

**DPS Verification of
BED's 2006 Claimed Annual MWh Savings,
Coincident Summer and
Winter Peak Savings**

Final Report

March 31, 2008

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I. Introduction

The Department of Public Service (“DPS” or “Department”) undertook a review of Burlington Electric Department’s (BED) 2006 energy efficiency activities, verifying the energy savings, and coincident peak savings amounts claimed by BED. This report summarizes the results of that review. Although the Department has reviewed Efficiency Vermont’s (EVT) savings claims every year under the requirements of the contract between EVT and the Public Service Board, this is the second such review of BED’s savings claims since 2002. The Department continues to commend BED’s effective promotion of energy efficiency. BED provides a valuable resource for Vermont, both in terms of supporting our economy by expanding the infrastructure to deliver energy efficiency services and providing the groundwork for moving toward greater energy independence.

On April 1, 2007, BED submitted its 2006 Energy Efficiency Annual Report. The DPS provided preliminary findings to BED on January 15, 2008, and BED responded with some clarifications on January 28, with discussions continuing through March 14. Agreement on savings adjustments was reached for all of the items identified in the DPS preliminary findings. The results of this review indicate that BED’s gross energy savings were overstated by 652 MWh (10.7%). The Department was not able to conduct a full review of all of the factors that contribute to the net savings. However, there appear to be significant errors with the application of the free rider rate, spill over rate and line losses. For the Efficient Products Program, the net energy savings are underestimated by over 100 MWh. Table 1 summarizes the adjustments to the gross energy savings as they currently stand. Specific adjustments to other savings claims, such as coincident peak and MMBtu savings, are listed under the project-specific reviews below.

Table 1: Summary of Adjustments

	# of Projects	Total Savings	Realization Rate	MWH Adjustment	% Reduction
C&I					
BEF Custom	52	2,368	79.9%	475	20.1%
BEF Prescriptive	67	413	96.0%	16	4.0%
BNC	8	2,211	95.0%	110	5.0%
Subtotal	127	4,992	88.0%	601	12.0%
Residential					
EP		602	94.0%	36	6.0%
LISF/REM		391	96.3%	14	3.7%
RNC		86	99.8%	0	0.2%
Subtotal		1,079	95.3%	51	4.7%
Totals		6,071	89.3%	652	10.7%

To measure savings for Business Existing Facilities (BEF), a stratified, random sample of 25 C&I projects covering the custom and prescriptive components of the BED initiative was reviewed. For the Business New Construction (BNC) measures, all eight completed projects were reviewed, for a total of 33 projects. The sampling and adjustment process is described in more detail under Section IV, Sampling. The Department is recommending adjustments based on twenty-three (70%) of these projects. This high percentage indicates that BED should place greater attention on accuracy of the calculations and assumptions. In addition, the Department found its verification process was hampered by the lack of documentation for many of the C&I Projects. Suggestions are made for improving documentation in Section III below.

In the residential sector, all eight space heat fuel switches were reviewed, as well as the prescriptive assumptions and average savings for other custom measures. No adjustments were recommended for the Residential New Construction (RNC) program. Adjustments were made to three of the eight fuel switches. The prescriptive measures in the EP program were reviewed to ensure that the TRM was correctly applied; discrepancies were found and adjusted.

The Department was not able to verify BED's Total Resource Benefits (TRB) claim due to lack of available documentation. From BED's Annual Report, it appears that BED calculated its TRB using customer costs based on BED's electric rates rather than the utility's avoided costs, as Efficiency Vermont uses.¹ The Department recommends that BED calculate the TRB with utility-specific avoided costs, if available. Otherwise, the statewide avoided costs should be used. Department staff and consultants are available to discuss this topic further with BED.

The Department has primarily recommended adjustments to energy savings claims. However, these changes will often also result in changes to demand savings and the TRB. The Department requests that BED make all other appropriate adjustments related to the projects listed in Section II below and to ensure that these changes are incorporated into BED's annual report on its energy efficiency activities undertaken in 2007. The Department further requests BED to identify and correct all errors in the calculation of net savings for C&I prescriptive measures.

The remainder of this report is divided into five sections. Section II details project and measure-level issues that provide the basis for the adjustments as currently estimated. Section III covers other concerns to be addressed on a prospective basis. The final section describes the sampling methodology in more detail.

II. Project- and Measure-Level Adjustments

A. Business Existing Facilities Custom Projects

Project #29199
Measure ID 51349, 49504

¹ 2006 Energy Efficiency Annual Report, Burlington Electric Department, presented to the Public Service Board. Spring, 2007.

Description of BED's Approach: This project involved the addition of VFDs and controls to aeration blowers in place of throttling valve control at a waste water treatment plant (WWTP).

