

# **REPORT TO THE VERMONT LEGISLATURE**

## **Independent Audit of the Reported Energy and Capacity Savings and Cost-Effectiveness of Vermont Energy Efficiency Utility Programs**

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**Submitted by the Vermont Public Utility Commission**

**December 5, 2019**

## I. Introduction and Statutory Basis

Vermont law requires an independent audit every three years of the energy efficiency programs approved by the Public Utility Commission. Pursuant to 30 V.S.A. § 209(f)(12), with respect to all energy efficiency programs approved under Section 209, the Commission shall:

Require verification, on or before January 1, 2003, and every three years thereafter, by an independent auditor of the reported energy and capacity savings and cost-effectiveness of programs delivered by any entity appointed by the Commission to deliver energy efficiency programs under subdivision (d)(2) of this section.

In fulfillment of this requirement, in February 2018 the Public Utility Commission contracted with Evergreen Economics for the independent audit of energy efficiency program years 2014-2016.<sup>1</sup> Evergreen Economics produced two documents, which are attached. The first document is a Legislative report that summarizes the findings and recommendations of the independent audit. The second document is a management letter that describes in detail the audit's objectives, methodology, findings, and recommendations.

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<sup>1</sup> There is a necessary lag between the end of a program year and the commencement of an audit because an energy efficiency utility's program savings must first be verified by the Vermont Department of Public Service ("Department"). The Department's verification report becomes part of the record that is subject to the audit.



# Independent Audit, 2014-2016

Report to the Legislature

Vermont Energy Efficiency Utilities

Submitted to the Vermont Public Utility  
Commission

FINAL – Submitted November 7, 2019





## Table of Contents

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INTRODUCTION.....	1
AUDIT OBJECTIVES.....	1
OVERVIEW OF EEU PROGRAMS.....	1
METHODOLOGY AND PROCESS REVIEW.....	3
TRM REVIEW .....	4
VALIDATION OF REPORTED ENERGY SAVINGS AND COSTS.....	5
COST EFFECTIVENESS ANALYSIS .....	5
RECOMMENDATIONS.....	6

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## Introduction

In February 2018, the Vermont Public Utility Commission (the Commission) selected the Evergreen Economics team<sup>1</sup> (Evergreen) to serve as the Independent Auditor of the 2014-2016 reported energy and capacity savings and cost effectiveness of programs delivered by the Vermont Energy Efficiency Utilities (EEUs) pursuant to 30 V.S.A. § 209(f)(12). The EEUs reviewed in this audit include Efficiency Vermont (EVT), the City of Burlington Electric Department (BED), and Vermont Gas Systems Inc. (VGS), which deliver electricity and thermal energy and process fuel energy efficiency services to residential and business customers throughout the state of Vermont. Vermont Energy Investment Corporation (VEIC) operates as Efficiency Vermont under an Order of Appointment issued by the Commission on December 20, 2010. Oversight of the EEU programs is assigned to the Commission by Vermont law. The Department of Public Service (the Department) serves as the state's energy office and as the public advocate in proceedings before the Commission. The programs reviewed in this report include all energy efficiency initiatives instituted by the EEUs during the latest three-year evaluation cycle consisting of January 1, 2014 through December 31, 2016.<sup>2</sup> This document serves as the Report to the Legislature.

## Audit Objectives

The Commission identified five main objectives for the Independent Auditor to review. The Evergreen team conducted a review of:

1. The cost effectiveness of the EEUs, including EVT, BED, and VGS programs;
2. The reported energy and capacity savings achieved by EVT and BED;
3. The reported gas savings achieved by VGS;
4. The Efficiency Vermont Technical Reference User Manual<sup>3</sup> (TRM) and the process for managing and updating it;
5. Databases and other information compiled by VEIC, BED, and VGS that are used to develop and track savings claims and project costs; and
6. The procedures and methods used in the Department's savings claim verification process.

## Overview of EEU Programs

In Vermont, the three EEUs provide a variety of energy efficiency program offerings that save residential and non-residential Vermonters money and energy in their homes and businesses. From 2014 through 2016, EVT, BED, and VGS implemented energy efficiency initiatives that

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<sup>1</sup> The Evergreen team consists of staff from Evergreen Economics and Michaels Energy.

<sup>2</sup> For Vermont Gas Systems, only savings from 2016 are covered under this audit.

<sup>3</sup> The Technical Reference Manual is a document containing a standard set of values and calculation methodologies for determining energy savings for a range of different efficient equipment options.

can be grouped into four residential and three non-residential energy efficiency program categories, including:

### **Residential Sector**

- Residential New Construction
- Efficient Products
- Existing Homes
- Upstream HVAC and Lighting

### **Commercial & Industrial Sector**

- Business New Construction
- Business Existing Facilities
- Upstream HVAC and Lighting

During this period, EVT, BED, and VGS spent over \$152 million combined on these energy efficiency initiatives. As summarized in Table 1, these initiatives resulted in nearly 328,000 MWh of energy savings, 38,894 kW of winter demand reduction, 60,804 kW of summer demand reduction, and over 50,000 Mcf in gas savings by Vermont residents and businesses.

**Table 1: Annual Results, Total EEU Portfolio**

Year	Summer		Winter	Incentive Costs	Admin Costs	Total Program	
	MWh	kW	kW			Costs	Participant Costs
2014	104,151	12,273	21,122	\$26,183,313	\$22,473,782	\$48,657,095	\$34,327,966
2015	106,837	12,882	19,260	\$27,094,792	\$23,284,438	\$50,379,230	\$35,248,041
2016	117,258	13,739	20,422	\$28,928,487	\$24,440,998	\$53,369,485	\$47,251,333
<b>Total</b>	<b>328,246</b>	<b>38,894</b>	<b>60,804</b>	<b>\$82,206,592</b>	<b>\$70,199,218</b>	<b>\$152,405,810</b>	<b>\$116,827,340</b>

Note: VGS reported 63,695 Mcf total gas savings, and 393 Mcf peak day savings for the EEU portfolio in 2016. VGS costs for 2016 are included in this table. Totals exclude TEPF projects.

Table 2 shows the annual savings achieved by the thermal energy and process fuels (TEPF) projects.

**Table 2: MMBtu Savings, TEPF Projects (EVT and BED)**

Year	EVT TEPF MMBtu Savings	BED TEPF MMBtu Saving
2014	36,534	403
2015	47,013	110
2016	119,810	169

## Methodology and Process Review

As part of this audit, the Evergreen team completed a review of the data tracking, evaluation research, and Technical Advisory Group<sup>4</sup> (TAG) processes in place during the 2014-2016 period. Based on this review, the team was also tasked with providing actionable recommendations for improvement. Our review of these program and evaluation processes included an assessment of the following:

- TAG process for updating the TRM;
- Data management and reporting by the EEUs; and
- The Department’s savings verification process.

For our review of the TAG process, data management procedures, and savings verification processes, we conducted a series of interviews with staff at EVT, BED, and VGS.

Overall, the TAG process is highly regarded by parties involved and seems to work well. Our review of TAG documentation indicates a thorough tracking system is in place to monitor the status of proposed updates, action items for TAG members, and records of TAG decisions. While EVT leads the TRM update process, the existing checks and balances built into the process could be enhanced by greater involvement of Department staff. For example, greater involvement could occur when TRM revisions are explored or through occasional comprehensive review of TRM assumptions by a third party that reports to the Department.

All three EEUs maintain a program tracking database that stores all relevant project data, and Evergreen was provided with a copy of these databases for review. In general, these databases are complete and capture all relevant information required for tracking and evaluating program savings.

In the prior audit, the auditor recommended “that the EEUs maintain a frozen copy of the tracking database provided to the evaluator and store this dataset in a predetermined location

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<sup>4</sup> The Technical Advisory Group is a forum that meets regularly to discuss research and determine which new or updated measures should be included in the TRM. The TAG process is managed by EVT and includes DPS, the EEUs, and their evaluation teams.

prior to the auditor's involvement so that both the auditor and evaluator have the opportunity to work from identical datasets as well as to expedite the audit process". It appears that the EEUs adopted this recommendation, and consequently, the savings review process was able to be completed easily for the current audit.

For all three EEUs, Evergreen found that the savings values calculated using the EEU datasets matched the evaluation report savings claims to within a reasonable degree of error.

## TRM Review

One of the key components of the energy efficiency implementation and evaluation processes in Vermont is the Efficiency Vermont Technical Reference User Manual (TRM). The TRM contains a substantial list of measures with methods on how to calculate energy savings for each measure. The TRM lists most of the assumptions used to determine savings, in addition to the algorithms and other auxiliary information such as incremental cost, free ridership rates, and operation and maintenance (O&M) savings.

The current version of the Efficiency Vermont TRM is technically sound and comprehensive in its coverage of efficiency measures. In general, the TRM uses load shapes derived from Vermont specifically, or New England more broadly, to develop the energy and demand savings for most measures. The use of locally-derived load shapes provides a reasonable assessment of the actual savings that are realized for these measures over the relevant energy and demand savings periods. The use of local load shapes represents a best practice, and helps to ensure reasonable temporal certainty for the deemed measures contained in the TRM.

The Vermont Public Utility Commission updated the avoided cost parameters and values in late 2015. This update included adjustments to the summer and winter generation peak periods, which are used to determine the demand savings for energy efficiency measures. The new summer peak generation capacity period is from 1 p.m. to 5 p.m. on non-holiday weekdays in June, July, and August, and the new winter peak generation capacity period is from 5 p.m. to 7 p.m. on non-holiday weekdays in December and January. The latest revision to the TRM has captured the effect of the peak period definition changes in the claimed demand savings for most measures. The alignment of the demand load shapes, cost periods, and avoided cost inputs for the Vermont TRM is an industry best practice.

Deemed savings values are well documented, reasonable, and consistent with industry practices found in other jurisdictions. A majority of the measures in the TRM are algorithm based, which is generally a more accurate savings calculation methodology than strictly deemed values. Algorithms allow for specific customer inputs, which improve savings estimation accuracy by tailoring the values to match more closely with specific customer conditions.

## Validation of Reported Energy Savings and Costs

Evergreen was tasked with reviewing and validating the energy savings (kWh), demand reduction (kW), and cost values reported in all evaluation reports filed by EVT and BED for program years 2014, 2015, and 2016. We also reviewed and validated the natural gas savings (Mcf) reported by VGS for 2016. Evergreen verified the savings amounts reported by the independent evaluator for each program year by reviewing an extract of each EEU's program participant database and replicating the savings amounts listed. We also reviewed the evaluation of each EEU's evaluation report covering these years.

## Cost Effectiveness Analysis

The Evergreen analysis found that the EEU program portfolio was cost effective between 2014 and 2016 using the Program Administrator Cost Test (PACT), Total Resource Cost Test (TRC), and Vermont Societal Cost Test (SCT).<sup>5</sup> Additionally, efficiency initiatives reported by EEU in Table 3 were also found to be cost effective, with benefit-cost ratios exceeding 1.00 in all cases.

**Table 3: Cost Effectiveness Model Summary, Total EEU Portfolio**

	Program Administrator Cost Test (PACT)	Total Resource Cost Test (TRC)	Societal Cost Test (SCT)
<b>Total EEU Portfolio</b>	<b>2.60</b>	<b>1.47</b>	<b>2.20</b>
<b>EVT</b>	<b>1.83</b>	<b>1.44</b>	<b>2.16</b>
<b>BED</b>	<b>3.02</b>	<b>1.74</b>	<b>2.31</b>
<b>VGS</b>	<b>4.06</b>	<b>2.06</b>	<b>3.07</b>

Table 4 shows the cost effectiveness results for the EVT TEPF projects only.<sup>6</sup> These projects show a negative cost effectiveness result using the PACT due to the negative electric savings in these applications. We have included the PACT with electricity benefits only to make it consistent with the test results from the other programs. We have also included the PACT using the benefits of just the fossil fuel savings from the TEPF projects, which is more in line with the purpose for the TEPF projects. Both electric and fossil fuel savings are included as

<sup>5</sup> These tests are variations of the cost effectiveness calculation from several different perspectives. The Program Administrator Cost Test (PACT) includes the costs from the program administrator (e.g., EVT, BED, VGS) and the value of the energy savings. The Total Resource Cost Test (TRC) includes all costs from both the program administrator and customer, in addition to the value of the energy savings and the benefits of non-electric fuel savings and water savings. The Vermont Societal Cost Test (VSCT) is a variation of the TRC test that also includes an adjustment to account for additional environmental and non-energy benefits.

<sup>6</sup> BED did not track separately the cost effectiveness inputs needed for their TEPF projects, and consequently we were unable to calculate the cost effectiveness TEPF projects for BED.

benefits in the TRC and SCT tests, resulting in a positive cost effectiveness result (i.e., a benefit cost ratio greater than 1.0).

