

5.1 Conclusions

5.1.1.1 PY2020 Performance

The program continues to generate significant natural gas savings. In RI, the PY2020 custom gas projects saved an estimated 1.30 million therms (adjusted gross savings) annually, with 84.5% of the program year savings realized based on the program evaluation sample for RI PY2020 sites. The current results are accurate within agreed upon precision standards and provide adequate planning and program reporting savings estimates.

A more detailed explanation of the PY2020 performance is found in Section 4.1.1.3. Site-specific details are shown in APPENDIX A. More details on the PY2020 results are presented in the sections below, and each site report included in APPENDIX D. Results from individual steam trap site evaluations are reported in the Steam Trap Results Memo found in APPENDIX F.

5.1.1.2 Combined three-year rolling (PY2018, PY2019, & PY2020) Performance

Combined over the three-year rolling sampling period, the program realized gross savings of 5.57 million therms, with 83.0% savings realized as shown in Table 4-9**Error! Reference source not found.**. The current three-year rolling results are accurate within agreed upon precision standards and provide adequate planning and program reporting savings estimates. In PY2020, the evaluation of steam trap sites was completed with a new methodology to account for the RI Energy Steam Trap Tool being already calibrated with operational adjustments. The evaluation team calculated separate results for steam trap and non-steam trap sites and discussed with RI Energy whether to report PY2020 results with separate realization rates for steam trap and non-trap categories or to report the current program year results as one combined result as in prior years. Ultimately, the team decided to remain with one result for PY2020 because the original sample design was not created to target two separate results.

A more detailed explanation of the combined three-year results is found in Section 4.2. DNV recommends RI Energy to consider for upcoming program years separating steam trap and non-steam trap results. A more detailed discussion of this proposed consideration is found in Section 5.2.1.4.

5.2 Recommendations

5.2.1.1 R1: Realization rate

DNV recommends RI Energy to use the PY2018, PY2019, and PY2020 combined RR of 83.0% for planning and program reporting, starting with PY2023 and continuing to in subsequent years until new program impact evaluation study results are available. This recommendation was based on the following factors:

- When PY2018 (92.7%), PY2019 (83.3%), and PY2020 (84.5%) results are pooled, the study produced statewide results that were close to precision targets of ±20% relative precision at 80% confidence (actual: ±16.2% at 80% confidence level).

Based on the results listed for PY2020, an individual program year sampling Error Ratio Target of 0.55 for non-steam trap and SEMP projects has been recommended for the 2021 RI Custom Gas Impact Evaluation to achieve the next three-year rolling savings program evaluation precision targets. For steam traps, we will adjust the error ratio down to reflect non-operational adjustments that would be part of ongoing steam trap evaluations. This will result in a reduced sample size for steam trap projects going forward.

5.2.1.2 R2: Steam Trap Tool Utilization

DNV recommends that RI Energy assess whether to implement the new MA steam trap study results within the next 6 months or determine an alternate approach to vetting RI steam trap sites which may include developing an independent steam trap tool in RI. Otherwise, in the next custom evaluation RI may need to revert to the previous approach under which steam trap sites are evaluated in the same manner as non-steam trap sites. The Steam Trap Tool is calibrated to account for all operational adjustments that may be traditional applied through M&V.

5.2.1.3 R3: Provide native savings analysis files

DNV recommends that project savings calculators be provided in the native format. Site evaluations depend on final savings calculators to understand assumptions and methodology to construct a site evaluation plan. Evaluators will attempt to recreate savings if the native calculation files are not provided but non-editable formats such as PDFs or images complicate the evaluation as incorrect assumptions may be made in order to attempt to recreate savings. Native savings analysis files provide more details on the calculation of savings and save time in evaluation. A specific example of this problem is listed below:

2019RIG019: Applicant files were provided as PDFs instead of native formats which complicated the evaluation.

5.2.1.4 R4: Implementor quality check at closure process

DNV recommends that the project implementer conduct a quality check during the project closure process. The evaluation team observed errors leading to significant discrepancies that could have been caught through a quality check at the closure of the project. Non-operational errors such as tracking, administrative, and certain methodology errors could be caught by the implementation team and corrected before entering final reported savings in the tracking system. DNV believes some degree of quality checking at the implementor level is already being performed but we would like to reinforce this type of quality procedure in order to mitigate the frequency of misreported savings. For example, this problem was observed in 2019RIG009 where the evaluators examined the analysis spreadsheet and found that the cell next to the correct savings number cell was used to report project savings. This applicant reported savings from the wrong cell which lead the tracking savings to be overreported by 57%. This type of error could have been avoided by performing a quality check at the project closure phase.

5.2.1.5 R5: Future custom gas impact evaluations will have independent non-steam trap and steam trap sample designs

DNV recommends for future program evaluations that the number of non-steam trap sites sampled be increased to achieve greater precision among non-steam trap sites which have greater variation under the new steam trap approach. DNV also recommends that in future iterations of custom gas evaluations, non-steam trap and steam trap sites should have separate sample designs which could result in separate or combined realization rates. DNV acknowledges that the approach in evaluation for steam traps and non-steam trap sites are fundamentally different and the sample designs should be independent one another.

