Verification of Vermont Gas Systems 2020 Savings Claims

July 28, 2021

SUBMITTED TO:
Vermont Department of Public Service

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Section 1 Executive Summary

This evaluation report documents the evaluation activities undertaken by NMR Group, Inc. (NMR) and BrightLine Group, collectively referred to as the NMR team, to verify the reported savings for Vermont Gas Systems' (VGS) energy efficiency programs in 2020. The NMR team was retained by the Vermont Department of Public Service (PSD) and completed this evaluation with their oversight. This evaluation project includes the following six VGS programs:

- Commercial Equipment Replacement (CER)
- Commercial Retrofit (CSR)
- Commercial New Construction (CNC)
- Residential Equipment Replacement (RER)
- Custom Residential New Construction (RNC)
- Custom Residential Retrofit (RIR)

A variety of measures were installed through these programs including boiler and hot water heater replacements, space heating, heat recovery equipment installation, building shell improvements, heating system control improvements, faucet and shower aerators, cooking equipment, and pipe wrap. VGS reported a total of 1,599 projects with a claimed annual savings of 69,460 MCF (thousand cubic feet of natural gas) for its entire portfolio in 2020.

The primary objective of this evaluation was to calculate the annual and peak day realization rates (RRs) associated with the VGS reported savings at the program and sector levels, while suggesting process improvements to streamline program implementation and savings verification efforts. Additionally, this report provides a comparison of the 2020 evaluation activities to the previous two evaluation activities conducted by the NMR team (2018 and 2019).

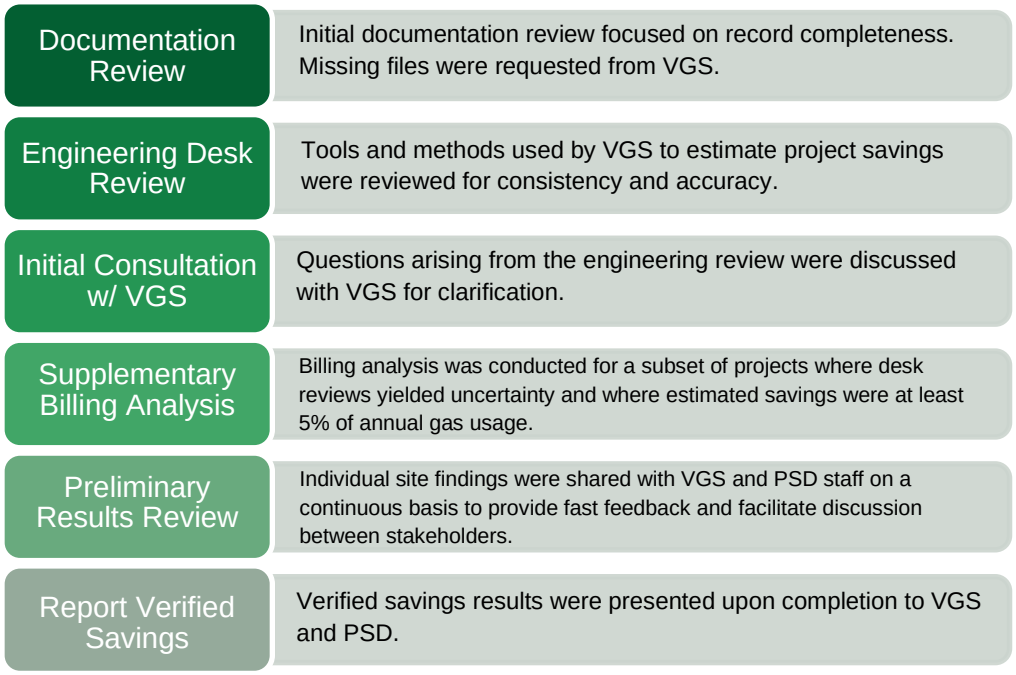
1.1 Sampling

The NMR team developed a sampling plan based on VGS reported savings and designed to achieve 80/10 confidence and precision for gross savings at sector level (commercial and residential), in accordance with PSD guidelines. The sample design was approved by the PSD in the initial phase of the evaluation project. Stratified ratio estimation (SRE) was employed to appropriately weight the impacts of different sizes of projects and reduce relative precision of results. Error ratios used to inform sample sizes were selected for each program based on prior evaluation results. Within each program, the largest projects were placed in a census stratum to ensure their inclusion in the evaluation sample. The NMR team formed the remainder of the 2020 evaluation sample by randomly selecting projects to satisfy each stratum in the sampling plan.

1.2 Methodology

The NMR team completed desk reviews for each project in the evaluation sample. These desk reviews followed the same general methodology across all programs, incorporating multiple phases of analysis and review, as described in Figure 1.

Figure 1. 2020 Evaluation Desk Review Process



1.3 RESULTS

The NMR team developed verified savings estimates for each project in the evaluation sample. The ratio of these verified results to the initial reported savings claimed by VGS is the realization rate which were then applied to the total population to determine the 2020 verified savings values. Table 1 and Table 2 summarized the realization rates and verified savings for each program, sector, and the overall portfolio for annual savings and peak day savings, respectively.