BED used the savings calculations provided by the customer as the savings estimate for improvements at the Main WWTP and corresponding to Measure ID 51349. These calculations were rudimentary in nature. No documentation was found to support Measure ID 49504.

DPS Position: BED should be developing their own estimate of savings or at a minimum provide a critical review of savings provided by vendors or customer. The savings calculation relied on to claim savings was insufficient to support the claim and a review of the available billing history also does not support the savings. The billing history also indicates an installation date that is a year before the installation date in the tracking system.

Billing history indicates 9% reduction in usage from '05 to '07. Assuming that this project is the only substantive change affecting usage, the DPS used the billing history and assumed 90% of the savings indicated for the main plant was the result of this project. In order for this assumption to be reasonable, the installation would have occurred at the end of 2005 and we are unable to ascertain that this is the case. However, there was a substantial reduction in this time period and there is no other BED program activity that would account for it.

DPS Recommendation: The DPS recalculated the savings from the billing history as described above. Measure ID 49504 has no documentation and savings are disallowed. However, the billing history approach presumably incorporates savings from both measures. The total project savings were decreased from 404,700 kWh per year to 190,512, for a total reduction of 214,188 kWh.

Project # 31415

Description of BED's Approach: This measure involved the modification of ventilation controls in a men's locker room and the modification of supply air and return fans in a local college the student life building. The ventilation equipment was originally running 100% of the time. This project installed two VFDs and CO₂ sensors. The post-installation condition assumes the ventilation will run 20% of the time, as outlined in detailed spreadsheet calculations.

DPS Position: Savings calculation appears reasonable, but reducing run time by 80% seems like the maximum achievable energy savings. In the absence of more detailed information, the Department adjusted the savings assuming a run time reduction of 60%. In order to support a higher reduction, the Department would need to see detailed documentation that supports such an assumption, such as an occupancy schedule.

DPS Recommendation: The Department adjusted the savings claim downward by 25% based on the position above, which results in a reduction of 15,954 kWh per year.

Project #22897

Description of BED's Approach: The project added VFDs and controls to exhaust fans in a basement and ground-level garage. The supply fans already had VFDs.

This garage receives substantial supply air from the adjacent commercial building which it serves. Energy savings projects in the commercial building reduced the quantity of air entering the garage from the building. This project was not only to save energy, but also to restore proper air balancing and maintain negative pressure in the garage.

While this project did not seem to affect the hours of use, the savings calculation indicates savings in hours as well as loading. The calculation also indicates that the supply fan hours are greater than the exhaust fan hours (which could result in positive pressure in the garage and back draft of garage fumes into the building).

DPS Position: To maintain negative pressure, it is reasonable to assume that the exhaust fan will need to operate for the same duration as the supply fan.

The minimum speed set on the VFD is unknown. For motor longevity, 30% is often used. The calculated minimum air flow implies 33% speed. Given the safety implication of maintaining minimum ventilation, the DPS assumed a minimum speed of 50%. The DPS revised the calculation to match the exhaust fan hours to the supply fan hours and match the post-retrofit hours to the pre-retrofit hours and assumes that the reduced hours of use in the basement was intentional. There is no documentation on the actual loading, so the DPS adjusted the assumed loading to reflect a more reasonable estimate of division of hours. Motor efficiency and a pre-retrofit loading factor are also needed for the pre-retrofit calculation.

DPS Recommendation: The DPS's revised calculations result in a decrease in total program savings from 92,700 kWh per year to 68,290 kWh, a reduction of 24,410 kWh.

Project #30471

Description of BED's Approach: The project was an upgrade to the existing HVAC system. The base scope of work was to re-condition the existing air handlers in place and re-establishing the same control strategies.

The project included consolidating the upper levels to one common air handler with VFD control and VAV zone modules and the lower levels to a similar air handler

with similar controls. The work encompassed the addition of a digital front end with software, modules for boiler and chiller/chilled water pump control, modules for 22 VAV boxes, new OAT and OAH sensors, upgrade of zone sensors and addition of VFD control for two fans. These fans were AHU-1 (20 HP) and AHU-2 (15 HP). The new system was commissioned in May, 2005.

BED calculated the savings in two ways:

- 1) A macro analysis compares pre- and post-retrofit electrical consumption.
- 2) A micro analysis on compares 8 fans (4 supply and 4 return) totaling 53.5 hp operating 8760 hours at an average 75% load to 2 fans (supply only) totaling 35 hp operating 4000 hours at 58% load.

DPS Position: Since this project was part of a major renovation, total electric consumption would not be expected to reflect changes in this project alone. Furthermore, according to Act 250 and City of Burlington policy, the baseline is a new code-compliant system, not the pre-retrofit system.

BED's decision to compare both supply and return fans (4 of each) to supply fans only (2) implies that the return fans will no longer be used under the post-retrofit conditions. However, a note on the HVAC contractor's proposal refers to "replacement return air fans." Whether the fans were replaced or not, this note indicates they were not expected to be removed from service.

