EVERGREEN ECONOMICS

Independent Audit, 2011-2013

Management Letter

Vermont Energy Efficiency Utility

Submitted to the Public Service Board

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Efficiency Vermont

BURLINGTON Electric DEPARTMENT

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1 Executive Summary

In April 2015, the Vermont Public Service Board (the Board) selected the Evergreen Economics team[1] (Evergreen) to serve as the Independent Auditor of the 2011-2013 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) and the City of Burlington Electric Department (BED), 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 Board on 12/20/10. Oversight of the EEU programs is assigned to the Board by Vermont law. The Department of Public Service (Department) is a separate state agency that serves as the state's energy office and as the public advocate in proceedings before the Board. 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, 2011 through December 31, 2013. This document serves as the Report to the Legislature.

1.1 Audit Objectives

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

1. The cost-effectiveness of the EEUs, including EVT's and BED's programs;
2. The reported energy and capacity savings achieved by EVT and BED;
3. The Efficiency Vermont Technical Reference User Manual (TRM) and the process for managing and updating it;
4. The database and other information compiled by VEIC that is used to develop and track savings claims and project costs;
5. The procedures and method 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 EEU Programs

In Vermont, the two EEUs (EVT and BED) provide a variety of energy efficiency program offerings that save residential and non-residential Vermonters money and energy in their homes and businesses. From 2011 through 2013, EVT and BED implemented energy

[1] The Evergreen Economics team consists of staff from Evergreen Economics and Michaels Energy.

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

Residential Sector

- Residential New Construction
- Efficient Products
- Existing Homes

Commercial & Industrial Sector

- Business New Construction
- Business Existing Facilities

Between 2011 and 2013, EVT and BED spent over $117 million on these energy efficiency initiatives. These initiatives resulted in nearly 323,825 MWh of energy savings, 62.3 MW of winter demand reduction, 43.8 MW of summer demand reduction, and over 276,186 MMBtu's in other fuel energy savings by Vermont residents and businesses.

Table 1: Annual Results, Total EEU Portfolio

Year	kWh	Summer kW	Winter kW	MMBtu	Incentive Costs	Admin Costs	Total Program Costs
2011	110,261,077	15,155	20,416	66,401	$22,934,804	$19,379,324	$42,314,128
2012	118,190,667	16,566	23,851	79,578	$19,982,247	$17,581,919	$37,564,166
2013	95,372,904	12,056	18,008	130,207	$16,637,386	$20,567,707	$37,205,093
Total	**323,824,648**	**43,776**	**62,276**	**276,186**	**$59,554,437**	**$57,528,950**	**$117,083,387**

1.3 Methodology and Process Review

As part of this audit, Evergreen was tasked with reviewing the data tracking, evaluation and Technical Advisory Group (TAG) processes currently in place and 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 the Department, EVT, BED and West Hill Energy and Computing, Inc. (West Hill). West Hill is currently the independent evaluator contracted by the Department to review and verify annual project savings for EVT

and BED. We also reviewed the 2013 EVT Verification report submitted to the Department by West Hill and TAG documentation provided by VEIC.

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 drives 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.

EVT and BED each maintain a program tracking database that stores all relevant project data, and Evergreen was provided with a copy of both EVT's and BED's databases. Both databases are complete, but the EVT database is much more complex, with numerous linked tables. For both EEUs, Evergreen found that the savings values calculated using the two datasets did not match the evaluation report savings claims for some programs. We attribute this to the fact that the data provided came from live databases that are continually changing. Therefore, we recommend that the EEUs maintain a frozen copy of the tracking database provided to the evaluator and store this dataset in a predetermined location 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.

Evergreen reviewed the savings verification process for EVT and BED conducted annually by the independent evaluator for the Department. We learned during our interviews with the Department and EEU staff that there is an effort underway to investigate the cost-benefits and make subsequent recommendations regarding the coordination of the forward capacity market (FCM) evaluation and EEU project verification for EVT, to allow for more rigorous evaluation that includes additional opportunities for on-site verification. BED already uses this approach for its projects, and we believe EVT could benefit from coordinated evaluation timelines and a more rigorous verification approach that includes additional on-site verification visits.

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.

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 a generally 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 2011, 2012 and 2013. 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.

Given that adjustments were made to the program tracking databases continuously over time, our savings replication effort was completed to within an acceptable margin of error (i.e., within 1-2 percent of savings reported in the original annual report) for most programs; however, the data provided for BED's Efficient Products program deviated from this trend with calculated energy savings only amounting to 88 percent of claimed savings. Consequently, our calculation of total residential sector energy savings was 10 percent lower than BED's reported claims, and the calculated savings of the combined portfolio of BED programs was off by 5 percent. For future audits, we recommend that both EVT and BED save the same version of each program tracking database provided to the independent evaluator in addition to the most current database so as to ensure that all evaluation and audit activities are using identical data, as well as to expedite the audit process. The results of the replication activity are discussed in more detail in Chapter 4.

Additionally, we reviewed the evaluation reports and associated site reports for program years 2011-2013. We found project documentation to be adequate; however, there were several areas that should be addressed in more detail in future evaluations, and we provide recommendations on these areas in Section 1.7.

1.6 Cost-Effectiveness Analysis

The Evergreen analysis found that the EEU program portfolio was cost-effective between 2011 and 2013 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)
Total EEU Portfolio	3.05	2.66	3.51

1.7 Recommendations

There are several overarching findings from the audit of the 2011-2013 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 the independent evaluator. 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 and BED 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 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 EEUs should maintain a frozen copy of the program tracking database/s provided to the evaluator that is consistent with annual reported savings values for future audits.** 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 both EVT and BED 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. This will ensure that all evaluation and audit activities are using identical data, and that the process is more fluid. 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.
- **EVT should continue to pursue efforts to investigate coordinating the FCM evaluation with the annual project verification.** The resulting evaluation would have the potential to be more rigorous while continuing to meet ISO New England evaluation requirements. Should this prove to not be feasible, EVT and the evaluator should consider beginning the evaluation earlier in the calendar year with a preliminary sample of projects. As general sector and end-use trends are unlikely to change significantly, this earlier start will allow the evaluator a longer timeframe in which to conduct a more rigorous analysis.

- **The evaluation of EVT's energy efficiency initiatives should begin earlier in the year.** 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. 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.

- **EVT should explore whether more project-specific data can be incorporated into its savings calculations**. This will produce more accurate savings estimates and lessen reliance on TRM assumptions, which should only be used where this information is not readily available. For two of the three years reviewed, the EVT evaluation report highlighted that parameters or assumptions from the TRM were being applied to applications or equipment for which they were not originally intended. This is an ongoing issue that needs to be addressed.

- **For all new TRM measures, EVT should allow sufficient time for TAG members to thoroughly review proposals for updates to the TRM.** Allowing more time for review will mean that TAG members are better prepared to discuss updates and can arrive at conclusions that all parties feel confident about.

- **The Board should reconsider the advisability of relying on an EEU functionally driving the TRM process.** The process seems to be working well, but there is a potential structural conflict of interest in having the program implementer also managing the TRM and the update process. One solution would be to hire an independent third party to conduct periodic in-depth reviews of the TRM.

- **The level of detail included in the individual site reports should be expanded.** While we found the site reports provided to adequately describe the general evaluation approach, changes made to the analysis, and the resulting impact on the savings estimates, we encourage the level of detail to be expanded even more. In many cases, the specifics of the evaluation process or findings are unclear. Specifically, on-site findings from the FCM evaluation and information from customer interviews (such as operating hours of the individual areas from energy data loggers, or self-reported hours of operation) were not included in the report text.

- **Future reports should adopt a more consistent structure.** While the most critical information was always included in each report, the inconsistency across programs and projects sometimes made the location and interpretation of the information more difficult. It is possible that this inconsistency is due in part to the many individuals and companies that completed individual project evaluations. Verification reports should clearly label which projects are custom and which are prescriptive; this would help facilitate the audit process.

- **The evaluator should put in a good faith effort to determine the project savings, even if the documentation level is poor or non-existent.** In our review, we found a number of evaluated projects that had energy savings reduced due to lack of documentation. Although the Evergreen team does applaud the evaluator's stance on requiring sufficient documentation, the evaluator should take the additional steps necessary to determine the correct savings estimates whenever possible. If, due to customer non-response or other factors, no independent estimate of the savings can be developed, we agree that an approach whereby savings estimates are reduced is appropriate as a last resort.

2 Methodology and Process Review

The Evergreen team (Evergreen) conducted a review of the data tracking, evaluation and Technical Advisory Group (TAG) processes currently in place by the Vermont Energy Efficiency Utilities (EEUs) 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 EEUs considered in this report. Our review of these program and evaluation processes included an assessment of the following:

- TAG process for updating the Efficiency Vermont Technical Reference User Manual (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 the Department, EVT, BED and West Hill Energy and Computing, Inc. (West Hill). West Hill is currently the independent evaluator contracted by the Department to review and verify annual project savings for EVT and BED. We also reviewed the 2013 EVT Verification report submitted to the Department by West Hill and TAG documentation provided by Vermont Energy Investment Corporation (VEIC). The remainder of this section describes our findings and recommendations resulting from this review.

2.1 TAG Process Review

Evergreen reviewed the procedures for managing and updating the TRM through the TAG update process by speaking with TAG members at the Department, EVT, BED and West Hill. The TAG process is an ongoing and collaborative effort involving the Department, EEUs and the evaluator. The TRM document is publicly available and owned by the State of Vermont; however, EVT is the de facto manager of the document. As such, EVT implements TAG-approved updates to the TRM and develops the majority of proposals for new measures or updates to assumptions in the TRM.