Table 1: PY2020 Verified Annual Savings Summary

Program	Total Projects	Sampled Projects	Annual Mcf			
			Reported Savings (MCF)	Verified Savings (MCF)	Realization Rate	Relative Precision[1]
Commercial Equipment Replacement	40	7	4,971	4,720	95.0%	0.7%
Commercial New Construction	20	6	10,321	10,108	97.9%	5.5%
Commercial Retrofit	46	7	35,516	34,677	97.6%	1.1%
Commercial Sector	**106**	**20**	**50,809**	**49,505**	**97.4%**	**1.4%**
Residential Equipment Replacement	1,484	12	15,447	14,460	93.6%	6.3%
Residential New Construction	7	7	2,984	2,951	98.9%	0.0%
Residential Retrofit*	2	2	220	219	100.0%	0.0%
Residential Sector	**1,493**	**21**	**18,651**	**17,631**	**94.5%**	**5.2%**
Portfolio Level	**1,599**	**41**	**69,460**	**67,136**	**96.7%**	**1.7%**

[1]At 80% confidence
*Custom multifamily residential retrofit projects only.

Table 2: PY2020 Verified Peak Day Savings Summary

Program	Total Projects	Sampled Projects	Peak Day Mcf		
			Reported Savings (MCF)	Verified Savings (MCF)	Realization Rate
Commercial Equipment Replacement	40	7	53.9	51.1	94.7%
Commercial New Construction	20	6	99.9	92.9	93.0%
Commercial Retrofit	46	7	85.5	45.0	52.7%
Commercial Sector	**106**	**20**	**239.3**	**189.0**	**79.0%**
Residential Equipment Replacement	1,484	12	116.4	113.3	97.3%
Residential New Construction	7	7	33.1	32.6	98.4%
Residential Retrofit	2	2	0.8	0.8	100.0%
Residential Sector	**1,493**	**21**	**150.4**	**146.7**	**97.5%**
Portfolio Level	**1,599**	**41**	**389.6**	**335.6**	**86.1%**

1.3.1 Key Drivers – Relative Precision

The sampling plan developed for this project successfully exceeded the targeted 80/10 program-level confidence and precision for the annual MCF savings. Most programs, both residential and commercial, are dominated by a few large projects. Including all such large projects in the evaluation sample through stratified sampling ensured low overall relative precisions.

1.3.2 Key Drivers – Commercial Annual Savings Realization Rates

The overall realization rate for the commercial sector was 97.4%. Project-level realization rates varied based on individual project findings, with findings from one large project significantly driving the sector realization rate. Key observations for the commercial sector are:

- **Adherence to the TRM and general consistency.** VGS employed a number of TRM-based and other calculators in a consistent manner, with noted improvements over prior years.
- **Using incorrect capacity for TRM algorithm to calculate space heating savings.** The VGS savings algorithm for space heating incorrectly used the input capacity instead of the output capacity. Using the corrected capacity, the verified savings decreased between 4-6% for the space heating measures.

1.3.3 Key Drivers – Residential Annual Savings Realization Rates

The Residential Equipment Replacement (RER) program which accounts for 83% of the sector savings and was the primary driver of the overall sector level realization rate of 95%. Project-level realization rates varied based on individual project findings but were primarily in a 6% band between 98% and 102%. The RER program realization rate was largely driven by one project that had a low realization rate of 18%. Key observations driving the realization rates for the residential sector are:

- **Measure identification error.** A measure error was identified for one RER project where the installed heating only boiler was counted as a combination appliance. As a correction, the verified savings are adjusted to only including the space heating savings.

- **Adherence to the TRM and general consistency.** VGS employed a number of TRM-based and other calculators in a consistent manner such that many projects achieved realization rates close to 100%.

1.3.4 Key Drivers – Peak Day Savings Realization Rates

VGS calculates peak day savings by applying a set of end-use multipliers to estimated annual savings. Therefore, findings that affect annual MCF savings carry over to peak day MCF savings proportionally.

1.4 RECOMMENDATIONS

The NMR team offers the following recommendations to Vermont Gas to improve future programs, bring realization rates closer to 100%, and streamline future evaluation activities. Additional recommendations and details are included in Section 6 of this report.

➢ **Expand Project Documentation Practices**

VGS is in the process of taking a deeper look at their analytical tools and overall processes in preparation for expansion of their programs. We recommend that VGS consider increasing the amount of information documented for each type of project. These expanded documentation practices will streamline future evaluations by providing a more organized view of each project and transparency into VGS's assumptions.

➢ **Add clarification on the type of capacity to be used to calculated savings for space heating measures.**

VGS savings algorithm for space heating incorrectly used the input capacity instead of the output capacity. VGS and Efficiency Vermont TRMs do not specify which capacity to use in their savings algorithm. NMR recommends that VGS makes changes to their TRM algorithm by changing the wording of "capacity" in their algorithm to "output capacity".

➢ **Additional Internal QC Processes**

VGS should consider adding an internal QC process or expanding existing processes to include a comprehensive final review of project documentation and savings calculations at the time of project closeout especially for large-sized projects. Items that could be relevant for inclusion in the final QC step and/or checklist are: QC review of savings calculation, documentation of differences between contracted and finalized project scope, demarcation of final savings calculations, consistent unit conversions between natural gas volume and energy quantities, etc.

Section 2 Project Background

The NMR team was retained by the Vermont PSD to provide technical assistance with Verification of Vermont Gas Systems (VGS) Annual Savings Claims. This evaluation project includes primarily impact evaluation activities for program years 2018, 2019 and 2020. This report is the third in the series and focuses on the evaluation activities for program year 2020 and compares the savings across all three program years which can be found in Section 5.4.

