

**Verification of
EVT 2014 Claimed Annual MWh Savings,
Coincident Summer and Winter Peak Savings
And Total Resource Benefit (TRB)**

Final Report

**Submitted to the
Department of Public Service**

by

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with Assistance from
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Table of Contents

I.	Introduction	4
II.	Methods.....	8
A.	Verification Process	8
1.	Commercial and Industrial (C&I) and Multifamily Retrofit Projects.....	8
2.	Commercial and Industrial (C&I) and Multifamily New Construction/MOP Projects	9
3.	C&I Stipulated Lighting.....	9
4.	C&I Upstream Initiatives	9
5.	Residential Efficient Products.....	10
6.	Residential Retrofit/Low Income Single Family	10
7.	Residential New Construction	10
8.	Residential Upstream	10
9.	Community Energy & Efficiency Development Fund.....	11
B.	Sampling	11
1.	Retrofit and NC/MOP Programs.....	12
C.	Calculation of the Realization Rates	16
1.	Commercial and Industrial (C&I) and Multifamily Sites (both Retrofit and New Construction/MOP).....	17
2.	C&I Upstream Projects	17
3.	C&I Stipulated Lighting.....	17
4.	Residential Efficient Products.....	17
5.	Residential Retrofit/Low Income Single Family (LISF)	18
6.	Residential New Construction (RNC).....	18
III.	Site-Specific Adjustments.....	18
A.	Commercial & Industrial and Multifamily Sites.....	18
IV.	Adjustments Due to Other Verification and QC Activities	23
A.	Stipulated Lighting.....	23
B.	Upstream Initiatives	25
1.	Smartlight.....	25
2.	HVAC Equipment Replacement.....	25
C.	Residential Initiatives.....	25
1.	Efficient Products Program.....	25

2.	Home Performance Program.....	26
3.	Residential Retrofit/Low Income Single Family	26
D.	Comparison to Other Evaluation Activities	27
V.	Ongoing Issues to be Addressed on a Prospective Basis.....	29
A.	Improved Documentation	29
B.	Verification of Savings Claimed for Upstream Measures	29
C.	Overreliance on the Technical Reference Manual	30
D.	TRM Lighting Categories	30
E.	Residential New Construction Custom Measures.....	30
F.	Upstream solar hot water pilot.....	31
G.	Faulty CAT assumptions and input values.....	31
H.	Brushless Permanent Magnet (BLPM) Circulator Pump.....	33
I.	Snowmaking	33

List of Appendices

Appendix A: Project-Specific Reports for C&I Projects with Adjustments

I. Introduction

On April 1, 2015, Vermont Energy Investment Corporation (VEIC), operating under an order of appointment by the Public Service Board (PSB) as Efficiency Vermont (EVT) to provide energy efficiency services in Vermont, submitted its "Year 2014 Preliminary Savings Claim" for calendar year 2014 activities. The Department of Public Service (DPS or Department), is required by the PSB to undertake a review to verify the energy, coincident peak, and Total Resource Benefit (TRB) savings claimed by EVT for purposes of certifying achieved savings toward VEIC's performance goals. To complete this review, the Department contracted the services of West Hill Energy and Computing, who conducted the verification with assistance from Cx Associates, Energy Resource Solutions (ERS), GDS Associates and Lexicon Energy Consultants.

The savings verification (SV) process is a paper review intended to identify errors in calculation, assumptions and methodology made by EVT in their savings claim. This review process is substantially less rigorous than standard impact evaluations required in many jurisdictions.¹ Given the limited budget and time frame for the SV process, there is no opportunity to conduct site visits or direct measurement. However, it is sometimes possible to assess whether savings are realistic in comparison to pre-installation consumption for retrofit projects with large expected savings.

Project by project preliminary findings were provided to EVT as the project reports were completed. EVT provided comments on the preliminary reports for consideration by the Department and its contracted verification team. This process helped facilitate agreement between the Department and EVT and EVT has indicated it accepts all of the adjustments to the 2014 claimed savings recommended by the Department in this report. Since the parties are in agreement on the magnitude of the adjustment, project by project issues and resolutions are only briefly described in the main report. Detailed discussion of the individual projects reviewed and the review outcomes are provided in Appendix A.

The DPS thanks the many staff members at Efficiency Vermont who coordinated the verification review, in particular Bill Fischer, Tom Fisher and Erik Brown.

The results of the Department's verification indicate that EVT's 2014 energy savings claims are overstated by approximately 6.3%, or 6,245 gross annual MWh, and coincident peak savings are overstated by 8.3% or 1,676 winter kW and 5.7%, or 656 summer kW. The Department's findings are the result of numerous adjustments both upward and downward.

In addition to the analysis of gross energy and demand savings, this review also covers net energy and demand savings, TRB, MMBtu savings from fossil fuels, and water savings. Some of the Department's recommended energy adjustments have significant impacts on these other indicators.