Updates to the TRM occur regularly to add new measures, update assumptions, address evaluation recommendations and incorporate codes and standards changes. EVT typically cycles through the TRM measure updates such that every measure is updated or examined at least once every three years to ensure that assumptions are up to date with market conditions. The TAG members hold monthly meetings and occasionally meet more frequently when actively working on updates.

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.[2]
4. EVT implements the corresponding update to the TRM.

We reviewed the TAG process through a combination of documentation reviews and phone interviews. VEIC provided TAG meeting notes, tracking spreadsheets and TRM update proposals from 2011 through 2013 for Evergreen review. We conducted hour-long interviews with a total of six people from the Department, EVT, BED and West Hill who are involved in the TAG process. These individuals regularly attend TAG meetings and participate in reviews of proposals to update the TRM. Individuals from EVT also participate in the development of new measures and updates to assumptions.

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. According to the individuals we interviewed, the TAG process is highly regarded by all parties involved and seems to work well, with only one minor exception. Participating TAG members expressed slight concern about the short timeline in which they must review proposed TRM updates or TAG meeting materials. TAG members typically have three to four weeks to review proposals before providing comments and meeting to discuss the proposal and come to a decision. This timeline can vary depending on the size of the update and other workloads. TAG members noted that a shortage of time and staff resources can sometimes make it difficult to meet the review deadlines and give the proposals thorough research and consideration.

The TAG members also mentioned that, occasionally, the EEUs will offer measures that have not yet been approved for the TRM, and the programs take on a bit of risk in doing so, as the savings values may change by the time the measure is approved. However, this seemed to be an acceptable level of risk according to EEU staff. As mentioned in the earlier section on the TRM review, the existing TRM measures and assumptions appear sound. Therefore, the risk to the EEUs of adopting new measures that have yet to be approved is likely low, as the existing measure savings seem to be reliable.

Descriptions of the process by each of the TAG members revealed that EVT has significant influence on the TRM update process. Not only does VEIC (acting on behalf of EVT) initiate most of the updates, but VEIC also conducts the technical and market research to develop updated assumptions and put forth suggested savings values. As one of the energy efficiency utilities, however, EVT has a vested interest in maximizing the credit for savings awarded for efficiency projects. While we have no specific reason to question the objectivity of EVT's work

[2] If needed, the Department makes the final decision of which updates are approved. The Board can also be called in to mediate if no agreement can be reached, but this step has not yet been required.

on the TRM, it seems that the TRM update process has a potential structural conflict of interest with the current arrangement.

Appropriately, the Department and BED representatives are active reviewers, in addition to West Hill Energy, an independent third party reviewer. West Hill conducts a review of existing TRM assumptions and highlights necessary updates and improvement opportunities, though the Department has the final approval authority for updates, which provides some checks and balances. However, neither the Department nor BED can match EVT's staff resources and market information and thus need to rely on information presented by EVT. The existing checks and balances could be enhanced with greater involvement of Department staff while revisions are explored—to the extent that the Department's staff person on the TAG has time available for greater involvement and decision-making during the process.

A database version of the TRM is currently in development by EVT, anticipated to be available online for all stakeholders to access by the end of 2015. This is expected to improve the TRM update process, making it more efficient by allowing measure development to be conducted within the online application. This will eliminate the need for various proposal documents to be coordinated and circulated to TAG members, as the measure update information will all be stored in one place. TAG members will have access to all proposal documents online and will be notified when approved TRM updates have been implemented. It is expected that the online TRM database will be used in next year's verification process.

Recommendations

For all new TRM measures, EVT plan appropriately to allow sufficient time for TAG members to thoroughly review proposals for updates to the TRM. Allowing more time for review will mean that TAG members are better prepared to discuss updates and can arrive at conclusions that all parties feel confident about.

The Board should reconsider the advisability of relying on an EEU functionally driving the TRM process. The process seems to be working well, but there is a potential structural conflict of interest in having the program implementer also managing the TRM and the update process. One solution would be to continue to hire an independent third party to conduct periodic in-depth reviews of the TRM.

2.2 Data Management and Reporting Review

EVT and BED each maintain a program tracking database that stores all relevant project data, and Evergreen was provided with a copy of both EVT's and BED's databases. The EVT database utilizes Microsoft Access and stores information in a number of interlinked tables. These tables provide a wealth of information including measure savings, measure life, project costs and participant contact information. While this wealth of information was appreciated, it added a degree of complexity to our analysis.

BED provided an export of data requested by Evergreen, which spanned the entire 2011-2013 evaluation cycle. The BED data were easier to work with as the database provided only the

information requested, and was limited to a single spreadsheet. While the EVT database included more detail, it proved to be more cumbersome. On the other hand, the BED dataset proved to be easier to analyze, but included less detail. Regardless of EEU, Evergreen found that the savings values calculated using the two datasets did not match the evaluation report savings claims for some programs. We attribute this to the fact that the data provided came from live databases that are continually changing. Therefore, we recommend that the EEUs maintain a frozen copy of the tracking database provided to the evaluator so that both the auditor and evaluator have the opportunity to work from identical datasets.

Recommendations

The EEUs should maintain both a frozen copy of the program tracking database/s provided to the evaluator for future audits that is consistent with annual reported savings values and any live up-to-date database/s that include necessary revisions to project information. Evergreen was able to verify 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 both EVT and BED 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. This will ensure that all evaluation and audit activities are using identical data, and that the process is more fluid. 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.

2.3 Savings Verification Process Review

Evergreen reviewed the savings verification process conducted annually by West Hill for the Department. Each year, West Hill reviews the TRM parameter assumptions used to calculate savings for prescriptive measures and conducts engineering desk reviews of a sample of custom projects. Due to limitations in the timeline of the verification, no on-site verification is conducted for EVT projects. While West Hill conducts the forward capacity market (FCM) evaluations for both EVT and BED, only the BED project verification is coordinated with the FCM evaluation and conducted simultaneously, which has allowed for some on-site verification of custom projects.

The savings verification process for the EEUs is as follows:

1. EVT and BED provide a complete database of project savings to the Department and West Hill.
2. West Hill selects a sample of custom projects to verify and requests additional documentation from EVT and BED for these projects.
3. West Hill conducts verification.
    a. For prescriptive projects, West Hill reviews TRM assumptions.
    b. For custom projects, West Hill conducts a desk review of inputs and calculations.

4. West Hill submits a draft verification report of findings to the Department, EVT and BED for review and comment.
5. The Department, EVT and BED have an opportunity to provide additional project information or clarify results.
6. West Hill finalizes and submits the annual verification report and savings to the Department.
7. EVT receives a performance incentive based on verified savings (BED does not receive a performance incentive).

We learned during our interviews that there is an effort underway to coordinate the FCM evaluation and EEU project verification to allow for more rigorous evaluation that includes on-site verification. BED already uses this approach for its projects, and EVT could benefit from coordinated evaluation timelines and a more rigorous verification approach.

BED's verification process allows for closer examination of projects and more custom inputs, partially due to its coordination with the FCM evaluation, but also because of its smaller customer base and familiarity with project locations. EVT has a much higher volume of projects and relies on the TRM for much of the project savings, both due to the separation of FCM and EEU project verification and number of projects.

The bulk of our review focused on the savings verification process as it is currently structured, however. We asked the various participants of the process about the degree of accuracy they feel is needed for the savings estimates provided by the entire evaluation process and the accuracy they think the process currently provides.

Interestingly, nearly all respondents focused on an 80/10 relative precision requirement in place for demand reductions that are to be bid into the ISO New England forward capacity market (Section 7.2 of Manual M-MVDR)[3]. This requirement covers sampling precision only. Accuracy of the savings numbers, however, depends mostly on the accuracy of the various inputs to the savings calculations, including information or assumptions about operating hours, the number and types of equipment installed and the differential energy consumption between equipment that was removed and installed. High sampling precision only limits the uncertainty introduced by sampling for the impact evaluation, but it does nothing to bound the accuracy of the savings inputs or calculations themselves. While the savings verification process does address and review these various inputs and calculated savings, there is no specific standard for how accurate the end-calculation of energy savings should be.

[3] ISO New England, 2014. *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources (Manual M-MVDR), Revision 6*. Retrieved from http://www.iso-ne.com/participate/rules-procedures/manuals

While common in the energy efficiency industry, a targeted sampling precision without a clear metric for the accuracy of the actual inputs or for calculated energy savings estimates results in some ambiguity concerning the desired level of accuracy. A smaller tolerance for error in savings requires a greater need for customized savings calculations and more rigorous verification methods by impact evaluators, such as on-site verification. With a greater acceptable tolerance, prescriptive assumptions and desk reviews can play a larger role in the savings evaluation process.

West Hill has noted in the past that the lack of on-site verification limits the diligence of its verification work, and we agree with that assessment. Inclusion of on-sites as part of the verification process would allow the evaluator to determine whether the equipment is installed as described in the documentation, in the same quantities and with the same settings, and whether the equipment is still operational. Currently, the evaluator is only relying on what is documented on program forms, and is not able to verify if the equipment is actually installed or operating as intended. Verifying this information for even a sample of projects will improve the overall reliability of savings for all programs.