2.1 Goals and Objectives

The primary goal of this evaluation is to provide assurance that programs cost-effectively address customer barriers to implementing energy-efficiency measures in their homes or businesses. The primary findings from these evaluation efforts will help the Vermont PSD and VGS plan for future program offerings, budget expenditures and evaluation strategies.

The objective of this evaluation is to calculate the annual and peak day realization rates (RRs) at the program and sector levels while suggesting process improvements to streamline program implementation and savings verification efforts.

The programs for which the gas savings were verified are as follows:

- Commercial Equipment Replacement (CER)
- Commercial Retrofit (CSR)
- Commercial New Construction (CNC)
- Residential Equipment Replacement (RER)
- Custom Residential New Construction (RNC)
- Custom Residential Retrofit (RIR)

The PSD has outlined the following specific objectives for the evaluation of VGS' energy-efficiency program annual savings claims for program years 2018-2020:

- Determine VGS' progress toward several quantifiable performance indicators (QPIs) for the program years 2018-2020, as described in the Vermont Public Utilities Commission (PUC) order from October 2017, including:
  - QPI #1: Annual Incremental MCF Savings
  - QPI #2: Total Resource Benefits (Costs)[1]
  - QPI #3: Peak Day MCF Savings
- Develop best in class, transparent, and thoroughly documented evaluations.

[1] This QPI is not addressed in the report. The NMR team will provide support to DPS to address this QPI outside the scope of this report.

2.2 SUMMARY OF EVALUATION ACTIVITIES

The NMR team divided the overall evaluation effort into six key tasks.

- **Task 1: Kick-off meeting and work plan development.** Develop an evaluation work plan to describe the processes that will be followed to complete the tasks outlined in this project for each program year.
- **Task 2: Tracking data review and analysis.** Review the VGS program participant tracking databases for accuracy and comprehensiveness. We will also include suggestions for potential improvements to the tracking system for streamlining future evaluations.
- **Task 3: Sampling plan development.** Develop a sampling plan designed to meet 80/10 confidence/precision for the Mcf savings for each program based on the outcomes of Task 1 and Task 2.
- **Task 4: Engineering analysis and verification.** Perform technical engineering analysis to verify natural gas energy savings for each program and sector.
- **Task 5: Project reporting and deliverables.** Deliver a final report that meets the requirements and deadlines set by the Vermont PSD and PUC. The NMR team will also provide PSD and VGS staff with all project documentation in a mutually agreed upon and easy to use database.
- **Task 6: Project Management.** Yogesh Patil of NMR is the Principal-in-Charge and single point of contact with the PSD and VGS for this project. He conducted regular scheduled project update/review meetings with the PSD and VGS teams.

2.3 SUMMARY OF PROGRAM REPORTED SAVINGS

VGS staff provided PY2020 tracking data for all the programs included in this evaluation. The NMR team reviewed and analyzed the tracking data to determine the actual program- and measure-level gas savings. Table 3 presents the overall portfolio savings at the program level as reported by VGS.

Table 3: Overall PY2020 Reported Savings Summary*

Program	Projects	Reported Annual Savings (MCF)	Reported Peak Day Savings (MCF)
Commercial Equipment Replacement	40	4,971	53.9
Commercial New Construction	20	10,321	99.9
Commercial Retrofit	46	35,516	85.5
Commercial Sector	**106**	**50,809**	**239.3**
Residential Equipment Replacement	1,484	15,447	116.4
Residential New Construction	7	2,984	33.1
Residential Retrofit	2	220	0.8
Residential Sector	**1,493**	**18,651**	**150.4**
Total	**1,599**	**69,460**	**389.6**

* Includes only the projects evaluated by the NMR team under this verification effort, not the entire portfolio

Section 3 Sampling

The NMR team developed a sampling plan designed to achieve 80/10 confidence and precision for gross savings at the program level, in accordance with DPS guidelines. The sample design was consistent with the previous two years and approved by the PSD in the initial phase of the evaluation project.

3.1 Sampling Plan

The NMR team employed stratified ratio estimation (SRE) to improve precision and minimize sample sizes. Each component of the sample design is described briefly in Figure 2. The projects accounting for the bottom 4% of reported savings were excluded from the sample frame. The largest projects within each program were allocated into a census stratum, ensuring their inclusion in the evaluation sample. Sample sizes were selected to meet the intended 80/10 confidence and precision target at sector level using assumed error ratios customized to each program based on results from the PY2018 and PY2019 evaluations.

Figure 2. Sampling Plan Approach

Sample Frame	All projects completed 1/1/2020 through 12/31/2020	Smallest projects (bottom 4% of savings) excluded
Method	Stratified Ratio Estimation (SRE)	Consistent with approach employed in 2016, 2017, 2018, and 2019
Primary Sampling Unit	Project	Project may contain multiple measures
Confidence/Precision	80/10	Targeted at the program level
Error Ratio	Program-specific values ranging from 0.20 to 0.30	Customized based on results from prior evaluations
Stratification Variables	Program, Project Size	Largest projects separated into a census stratum

3.2 Summary

Table 4 presents the overall sample design indicating the sample sizes and the anticipated precision for all the programs and stratum.