¹ For example, verification through paper review without on-site visits (as conducted for the current annual savings verification process) is not listed as an acceptable approach for measurement and verification in the *California Energy Efficiency Evaluation Protocols* (prepared by TecMarket Works, et al., April 2006, Chapter on M&V Protocol).

When EVT's savings are revised for the EVT 2014 annual report, all of the relevant indicators need to be re-calculated.

The above described recommended adjustments to EVT's savings claims is based on the review of EVT's entire portfolio, including review of a randomly selected sample of Commercial and Industrial (C&I) and multifamily projects and a comprehensive review of residential prescriptive measures. The sampling process was designed to ensure that the sample was weighted toward the larger projects that embody greater variability and more complex methods for calculating savings.

Since many of the residential initiatives are primarily prescriptive in nature, the Department's review of this sector consisted largely of verifying that the assumptions as compiled in EVT's Technical Reference Manual (TRM) were correctly applied. This validation process is easily conducted for the entire data set, eliminating the need for random sampling. Custom residential initiatives are small in magnitude (less than 1% of total claimed savings) and the Department reviewed only the larger residential projects with higher savings.

The adjustments to gross annual savings and coincident peak reductions for all initiatives are summarized in Table 1.

Table 1: Electric Adjustments by Program Group

	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed MWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
C&I and Multifamily						
Retrofit	28,991	87.1%	5,956	83.6%	1,839	90.8%
NC/MOP	19,318	89.7%	2,774	82.1%	2,430	86.1%
Stipulated Lighting	4,642	97.0%	593	89.0%	901	87.5%
Smartlight	6,555	94.4%	856	92.5%	1,341	100.1%
Upstream HVAC	440	100.0%	28	100.0%	51	100.0%
C&I Subtotal	59,945	89.6%	10,206	84.3%	6,563	90.6%
Residential						
Efficient Products	32,076	99.9%	8,273	100.0%	4,421	99.9%
Residential Retrofit/Low Income Single Family	2,614	99.8%	574	99.9%	257	99.6%
Home Performance with Energy Star	158	86.0%	89	86.0%	0	86.0%
Residential New Construction	1,006	100.0%	237	100.0%	97	100.0%
Smartlight	2,381	87.1%	571	92.0%	157	79.5%
Upstream HVAC (+ HP water heaters)	615	156.1%	158	93.1%	-13	100.0%
Residential Subtotal	38,851	100.0%	9,902	99.3%	4,919	99.2%
Portfolio Total	98,796	93.7%	20,109	91.7%	11,482	94.3%

The relative precision² of the realization rates associated with the energy savings (annual kWh) for the C&I and Multifamily retrofit initiatives, and the C&I and Multifamily New Construction and Market Opportunity initiatives is 3.2% and 3.0% at the 90% confidence level, respectively. Overall, for the portfolio as a whole, the relative precision is 2.0%.

Provided in the table below is the MMBtu savings and associated realization rates by program group.

² Relative precision indicates variability of the estimator, in this case the realization rate, in relationship to its magnitude. It is calculated at the 90% confidence level as 1.645 * standard deviation of the realization rate/mean realization rate.

Table 2: MMBtu Adjustments by Program Group

	Energy Saved	
	EVT Gross Claimed MMBtu	Realization Rate
C&I and Multifamily		
Retrofit	73,395	68.6%
NC/MOP	21,109	87.2%
Stipulated Measures	(3,171)	97.0%
Smartlight	(5,311)	94.4%
Upstream HVAC	-	100.0%
C&I Subtotal	86,022	70.5%
Residential		
Efficient Products	(2,407)	100.0%
Residential Retrofit/Low Income Single Family	101	100.0%
Home Performance with Energy Star	22,890	76.0%
Residential New Construction	8,639	100.0%
Smartlight	-	87.1%
Upstream HVAC (+HP water heaters)	3,443	100.0%
Residential Subtotal	32,666	83.2%
Portfolio Total	118,688	74.0%

The remainder of this report is divided into four sections. Section II describes the methods (including the sampling process) and Section III covers the detailed site-level issues that provide the basis for the adjustments made to the C&I sample of projects. Section IV discussed the adjustments made to other components of EVT’s portfolio. Section V covers specific issues with program year 2014 (PY2014) projects and other concerns to be addressed on a prospective basis.

II. Methods

This section describes the methods used in this evaluation. The first part describes the verification process for each of the major components of EVT's portfolio, following by a description of the sampling conducted for custom C&I projects and an explanation of how the realization rates were calculated.

A. Verification Process

Annual savings verification starts in mid-March, when EVT provides the list of projects and savings for the previous program year to the DPS. In past years, the goal has been completing the entire review and generating a final report by the beginning of July, a span of less than four months. For program year 2014, the timeline shortened to accommodate a final report in early June resulting in an even more compressed timeline. EVT's entire portfolio is included in the review, which covers the energy savings, demand savings, other fuel savings or extra use and all other inputs into the total resource benefit (TRB) calculation.