In addition, interviewees and our technical staff reviewing the TRM commented that there appears to be greater reliance on TRM assumptions by EVT than BED, which tends to have more specific information about projects completed. While the TRM should be used for prescriptive measures, especially when project-specific data are not available or not feasible to collect, EVT may be able to improve the accuracy of its savings estimates by including project-specific data when possible. As a small utility, BED has closer relationships with its customers than EVT, which facilitates greater knowledge of projects and the sites at which they are implemented. For example, BED will attempt to calculate customized savings for projects when it knows that operating hours or delta watts (for lighting projects) do not align with assumptions in the TRM. While we did not explore the degree to which EVT could collect and incorporate more project-specific insights into savings calculations using data that program staff already have, we believe it would be worthwhile for EVT to consider opportunities to include more project-specific inputs, such as operating hours or actual baseline efficiencies of replaced equipment.

Recommendations

The following recommendations resulted from our review of the BED and EVT savings verification processes:

- EVT should continue to pursue efforts to investigate coordinating the FCM evaluation with the annual project verification, so that the overall evaluation can potentially be more rigorous and continue to meet ISO New England evaluation requirements.
- EVT should explore whether more project-specific data can be incorporated into its savings calculations so reliance on TRM assumptions is the default only for values that are not readily available.

3 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, 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 (Evergreen) 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.

In general, the deemed savings values throughout the TRM 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 a generally more accurate savings calculation methodology than strictly using deemed values. Each algorithm allows for specific customer inputs, which improves savings estimation accuracy by tailoring the values to match more closely with specific customer conditions. For example, the Electric HVAC measure included in the TRM uses an equation where the cooling capacity of the unit (kBtu/hr), the efficiency factor (EF), and the full load hours (FLH) are used to determine cooling energy savings. In this equation, the baseline efficiency is specified by code, but the cooling capacity of the unit is based on the actual capacity of the installed unit; the full load hours are derived based on the customer's facility type. This level of quasi-custom calculation provides very accurate prescriptive savings estimates both at the individual project level and at the entire portfolio level.

During this review, Evergreen 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.

Multiple deemed savings documents were referenced during the review to ensure the program is consistent with industry best practices. The documents used throughout this review were:

- California Database for Energy Efficiency Resources (DEER);
- Pacific Northwest Regional Technical Forum Unit Energy Savings Measures;
- Ohio Statewide Technical Reference Manual (updated October 2013);
- Illinois Statewide Technical Reference Manual for Energy Efficiency (Version 2.0 Effective June 1, 2013);

- Arkansas Statewide Technical Reference Manual (Version 4, September 2014);
- Hawaii Energy Technical Reference Manual covering program year from July 1, 1013 to June 30, 2014;
- New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (October 2010);
- Indiana Technical Resource Manual (Version 1.0 January 10, 2013);
- Michigan Energy Measure Database (MEMD);
- Connecticut Program Savings Document (8th Edition for 2013 Program Year); and
- Pennsylvania Technical Reference Manual (updated June 2014).

There are a total of 151 different measures in the TRM that cover a wide range of lighting, motors, HVAC, appliance and refrigeration technologies. The review of the TRM consisted of two main parts: a general high level review of the document to ensure consistency and a more in-depth technical review for several high impact measures. The results of the review are discussed in the following sections.

3.1 General Review

The first step was to complete a general review of the entire document to look for code changes and other high level or incorrect mathematical issues. After completion of this review, we found that there are several code changes and other administrative issues that should be addressed in the next revision of the TRM.

Energy Code Update

On June 17, 2013 and November 24, 2014, the Residential Building Energy Standards (RBES)[4] and the Commercial Building Energy Standards (CBES),[5] respectively, were updated. These updates and revisions went into effect on March 1, 2015. Since EVT has the ability to provide updated TRMs on an annual basis, it is recommended that these changes be updated and included for the 2016 TRM. Some of the updates may include:

- 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.

[4] Residential Building Energy Standards, Public Service Department of the State of Vermont. http://publicservice.vermont.gov/topics/energy_efficiency/rbes

[5] Commercial Building Energy Standards, Public Service Department of the State of Vermont.

Prior Audit Recommendations for the TRM

During the previous independent audit,[6] a TRM review was completed and several recommendations were included. Evergreen reviewed those recommendations to ensure they had been properly incorporated into the last version of the TRM. The measures were broken down into several technology-based categories, which are discussed in subsequent sections of this report.

Lighting

There were several recommendations for lighting measures, including correcting inconsistencies between the CFL and linear fluorescent measures and reviewing more up-to-date information for waste heat factors. All of these recommendations appear to have been implemented in the last update to the TRM.

Motors, Industrial and Space Heating

There were no specific recommendations for the industrial or space heating measures. Additionally, there was no measure for installing high efficiency motors in the TRM for this audit period as the updated federal efficiency standards[7] have made National Electrical Manufacturers Association (NEMA) premium efficiency motors required. Removing this measure addresses all of the comments proposed during the previous audit period for these measure categories.

Refrigeration

There were a total of four recommendations for refrigeration measures. Three of them pertained to collecting or completing additional metering studies to validate the assumptions used in the TRM calculations: updating refrigeration economizer persistence, completing a metering study for refrigeration compressor duty cycles, and validating the operating hours for floating heat pressure controls. The duty cycles were updated using a more recent study,[8] and the floating head pressure controls measure was removed from the TRM. The persistence factor used for the refrigeration economizers was still assumed to be 1.0. This measure provides a significant portion of the refrigeration technology group savings; therefore, using evaluation data to update/validate the assumed value should be considered.

Future Updates

Based on interviews that Evergreen completed as part of this audit, there does not appear to be sufficient time to complete proper data collection during the program evaluation cycle.

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[6] Independent Audit, 2008-2010 Management Letter, Vermont Energy Efficiency Utility. Submitted to Vermont Public Service Board. Frontier Associates, LLC. May 30, 2012

[7] US DOE Building Technology Office Electric Motors Standards. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/50

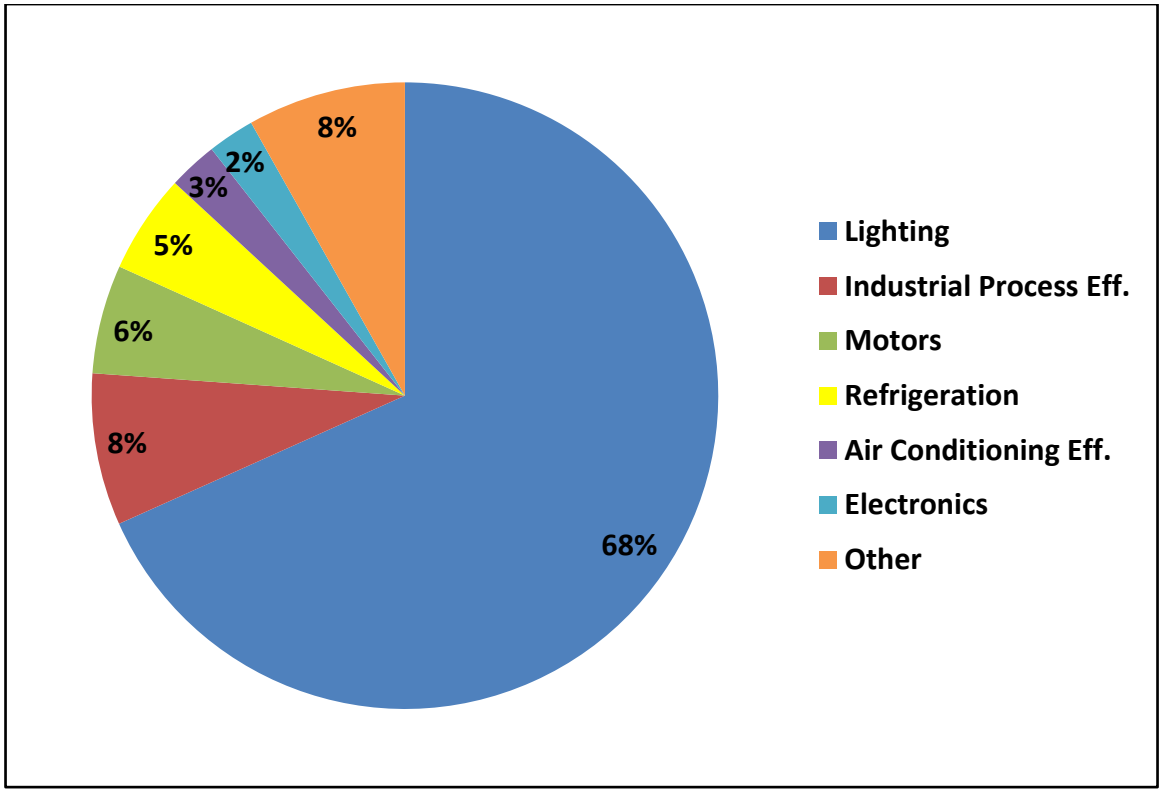
[8] Based on run time estimates from *Performance Standards for Walk-In Refrigerator and Freezer Systems*, AHRTI Report No. 09002-01, by Bryan R. Becker, et al., January 2012, Tables 30-33.

This puts limits on the amount of primary data that can be collected and fed into future updates of the TRM. As is discussed in Section 2.2 of this report, adjusting the timeline for evaluation could provide a substantial opportunity to research and further refine numerous parameters in the TRM. However, in the absence of adjusting the evaluation timeline, it could be possible to leverage any work that is completed to verify savings that are bid into the ISO New England forward capacity market.