**Table 4: Cost Effectiveness Test Results, EVT TEPF Projects**

	PACT – Fossil Fuels Only	PACT – Electric Only	TRC	SCT
<b>Benefit/Cost Ratio</b>	<b>3.19</b>	<b>-0.26</b>	<b>1.05</b>	<b>1.17</b>

## Recommendations

There are several overarching findings from the audit of the 2014-2016 EEU program activities. While we have a number of recommendations on how the evaluation process can be improved, it is important to discuss these within the overall context of the work that has been completed by the Vermont EEUs and their evaluation teams. Specifically, all recommendations should be considered within the context of these overall findings:

- Evaluation reports reviewed were of high quality and conformed to the standard practices of the evaluation industry.
- The TAG process is highly regarded by parties involved and seems to work well. Our review of TAG documentation indicates a thorough tracking system is in place to monitor the status of proposed updates, action items for TAG members, and records of TAG decisions.
- Savings estimates are accurate. The savings databases examined for EVT, BED, and VGS yielded energy savings totals to within a few percentage points of the reported savings noted in the evaluation reports filed by the EEUs. Furthermore, savings estimates are generally consistent with TRM guidelines.

Our review of the evaluation reports, savings estimates, and program processes identified several areas where improvements can be made. Related recommendations are summarized below.

- **The evaluation of all the EEU energy efficiency initiatives should begin earlier in the year.** This was a recommendation made in the last audit and is repeated here. Evaluators for each of the EEUs noted the very short time periods and budgets allocated for the evaluations. Typically, the final program data was provided in March and an evaluation report produced in June. An earlier start will allow the evaluator to complete a more rigorous analysis by affording them more time to conduct additional site visits and complete more in-depth engineering analyses. With an earlier start time the evaluations could also be expanded to include more in-depth analysis of other programs besides those in the commercial and industrial sector (which is the current focus). It is appropriate for the evaluator to draw a preliminary sample of projects from the first part of the year, which allows for some on-sites to be completed by the

end of the year. The on-site sample can then be supplemented at the beginning of the following year to incorporate projects completed in the latter part of the prior year.

- **Expand the evaluations to include customer surveys.** An earlier start time (and larger evaluation budgets) would also allow for customer surveys to be completed across more programs. Regularly surveying program participants a minimum of once every three years is a common evaluation practice. Currently for each of the EEU's, only a few customers are contacted as part of the review of specific commercial and industrial projects, with questions narrowly focused on obtaining additional details about the installation and operation of the rebated equipment. In the current audit (as well as the prior audit), it appears that most programs have not had any customer surveys for the entire 2011-2016 period. Adding customer surveys would provide valuable customer feedback on the program operations, in addition to verifying equipment installation and other useful information that could inform future program designs.
- **BED verification reports need to be completed sooner.** For all three program years covered in this audit, the BED verification reports were completed much later than those for EVT and VGS. In general, evaluation reports should be completed as soon as possible after the program year ends so that the results can be used to inform the next program year. While the EVT and VGS evaluation reports were completed about 6 months after the end of the program year, the BED reports were typically completed 18 to 22 months after the program year ended. This late reporting was likely done to meet the requirement for the forward capacity market (FCM) that requires a significant amount of post-installation monitoring.

While these reports might provide an adequate retrospective look at the program achievements, the delay does not make them useful prospectively as the recommendations arrive too late to inform the next program year. Both BED and the evaluation team should work together to produce these reports in a more timely fashion. Of course, the recommendation above to start the evaluation work earlier in the year will help address this issue.

- **The EEUs need to address the recommendations included in their evaluation reports.** For both EVT and BED, the same evaluation recommendations have been repeated each year, which indicates that these problems are ongoing and have not been addressed. In particular, these evaluation reports have called out problems of poor documentation and inappropriate applications of TRM values (or use of outdated or undocumented sources) to calculate savings. The EEUs should work to improve in these areas so that they do not remain as ongoing issues.
- **EVT should explore whether more project-specific data can be incorporated into its savings calculations to reduce reliance on default assumptions in the TRM.** This is related to the recommendation for improving project documentation, as this

should produce more accurate savings estimates and lessen reliance on TRM default assumptions. As noted in our prior audit, the default TRM assumptions should be used only when project-specific information is not readily available. For each of the three years reviewed in the audit, the EVT evaluation reports recommend that EVT reduce its reliance on the TRM default assumptions for its savings calculations. The incorrect application or use of outdated TRM factors was also noted in the BED verification reports. This issue was also noted in our prior audit report and needs to be addressed by the EEUs.

- **Include TEPF projects in the annual evaluation process.** For both BED and EVT, the annual evaluation process should include (at a minimum) a review of a representative sample of TEPF projects so that a realization rate specific to these projects can be created. The verification methods and results for the TEPF projects should be clearly documented in the evaluation reports for both utilities.
- **The Commission should reconsider the advisability of relying on an EEU functionally driving the TRM process.** The process seems to be working well, but (as noted in our prior audit) there is a potential structural conflict of interest in having the program implementer also managing the TRM and the update process. EVT does contract with an independent evaluation firm to assist with the TRM review and to provide input on measure updates, but their role appears to be limited and does not address the overall potential for a conflict of interest inherent in the current TRM management arrangement.
- **The EEUs should maintain frozen copies of the program tracking databases provided to the evaluator that are consistent with annual reported savings values for future audits.** This recommendation was made in the prior audit and was followed by the EEUs for the current verification period. We are recommending that this process be continued to facilitate efficient savings audits in future years. Because there were frozen databases available, Evergreen was able to verify energy savings to within an acceptable margin of error for most programs; however, deviations from the reported savings numbers were found. For future audits, we recommend that EVT, BED, and VGS save the same version of each program tracking database provided to the evaluator and make it readily available for the independent audit prior to the audit process beginning. By providing both sets of data, the auditor will be able to determine where significant changes in savings occurred, and this will inform the TRM and measure review process.



# Independent Audit, 2014-2016

Management Letter

Vermont Energy Efficiency Utilities

Submitted to the Vermont Public Utility  
Commission

FINAL Submitted November 7, 2019





# Table of Contents

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<b>1 EXECUTIVE SUMMARY .....</b>	<b>1</b>
1.1 AUDIT OBJECTIVES .....	1
1.2 OVERVIEW OF EEU PROGRAMS.....	1
1.3 METHODOLOGY AND PROCESS REVIEW .....	2
1.4 TRM REVIEW .....	3
1.5 VALIDATION OF REPORTED ENERGY SAVINGS AND COSTS.....	4
1.6 COST-EFFECTIVENESS ANALYSIS.....	4
1.7 RECOMMENDATIONS.....	4
<b>2 METHODOLOGY AND PROCESS REVIEW .....</b>	<b>8</b>
2.1 TECHNICAL ADVISORY GROUP PROCESS REVIEW .....	8
<i>Recommendations</i> .....	9
2.2 DATA MANAGEMENT AND REPORTING REVIEW.....	10
<b>3 TRM REVIEW.....</b>	<b>11</b>
3.1 SUMMARY REVIEW.....	11
<i>TRM Technical Accuracy</i> .....	12
<i>Prior Audit Recommendations for the TRM</i> .....	12
<i>Recommendations</i> .....	14
<b>4 VALIDATION OF REPORTED SAVINGS AND COSTS .....</b>	<b>15</b>
4.1 REPORTED SAVINGS.....	15
4.2 REPORTED COSTS.....	24
4.3 EVALUATION REPORT REVIEW.....	24
<b>5 COST-EFFECTIVENESS ANALYSIS .....</b>	<b>30</b>
5.1 COST-EFFECTIVENESS TESTS AND INPUTS.....	30
<i>Program Administrator Cost Test (PACT)</i> .....	30
<i>Total Resource Cost Test (TRC)</i> .....	31
<i>Vermont Societal Cost Test</i> .....	31
<i>Cost-Effectiveness Inputs</i> .....	31
5.2 COST-EFFECTIVENESS RESULTS .....	32
<i>EEU Portfolio</i> .....	32
<i>Residential</i> .....	33
<i>Commercial &amp; Industrial</i> .....	34
<i>Efficiency Vermont</i> .....	34
<i>City of Burlington Electric Department</i> .....	35
<i>Vermont Gas</i> .....	36
<b>6 RECOMMENDATIONS .....</b>	<b>37</b>



# 1 Executive Summary

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In February 2018, the Vermont Public Utility Commission (the Commission) selected the Evergreen Economics team<sup>1</sup> (Evergreen) to serve as the Independent Auditor of the 2014-2016 reported energy and capacity savings and cost-effectiveness of programs delivered by the Vermont Energy Efficiency Utilities (EETs) pursuant to 30 V.S.A. § 209(f)(12). The EETs reviewed in this audit include Efficiency Vermont (EVT), the City of Burlington Electric Department (BED), and Vermont Gas Systems Inc. (VGS), which deliver electricity and thermal energy and process fuel energy efficiency services to residential and business customers throughout the state of Vermont.<sup>2</sup> Vermont Energy Investment Corporation (VEIC) operates as Efficiency Vermont under an Order of Appointment issued by the Commission on December 20, 2010. Oversight of the EET programs is assigned to the Commission by Vermont law. The Department of Public Service (the Department) serves as the state's energy office and as the public advocate in proceedings before the Commission. The programs reviewed in this report include all energy efficiency initiatives instituted by the EETs during the latest three-year evaluation cycle consisting of January 1, 2014 through December 31, 2016. This document serves as the Report to the Legislature.

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4. The Efficiency Vermont Technical Reference User Manual (TRM) and the process for managing and updating it;
5. Databases and other information compiled by VEIC, BED, and VGS that are used to develop and track savings claims and project costs; and
6. The procedures and methods used in the Department's savings claim verification process.

The remainder of this document outlines the methodology used by Evergreen to complete these objectives, in addition to all relevant savings and cost figures where necessary.

## 1.2 Overview of EET Programs

In Vermont, the three EETs provide a variety of energy efficiency program offerings that save residential and non-residential Vermonters money and energy in their homes and businesses.

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From 2014 through 2016, EVT, BED, and VGS implemented energy efficiency initiatives that can be grouped into four residential and three non-residential energy efficiency program categories, including:

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Note: VGS reported 63,695 Mcf total gas savings, and 393 Mcf peak day savings for the EEU portfolio in 2016. VGS costs for 2016 are included in this table. Totals exclude TEPF projects.

## **1.3 Methodology and Process Review**

As part of this audit, the Evergreen team completed a review of the data tracking, evaluation research, and Technical Advisory Group (TAG) processes in place during the 2014-2016 period. Based on this review, the team was also tasked with providing actionable recommendations for improvement. Our review of these program and evaluation processes included an assessment of the following:

- TAG process for updating the TRM;
- Data management and reporting by the EEU's; and

- The Department's savings verification process.

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All three EEUs maintain a program tracking database that stores all relevant project data, and Evergreen was provided with a copy of these databases for review. In general, these databases are complete and capture all relevant information required for tracking and evaluating program savings.

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For all three EEUs, Evergreen found that the savings values calculated using the EEU datasets matched the evaluation report savings claims to within a reasonable degree of error.

## 1.4 TRM Review

One of the key components of the energy efficiency implementation and evaluation processes in Vermont is the Efficiency Vermont Technical Reference User Manual (TRM). The TRM contains a substantial list of measures with methods on how to calculate energy savings for each measure. The TRM lists most of the assumptions used to determine savings, in addition to the algorithms and other auxiliary information such as incremental cost, free ridership rates, and operation and maintenance (O&M) savings.

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Deemed savings values are well documented, reasonable, and consistent with industry practices found in other jurisdictions. A majority of the measures in the TRM are algorithm based, which is generally a more accurate savings calculation methodology than strictly deemed values. Algorithms allow for specific customer inputs, which improve savings estimation accuracy by tailoring the values to match more closely with specific customer conditions.

## 1.5 Validation of Reported Energy Savings and Costs

Evergreen was also tasked with reviewing and validating the energy savings (kWh), demand reduction (kW), and cost values reported in all evaluation reports filed by EVT and BED for program years 2014, 2015, and 2016. We also reviewed and validated the natural gas savings (Mcf) reported by VGS for 2016. Evergreen verified the savings amounts reported by the independent evaluator for each program year by reviewing an extract of each EEU's program participant database and replicating the savings amounts listed. We also reviewed the evaluation of each EEU's evaluation report covering these years.

## 1.6 Cost-Effectiveness Analysis

The Evergreen analysis found that the EEU program portfolio was cost effective between 2014 and 2016 using the Program Administrator Cost Test (PACT), Total Resource Cost Test (TRC), and Societal Cost Test (SCT). Additionally, efficiency initiatives reported by sector and EEU in Table 2 were also found to be cost effective, with benefit-cost ratios exceeding 1.00 in all cases.