5.3 Considerations

5.3.1.1 C1: Separate Steam Trap and Non-Steam Trap Results

DNV proposes that RI Energy consider separating steam trap and non-steam trap results and report two realization rates in upcoming program years. Assuming the steam trap tool is continued to be used, steam trap sites will be evaluated using a different approach than non-steam trap sites.

5.3.1.2 C2: Update Steam Trap Tool

DNV proposes that RI Energy consider developing a Steam Trap Tool in RI and continuously expand it with more recent billing data for operational adjustments. In MA, the current recommendation is to update the steam trap tool continually every couple years. DNV recommends RI Energy to monitor the MA Steam Trap Tool development and consider modelling the RI tool in a similar approach if future steam traps implementation continues to be substantial and evaluation budget is available. The approach would include both implementers and evaluators using the same tool to model steam traps.

5.3.1.3 C3: Implementors flag steam systems for potential design flaws

DNV recommends potential steam trap replacement / repair projects include an assessment from the installation vendor detailing whether or not a steam system may have inherent design flaws that may results steam trap failures shortly after installation. DNV observed that some steam trap sites in the PY2020 sample exhibited a high number of steam trap failures which negatively impacted the perception of the energy efficiency program. A specific example of this problem is listed below:

2019RIG064S: The evaluation team was informed that the customer was not happy with the project because of the high number of failed steam traps within the first year of installation. The site contact indicated that at least 16 of the 31 traps replaced/repaired had failed within a year of install. Furthermore, 2 had failed more than twice and the vendor did not cover the costs of replacements. 5 traps are currently being bypassed due to ongoing issues with waterhammer and trap failures. The site contact has been investigating the issue but could not reach a conclusion. The vendor suggested there may be inherent design flaws with the steam system including but not limited to the end-use equipment, pipe lengths and bends.

APPENDIX A. SITE EVALUATION RESULTS & REALIZATION RATES

This Appendix includes the site ID, the verified measure description, tracking savings and site RR that were used to calculate over realization rates for the program. Operational realization rates include adjustments from metered data and non-metered observational data collected on-site. Non-operational realization rates include only non-metered observational data confirmed on-site or through site contact interview. Steam trap sites are considered to have pre-evaluation operational adjustments through the use of the steam trap tool combined with observational data confirmed on-site. The realization rates for all categories are shown in the Table 5-1 shown below.

Table 5-1. Evaluated site summary

Sample ID	Applications	Measure Description	Site Evaluation Type	Tracking Savings	Evaluated Savings	Combined Ops/Non-Ops Realization Rate
2020RIG002N	7576109	Process Pipe Insulation	Non-Operational	11,780	11,780	100%
2020RIG082N	11160436	Pipe and Boiler Insulation	Operational	5,012	5,173	103%
2020RIG019N	10731883, 11388357, 11701603, 11954010	VAV Airflow Reduction, Smart CHW control valve, piping replacement, pipe insulation	Non-Operational	23,754	8,519	36%
2020RIG058S	11371101	Steam Trap Replacement	Steam Trap	1,775	1,775	100%
2020RIG004S	Parent 8678109 / Child 9241027	Steam Trap Replacement	Steam Trap	49,822	49,822	100%
2020RIG033S	11016913	Steam Trap Replacement	Steam Trap	29,192	29,192	100%
2020RIG064S	11510840	Steam Trap Replacement	Steam Trap	13,749	13,749	100%
2020RIG009N	9624593	Install dual duct terminal unit retrofits, HVAC Controls for Offices and Conference rooms	Non-Operational	24,037	11,698	49%

APPENDIX B. ADJUSTING GROSS REALIZATION RATE STANDARD ERRORS FOR IMPUTED OPERATING ADJUSTMENT

This appendix explains the process for calculating the current and three-year realization rates incorporating imputed operational adjustment for part of the second and third-year sample.

Basic structure

We have samples for three successive periods: 1, 2, and 3. In this evaluation these samples are 1) PY2018, 2) PY2019, and 3) PY2020. Sample 1 was a full sample with operational adjustments for all sampled sites. Samples 2 and 3 have non-operational results for all sites and operational results for only a subset of sites. The three-year realization rate has imputed operational adjustments for PY2019 and PY2020 results.

For PY2020 sampled customers used in the third year of the rolling three year sample, the operational RR formula was adjusted to make each year in the imputation weighted according the sample weighted savings of sites with operational adjustments rather the previous formula that used population tracking savings to weight historical years operational adjustments. The new weighting for 2020 takes into account that historical evaluations also imputed portions of the operational adjustment. By using sample weighted savings the historical data is more balanced in its representation.