Given the short time frame and the scope of the work, the verification method is restricted to a review of a sample of the custom C&I projects and comparison of prescriptive savings to the TRM for the rest of EVT's portfolio. Other common verification methods, such as direct measurement, participant surveys and on-site verification, cannot be carried out within the available time frame. Consequently, the verification review consists almost entirely of review of EVT's project files and program tracking database. On a case-by-case basis, and time permitting, participant billing data may be reviewed for large retrofit projects.

In this context, it is necessary to prioritize and identify the key components of the portfolio requiring more intensive review. EVT's portfolio was divided into eight components:

- C&I and Multifamily Custom Retrofit Projects
- C&I and Multifamily Custom New Construction/MOP Projects
- C&I Stipulated Lighting Projects
- C&I Upstream Initiatives
- Residential Efficient Products Savings
- Residential Retrofit/Low Income Single Family
- Residential New Construction
- Residential Upstream

The approach to each of these components is discussed briefly below.

1. Commercial and Industrial (C&I) and Multifamily Retrofit Projects

These projects account for 48% of the total C&I and Multifamily sector savings and 29% of EVT's total portfolio savings for PY2014. These projects are varied, ranging from relatively simple lighting system to highly complex industrial processes. Due to the characteristics of the projects and their relative importance to EVT's portfolio, the DPS Evaluation Team selected a random sample of projects to review and applies the results to this component of the portfolio. The following section provides details of the sampling process.

The DPS Evaluation Team reviewed the project files to assess whether the savings estimates are reasonable. This process is almost entirely dependent on the information provided by EVT. In a few cases, billing data was reviewed.

2. Commercial and Industrial (C&I) and Multifamily New Construction/MOP Projects

These projects account for 32% of the total C&I and Multifamily sector savings and 20% of EVT's total portfolio savings for PY2014. Similar to the retrofit category described above, these projects are varied, ranging from relatively simple lighting system to highly complex industrial processes. As with the retrofit projects in this sector, the DPS Evaluation Team selected a random sample of projects to review and applies the results to this component of the portfolio. The following section on sampling provides details of the sampling process.

The process is the same as for the C&I retrofit projects. The DPS Evaluation Team reviewed the project files to assess whether the savings estimates are reasonable. This process is almost entirely dependent on the information provided by EVT. In a few cases, billing data was reviewed or the participant was contacted by the DPS Evaluation Team to fill in missing information.

3. C&I Stipulated Lighting

These projects account for 8% of the total C&I and Multifamily sector savings and 5% total portfolio savings for PY2014. These projects consist of standard lighting projects using coincidence factors that were determined through an independent evaluation conducted for the Northeast Energy Efficiency Partnership. Stipulated lighting projects are included in a number of EVT initiatives, covering retrofit, market opportunity (MOP) and new construction.

For the FCM impact evaluation, these projects do not require metering, and constructing a separate stratum allows the evaluation team to develop an appropriate and cost efficient M&V process. As part of the FCM impact evaluation for PY2012, the DPS Evaluation Team conducted separate evaluation activities to estimate the in service rate and accuracy of the underlying assumptions for these projects. The study began with a telephone survey in early January 2014 and collected additional data through site visits conducted in February and March of 2014. The data collected was then compared to information from the EVT tracking system. The results of this study were used to verify the PY2014 stipulated lighting measures.

4. C&I Upstream Initiatives

These projects account for 12% of the total C&I and Multifamily sector savings and 7% total portfolio savings for PY2014. EVT's upstream initiatives are intended to promote energy efficiency through offering incentives to distributors. The distributors then offer efficient products at a discount to their customers. The upstream projects are typically the aggregated sales from a specific distributor. As these projects require different evaluation methods, they were verified separately from the other C&I projects.

There are two major upstream initiatives, one for lighting products and the other for heating, ventilation and air conditioning (HVAC) equipment. The savings are prescriptive, and verification consisted primarily of comparing the savings assumptions to the TRM.

One of the unintended consequences of the upstream approach is that it adds a separate layer to the installation process (the distributor) and thus, it becomes more difficult to verify the installation of the actual products. Despite this difficulty, an evaluation of the upstream lighting program was completed as part of the FCM evaluation for PY2013, and these results were applied to the PY2014 upstream lighting measures.

5. Residential Efficient Products

The Efficient Products Program (EP) accounts for 83% of EVT's claimed energy savings in the residential sector, 32% of EVT's total portfolio savings for PY2014. These measures are prescriptive and the verification process involved ensuring that EVT's claimed savings match the values specified in the TRM.

6. Residential Retrofit/Low Income Single Family

These projects account for 7% of the total residential sector savings and 3% of EVT's total portfolio savings for PY2014. Many of these measures are prescriptive and were reviewed by comparing the claimed savings to the TRM. This group only includes projects completed through the Home Performance with Energy star program; the verification process relied on the previous impact evaluation of this program, as modified by agreement between the Department and EVT³.