Table 4: Overall Sample Design PY2020

Program	Strata	Annual Mcf	# Projects	% Savings	Error Ratio	Sample Size	Relative Precision
Commercial Equipment Replacement	Census	1,840	3	37%	0.30	3	0%
	1	1,532	5	31%	0.30	2	21%
	2	1,452	24	29%	0.30	2	26%
	3	148	8	3%	0.30	0	n/a
CER Total		**4,971**	**40**			**7**	**10%**
Commercial New Construction	Census	5,892	3	57%	0.20	3	0%
	1	4,087	11	40%	0.20	3	13%
	2	343	6	3%	0.20	0	n/a
CNC Total		**10,321**	**20**			**6**	**5%**
Commercial Retrofit	Census	16,909	3	48%	0.30	3	0%
	1	17,507	21	49%	0.30	4	17%
	2	1,100	22	3%	0.30	0	n/a
CSR Total		**35,516**	**46**			**7**	**9%**
Commercial Sector		**50,809**	**106**			**20**	**6%**
Residential Equipment Replacement	Census	486	2	3%	0.30	2	0%
	1	7,244	259	47%	0.30	5	17%
	2	7,253	935	47%	0.30	8	14%
	3	464	288	3%	0.30	0	n/a
RER Total		**15,447**	**1,484**			**12**	**12%**
Residential New Construction	Census	2,984	7	100%	n/a	7	0%
RNC Total		**2,984**	**7**			**7**	**0%**
Residential Retrofit	Census	220	2	100%	n/a	2	0%
RIR Total		**220**	**2**			**2**	**0%**
Residential Sector		**18,651**	**1,493**			**21**	**10%**
Overall Portfolio		**69,460**	**1,599**			**41**	**5%**

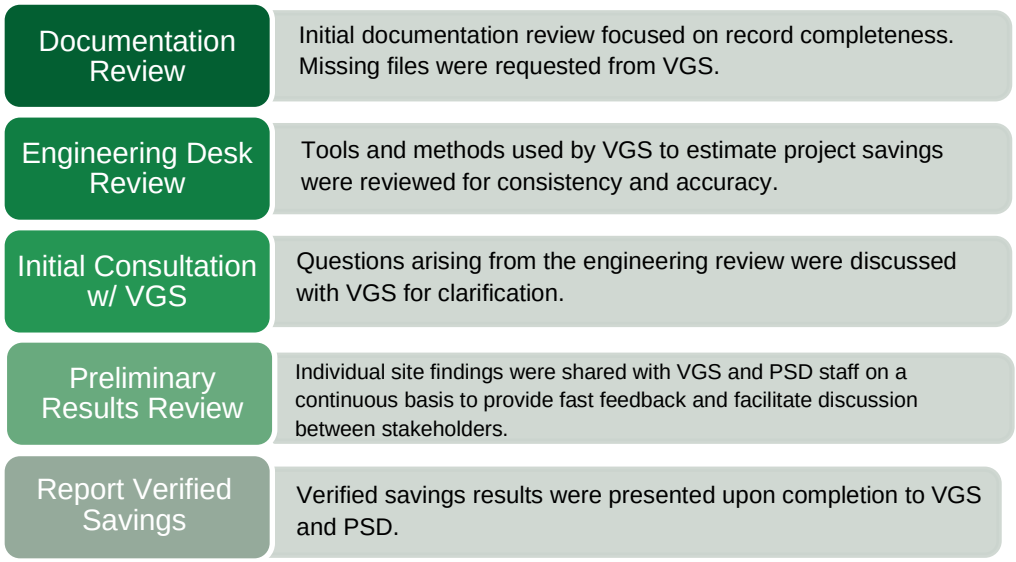
Section 4 Methodology

Following approval of the sampling plan, the NMR team formed the 2020 evaluation sample by randomly selecting projects to satisfy each sample stratum. All records and documents associated with the projects in the evaluation sample were then obtained from VGS. Desk reviews were completed for each project. Verified savings for these projects were then rolled up to the program- and sector-level.

4.1 Desk Review Process

The NMR team applied the same general method to evaluate savings for all programs, incorporating the steps described in Figure 3. More detail into the specifics of these steps is provided in subsequent sections.

Figure 3. Evaluation Desk Review Activities



4.1.1 Documentation Reviews

Documentation review was completed for all projects in the evaluation sample as a critical pre-cursor to completing further savings analysis activities. The documentation review sought to determine whether the provided project files were complete, well documented, and adequate for calculation of energy savings.

Projects with missing documentation were flagged and VGS was able to locate and transfer the missing documentation in all cases.

4.1.2 Engineering Desk Reviews

Engineering desk reviews were also completed for all projects in the evaluation sample. This review focused on verifying the energy savings for each measure within each sampled project. Key questions answered through this review process are:

1. Do the calculation methods rely on deemed or prescribed technical reference manual (TRM) algorithms, program tools, or custom savings calculations performed by participants or third-party contractors (if applicable)?
2. Are the calculation methods correctly applied, appropriate, and accurate?
3. What reliable documentation is available on the baseline conditions, including information in the program database, such as applications, savings calculations performed by participants or third-party contractors (if applicable), audits, construction energy codes (new construction only), invoices for equipment or contracting services, and any other documentation available to VGS?
4. What data sources were used as the basis of savings calculations (e.g. manufacturer spec sheets, site-specific data, or rules of thumb)?

For measures incentivized using prescribed TRM algorithms, the NMR team independently re-calculated savings using parameters verified through inspection of equipment documentation like spec sheets or AHRI certificates. For measures based on custom savings calculations, the NMR team assessed both the incorporated algorithms and the associated input parameters. Algorithms were evaluated for alignment with industry best practices, including consideration of other publicly available TRMs, DOE UMPs, and ASHRAE publications.