Notation

w_j = full-sample weight for sample site j in the period-3 sample

S_y = population tracked savings of period y

S_T = population tracked savings for all 3 periods combined

$= S_1 + S_2 + S_3$

q_y = period-y savings as a fraction of the 3-period total

$= S_y/S_T$

SW_y = full sample weighted savings represented by “good” sites, i.e. those with operational data for period y

SW_T = full sample weighted savings represented by “good” sites, i.e. those with operational data for all 3 periods combined

$= SW_1 + SW_2 + SW_3$

f_{g3} = fraction of Period-3 savings represented by “good” sites, i.e. those with operational data

= (full-sample-weighted savings of Period-3 sample sites with operational data)/(total full-sample weighted savings for Period 3)

S_{Tg} = total savings for population represented by sites with operational data, across all samples

$= S_1 + S_2 + f_{g3}\, S_3$

RR_{oy} = operational-only realization rate for the period-y sample

RR_{Ny} = non-operational-only realization rate for the period-y sample

RR_{og3} = operational-only realization rate for the population represented by good sites in the period-3 sample, those with operational data

RR_{ob3} = imputed operational-only realization rate for the population represented by bad sites in the period-3 sample, those without operational data

SE(X) = standard error of estimate X

RSE(X) = relative standard error of estimate X

=SE(X)/X

Period 3 operational realization rate RR_{o3}

- For the portion of the population represented by sampled sites with operational adjustments ("good" sites g), RR_{og3} is directly calculated from the sample, using the full sample weights w_j. That is, RR_{og3} is the weighted sum of verified gross savings, divided by the weighted sum of tracked gross savings.
- For sampled sites without operational adjustment ("bad" sites b), RR_{ob3} is imputed as

  $RR_{ob3} = (SW_1RR_{o1} + SW_2RR_{o2} + SW_3RR_{og3})/SW_{Tg}$

  That is, all available sites with operational data are used to impute the RR for the uncovered portion of the period-3 population, with the RR from different periods weighted by the savings it represented.[4]

- Overall Operational Adjustment for Period 3 is calculated as

  $RR_{o3} = f_{g3}\ RR_{og3} + (1\text{-}f_{g3})RR_{ob3}$.

  That is, the operational adjustment for the directly represented portions of the population and the remainder are combined in proportion to their shares of period-3 tracked savings. This formula can be expanded as

  $RR_{o3} = f_{g3}\ RR_{og3} + (1\text{-}f_{g3})\ (SW_1RR_{o1} + SW_2RR_{o2} + SW_3RR_{og3})/SW_{Tg}$
  $= (1 + (1\text{-}f_{g3})\ SW_3/SW_{Tg})f_{g3}RR_{og3} + (1\text{-}f_{g3})(SW_1/SW_{Tg})RR_{o1} + (1\text{-}f_{g3})(SW_2/SW_{Tg})RR_{o2})$
  $= a_{og3}\ RR_{og3} + a_1RR_{o1} + a_2RR_{o2}$,

  Where

  $a_{og3} = (1 + (1\text{-}f_{g3})\ SW_3/SW_{Tg})f_{g3}$
  $a_1 = (1\text{-}f_{g3})(SW_1/SW_{Tg})$
  $a_2 = (1\text{-}f_{g3})(SW_2/SW_{Tg})$

  This expansion expresses the overall Period 3 operational realization rate as a weighted average of three independently estimated terms, the directly observed operational realization rate from each period. The factors multiplying the three

[4] In the evaluation of program year 2020 the formula was adjusted to weight historical years proportional to their weighted "good" site savings rather than using tracking savings. This way if a historical year had less operational adjustments it would have a lower weight in the imputation.

realization rates have the property that

$a_{og3} + a_1 + a_2 = 1$.

- Standard error of Period 3 realization rate: The standard error is calculated from the individual standard errors as

  $SE(RR_{o3}) = sqrt[a_{og3}^2\ SE^2(RR_{og3}) + a_1^2\ SE^2(RR_{o1}) + a_2^2\ SE^2(RR_{o2})]$

  This is true because the three RRs at step 3 are from independent samples.

Period 3 combined RR

- **The non-operational realization rate** RR_{N3} is calculated from the full sample using the full sample weights and the non-operational adjusted savings for the sample, via the usual formulas.

- **The Overall RR** is the product of the operational and non-operational RR

  $RR_3 = RR_{o3}\ \ RR_{N3}$

- **Standard error:** First calculate the relative standard error
  a. $RSE(RR_3) = sqrt[RSE^2(RR_{o3}) + RSE^2(RR_{N3})]$

  This formula is approximately correct, assuming that even though RR_o and RR_N are from a common sample, they are essentially unrelated so can be treated as independent.

  The standard error is then calculated from the RSE.

  b. $SE(RR_3) = RR_3\ RSE(RR_3)$

3-year combined RR

Preferred calculation

$RR_{1\text{-}3} = (S_1RR_1 + S_2RR_2 + S_3RR_3)/S_T$

$= q_1RR_1 + q_2RR_2 + q_3RR_3$

That is, the three-year RR is the savings-weighted average of the three separately estimated RRs.

This calculation produces an overall realization rate for each period, then combines these across periods. This approach is the natural one, combining the historical overall results with the most recent, consistent with our general method for three-year rolling realization rate calculation, and is therefore the preferred way to produce the three-year value.