7. Residential New Construction

These projects account for 3% of the total residential sector savings and 1% of EVT's total portfolio savings for PY2014. These measures are largely prescriptive and were reviewed by comparing the claimed savings to the TRM.

8. Residential Upstream

Projects in this category include lighting products and measures for residential HVAC equipment. These projects account for 3% of the total residential sector savings and 8% of EVT's total portfolio savings for PY2014. Verification consisted of comparing the claimed savings to the TRM.

³ Efficiency Vermont's Home Performance with ENERGY STAR® Program Impact Evaluation Final Report, Prepared for the Vermont Department of Public Service. May 2013

9. Community Energy & Efficiency Development Fund

Measures and projects that were funded through the Community Energy & Efficiency Development Fund (CEED) were included in the C&I and multi-family samples and were represented proportionately in the study. A total of 6 retrofit and 11 NC/MOP projects with CEED funding were included in the sample. All of the strata had at least one CEED project, although the only CEED projects in the retrofit smallest stratum had no kW Summer savings. These projects were included in the overall realization rates. In addition, a separate analysis was conducted to calculate the RRs for these projects alone.

B. Sampling

In this evaluation, sampling was conducted only for verification of the custom C&I projects. For program years 2009 through 2011, a single sample was selected for SV and the FCM impact evaluation to leverage the DPS Evaluation Team's review of the projects during SV as preparation for the FCM evaluation.

The DPS and EVT modified the approach to the FCM sample for program years 2011 and 2012. Rather than drawing a completely independent sample of custom C&I projects for these two program years, only the projects in the largest size stratum in each of the two major program categories (new construction/market opportunity and retrofit) were evaluated and the results from the FCM impact evaluation for program year 2010 were applied to the other strata. For both of these program years, a sample was selected independently for SV.

This three-year process was started again in PY 2013, with combined SV and FCM sampling and a full FCM evaluation for all selected projects. For PY2014, the SV sample was selected independently and the size categories were defined by the energy savings (kWh) rather than the peak demand reduction (kW). All measures were grouped into two major categories according to the initiative. A summary of savings by category is provided below.

Table 3: Summary of C&I Projects

	EVT Program Reported MWh Savings	EVT Program Reported Winter Peak Savings	EVT Program Reported Summer Peak Savings
Retrofit	28,991	5,956	1,839
New Construction /MOP	19,318	2,774	2,430
Totals	48,309	8,730	4,269

As in previous years, stratified random samples were selected for the Retrofit and NC/MOP projects. The remainder of this section outlines the sampling strategies using within each initiative category.

1. Retrofit and NC/MOP Programs

The same sampling process was used for sites in both the Retrofit and NC/MOP program types. The guidelines for the SV14 sampling process for the C&I projects are listed below.

- Sampling was conducted separately for two broad program types, i.e., retrofit and MOP/new construction. Multifamily projects were included with the C&I projects.
- The primary sampling unit was the program type/site ID. All measures associated with the site were reviewed. During the review of the program data, the DPS Evaluation Team found that many site ID's had multiple projects, and sampling by site ID was adopted to allow the DPS evaluation team to consider all measures installed at the site and the potential for interactive effects among the measures.
- The primary variable for establishing the size strata was the total kWh savings
- The sample size for each broad category of projects was not designed to meet a specific confidence/precision level.
- Stratification by size was conducted, resulting in three size strata for the retrofit and four size strata the new construction/MOP projects.
- A census of the sites with the highest savings in each broad category was reviewed. Sites in the smaller size strata were randomly selected.
- Expansion weights were calculated based on the number of completed site reviews.
- The cut offs for the strata were determined according to the methodology presented in the California Evaluation Framework.
- Projects with the smallest savings which accounted for 1% of the category were removed, as they are too small to verify and have little impact on the overall savings.
- Stipulated lighting projects were removed from the sample frame.

Summary of Sites

All of the sites were separated into the two major categories of Retrofit and MOP/New Construction, based on the differing baselines used in assessing savings (previous equipment vs. code). Table 4 below shows the number of sites in each of these categories and the total savings.

Table 4: Summary of C&I and Multifamily Projects

	Projects	EVT Program Reported Savings (MWh)	Percent of EVT C&I Program Reported Savings
Retrofit	768	28,991	60%
MOP/NC	1837	19,318	40%
Totals	2,605	48,309	100%

The size cut offs for each stratum were calculated according to the methodology presented in the California Framework (Framework) based on stratified ratio estimation.⁴ Sample sizes were established based on previous experience and the time and budget constraints specific to SV14.

Using the methods described in the Framework, the number of projects selected from each stratum should be equal, with some exceptions. An example of an exception is including a census of the largest projects even if the stratum contains fewer or more projects than required for the other strata. Once the strata and the sample sizes were defined, the specific projects were selected randomly. No adjustments were made to the methodology laid out in the California Framework.