From review of the VT COMcheck-EZ 2001, Section IV, the code requires that systems serving more than one zone are to be VAV. Furthermore, minimum HVAC capabilities must include 7-day occupied/unoccupied programmable controls.

The DPS has adjusted the savings calculation as follows:

- Remove the return fans from the pre-installation scenario (since they are not included in the post-retrofit modeling)
- Use the same hours for baseline and installed, since occupied/unoccupied controls would be required of the base system
- Match the load between the baseline and the installed supply fans.

The intent of these adjustments is to isolate the VFD savings that BED can legitimately claim for this project.

DPS Recommendation: The Department estimates that the total project savings are 33,540 kWh per year, representing a decrease of 191,460 kWh from the original claim of 225,000 kWh.

Project # 30868

Description of BED's Approach: This project involved the installation of 22 screw-based CFL lamps. Savings for these measures were calculated using the algorithms

imbedded into the BED Tracking System for prescriptive lighting measures. There was no additional documentation provided for the project.

DPS Position: If prescriptive values and assumptions are going to be used, the project should be clearly identified as prescriptive. In addition, the imbedded tracking system algorithms did not correctly apply the waste heat adjustment of 1.06 to lighting savings.

DPS Recommendation: Savings for measures 52134 and 56420 should be calculated in accordance with the TRM, resulting in an increase in savings from 1,872 to 1,945 kWh and 2,246 to 2,334 respectively.

Project #33057

Measure ID 55092 (Lighting Occupancy Sensors))

Description of BED's Approach: A spreadsheet calculation (in the spreadsheet "Lighting SuperT8 Occ") shows savings resulting from lighting occupancy sensors and lighting retrofit. The applicable correction factors were not applied to the lighting savings. BED has recently provided additional information on this project.

DPS Position: The Department is willing to accept the revised calculations provided by BED.

DPS Recommendation: The DPS recommends that the savings be decreased by 3,795 kWh per year to 26,891 kWh.

Project #30265

Description of BED's Approach: This commercial facility was retrofitted with custom lighting timer controls and occupancy sensor measures. The primary issue is that the documentation of the lighting timer measure savings is not adequate to ascertain if the methodology is sound. The calculations for the occupancy control appear to be in order.

DPS Position: This project needs much clearer documentation and a project summary. There appears to be four different buildings (numbers 1, 6, 7, and 15) referenced in the savings calculation spreadsheet for this measure. (The original spreadsheet is named "lightimer128lake.")

- It appears that the fixtures being controlled by lighting timer controls are different than those controlled by occupancy sensors (since there are roughly 100 fixtures controlled by occupancy sensor, and about 150 fixtures controlled by lighting timer), but the documentation is scant and confusing.
- During an interview with the project manager, it was found that this project (30265) refers to savings for the first floor and second floor of the building, but the documentation does not clearly present that distinction.

To the best of the DPS's ability to interpret the documentation, it appears that savings for the timer controls were included for the third and fourth floors, resulting in savings for the same measures in the same areas being counted in both projects 30265 and 30266.

DPS Recommendation: The DPS adjusted the savings to remove the double counting for the timer controls, resulting in a reduction in savings of 20,497 annualized gross kWh. No adjustment was made on the occupancy sensors.

Project #30266

Description of BED's Approach: This commercial facility was retrofitted with custom lighting timer controls and occupancy sensor measures. The savings for this project are supposedly for floors three and four of the building, according to an interview with program manager. The lighting timer measure is not well documented, and appears inconsistent with the database.

In addition, HVAC, lighting and motor savings appear to be based on outdated TRM assumptions, and the actual installation efficiency of the heat pump was not well documented. The efficiencies for the motor upgrade were rounded, which had a noticeable impact on the resulting savings.

DPS Position: Timer controls (measures 51388 and 52569) should be combined to correspond with spreadsheet backup calculation. For the prescriptive HVAC, lighting and motor measures, the savings should be based on the current TRM assumptions. The motor savings should be calculated using the correct efficiencies with the necessary number of significant digits to avoid misstating the savings.

DPS Recommendation: The DPS grouped the savings for the lighting timer measures as is consistent with the documentation, and corrected the TRM assumptions. These adjustments resulted in a reduction of 1,708 kWh for the project.

Project # 33049

Description of BED's Approach: This project involved the conversion of electric baseboard heat to a gas space heater. The spreadsheet with the billing history tracks the electric usage over a four year period and one year has a greater fluctuation in energy usage. The average of the "three good years" is used as baseline, which has the effect of increasing savings.