However, because the third term RR_3 is determined in part from the operational portions of RR_1 and RR_2, the three are not independent estimates. Moreover, there's no obvious way to express the calculation as the sum of independent estimates, as would be needed to produce the standard error. We therefore look at an alternative calculation for purposes of standard error calculation only.

SE calculation

We use the standard error of an alternative calculation as an approximate to the standard error of the preferred calculation. The alternative calculation would be to calculate separate operational and non-operational realization rates for the three-

year period and multiply them. We calculate this SE. We can check how different the results are, but the SEs or inflation of SE ought to be ballpark the same.

Alternative RR calculation for SE calculation only

- 3-year operational realization rate
  $RR_{o1\text{-}3} = q_1 RR_{o1} + q_2 RR_{o2} + q_3 RR_{o3}$
- 3-year non-operational realization rate
  $RR_{N1\text{-}3} = q_1 RR_{N1} + q_2 RR_{N2} + q_3 RR_{N3}$
- Combined 3-year realization rate
  $RR_{1\text{-}3} = RR_{o1\text{-}3}\ RR_{N1\text{-}3}$

Standard error calculations for the alternative RR calculation

Non-operational three-period realization rate SE

The non-operational three-period realization rate is the savings-weighted average of the separate period realization rates. Since these are all independent, we can use the formula for combinations of independent estimates to produce the standard error.

$$SE(RR_{N1\text{-}3}) = sqrt[q_1^2\, SE^2(RR_{N1}) + q_2^2\, SE^2(RR_{N2}) + q_3^2\, SE^2(RR_{N3})]$$

Operational three-period realization rate SE

The operational realization rate is also the savings-weighted average of the three periods' operational realization rates, but these aren't all independent. We rearrange the formula to express the operational realization rate as a combination of independent estimates.

$$RR_{o1\text{-}3} = q_1\, RR_{o1} + q_2\, RR_{o2} + q_3 RR_{o3}$$
$$= (q_1 + a_1\ q_3)\, RR_{o1} + (q_2 + a_2\, q_3)\, RR_{o2} + q_3\, a_{og3}\, RR_{og3}$$

where the factors a_x are as defined above. With this expression of the three-period operational realization rate as a combination of independent estimates, is standard error is calculated as

$$SE(RR_{o1\text{-}3}) = sqrt[(q_1 + a_1\ q_3)^2\, SE^2(RR_{O1}) + (q_2 + a_2\, q_3)^2\, SE^2(RR_{O2}) + (q_3\, a_{og3})^2\, SE^2(RR_{O3})].$$

Relative standard error of overall three-period realization rate

By the same argument as above, the relative standard errors of the two realization rate factors are combined as if they were independent estimates. This is approximately correct, assuming that even though RR_o and RR_N are from a common sample, they are essentially unrelated so can be treated as independent.

$$RSE(RR_{1\text{-}3}) = sqrt[RSE^2(RR_{o1\text{-}3}) + RSE^2(RR_{N1\text{-}3})]$$

Standard error of the three-year realization rate

$$SE(RR_{1\text{-}3}) = RR_3\, RSE(RR_{1\text{-}3})$$

Level of aggregation for applying the formulas

Calculating Period 3 and three-period realization rates

The formulas for calculating the Period 3 operational realization rate RR_{o3}, the Period 3 overall realization rate RR_o, and the preferred three-period overall realization rate $RR_{1\text{-}3}$ are applied separately for each reporting category of realization rate. Typically, each reporting category includes sample points from multiple sampling cells.

For reporting categories with no Period 3 sample that has operational data the same formulas are used, with Period 3 contributing nothing to the three-period operational realization rate. For this study all of the reporting categories used had at least one sample point with operational data.

APPENDIX C. PY2020 UPDATED CUSTOMER COMMUNICATION PROTOCOL

Memo to: National Grid

Originally Prepared by: Srikar Kaligotla, Chad Telarico and Olav Hegland
DNV

Updated by: Laengheng Khoun, Glenn Gavi
DNV

Date: 12/15/2021

Copied to:
Geoff Cooper, Cameron Tuttle, Ryan Brown
DNV

RI – Customer Outreach Communications Protocol

1 INTRODUCTION

In response to the COVID-19 pandemic, National Grid has provided guidelines for customer communications as it relates to all studies that are underway or in the planning stages. National Grid provided additional guidelines for impact studies, specifically related to short- and long-term planning activities. This memo represents our response and implementation of these guidelines, specifically as they relate to RI PY2020 Custom Elec, RI PY2020 Custom Gas, and Lighting Market Characterization study applications.