3.2 Specific Measure Review

In order to more effectively and efficiently review the most significant measures in the TRM, the team prioritized them based on contribution to annual savings. Evergreen received and analyzed participation data from EVT in order to determine the proportion of savings contributed by each measure group. A description of energy savings by measure category can be seen in Figure 1.

Figure 1: Summary of Energy (kWh) Savings by Category



Based on this analysis, there are four main technology types that provide a majority of the savings for the portfolio; Lighting, Motors, Industrial Processes and Refrigerators. These categories were further examined to determine the major individual measures that comprised the largest portion of the savings for each. Every measure that constituted more than 5 percent of the energy (kWh), summer demand (kW) or winter demand (kW) was included in

the more in-depth TRM review. The measures selected can be seen in Table 3. The results of each measure category reviewed are discussed in subsequent sections.

Table 3: TRM Measures Selected for In-depth Review

Measure Name	Measure Category	Measure Code
Compact fluorescent screw-base bulb	Lighting	LBLCFBLB
Compact fluorescent screw-base bulb Com	Lighting	LBLCFCOM
Specialty Bulb	Lighting	LBLCFSPC
LED Screw-Base Lamp	Lighting	LBLSBLED
LED Smartlight Commercial	Lighting	LBLSCLED
New T5 High-Bay	Lighting	LFHST5HB
Relamp/Reballast to Super T8	Lighting	LFHST8RR
Dairy Milk Pump VFD	Motors and VFDs	MTCDFVFD
Variable frequency drive motor control	Motors and VFDs	MTCPRVFD
Efficient blower fan	Refrigerators	RFRBLFAN
Refrigeration compressor, discus	Refrigerators	RFRCMPDS
Refrigeration door heater controls	Refrigerators	RFRDRCON
Refrigeration zero energy doors	Refrigerators	RFRDRZER
Energy star refrigerator, early replacement	Refrigerators	RFRESRER
Freezer early retirement program, secondary	Refrigerators	RFRFERPS
Refrigerator economizer	Refrigerators	RFRMIZER
Refrigerator early retirement program, secondary	Refrigerators	RFRRERPS

Lighting Measures

There is a wide range of lighting measures; the most popular measures include compact fluorescent lamp replacements, specialty bulbs, light emitting diode (LED) lamps and commercial linear fluorescent fixtures. All of these measures were found to be technically accurate and consistent with engineering fundamentals. Additionally, the waste heat factor recommendations from the previous audit have all been implemented. One of the most important issues with regards to screw-in lighting is the application of the EISA 2007 standards[9], and our review confirmed that these standards have been properly accounted for by decreasing baseline wattage from 2012 through 2014.

However, there was one important factor pertaining to the lifetime savings that should be updated. The 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. At that time, general service lamps must comply with a 45 lumen per watt efficacy standard. Since the

[9] US DOT Building Technologies Office, General Service Incandescent Lamps. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/61

effective useful life (EUL) of some lamps in this measure extend beyond that date, the baseline should be adjusted to the second Tier for any years after 2022,[10] which is when a baseline halogen lamp would require replacement. An example is noted in Figure 2.

Figure 2: Depiction of Replacement Cycle for LED Lamps

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	…..
LED Installed in 2015	**LED Lifetime**											
Halogen Installed in 2015	Baseline Halogen Life				Halogen Replacement				CFL Replacement			

A similar process is already in place for the CFL lamp measures, which caps the useful life at the year 2020. This is valid for CFLs, as they are the assumed baseline at that point, but with LEDs, there are still additional savings that can be claimed past this point. Therefore, the savings for LED fixtures should be updated to include the baseline adjustment that takes place in 2020. It should be noted that this adjustment could affect the O&M savings attributable to these measures as well, and care should be taken to update all aspects of the measure appropriately.

Motor Measures

There were several significant measures for the motor category including dairy milk pump variable-frequency drives (VFDs) and HVAC motor VFDs. There are few other jurisdictions in the United States that utilize the dairy milk pump VFD measure. However, the savings algorithms and assumptions for both measures appear to be reasonable and appropriate. An area where the savings calculation for this measure could be improved is the persistence factor, which is listed as 1.0.

The TRM references a study completed by National Grid in 1999[11] as the source of the persistence value. While the National Grid finding is that the persistence is close to 1.0, it was not found to be equal to 1.0. The report found that 97 percent of installations from 1995 were functioning four years later. These two values are not equal, and thus the persistence value in the TRM, in absence of further study, should be updated to 0.97 to be consistent with the source identified. As the data from this research are now more than 15 years old, we recommend that persistence should be reexamined with more recent participants.

[10] 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.

[11] National Grid evaluated persistence in 1999 of VFDs installed in 1995 and estimated a factor of 97%.

Refrigeration Measures

There are a total of 31 different refrigeration measures found in the tracking system covering a wide range of refrigeration measures. Most of the measures that we reviewed were found to be reasonable and consistent with industry best practices. However, there were three specific areas where the TRM can be improved, as discussed below.

Efficient Refrigeration Compressors

This measure involves the installation of an efficiency compressor in a refrigeration system. All of the inputs for this measure appear to be reasonable and appropriate. However, one of the key inputs for the savings algorithm is the EER[12] of the baseline ($EER_{ns,base}$) and high efficiency compressors ($EER_{nS,Efficient}$). The values for these inputs were derived in two different ways:[13]

- Baseline EERs calculated as ½ standard deviation below average EER for each capacity bin of available models. See referenced document "compressor efficiency analysis EVT Refrigeration 2013.xlsx" for details.
- Qualifying EER calculated as ½ standard deviation above average EER for each capacity bin of available models. See referenced document "compressor efficiency analysis EVT Refrigeration 2013.xlsx" for details.

Using current manufacturer specifications is a reasonable and accurate method to determine the appropriate installed efficiencies, but they should be updated to the most recent available information. Updating these numbers should occur at the beginning of each three year cycle at a minimum, and could happen more often if new products or other market conditions warrant.

ENERGY STAR Refrigerator/Freezer

There are a variety of stand alone refrigerator measures that are included in the TRM:

- Commercial solid door refrigerator/freezer;
- Commercial glass door refrigerator/freezer;
- Residential refrigerator/freezer;
- Refrigerator/freezer early retirement; and
- Refrigerator/freezer removal (recycling).

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[12] Energy Efficiency Ratio, a measure of efficiency common for refrigeration and air conditioning equipment.
[13] *Efficiency Vermont Technical Reference User Manual*. No. 2014-85b. Page 73, footnotes 230 and 231.

All of these measures (with the exception of the removal measures) utilize similar information from ENERGY STAR and the Consortium for Energy Efficiency (CEE) to determine the baseline and minimum efficiency requirements. These are widely used and accepted sources for these measures, and continuing to reference them in the future will remain appropriate. However, both of these organizations made updates to their standards in the fall of 2014. The US DOE has implemented higher federal standards for all residential refrigerators and freezers as of September 14, 2014,[14] and for commercial refrigerators as of January 1, 2012.[15] Additionally, CEE has updated Tier efficiency levels in accordance with the updated standards for residential[16] refrigerators and freezers. The CEE specifications for commercial refrigerators have been in effect since 2010 and was already incorporated into the TRM.

These standards apply to all residential and commercial refrigerator measures, and should be updated going forward.

[14] Federal Efficiency Standards for Residential Refrigerators and Freezers. Code of Federal Regulations, 10 CFR 430.32(a). http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43

[15] Feceral Efficiency Standards for Commercial Refrigeration Equipment. Commercial refrigeration equipment manufactured and distributed in commerce, as defined by 42 U.S.C. 6291(16), must meet the energy conservation standards specified in the Code of Federal Regulations 10 CFR 431.66 http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/52

[16] CEE Super Efficient Home Appliance Initiative. http://library.cee1.org/sites/default/files/library/9563/CEE_ResidentialRefrigeratorSpecification_15Sep2014.pdf

4 Validation of Reported Savings and Costs

As part of this audit, the Evergreen team (Evergreen) was tasked with reviewing and validating the energy savings (kWh), demand reduction (kW) and cost values reported in all evaluation reports filed by Efficiency Vermont (EVT) and the City of Burlington Electric Department (BED) for program years 2011, 2012 and 2013.

4.1 Reported Savings

The Evergreen team verified the savings amounts reported by the independent evaluator for each program year by reviewing an extract of each Energy Efficiency Utility's (EEU's) program participant database and replicating the savings amounts listed. West Hill is currently the independent evaluator contracted by the Department to review and verify annual project savings for EVT and BED. Section 2.3 outlines the evaluation process in more detail.

Given that adjustments were made to the program tracking databases continuously over time, our savings replication effort was completed to within an acceptable margin of error (i.e., within 1-2 percent of savings reported in the original annual report) for most programs; however, the data provided for BED's Efficient Products program deviated from this trend with calculated energy savings amounting to 88 percent of claimed savings. Consequently, our calculation of total residential sector energy savings was 10 percent lower than BED's reported claims, and the calculated savings of the combined portfolio of BED programs was off by 5 percent. The difference between claimed/reported savings and ex post calculated savings could have been a function of several factors, including but not limited to subsequent changes in realization rates that are applied retroactively in the live databases to prior reporting years and other known changes in measure attributes. For future audits, we recommend that both EVT and BED save the same version of each program tracking database provided to the independent evaluator to ensure that all evaluation and audit activities are using identical data. The results of the replication activity are shown in Table 4 for energy savings (kWh), Table 5 for winter demand (kW) savings and Table 6 for summer demand (kW) savings.