DPS Position: If the baseline energy use is calculated from multiple years of billing history, one year should not be eliminated unless there is a solid and defensible reason for doing so. The documentation for this project did not indicate that this is the case. The baseline average energy usage from all four years of billing history is 7,870 kWh per year. After installation of a natural gas heater,

remaining call for make-up electric heat is 1,603 kWh per year, giving savings of 6,268 kWh per year.

DPS Recommendation: This adjustment resulted in a reduction of 532 kWh per year.

Project #22

Measure: Economizer

Description of BED's Approach: Economizer savings are based on metered energy data pre- and post- installation. Demand post installation was 142.4 kW and average demand of the three months pre-installation was 200.3 kW. Power reduction was attributed to installation of economizer. The typical number of hours of free cooling (dry bulb temperature < 30 for Burlington) is 1,650 hours. Summer demand savings of 23.7 KW are claimed for this measure.

DPS Position: This is a simplistic, but reasonable, estimate of energy savings attributable to the economizer. However, there should be no demand savings from this measure in the summer – only in the winter and in shoulder months.

DPS Recommendation: No adjustment to energy savings is necessary. The coincident peak summer demand savings should be reduced by 23.7 KW.

Project #33356

Description of BED's Approach: This project involved the installation of a new 60-hp VFD air compressor and compressor system leak mitigation. BED calculated savings for this project in two ways: 1) An estimation of expected load and power, resulting in savings of 32,429 kWh/yr and 2) a pre-post metering comparison derived savings of 153,435 kWh/yr. BED claimed the latter figure based on the pre-post metering. BED has also subsequently explained that the project included the leak mitigation in addition to the replacement of the compressor.

DPS Position: This project represents two (2) measures that need to be treated separately:

- 1) repair compressed air leaks
- 2) replace compressor (base case is new standard performance compressor)

The metering results indicate pre-retrofit and installed energy use. Since the base case compressor is not the pre-retrofit compressor, the savings due to these two measures should be *less than* the difference in metering results.

With the additional information concerning the leak mitigation it was possible for the DPS to re-analyze the savings estimate as follows.

- Using the post-retrofit metering, the DPS estimated the percent of time the system runs at a variety of percent loaded conditions.

- Using the time/load model thus developed, the DPS estimated the energy use of both the base case and installed compressors. The resulting savings is 95,708 kWh/yr for the compressor replacement measure.
- The DPS then used the time/load model to estimate the energy of the pre-retrofit compressor. The difference between this modeling result and the pre-retrofit measurements represents the savings due to leak reduction of 50,287 kWh/yr. These savings should be claimed with the measure life appropriate for leak reduction, e.g. 1 year.

DPS Recommendation: The DPS's revised calculations indicate that the savings should be decreased from 153,435 kWh per year to 145,995, for a total reduction of 7,440 annual kWh. Additionally, the measure should be split into the compressor replacement component and the leak mitigation component with the savings breakout discussed above. The leak mitigation measure savings should only be claimed for one year.

Project # 33560

Description of BED's Approach: This custom lighting measure involved replacing metal halide (MH) with pulse start metal halide (PSMH). Apparently BED was able to use lower wattage bulbs during replacement than TRM guidelines for MH to PSMH change-out.

DPS Position: There appears to be a clerical error in that the DSM tracking system recorded the actual energy consumed instead of savings. Savings from custom spreadsheet calculations are 2.1 kW and 8,260 kWh.

DPS Recommendation: Savings for this project should be increased from 6,640 kWh per year to 8,260 kWh and 1.6 KW to 2.1 KW.

Project # 32553 Measure ID # 54405

Description of BED's Approach: This project involved the replacing the lighting fixtures with efficient products. A standard calculation for the lighting savings was used. A factor of 1.06 was applied to account for AC savings due to reduced cooling load. No equivalent adjustment was applied to the demand savings.

DPS Position: The lighting efficiency savings were calculated in a spreadsheet that used lighting wattage, fixtures, and operating hours to determine that the project would save 259,252 kWh. Then, in BED's database tracking system a cooling bonus factor from the TRM of 1.06 was used. The TRM cooling bonus is for prescriptive projects and assumes that 50% of the buildings will not be air-conditioned. When the project is custom and the building is air conditioned, a cooling bonus of 1.12 should be used to calculate energy savings.

The BED database tracking showed a KW savings of 29.2, but the supporting spreadsheet had a calculated KW savings of 29.6. In addition, no cooling bonus was applied to the KW savings number. Based on discussion with BED, the correct KW savings number is 29.6, and BED agreed a cooling bonus should be added to the KW savings.

DPS Recommendation: By applying the correct cooling bonus of 1.12, energy savings can be increased by an annualized 15,712 kWh. By applying a cooling bonus factor of 1.34 (based on the TRM) to the 29.6 KW savings number, the KW savings can be increased by 9.9 KW. In addition, based on the new kWh savings, the waste heat penalty was recalculated to be -322.1 MMBtu, an increase of 12.6 MMBtu.