The final sample included 19 retrofit and 49 MOP/NC sites. An overview of the sample is shown below in Table 5.

Table 5: Overview of the Sample

Program	Stratum	Total Number of Sites	Sites In Sample	Sample kwh Total	Population kwh Total
Retrofit	0	562	0	0	286,273
	1	170	5	130,152	6,335,104
	2	27	5	1,586,771	9,175,106
	3	9	9	13,194,433	13,194,433
New Construction / MOP	0	822	0	0	192,776
	1	772	11	42,261	2,775,381
	2	174	11	318,042	3,841,237
	3	53	11	1,207,451	5,166,520
	4	16	16	7,342,420	7,342,420
Totals		2,605	68	23,821,529	48,309,249

The distribution of all sites in terms of size is presented below in

⁴ 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.

Table 6. This analysis shows that sites vary in size from 0 to 2,461 MWh.

Table 6: Distribution of Sample by Size

Program	Stratum	Total Number of Sites	Sites In Sample	Minimum kWh	Maximum kWh	Mean kWh
Retrofit	0	562	0	0	5,748	869
	1	170	5	6,062	130,796	37,265
	2	27	5	166,202	695,090	339,819
	3	9	9	719,296	2,461,281	1,466,048
NC/MOP	0	822	0	0	949	493
	1	772	11	949	12,244	3,595
	2	174	11	12,254	49,359	22,076
	3	53	11	49,656	248,059	97,482
	4	16	16	269,793	1,149,151	458,901

Due to the distribution of projects in the PY14 sample, the number of strata in the retrofit and NC/MOP categories differs. For the NC/MOP projects, four strata were used because the projects are fairly evenly distributed by size and this strategy resulted in a manageable sample size and diversity of projects in the census stratum. Due to a large number of, and high savings from, snowmaking projects in the retrofit programs, the census stratum was almost entirely comprised of snowmaking projects when the sample frame was divided into four strata. Reducing the number of strata to three resulted in a more diverse group of census projects.

To understand the degree to which the measure mix of the selected sample matched the measure mix of the population (all C&I and Multifamily sites), the DPS Evaluation Team analyzed the distribution of savings by end use. Results are presented below in Table 7. The top stratum (the largest sites in terms of EVT claimed savings) was removed from this analysis, as all of these projects were reviewed. Thus, the percentage of savings reflects only the lower tiers (strata 1 and 2 for retrofit and 1 through 3 for NC/MOP). This analysis shows that the measures in the sample are reasonably well distributed in comparison to the population.

Table 7: Comparison of Sample and Population Claimed Savings by End Use

End Use	Percentage of EVT Claimed kWh Savings			
	Retrofit		MOP/NC	
	Sample	Population	Sample	Population
HVAC	15%	6%	17%	18%
Lighting	26%	26%	46%	47%
Industrial Processes	17%	11%	11%	11%
Other	34%	40%	14%	8%

The expansion weights were developed based on the number of sites in the sample and in the population, by broad program category and by size stratum. The expansion weights are given in Table 9 below.

Funding source was not a variable that directly influenced the sampling strategy. However, the DPS has expressed an interest in understanding what portion of the savings are paid with funding from the Community Energy and Efficiency Development Fund (CEED). As can be seen in Table 8, the ratio of savings associated with measures funded through CEED in the sample is similar to that of the population.

Table 8: Percentage of Savings with CEED Funding

Project Category	Stratum	% Sample with CEED Funding	% of Population with CEED Funding
Retrofit	1	40%	42%
	2	36%	38%
	3	25%	25%
NC/MOP	1	23%	34%
	2	17%	28%
	3	22%	25%
	4	20%	20%

The representation of projects in EVT’s program tracks was reviewed to assess whether the sample covered a variety of project types. The sample includes projects from all tracks with the exception of two which account for less than 2% of the total savings.

Table 9: Expansion Weights by Stratum

Program	Size Stratum	Total Number of Sites	Sites in Sample	Expansion Weight
Retrofit	1	170	5	34.00
	2	27	5	5.40
	3	9	9	1.00
NC/MOP	1	772	11	70.18
	2	174	11	15.82
	3	53	11	4.82
	4	16	16	1.00

C. Calculation of the Realization Rates

The realization rates were calculated for each of the components described above and then applied to the whole portfolio based on the relative contribution of each component to the total portfolio savings. The calculation of the realization rate for each portfolio category is discussed below.

