

Verification of Vermont Gas Systems 2023 Annual Savings Claims

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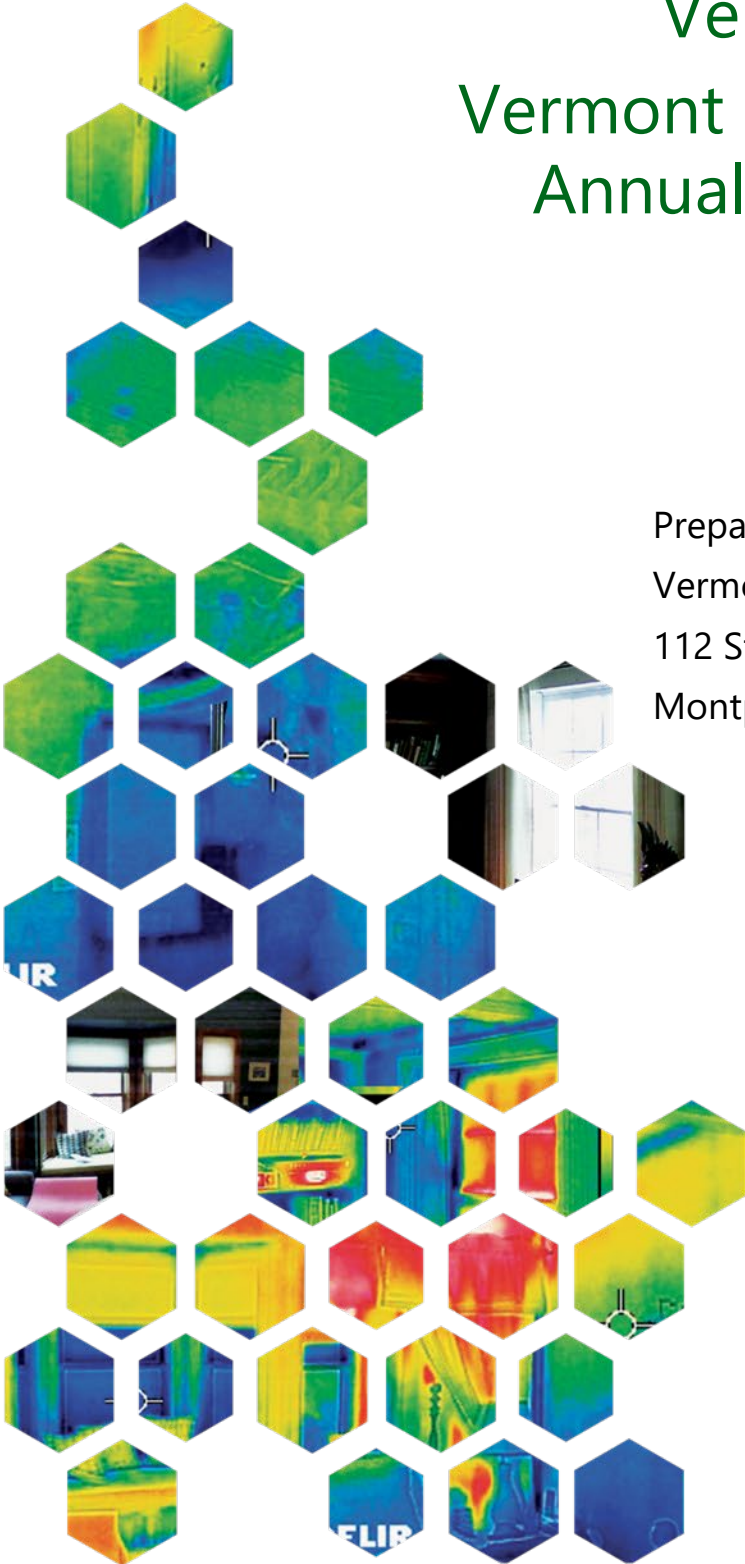


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Appendix

Appendix A: Site-Level Reports



ES Executive Summary

This report covers savings verification for Vermont Gas Systems (VGS) energy efficiency programs for program year (PY) 2023. The 3-year verification cycle covers PY2021 through PY2023. The Vermont Department of Public Service (PSD) contracted with West Hill Energy and Computing (West Hill Energy) to provide independent verification of VGS's energy efficiency portfolio. The PSD Evaluation Team, consisting of West Hill Energy and Cx Associates, implemented this evaluation, which covers VGS's residential and commercial energy efficiency programs.

The primary objective of this evaluation was to estimate the program and portfolio annual and peak day Mcf realization rates (RRs) associated with VGS reported savings. The PSD Evaluation Team also reviewed VGS's progress in meeting the quantifiable performance indicators (QPIs) established by the Vermont Public Utilities Commission (PUC) and provided recommendations to improve RRs and streamline verification efforts.

ES.1 Methods

This evaluation verified the annual incremental Mcf saving, peak day savings, and lifetime natural gas savings for PY2023. The PSD Evaluation Team also determined VGS's progress toward several QPIs, as described in the Vermont PUC order.

The main savings verification method was to conduct engineering desk reviews for a sample of sites. Where applicable, a billing analysis was conducted to estimate actual savings or to inform the results of the desk review. Sample sizes were designed to meet 80/10 confidence and precision for the gross annual Mcf savings at the program level. Error ratios were informed by prior PY2020, PY2021, and PY2022 savings verification results. Table ES-1 provides a summary of the sampling and evaluation approach by program.

TABLE ES-1: SUMMARY OF VGS PY2023 SAMPLING AND EVALUATION APPROACH

| Program | Sampling Approach | Evaluation Approach |
|---|--|---|
| Commercial and Industrial (C&I) Programs | Stratified random sample by unique site to capture interactive effects | Engineering desk review and billing analysis for select projects, where appropriate. |
| Residential Multifamily Programs | Stratified random sample by unique site | |
| Residential Equipment Replacement (RER) Single Family | Stratified random sample with separate strata for control measures | The PSD Evaluation Team conducted sampling and the PSD conducted desk reviews for this program. |
| Residential Single-Family Retrofit | N/A | RRs from the previous impact evaluation were applied. ¹ |
| Residential Single-Family New Construction | N/A | RR for the RNC program from EVT's 2022 Annual Savings Verification was applied. ² |

¹ Impact Evaluation of Vermont Gas System's Residential Retrofit Program. Prepared by West Hill Energy and Computing. September 2018. Page 7.

² Report to Verify Efficiency Vermont 2022 Savings Claim. Prepared by Cadmus Group. June 2023. Page 19. The results from the 2023 verification cycle were not yet available when the VGS verification analysis was completed.



The PSD Evaluation Team completed desk reviews for each project in the sample. The steps in evaluating each project across all programs were similar and included multiple steps of initial project file review, data requests, analysis, and review. The evaluation process is shown in Figure ES-1.

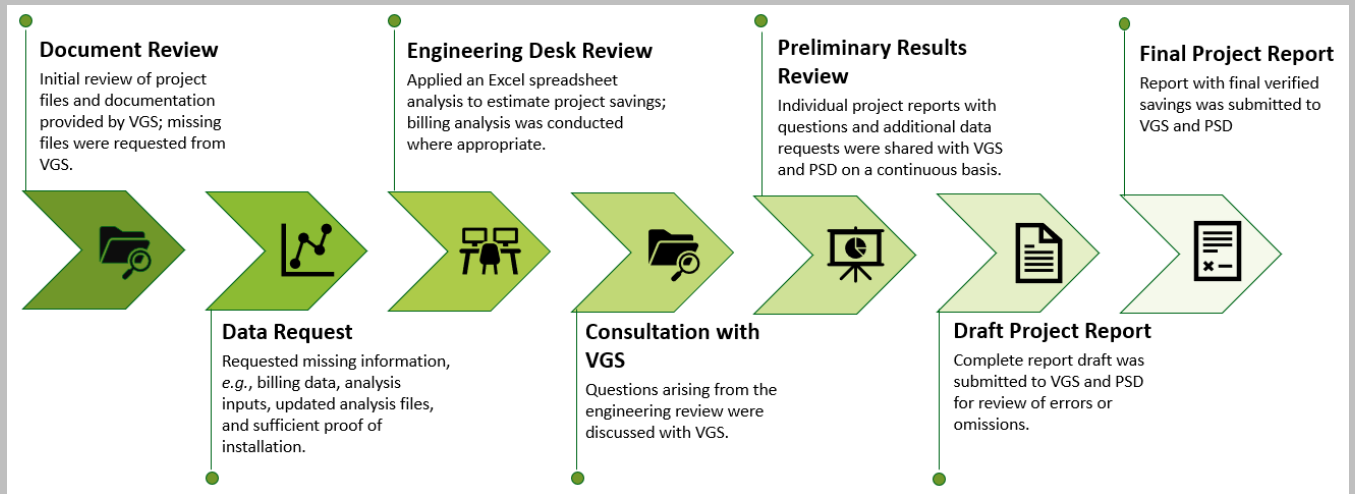


FIGURE ES-1: EVALUATION DESK REVIEW APPROACH

The PSD Evaluation Team was in regular communication with VGS and the Vermont PSD staff to ensure verified savings were based on a complete understanding of the project details.