Project #30505
Project #30821

Description of BED's Approach: The back up provided for these projects is identical. They have the same number of units installed, same hours of operation and same annual savings. There was insufficient documentation to ascertain whether this is really the case or a clerical error. The database savings do not match the supporting documents. In addition, the MMBtu waste heat penalty appears to be understated in the database and overstated in the supporting documentation.

DPS Position: The Department is unable to ascertain whether the savings are correct. The Department requested that BED investigate this issue, but no further information has been forthcoming.

DPS Recommendation: Since the savings from these projects are not verifiable, the Department adjusted the savings for project 30505 to be consistent with the supporting documentation (with the corrected MMBtu penalty) and removed the savings from project 30821 in their entirety. These adjustments result in an increase of 222 kWh for project #30505 and a reduction of 2,028 kWh for project #30821. The MMBtu waste heat penalty was increased by 1.5 MMBtu for project #30505 and the waste heat penalty of 2.4 MMBtu was removed for project #30281.

B. Business Existing Facilities Prescriptive Projects

Projects #30474, 31857, 30864, 30865, 32754

Description of BED's Approach: BED uses algorithms embedded in their tracking system to calculate savings for prescriptive measures based on the Efficiency Vermont Technical Reference Manual (TRM). The results of these calculations were incorrect for a significant number of measures. Either through internal errors in logic or operator error, the database calculation was conducted with an incorrect version of the TRM assumptions. BED is correcting this internal problem.

DPS Position: BED should have used the correct TRM assumptions for 2006. Five of the nine projects in the random sample required corrections.

DPS Recommendation: The measures reviewed by the DPS represented 74,159 kWh per year of savings. Correcting the calculations yielded savings of 70,198 kWh, a reduction of 3,961 kWh. These projects with the adjustments are listed in the back up materials provided by the Department.

C. Business New Construction

Project #33390

Description of BED's approach: BED used a fixture to fixture replacement energy savings calculation for this large renovation project.

DPS Position: For a completely gutted building of this size (45,000 sf), the LPD method should be used. There was insufficient documentation for the DPS to estimate savings based on the space by space method, so a total building approach was taken to estimate savings based on the following assumptions.

- All fixtures were included in the project.
- Project documentation does not clearly list building square footage, and the DPS used the building area described during interview with program manager.
- This is a mix-used building. Since the space usage and square footage was not tracked, the lowest appropriate LPD baseline was used in the DPS savings calculation (that for warehouse space at 1.2 W/sf).
- Hours of operation are rounded and estimated because they are not clearly documented in a project description.
- Assumed hours of reduction were reduced to reflect more realistic energy savings potential.

Similarly, lighting savings due to occupancy sensors was adjusted using total building approach.

DPS Recommendation: The DPS calculations indicate that savings for this project should be reduced from 451,558 annual kWh to 376,459, reflecting a decrease of 75,099 kWh.

Project # 31621

Measure ID # 53093 & 53094

Description of BED's Approach. This is a custom project that included VFDs and premium motors for the HVAC system, and an energy efficient lighting measure for the parking garage. The parking garage was all that was completed. BED inadvertently entered the savings from the estimate for the entire project including parts that are incomplete rather than just the parking garage.

DPS Position: When reviewing the projects electronic and paper files, the DPS could not verify the savings numbers in the BED's database tracking system with the supporting documentation provided. BED provided revised spreadsheets with recalculated savings numbers; the DPS finds their revised numbers to be satisfactory.

DPS Recommendation: The lighting measure savings number should be adjusted down by 107,647 kWh per year to 17,453 kWh, the demand (KW) for this measure should be adjusted down by 44.9 KW to 2 KW, and the waste heat penalty should be zero, due to the fact it is an unheated parking garage. The savings numbers for the VFD's and premium motors measure should be increased by 27,337 kWh to 62,637 kWh, and the KW should be increased from 0 WK to 1 KW to account for the demand savings associated with the premium motors.

Project # 30818

Measure ID 52079 (DCV), 52080 (Lighting System Interior LPD) and 53377 (Custom Lighting Efficiency)

Description of BED's Approach: As documentation to this project, nine DCV analysis spreadsheets for various air handling units (AHUs) were attached. The savings for this measure are the sum of the fan savings for all of the DCV for all of the AHUs.

The savings calculation for the lighting measures is found in spreadsheet and although BED used reasonable assumptions and methods to estimate these savings, the total savings claimed for the two measures in the database exceeds the total building savings as calculated in this spreadsheet.

DPS Position: The sum of the fan savings for all of these AHUs is 29,964 kWh, which is slightly higher than the savings claimed in the database (28,900). However, the DPS and BED have agreed to adjust savings for DCV measures by an "operational testing factor" (OTF) of .80 to account for lower savings expected in facilities with no commissioning or other operational testing procedures in place. This adjustment is documented in the TRM. BED has not provided any project-level documentation to demonstrate that commissioning or operational testing procedures were undertaken at this site. Consequently, the Department concludes that the claimed savings should be 80% of 29,964 kWh.