Findings from engineering desk reviews were discussed at multiple points with VGS and PSD staff to allow for additional consideration into project context and background. Finalized savings calculations for each project become the evaluation verified savings.

4.1.3 Continuous Feedback

The VGS team incorporated multiple points of communication with VGS and PSD throughout the evaluation to ensure that verified savings estimates for each project incorporated a complete understanding of project conditions. Requests for clarification and additional documentation were provided to VGS on a rolling basis through the desk review process. Verified savings were also provided in batches upon completion for review and comment.

4.2 Report Verified Savings

The evaluation desk review activities result in adjustment factors, or realization rates (RR), calculated for each stratum in the sample using the following relationship:

$$RR = \frac{\sum Sample\ Verified\ Savings}{\sum Sample\ Reported\ Savings}$$

Verified savings for each stratum are obtained by multiplying strata realization rates against the total reported savings for that stratum. Results from each stratum were rolled up to the program-, sector-, and portfolio-level using project weights and stratification tiers as appropriate.

Section 5 Observations and Results

VGS's programs were determined to be providing significant annual energy and peak day energy savings. This section describes findings and results from the evaluation of VGS's 2020 programs and presents a comparison with findings from the evaluations of VGS's 2018 and 2019 programs. Detailed results for the projects included in the evaluation sample are provided in Appendix A.

5.1 Observations

During the evaluation, the NMR team made the following high-level observations.

- The NMR team's review of reported savings for all programs found that, overall, the reported savings estimations were aligned with the evaluation framework, followed proper custom site-specific activities, applied TRM protocols correctly, and that the reported savings are generally accurate.
- VGS program staff members displayed in-depth technical understanding of natural gas equipment operation and engineering principles surrounding energy efficiency savings calculations.
- VGS has incorporated recommendations from the PY2018 and PY2019 evaluation into practice and has showed increased attention to detail in PY2020.
- VGS's consistency in Mcf/MMBtu conversion factors has greatly improved for PY2020 compared to PY2018 and PY2019.
- VGS program staff members also expressed an ongoing commitment to maintaining positive customer relationships and improving program offerings.
- VGS is employing TRM-based calculation approaches for several measures including boiler, furnace, and hot water heater replacements.
- VGS's project documentation can be challenging for an outside observer to piece together. Assumptions included in savings estimates, at times, were found to be undocumented. These factors pose challenges to evaluators but can also pose internal hurdles during project handoffs between VGS staff. However, VGS has been working on reducing these challenges by implementing newer modified tools. These tools are specifically designed to gather and document additional supporting information thereby providing evaluators with the relevant measure details.

5.2 Commercial Program Results

5.2.1 2020 Commercial Program Annual MCF Savings Results

The verified annual savings for VGS's commercial programs was 49,505 MCF, with an overall sector realization rate of 97%. Table 5 provides the program-level results and associated relative

precision. At the 80% confidence level designated at the outset of this study, these results have a ±1.4% precision band. This low relative precision was achieved by employing census sampling for large project strata.

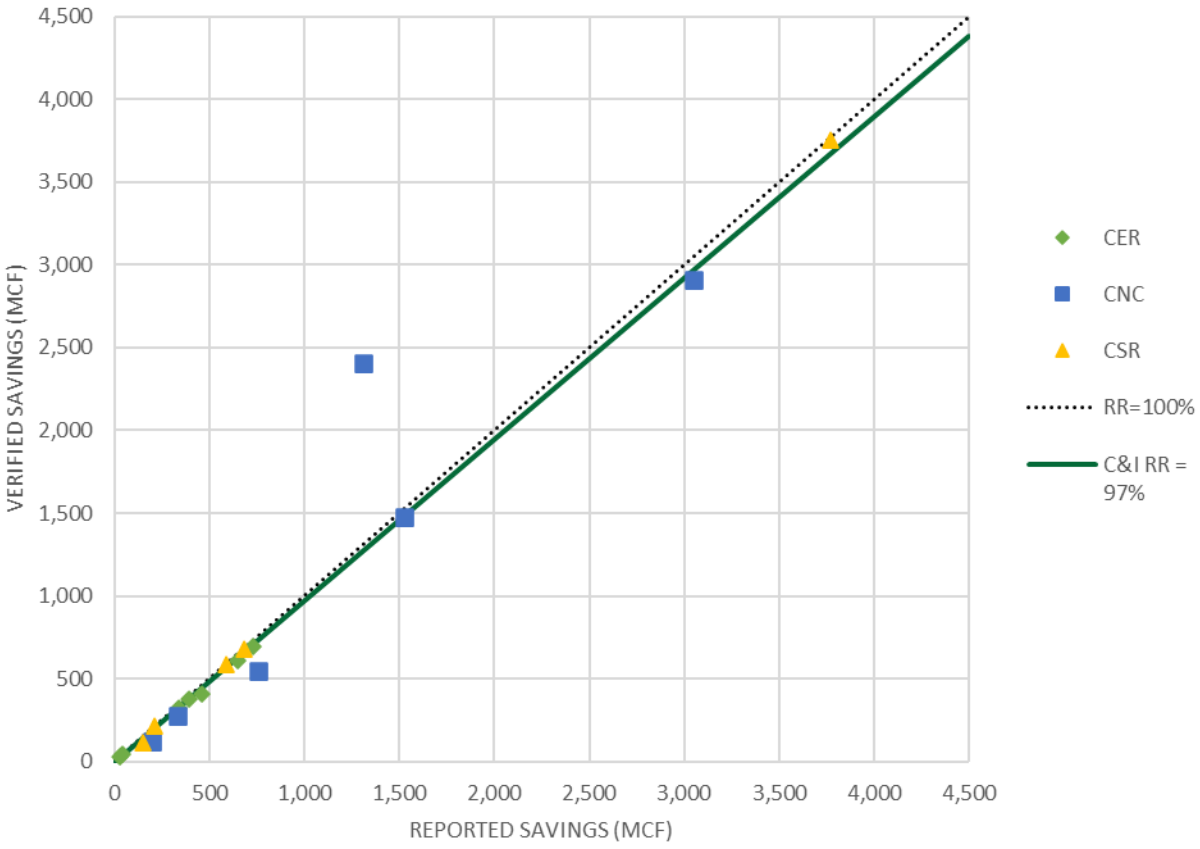
Table 5: PY2020 Commercial Sector Verified Annual Savings Summary