**Table 2: Cost-Effectiveness Model Summary, Total EEU Portfolio**

	Program Administrator Cost Test (PACT)	Total Resource Cost Test (TRC)	Societal Cost Test (SCT)
<b>Total EEU Portfolio</b>	<b>2.60</b>	<b>1.47</b>	<b>2.20</b>

## 1.7 Recommendations

There are several overarching findings from the audit of the 2014-2016 EEU program activities. While we have a number of recommendations on how the evaluation process can be

improved, it is important to discuss these within the overall context of the work that has been completed by the Vermont EEUs and their evaluation teams. Specifically, all recommendations should be considered within the context of these overall findings:

- Evaluation reports reviewed were of high quality and conformed to the standard practices of the evaluation industry.
- The TAG process is highly regarded by parties involved and seems to work well. Our review of TAG documentation indicates a thorough tracking system is in place to monitor the status of proposed updates, action items for TAG members, and records of TAG decisions.
- Savings estimates are accurate. The savings databases examined for EVT, BED, and VGS yielded energy savings totals to within a few percentage points of the reported savings noted in the evaluation reports filed by the EEUs. Furthermore, savings estimates are generally consistent with TRM guidelines.

Our review of the evaluation reports, savings estimates, and program processes identified several areas where improvements can be made. Related recommendations are summarized below.

- **The evaluation of all the EEU energy efficiency initiatives should begin earlier in the year.** This was a recommendation made in the last audit and is repeated here. Evaluators for each of the EEUs noted the very short time periods and budgets allocated for the evaluations. Typically, the final program data was provided in March and an evaluation report produced in June. An earlier start will allow the evaluator to complete a more rigorous analysis by affording them more time to conduct additional site visits and complete more in-depth engineering analyses. With an earlier start time the evaluations could also be expanded to include more in-depth analysis of other programs besides those in the commercial and industrial sector (which is the current focus). It is appropriate for the evaluator to draw a preliminary sample of projects from the first part of the year, which allows for some on-sites to be completed by the end of the year. The on-site sample can then be supplemented at the beginning of the following year to incorporate projects completed in the latter part of the prior year.
- **Expand the evaluations to include customer surveys.** An earlier start time (and larger evaluation budgets) would also allow for customer surveys to be completed across more programs. Regularly surveying program participants a minimum of once every three years is a common evaluation practice. Currently for each of the EEU's, only a few customers are contacted as part of the review of specific commercial and industrial projects, with questions narrowly focused on obtaining additional details about the installation and operation of the rebated equipment. In the current audit (as well as the prior audit), it appears that most programs have not had any customer surveys for the entire 2011-2016 period. Adding customer surveys would provide valuable customer feedback on the program operations, in addition to verifying

equipment installation and other useful information that could inform future program designs.

- **BED verification reports need to be completed sooner.** For all three program years covered in this audit, the BED verification reports were completed much later than those for EVT and VGS. In general, evaluation reports should be completed as soon as possible after the program year ends so that the results can be used to inform the next program year. While the EVT and VGS evaluation reports were completed about 6 months after the end of the program year, the BED reports were typically completed 18 to 22 months after the program year ended. This late reporting was likely done to meet the requirement for the forward capacity market (FCM) that requires a significant amount of post-installation monitoring.

While these reports might provide an adequate retrospective look at the program achievements and meet the requirements of the FCM, the delay does not make them useful prospectively for program planning as the recommendations arrive too late to inform the next program year. Both BED and the evaluation team should work together to produce these reports in a more timely fashion. Of course, the recommendation above to start the evaluation work earlier in the year will help address this issue.

- **The EEUs need to address the recommendations included in their evaluation reports.** For both EVT and BED, the same evaluation recommendations have been repeated each year, which indicates that these problems are ongoing and have not been addressed. In particular, these evaluation reports have called out problems of poor documentation and inappropriate applications of TRM values (or use of outdated or undocumented sources) to calculate savings. The EEUs should work to improve in these areas so that they do not remain as ongoing issues.
- **EVT should explore whether more project-specific data can be incorporated into its savings calculations to reduce reliance on default assumptions in the TRM.** This is related to the recommendation for improving project documentation, as this should produce more accurate savings estimates and lessen reliance on TRM default assumptions. As noted in our prior audit, the default TRM assumptions should be used only when project-specific information is not readily available. For each of the three years reviewed in the audit, the EVT evaluation reports recommend that EVT reduce its reliance on the TRM default assumptions for its savings calculations. The incorrect application or use of outdated TRM factors was also noted in the BED verification reports. This issue was also noted in our prior audit report and needs to be addressed by the EEUs.
- **Include thermal energy and process fuels (TEPF) projects in the annual evaluation process.** For both BED and EVT, the annual evaluation process should include (at a minimum) a review of a representative sample of TEPF projects so that a realization rate specific to these projects can be created. The verification methods and

results for the TEPF projects should be clearly documented in the evaluation reports for both utilities.

- **The Commission should reconsider the advisability of relying on an EEU functionally leading the TRM process.** The process seems to be working well, but (as noted in our prior audit) there is a potential structural conflict of interest in having the program implementer also managing the TRM and the update process. EVT does contract with an independent evaluation firm to assist with the TRM review and to provide input on measure updates, but their role appears to be limited and does not address the overall potential for a conflict of interest inherent in the current TRM management arrangement.
- **The EEUs should maintain frozen copies of the program tracking databases provided to the evaluator that are consistent with annual reported savings values for future audits.** This recommendation was made in the prior audit and was followed by the EEUs for the current verification period. We are recommending that this process be continued to facilitate efficient savings audits in future years. Because there were frozen databases available, Evergreen was able to verify energy savings to within an acceptable margin of error for most programs; however, deviations from the reported savings numbers were found. For future audits, we recommend that EVT, BED, and VGS save the same version of each program tracking database provided to the evaluator and make it readily available for the independent audit prior to the audit process beginning. By providing both sets of data, the auditor will be able to determine where significant changes in savings occurred, and this will inform the TRM and measure review process.

## 2 Methodology and Process Review

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The Evergreen team conducted a review of the data tracking, evaluation, and TAG processes currently in place by the Vermont Energy Efficiency Utilities (EETUs) and the Department of Public Service (the Department) to determine recommendations for improvement. Efficiency Vermont (EVT) and the City of Burlington Electric Department (BED) make up the two EETUs considered in this report for the entire 2014-2016 audit period. Vermont Gas Systems Inc. (VGS) savings are subject to this audit for 2016 only. Our review of these program and evaluation processes included an assessment of the following:

- Technical Advisory Group (TAG) process for updating the Efficiency Vermont Technical Reference User Manual (TRM);
- Data management and reporting by the EETUs; and
- The Department's savings verification process.

### 2.1 Technical Advisory Group Process Review

The purpose of the TAG is to provide a forum for research and approval of new or updated measure inclusion in the TRM. Evergreen reviewed the procedures for managing and updating the TRM through the TAG update process by speaking with three TAG members at EVT, BED, and VGS, as well as reviewing notes and other documentation from the TAG. The TAG process has been in place for several program cycles and in general, the process has not changed significantly in the past three years. The TAG process continues to be an ongoing and collaborative forum involving the Department, EETUs, and the evaluator. The TAG is led and managed by EVT (VEIC), and the TRM document is publicly available and owned by the State of Vermont.

Updates to the TRM occur regularly to add new measures, update assumptions, address evaluation recommendations, and incorporate codes and standards changes. Measures are triggered for review and potential updating based on two general rules:

1. Each measure is subject to examination and updating every three years to ensure that assumptions are up to date with market conditions.
2. Measures are subjected to review if evaluation recommendations or changes in state or federal codes impact the measure assumptions.

The current TAG process for updating the TRM is as follows:

1. Any TAG member may develop proposals for updates to the TRM.
2. The update proposal is circulated to all TAG members for review.

3. TAG members discuss the proposed update and come to a mutually agreed-upon decision.<sup>3</sup>
4. The TAG-proposed update or addition is reviewed by external reviewers including the independent evaluator.
5. EVT implements the corresponding update to the TRM.

Our review of TAG documentation indicates that the group continues to have a thorough tracking system in place to monitor the status of proposed updates, action items for TAG members, and records of TAG decisions. Individuals interviewed from the EEUs continue to view the TAG process positively, and there were no concerns or problems reported. In some cases, there are disagreements and debates, but the interviewees agreed that these discussions were overall beneficial to the process.

EVT continues to have the primary administration and management role of the TAG and TRM process. This role includes administration of meetings, including meeting scheduling and agenda setting, implementation of the TAG-approved updates to the TRM document, and management of the electronic database version of the TRM as it is developed. While EVT administers the TAG process, all TRM updates or new measure additions are assessed and approved by internal and external reviewers, including staff from the Department, BED, VGS, and the independent evaluators.

As noted in the previous three-year independent audit, EVT's role as the manager of the TAG process may introduce a structural conflict of interest. EVT is the largest EEU, and typically is most active in updating measures or bringing new measures. Combined with EVT's extensive management role, this could lead to EVT having a significant influence on the TRM update process, given that EVT, as an EEU, has a vested interest in maximizing the credit for savings awarded for efficiency projects. Despite this concern, the independent auditor has seen no reason to doubt EVT's objectivity in the TRM process, and interviewees from the Department and the EEUs all saw the process as transparent and appropriately managed.

The database version of the TRM is live and continues to be developed by EVT. Interviewees from the EEUs all stated that the database version improves the TRM update process, reducing errors and making the process more efficient by allowing measure development to be conducted within the online application.

## Recommendations

The Commission should continue to monitor EVT's role as the TAG administrator with a view to ensuring that potential conflicts of interest are avoided. The Department should also continue to hire an independent third party to conduct periodic in-depth reviews of the TRM.

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<sup>3</sup> If needed, the Department makes the final decision of which updates are approved. The Commission can also be called in to mediate if no agreement can be reached, but this step has not yet been required.

## 2.2 Data Management and Reporting Review

EVT, BED, and VGS each maintain a program tracking database that stores all relevant project data. Each EEU provided Evergreen with a static version of their database reflecting all data for the three evaluation years. We reviewed each database to ensure that TRM values were accurately applied and verify that savings reported in the annual evaluations and annual reports accurately reflect the values in the respective EEU's database. In general, Evergreen found that the EEU databases were complete and accurate with no significant issues. Evergreen did find some typographic errors in the BED report for 2015.

In our current review of the databases, we found that BED and EVT adopted a key recommendation from the previous audit. In the 2011-2013 Independent Audit, we had found discrepancies between the evaluation reports and participant database values. It was determined that these discrepancies were largely due to the fact that the EEU databases provided were "live" versions, which were being constantly updated and retroactively changed. The independent auditor recommended the EEUs save the same version of each program tracking database provided to the independent evaluator and make it readily available for the independent audit. All three EEUs provided these static database versions for the current audit, and consequently, the savings verification process was much simpler to complete.

### 3 TRM Review

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One of the key components of the energy efficiency implementation and evaluation processes in Vermont is the Efficiency Vermont TRM. The TRM contains characteristics of over 100 different measures that cover a wide range of lighting, motors, HVAC, appliance, and refrigeration technologies across the residential, commercial, low income, and multifamily sectors. The TRM includes a description of each measure, method to calculate the energy savings, assumptions used, and algorithms, as well as other auxiliary information such as incremental cost, free ridership rates, and O&M savings.

To evaluate the TRM parameters and assumptions, the Evergreen team first completed a general review of the entire document. This review allowed us to identify code changes and other high level or incorrect mathematical issues. We then reviewed the most significant measures in the TRM, including all engineering parameters and assumptions.

During this review, we examined the background documentation to ensure:

- Savings calculations used were accurate and consistent with engineering fundamentals; and
- The assumptions for operating parameters, efficiencies, etc., are reasonable and consistent with industry best practices.

Detailed results of the review are discussed in the following sections.

#### 3.1 Summary Review

In general, our review found that the current version of the Vermont TRM is technically sound and relatively comprehensive. Deemed savings values are well documented, reasonable, and consistent with industry practices found in other jurisdictions. Savings for a majority of the measures in the TRM are algorithm based, which is generally a more accurate savings calculation methodology than strictly deemed values. Algorithms allow for specific customer inputs, which improve savings estimation accuracy by tailoring the values to match more closely with specific customer conditions. In addition, the TRM uses load shapes derived from Vermont specifically, or New England more broadly, to develop the energy and demand savings for most measures. The use of locally derived load shapes provides a reasonable assessment of the actual savings that are realized for these measures over the relevant energy and demand savings periods. The use of local load shapes represents a best practice, and helps to ensure reasonable temporal certainty for the deemed measures contained in the TRM.