Table 4: 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	4,642	4,642	100%	292	292	100%
Existing Homes	116,109	116,109	100%	875	875	100%
Efficient Products	8,454	8,437	100%	9,064	8,016	88%
Residential Total	**129,205**	**129,187**	**100%**	**10,231**	**9,183**	**90%**
Business New Construction	30,872	30,872	100%	1,282	1,398	109%
Business Existing Facilities	136,967	143,131	105%	10,160	10,054	99%
C&I Total	**167,839**	**174,003**	**104%**	**11,442**	**11,453**	**100%**
Portfolio Total	**297,044**	**303,190**	**102%**	**21,673**	**20,635**	**95%**

Table 5: 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	1,040	1,065	102%	48	48	100%
Existing Homes	29,097	29,803	102%	367	367	100%
Efficient Products	1,618	1,651	102%	2,061	1,854	90%
Residential Total	**31,755**	**32,518**	**102%**	**2,477**	**2,270**	**92%**
Business New Construction	3,882	3,965	102%	178	178	100%
Business Existing Facilities	20,708	22,094	107%	1,269	1,250	99%
C&I Total	**24,590**	**26,060**	**106%**	**1,446**	**1,428**	**99%**
Portfolio Total	**56,345**	**58,578**	**104%**	**3,923**	**3,698**	**94%**

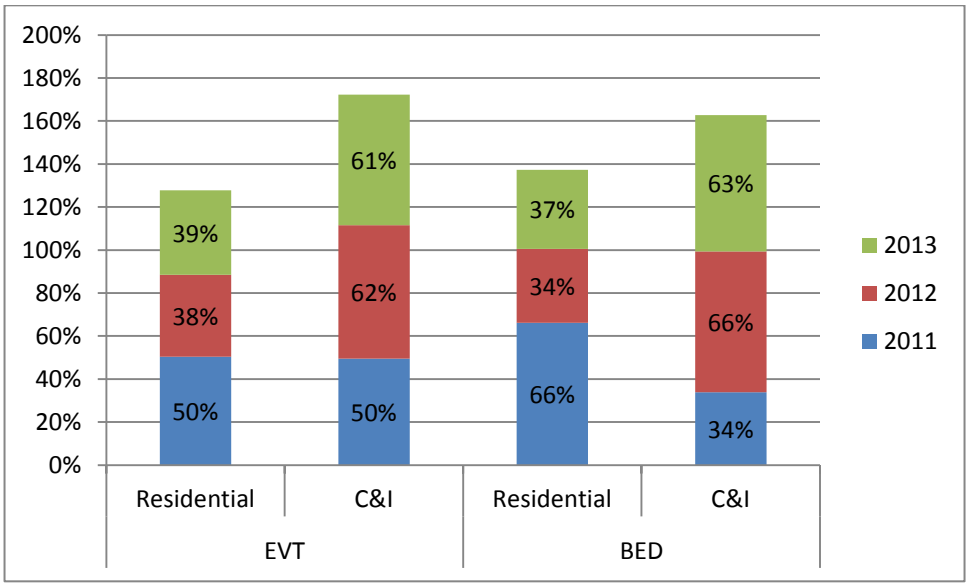
Table 6: Summer Demand (kW) Savings Verification Summary, Combined EEU Portfolio

Program	EVT			BED		
	Reported Summer Demand Reduction (kW)	Calculated Summer Demand Reduction (kW)	% of Reported Value	Reported Summer Demand Reduction (kW)	Calculated Summer Demand Reduction (kW)	% of Reported Value
Residential New Construction	517	523	101%	43	43	100%
Existing Homes	14,824	15,132	102%	157	157	100%
Efficient Products	778	791	102%	1,309	1,030	79%
Residential Total	**16,119**	**16,446**	**102%**	**1,509**	**1,230**	**82%**
Business New Construction	4,438	4,521	102%	304	347	114%
Business Existing Facilities	18,640	19,880	107%	1,432	1,353	94%
C&I Total	**23,078**	**24,401**	**106%**	**1,736**	**1,700**	**98%**
Portfolio Total	**39,197**	**40,846**	**104%**	**3,245**	**2,930**	**90%**

In addition to replicating EEU savings claims, 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.

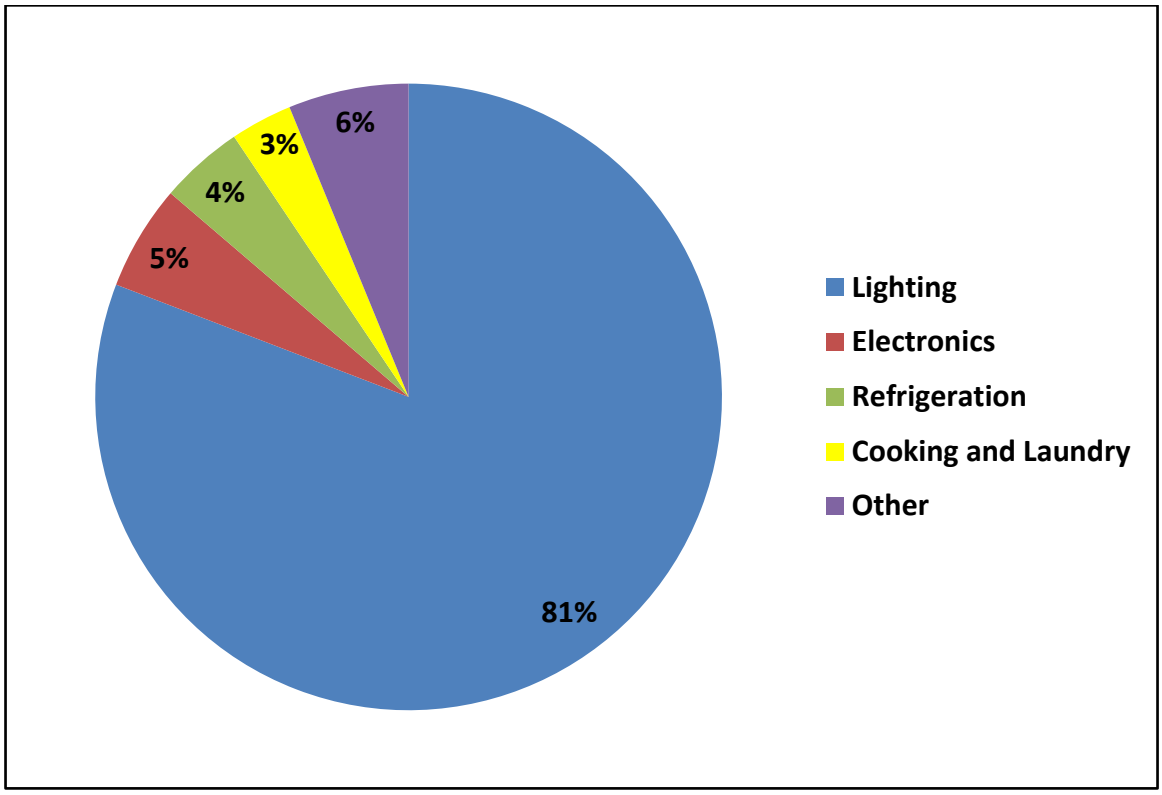
Energy savings by sector and EEU are presented in Figure 3. This chart indicates that in 2012 and 2013, approximately 60 percent of electricity savings came from measures installed through commercial and industrial program initiatives for both EEUs, with the remainder of savings coming from residential measures. This is in contrast with BED's program savings in 2011 where approximately 66 percent of savings came from residential measures, and 34 percent of savings came from measures installed by businesses. This change in savings from primarily residential to commercial and industrial represents a shift of approximately 30 percentage points.

Figure 3: Energy Savings Summary by EEU, Sector, and Program Year



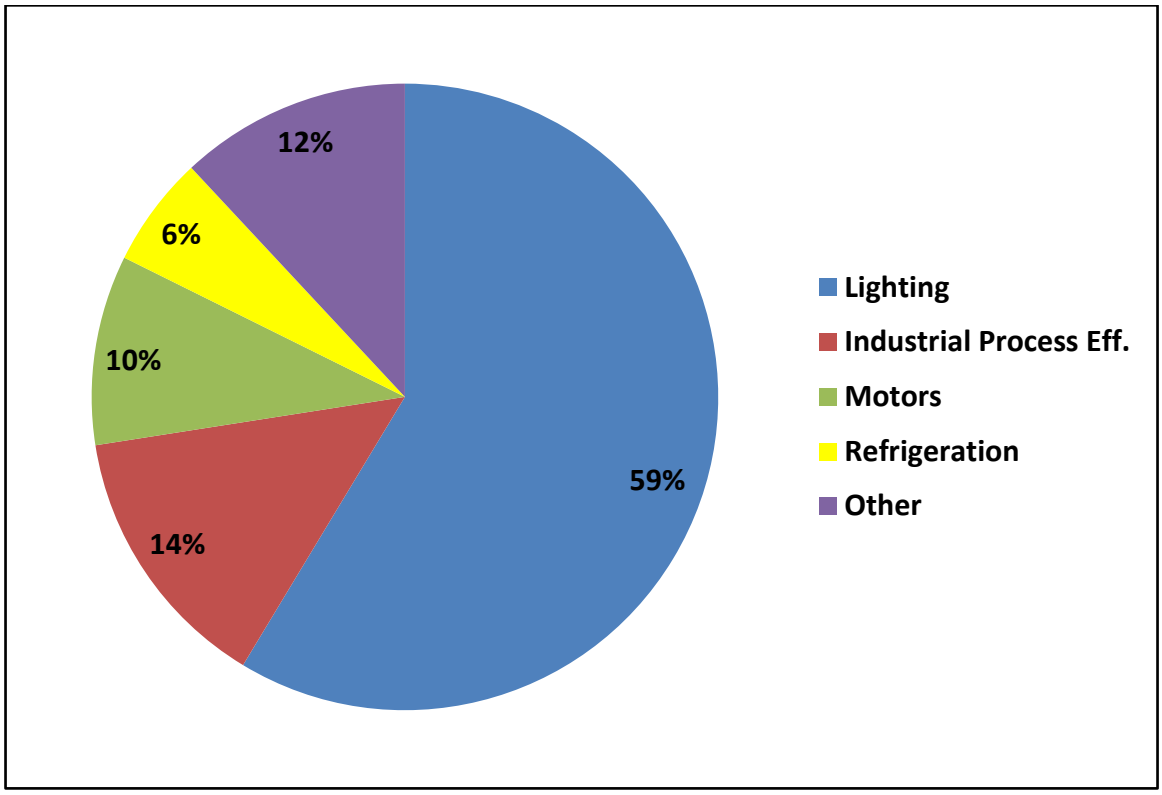
Energy savings for EVT, presented in Figure 4, show that lighting is the primary source (81 percent) of savings for the residential sector. Savings attributed to electronic plug load measures make up an additional 5 percent of savings. Refrigerators and other appliances contribute 7 percent, and all other measures not accounted for in the four main measure groupings comprise the remaining 6 percent of savings.