1. Commercial and Industrial (C&I) and Multifamily Sites (both Retrofit and New Construction/MOP)

The realization rate (RR) is the ratio of verified energy savings to the program's reported savings. The RR represents the percentage of program-estimated savings that is actually achieved based on the results of the evaluation M&V analysis. The RR was calculated as follows:

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

where,

b is the realization rate (ratio estimator)

i represents the site number

n is the total number of verified sites in the sample

w_i is the expansion weight

y_i is the verified savings for site i

x_i is the original claimed savings for site i

The basis for these calculations and the method for calculating the variance are provided in *The California Evaluation Framework*.⁵

2. C&I Upstream Projects

The realization rate was calculated by comparing the program report savings to the verified values calculated using TRM assumptions. For the Smartlight initiative, the in-service rate (ISR) from the phone survey conducted by the DPS evaluation team for the FCM impact evaluation was applied.⁶

3. C&I Stipulated Lighting

Adjustments were made based on the results of a telephone survey completed as part of the FCM impact evaluation. The realization rate was calculated by comparing the adjusted savings to the program reported savings.⁷

4. Residential Efficient Products

The realization rate was calculated by comparing the program report savings to the verified values calculated using TRM assumptions.

⁵ 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, 327 to 339 and 361 to 384.

⁶ Report prepared for the Vermont Department of Public Service. Included in appendix of FCM13 report.

⁷ Verification of Efficiency Vermont's Stipulated Lighting Portfolio for the ISO-NE Forward Capacity Market for the Vermont Department of Public Service. March, 2015.

5. Residential Retrofit/Low Income Single Family (LISF)

Savings associated with the Home Performance with ENERGY STAR® Program were not adjusted as a global adjustment was made by EVT prior to finalizing the PY2013 savings claim. The realization rate (86% for electricity and 60% for unregulated fuels) found by the recently completed impact evaluation study of that program was applied to all projects in this program. In addition, the program reported savings from the efficiency kits distributed through the Residential Retrofit Program were adjusted. Calculation of the adjusted RR was thus completed as follows:

$$b = \frac{1.00 \times hp + nonhp + \Delta rx}{hp + nonhp}$$

where

b is the realization rate (ratio estimator)

hp is the total EVT claimed Home Performance savings

nonhp is the remainder of total EVT claimed savings in the LISF category

Δrx is the total change in savings from correcting the ISR for the efficiency kits

As EVT had already made the 86% adjustment, the HPwES savings were not reduced further by the DPS.

6. Residential New Construction (RNC)

The RNC program is the smallest, with less than 1% of EVT's total program reported savings. Savings were verified by comparing the claimed savings to the TRM. The RR reflects the adjustments to all measures with discrepancies.

III. Site-Specific Adjustments

As discussed above, a sample of C&I custom sites was selected for more detailed review, and the results of this analysis were applied to the entire population. This section provides an overview of these site-specific adjustments.

A. Commercial & Industrial and Multifamily Sites

The random sample consisted of 68 Commercial and Industrial (C&I) and multifamily sites covering the range of EVT initiatives in those sectors. The Department's adjustments are based on 48 of the selected sites, i.e., issues were found with the savings claimed in over half of the selected sites. Some adjustments were relatively small in magnitude.

Table 10: Summary of Sites with Adjustments

	Total # of Sites	# of Sites in Sample	# of Sites with Site-Specific Adjustments	# Sites with kWh or kW Summer Adjustments >+/-5%
NC/MOP	768	49	32	32
Retrofit	1,837	19	16	12
Totals	2,605	68	48	44

Table 10 and Table 12 below, provide a brief summary of the sites in the sample where the savings were adjusted and either the energy or the summer peak savings were revised by 5% or more. Realization rates by site as well as the size stratum and reason for adjustment are provided in Table 10 for C&I and multifamily retrofit projects. Table 11 provides the same information for the C&I New Construction and Market Opportunity projects in the sample. A detailed report for each site with an adjustment is attached in Appendix A.

CEED projects are italicized in the lists below. An analysis of the results showed that the realization rates for CEED funded projects and measures were not statistically different than the RR's for the sample as a whole.

Table 11: Realization Rates for C&I and Multifamily Retrofit Sites

DPSEvalID	Title	Size	RR kWh	RR kWWin	RR kWSum	Reason for Adjustment
6581371	WWTF Process Audit	1	0.92	0.38	0.86	Motor timer control method required adjustment, VFD commissioning factor adjusted, design assistance savings removed
290521	P4P CAS Audit	3	0.65	0.67	0.69	VFD and OS commissioning factor adjusted, compressed air method required adjustment, air curtain and compressor inputs required adjustment
12161	BROC-4-14-MF	1	0.91	0.96	0.91	Key inputs adjusted to match TRM
20481	Chiller Optimization	2	1.00	N/A	1.14	Chiller method adjusted using temperature data
3268591	Lighting	1	0.99	0.98	0.95	Lighting wattage corrected, OS savings factor adjusted, site specific hours of operation used.
22221	CAS P4P Audit	3	0.97	0.90	0.90	<i>Adjusted to match analysis, compressed air savings removed based on production change</i>
16981	Snowmaking 2014	3	0.73	0.73	N/A	<i>Modifications to mountain specific analysis</i>
2798421	WWTF Process Audit	2	0.98	0.80	0.77	<i>Baseline adjusted to account for interactive effects, annual hours required adjustment</i>
355921	Chilled Water RCx	3	0.50	0.77	1.15	Method adjusted to use interval data, cooling bonus and OS savings factor required adjustment, calculation error in chiller and AC controls
2913131	2014 - 2015 Snowmaking Upgrades	3	0.91	0.91	N/A	Adjusted based on water available for 2014 project
5079381	<i>Snowmaking Upgrades – 2014</i>	3	0.60	0.60	N/A	<i>Modifications to the mountain specific analysis</i>
3351861	2014 - 2015 Snowmaking Upgrades	3	0.60	0.60	N/A	Adjusted based on water available for 2014 project