The following summarizes key takeaways from National Grid guidelines[5]:

Customer Outreach

- National Grid will check with account managers on a case-by-case basis to determine if evaluators may pursue recruitment for all sampled sites
- If health care facilities, such as hospitals, nursing homes, or assisted living facilities, are selected in the sample, evaluators will immediately prepare a backup site in the case account managers do not provide permissions to recruit as those facilities pose the highest risk of needing to pursue other sites. If recruiting is permitted, the primary site will be interviewed and assessed for major impacts related to the pandemic or active cases of COVID-19 in the facility.
- If a site is majorly impacted by the pandemic or if it is not safe for the evaluation staff to visit the facility, the evaluation team may consider a virtual visit or select a backup site.
- Evaluation will not ask anyone to go into their facility if they are not already there or create a situation where a customer feels compelled to provide data during this difficult time.
- Evaluation will be mindful that response rates could differ from normal circumstances and any data we collect may be influenced by the current COVID19 situation. We will use our best judgment about what types of data would be meaningful to try to collect.

[5] RI Energy may change these guidelines over time, which may warrant revisions to this protocol.

- Evaluation may contact internal implementation staff (i.e., National Grid employees) regarding evaluation topics, but any communication will be sensitive to the fact that National Grid staff may be overwhelmed with other requests or immediate issues related to COVID19. We will be patient and understanding in communications.
- DNV will present all the results from the outreach to National Grid and seek their approval to visit the site.
- A site will be replaced with a backup site when there is a customer refusal.

2 METHODOLOGY

In response to the guidelines, we have prepared the following protocols to be used by all evaluators involved with the study for conducting customer outreach and for setting appropriate customer expectations. This protocol includes all planned customer interaction steps in the recruiting phase ONLY of the study, including:

- Initial outreach email
- Phone script for initial customer phone call

The evaluation team will first attempt to reach out to the site contact via email, followed by a phone call to solidify the customer's willingness to participate in the study, and an outline of the customer's involvement in the next steps. The protocol consists of the following steps:

- **Step 1**: Send an initial outreach email to the site contact describing the reason and objectives for reaching out.
- **Step 2:** If the contact does not reply within 48 hours after the initial contact, we will follow-up with a phone call. If the contact answers the call, we will use the same script. If the contact does not answer the call, we will leave a brief voicemail referring to the initial email and requesting a call-back. If we cannot make contact after Step 2, we will notify National Grid to discuss options.
- **Step 3:** We will report all responses gathered through communications described in steps 1 and 2 above, to National Grid.
- **Step 4:** We will monitor the situation and, based on recommendations provided by ***National Grid,*** we will adjust the language and/or approach for future follow up.

2.1 Step 1: Initial outreach email

2.1.1 Group 1: New Sites (no previous calls were made or emailed)

APPLICABLE PROJECTS:

- RI Custom Electric PY2020
- RI Custom Gas PY2020
- RI Lighting Market Characterization Study

Email the customer for recruiting purposes as soon as National Grid approves the script provided below. The purpose of this step is to reach the site contact and gather site-specific details on the measure(s) installed and possibly collect some intelligence on the status of the business right now.

Script:

Hello, my name is _____, and I am an Engineer at DNV. I'm contacting you on behalf of National Grid.

I would like to talk to you about the energy efficiency measure(s) installed at your facility through National Grid's [Program Name with program year]. National Grid has contracted independent consultants from my firm, DNV/DMI, to contact a sample of program participants and evaluate the performance of this energy-efficiency equipment. Our records indicate the following:

National Grid Application Number	*Installed Equipment Description*	*Estimated Annual Energy Savings (kWh)*	*Year of Completion*
1234567	*Variable Speed Drives on 2 Rooftop unit fans*	*45,678*	*2018*

*I am mainly interested in gathering more details on this equipment, its operation, and any other relevant details over the phone or by email. I would like to set up a phone call with you to go over these details at a time that is convenient for you. Please let me know if [**Date & Time**] would work for you. If not, can you please provide a time that works best for you?*

If you are not the right person, kindly forward the contact information of the person who is most familiar with this equipment. If you have any questions or concerns, please do not hesitate to contact me @email, ph.no).

I really appreciate your time and thank you for participating in National Grid's Energy Efficiency Program.

Best regards,

[Evaluation Engineer's Name]

2.2 Step 2: Follow-up phone call

The purpose of this call is to follow up on the objectives listed in the initial email, including:

a) Confirm that the contact person listed in the tracking data is the correct person to speak with
b) If not, identify the person most familiar with the installed measures and request an introduction and/or contact information for that person
c) The call should be brief and should aim at confirming the site's willingness to participate in the study and to briefly go over what's involved and briefly outline the next steps
d) If the site contact has time, also ask a few questions regarding facility operation during the COVID pandemic (Current/Planned facility operations)
e) Assess the impact of the COVID pandemic on the facility and the risk of conducting a site visit to the evaluation staff and facility staff.

Note for all engineers: continuously monitor conversation tone and acceptance to talk. If the site contact does not have time to speak, gently see if there is a time more convenient for them. Thank and terminate the call if the site contact is audibly frustrated.

If the site contact answers the phone:

Hello, my name is _____, and I am an Engineer at DNV/DMI. I'm contacting you on behalf of National Grid who has contracted with my firm, DNV/DMI, to contact a sample of program participants and evaluate the performance of energy-efficiency measures installed at your facility as part of National Grid's [Program Name with program year].