ES.2 Results

The PSD Evaluation Team developed verified savings estimates for each project in the sample. The ratio of these verified results to the program reported savings is the RR, which was then applied to the total population to determine the 2023 verified savings. For the residential single-family Residential Retrofit (RIR) and Residential New Construction (RNC) programs, the RR from other studies were applied, as specified in Figure ES-1.

ES.2.1 Annual Mcf Savings

The RRs and relative precision for VGS’s annual Mcf savings are provided in Table ES-2. The portfolio RR is 84% with a relative precision of 1.4% at the 80% confidence level.

TABLE ES-2: SUMMARY OF PROGRAM REPORTED AND VERIFIED PY2023 ANNUAL MCF SAVINGS

| Program | Total Sites | Sampled Sites | Reported Annual Savings (Mcf) | PSD Verified Annual Savings (Mcf) | Realization Rate | Relative Precision |
|---------------------------|-------------|---------------|-------------------------------|-----------------------------------|------------------|--------------------|
| <i>Commercial Sector</i> | | | | | | |
| Equipment Replacement | 68 | 4 | 11,314 | 11,145 | 99% | 9.3% |
| New Construction | 6 | 2 | 1,631 | 1,531 | 94% | 2.3% |
| Retrofit | 25 | 6 | 120,908 | 96,798 | 80% | 1.5% |
| Total Commercial Sector | 99 | 12 | 133,853 | 109,474 | 82% | 1.6% |
| <i>Residential Sector</i> | | | | | | |
| Equipment Replacement | 1,600 | 22 | 9,764 | 9,671 | 99% | 1.5% |
| New Construction | 27 | 4 | 2,644 | 2,542 | 96% | 3.7% |
| Retrofit | 545 | 1 | 4,351 | 4,347 | 100% | 8.7% |
| Total Residential Sector | 2,172 | 27 | 16,759 | 16,560 | 99% | 2.5% |
| Portfolio Total | 2,271 | 39 | 150,612 | 126,033 | 84% | 1.4% |

The most common reasons for differences in realized savings are listed below.

- **Incorrect inputs** – Errors included incorrect efficiencies, pipe length, savings factors (for thermostats), and heat loss values. For one measure, the lifetime savings was incorrectly inputted as the annual savings.
- **Incorrect peak day and lifetimes** - One measure used a lifetime that did not match the Vermont Technical Reference Manual (TRM) defaults or agreements with the Vermont PSD. A few measures used incorrect peak day factors. In one project, the PSD Evaluation Team adjusted the peak factor because VGS used the heating system peak factor for a measure that was a combination of end uses, *i.e.*, pipe insulation serving domestic hot water (DHW) and heating, resulting in an overstatement of the program reported savings.
- **Mismatch to billing data** – Savings for one of the largest C&I projects were estimated using engineering calculations only and comparison to the bills indicated the savings were not being realized as expected, which substantially affected the RR for the Commercial Retrofit Program (CSR). Several other projects had lower heating loads than the TRM assumptions when compared to billing data and one site had a higher load as the VGS estimate was based on outdated historic data.
- **Conversion and unit errors** – Other unit errors included incorrectly converting from CFM75 to CFM50.

- o **Measure double counted** – One measure was included in VGS’s program reported savings twice due to an error in project tracking.

Reviewing pre-install billing records as a reality check is one approach to avoid some errors in future verification cycles.

ES.2.2 Peak Day Mcf Savings

The RRs and relative precision for VGS’s peak day Mcf savings are provided in Table ES-3. The portfolio RR is 77% with a relative precision of 0.8% at the 80% confidence level.

TABLE ES-3: SUMMARY OF PROGRAM REPORTED AND VERIFIED PY2023 PEAK DAY MCF SAVINGS

| Program | Total Sites | Sampled Sites | Reported Peak Day Savings (Mcf) | PSD Verified Peak Day Savings (Mcf) | Realization Rate | Relative Precision |
|---------------------------|--------------|---------------|---------------------------------|-------------------------------------|------------------|--------------------|
| <i>Commercial Sector</i> | | | | | | |
| Equipment Replacement | 68 | 4 | 67.0 | 56.9 | 85% | 3.3% |
| New Construction | 6 | 2 | 16.8 | 15.7 | 94% | 2.4% |
| Retrofit | 25 | 6 | 95.5 | 25.7 | 27% | 0.0% |
| Total Commercial Sector | 99 | 12 | 179.4 | 98.3 | 55% | 1.2% |
| <i>Residential Sector</i> | | | | | | |
| Equipment Replacement | 1,600 | 22 | 98.4 | 97.8 | 99% | 1.3% |
| New Construction | 27 | 4 | 26.7 | 26.3 | 98% | 1.6% |
| Retrofit | 545 | 1 | 55.5 | 55.5 | 100% | 2.7% |
| Total Residential Sector | 2,172 | 27 | 180.7 | 179.5 | 99% | 1.1% |
| Portfolio Total | 2,271 | 39 | 360.1 | 277.8 | 77% | 0.8% |

Peak savings are based on the verified annual Mcf multiplied by the peak day factor for each measure depending on the end use; therefore, findings that affect annual Mcf savings also affect peak day Mcf savings. The peak savings factor was adjusted for some commercial and residential measures to match the end use. For example, VGS applied the heating system peak savings factor for pipe insulation on a system that served only process loads rather than the DHW peak savings factor.

ES.2.3 Lifetime Mcf Savings

The RRs and relative precision for VGS’s lifetime Mcf savings are provided in Table ES-4. The portfolio RR is 83% with a relative precision of 1.5% at the 80% confidence level.



TABLE ES-4: SUMMARY OF PROGRAM REPORTED AND VERIFIED PY2023 LIFETIME MCF SAVINGS

| Program | Total Sites | Sampled Sites | Reported Lifetime Savings (Mcf) | PSD Verified Lifetime Savings (Mcf) | Realization Rate | Relative Precision |
|---------------------------|-------------|---------------|---------------------------------|-------------------------------------|------------------|--------------------|
| <i>Commercial Sector</i> | | | | | | |
| Equipment Replacement | 68 | 4 | 232,412 | 228,939 | 99% | 9.5% |
| New Construction | 6 | 2 | 25,349 | 23,610 | 93% | 3.0% |
| Retrofit | 25 | 6 | 2,223,614 | 1,768,232 | 80% | 1.6% |
| Total Commercial Sector | 99 | 12 | 2,481,375 | 2,020,781 | 81% | 1.7% |
| <i>Residential Sector</i> | | | | | | |
| Equipment Replacement | 1,600 | 22 | 195,599 | 191,817 | 98% | 1.3% |
| New Construction | 27 | 4 | 50,683 | 47,098 | 93% | 7.8% |
| Retrofit | 545 | 1 | 94,101 | 93,998 | 100% | 2.4% |
| Total Residential Sector | 2,172 | 27 | 340,383 | 332,913 | 98% | 1.5% |
| Portfolio Total | 2,271 | 39 | 2,821,758 | 2,353,694 | 83% | 1.5% |

To determine lifetime savings, the PSD Evaluation Team multiplied the verified annual Mcf savings by the lifetime for each measure. Thus, findings that affect annual Mcf savings also affect the lifetime Mcf savings. The variation in lifetimes across measure type results in some differences in the final RR. In addition, there was one measure for which VGS used a lifetime that did not match the Vermont TRM defaults or values agreed on with the Vermont PSD for the measure.

ES.3 Recommendations

The PSD Evaluation Team offers the following recommendations to improve future VGS programs RRs and streamline future verification processes. Addressing ongoing issues will reduce the amount of time spent on each project review and provide transparency into VGS calculations and assumptions.