Figure 4: Residential Savings by End Use/Measure, EVT EEU Portfolio (2011-2013)



As shown in Figure 5, non-residential energy savings from EVT's efficiency initiatives are also primarily lighting based (59 percent), but to a smaller extent than residential savings. Other large measure groups consist of industrial processes (14 percent), motors (10 percent) refrigeration (6 percent) and "Other" measures (12 percent).

Figure 5: Commercial Savings by End Use/Measure, EVT EEU Portfolio (2011-2013)



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 6 and Figure 7. For the residential sector, the vast majority of savings (76 percent) comes from lighting measures. Electronic plug load measures contribute an additional 7 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, lighting is also the primary source of savings (48 percent), followed closely by custom projects (47 percent).

Figure 6: Residential Savings by End Use/Measure, BED EEU Portfolio (2011-2013)

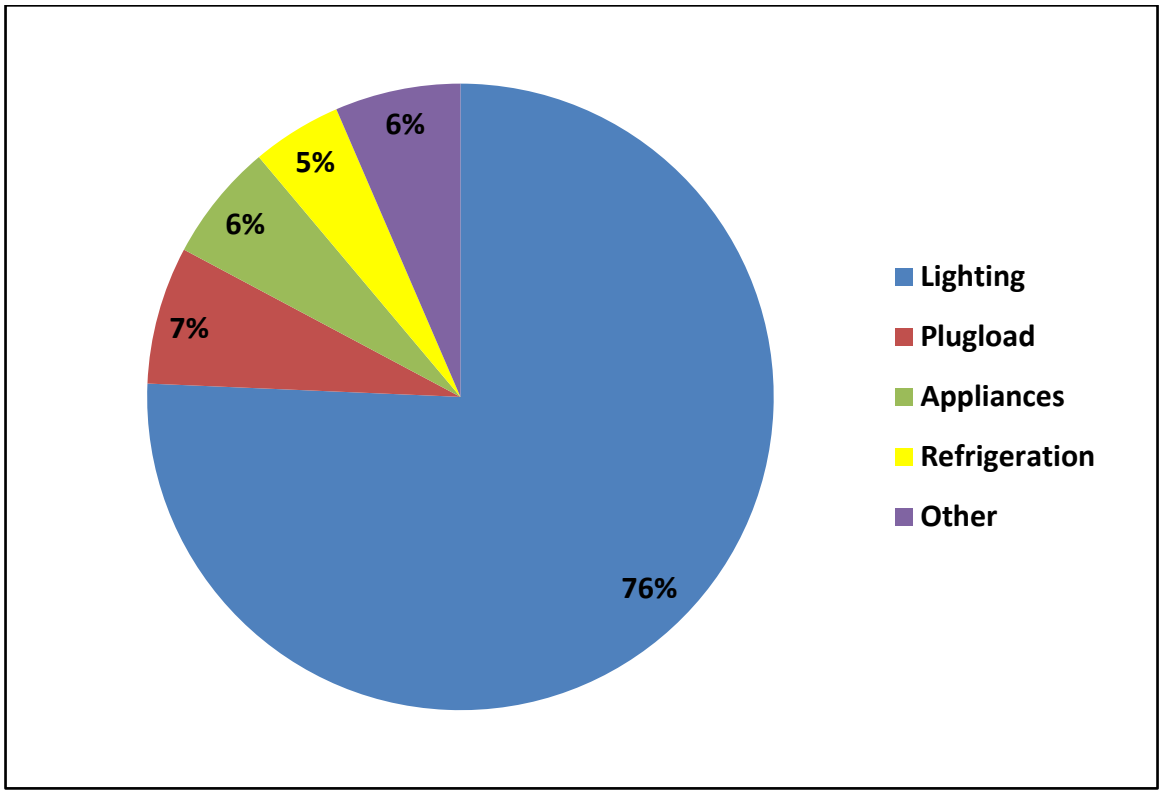
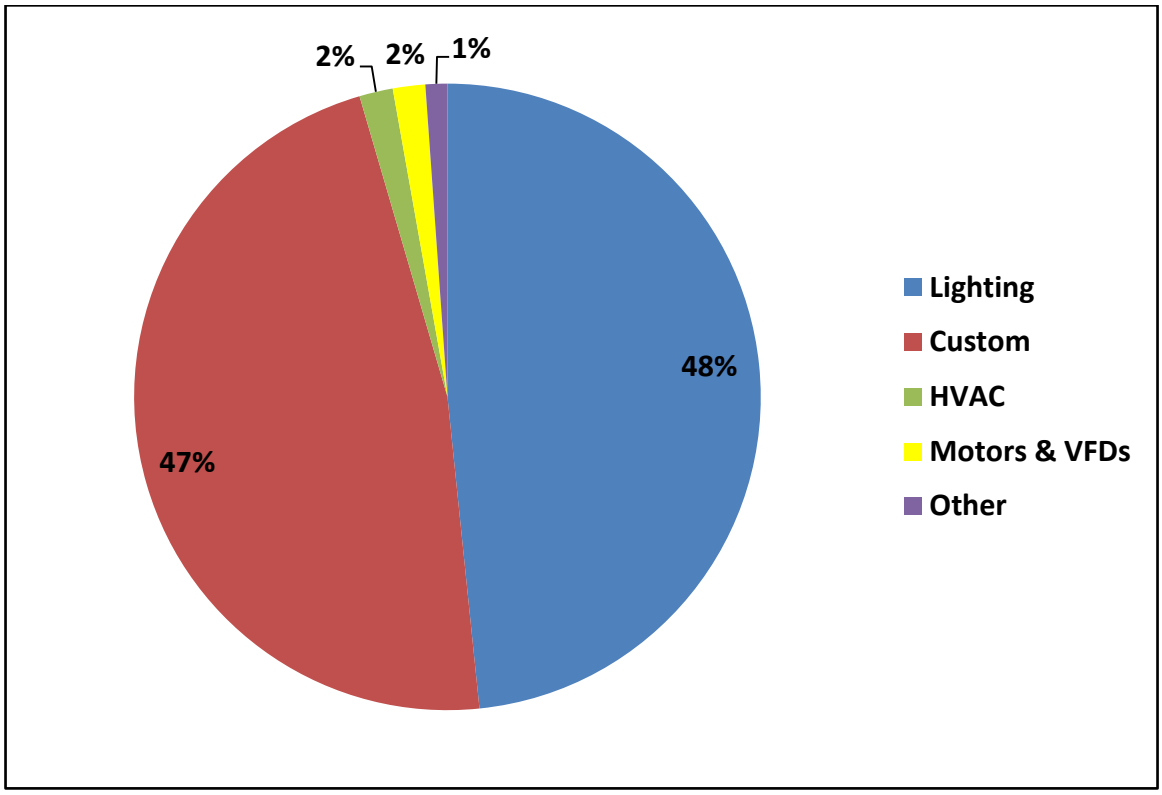


Figure 7: Commercial Savings by End Use/Measure, BED EEU Portfolio (2011-2013)



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 Project and Annual Report Review Process

In addition to the review of the TRM, Evergreen also reviewed each evaluation report from 2011 through 2013, for both EVT and BED.

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.

In addition to the annual reports, the individual project verification reports from the appendix of each evaluation report were reviewed. Each project report was reviewed to determine the method of data collection used to adjust the savings estimate, the major causes of the discrepancy of the savings, and the appropriateness of the calculation methodology used. The EEUs and independent evaluator also provided the original project files for the projects reviewed by the independent evaluator. In some cases, these files and/or the evaluator calculations were reviewed to verify technical accuracy.

4.4 Project and Evaluation Report Review Findings

The annual evaluation reports and the site reports were reviewed and, overall, were found to be adequate. However, there were several areas that should be addressed in more depth.

Inconsistent Levels of Rigor

The first finding that was apparent was that the evaluations for EVT and BED were completed with dramatically different levels of rigor.