Total savings for lighting improvements in building are 51,103 kWh per year and the program manager for this project agrees with that assessment. It makes sense to combine these two measures into one, since the documentation does not clearly delineate the savings for two separate measures.

DPS Recommendation: Combining the two lighting measures with total savings of 51,103 results in a reduction of 21,793 kWh. Adjusting the DCV savings to account for the OTF reduces savings by 4,929 kWh per year.

**Projects #35120 & #35121
Measures 52975 & 52986**

Description of BED's Approach: This custom project involved various energy efficiency measures, including lighting and VFDs with premium motors. In calculating the savings for the lighting retrofit, BED applied 1.06 as the waste heat factor. BED used the total kWh savings, converted to MMBtu's, and divided by the efficiency of a standard boiler, to calculate the MMBtu penalty from the efficient lights.

DPS Position: BED used an incorrect calculation in determining the waste heat penalty for the project and grossly overstated the lighting waste heat penalty. By overstating the heating penalty, BED is reducing their total resource benefits (TRB) that can be claimed. In addition, since the building is cooled by a natural gas-fired absorption chiller, the cooling bonus for installing the energy efficiency lighting will save natural gas, and can be an offset to the increased fuel use for additional heating.

For this lighting measure in BED's tracking system, the KW savings were recorded as 119.6, but in their supporting spreadsheet, the KW savings were calculated to be 129. When questioned on this discrepancy, BED indicated that the 119.6 KW was an early estimate, and it should have been updated to the 129 KW that was calculated in the supporting spreadsheet.

DPS Recommendation: By applying the correct waste heat penalty calculation that is listed in the TRM, and netting out the fuel savings for the absorption chiller. BED's heating penalty of -3,144 MMBtu, should be increased by 3,067 MMBtu, so the annualized waste heat penalty is -77 MMBtu. In addition, the KW savings number should be increased 9.4 KW to account for the incorrect KW number entered into the database tracking system. These adjustments were applied to both projects, resulting in a total decrease of 6,134 MMBtu in additional fossil fuel use and 19 KW in demand savings.

**Project #29522
Measure ID # 50252, 50253, & 50254**

Description of BED's Approach: This is a custom lighting project where a standard calculation (based on hours of use and wattage reduction) was used to calculate savings. No interactive effects with other building components were considered.

DPS Position: When reviewing the projects electronic and paper files, the DPS could not verify the savings in BED's database tracking system with the supporting

documentation provided. BED looked into the project and discovered the cooling bonus was not applied to the savings. BED provided a revised spreadsheet with corrected savings numbers. The DPS finds the revised BED savings numbers satisfactory.

DPS Recommendation: The DPS recommends the savings numbers in the database tracking system be updated to reflect BED's revised calculations of 273,657 kWh, 78.3 KW, and -304 MMBtu. This is an increase of 50,457 kWh, 27.90 KW, and - 32 MMBtu respectively.

D. Residential Single Family Existing Homes

Direct Install Lighting

Description of BED's Approach: Average savings for CFL screw-in bulbs is 84 kWh per lamp.

DPS Position: BED's per lamp savings seem high for residential applications. If these savings are estimated based on hours of use reported by the participants, recent studies indicate that self-reported hours of use tend to be overstated on average. In the process of verifying Efficiency Vermont's 2006 claimed savings, the Department recommended that lighting savings for similar programs with self-reported hours of use be reduced by 20%.

DPS Recommendation: The Department recommends that BED reduce the lighting savings from direct install CFL's by 20%. This adjustment results in a total reduction of 7,058 annual kWh.

Project #32147

Description of BED's Approach: Notes indicate that this participant had previously installed one kerosene space heater in the lowest level bedroom and the current measure involves installing a second one in the upstairs living room. There does not appear to be a change in occupancy.

Savings were calculated from the estimated heat load, and the calculations were provided by BED along with the billing history. The heat load was multiplied by 35% to obtain the claimed savings. The total load removed through the fuel switch is 2 KW. BED claimed 4,245 kWh per year for this fuel switch.

DPS Position: The Department is not sure why these savings were based on a heat load calculation rather than billing history. The consumption in this household fluctuates over the three years of billing history, suggesting that one or more fuel switches may have taken place in the past. While this approach makes the billing analysis more complicated and less reliable, the total winter use (October through

April) during the 2004/2005 heating season was about 3,700 kWh, which suggests that savings of 4,245 are likely to be overstated. The billing records for 2004/2005 indicate potential savings of about 2,950 kWh. As an alternative check to the billing analysis, removing 2 KW of space heating load and assuming that the space heat is used about 1,400 hours per year results in savings of 2,800 kWh. Both of these reality checks suggest that BED's savings are overestimated.