TABLE ES-5: SUMMARY OF PROGRAM RECOMMENDATIONS

| Recommendation | Description |
|--|---|
| Continue to Improve Project-Level Documentation* | Continue with PY2023 improvements by providing more detailed descriptions of the projects, listing sources of all inputs, and including invoices. |
| Confirm Heat Load Estimation with Billing Analysis | Check heat loads calculated using engineering calculations to billing data whenever possible. |
| Update Normalization to Use Average Weather Values Rather than Typical Meteorological Year (TMY)3* | PY2023 verification used TMY3 weather as it was the basis for developing VGS’s goals. West Hill Energy recommends updating weather normalization to the 6-to-10-year average for future use to better reflect the impacts of global climate change. |
| Continue to Improve Internal Savings Calculation Quality Control (QC)* | Continue to work on internal QC processes to include a comprehensive review of project documentation, savings calculations, application of the correct peak savings factor, and comparison to consumption records (if appropriate). |
| Timing of Project Completion | Particularly for large, complex projects, finalize project reported savings and complete the project after the equipment or systems are tested and operational to ensure full savings are being achieved. |
| Establish an Evaluation Framework | Set guidelines for turnaround times, acceptance of project-specific reports, and limits on the number of times the same issue can be raised and addressed to ensure that evaluators can complete the project on time and within budget. |

*These recommendations were also made in whole or in part in the PY2020 savings verification report prepared by NMR and/or the PY2021 and/or PY2022 savings verification report prepared by West Hill Energy.



1 Introduction

This report documents the savings verification of VGS's energy efficiency programs during PY2023. Vermont PSD contracted with West Hill Energy to provide independent verification of VGS's energy efficiency portfolio. The PSD Evaluation Team, consisting of West Hill Energy and Cx Associates, conducted the evaluation. The evaluation included the following VGS programs:

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

VGS offers incentives for a variety of measures including space heating (boilers, furnaces), heating systems controls, hot water replacement, building shell improvements, pipe insulation, cooking equipment, faucet, and shower aerators.

The primary objective of this evaluation was to estimate the program and portfolio annual and peak day Mcf RRs associated with VGS reported savings. The PSD Evaluation Team also reviewed VGS's progress in meeting the QPIs established by the PUC and provided recommendations to improve RRs and streamline verification efforts.

The following subsections provide details on VGS's PY2023 program activity and previous evaluation history.

1.1 Program Activity

The PSD Evaluation Team reviewed VGS PY2023 program tracking database to determine program and sector level savings. Table 1-1 provides a summary of the overall portfolio savings at the program level, as reported by VGS. As shown in Table 1-1, about 88% of the portfolio annual Mcf savings are from C&I programs and over 66% of the portfolio savings are from the two largest C&I projects.

TABLE 1-1: SUMMARY OF PROGRAM REPORTED PY2023 SAVINGS

| Program | Number of Projects | Reported Annual Savings (Mcf) | Reported Peak Day Savings (Mcf) |
|-------------------------------------|--------------------|-------------------------------|---------------------------------|
| <i>Commercial Sector</i> | | | |
| Equipment Replacement (CER) | 68 | 11,314 | 67.0 |
| New Construction (CNC) | 6 | 1,631 | 16.8 |
| Retrofit (CSR) – 2 Largest Projects | 2 | 101,572 | 0.0 |
| Retrofit (CSR)- All Other Projects | 23 | 19,336 | 95.5 |
| Total Commercial Sector | 99 | 133,853 | 179.4 |
| <i>Residential Sector</i> | | | |
| Equipment Replacement (RER) | 1,600 | 9,764 | 98.4 |
| New Construction (RNC) | 27 | 2,644 | 26.7 |
| Retrofit (RIR) | 545 | 4,351 | 55.5 |
| Total Residential Sector | 2,172 | 16,759 | 180.7 |

1.2 Evaluation History

The PSD has conducted annual savings verification for VGS for the past several years. From PY2018 through PY2020, the NMR Group was the evaluator. West Hill Energy was contracted to conduct savings verification for PY2021 through PY2023. This report is the final savings verification report for the 3-year cycle.

VGS operates the single-family RNC in conjunction with Efficiency Vermont (EVT). The PSD has conducted annual savings verification for EVT from its inception in 2000. Cadmus conducted the most recent verification cycle.¹

The PSD also oversaw impact evaluations of the components of VGS's residential portfolio for PY2014 to 2016.²

¹ Report to Verify Efficiency Vermont 2022 Savings Claim. Prepared by Cadmus Group. June 2023. The results from the 2023 verification cycle were not yet available when the VGS verification analysis was completed.

² Impact Evaluation of Vermont Gas System's Residential Retrofit Program. Prepared by West Hill Energy and Computing. September 2018.



2 Methods

The primary goal of this evaluation was to estimate annual Mcf and peak day natural gas savings for PY2023. The main verification method was to conduct desk reviews on a sample of sites. Where applicable, a billing analysis was conducted to estimate actual savings or to inform the results of the desk review. Table 2-1 provides a summary of the evaluation approach by program.

TABLE 2-1: SUMMARY OF VGS PY2023 EVALUATION APPROACH BY PROGRAM

| Program | Evaluation Approach |
|--|---|
| Commercial & Industrial Programs | Engineering desk review and billing analysis for sampled projects |
| Residential Multifamily Programs (MER, MNC, MIR/MLI) | |
| RER Single Family | The PSD Evaluation Team conducted sampling and the PSD conducted desk reviews for this program. |
| RIR Single Family | VGS applied RR from the previous impact evaluation. ¹ |
| RNC Single Family | The RR for the RNC program from the EVT's 2022 Annual Savings Verification was applied to the trued-up values provided by EVT. ² |

¹ Impact Evaluation of Vermont Gas System's Residential Retrofit Program, page 7. Prepared by West Hill Energy and Computing. September 2018.

² Report to Verify Efficiency Vermont 2022 Savings Claim. Prepared by Cadmus Group, June 2023, page 19. VGS reported savings as 22 Mcf per project and EVT provided trued-up values based on EVT's modeling. For PY23, the trued-up values were provided to VGS after the tracking data was provided to West Hill Energy for evaluation. The results from the 2023 verification cycle were not yet available when the VGS verification analysis was completed.

The following sections describe the sampling and analysis.

2.1 Sampling

VGS programs were divided into three groups of programs for sampling purposes:

- C&I programs
- Residential multifamily programs, including the Multifamily Equipment Replacement (MER), Multifamily Retrofit/Multifamily Low Income (MIR/MLI) and Multifamily New Construction (MNC),
- RER single-family program

The sampling plans were designed to address program specific characteristics.

TABLE 2-2: SAMPLING OVERVIEW

| VGS Program | Number of Sites/ Projects | Sample Size | Sampling Group | Notes |
|--|---------------------------|-------------|-------------------------|--|
| <i>Commercial</i> | | | | |
| CER | 68 | 7 | CER/CNC/CSR | Sampling was done by site. Poststratification was conducted to determine RRs by program. |
| CNC | 6 | | | |
| CSR | 23 | | | |
| CSR – Large | 2 | 2 | CSR | Two largest projects were placed in a separate stratum as they accounted for over 66% of the total portfolio savings. |
| <i>Residential Multifamily</i> | | | | |
| RER | 8 | 7 | Residential multifamily | Sampling was done by site. Poststratification was conducted to determine RRs by program. |
| RIR | 3 | | | |
| RNC | 5 | | | |
| <i>Residential Single Family</i> | | | | |
| RER | 1,592 | 20 | Single-family RER | The PSD Evaluation Team conducted the sampling. The sample frame was stratified by controls and no controls, as well as by size. The PSD conducted the reviews for this program. |
| RIR | 542 | N/A | Single-family RIR | RRs from the previous impact evaluation were applied. |
| RNC ¹ | 22 | N/A | Single-family RNC | The RR for the RNC program from EVT's 2022 Annual Savings Verification was applied. |
| ¹ VGS operates this program in conjunction with Efficiency Vermont. | | | | |

The following sections provide the sampling plan for each of the three programs.