The Vermont Public Utility Commission updated the avoided cost parameters and values in late 2015. This update included adjustments to the summer and winter generation peak periods, which are used to determine the demand savings for energy efficiency measures. The new summer peak generation capacity period is from 1 p.m. to 5 p.m. on non-holiday weekdays in June, July, and August, and the new winter peak generation capacity period is from 5 p.m. to 7 p.m. on non-holiday weekdays in December and January. The latest revision

to the TRM has captured the effect of the peak period definition changes in the claimed demand savings for most measures. The alignment of the demand load shapes, cost periods, and avoided cost inputs for the Vermont TRM is an industry best practice.

### TRM Technical Accuracy

In almost all cases, our review found the TRM to be technically accurate. Our review did not conduct an in-depth engineering analysis for each measure, but did conduct a general review to assess the reasonableness of the savings methodology for the TRM overall. During this review, we did identify a few issues:

- The Dual Enthalpy Economizer measure did not claim any peak generation period savings. The savings from this measure appears to be derived from a bin analysis that did not include temporal parameters, which is inconsistent with the methodology used for the bulk of the measures in the TRM. A review of the typical meteorological year (TMY3) climate data for BED showed that there are weather conditions during the peak periods that may allow a Dual Enthalpy Economizer measure to generate demand savings. We recommend updating the load shapes and methodology used to determine the savings for this measure in future iterations of the TRM to be consistent with most other measures.
- Some of the load profile factors provided in the load shape portion of the TRM may not be consistent with the savings algorithms and measures found in the individual measure descriptions. For example, boiler feed water pumps <10 HP have a 100% and 67% load shape for winter and summer kW, respectively. However, the summer on-peak and off-peak kWh factors are 0.0% and 0.1% respectively. The load shapes do not appear to be consistent with the energy savings factors and demand savings factors in the measure description for boiler feed water pumps, which assume no summer peak savings.

In general, we did not discover any significant issues with measure baselines, and believe that the Vermont TRM is well suited to provide accurate savings estimates for the state. As the TRM is updated, care should be taken to normalize the load shapes used for the cost effectiveness testing and the inputs, such as summer and winter demand savings factors, used to determine the savings for each measure. Additionally, future program evaluations should consider documenting cases where the load shapes are found to have errors in a systematic way to help improve the TRM in future iterations.

### Prior Audit Recommendations for the TRM

During the previous independent audit,<sup>4</sup> a TRM review was completed and several recommendations were included. Evergreen reviewed those recommendations to ensure they

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<sup>4</sup> Evergreen Economics. 2015. *Independent Audit, 2011-2013 Management Letter, Vermont Energy Efficiency Utility*. Submitted to Vermont Public Utility Commission.

had been properly incorporated into the last version of the TRM. The following recommendations do not appear to have been adopted.

### *Energy Code Update*

On March 1, 2015, the Residential Building Energy Standards (RBES)<sup>5</sup> and the Commercial Building Energy Standards (CBES),<sup>6</sup> updated revisions went into effect. The previous independent audit recommended that since EVT has the ability to provide updated TRMs on an annual basis, it was recommended that these changes be updated and included for the 2016 TRM. Some suggested updates were:

- Updating the baseline efficiency requirements for the Electric HVAC measure;
- Updating the baseline lighting power density requirements;
- Updating the baseline insulation and shell requirements; and
- Updating baseline efficiency for packaged terminal heat pumps.

This recommendation was not adopted in the 2016 TRM.

### *LED Lighting*

The previous independent audit noted that the assumed lifetime for LED lamps in the current TRM is capped at 15 years; however, the second Tier of EISA 2007 regulations go into effect beginning January 2020. The recommendation was that the baseline should be adjusted to the second Tier for any years after 2022,<sup>7</sup> which is when a baseline halogen lamp would require replacement.

This recommendation was not adopted in the 2016 TRM.

### *Motor Measures*

The previous independent audit noted that an area where savings calculations for motor measures could be improved was the persistence factor, which was listed as 1.0. The 2014 TRM referenced a study completed by National Grid in 1999<sup>8</sup> as the source of the persistence value. As the data from the National Grid research were more than 15 years old, the independent evaluator recommended that persistence should be reexamined with more recent participants.

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<sup>5</sup> *Residential Building Energy Standards*, Public Service Department of the State of Vermont.

[https://publicservice.vermont.gov/energy\\_efficiency/rbes](https://publicservice.vermont.gov/energy_efficiency/rbes)

<sup>6</sup> *Commercial Building Energy Standards*, Public Service Department of the State of Vermont.

[https://publicservice.vermont.gov/energy\\_efficiency/cbes](https://publicservice.vermont.gov/energy_efficiency/cbes)

<sup>7</sup> First tier EISA compliant halogens have a lifetime of four years (3,000 hours at 2.17 hours per day). The last year these lamps are available is 2019, and they will need replacement at the end of 2022. . Thus, the new standard must be used after 2022.

<sup>8</sup> National Grid evaluated persistence in 1999 of VFDs installed in 1995 and estimated a factor of 97%.

This recommendation was not adopted in the 2016 TRM.

### **Recommendations**

As noted above, we believe that the current version of the Vermont TRM in general is technically sound and appropriately comprehensive. In addition to adopting the remaining recommendations from the previous independent audit, the Evergreen team recommends the following:

- During the TRM update process, care should be taken to normalize the load shapes used for the cost effectiveness testing and for determining savings for each measure.
- Future program evaluations should consider documenting cases where the load shapes are found to have errors in a systematic way to help improve the TRM in future iterations.

## 4 Validation of Reported Savings and Costs

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As noted above, for the audit the Evergreen team reviewed the electric energy savings, demand reduction (both winter and summer), and cost values included in all evaluation reports filed by EVT and BED for program years 2014-2016. The audit also covers gas savings for VGS in 2016.

### 4.1 Reported Savings

The Evergreen team verified all savings values reported by the independent evaluator for each program year and for each EEU. During the audit period, West Hill and The Cadmus Group were the independent evaluators contracted by the Department to review and verify annual project savings for EVT and BED. Energy and Resource Services (ERS) were the independent evaluators contracted by the Department to review and verify annual project savings for VGS. Evergreen requested and received a copy of each EEU's program participant database and replicated the savings amounts listed.

Overall, Evergreen was able to review and replicate savings for each EEU to within a small margin of error. In the previous audit of the 2011-2013 program cycle, the audit team found that adjustments were made to the program tracking databases continuously over time, making verification of reported savings problematic. As a result, the auditor recommended that the EEUs maintain static copies of the databases used to report savings. It appears that each of the EEUs adopted this recommendation, as the savings replication closely matched the savings reported in the evaluation reports and annual reports.

The results of the replication activity are shown for EVT and BED in Table 3 for energy savings, Table 4 for winter demand savings, and Table 5 for summer demand savings.

**Table 3: Energy (kWh) Savings Verification Summary, Combined EEU Portfolio**

Program	EVT			BED		
	Reported Energy Saved (MWh)	Calculated Energy Saved (MWh)	% of Reported Value	Reported Energy Saved (MWh)	Calculated Energy Saved (MWh)	% of Reported Value
Residential New Construction	3,439	3,439	100%	415	420	101%
Existing Homes	6,242	6,242	100%	651	662	102%
Efficient Products	115,485	115,484	100%	5,415	5,506	102%
Upstream HVAC and Lighting	17,899	17,899	100%	N/A	N/A	N/A
<b>Residential Total</b>	<b>143,064</b>	<b>143,064</b>	<b>100%</b>	<b>6,481</b>	<b>6,588</b>	<b>102%</b>
Business New Construction	49,423	49,423	100%	3,090	3,039	98%
Business Existing Facilities	92,278	92,278	100%	7,793	7,417	95%
Upstream HVAC and Lighting	26,117	26,117	100%	N/A	N/A	N/A
<b>C&amp;I Total</b>	<b>167,818</b>	<b>167,818</b>	<b>100%</b>	<b>10,883</b>	<b>10,456</b>	<b>96%</b>
<b>Portfolio Total</b>	<b>310,882</b>	<b>310,882</b>	<b>100%</b>	<b>17,364</b>	<b>17,044</b>	<b>98%</b>

**Table 4: Winter Demand (kW) Savings Verification Summary, Combined EEU Portfolio**

Program	EVT			BED		
	Reported Winter Demand Reduction (kW)	Calculated Winter Demand Reduction (kW)	% of Reported Value	Reported Winter Demand Reduction (kW)	Calculated Winter Demand Reduction (kW)	% of Reported Value
Residential New Construction	883	883	100%	14	14	100%
Existing Homes	1,482	1,482	100%	170	171	101%
Efficient Products	25,898	25,898	100%	1,316	1,326	101%
Upstream HVAC and Lighting	3,712	3,712	100%	N/A	N/A	N/A
<b>Residential Total</b>	<b>31,975</b>	<b>31,975</b>	<b>100%</b>	<b>1,499</b>	<b>1,511</b>	<b>101%</b>
Business New Construction	6,742	6,742	100%	403	404	100%
Business Existing Facilities	16,192	16,192	100%	709	712	100%
Upstream HVAC and Lighting	3,283	3,283	100%	N/A	N/A	N/A
<b>C&amp;I Total</b>	<b>26,217</b>	<b>26,217</b>	<b>100%</b>	<b>1,112</b>	<b>1,116</b>	<b>100%</b>
<b>Portfolio Total</b>	<b>58,192</b>	<b>58,192</b>	<b>100%</b>	<b>2,612</b>	<b>2,627</b>	<b>101%</b>

**Table 5: Summer Demand (kW) Savings Verification Summary, Combined EEU Portfolio**

Program	EVT			BED		
	Reported Summer Demand (kW)	Calculated Summer Demand (kW)	% of Reported Value	Reported Summer Demand Reduction (kW)	Calculated Summer Demand Reduction (kW)	% of Reported Value
Residential New Construction	321	321	100%	38	38	100%
Existing Homes	516	516	100%	61	61	100%
Efficient Products	13,933	13,933	100%	652	651	100%
Upstream HVAC and Lighting	794	794	100%	N/A	N/A	N/A
<b>Residential Total</b>	<b>15,564</b>	<b>15,564</b>	<b>100%</b>	<b>752</b>	<b>750</b>	<b>100%</b>
Business New Construction	7,263	7,263	100%	388	388	100%
Business Existing Facilities	9,134	9,134	100%	813	813	100%
Upstream HVAC and Lighting	4,980	4,980	100%	N/A	N/A	N/A
<b>C&amp;I Total</b>	<b>21,377</b>	<b>21,377</b>	<b>100%</b>	<b>1,201</b>	<b>1,201</b>	<b>100%</b>
<b>Portfolio Total</b>	<b>36,941</b>	<b>36,941</b>	<b>100%</b>	<b>1,953</b>	<b>1,951</b>	<b>100%</b>

Table 6 shows the annual savings achieved by the TEPF projects.

**Table 6: MMBtu Savings, TEPF Projects (EVT and BED)**

Year	EVT TEPF MMBtu Savings	BED TEPF MMBtu Savings
<b>2014</b>	36,534	403
<b>2015</b>	47,013	110
<b>2016</b>	119,810	169

Table 7 and Table 8 present the replicated savings results for VGS for 2016.