Program	Projects	Reported Savings (MCF)	Verified Savings (MCF)	Realization Rate	Relative Precision[1]
Commercial Equipment Replacement	40	4,971	4,720	95.0%	0.7%
Commercial New Construction	20	10,321	10,108	97.9%	5.5%
Commercial Retrofit	46	35,516	34,677	97.6%	1.1%
Commercial Sector	**106**	**50,809**	**49,505**	**97.4%**	**1.4%**

[1]At 80% confidence level

Figure 4 is a graphical representation of the project-level results for each project in the evaluation sample. While many projects were found to have a near-100% realization rate, findings for one of VGS's projects from the CNC program deviated from the 100% realization rate.

Figure 4. PY2020 Commercial Project-Level Results



Project-level realization rates varied based on individual project findings. Key observations influencing the realization rates for the commercial sector are:

- **Incorporating billing gas usage data into TRM-based algorithms.** VGS used billing gas usage data as a 'heating load' input into TRM algorithms for equipment replacements. To estimate 'heating load', billing data should typically be adjusted to account for the efficiency of the boiler in place during the billing periods used.
- **Discrepancy with using the correct capacity** The VGS savings algorithm for space heating incorrectly used the input capacity instead of the output capacity. Using the corrected capacity, the verified savings decreased between 4-6% for the space heating measures.
- **Adherence to the TRM and general consistency.** VGS employed a number of TRM-based and other calculators in a somewhat consistent manner. This consistency resulted in 14 of 20 projects in the commercial sample achieving realization rates between 93% and 100%.
- **Minor discrepancies between savings calculations and tracked savings.** The NMR team observed several projects where minor differences were noted between the savings values in the tracking database and the final calculations. One project in particular had the savings entered in CCFs instead of MCFs in the tracked savings, resulting in an error by a factor of 10 from the intended value.
- **Minor discrepancies with unit conversions.** The NMR team observed an overall improvement with unit conversions compared to previous program years. However, a few projects still had inconsistencies in conversions between MMBtus and MCFs.
- **Savings are driven by only a few projects.** For commercial projects, more than 50% of savings came from 10 of the 106 projects.

5.2.2 2020 Commercial Program Peak Day MCF Savings Results

The verified peak day savings for VGS's commercial programs was 189.0 MCF, with an overall sector realization rate of 79%. Table 6 provides the program-level results. The realization rate for the commercial sector was greatly affected by a single commercial retrofit project, where VGS used an incorrect load shape for the process equipment.

Table 6: PY2020 Commercial Sector Verified Peak Day Savings Summary

Program	Projects	Reported Savings (MCF)	Verified Savings (MCF)	Realization Rate
Commercial Equipment Replacement	40	53.9	51.1	94.7%
Commercial New Construction	20	99.9	92.9	93.0%
Commercial Retrofit	46	85.5	45.0	52.7%
Commercial Sector	**106**	**239.3**	**189.0**	**79.0%**

VGS does not claim peak day savings for customers enrolled in interruptible service rates. Thus, the projects that make up the reported peak day savings are a subset of the total population. VGS calculates peak day savings by applying a set of end-use-specific multipliers to estimated annual savings at the measure level. The NMR team verified peak day savings by first determining the

appropriate end-use multiplier for each measure and then multiplying by the verified annual MCF savings for each measure. Therefore, findings that affect annual MCF savings as outlined in Section 5.2.1 carry over to peak day MCF savings proportionally for the mix of non-interruptible projects in the sample.

For PY2020, the NMR team found a large discrepancy with one of VGS's application of peak day multipliers.

5.3 RESIDENTIAL PROGRAM RESULTS

5.3.1 2020 Residential Program Annual MCF Savings Results

The verified annual savings for VGS's residential programs was 17,631 MCF, with an overall sector realization rate of 95%. Table 7 provides the program-level results and associated relative precision. At the 80% confidence level designated at the outset of this study, these results have a ±5.2% precision band. This low relative precision was achieved by employing census sampling for large strata.