2.1.1 Commercial and Industrial

C&I programs account for 89% of VGS's PY2023 portfolio annual Mcf. The projects in this category include equipment replacement, new construction, and retrofit projects completed at C&I facilities. The first step of the sampling process was to separate the sites with the two largest projects and place them in a census stratum, as they accounted for over 66% of the entire portfolio for PY2023. The PSD Evaluation Team then employed stratified ratio estimation for the remaining population and sample sizes were calculated to meet or exceed 80/10 confidence/precision level for the sector. A summary of the sampling approach is provided in Table 2-3.

TABLE 2-3: SAMPLING APPROACH FOR THE C&I PROGRAMS

| Sampling Component | Description | Comments |
|-----------------------|-----------------------------|--|
| Population Size | 94 sites | All CER and CNC sites were included in the population. All CSR except the 2 largest were included in the population. VGS's database had 3 sites with measures in more than one program. The unique site was used for sampling. |
| Sample Frame | 55 sites | The smallest projects accounting for less than 3% of the program reported annual Mcf savings were excluded from the sample frame. |
| Stratification | Annual Mcf reported savings | Projects were divided into three strata based on the size of the annual Mcf savings and sample sizes were calculated using an error ratio of 0.50. The two largest projects were placed in stratum 4. |
| Primary Sampling Unit | Site | The unique site was the sampling unit to account for interactive effects. |
| Target Sample Size | 9 | Random selection was applied to small sites (strata 1 and 2) and a census of the largest sites (strata 3 and 4) was reviewed. |

Table 2-4 provides a summary of the C&I savings by stratum and the sample sizes. The sites with the largest two projects (stratum 4) are excluded from this table.

TABLE 2-4: C&I SAMPLE SIZES FOR PY2023 FOR STRATA 1 TO 3

| Program | Strata | % Annual Mcf Commercial Savings | % Peak Day Mcf Commercial Savings | Total Number of Sites | Sampled Sites ¹ |
|-------------|--------|---------------------------------|-----------------------------------|-----------------------|----------------------------|
| CER/CNC/CSR | 0 | 3% | 5% | 39 | 0 |
| CER/CNC/CSR | 1 | 20% | 27% | 43 | 2 |
| CER/CNC/CSR | 2 | 34% | 50% | 9 | 2 |
| CER/CNC/CSR | 3 | 43% | 17% | 3 | 3 |
| Total | | | | 94 | 7 |

¹Two sites had projects in both the CSR and CER programs.

All sites were reviewed for strata 3 and 4, which accounted for about 95% of the total C&I annual Mcf savings.



2.1.2 Residential Multifamily

The residential multifamily projects account for approximately 2% of VGS's PY2023 portfolio annual Mcf. The projects in this category include retrofit, equipment replacement, and new construction projects completed in multifamily facilities.

The PSD Evaluation Team stratified projects by project size. Table 2-5 summarizes the sampling approach.

TABLE 2-5: RESIDENTIAL MULTIFAMILY SAMPLING APPROACH

| Sampling Component | Description | Comment |
|-----------------------|-----------------------------|--|
| Population Size | 16 projects | All MER, MIR/MLI, and MNC multifamily projects were included in the population. |
| Sample Frame | 13 projects | Projects accounting for 3% or less of the program reported annual Mcf savings were excluded from the sample frame. |
| Stratification | Annual Mcf reported savings | Projects were divided into 3 strata based on the size of the annual Mcf savings and sample sizes were calculated using an error ratio of 0.30. |
| Primary Sampling Unit | Project | The site was the sampling unit. |
| Target Sample Size | 7 projects | Random selection was applied to small projects (strata 1 and 2) and a census of the largest projects (stratum 3) was reviewed. |

Sample sizes were calculated to meet or exceed 80/10 confidence/precision level at the sector level, as shown in Table 2-6. The census stratum covered over half of the annual Mcf savings in this sector.

TABLE 2-6: RESIDENTIAL MULTIFAMILY SAMPLE SIZES FOR PY2023

| Strata | % of Total Annual Mcf Residential MF Savings | % of Total Peak Day Residential MF Savings ¹ | Total Number of Sites | Sampled Sites ² |
|--------|--|---|-----------------------|----------------------------|
| 0 | 3% | 3% | 3 | 0 |
| 1 | 25% | 27% | 8 | 2 |
| 2 | 20% | 15% | 2 | 2 |
| 3 | 52% | 54% | 3 | 3 |
| Total | | | 16 | 7 |

¹ Rounding resulting in a total of 99%.

² One sampled site had measures in both the MNC and CNC programs.

2.1.3 RER Single Family

RER single-family projects account for 6% of VGS’s PY2023 annual savings portfolio. VGS calculated savings for these measures using the VGS TRM. Sample sizes were calculated to meet or exceed 80/18 confidence/precision level. A summary of the sampling approach is provided in Table 2-7.

TABLE 2-7: RESIDENTIAL SINGLE-FAMILY SAMPLING APPROACH

| Sampling Component | Description | Comment |
|-----------------------|-----------------------------|---|
| Population Size | 1,592 projects | All RER single-family projects were included in the population. |
| Sample Frame | 1,313 projects | Projects accounting for 3% or less of the program reported annual Mcf savings were excluded from the sample frame. |
| Stratification | Annual Mcf reported savings | Projects were divided into 6 strata, 2 strata with control-only projects to ensure control measures were included in the sample and 4 with all other measures. The strata were based on the size of the annual Mcf savings. Sample sizes were estimated using an error ratio of 0.30 for the controls strata and 0.50 for all other measures. |
| Primary Sampling Unit | Project | The project was the sampling unit. |
| Target Sample Size | 20 projects | Random selection was applied to all strata. Four selected projects were controls only and 16 projects were all other ER measures. |

Table 2-8 provides a summary of the RER single-family savings and sample sizes by stratum. “Control” measures are advanced thermostats. Equipment replacement (ER) measures include all equipment replacement measures (boilers, furnaces, water heaters, etc.)

TABLE 2-8: RER SINGLE-FAMILY SAMPLE SIZE

| Group ¹ | Strata | % Annual RER SF Mcf | % Peak Day RER SF Mcf | Total Number of Projects | Sampled Sites |
|--------------------|--------|---------------------|-----------------------|--------------------------|---------------|
| All Measures | 0 | 3% | 3% | 279 | 0 |
| ER | 1 | 19% | 20% | 416 | 4 |
| ER | 2 | 21% | 21% | 278 | 4 |
| ER | 3 | 23% | 22% | 221 | 4 |
| ER | 4 | 25% | 23% | 155 | 4 |
| Control Only | 5 | 4% | 5% | 153 | 2 |
| Control Only | 6 | 5% | 6% | 90 | 2 |
| Total | | | | 1,592 | 20 |

¹ Fourteen projects with ER measures also had an advanced thermostat; these projects were included in the ER strata. None of these projects were selected in the random sample for the ER projects.



2.2 Review Process

The PSD Evaluation Team conducted desk reviews for all sampled commercial and residential multifamily projects and the Vermont PSD conducted desk reviews on the single-family RER projects. The verification process is shown in Figure 2-1.

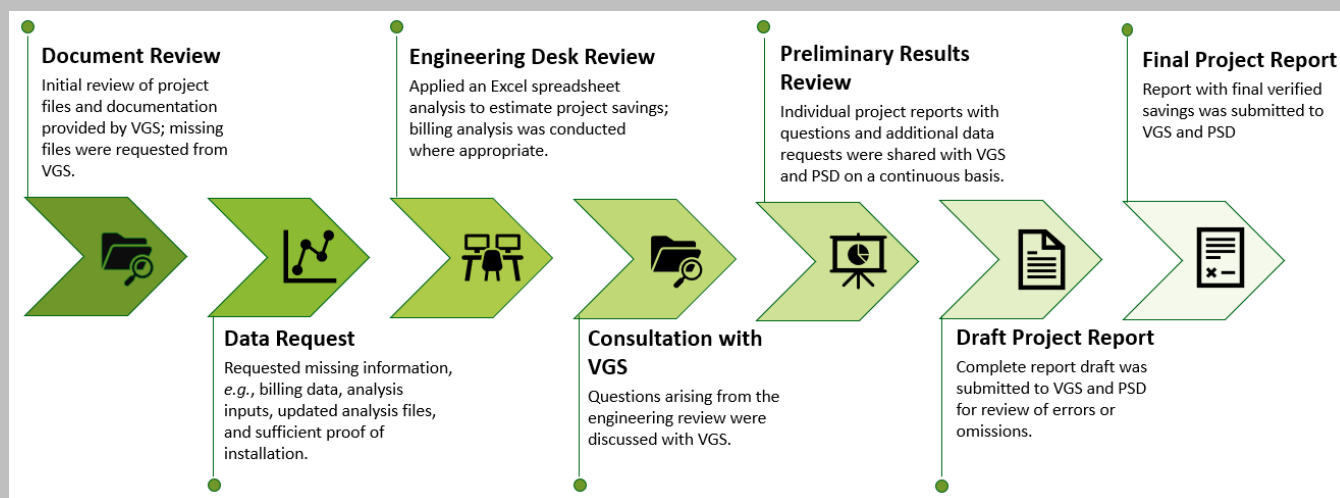


FIGURE 2-1: EVALUATION OF DESK REVIEW APPROACH

2.2.1 Documentation Review

Documentation review was the initial step in the evaluation process for all projects in the evaluation sample. This was done to determine if any project files were missing and if there was adequate information to calculate energy savings and verify proof of installation. The PSD Evaluation Team sent data requests to VGS for projects with missing or insufficient documentation.