Screener Question: Based on our records, these measures are installed at a [Facility Type]. Can you please confirm the same?

*[**Q1**]: National Grid had listed you as the contact person and I want to confirm that you are the person I should speak to about these measures. [if NO, go to **Q2**, if YES, go to **Q3**]*

*[**Q2**] I would appreciate it if you could provide the name and contact information of the person I should speak with, or make an introduction [using the email I sent as background]?*

*[**Q3**]: Great! We don't have to go into details in this call, however if you have a few minutes, I'd like to go over the steps in the evaluation process. It should take no more than 5 minutes. Is that ok with you? [If NO, go to **Q4**, if **YES**, go to the **Scope Summary**]*

*[**Scope Summary**] The objective of the evaluation is to 1) verify the installed measures (listed in my email) and 2) to evaluate the associated kWh savings listed in the National Grid application(s).*

The evaluation process typically involves us reviewing all the project or application materials and conduct a site-visit either virtually or in-person or both, to verify and measure the actual energy usage of the installed equipment. If available, we will take account of any data sources available at the site. These sources include: Energy Management systems, sub-meters, trend data, etc. I'd appreciate it if you could describe any data sources available at your facility.

*I should mention that this process does not affect any incentives you have already received for the installed measures. Instead, it provides National Grid with general and independent feedback on how these measures perform and is mainly used by National Grid to improve the design of future energy efficiency programs. [When done, go to **Q5**]*

*[**Q4**]: Ok, that's no problem. Let's instead schedule a time that works better for you. Does [**date, time**] work for you? If not, can you suggest a time that works for you?*

*[**Q5**] Do you have any questions about this and can we schedule a time to go over the specifics of the measures installed? [if YES, go to **Q6**. If NO, go to **Refusal Wrap-up**]*

*[**Q6**] Great, thank you! Before we wrap up, I'd like to ask a few questions about your facility's operations. Is that ok? [If YES, ask **Q7**-**Q10**, if NO go to **Next Steps Wrap-up** and cover Q7-Q10 in the next call]*

Q7. Are you currently on-site or working remotely?

01 [Yes] *How often do you come on-site?*	*When done recording the answers Go to **[Q8]***
02 [No]	
97 [Don't know]	
98 [Refused]	

Q8. Are there other staff currently at the building?

01 [Yes] *How many on average and how does this relate to normal or historical staffing levels?*	*When done recording the answers*

02 [No]	*Go to **[Q9]***
03 [Don't know]	
04 [Refused]	

Q9. Has there been a significant change in building operations due to ?????

01 [Business running as normal] – ***Skip Q10***	*When done recording the answers Go to **[Q10]***
02 [Business operations have changed] *How has it impacted the business and how has that affected the measure(s)*	
03 [Don't know]	
04 [Refused]	

Q10. Can you describe any short or near-term plans for reopening?

	*When done recording the answers Go to **[Next Steps Wrap Up]***

[*Answer to **Q5** was NO, **Refusal Wrap up]***

Thank you for taking the time to speak with me today and thank you for participating in National Grid's energy efficiency programs.

*[**Next Steps Wrap up**]*

Thank you so much for your time, today. I will review these responses with my team and get back to you about an onsite visit shortly. Is there a good time for me to call you back this week or would you prefer an email?

On behalf of National Grid, we would like to thank you for taking the time to speak with me today and for participating in their energy efficiency programs.

[if follow up call date and time is confirmed]

*I look forward to speaking with you on **[date, time**].*

[if follow up call date and time is <u>not</u> confirmed]

I'd appreciate it if you can get back to me with a date and time for a follow-up conversation.

*In the meantime, don't hesitate to contact me or [**PA lead**] if you have any questions.*

Thank you!

APPENDIX D. SITE REPORTS

Individual site reports will be added once the program report is finalized.

APPENDIX E. UPDATED STEAM TRAP EVALUATION METHODOLOGY

Memo to:
Erin Crafts, National Grid
David Jacobson, Jacobson Energy
Copied to:
Srikar Kaligotla, DNV

Prepared By: Laengheng Khoun, DNV

Date: May 20, 2022

2020 RI Custom Gas Steam Trap Memo

1 Summary

This memo outlines DNV's plan to update the approach for evaluating steam trap projects included in the impact evaluation of the 2020 Custom Gas program administered by National Grid in Rhode Island. The evaluation approach for steam traps was updated to align with the new steam trap evaluation approach used beginning in the PY2020 Custom Gas evaluation by PAs in MA. The new approach used in MA is based on the following:

- Evaluators calibrated the steam trap tool to account for all operational characteristics of the steam system
- Both implementers and evaluators use the same tool to model steam traps

The updated approach to evaluate steam trap projects is presented in Section 2 below:

2 Steam Trap Evaluation

1. Review project files and compare them to tracking data.
    a. Identify any difference in tracking savings vs. application file savings. The evaluator will report the difference and classify it as an Admin error.
2. Confirm if the current National Grid steam trap tool (STT) was used (labelled as the "Steam Trap Repair / Replacement Custom Express Spreadsheet").
    a. If a different tool was used than the one that was current at the time of the project, fill in the correct tool with the applicant inputs and recalculate savings. This gives the difference in savings. The evaluator will report the difference and classify it as a Methodology difference.
3. Confirm if the steam system is still in place at the time of evaluation.
    a. If the steam system is no longer in place, the first-year savings is represented by the following:

$$First\ Year\ Savings = \frac{Number\ of\ months\ system\ was\ in\ place}{72\ Months} \times STTResults$$

The evaluator will report the difference and classify it as an "Other" difference.
Lifetime savings is represented by the following:

$$Lifetime\ Savings = First\ Year\ Savings \times 6\ Years$$

4. Identify any major discrepancies (orders of magnitude) through an interview or on-site verification.
    a. Report the large discrepancies (10x, 50x, 100x, etc.) but do not quantify the differences in savings results.

For all four sites that had steam trap projects and have been included in this evaluation, site engineers will report on all four items presented above.

3 Next Steps

- DNV will adjust the results for PY2018 and PY2019 steam trap sites to follow the approach described above.
- DNV will summarize the PY2018 and PY2019 updated site-level results for steam trap projects and present them in a summary memo that includes the PY2020 results for steam trap projects.
- DNV will request an addon budget to cover the costs of updating PY2018 and PY2019 results.
- DNV will use preliminary evaluation results and determine if there is enough historical data for steam trap and non-steam trap results to maintain the 80/20 3 year combined precision target if reported separately. Depending on the investigation, DNV will present the results as one of the following two options:
    a. Report the results for steam trap sites and non-steam trap sites as separate values.
    b. Combine the results of steam trap sites and non-steam trap sites as a single value.

APPENDIX F. STEAM TRAP RESULTS MEMO

Memo to:

Erin Crafts, National Grid

David Jacobson, Jacobson Energy

Prepared By: Laengheng Khoun, DNV

Copied to:

Srikar Kaligotla, DNV

Chad Telarico, DNV

Date: July 8, 2022

2020 RI Custom Gas Steam Trap Memo

6 Summary

This memo outlines DNV's update to the approach for evaluating steam trap projects included in the impact evaluation of the 2020 Custom Gas program administered by National Grid in Rhode Island. The evaluation approach for steam traps was updated to align with the new steam trap evaluation approach used beginning in the PY2020 Custom Gas evaluation by PAs in MA. The new approach used in MA is based on the following:

- Evaluators calibrated the steam trap tool to account for all operational characteristics of the steam system, thus in a sense already "evaluated".
- Both implementers and evaluators use the same tool to model steam traps

The updated approach to evaluate steam trap projects is presented in Section 2 below:

7 Steam Trap Evaluation

5. Review project files and compare them to tracking data.
    a. Identify any difference in tracking savings vs. application file savings. In this case, application file savings refers to the detailed savings calculation back-up in the program files, The evaluator will report the difference and classify it as an administrative error.
6. Confirm if the current National Grid steam trap tool (STT) was used (labelled as the "Steam Trap Repair / Replacement Custom Express Spreadsheet").
    a. If a different tool was used than the one that was current at the time of the project, fill in the correct tool with the applicant inputs and recalculate savings. This gives the difference in savings. The evaluator will report the difference and classify it as a Methodology difference.

7. Confirm if the steam system, not individual traps, is still in place at the time of evaluation.

    a. If the steam system is no longer in place, the first-year savings is represented by the following:

$$First\ Year\ Savings = \frac{Number\ of\ months\ system\ was\ in\ place}{72\ Months} \times STTResults$$

The 72 being the 6 year lifetime assumed for steam trap projects. The evaluator will report the difference and classify it as an "Other" difference.

Lifetime savings is represented by the following:

$$Lifetime\ Savings = First\ Year\ Savings \times 6\ Years$$

8. Identify any major discrepancies (orders of magnitude) through an interview or on-site verification. These major discrepancies will highlight issues or common trends among steam trap evaluations.

    a. For each evaluation of the custom program, the population will be stratified into steam trap and non-steam trap segments and the sample will be allocated to the two strata to meet precision targets. The evaluators will report a Steam Trap Realization Rate (STRR) and non-steam trap realization rate. The steam trap site evaluation will only examine and evaluate those parameters that a billing analysis may not capture, like orders-of-magnitude errors in data entry or when the steam system has been decommissioned.

    b. Periodically, the statewide STT will be recalibrated using a billing analysis model of an attempted census of participants. The calibration pool will exclude participants with billing data that fails quality screening and those that report non-routine events (NRE). The NRE's will be identified during surveys of potential billing analysis candidates. The calibrated model will be released as the next authorized version of the STT.

8 2020 Steam Trap Results

The results for the 2020 RI Custom Gas steam trap sites are summarized in Table 5-2 below. These show the findings for the 4 steam trap sites included in the PY2020 primary sample.