**Table 7: Gas (Mcf) Savings Verification Summary, VGS Portfolio**

Program	VGS		
	Reported Energy Saved (Mcf)	Calculated Energy Saved (Mcf)	% of Reported Value
Residential New Construction	5,569	5,569	100%
Residential Existing Facilities	4,780	4,780	100%
Residential Equipment Replacement	10,678	10,678	100%
<b>Residential Total</b>	<b>21,027</b>	<b>21,027</b>	<b>100%</b>
Commercial New Construction	7,875	7,875	100%
Commercial Existing Facilities	29,287	29,287	100%
Commercial Equipment Replacement	5,506	5,506	100%
<b>C&amp;I Total</b>	<b>42,668</b>	<b>42,668</b>	<b>100%</b>
<b>Portfolio Total</b>	<b>63,695</b>	<b>63,695</b>	<b>100%</b>

**Table 8: Gas (Mcf) Peak Day Savings Verification Summary, Combined EEU Portfolio**

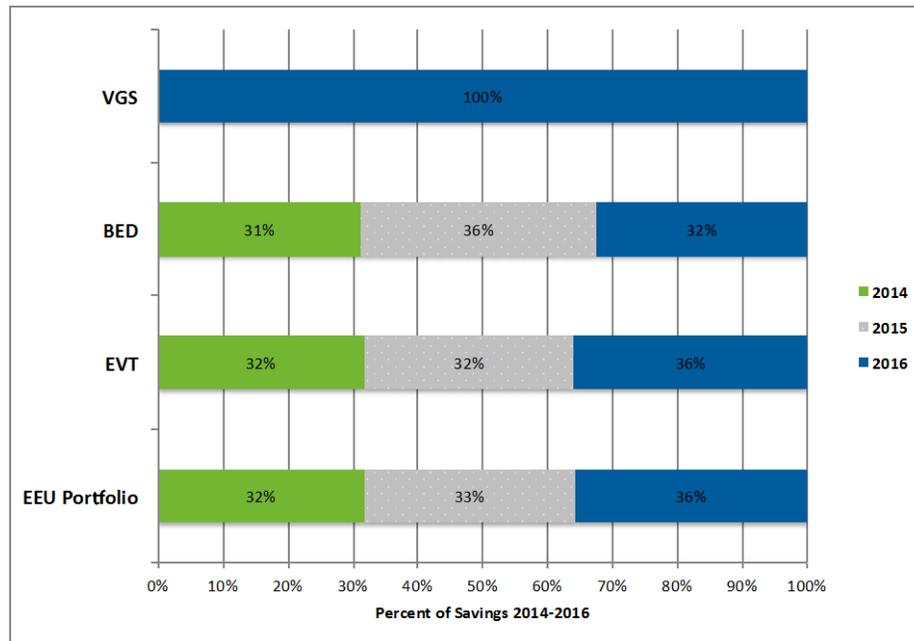
Program	VGS		
	Reported Energy Saved (Mcf)	Calculated Energy Saved (Mcf)	% of Reported Value
Residential New Construction	64	64	100%
Residential Existing Facilities	62	62	100%
Residential Equipment Replacement	93	93	100%
<b>Residential Total</b>	<b>218</b>	<b>218</b>	<b>100%</b>
Commercial New Construction	101	101	100%
Commercial Existing Facilities	45	45	100%
Commercial Equipment Replacement	29	29	100%
<b>C&amp;I Total</b>	<b>175</b>	<b>175</b>	<b>100%</b>
<b>Portfolio Total</b>	<b>393</b>	<b>393</b>	<b>100%</b>

Evergreen used the participant data provided by each EEU to characterize where savings were being achieved by sector and end use. This was done to determine how energy savings by measure type were changing over time. These areas can be used to set evaluation priorities in future years as well as to provide a focus for comparisons across EEUs and program years.

Energy savings by year by EEU are presented in Figure 1. This chart indicates that energy savings were consistently distributed across the three program years, with the exception of VGS, which is only considered for 2016 in this audit. Note that the following graphs all exclude

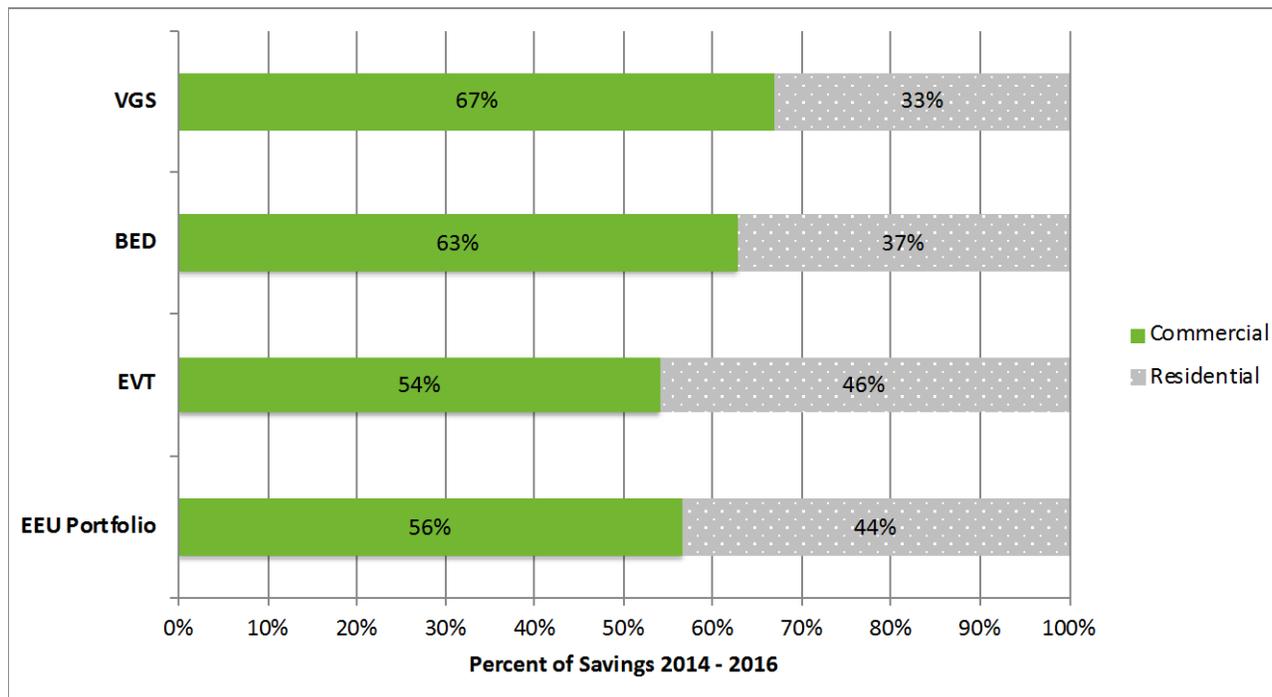
savings from the TEPF projects as these are primarily achieving savings in MMBtu's and not kWh.

**Figure 1: Energy Savings Summary by EEU and Program Year**



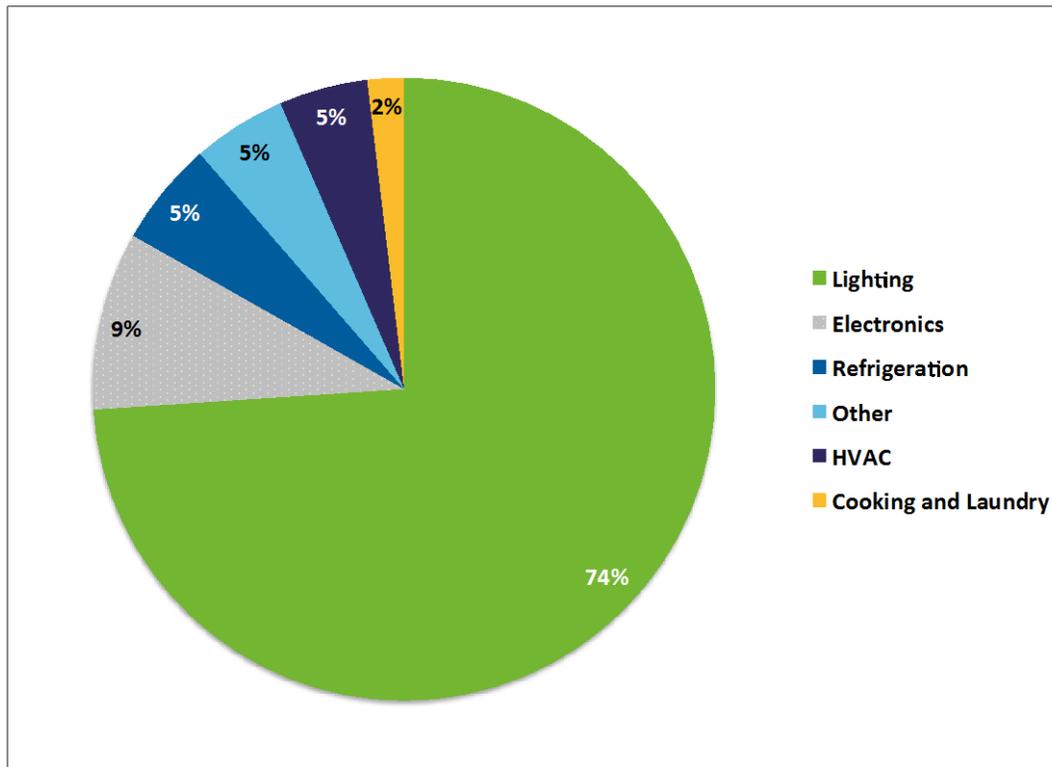
Energy savings by sector by EEU are presented in Figure 2. This chart indicates that more energy savings were achieved in the commercial sector than in the residential sector across all EEUs.

**Figure 2: Energy Savings Summary by EEU and Sector**



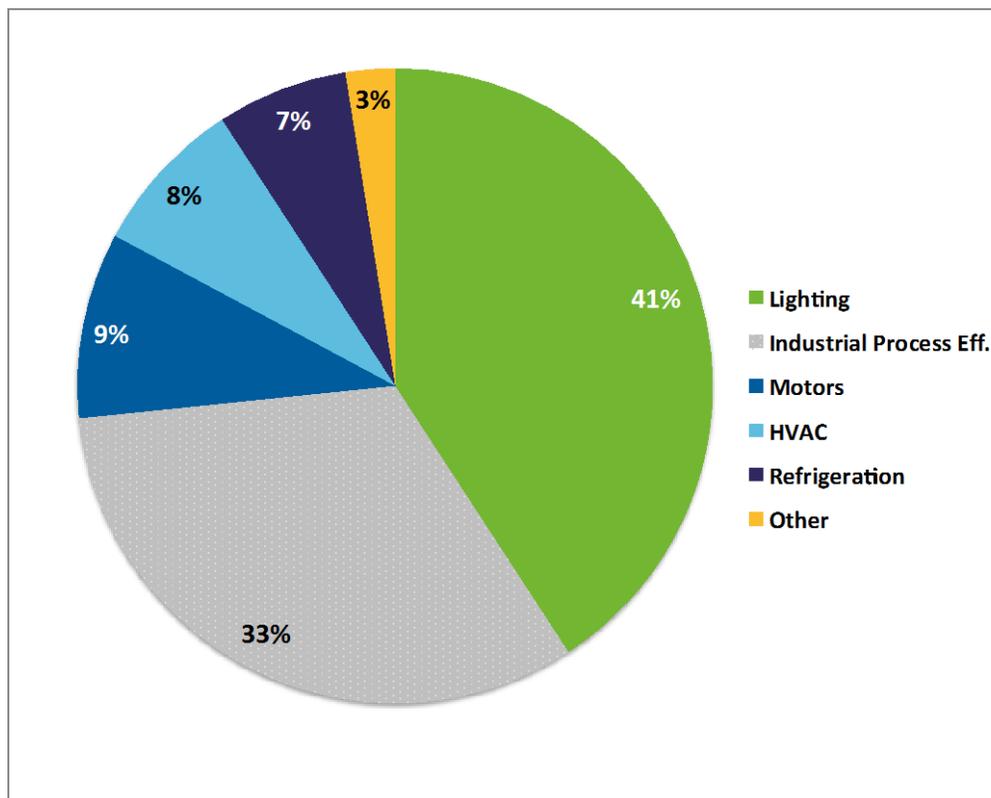
Energy savings for EVT, presented in Figure 3, show that lighting remains the primary source (74%) of savings for the residential sector. Savings attributed to electronic plug load measures make up an additional 9 percent of savings. Refrigerators and HVAC measures contribute 5 percent each. Cooking, laundry, and other measures including motors and hot water measures comprise the remaining 7 percent of savings.

**Figure 3: Residential Savings by End Use/Measure, EVT EEU Portfolio (2014-2016)**



As shown in Figure 4, non-residential energy savings from EVT’s efficiency initiatives are also primarily lighting based (41%), but to a smaller extent than residential savings. Other large measure groups consist of industrial processes (33%), motors (9%), refrigeration (7%), and HVAC measures (8%).