Specifically, the evaluations for BED were completed with a high degree of rigor. Each evaluated site had revised savings estimates developed through metered data, customer interviews or on-site inspections paired with stipulated load-shapes as allowed under ISO New England Manual M-MVDR. In each case, the data source and rationale is clearly indicated. The overall evaluation included information to support the project evaluation as well as to support BED's submission of portfolio savings into the ISO New England forward capacity market.

By contrast, based on the reviewed reports covering three years of evaluation activities, the EVT evaluations did not include any site data collection or metering. Additionally, based on the supplied documentation, the Evergreen team could not verify if any customers had been interviewed or additional data were collected for the projects evaluated, although the described methods did indicate that customers could be contacted as needed. Instead, these projects were listed as being evaluated through a desk review that included a review of the project files and the tracking system.

As reported in the EVT evaluation reports, the overall project scope included a portfolio review of energy savings, demand savings, other fuel savings and all other inputs into the total resource benefit (TRB) calculations. A desk review approach was used due to the short timeframe allocated for the evaluation (less than four months). In an interview with the independent evaluator, West Hill, it was noted that in more ideal circumstances, more rigorous measurement and verification methods would be used; however, the time-frame of the evaluation dictated the methodology used.

Although not specifically described as a cause for the discrepancy, it should be noted that the EVT savings verification work was completed independent of the sampling and evaluation of projects for the purposes of submission for the ISO New England forward capacity market.

Therefore, essentially two independent evaluations of the same projects were completed for EVT for different purposes.

This approach may be necessary to meet regulatory reporting requirements or other factors. However, this methodology may also result in added overall costs to the program as well as potential inaccuracies in the savings and resulting total resource benefit calculation due to the lack of rigorous data collection. Evergreen recommends that the projects selected for the savings verification and forward capacity market evaluations be reviewed and compared in order to determine any disparity in each savings estimates method.

Custom Versus Prescriptive Projects

BED custom projects were primarily reviewed using on-site visits or engineering desk reviews by the evaluator, while EVT custom projects were reviewed only by engineering desk reviews. On the other hand, prescriptive and residential projects for both EEUs were primarily verified by comparing claimed savings values to existing loadshape 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.

Reporting Clarity and Consistency Improvements

Individual site reports were found to adequately describe the general evaluation approach, changes made to the analysis and the resulting impact on the savings estimates. Specifically, the project overview sections were found to sufficiently describe the project as completed by EVT. Reasons as to why a verification adjustment was included are described in the findings of the evaluation team and are categorized accordingly. For most of the projects, the specific information changes were fully described, including the specific values (such as hours of operation, motor efficiency or other factors) used in the original analysis and the revised value from the evaluation analysis. However, we would encourage the level of detail to be expanded even more. In many cases, the specifics of the evaluation process or findings were not clear. Specifically, on-site findings from the FCM evaluation and information from customer interviews (such as operating hours of the individual areas or loggers, or self-reported hours of operation) were not included in the report text. Additionally, the EVT site reports had less information than the BED reports.

We would also suggest that the future reports adopt a more consistent structure. While the most critical information was always included in the report, the inconsistency across programs and projects sometimes made the location and interpretation of the information more difficult. In particular, custom and prescriptive projects were not labeled as such within the evaluation reports and were difficult to immediately identify for audit purposes. It is possible that this inconsistency is due in part to the many individuals who completed individual project evaluations.

The tables within the evaluation reports were also inconsistent, which led to difficulties in comparing the information across programs. Specifically, within the 2013 EVT verification report, the table of results for the C&I and multifamily retrofit programs (Table 10[17]) gives the energy and demand realization rates but does not include the original or verified project savings. The lack of the original project savings removes the ability to quickly assess the relative importance of each point as it is not possible to tell if the amount of savings involved is large or small.

Similarly, Table 12[18] of the same report, which summarized the unregulated fuel projects, includes information on the original and verified savings levels but does not give the realization rates. This table gives a more complete picture of the projects; however, the inconsistency with prior tables makes comparison difficult.

Overreliance on the Technical Reference Manual

For two of the three years reviewed, the EVT evaluation report highlighted the expanded use of the parameters or assumptions from the TRM. Assumptions such as fixture wattage, operating hours or loadshape data were applied to applications or equipment for which they were not originally intended. The evaluation report noted that this is an ongoing issue that needs to be addressed.

Evergreen agrees that caution must be used when applying the TRM default assumptions to measures outside their original intended scope. In these cases, it is important to take additional steps to verify the actual equipment operation to determine if the use of the TRM assumptions is appropriate going forward. We would also encourage the use of TRM assumptions in cases where there is a clear indication that the assumption is reasonable, based on prior experience and/or customer interviews, or when the use of other sources of information is not likely to provide additional accuracy. Support for these applications needs to be documented, however.

Missing Project Documentation

In our review, we found a number of evaluated EVT projects where savings levels were reduced or set to zero for a measure due to lack of documentation. Although Evergreen does applaud the evaluator's stance on requiring sufficient documentation, the reduction in savings for some projects may be overreaching. The responsibility of the evaluator is to develop an independent estimate of project savings, and the lack of adequate documentation does not negate that responsibility. While we recognize that the timeframe allotted for evaluation is challenging, the evaluator should take the additional steps necessary to develop savings estimates whenever possible. If, due to customer non-response or other factors, no

[17] Verification of EVT 2013 Claimed Annual MWh Savings, Coincidenct Summer and Winter Peak Savings and Total Resource Benefit (TRB). West Hill Resources. July 7, 2014.
[18] Ibid.

independent estimate of the savings can be developed, we agree that an approach whereby savings estimates are reduced is appropriate as a last resort.

5 Cost-Effectiveness Analysis

Evergreen Economics calculated program cost-effectiveness for each year in the current evaluation cycle (i.e., 2011-2013) using the methodology noted in the California Standard Practice Manual.[19] Benefit-cost ratios were calculated for the Program Administrator Cost Test (PACT)[20], Total Resource Cost Test (TRC) and Vermont Societal Cost Test (SCT) as required in the RFP. 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).

As shown in Table 7, our analysis found that the overall EEU portfolio was cost-effective at all levels. Additional benefit-cost ratios are provided below for all programs combined, as well as by EEU and sector. A description of each test and the relevant inputs is also provided.

Table 7: Cost-Effectiveness Model Summary, Total EEU Portfolio

	Program Administrator Cost Test (PACT)	Total Resource Cost Test (TRC)	Societal Cost Test (SCT)
Total EEU Portfolio	3.05	2.66	3.51

5.1 Cost-Effectiveness Tests and Inputs

Program Administrator Cost Test

The PACT measures the cost-effectiveness of program offerings from the perspective of the program administrator by examining 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 net costs incurred by the participant. The benefits include net avoided supply costs (including reductions in transmission, distribution, generation and capacity costs). Costs include program incentives and all program administration costs including administrative, information technology and monitoring and evaluation costs.

[19] See the California Standard Practice Manual for more information: http://www.cpuc.ca.gov/NR/rdonlyres/004ABF9D-027C-4BE1-9AE1-CE56ADF8DADC/0/CPUC_STANDARD_PRACTICE_MANUAL.pdf

[20] 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.

Total Resource Cost Test

The TRC measures the net costs of demand side management (DSM) programs relative to the benefits of the programs from the perspective of both the participants and the EEUs. 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 program administration costs, 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[21] is also included to reflect the lower risk associated with DSM programs relative to supply-side alternatives.

Cost-Effectiveness Inputs

Evergreen analyzed cost-effectiveness for EVT and BED and assumed the same avoided costs, discount rates, risk adjustments, externalities and adders for the two EEUs. The 2013 Screening Tool maintained by Vermont Energy Investment Corporation (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 8 summarizes the key input values and sources used by Evergreen to complete the cost-effectiveness analysis.

[21] 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 8: Cost Effectiveness Model Inputs

Inputs	Value	Source
Discount Rate	3.00%	2013 Screening Tool
Avoided Energy Costs	varies	2013 Screening Tool
Avoided Water Cost	$10.25/CCF	2013 Screening Tool
Load Shapes	varies	2013 Screening Tool
Lines Losses	varies	2013 Screening Tool
Persistence/Free-ridership	varies	TRM
Risk Adjustment	10.00%	2013 Screening Tool
Electric Externality	varies	2013 Screening Tool
Non-electric Externalities	varies	2013 Screening Tool
Non-energy Benefits Adder	15.00%	2013 Screening Tool
Low-income Adder	15.00%	2013 Screening Tool

Since the previous audit of the Vermont EEUs,[22] avoided costs have been revised significantly. For example, avoided energy (kWh) costs in the 2013 Screening Tool have decreased to about one half of the corresponding values in the 2010 tool (i.e., approximately $0.10/kWh to $0.06/kWh). Summer capacity (kW) costs also decreased by 8 percent from 2010 to 2013, while winter capacity costs increased by approximately 14 percent. Additionally, the Vermont PSB issued an order in 2011 that substantially increased the price of non-electric energy externalities (e.g., residential space heat natural gas costs rose from $1.22/MMBtu to $4.81/MMBtu, which increases the benefit of gas savings in the benefit-cost calculations). Moreover, new non-energy benefit and low-income adders of 15 percent were adopted in 2012 to account for additional benefits. As can be seen in the following section, all of these changes affected the cost-effectiveness calculations and resulted in higher benefit-cost ratios when compared to the 2010 audit results.

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 performed well, 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 both EEUs combined is included below in Table 9 and Table 10. For

[22] "Independent Audit, 2008-2010: Management Letter, Vermont Energy Efficiency Utility", May 30, 2012 Frontier Associates, LLC.

comparative purposes, Table 10 also includes the benefit-cost ratios for each test from the 2008-2010 audit.