Table 5-2. 2020 Steam Trap Results Summary

Site ID	Application Number	Tracking Errors (Yes/No)	Applicant Calculation Tool Used	Tracked Savings (therms)	Evaluated Savings (therms)	Realization Rate	Lifetime Savings (therms)
2020RIG004S	Parent 8678109 / Child 9241027	No	2018 National Grid Steam Trap Tool	49,822	49,822	100%	298,932
2020RIG033S	11016913	No	2018 National Grid Steam Trap Tool	29,192	29,192	100%	175,152
2020RIG058S	11371101	No	2018 National Grid Steam Trap Tool	1,775	1,775	100%	10,650
2020RIG064S	11510840	No	2018 National Grid Steam Trap Tool	13,749	13,749	100%	82,494
Total				**94,538**	**94,538**	**100%**	**567,228**

The evaluators conducted a review of the applicant analyses for each steam trap site and determined there were no major errors among the calculations or methodology. All steam systems were in place during the time of the evaluation. Upon conducting the review for 2020RIG004S, the evaluator found that the observed failure rate was lower than theoretical failure rate. Based on the short life measure adjustment memo and a follow-up audit conducted by vendor, 15% steam traps were failed within two years which is less than the theoretical failure rate. This type of operational discrepancy is calibrated for in the SST and already accounted in the savings algorithms used in the tool. For 2020RIG064S, the evaluators were informed that the site had issues with steam trap failures after the project was installed. Evaluators visited the site and inspected a sample of 16 traps out of 31 traps replaced / repaired. The evaluators noted that 5 traps out of the 31 are currently bypassed and steam is vented to the atmosphere. At least 2 of those traps were reported to have failed more than twice. The evaluators determined that although the 5 bypassed traps yield no savings, no adjustment was made to the measure life as a result of this one case. No other discrepancies were found among the 2020 steam trap projects. The overall realization rate for 2020 steam trap projects was determined to be 100%.

9 2019 Steam Trap Results

Table 5-3. 2019 Steam Trap Results Summary

Site ID	Application Number	Tracking Errors (Yes/No)	Applicant Calculation Tool Used	Tracked Savings (therms)	Evaluated Savings (therms)	Realization Rate	Lifetime Savings (therms)
2019RIG026S	8884415	No	2018 National Grid Steam Trap Tool	2,120	2,120	100%	12,720
2019RIG064S	8651739	No	2018 National Grid Steam Trap Tool	13,038	13,038	100%	78,228
2019RIG095S	9494451, 8116687, 9208255	No	2018 National Grid Steam Trap Tool	8,530	8,545	100.1%	51,180
2019RIG104S	9494451	No	2018 National Grid Steam Trap Tool	1,676	1,676	100%	10,056
Total				**25,364**	**25,379**	**100%**	**152,184**

The evaluators conducted a review of the applicant analyses for each steam trap site and determined there were no major errors among the calculations or methodology. All steam systems were in place during the time of the evaluation. Upon conducting the review for 2019RIG026S, the evaluator found differences in steam trap operation hours and boiler efficiency. These types of discrepancies were already taken into account by the evaluators in the calibration of the STT so no adjustments were made. Upon conducting the review for 2019RIG064S, the evaluator found differences in steam trap operation pressure and found that one steam trap was taken offline, but again these types of discrepancies were already taken into account by the evaluators in the calibration of the STT so no adjustments were made. The evaluator noted that applications from the Strategic Energy Management Planning (SEMP) year 1 (2018) and year 2 (2019) were part of the 2019 evaluation and 2019RIG095S was a SEMP site. Upon conducting the review for 2019RIG095S, the evaluator noted that two steam traps were calculated using deemed savings rather than the Steam Trap Tool, equating to 200 therms of savings (100 therms each). One of these steam traps was double counted in 2019 so the evaluator subtracted 100 therms from the savings. For the remaining steam trap, the evaluators used the STT to calculate a savings of 215 therms. The combination of these two changes result in a difference of 15 therms overall. The overall realization rate for 2019 steam trap projects was determined to be 100%.

10 2018 Steam Trap Results

Table 5-4. 2018 Steam Trap Results Summary

Site ID	Application Number	Tracking Errors (Yes/No)	Applicant Calculation Tool Used	Tracked Savings (therms)	Evaluated Savings (therms)	Realization Rate	Lifetime Savings (therms)
2018RIG19	7919893	No	2018 National Grid Steam Trap Tool	8,730	8,730	100%	52,380
2018RIG58	7474075	No	2018 National Grid Steam Trap Tool	18,863	18,863	100%	113,178
Total				**27,593**	**27,593**	**100%**	**165,558**

The evaluators conducted a review of the applicant analyses for each steam trap site and determined there were no major errors among the calculations or methodology. All steam systems were in place during the time of the evaluation. Upon conducting the review for 2018RIG19, the evaluator found differences in steam trap operation hours, steam pipe pressure, and boiler efficiency. These discrepancies were already taken into account by the evaluator. Upon conducting the review for 2018RIG58, the evaluator found differences in steam trap operation hours and steam pipe pressure. These discrepancies were already taken into account by the evaluator. The overall realization rate for 2018 steam trap projects was determined to be 100%.

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