**Figure 4: Commercial Savings by End Use/Measure, EVT EEU Portfolio (2014-2016)**

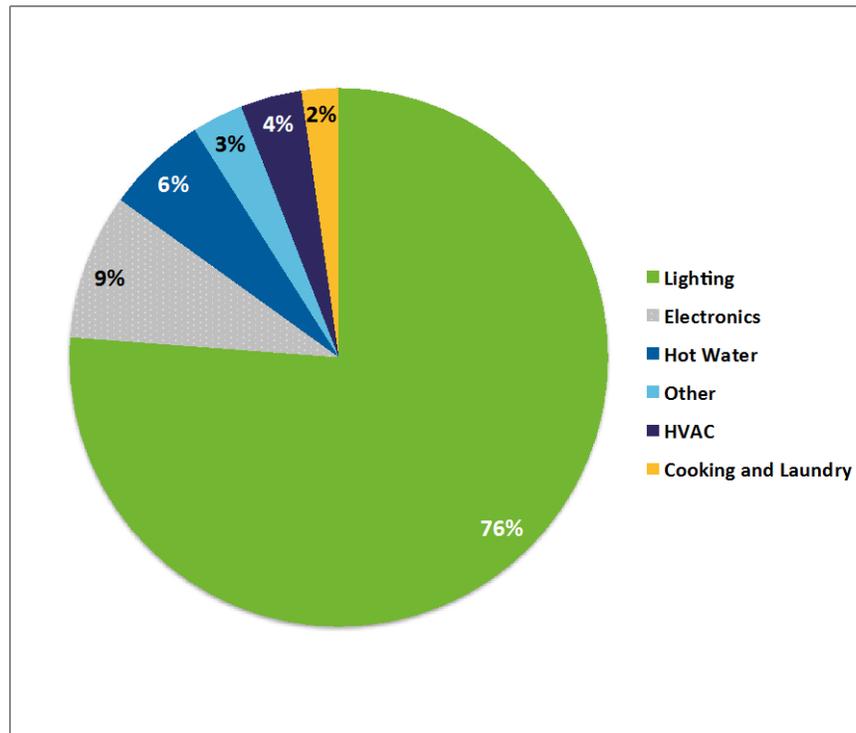


**Note:** “Other” includes air conditioning efficiency, design assistance, ventilation, and other miscellaneous measures.

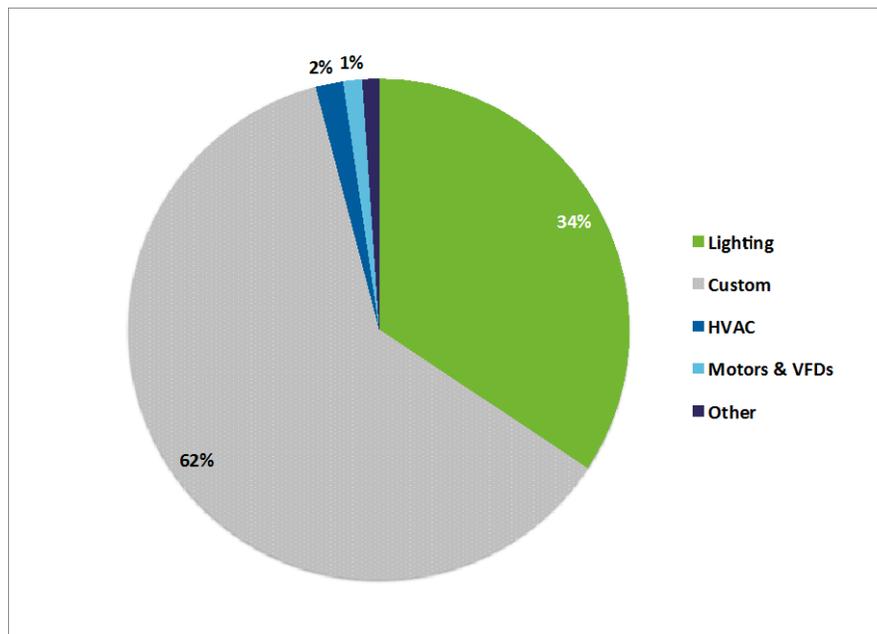
For BED, we also examined which measures and end uses were contributing to reported savings by sector within the program tracking data. The results of this analysis are shown in Figure 5 and Figure 6. For the residential sector, the vast majority of savings (76%) comes from lighting measures. Electronic plug load measures contribute an additional 9 percent of savings, while the remainder of savings consists of refrigerators, appliances, and “Other” measures such as building envelope improvements and water heating measures.

For the non-residential sector, custom projects are the primary source of savings (62%), followed by lighting projects (34%).

**Figure 5: Residential Savings by End Use/Measure, BED EEU Portfolio (2014-2016)**



**Figure 6: Commercial Savings by End Use/Measure, BED EEU Portfolio (2014-2016)**



## 4.2 Reported Costs

Evergreen examined and extracted annual program cost data from the annual reports filed by each EEU for each program year. We used these cost data to conduct the cost-effectiveness analysis included in this report. For EVT, all examined costs exclude customer credit programs. For BED, the summary reports included all necessary and relevant program and participant costs. All costs were compared to values in the previous evaluation and audit reports, and were found to be on a level that is both reasonable and consistent given the calculated energy savings. Calculated project costs were compared to participant costs reported in the evaluation reports.

## 4.3 Evaluation Report Review

In addition to the review of the TRM, Evergreen also reviewed each evaluation report from 2014 through 2016, for EVT, BED, and VGS. For each report year, the methodology was reviewed for reasonableness and appropriateness. Specifically, this review included an assessment of the sampling plan as well as the techniques used to adjust the savings estimates. Each evaluation recommendation was also reviewed to determine if it was appropriate and well supported based on the completed evaluation activities.

Based on our review, the EEU evaluation reports appear to be adequate for reporting savings. The EVT evaluations appeared to be limited in scope and relied on document reviews to verify the program savings. The evaluations of the VGS and BED programs were more rigorous and used billing regression and on-site data collection, in addition to document reviews, to verify the savings from these programs. Finally, the EVT evaluations did not appear to provide enough reporting to support adjustments to load shapes, which are used for cost benefit testing, even when adjustments were made to summer and winter peak savings on a measure level basis.

A review of the evaluation reports for each EEU is included below. While we make some recommendations for improving and expanding the evaluation process, in general we did not find any problems in the verification process that would lead to systemic errors in data entry or accuracy for the programs covered.

### *Efficiency Vermont Evaluation Reports*

The West Hill Energy team conducted the EVT evaluation in 2014 and Cadmus completed the evaluations for 2015 and 2016. For each of these years, the verification review had a very limited scope focusing mostly on projects in the Commercial and Industrial (C&I) sector. The realization rates produced by the evaluation teams ranged from 97 to 100 percent for residential programs and 84 to 105 percent for commercial programs, which is fairly typical for these types of programs. This indicates that the initial savings estimates provided by EVT are reasonable and are receiving a normal amount of adjustment as a result of the evaluation process.

The impact analysis consisted primarily of desk reviews for prescriptive measures, and desk reviews and limited billing analysis for custom and new construction measures. Desk reviews are essentially a check to ensure that the calculations and documentation for each reviewed project are consistent and reasonable. For a mature program, this is probably adequate, but there are two notable points.

First, the evaluation did not appear to include any independent data for prescriptive measures. Prescriptive measures represent the majority of the portfolio savings for both program cycles. A desk review typically involves ensuring that the claimed quantities and efficiencies match the data provided in the invoices and equipment specification sheets, and ensuring that the proper TRM algorithms and inputs are used for a specific building or measure type. However, this method of review is very limited. There did not appear to be any independent data, such as billed usage, for the prescriptive analysis. We recommend that future evaluations have some independent reference points beyond what is included in the project documentation. For example, it can be useful to compare claimed savings for specific measures against facility billed consumption to check for reasonableness, or to ensure that the project does not claim more energy savings than the facility was using prior to the completion of the project.

Second, the evaluation reports do not include the same metrics that are used in the cost benefit analysis. The evaluation report includes realization rates for gross kWh, summer demand, and winter demand. The cost-benefit testing includes summer and winter on-peak and off-peak energy factors, as well as the summer demand and winter demand. The evaluation report should report the savings adjustments made to the summer and winter on- and off-peak energy savings, but this does not appear to be included. For example, project 457011 involved an adjustment to the savings for floating head pressure. This involved a reduction to the gross kWh and the summer kW, while the winter kW savings were not adjusted. Presumably, the energy savings during the summer on- and off-peak periods are affected more than the winter energy savings. However, only the gross savings adjustment was reported. Other adjustment summaries included in the report used modified load shapes to adjust demand savings, but these adjustments did not appear to be carried over into the on- and off-peak factors included in the TRM. This does not provide the feedback to verify the inputs used in the cost benefit testing are accurate.

For EVT (and for the other EEU's), we recommend that the evaluation be expanded to include additional surveys with participating customers in other programs. From the evaluations for the 2014-2016 period and those in the prior audit years (2011-2013), there has been no surveys conducted for participating customers other than collecting limited information to assist with the evaluation of the commercial projects for a small sample of customers. As we discuss more below, we recommend that EVT expand their evaluation efforts to include process evaluations of the other programs that include more surveys of participating customers.

We also recommend that the EVT evaluations start earlier, such as September of the program year being evaluated, so that phone surveys and additional evaluation work can be completed. The evaluation could use participation from earlier in the program year (January – August) to draw the survey and analysis samples and still be able to produce an evaluation report by June of the following year. Additional evaluation work would be conducted after the program year ends and the total evaluation results can be trued up using the final program year participation data. This would help address the complaint from the EVT evaluators of having limited time to complete the evaluation under the current schedule that begins in March and ends in June. Note that the earlier start to the evaluation also does not require that the participation database be finalized, as there should be adequate time for the final numbers to be trued up after the year ends.

As a separate task, we reviewed the verification process used by EVT for its TEPF projects. The total savings claimed for these projects is shown in Table 9.

**Table 9: MMBtu Savings, EVT Portfolio**

Year	TEPF MMBtu
	Savings
<b>2014</b>	36,534
<b>2015</b>	47,013
<b>2016</b>	119,810

Based on our conversations with the Department, the TEPF projects were not verified in 2014 or 2015, but the realization rates obtained from the evaluation of the commercial programs were applied to the TEPF projects to create an estimate of realized savings for those years. This changed in 2016 when a sample of TEPF projects was verified by Cadmus to develop a specific realization rate just for these projects. This information was provided in an Excel file that had very limited detail on what savings adjustments were made based on the review. Neither the TEPF verification methods nor results were included in the final evaluation report for 2016.

Given the amount of the TEPF savings, we recommend that the TEPF projects be included in the annual evaluations and that a representative sample of projects be reviewed each year. The methods and results from the TEPF verification should also be written up in the final evaluation report with a similar level of detail provided for the commercial programs.

### *Vermont Gas Systems' Evaluation Report (2016 only)*

The 2016 VGS evaluation was conducted by Energy & Resource Solutions (ERS) and covered the Commercial/Industrial and Custom Residential New Construction programs. Overall, the VGS evaluation appears to have been rigorous and consistent with industry best practices. The evaluation included widespread use of site-specific data for projects, as well as a representative sampling plan. Notably, the projects were cross-checked for reasonableness

using facility billed data. Many projects appeared to have had a thorough review and significant adjustments to savings based on the evaluation analysis. It was unclear from the evaluation report how many of the sampled sites received an on-site visit or a phone interview, and making this clear in future reports would be helpful.

For future evaluations, we recommend continuing with the current approach but expanding the scope to include additional surveys that can collect process-related information to obtain feedback on the programs. If additional programs are offered by VGS in future years (as recommended by the ERS evaluation team), then the customer survey effort should also be expanded to include these programs.

### *Burlington Electric Department Evaluation Reports*

West Hill Energy conducted the BED program evaluations for each of the 2014-2016 program years. These evaluations included a review of deemed savings values as well as a deeper investigation into the C&I sector projects. The realization rates produced by the evaluation teams ranged from 86 to 107 for commercial programs, which is fairly typical for these types of programs. This indicates that the initial savings estimates provided by BED are reasonable and are receiving a normal amount of adjustment as a result of the evaluation process. On the residential side, the realization rates ranged from 8 to 138 percent, with the smallest realization rates for the smaller and newer programs such as Prescriptive Other Non-eShapes and AMI Data Analysis. These types of applications are tailored more specifically to individual customer types or custom measures, and consequently tend to have a wider range of both savings values and evaluation adjustments.

The evaluation for the BED C&I sector projects was rigorous with extensive use of AMI data and on-site data collection that ensured a thorough review of each of the sampled projects. The sampling plan was reasonable, and the methods employed are likely compliant with the relevant ISO-NE forward capacity market standards.

The evaluation report correctly noted that the BED programs appeared to use outdated TRM savings values. Going forward, adjustments that stem from modifications to the load shapes to adjust demand savings should be carried over into the on- and off-peak factors included in the TRM. This was not an issue under the conditions in place during the evaluation of the 2014 and 2015 programs, but should be taken into consideration prospectively.

This biggest area of concern is the timing of the completed evaluation reports, where final reports were typically completed 17 to 22 months after the end of the program year. By comparison, VGS and EVT evaluation reports were done generally within 6-7 months after the end of the program year (as is common in other jurisdictions). Having reports delayed this long drastically reduces the usefulness of the evaluation results<sup>9</sup> as they are often outdated by

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<sup>9</sup> The delay is likely due to waiting to have sufficient post-period billing data to calculate actual savings achieved from the commercial project installations and meet the M&V requirements of the FCM. We do not believe that

the time the report is completed and cannot be used to help make program adjustments the following year.