DPS Recommendation: The Department recommends that savings for this project be reduced to 2,900 kWh per year, resulting in a reduction of 1,345 kWh.

Project #32735

Description of BED's Approach: This space heating fuel switch was described as removing the electric space heat from the kitchen and extending the ductwork from the existing fossil fuel heating plant to cover this area of the home. It is unclear whether there was a change in occupancy. The project file indicates that there is pool pump, air conditioning and a dehumidifier that are used during the summer months.

Savings were calculated from the estimated heat load, and the calculations were provided by BED along with the billing history.

DPS Position: The claimed savings for this project are 6,105 kWh. On the surface, these savings seem high given the limited nature of the fuel switching. In addition, a review of the billing history does not show a clear pattern of electric space heating use. Total winter use is in the range of 4,200 kWh and space heating savings appear to be in the vicinity of 1,400 kWh, substantially less than the claimed savings.

DPS Recommendation: The Department recommends that savings for this project be reduced to 1,400 kWh per year, resulting in a reduction of 4,705 kWh.

Project #32747

Description of BED's Approach: This project involved a partial space heating fuel switch in an apartment. The installation date in the tracking system indicates the fuel switch was done in September of 2006. There was also a DHW fuel switch at the same location, installed in May of 2006 according to the tracking database. In June of 2006, there was a turn over in occupancy.

The savings were calculated as 70% of the calculated heat load. The actual heat load calculations were not provided to the DPS, although the 3-year billing history for the apartment was.

DPS Position: There are many moving parts in this project, including the change in occupancy and the two fuel switches (DHW and space heat) installed at different

times. In the billing history file, BED estimated that the three-year average electric space heating load for the entire apartment was 6,974 based on the consumption patterns of the prior tenant, as documented in the back up spreadsheet. However, the actual claimed savings were 70% of the undocumented heat load calculation of 8,707. Without further information, the Department cannot support using a heat load calculation that is higher than the actual heating consumption of the prior tenant.

DPS Recommendation: The Department recommends that the savings be calculated at 70% of the actual space heating use of the previous tenant (6,974), with the 70% adjustment reflecting that some electric space heating will still be used. This modification results in total savings of 4,882 kWh per year and a reduction of 1,213 kWh.

E. Residential Efficient Products

Lighting measures

Description of BED's Approach: BED automatically calculates the savings for prescriptive measures in its DSM tracking database. However, in some cases, the assumptions used in the calculations were not consistent with the 2006 TRM. This issue was found for some lighting measures. Energy savings for exterior fixtures, refrigerators, freezers, clothes washers match the 2006 TRM.

DPS Position: BED should be using the correct TRM assumptions. The adjustments for CFL lamps and interior fixtures are summarized below in Table 2. The adjustments for other interior lighting products were very small and are not included in this table or in the DPS recommended adjustment.

Table 2: EP Lighting Adjustments by Measure

	# of Records	# of Items	BED kWh per Item	TRM kWh per Item	Adjustment (kWh)
CFL Bulbs	453	1,349	63.3	44.2	25,766
CFL Bulbs	23	141	229.7	162.6	9,461
Subtotals	476	1,490			35,227
Interior Fixtures	13	23	65.8	43.8	506
Interior Fixtures	3	7	211.3	162.6	341
Subtotals	16	30			847
Total Lighting	492	1,520			36,074

DPS Recommendation: The aggregated overstatement for these measures comes to 36,074 kWh per year. Additional review indicates that the net savings for lighting measures are substantially understated for this program, by about 106 MWh. The

DPS recommends that BED adjust its measure savings for this program accordingly.

III. Issues to be Addressed on a Prospective Basis

A. Documentation

A lack of documentation made verification of many of BED's project extremely difficult and time consuming. In some cases, it was not possible to complete the level of review that is needed for verification. Another issue that made verification more complex was the tendency of some BED staff to round the savings when entering them in the database. Consequently, the calculated savings from the spreadsheet could not be matched easily to the database. While this practice is unlikely to have much of an impact on overall program savings, it is problematic from the perspective of the evaluators conducting the verification. In order for savings to be verifiable, the following information should be readily available. This information can be maintained in either hard copy or electronic format.

1. Project Overview

A one page summary of a project can be very helpful to the review process. Further, a project overview can have value to an internal staff person who is looking at a project that was managed or completed by another or former BED employee. We suggest BED routinely create a short summary of any custom project.

2. Documentation of Savings Methodology and Assumptions

The methodology and rationale used to derive the estimated savings needs to be clearly defined. The source of all factors, including assumptions, profiles, operating schedules, etc., should be documented. For example, BED assumed a 60% reduction in lighting use for project 33057 at Fletcher Allen Healthcare. There is no documentation as to the space being controlled or why such a large reduction can be assumed. It is also important to define clearly the specific components of the measure and document interactive effects between measures. For example, in projects 30266 and 30818, it is unclear how savings are allocated between the various lighting measures.