2.2.2 Engineering Desk Reviews

Engineering desk reviews were completed for all projects in the evaluation sample. The review included verifying annual energy and peak day savings for each measure installed at the sampled site. The engineering desk review included a review of the inputs, calculations, and proof of installation, as shown in Figure 2-2.

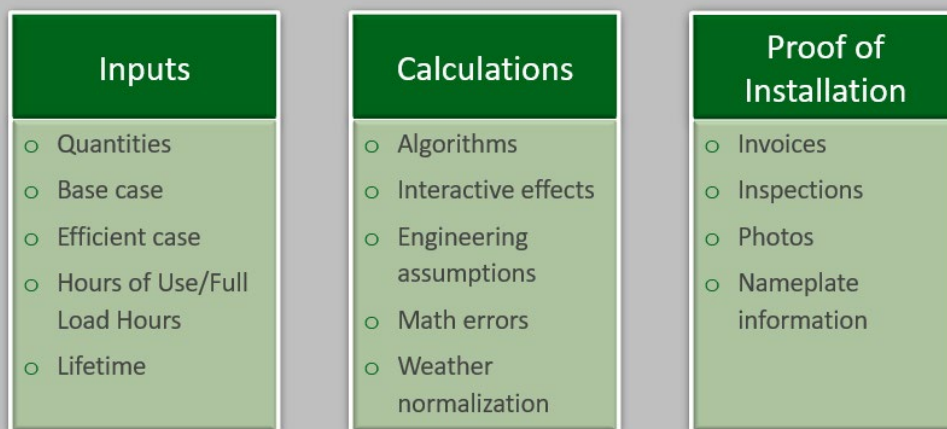


FIGURE 2-2: ENGINEERING REVIEW DETAIL

The desk reviews verified energy savings for each measure within the sampled project. The reviews focused on the following:

- **Calculation methods** - Identify if methods rely on deemed or custom analysis approach and if the methods are accurate and applied correctly.
- **Data sources** - Identify basis for savings calculations (*e.g.*, manufacturer specification sheets, site-specific data, billing data, energy code, audits).
- **Baseline and efficient case** - Identify project type (new construction, retrofit, equipment replacement) and analysis inputs for baseline and efficient conditions.
- **Proof of installation** - Check if each project has itemized invoices, inspection forms, photos, and nameplate information.

The VGS analyses generally used TRM methods and/or VGS standardized tools, which the PSD Evaluation Team reviewed to determine whether they met industry standards and used the best available information. The PSD Evaluation Team also reviewed billing data when available and, if appropriate, used billing analysis to calculate the savings, inputs into the savings algorithms, or to inform the desk review.

2.2.3 Continuous Feedback

The PSD Evaluation Team conducted biweekly check-in calls and regular email communication with VGS and the PSD throughout the evaluation to meet the stringent timeline. These calls provided the opportunity to discuss project-specific details and to ensure that the PSD Evaluation Team had a complete understanding of each project.

The PSD Evaluation Team sent data requests to VGS for clarification and additional documentation on a rolling basis. Preliminary and draft project reports were sent upon completion to provide enough time for VGS to review the analyses for errors and omissions.

2.3 Realization Rate

The RR is the ratio of verified energy savings to the program's reported savings. The RR represents the percentage of program reported savings that is achieved based on the results of the savings verification. The RR was calculated as follows:

$$RR = \frac{\sum_{i=1}^n w_i y_i}{\sum_{i=1}^n w_i x_i}$$

Where,

RR is the realization rate (ratio estimator);

i is the site;

n is the total number of verified sites in the sample;

w_i is the expansion weight (the total number of sites in the stratum divided by the number of verified sites in the stratum);

y_i is the verified savings for site i ; and

x_i is the original claimed savings for site i .

Results from each stratum were rolled up to program-, sector-, and portfolio-level using expansion weights as appropriate.

2.3.1 *Post Hoc* stratification

The two largest C&I projects accounted for about two-thirds of the portfolio savings and required substantial effort to verify the savings. These projects were placed in a separate stratum and accounted for a substantial portion of the time and effort spent on verification.

Given the abbreviated time and budget constraints for this project and requirements for verification of the largest projects, the residential multifamily programs were sampled as a group. Following the project-level review, *post hoc* stratification was conducted to allow estimation of the RR at the program level, *i.e.*, the sample was re-stratified by program. The same approach was used for the C&I programs, excluding the 2 largest projects.

For both sectors, the site was used as the sampling unit to allow the PSD Evaluation Team to account for possible interactive effects. A few sites in the samples had projects in two programs and the verified measures were assigned to each program, respectively.

All sites in the census strata were selected with certainty and a weight of 1 was applied. The weights for the randomly selected projects were determined by the number of sites in each program. For the site that was selected in the multifamily sample and also had a measure in the CNC, the CNC measure was added to the C&I census strata so that it was incorporated into the verification review but the site accounted only for itself and the results were not expanded to other projects.

Tables 2-9 and 2-10 show the distribution of projects across the strata for the population and the sample for the multifamily and C&I programs, respectively.

TABLE 2-9: RESIDENTIAL MULTIFAMILY DISTRIBUTION AMONG PROGRAMS (POPULATION AND SAMPLE)

| Strata | Sites in Population | | | | Sites in Sample | | | |
|--------|---------------------|---------|-----|-------|-----------------|---------|-----|-------|
| | MER | MIR/MLI | MNC | Total | MER | MIR/MLI | MNC | Total |
| 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 |
| 1 | 5 | 2 | 1 | 8 | 2 | 0 | 0 | 2 |
| 2 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 2 |
| 3 | 0 | 1 | 2 | 3 | 0 | 1 | 2 | 3 |
| Totals | 8 | 3 | 5 | 16 | 2 | 1 | 4 | 7 |

TABLE 2-10: C&I DISTRIBUTION AMONG PROGRAMS (POPULATION AND SAMPLE)

| Strata | Sites in Population | | | | Sites in Sample | | | |
|--------|---------------------|-----|-----|-------|-----------------|-----|-----|-------|
| | CER | CSR | CNC | Total | CER | CSR | CNC | Total |
| 0 | 35 | 1 | 3 | 39 | 0 | 0 | 0 | 0 |
| 1 | 28 | 4 | 12 | 43 | 2 | 0 | 0 | 2 |
| 2 | 3 | 1 | 5 | 9 | 0 | 1 | 1 | 2 |
| 3 | 2 | 0 | 3 | 3 | 2 | 0 | 3 | 5 |
| Totals | 68 | 6 | 23 | 94 | 4 | 1 | 4 | 9 |

3 Results

This section provides the results from VGS PY2023 programs savings verification. Results are provided for annual, peak day, and lifetime savings. Site-level reports are aggregated in Appendix A, which is available upon request from the PSD.

3.1 C&I Annual Mcf Savings

The RRs and relative precision for VGS's C&I annual Mcf savings are provided in Table 3-1. The commercial portfolio RR is 82% with a relative precision of 1.6% at the 80% confidence level. The confidence/precision met or exceeded the 80/10 target for all programs.