Table 9: Annual Results, Total EEU Portfolio

Year	kWh	Summer kW	Winter kW	MMBTU	Incentive Costs	Admin Costs	Total Program Costs
2011	110,261,077	15,155	20,416	66,401	$22,934,804	$19,379,324	$42,314,128
2012	118,190,667	16,566	23,851	79,578	$19,982,247	$17,581,919	$37,564,166
2013	95,372,904	12,056	18,008	130,207	$16,637,386	$20,567,707	$37,205,093
Total	**323,824,648**	**43,776**	**62,276**	**276,186**	**$59,554,437**	**$57,528,950**	**$117,083,387**

Table 10: Test Results, Total EEU Portfolio

	PACT	TRC	SCT
Benefit-Cost Ratio (2008-2010)	2.96	2.57	3.15
Benefit-Cost Ratio (2011-2013)	3.05	2.66	3.51
Total Benefits	$356,944,811	$395,689,514	$469,555,387
Total Costs	$117,083,387	$148,542,341	$133,688,107

Residential

For the residential sector, Evergreen found the combined EEU portfolio to be cost-effective according to all three cost-effectiveness tests. Table 11 and Table 12 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 11: Annual Results, Residential EEU Portfolio

Year	kWh	Summer kW	Winter kW	MMBTU	Incentive Costs	Admin Costs	Total Program Costs
2011	92,065,168	11,761	35,785	117,875	$7,927,915	$8,020,716	$15,948,631
2012	37,039,733	4,859	39,283	51,529	$8,016,084	$9,649,272	$17,665,356
2013	4,717,949	599	28,705	16,715	$7,296,002	$10,895,880	$18,191,882
Total	**133,822,851**	**17,219**	**103,774**	**186,119**	**$23,240,001**	**$28,565,868**	**$51,805,869**

Table 12: Test Results, Residential EEU Portfolio

	PACT	TRC	SCT
Benefit/Cost Ratio	2.17	2.11	2.84
Total Benefits	$112,233,688	$139,259,811	$168,116,757
Total Costs	$51,805,869	$65,858,999	$59,273,099

Commercial & Industrial

Vermont's EEUs 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. Table 13 and Table 14 summarize the calculation inputs and resulting benefit-cost ratios.

Table 13: Annual Results, C&I EEU Portfolio

Year	kWh	Summer kW	Winter kW	MMBTU	Incentive Costs	Admin Costs	Total Program Costs
2011	18,195,908	3,394	-3,007	30,616	15,006,889	11,358,608	26,365,497
2012	81,150,934	11,707	14,674	40,295	11,966,163	7,932,647	19,898,810
2013	90,654,955	11,457	16,792	101,502	9,341,384	9,671,827	19,013,211
Total	**190,001,797**	**26,558**	**28,459**	**172,412**	**$36,314,436**	**$28,963,082**	**$65,277,518**

Table 14: Test Results, C&I EEU Portfolio

	PACT	TRC	SCT
Benefit/Cost Ratio	3.84	3.17	4.26
Total Benefits	$244,711,142	$266,617,313	$321,929,130
Total Costs	**$63,678,107**	**$83,999,730**	**$75,599,757**

Efficiency Vermont

Table 15 and Table 16 summarize the calculation inputs and resulting benefit-cost ratios for EVT's portfolio of DSM initiatives for the 2011-2013 period. 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 15: Annual Cost Effectiveness Inputs, EVT EEU Portfolio

Year	kWh	Summer kW	Winter kW	MMBTU	Incentive Costs	Admin Costs	Total Program Costs
2011	139,990,898	19,647	30,542	66,699	$21,562,122	$18,620,473	$40,182,595
2012	107,270,962	14,390	19,700	78,361	$18,947,197	$16,796,555	$35,743,752
2013	55,927,681	6,809	8,336	132,261	$15,408,826	$19,728,819	$35,137,645
Total	**303,189,542**	**40,846**	**58,578**	**280,321**	**$55,918,145**	**$55,145,847**	**$111,063,992**

Table 16: Cost Effectiveness Test Results, EVT EEU Portfolio

	PACT	TRC	SCT
Benefit/Cost Ratio	3.02	2.64	3.45
Total Benefits	$335,271,198	$372,597,435	$439,557,263
Total Costs	$111,063,992	$141,376,749	$127,239,074

City of Burlington Electric Department

For the 2011-2013 period, Evergreen found BED's energy efficiency initiatives 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. Program cost data were collected from BED's annual DSM evaluation reports. Because BED only reports the non-electric fuel increases resulting from its efficiency programs, but does not necessarily report any non-electric fuel savings, the results listed below may understate the benefits of total fuel savings (electric and non-electric combined). Even with some benefits excluded, BED's EEU portfolio is cost-effective according to the PACT, TRC and SCT criteria.

Table 17: Annual Cost Effectiveness Inputs, BED EEU Portfolio

Year	kWh	Summer kW	Winter kW	MMBTU	Incentive Costs	Admin Costs	Total Program Costs
2011	7,207,181	1,070	1,308	-3,298	$1,372,682	$758,851	$2,131,533
2012	6,423,485	951	1,117	1,217	$1,035,050	$785,364	$1,820,414
2013	7,004,440	909	1,273	-2,054	$1,228,560	$838,888	$2,067,448
Total	**20,635,106**	**2,930**	**3,698**	**-4,135**	**$3,636,292**	**$2,383,103**	**$6,019,395**

Table 18: Cost Effectiveness Test Results, BED EEU Portfolio

	PACT	TRC	SCT
Benefit/Cost Ratio	3.60	3.22	4.65
Total Benefits	$21,673,613	$23,092,079	$29,998,124
Total Costs	$6,019,395	$7,165,592	$6,449,033

6 Recommendations

There are several overarching findings from the audit of the 2011-2013 Vermont Energy Efficiency Utilities (EEUs) 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 the independent evaluator, West Hill. Specifically, all recommendations should be considered within the context of these overall findings:

- The evaluation reports reviewed were generally of high quality and conformed to the standard practices of the evaluation industry.
- The Technical Advisory Group (TAG) process is highly regarded by all 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 Efficiency Vermont (EVT) and the City of Burlington Electric Department (BED) 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 consistent with Efficiency Vermont Technical Reference User Manual (TRM) guidelines.

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

- **The EEUs should maintain a frozen copy of the program tracking database/s provided to the evaluator that is consistent with annual reported savings values for future audits.** 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 both EVT and BED 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. This will ensure that all evaluation and audit activities are using identical data, and that the process is more fluid. 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.
- **EVT should continue to pursue efforts to investigate coordinating the FCM evaluation with the annual project verification.** The resulting evaluation would have the potential to be more rigorous while continuing to meet ISO New England evaluation requirements. Should this prove to not be feasible, EVT and the evaluator should consider beginning the evaluation earlier in the calendar year with a preliminary sample of projects. As general sector and end-use trends are unlikely to change significantly, this earlier start will allow the evaluator a longer timeframe in which to conduct a more rigorous analysis.

- **The evaluation of EVT's energy efficiency initiatives should begin earlier in the year.** An earlier start will allow the evaluator to complete a more rigorous analysis, by affording them more time to conduct site visits and complete more in-depth engineering analyses. 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.

- **EVT should explore whether more project-specific data can be incorporated into its savings calculations**. This will produce more accurate savings estimates and lessen reliance on TRM assumptions, which should only be used where this information is not readily available. For two of the three years reviewed, the EVT evaluation report highlighted that expanded use of the parameters or assumptions from the TRM were being applied to applications or equipment for which they were not originally intended. This is an ongoing issue that needs to be addressed.
- **For all new TRM measures, EVT should plan to allow sufficient time for TAG members to thoroughly review proposals for updates to the TRM.** Allowing more time for review will mean that TAG members are better prepared to discuss updates and can arrive at conclusions that all parties feel confident about.
- **The Board should consider the advisability of relying on an EEU functionally driving the TRM process.** The process seems to be working well, but there is a potential structural conflict of interest in having the program implementer also managing the TRM and the update process. One solution would be to hire an independent third party to conduct periodic in-depth reviews of the TRM.
- **The level of detail included in the individual site reports should be expanded.** While we found the site reports provided to adequately describe the general evaluation approach, changes made to the analysis, and the resulting impact on the savings estimates, we encourage the level of detail to be expanded even more. In many cases, the specifics of the evaluation process or findings are unclear. Specifically, on-site findings from the FCM evaluation and information from customer interviews (such operating hours of the individual areas or energy data loggers, or self-reported hours of operation) were not included in the report text.
- **Future reports should adopt a more consistent structure.** While the most critical information was always included in each report, the inconsistency across programs and projects sometimes made the location and interpretation of the information more difficult. It is possible that this inconsistency is due in part to the many individuals and companies that completed individual project evaluations. Verification reports should clearly label which projects are custom and which are prescriptive; this would help facilitate the audit process.

- **The evaluator should put in a good faith effort to determine the project savings, even if the documentation level is poor or non-existent.** In our review, we found a number of evaluated projects that had energy savings reduced due to a lack of documentation. Although the Evergreen team does applaud the evaluator's stance on requiring sufficient documentation, the evaluator should take the additional steps necessary to determine the correct savings estimates whenever possible. If, due to customer non-response or other factors, no independent estimate of the savings can be developed, we agree that an approach whereby savings estimates are reduced is appropriate as a last resort.