In addition, BED should not be relying on vendor-supplied calculations to estimate savings, as occurred with project 51349. At a minimum, an independent, critical review of such third-party savings estimates is necessary. The Department prefers that BED develop independent estimates based on its knowledge of the project, operating procedures and standard methods.

3. Recommendations

Project files should include a record of recommendations made to the participant and the screening that demonstrated the measure is cost effective. This information should be included in every file and should include a calculation of the TRB. There was very little documentation of recommendations in the BED files. We were also unable to verify TRB for BED as this information was not available either in the files or the tracking system.

4. Bids

Copies of any and all bids for work on the project should be available. There should also be documentation of the final costs of the project.

5. Contracts, Invoices and Inspection Form

Copies of BED's agreement with the customer, copies of paid invoices associated with a project and any post-installation inspections completed for the project all provide documentation of what was actually installed as a result of BED's efforts and demonstrate a level of involvement by BED. While BED did routinely have copies of the contractual agreements, there was little in the way invoice documentation.

B. Correct Classification of Projects

The Department recommends that BED exercise greater care in designating projects and measures correctly as prescriptive or custom. Projects 30868 and 32536 can be used to illustrate this issue. The former was designated as a custom project even though the measures were calculated through BED's database tool in a prescriptive manner. For the latter project, a custom calculation was completed for a project that consisted of replacing incandescent with CFL bulbs, a highly prescriptive endeavor. Proper classification of projects provides a greater level of accuracy in the sampling process used for verification and a greater degree of confidence in the subsequent results.

C. Peer Review

BED could improve the reliability of the estimating savings by instituting a system of Peer Review for custom projects. This can be particularly important for larger, more complex projects. Such a system provides several advantages:

1. It provides the opportunity for staff to give internal feedback and emphasizes a broader perspective that may optimize savings.
2. Assumptions and calculations can be checked for errors.
3. Knowledge of a project is not as easily lost when staffing changes.

D. Calculation of the TRB

The Department understands that BED calculated the TRB using retail electric rates. If this is the case, the Department strongly recommends that BED use either utility-specific or statewide avoided costs to be consistent with EVT's method and also with the standard approach to calculating the TRB in Vermont. The Department staff and consultants are available to discuss this topic further with BED.

IV. Sampling

A stratified random sample was selected from BED's C&I BEF projects. Sampling was conducted by project and the strata were defined according to the total annual energy savings for each project. There is reason to believe this approach provides sufficient sampling precision for the other performance indicators (TRB, summer and winter coincident peak demand savings and lifetime kWh). The samples were selected independently for custom and prescriptive projects within the BEF.

Given the small size of BED's programs, the sample strategy was relatively simple. The cut offs for the strata and the sample sizes within each stratum were determined according to the methodology presented in the California Evaluation Framework.² A census of the projects in the top two strata in the custom BEF was reviewed. All eight of the BNC completed projects were reviewed.

Table 3 shows the summary of projects and savings for the program and for the sample. Reviewing a census of the BNC projects and the upper two strata of the BEF custom projects leads to a sample with somewhat less emphasis on the BEF prescriptive measures than found in the overall population. However, there also tends to be less variability among these measures due to the fact that the methods and many of the inputs are established in the TRM, as further indicated by the high degree of sampling precision (2.3% relative precision) for the prescriptive component of the BEF.

Table 3: Summary of Projects

	Total # of Projects	Total MWh Savings	% of Savings	# Of Projects in Sample	Sample MWh Savings	% of Sample Savings
BEF Custom	52	2,402	48%	16	1,847	44%
BEF Prescriptive	67	335	7%	9	95	2%
BNC	8	2,529	45%	8	2,255	53%
Totals	127	5,266		33	2,350	

The sample for the BEF prescriptive track covered the range of measures offered through the program, including lighting fixtures and controls, air conditioning, motors and refrigeration. The BEF custom sample covered 77% of the total program savings, and consequently there was no need for further analysis to verify that the sample covered the range of measures, etc. The BNC

² TecMarket Works, et. al. The California Evaluation Framework. Project Number: K2033910. Prepared for the California Public Utilities Commission and the Project Advisory Group. June 2004. Pages 327 to 339 and 361 to 384.

sample was a census. For the C&I sector overall, the sample projects represented 84% of the total savings for the three initiatives.

This sampling strategy produced realization rates within a reasonable level of precision, with the relative precision of 11.6% and 2.3% at the 90% confidence level for the custom Business Existing Facility (BEF) and prescriptive BEF initiatives, respectively. There was no sampling error in the BNC program since all eight projects were reviewed.