We strongly encourage that the BED reporting schedule be tightened up to produce a report in a timeframe similar to the other EEU's (i.e., within 6 months after the program year ends). This will be especially important if future evaluations are expanded to include additional surveys and process evaluations, as we recommend below for all EEU's.

As with EVT, for the BED evaluations we also recommend that the evaluation work begin during the program year as some of the sampling, project review and survey work can be completed using customers that participate earlier in the year. The partial year results can then be trued up once the program year participation data are finalized, and supplemented with additional evaluation work as needed once the program year ends.

The TEPF project savings and the relative comparison to the rest of the portfolio are shown in Table 10. For the BED TEPF projects, there is not any formal verification done for any of the years but instead the realization rate from the sample of verified commercial projects is applied to the TEPF projects to create an estimate of realized savings. The Department indicated that the small amount of savings from these projects did not justify the additional cost associated with doing a formal verification. We show the TEPF savings in the table below.

**Table 10: MMBtu Savings, BED Portfolio**

Year	TEPF MMBtu Savings
2014	403
2015	110
2016	169

As with EVT, we recommend that the BED TEPF projects be subjected to an annual evaluation that includes the review of a representative sample of projects. At a minimum, the commercial evaluation sample should be expanded to include the TEPF projects. The verification methods and results should also be clearly documented in BED's annual evaluation report.

### *Evaluation Report Recommendations*

As discussed above, generally, the evaluation reports are adequate. However, they suffer from similar shortcomings as noted in the previous independent audit, specifically:

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this benefit is great enough to justify delaying the report this long, especially considering that this evaluation is the only one being completed each year and consequently BED is losing the opportunity to obtain evaluation results that can provide timely feedback on program performance.

- **Inconsistent levels of rigor:** The EVT evaluations were limited in scope and relied on document reviews to verify the program savings. The evaluations of the VGS and BED programs were more rigorous and used billing regression and some on-site data collection, in addition to document reviews, to verify the savings from these programs.
- **Prescriptive measure assumptions:** Prescriptive and residential projects for the EEU's were primarily verified by comparing claimed savings values to existing load shape or TRM values. While this approach is sufficient for the evaluations completed, it is important to note that prescriptive and residential measures comprised more than 50 percent of the savings evaluated. For continued accuracy, these measures must be updated on a regular basis, preferably with primary data collection in Vermont or other locations in the region.
- **Customer surveys and process evaluation.** All of the evaluations lacked any significant survey effort with participating customers or any type of process evaluation that would provide feedback on how well the programs are functioning. The evaluation scopes should be expanded to include (at a minimum) some customer surveys for a variety of programs (i.e., not limited to the C&I sectors). Beginning the evaluations earlier in the program year would also facilitate adding the survey and process evaluation elements.
- **TEPF projects.** For all EEU's, we recommend that the TEPF projects be included as part of the annual evaluations, with a representative sample of projects covered each year. The verification methods and results for the TEPF projects should also be included in the annual evaluation reports.

## 5 Cost-Effectiveness Analysis

Evergreen Economics calculated program cost effectiveness for each year in the current evaluation cycle (i.e., 2014-2016) using the methodology noted in the California Standard Practice Manual.<sup>10</sup> Benefit-cost ratios are reported for the Program Administrator Cost Test (PACT),<sup>11</sup> Total Resource Cost Test (TRC), and Vermont Societal Cost Test (SCT). For all these tests, the total benefits are divided by total costs to obtain a ratio reflecting cost effectiveness, with values greater than 1.00 signifying that the program is cost effective (i.e., the benefits are greater than the costs).

Based on our review of the EEU savings claims and the cost effectiveness calculations, we believe that the cost effectiveness results reported by the EEU's are robust. We did not find any systematic errors or procedural issues that would significantly affect the accuracy of these calculations. Some of the evaluation recommendations made in the prior section should help further improve the accuracy of the cost effectiveness calculations, however, as more programs would be covered by the evaluation and produce different final savings numbers.

As shown in Table 11, overall the EEU portfolio as a whole was cost effective for all three tests. Additional benefit-cost ratios are provided below for all programs combined, as well as by residential and C&I sector, and EEU. A description of each test and the relevant inputs is also provided.

**Table 11: Cost-Effectiveness Model Summary, Total EEU Portfolio**

	Program Administrator Cost Test (PACT)	Total Resource Cost Test (TRC)	Societal Cost Test (SCT)
<b>Total EEU Portfolio</b>	<b>2.60</b>	<b>1.47</b>	<b>2.20</b>

### 5.1 Cost-Effectiveness Tests and Inputs

#### Program Administrator Cost Test (PACT)

The PACT measures the cost effectiveness of demand side management (DSM) programs from the perspective of the program administrator. The test compares the net costs of the programs incurred by the program administrator relative to the benefits resulting from the reduction of program participant energy consumption. The PACT excludes any costs incurred by the participant. The benefits include net avoided supply costs (including reductions in

<sup>10</sup> See the California Standard Practice Manual for more information:

[http://www.cpuc.ca.gov/uploadedFiles/CPUC\\_Public\\_Website/Content/Utilities\\_and\\_Industries/Energy - Electricity and Natural Gas/CPUC STANDARD PRACTICE MANUAL.pdf](http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf)

<sup>11</sup> The Utility Cost Test (UCT) is the same as the PACT. To maintain consistency between this report and previous auditor reports as well as the California Standard Practices Manual, we refer to this test as the PACT throughout our report.

transmission, distribution, generation, and capacity costs). Costs include program incentives and all program administration costs including administrative, information technology, and monitoring and evaluation costs.

### **Total Resource Cost Test (TRC)**

The TRC measures the net costs of energy efficiency programs relative to the benefits of the programs from the perspective of both the participants and the EEU. Benefits included in the TRC include net avoided supply costs (including reductions in transmission, distribution, generation, and capacity costs), non-electric fuel savings, and water savings. Costs include all costs included in the PACT such as program incentives and program administration costs, as well as incremental efficiency measure costs incurred by participants and any performance bonuses (if applicable).

### **Vermont Societal Cost Test**

The Vermont SCT is a variant of the TRC. The SCT differs in that it includes the effect of non-energy and other external benefits. These externalities are incorporated into the cost-effectiveness calculation through the inclusion of an environmental adjustment, which accounts for the environmental impacts of reduced energy consumption. Additionally, a risk adjustment<sup>12</sup> is also included to reflect the lower risk associated with DSM programs relative to supply-side alternatives.

### **Cost-Effectiveness Inputs**

Evergreen replicated cost effectiveness for EVT, BED, and VGS. The 2014-2016 Screening Tool maintained by VEIC was relied upon heavily for this task. The Screening Tool is an Excel-based tool used to primarily determine the cost effectiveness of individual measures; however, the assumptions included in the workbook may also be used to determine cost effectiveness at the project, initiative, and/or program levels. Table 12 summarizes the key input values and sources used by Evergreen to complete the cost-effectiveness analysis.

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<sup>12</sup> Vermont adopted a 10 percent adjustment to reflect the lower risk of efficiency in a 1990 PSB Order (Docket 5270), and this adjustment was reaffirmed in Docket 5980.

**Table 12: Cost-Effectiveness Model Inputs**

<b>Inputs</b>	<b>Value</b>	<b>Source</b>
Discount Rate	3.00%	2015 Screening Tool
Avoided Energy Costs	varies	2015 Screening Tool
Avoided Water Cost	\$10.25/CCF	2015 Screening Tool
Load Shapes	varies	2015 Screening Tool
Lines Losses	varies	2015 Screening Tool
Persistence/Free-ridership	varies	TRM
Risk Adjustment	10.00%	2015 Screening Tool
Electric Externality	varies	2015 Screening Tool
Non-electric Externalities	varies	2015 Screening Tool
Non-energy Benefits Adder	15.00%	2015 Screening Tool
Low-income Adder	15.00%	2015 Screening Tool

## 5.2 Cost-Effectiveness Results

The following sections present the results of the cost-effectiveness analysis for the combined EEU portfolio, sector, and individual EEU.

### EEU Portfolio

As a whole, the EEU portfolio was cost effective, exceeding a benefit-cost ratio of 1.00 for all three cost-effectiveness tests. A summary of the energy savings and costs used to compute all benefit-cost ratios for all EEUs combined is included below in Table 13 and Table 14. For comparative purposes, Table 14 also includes the benefit-cost ratios for each test from the 2011-2013 audit. Note that these tables do not include the cost effectiveness results for the TEPF projects (since the needed inputs were not tracked consistently by the EEU's), but the cost effectiveness tests for the EVT TEPF projects are shown separately later in this section.

In general, overall cost effectiveness fell from the 2011-2013 to the 2014-2016 audit period due to increased incentive and administration costs per kWh. In the 2011-2013 audit period, incentive costs were approximately 18 cents per kWh and admin costs were approximately 18 cents per kWh saved. In the 2014-2016 audit period, incentive costs were approximately 25 cents per kWh and admin costs were approximately 21 cents per kWh saved. Even with these higher costs, the overall program portfolio was cost effective across the various tests.

**Table 13: Annual Results, Total EEU Portfolio**

Year	Summer		Winter	Total Program			
	MWh	kW	kW	Incentive Costs	Admin Costs	Costs	Participant Costs
2014	104,151	12,273	21,122	\$26,183,313	\$22,473,782	\$48,657,095	\$34,327,966
2015	106,836	12,882	19,260	\$27,094,792	\$23,284,438	\$50,379,230	\$35,248,041
2016	117,259	13,739	20,422	\$28,928,487	\$24,440,998	\$53,369,485	\$47,251,333
<b>Total</b>	<b>328,246</b>	<b>38,894</b>	<b>60,804</b>	<b>\$82,206,592</b>	<b>\$70,199,218</b>	<b>152,405,810</b>	<b>\$116,827,340</b>

Note: VGS reported 63,695 Mcf total gas savings, and 393 Mcf peak day savings for the EEU portfolio in 2016. VGS costs for 2016 are included in this table.

**Table 14: Test Results, Total EEU Portfolio**

	PACT	TRC	SCT
Benefit-Cost Ratio (2011-2013)	3.05	2.66	3.51
<b>Benefit-Cost Ratio (2014-2016)</b>	<b>2.60</b>	<b>1.47</b>	<b>2.20</b>
Total Benefits	\$294,001,015	\$395,565,824	\$531,935,222
Total Costs	\$152,405,810	\$269,233,150	\$242,309,835

Note: VGS costs and benefits for 2016 are included in this table.

## Residential

For the residential sector, Evergreen found the combined EEU portfolio to be cost effective according to all three cost-effectiveness tests. Table 15 and Table 16 summarize the calculation inputs and resulting benefit-cost ratios. The residential benefit-cost ratios are slightly lower than the ratios for the commercial sector but are still above the 1.00 threshold.

**Table 15: Annual Results, Residential EEU Portfolio**

Year	Summer		Winter	Total Program			
	MWh	kW	kW	Incentive Costs	Admin Costs	Costs	Participant Costs
2014	40,953	5,247	10,460	\$11,018,996	\$10,047,500	\$21,066,496	\$14,185,143
2015	55,294	5,803	12,065	\$14,514,695	\$11,815,823	\$26,330,518	\$13,240,576
2016	53,298	5,266	10,949	\$14,866,620	\$12,496,842	\$27,363,462	\$23,482,800
<b>Total</b>	<b>149,545</b>	<b>16,316</b>	<b>33,474</b>	<b>\$40,400,311</b>	<b>\$34,360,165</b>	<b>\$74,760,476</b>	<b>\$50,908,519</b>

Note: VGS reported 21,027 Mcf total gas savings, and 218 Mcf peak day savings for the residential sector in 2016. 1 Mcf is equivalent to 10.37 therms. VGS costs for residential programs for 2016 are included in this table.

**Table 16: Test Results, Residential EEU Portfolio**

	PACT	TRC	SCT
<b>Benefit/Cost Ratio</b>	<b>1.65</b>	<b>1.41</b>	<b>2.24</b>
Total Benefits	\$123,200,788	\$177,397,337	\$252,847,133
Total Costs	\$74,760,476	\$125,668,995	\$113,102,095

Note: VGS costs and benefits for residential programs in 2016 are included in this table.

## Commercial & Industrial

Vermont's EEU's performed well with regards to commercial and industrial sector efforts, with all efficiency activities found to be cost effective according to the PACT, TRC, and SCT cost-effectiveness tests. Table 17 and Table 18 summarize the calculation inputs and resulting benefit-cost ratios.