Table 12: Realization Rates for C&I and Multifamily New Construction and MOP Sites

DPSEvalID	Title	Size	RR kWh	RR kWin	RR kWSum	Reason for Adjustment
15262	<i>P4P CAS Audit</i>	4	1.00	0.95	0.95	<i>Baseline mischaracterization and VFD calculation error.</i>
5945752	<i>Rx Lighting 1</i>	2	0.64	0.65	0.65	<i>Exterior LED methodology required adjustment.</i>
17262	CNG Conversion	4	0.74	0.79	0.77	Revised methodology to only heat flowing gas.
5801952	Rx Lighting 1	2	0.86	0.88	0.88	Exterior LED methodology required adjustment and annual hours adjustment.
2003352	New Construction	3	0.40	0.37	0.40	Method required adjustment. Key refrigeration inputs required adjustment.
5782802	New Construction	3	0.86	0.56	1.03	LPD cooling bonus and OS savings factor adjusted. VFD methodology adjusted based on meter data.
7169502	Rx Lighting 1	2	0.44	0.45	0.31	Exterior LED methodology required adjustment and OS savings factor adjusted to TRM.
3910362	Sealer Vacuum Pumps	4	0.77	0.63	0.63	Commissioning factor not taken into account for all measures. Baseline and efficient case mischaracterization.
2158632	Various Measures	4	0.84	0.65	0.73	Baseline and efficient case mischaracterized. Key inputs required adjustments.
5649032	Various Measures	4	0.88	0.95	0.95	Baseline and efficient case mischaracterized. Key inputs required adjustments based on metered data.
7491722	New Construction	3	0.93	0.95	0.98	Insufficient documentation for thermal measures. OS savings factor adjusted and exterior LED method required adjustment.
7520262	<i>Rx Lighting 3</i>	1	0.69	0.71	0.70	<i>Exterior LED methodology required adjustment.</i>
7289402	New Construction	3	0.80	0.85	0.85	Baseline for ECM motors and OS savings factor adjusted. Refrigeration method adjusted to the TRM. LPD cooling bonus adjusted.
3283662	New Construction	3	0.92	0.71	0.72	Method required adjustment. Baseline and efficient case mischaracterization. Lighting waste heat factor and OS savings adjusted.
7291042	Fleet Vehicle Timer	1	0.25	0.57	N/A	Calculation inputs adjusted to match site specific information from BEP form.
746852	HVAC & Lighting	1	0.96	0.57	0.42	Lighting efficient case mischaracterized. Heat pump inputs adjusted to match unit submittal and savings method updated to use unit heating capacity.

DPSEvalID	Title	Size	RR kWh	RR kWWin	RR kWSum	Reason for Adjustment
3109932	Ventilation	2	0.98	1.05	1.00	Exterior LED methodology required adjustment. CF and annual hours adjusted based on photocell dusk to dawn operation.
7171692	Rx Refrigeration 3	1	1.07	1.21	1.21	Calculation error for efficient blower fans.
7129392	New Construction	2	0.87	0.93	1.10	OS savings factor adjusted to TRM. LPD fixture quantity adjusted based on lighting plans.
7291052	Rx Lighting 2	1	0.71	0.71	0.70	Exterior LED methodology required adjustment.
5412232	Federal RTU Pilot	4	1.02	0.06	0.54	Adjusted HVAC savings calculator's TMY hours, tonnage, cfm and used SEER/IEER for energy and EER for demand savings.
7048862	New Construction	4	0.86	0.93	0.89	OS savings and waste heat factor adjusted. AC units capacity adjusted to site specific. Baseline and efficient case mischaracterization.
2010012	Major Renovation DI	3	0.97	0.99	0.13	LPD baseline adjusted per 2011 Vermont energy code.
874002	Engine Block Heater Controls	4	1.00	0.95	0.95	Exterior LED methodology required adjustment. Change in VFD quantity in operation.
7200222	New Construction	3	1.00	1.00	0.90	Applied a more appropriate heat pump load shape, heating capacity for winter savings and EER.
3249822	Rx Lighting 2	1	0.62	0.63	0.62	Exterior LED methodology required adjustment.
7693862	Market Deli Building	2	0.53	0.43	0.54	OS savings factor adjusted to TRM. Efficient case mischaracterized for refrigeration equipment.
7147552	New Construction	4	0.97	0.88	0.73	ECM motors/AC system baseline mischaracterized. Calculation error. Refrigeration CF adjusted to site specific.
6185442	Multi-Family Redevelopment	4	0.74	0.53	0.61	Baseline mischaracterization. Method required adjustment. OS factor and LPD cooling bonus factor adjusted. VSD savings on pumps appeared to be redundant.
7577212	Fit-Up	3	0.76	0.54	0.50	Adjustment to 2011 CBED. LPD space mischaracterization. TRM furnace motor characterization incorrectly applied to pump fan motors.
5985312	Expansion & Renovation	4	0.96	0.92	0.92	OS savings factor adjusted to TRM. Bonus factor for cooler fan custom calculation added. EER adjusted.
6242312	New Construction	3	0.98	0.99	0.94	OS savings factor adjusted to TRM and insufficient documentation for thermal measures.