TABLE 3-1: SUMMARY OF C&I REPORTED AND VERIFIED PY2023 ANNUAL MCF SAVINGS

| Program | Total Sites | Sampled Sites | Program Reported Annual Savings (Mcf) | PSD Verified Annual Savings (Mcf) | Realization Rate | Relative Precision |
|----------------------------------|-------------|---------------|---------------------------------------|-----------------------------------|------------------|--------------------|
| Commercial Equipment Replacement | 68 | 4 | 11,314 | 11,145 | 99% | 9.3% |
| Commercial New Construction | 6 | 2 | 1,631 | 1,531 | 94% | 2.3% |
| Commercial Retrofit | 25 | 6 | 120,908 | 96,798 | 80% | 1.5% |
| Commercial Total | 99 | 12 | 133,853 | 109,474 | 82% | 1.6% |

There were 12 C&I sites included in the desk review and 6 had verified annual savings within 10% of the VGS reported savings. Two of the remaining sites had over a 50% reduction in verified savings. Some of the key issues that influenced the RR are described below.

- **Incorrect inputs** - Errors included incorrect efficiencies, pipe length, and heat loss values. One measure incorrectly input the lifetime savings as the annual savings.
- **Baseline usage** - Baseline usage was overestimated in several analyses; billing data was used to verify the baseline consumption where possible.
- **Incorrect peak day and lifetimes** - One measure used a lifetime that did not match the Vermont TRM defaults or agreements with the Vermont PSD. A few measures used incorrect peak day factors.
- **Mismatch to billing data** - Savings for one of the largest C&I projects were estimated using engineering calculations only and comparison to the bills indicated the savings were not being realized as expected, which substantially affected the RR for the CSR. Several other projects had lower heating loads than the TRM assumptions when compared to billing data and one site had a higher load as the VGS estimate was based on outdated billing data. The DHW load was greatly overestimated for another site as it

was based on an entire commercial site rather than the multifamily building laundry it served.

- o **Measure double counted** – One measure was included in VGS’s program reported savings twice due to an error in project tracking.

Reviewing pre-install billing records as a reality check is one approach to avoid some errors in future verification cycles. Other issues and additional details are discussed in the site-level reports.

3.2 Commercial and Industrial Peak Day Mcf Savings Results

The RRs and relative precision for VGS’s peak day Mcf savings are provided in Table 3-2. The C&I RR is 55% with a relative precision of 1.2% at the 80% confidence level.

TABLE 3-2: SUMMARY OF C&I REPORTED AND VERIFIED PY2023 PEAK DAY MCF SAVINGS

| Program | Total Sites | Sampled Sites | Program Reported Peak Day Savings (Mcf) | PSD Verified Peak Day Savings (Mcf) | Realization Rate | Relative Precision |
|----------------------------------|-------------|---------------|---|-------------------------------------|------------------|--------------------|
| Commercial Equipment Replacement | 68 | 4 | 67.0 | 56.9 | 85% | 3.3% |
| Commercial New Construction | 6 | 2 | 16.8 | 15.7 | 94% | 2.4% |
| Commercial Retrofit | 25 | 6 | 95.5 | 25.7 | 27% | 0.0% |
| Commercial Total | 99 | 12 | 179.4 | 98.3 | 55% | 1.2% |

To determine verified peak savings, the PSD Evaluation Team multiplied the verified annual Mcf savings by the peak savings factor for the end use. Measures installed for large customers on interruptible rates do not have peak day savings, which accounted for a large proportion of the C&I projects.

The peak savings factor was adjusted for several projects. For example, VGS applied the heating system peak savings factor for a pipe insulation project involving a boiler that served only process loads.

3.3 Commercial and Industrial Lifetime Mcf Savings Results

The RRs and relative precision for VGS’s lifetime Mcf savings are provided in Table 3-3. The C&I RR is 81% with a relative precision of 1.7% at the 80% confidence level.

TABLE 3-3: SUMMARY OF C&I REPORTED AND VERIFIED PY2023 LIFETIME MCF SAVINGS

| Program | Total Sites | Sampled Sites | Program Reported Lifetime Savings (Mcf) | PSD Verified Lifetime Savings (Mcf) | Realization Rate | Relative Precision |
|----------------------------------|-------------|---------------|---|-------------------------------------|------------------|--------------------|
| Commercial Equipment Replacement | 68 | 4 | 232,412 | 228,939 | 99% | 9.5% |
| Commercial New Construction | 6 | 2 | 25,349 | 23,610 | 93% | 3.0% |
| Commercial Retrofit | 25 | 6 | 2,223,614 | 1,768,232 | 80% | 1.6% |
| Commercial Total | 99 | 12 | 2,481,375 | 2,020,781 | 81% | 1.7% |

To determine lifetime savings, the PSD Evaluation Team multiplied the verified annual Mcf savings by the lifetime for each measure; therefore, findings that affect annual Mcf savings also affect the lifetime Mcf savings. VGS used the correct measure life for all verified measures except one, which was adjusted as the VGS lifetime did not match the Vermont TRM defaults or values agreed upon by the PSD. The normal variation in lifetimes across measure types and the one measure with an adjustment resulted in some differences between the final RR for the annual and peak day Mcf savings.

3.4 Residential Program Annual Mcf Savings

The RRs and relative precision for VGS's annual Mcf savings are provided in Table 3-4. The residential portfolio RR is 99% with a relative precision of 2.5% at the 80% confidence level. The RNC verified savings are based on the final trued-up savings values provided by EVT with the RR from the PY2022 EVT savings verification results for the RNC.³

³ VGS claimed prescriptive savings of 22 Mcf per project and these values were then trued up by EVT to reflect the savings based on EVT's modeling. As the program reported savings provided by VGS had not been trued up, the PSD Evaluation Team made this adjustment. The PY22 EVT verification results were used as the PY23 verification report was not available at the time that the RR analysis was completed.

TABLE 3-4: SUMMARY OF RESIDENTIAL PROGRAM REPORTED AND VERIFIED ANNUAL MCF SAVINGS

| Program | Total Sites | Sampled Sites/ Projects | Program Reported Annual Savings (Mcf) | PSD Verified Annual Savings (Mcf) | Realization Rate | Relative Precision |
|-------------------------------|-------------|-------------------------|---------------------------------------|-----------------------------------|------------------|--------------------|
| <i>Residential Sector</i> | | | | | | |
| Equipment Replacement | 1,600 | 22 | 9,764 | 9,671 | 99% | 1.5% |
| New Construction ¹ | 27 | 4 | 2,644 | 2,542 | 96% | 3.7% |
| Retrofit ² | 545 | 1 | 4,351 | 4,347 | 100% | 8.7% |
| Total Residential Sector | 2,172 | 27 | 16,759 | 16,560 | 99% | 2.5% |

¹ The RNC RR for single-family projects was from the report to Verify Efficiency Vermont 2022 Savings Claim, June 2023. The results from the 2023 verification cycle were not yet available when the VGS verification analysis was completed.

² VGS applied the RR from the 2018 impact evaluation of the VGS residential single family retrofit program, which was applied to all 542 single-family retrofit projects.

Adjustments of more than 10% were made to the reported savings for 3 of the 7 multifamily sites in the sample. The verified savings for two of these projects were more than 50% lower than the program reported savings. The most common reasons for differences in realized savings for the residential sector are discussed below.

- Incorrect inputs** - For two of the RER on-demand water heater measures, VGS used an “existing” AFUE/UEF and a “base” AFUE/UEF for calculating the heat load from the consumption and calculating the savings, respectively. These values were adjusted to match the existing AFUE/UEF for consistency. The control measures all used a savings factor lower than the TRM value, resulting in understated savings. One control measure had the incorrect percentage of heat load, which substantially overstated savings. For multifamily projects, there were a few errors in inputs including annual hours, efficiencies, and quantity of ERVs.
- Mismatch to billing data** - Several projects had lower heating loads than the TRM assumptions when compared to billing data. The DHW load was greatly overestimated for one site as it was based on an entire commercial site rather than the multifamily building laundry it served.

Reasons for site-level adjustment and related issues are described in the site-level reports aggregated in Appendix A, which is available upon request from the PSD.

3.5 Residential Peak Day Annual Mcf Savings

The RRs and relative precision for VGS’s peak day Mcf savings are provided in Table 3-5. The residential RR is 99% with a relative precision of 1.1% at the 80% confidence level.