Table 7: PY2020 Residential Sector Verified Annual Savings Summary

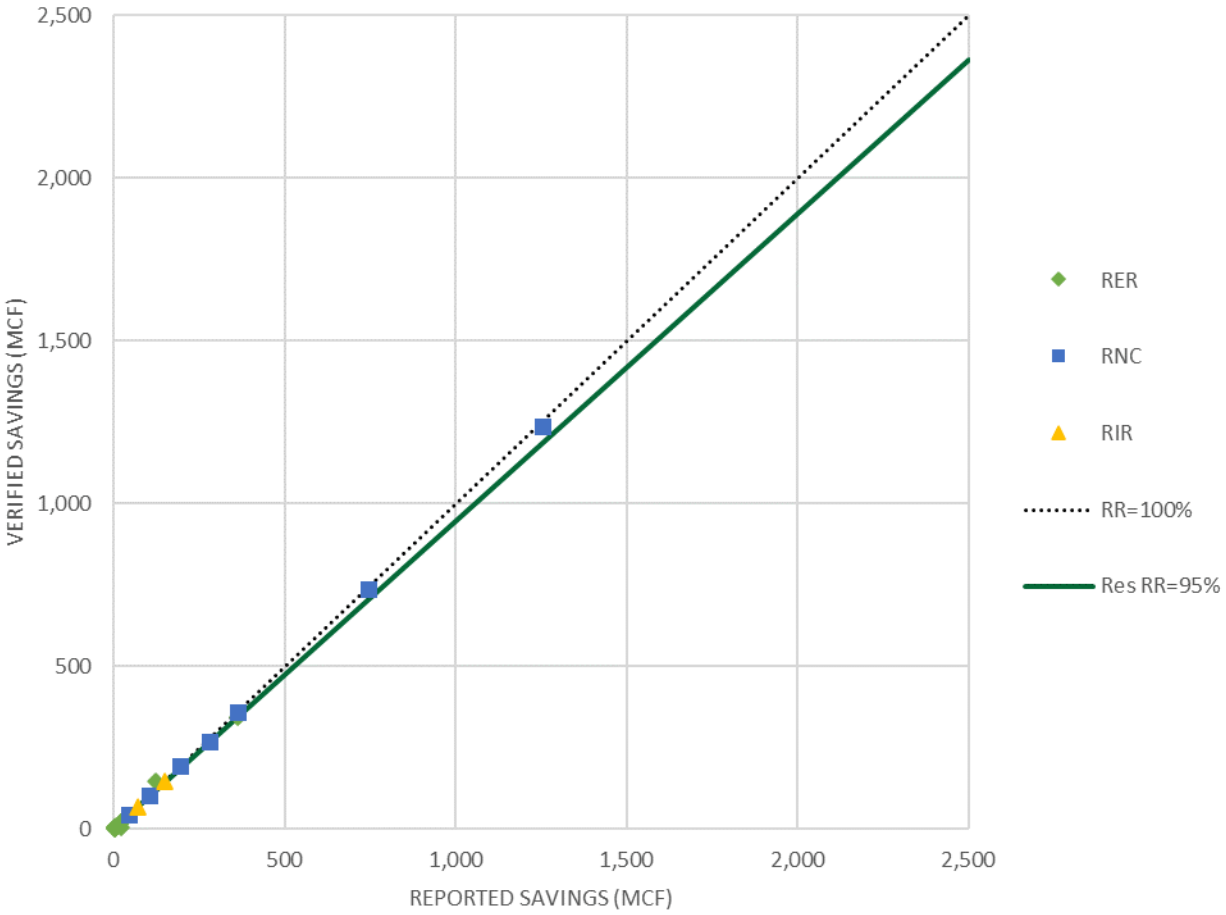
Program	Projects	Reported Savings (MCF)	Verified Savings (MCF)	Realization Rate	Relative Precision[1]
Residential Equipment Replacement	1,484	15,447	14,460	93.6%	6.3%
Residential New Construction	7	2,984	2,951	98.9%	0.0%
Residential Retrofit	2	220	219	100.0%	0.0%
Residential Sector	**1,493**	**18,651**	**17,631**	**94.5%**	**5.2%**

[1]At 80% confidence level

Note that only two custom projects for RIR program were evaluated. The remainder of the non-custom projects were evaluated in separate studies.

Figure 5 is a graphical representation of the project-level results for each project in the evaluation sample. Two of the RNC projects accounted for 67% of the program savings. For RER, the top three projects only accounted for 3% of the program savings.

Figure 5.Residential Project-Level Results



Project-level realization rates varied based on individual project findings. Key observations influencing the realization rates for the residential sector are:

- **Discrepancy with using the correct capacity** The VGS savings algorithm for space heating incorrectly used the input capacity instead of the output capacity. Using the corrected capacity, the verified savings decreased between 4-6% for the space heating measures.
- **Minor discrepancies with unit conversions.** The NMR team observed an overall improvement with unit conversions compared to previous program years. However, a few projects still had inconsistencies with MMBtu to MCF conversion.
- **Measure identification error.** A measure error was identified for one RER project where the installed "space heating only" boiler was treated as a combination appliance. As a correction, the verified savings are adjusted to only including the space heating savings.

5.3.2 2020 Residential Program Peak Day MCF Savings Results

The verified peak day savings for VGS's residential programs was 146.7 MCF, with an overall sector realization rate of 98%. Table 8 provides the program-level results and associated relative precision.

Table 8: PY2020 Residential Sector Verified Peak Day Savings Summary

Program	Projects	Reported Savings (MCF)	Verified Savings (MCF)	Realization Rate
Residential Equipment Replacement	1,484	116.4	113.3	97.3%
Residential New Construction	7	33.1	32.6	98.4%
Residential Retrofit	2	0.8	0.8	100.0%
Residential Sector	**1,493**	**150.4**	**146.7**	**97.5%**

The peak day MCF savings verification was based on determining appropriate application of VGS's peak savings factors used in the tracking database. Through interaction with VGS staff the NMR team was able to understand how those factors are developed and applied.