**Table 17: Annual Results, C&I EEU Portfolio**

Year	MWh	Summ	Winter	Total Program			
		er kW	kW	Incentive Costs	Admin Costs	Costs	Participant Costs
2014	63,198	7,027	10,662	\$15,164,317	\$12,426,282	\$27,590,599	\$20,142,823
2015	51,542	7,078	7,195	\$12,580,097	\$11,468,615	\$24,048,712	\$22,007,465
2016*	63,961	8,473	9,472	\$14,061,866	\$11,944,158	\$26,006,024	\$23,768,533
<b>Total</b>	<b>178,701</b>	<b>22,578</b>	<b>27,329</b>	<b>\$41,806,280</b>	<b>\$35,839,055</b>	<b>\$77,645,335</b>	<b>\$65,918,821</b>

Note: VGS reported 42,668 Mcf total gas savings, and 175 Mcf peak day savings for the C&I sector in 2016. 1 Mcf is equivalent to 10.37 therms. VGS costs for C&I programs for 2016 are included in this table.

**Table 18: Test Results, C&I EEU Portfolio**

	PACT	TRC	SCT
<b>Benefit/Cost Ratio</b>	<b>2.20</b>	<b>1.52</b>	<b>2.16</b>
Total Benefits	\$170,800,226	\$218,168,485	\$279,084,361
Total Costs	\$77,645,335	\$143,564,156	\$129,207,740

Note: VGS costs and benefits for C&I programs in 2016 are included in this table.

## Efficiency Vermont

Table 19 and Table 20 summarize the calculation inputs and resulting benefit-cost ratios for EVT's portfolio of DSM initiatives for the 2014-2016 period. The cost effectiveness tests for the TEPF projects are shown separately in Table 21. Over the current audit period, EVT was found to have a cost-effective program portfolio according to all three cost-effectiveness tests. In general, EVT savings and costs constituted the majority of the combined EEU portfolio and as such, have a significant effect on the overall benefit-cost ratios.

**Table 19: Annual Cost-Effectiveness Inputs, EVT EEU Portfolio**

Year	MWh	Summer	Winter	Incentive Costs	Admin Costs	Total Program	
		kW	kW			Costs	Participant Costs
2014	98,796	11,481	20,109	\$24,936,829	\$21,452,754	\$46,389,583	\$31,050,366
2015	100,635	12,232	18,367	\$25,803,378	\$22,316,638	\$48,120,016	\$33,224,434
2016	111,451	13,228	19,716	\$25,860,105	\$22,253,696	\$48,113,801	\$41,246,369
<b>Total</b>	<b>310,882</b>	<b>36,941</b>	<b>58,192</b>	<b>\$76,600,312</b>	<b>\$66,023,088</b>	<b>\$142,623,400</b>	<b>\$105,521,169</b>

**Table 20: Cost-Effectiveness Test Results, EVT EEU Portfolio**

	PACT	TRC	SCT
<b>Benefit/Cost Ratio</b>	<b>1.83</b>	<b>1.44</b>	<b>2.16</b>
Total Benefits	\$261,392,009	\$356,756,352	\$483,506,259
Total Costs	\$142,623,400	\$248,144,569	\$223,330,112

**Table 21: Cost-Effectiveness Test Results, EVT TEPF Projects**

	PACT – Fossil Fuel Savings Only	PACT – Electric Savings Only	TRC	SCT
<b>Benefit/Cost Ratio</b>	<b>3.19</b>	<b>-0.26</b>	<b>1.05</b>	<b>1.17</b>
Total Benefits	\$53,509,202	-\$4,428,659	\$49,207,913	\$49,319,054
Total Costs	\$16,795,787	\$16,795,787	\$46,812,346	\$42,131,111

These projects show a negative cost effectiveness result using the PACT test due to the negative electric savings in these applications. We have included the PACT with electricity benefits only to make it consistent with the test results from the other programs. We have also included the PACT using the benefits of just the fossil fuel savings from the TEPF projects, which is more in line with the purpose for the TEPF projects. Both electric and fossil fuel savings are included as benefits in the TRC and SCT tests, resulting in a positive cost effectiveness result (i.e., a benefit cost ratio greater than 1.0).

### City of Burlington Electric Department

For the 2014-2016 period, Evergreen found BED's energy efficiency initiatives to be cost effective according to the PACT, TRC, and SCT cost-effectiveness tests. Table 22 and Table 23 summarize the calculation inputs and resulting benefit-cost ratios. Program cost data were collected from BED's annual DSM evaluation reports. BED did not track separately the cost effectiveness inputs needed for the TEPF projects, and consequently we were unable to calculate the cost effectiveness for the BED TEPF projects.

**Table 22: Annual Cost-Effectiveness Inputs, BED EEU Portfolio**

Year	Summer		Winter	Total Program			
	MWh	kW	kW	Incentive Costs	Admin Costs	Costs	Participant Costs
2014	5,355	792	1,013	\$1,246,484	\$1,021,028	\$2,267,512	\$3,277,600
2015	6,202	650	893	\$1,291,414	\$967,800	\$2,259,214	\$2,023,607
2016	5,807	511	706	\$1,367,951	\$964,749	\$2,332,700	\$2,292,047
<b>Total</b>	<b>17,364</b>	<b>1,953</b>	<b>2,612</b>	<b>\$3,905,849</b>	<b>\$2,953,577</b>	<b>\$6,859,426</b>	<b>\$7,593,254</b>

**Table 23: Cost-Effectiveness Test Results, BED EEU Portfolio**

	PACT	TRC	SCT
<b>Benefit/Cost Ratio</b>	<b>3.02</b>	<b>1.74</b>	<b>2.31</b>
Total Benefits	\$20,728,158	\$25,146,497	\$30,080,014
Total Costs	\$6,859,426	\$14,452,680	\$13,007,412

## Vermont Gas

This audit covers Vermont Gas programs for 2016 only. Evergreen found VGS' energy efficiency initiatives to be cost effective across all three cost-effectiveness tests. Table 24 and Table 25 summarize the calculation inputs and resulting benefit-cost ratios.

**Table 24: Annual Cost-Effectiveness Inputs, VGS EEU Portfolio**

Year	Mcf	Peak Day	Total Program			
		Savings (Mcf)	Incentive Costs	Admin Costs	Costs	Participant Costs
2016	63,695	393	\$1,700,431	\$1,222,553	\$2,922,984	\$3,712,917
<b>Total</b>	<b>63,695</b>	<b>393</b>	<b>\$1,700,431</b>	<b>\$1,222,553</b>	<b>\$2,922,984</b>	<b>\$3,712,917</b>

**Table 25: Cost-Effectiveness Test Results, VGS EEU Portfolio**

	PACT	TRC	SCT
<b>Benefit/Cost Ratio</b>	<b>4.06</b>	<b>2.06</b>	<b>3.07</b>
Total Benefits	\$11,880,848	\$13,662,975	\$18,348,949
Total Costs	\$2,922,984	\$6,635,901	\$5,972,311

## 6 Recommendations

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There are several overarching findings from the audit of the 2014-2016 EEU program activities. While we have a number of recommendations on how the evaluation process can be improved, it is important to discuss these within the overall context of the work that has been completed by the Vermont EEUs and their evaluation teams. Specifically, all recommendations should be considered within the context of these overall findings:

- Evaluation reports reviewed were of high quality and conformed to the standard practices of the evaluation industry.
- The TAG process is highly regarded by parties involved and seems to work well. Our review of TAG documentation indicates a thorough tracking system is in place to monitor the status of proposed updates, action items for TAG members, and records of TAG decisions.
- Savings estimates are accurate. The savings databases examined for EVT, BED, and VGS yielded energy savings totals to within a few percentage points of the reported savings noted in the evaluation reports filed by the EEUs. Furthermore, savings estimates are generally consistent with TRM guidelines.

Our review of the evaluation reports, savings estimates, and program processes identified several areas where improvements can be made. Related recommendations are summarized below.

- **The evaluation of all the EEU energy efficiency initiatives should begin earlier in the year.** This was a recommendation made in the last audit and is repeated here. Evaluators for each of the EEUs noted the very short time periods and budgets allocated for the evaluations. Typically, the final program data was provided in March and an evaluation report produced in June. An earlier start will allow the evaluator to complete a more rigorous analysis by affording them more time to conduct additional site visits and complete more in-depth engineering analyses. With an earlier start time the evaluations could also be expanded to include more in-depth analysis of other programs besides those in the commercial and industrial sector (which is the current focus). It is appropriate for the evaluator to draw a preliminary sample of projects from the first part of the year, which allows for some on-sites to be completed by the end of the year. The on-site sample can then be supplemented at the beginning of the following year to incorporate projects completed in the latter part of the prior year.
- **Expand the evaluations to include customer surveys.** An earlier start time (and larger evaluation budgets) would also allow for customer surveys to be completed across more programs. Regularly surveying program participants a minimum of once every three years is a common evaluation practice. Currently for each of the EEU's, only a few customers are contacted as part of the review of specific commercial and industrial projects, with questions narrowly focused on obtaining additional details

about the installation and operation of the rebated equipment. In the current audit (as well as the prior audit), it appears that most programs have not had any customer surveys for the entire 2011-2016 period. Adding customer surveys would provide valuable customer feedback on the program operations, in addition to verifying equipment installation and other useful information that could inform future program designs.

- **BED verification reports need to be completed sooner.** For all three program years covered in this audit, the BED verification reports were completed much later than those for EVT and VGS. In general, evaluation reports should be completed as soon as possible after the program year ends so that the results can be used to inform the next program year. While the EVT and VGS evaluation reports were completed about 6 months after the end of the program year, the BED reports were typically completed 18 to 22 months after the program year ended. This late reporting was likely done to meet the requirement for the forward capacity market (FCM) that requires a significant amount of post-installation monitoring.

While these reports might provide an adequate retrospective look at the program achievements and meet the requirements of the FCM, the delay does not make them useful prospectively for program planning as the recommendations arrive too late to inform the next program year. Both BED and the evaluation team should work together to produce these reports in a more timely fashion. Of course, the recommendation above to start the evaluation work earlier in the year will help address this issue.

- **The EEUs need to address the recommendations included in their evaluation reports.** For both EVT and BED, the same evaluation recommendations have been repeated each year, which indicates that these problems are ongoing and have not been addressed. In particular, these evaluation reports have called out problems of poor documentation and inappropriate applications of TRM values (or use of outdated or undocumented sources) to calculate savings. The EEUs should work to improve in these areas so that they do not remain as ongoing issues.
- **EVT should explore whether more project-specific data can be incorporated into its savings calculations to reduce reliance on default assumptions in the TRM.** This is related to the recommendation for improving project documentation, as this should produce more accurate savings estimates and lessen reliance on TRM default assumptions. As noted in our prior audit, the default TRM assumptions should be used only when project-specific information is not readily available. For each of the three years reviewed in the audit, the EVT evaluation reports recommend that EVT reduce its reliance on the TRM default assumptions for its savings calculations. The incorrect application or use of outdated TRM factors was also noted in the BED verification reports. This issue was also noted in our prior audit report and needs to be addressed by the EEUs.

- **Include TEPF projects in the annual evaluation process.** For both BED and EVT, the annual evaluation process should include (at a minimum) a review of a representative sample of TEPF projects so that a realization rate specific to these projects can be created. The verification methods and results for the TEPF projects should be clearly documented in the evaluation reports for both utilities.
- **The Commission should reconsider the advisability of relying on an EEU functionally leading the TRM process.** The process seems to be working well, but (as noted in our prior audit) there is a potential structural conflict of interest in having the program implementer also managing the TRM and the update process. EVT does contract with an independent evaluation firm to assist with the TRM review and to provide input on measure updates, but their role appears to be limited and does not address the overall potential for a conflict of interest inherent in the current TRM management arrangement.
- **The EEUs should maintain frozen copies of the program tracking databases provided to the evaluator that are consistent with annual reported savings values for future audits.** This recommendation was made in the prior audit and was followed by the EEUs for the current verification period. We are recommending that this process be continued to facilitate efficient savings audits in future years. Because there were frozen databases available, Evergreen was able to verify energy savings to within an acceptable margin of error for most programs; however, deviations from the reported savings numbers were found. For future audits, we recommend that EVT, BED, and VGS save the same version of each program tracking database provided to the evaluator and make it readily available for the independent audit prior to the audit process beginning. By providing both sets of data, the auditor will be able to determine where significant changes in savings occurred, and this will inform the TRM and measure review process.

## 7 Addendum: Audit Review Team

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Evergreen Economics (prime contractor) and Michaels Energy were the firms that completed this independent audit of the Vermont EEU savings claims and evaluation research. From Evergreen, Dr. Steve Grover was the project manager and the lead author of the audit reports. Keith Rivers, John Cornwell, and Nick McMillan (all from Evergreen) conducted the detailed analysis and assisted with creating the final reports. From Michaels Energy, Brian Uchtman conducted an engineering review of the evaluation reports for each EEU.