TABLE 3-5: SUMMARY OF RESIDENTIAL PROGRAM REPORTED AND VERIFIED PY2023 PEAK DAY MCF SAVINGS

| Program | Total Sites | Sample Sites | Reported Peak Day Savings (Mcf) | PSD Verified Peak Day Savings (Mcf) | Realization Rate | Relative Precision |
|-------------------------------|-------------|--------------|---------------------------------|-------------------------------------|------------------|--------------------|
| <i>Residential Sector</i> | | | | | | |
| Equipment Replacement | 1,600 | 22 | 98.4 | 97.8 | 99% | 1.3% |
| New Construction ¹ | 27 | 4 | 26.7 | 26.3 | 98% | 1.6% |
| Retrofit ² | 545 | 1 | 55.5 | 55.5 | 100% | 2.7% |
| Total Residential Sector | 2,172 | 27 | 180.7 | 179.5 | 99% | 1.1% |

¹ The RNC RR for single-family projects was from the report to Verify Efficiency Vermont 2022 Savings Claim, June 2023. The results from the 2023 verification cycle were not yet available when the VGS verification analysis was completed.

² VGS applied the RR from the 2018 impact evaluation of VGS residential, which was applied to all 542 single-family retrofit projects.

The PSD Evaluation Team found one discrepancy with VGS's application of peak day multipliers, a pipe insulation measure that served both heating and hot water where the heating savings factor was used. The peak savings factor for those was adjusted to use weighted average of the heating and DHW peak factors. There were no adjustments to the RER peak day multipliers for the single-family projects.

3.6 Residential Lifetime Mcf Savings

The RRs and relative precision for VGS's lifetime Mcf savings are provided in Table 3-6. The residential portfolio RR is 98% with a relative precision of 1.5% at the 80% confidence level.

TABLE 3-6: SUMMARY OF RESIDENTIAL PROGRAM REPORTED AND VERIFIED PY2023 LIFETIME MCF SAVINGS

| Program | Total Sites | Sample Sites | Reported Lifetime Savings (Mcf) | PSD Verified Lifetime Savings (Mcf) | Realization Rate | Relative Precision |
|-------------------------------|-------------|--------------|---------------------------------|-------------------------------------|------------------|--------------------|
| <i>Residential Sector</i> | | | | | | |
| Equipment Replacement | 1,600 | 22 | 195,599 | 191,817 | 98% | 1.3% |
| New Construction ¹ | 27 | 4 | 50,683 | 47,098 | 93% | 7.8% |
| Retrofit ² | 545 | 1 | 94,101 | 93,998 | 100% | 2.4% |
| Total Residential Sector | 2,172 | 27 | 340,383 | 332,913 | 98% | 1.5% |

¹ The RNC RR for single-family projects was from the Report to Verify Efficiency Vermont 2022 Savings Claim, June 2023. The results from the 2023 verification cycle were not yet available when the VGS verification analysis was completed.

² VGS applied the RR from the 2018 impact evaluation of VGS residential single-family retrofit program, which was applied to all 542 single-family retrofit projects.

To determine lifetime savings, the PSD Evaluation Team multiplied the verified annual Mcf savings by the lifetime for each measure; therefore, findings that affect annual Mcf savings carry

over to lifetime Mcf savings proportionally, although the variation in lifetimes across measure types results in differences in the final RR. The lifetime for all residential measures matched the Vermont TRM.

3.7 Quantifiable Performance Indicators

The PSD Evaluation Team also reviewed VGS's progress toward selected QPIs for PY2021-PY2023, as described in the Vermont PUC order from October 22, 2020. These QPIs were designed to assess whether efficient energy utilities (EEUs) are meeting established goals on schedule and at levels set by the PUC. As verification of some of the QPIs were either part of the verification process or could be easily added, the PSD Evaluation Team reviewed VGS's progress toward meeting these selected QPIs.

Table 3-7 provides a summary of VGS's progress toward the portfolio-level savings and greenhouse gas emissions QPIs. VGS fell short for all four goals, with the lifetime savings being the closest. The QPI for the peak day Mcf savings was the lowest, possibly due to the high number of projects with no peak day savings as the facilities are on interruptible accounts.

TABLE 3-7: SUMMARY OF PORTFOLIO-LEVEL QPIS

| QPI | Sector | QPI Description | 3-year Goal | PY2021 Verified Savings ¹ | PY2022 Verified Savings ² | PY2023 Verified Savings | 3-Year Total | Achieved vs 3-Year Goal |
|--------|-----------|---------------------------|-------------|--------------------------------------|--------------------------------------|-------------------------|--------------|-------------------------|
| QPI1a. | Portfolio | Annual net Mcf savings | 239,650 | 43,771 | 56,362 | 126,033 | 226,166 | 94% |
| QPI1b. | Portfolio | GHG metric tons emissions | 13,214 | 2,414 | 3,108 | 6,949 | 12,471 | 94% |
| QPI2b. | Portfolio | Lifetime Mcf savings | 4,196,753 | 840,812 | 908,932 | 2,353,694 | 4,103,431 | 98% |
| QPI3. | Portfolio | Peak day Mcf savings | 1,356 | 364 | 362 | 278 | 1,004 | 74% |

¹ PY2021 savings from Verification of Vermont Gas Systems 2021 Annual Savings Claims. Prepared by West Hill Energy and Computing, July 2022. These numbers are based on the West Hill Energy report provided to the PSD for PY2021, which includes an adjustment to VGS's RER savings as the VGS billing analysis did not include the efficiency of the existing equipment. The PSD report provided to the PUC did not include this adjustment, resulting in a small difference between the final PSD and the West Hill Energy verification reports.

² PY2022 savings from Verification of Vermont Gas Systems 2022 Annual Savings Claims. Prepared by West Hill Energy and Computing, July 2023

Table 3-8 provides a summary of the selected residential QPIs. The goals for all of these QPIs were met.

TABLE 3-8: SUMMARY OF RESIDENTIAL AND RESIDENTIAL SINGLE-FAMILY QPIS

| QPI | Sector | QPI Description | 3-year Goal | PY2021 Results | PY2022 Results | PY2023 Results | Total |
|--------|--|---|----------------|----------------|----------------|----------------|-------|
| QPI4a. | Residential Single Family ¹ | Percent of home energy audits converted to a measure installation within 12 months (Existing) | 30% | 38% | 38% | 32% | 37% |
| | | Percent of home energy audits converted to a measure installation within 12 months (Addison) | 30% | 50% | 33% | 60% | 43% |
| QPI5. | Residential | Energy audits completed | 600 (Annually) | 707 | 642 | 680 | 676a |

¹ VGS Note: "Will be based on prior year's number of audits that had cost effective measures. For example, for calendar year (CY) 2018 results, the denominator will be single-family audits completed in CY2017 that had cost effective measures, and the numerator will be how many of those became completions within 365 days of the audit."

^a Average per year

Table 3-9 provides a summary of the selected commercial retrofit (CSR) QPIS. As shown in Table 3-9, VGS has met or exceeded the three-year requirements for diversity of measures implemented in the C&I retrofit program in all categories except for the heating system, heat recovery, and DHW measure group, which is 4% short of the goal. The goal was met for all categories in Addison County.

TABLE 3-9: SUMMARY OF C&I QPIS

| QPI | Sector | QPI Description | 3-year Goal | PY2021 Results | PY2022 Results | PY2023 Results | Total |
|-------|--------------|---|-------------|----------------|----------------|----------------|-------|
| QPI.7 | C&I Retrofit | Diversity of measures implemented in CSR projects (Existing) | | | | | |
| | | Controls | 5% | 12% | 14% | 4% | 9% |
| | | Heating systems, heat recovery or domestic hot water (DHW) system | 20% | 21% | 6% | 19% | 16% |
| | | Process | 5% | 12% | 14% | 21% | 16% |
| | | Shell or other-related | 15% | 55% | 66% | 57% | 58% |
| QPI.7 | C&I Retrofit | Diversity of measures implemented in CSR projects (Addison) | | | | | |
| | | Controls | 5% | 0% | 0% | 13% | 6% |
| | | Heating systems, heat recovery or DHW system | 20% | 14% | 0% | 38% | 22% |
| | | Process | 5% | 0% | 33% | 0% | 6% |
| | | Shell or other-related | 15% | 86% | 67% | 50% | 67% |

4 Recommendations

This section provides recommendations to improve future VGS programs' RRs and streamline future verification processes. Recommendations are divided into program- and evaluation-related issues.

4.1 Program Recommendations

These recommendations are intended to assist VGS with improving its RRs and providing sufficient documentation in future evaluations.