5.4 Comparison with Previous Evaluations

Results from PY2020 as compared to PY2018 and PY2019 are shown in Table 9 for the commercial sector and

For the residential sector, the reported savings in PY2020 were less than those reported in PY2018 and PY2019. For PY2020 the reported residential savings were about one third (36%) of the commercial savings.

Table 10 for the residential sector. For the commercial sector, the reported savings in PY2020 were significantly more than those reported in PY2018 and PY2019. The realization rate for the PY2020 annual savings were closer to 100% compared to PY2018 and PY2019.

Table 9: PY2020 Commercial Sector Verified Annual Savings 3-year Comparison

Commercial Sector	2018	2019	2020	3 Year Total
Total Qty of Projects	91	104	106	301
Sampled Projects	23	18	20	61
Annual Savings				
Reported Annual Savings (MCF)	29,819	27,763	50,809	108,391
Verified Annual Savings (MCF)	32,498	26,241	49,505	108,244
Realization Rate	109%	95%	97%	100%
Relative Precision	4.0%	2.5%	2.6%	NA
Peak Day Savings				
Reported Peak Day Savings (MCF)	124.1	199.6	239.3	563
Verified Peak Day Savings (MCF)	136.9	183.1	189.0	509

Realization Rate	110%	92%	79%	90%

For the residential sector, the reported savings in PY2020 were less than those reported in PY2018 and PY2019. For PY2020 the reported residential savings were about one third (36%) of the commercial savings.

Table 10: PY2020 Residential Sector Verified Annual Savings Summary

Program Year	2018	2019	2020	3 Year Total
Total Qty of Projects	1,690	1,592	1,493	4,775
Sampled Projects	50	20	24	94
Annual Savings				
Reported Annual Savings (MCF)	24,067	29,880	18,651	72,598
Verified Annual Savings (MCF)	24,425	28,377	17,631	70,433
Realization Rate	101%	95%	95%	97%
Relative Precision	3%	5.2%	5.7%	NA
Peak Day Savings				
Reported Peak Day Savings (MCF)	218.7	286.8	150.4	656
Verified Peak Day Savings (MCF)	223.4	270.3	146.7	640
Realization Rate	102%	94%	98%	98%

5.5 ERROR RATIOS

Observed error ratios in the 2020 evaluation sample are listed in Table 11, alongside the assumed ratios used in sample design. For all programs, the observed error ratio was smaller than our sample design assumption. Error ratio is not applicable to RIR in 2020 since only two projects were evaluated.

Table 11: 2020 Program Level Error Ratios

Program	Error Ratio	
	2020 Design	2020 Evaluated
Commercial Equipment Replacement (CER)	0.30	0.03
Commercial New Construction (CNC)	0.20	0.36
Commercial Retrofit (CSR)	0.30	0.03
Residential Equipment Replacement (RER)	0.30	0.27
Residential New Construction (RNC)	0.20	0.01
Residential Retrofit (RIR)	n/a	n/a

Section 6 Recommendations

The NMR team offers the following recommendations to Vermont Gas to improve future programs, bring realization rates closer to 100%, and streamline future evaluation activities.

- **Expand Project Documentation Practices**

VGS is in the process of taking a deeper look at their analytical tools and overall processes in preparation for expansion of their programs. We recommend that VGS consider increasing the amount of information documented for each type of project. The NMR team recommended something similar last year and has seen VGS starting to implement it, starting with modification of analysis tools. By deciding to revamp the analytical tools, VGS will be able to consistently gather and document additional information such as:

- A project summary document in text form that describes the installed energy efficiency measure(s), the relevant baseline condition, equipment operating conditions, project timeline, and project invoices.
- The source(s) behind all key parameters driving energy savings estimates in the calculation spreadsheets.
- Inspection reports and invoices for prescriptive measures to more thoroughly document project scope.

In addition, these expanded documentation practices will streamline future evaluations by providing a more organized view of each project and transparency into VGS's assumptions.

- **Add clarification on the type of capacity to be used to calculated savings for space heating measures.**

VGS savings algorithm for space heating incorrectly used the input capacity instead of the output capacity. VGS and Efficiency Vermont TRMs do not specify which capacity to use in their savings algorithm. NMR recommends that VGS makes changes to their TRM algorithm by changing the wording of "capacity" in their algorithm to "output capacity".

- **Additional Internal QC Processes**

VGS should consider adding an internal QC process or expanding existing processes to include a comprehensive final review of project documentation and savings calculations at the time of project closeout especially for large-sized projects. Items that could be relevant for inclusion in the final QC step and/or checklist are: QC review of savings calculation, documentation of differences between contracted and finalized project scope, demarcation of final savings calculations, consistent unit conversions between natural gas volume and energy quantities, etc.

Specific processes that could improve realization rates include:

- Add internal QC review for high impact measure savings calculations and include scrutiny of vendor-submitted savings calculation.

- Develop process to ensure that final savings calculations are stored, and final savings values are entered in tracking database.

➢ **Specific Algorithm Updates**

The NMR team proposes one specific update to VGS space heating algorithm for energy savings to improve consistency. This suggestion has been passed to VGS throughout the evaluation.

Appendix A Site Results

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