4.1.1 Continue Efforts to Improve Project-level Documentation

Issue: The PY2021 and PY2020 savings verification reports identified issues with missing project-level documentation and VGS has made substantial progress in addressing these issues. The proof of installation documentation has significantly improved, with all but one measure having some sort of documentation. The PSD Evaluation Team noted substantial improvements in photo documentation. In general, inputs and methods were better documented than found in previous years.

However, there is room for further improvement. Invoices are still missing for many projects. For 9 of the 16 C&I and multifamily sites selected for desk review, the PSD Evaluation Team had to request additional documentation to determine or confirm key inputs into the savings algorithms. With the increased number of pipe insulation projects, invoices are more important as photos are often inconclusive. For several projects, documentation was included indirectly but more direct references could limit mistakes, especially when the Vermont energy codes are updated.

Recommendation: The PSD Evaluation Team recommends that VGS continue its efforts to improve project-level documentation by providing more detailed description of the project files and analysis tools. Specific items to include in the project files include the following:

- A project overview that describes the installed energy efficiency measures, the baseline and efficient operating conditions, and project timeline. While a few projects included a narrative description, most did not.
- Sources for all inputs to the savings algorithm in the analysis spreadsheet. This is especially important for any inputs that are different from the TRM defaults. While references were documented for most projects, they were not consistently provided.
- Proof of installation, such as itemized invoices, inspection reports, and clear photos of nameplate information and installation photos.

Permit dates are critical for determining the applicable building energy code for new construction projects. While this was not an issue in PY2023, the PSD Evaluation Team recommends that the



date of the permit and the applicable building energy code should be clearly stated where applicable.

Addressing these documentation issues will reduce the amount of time spent on each project review and provide transparency into VGS assumptions.

4.1.2 Confirm Heat Load Estimation with Billing Analysis

Issue: The PSD Evaluation Team noted substantial progress in correcting previous errors related to the estimation of heat loads, as discussed in the PY2021 and PY2022 savings verification reports. VGS appears to be using billing data more frequently to estimate heating loads, which is consistent with recommendations from the PSD Evaluation Team and the PUC auditor and with the related measure characterizations in the PY2024 VGS TRM.

A couple of minor issues still remain.

1. In PY2022, VGS adjusted the pre-install billing consumption for all single-family RER equipment replacements to reflect the average actual efficiency of the existing equipment; however, the efficiency was higher than the baseline efficiency. In PY2023, VGS corrected this error for all measures with the exception of on-demand water heaters, which still needs to be corrected.
2. The PSD Evaluation Team noted a small discrepancy in the VGS billing data in PY2022, in which the HDD was slightly overstated (by 3% on average) due to a mismatch in the days in each billing cycle. This results in a minor underestimation of savings for any projects (all RER, some custom projects) that rely on billing data. As this error is embedded in the VGS billing system, it is difficult to correct. This small discrepancy was not corrected as of PY2023 and is noted here for future evaluators.
3. In PY2023, VGS argued that billing analysis should only be used in the C&I sector to estimate savings for custom measures and not for prescriptive ER measures. This argument runs counter to the PSD evaluation approach, the PUC auditor's recommendation, and also is inconsistent with VGS's use of billing analysis for estimating the savings for residential ER measures.

Recommendation: The PSD Evaluation Team continues to recommend that loads calculated using engineering calculations should be checked against billing data to verify that the load is reasonable and the savings are realistic. The new VGS TRM for PY2024 may help to resolve these issues as it explicitly recommends the use of billing analysis to estimate savings and/or inform the savings calculations for some measures and applications.

4.1.3 Update Weather Normalization

Issue: Currently VGS uses TMY3 weather data to normalize all weather dependent calculations. Due to climate change, TMY3 30-year data (1976-2005) is not the best available information that represents future climate conditions for measures going forward. VGS current goals are based



on TMY3, and thus, the PSD Evaluation Team used the TMY3 weather normalization for the PY2023 savings verification.

Recommendation: West Hill Energy recommends using the most recent 6-to-10 years for the nearest National Oceanic Atmospheric Administration (NOAA) weather station to estimate the future heating loads more accurately. The average heating degree days for the selected period could be calculated before the beginning of each triennial performance period and used for the corresponding Demand Resource Plan.

4.1.4 Continue to Improve Internal Savings Calculation Quality Control

Issue: Efficiency savings require attention to many details. Some of the errors in the calculations appear to result from simple errors that could be prevented with additional quality control (QC). For example, the lifetime savings for one site were entered as the annual Mcf savings, one measure was incorrectly double counted, and the peak savings for several measures were calculated using the wrong peak day factor.

Recommendation: The PSD Evaluation Team recommends that VGS continue to work on their internal QC process to include a comprehensive review of project documentation and savings calculations. Topics to cover could include the following:

- Check that the analysis file savings match the program tracking database.
- Reality checks on the magnitude of savings, using billing data if available.
- Check that the peak day factor matches the end use and/or standardize the approach to assigning the peak day multiplier to the end use.
- Ensure that installed measures are assigned to the correct program and verify that the same measures are not counted in multiple programs.

Improving the internal QC is likely to improve RRs. This recommendation was also made in the PY2021 savings verification report and the PY2022 review indicated ongoing issues.

4.1.5 Timing of Project Completion

Issue: Larger, complex projects have higher risk and more factors that could affect whether the savings are realized. For some projects, commissioning or other fine-tuning of the equipment or systems seems to be conducted after the savings have been calculated and the project is marked as complete. Savings verification is based on a desk review and billing analysis (where appropriate), which may not consider ongoing efforts on site to improve the operation of the equipment, especially if it is still ongoing during the verification process.

Recommendation: Particularly for large, complex projects, the PSD Evaluation Team recommends that VGS calculate savings after the equipment or systems are completely operational and sufficient time has elapsed to review post-install billing data. At that point, the project can be counted as completed. This approach may require some changes to program procedures, such as holding out a part of the incentive until proof of commissioning has been provided.



4.2 Evaluation Recommendations

These recommendations are designed to provide some suggestions for improving the next evaluation cycle.

4.2.1 Establish an Evaluation Framework

Issue: The short period for this review (3 months) and tight budget requires a high degree of coordination among the parties. Receiving the program tracking data promptly and short turnaround times on data requests and project-level reports is critical. The PSD Evaluation Team appreciated VGS's timely delivery of the program for PY2023 and fully understands that VGS's review of the project-specific reports for errors and omissions is a critical part of the evaluation process.

However, lengthy meetings and repetitive discussions require substantial addition of time and effort from all parties and make it difficult for evaluators to complete the project within the time and budget constraints.

Recommendation: Establishing a stronger framework for VGS's review process may facilitate future evaluations. For PY2023, the parties met early in 2024 and set the timeframe for the delivering the program tracking data, which was very helpful. Future topics could include a timeframe for the PSD to provide the project-level reports, turn-around times for VGS to respond to data requests and to provide comments on project-specific reports, a clear deadline for VGS's acceptance of the project-level reports, a limit on how many times the same or similar issues are raised and addressed, and other guidelines for VGS's review process.

4.2.2 Evaluating C&I Pipe Insulation Projects

Issue: VGS completed a substantial number of C&I pipe insulation projects in PY2023, using a standard engineering approach to estimate savings. Five of these pipe insulation projects were selected for verification. Savings are highly dependent on key assumptions which may be difficult to determine with certainty, such as the percentage of useful heat.

For three of the selected projects, the savings were a small percentage of the pre-install use at the site and the engineering estimates were verified and accepted. The other two had substantial savings and were installed at manufacturing facilities. Both projects showed savings that were smaller than the engineering estimates. An extensive analysis was conducted for one project that identified a range of potential uncertainties due to manufacturing process and changes on site and a hybrid approach using both the engineering and billing analyses was adopted. In the absence of production data for the other project, the engineering analysis was accepted.

Recommendation: Caution should be used in accepting engineering estimates for pipe insulation as there are many factors that could affect whether the savings are being realized, particularly in manufacturing facilities. When the savings are 8% or more of the pre-install use and sufficient information about the process is available, comparison to billing may be



indicated. At a minimum, the key inputs into the engineering calculations should be verified to the extent possible, which may require discussion with the facility manager. If uncertainty about the inputs is high, a conservative approach may be appropriate.



Appendix A
Site-Level Reports

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