IV. Adjustments Due to Other Verification and QC Activities

Adjustments were also made based on other verification and QC activities, as described below:

- Comparison of EVT claimed savings to TRM assumptions at the measure level
- External evaluations of EVT's programs
- Additional evaluation activities conducted as part of the FCM impact evaluation
- EVT's QC activities

In comparison to the C&I custom site analysis, the realization rate was calculated using all of the relevant measures in the SV13 portfolio rather than selecting a sample and applying the realization rate from that sample to the program savings as a whole. In some cases, the adjustments are based on other evaluation or QC studies, which may have included sampling. However, no additional sampling was conducted as part of this verification.

The components of EVT's portfolio that were verified using these methods are the following: stipulated lighting, upstream initiatives, and all of the residential initiatives.

A. Stipulated Lighting

The DPS Evaluation Team recently completed a separate evaluation to reduce the uncertainty of the savings estimates for the stipulated lighting measures in EVT's portfolio.⁸ The following three assumptions were identified as important to improving the savings estimates for stipulated lighting and the study was designed to improve the validity of these assumptions:

1. The in service rate (ISR), defined as the percentage of efficient lighting products claimed that are actually installed
2. The reduction in kW load due to the installation of the efficient lighting
3. The stipulated load profile used in the savings calculation

The study included two primary research activities, i.e., a telephone survey (for Retrofit/MOP projects only) and on-site inspections. Site visits were completed for a subset of the telephone survey population. This information was combined with secondary data, such as manufacturers' specifications, and with EVT's detailed project-level data to estimate the evaluated peak kW reduction at each site. The results of this evaluation are presented in the following three tables. The first identifies the evaluation in-service rate and the second and third provide the evaluated energy (kW) and peak demand (kW) reduction as a percentage of the EVT program reported kW reduction.

⁸ The realization rate is the ratio of the evaluated savings to the claimed savings.

Table 13: In-Service Rates for Stipulated Lighting Projects

Initiative	Projects in Sample	Quantity of Program Reported Lighting Products	Evaluated In-Service Rate	Relative Precision	EVT In-Service Rate
Prescriptive MOP	36	1,208	0.751	13%	0.90
Custom Retrofit	37	1,693	0.912	5%	1.00
Total	73	2,901	0.854a	5%a	0.96

a The overall ISR's and relative precision were weighted based on the percent of the kW coincident peak savings in each initiative.

Table 14: Program Reported and DPS Evaluated Energy Savings for Stipulated Lighting Projects

Initiative	Program Reported Annual kWh Savings	DPS Evaluated kWh Savings	RR
Prescriptive MOP	3,896,793	3,592,188	92%
Custom Retrofit	6,280,107	5,420,312	86%
Custom NC	988,727	1,168,353	118%
Total	11,165,627	10,180,853	91%

Table 15: Program Reported and DPS Evaluated Peak kW Reduction for Stipulated Lighting Projects

	Program Reported kW Reduction	Evaluated kW Reduction	Realization Rate	Relative Precision
Winter Peak				
Prescriptive	530	466	88%	6%
Custom Retrofit	942	828	88%	7%
New Construction	148	136	92%	8%
Total	1620	1429	88%	3%
Summer Peak				
Prescriptive	812	710	87%	9%
Custom Retrofit	1405	1175	84%	6%
New Construction	245	226	92%	9%
Total	2462	2110	86%	3%

B. Upstream Initiatives

The Upstream Initiatives include the Smartlight and HVAC Equipment Replacement Programs.

1. Smartlight

As part of the FCM13 evaluation, the DPS evaluation team conducted a comprehensive evaluation of lighting sold through the Smartlight program. The purpose of this evaluation was to verify the in-service rate and other inputs used to calculate savings for these measures. A paper review was completed in conjunction with site visits for the commercial customers and a telephone survey for the residential customers. A comparison of the ISR used by EVT and the evaluated ISR is provided below.

Table 16: Smartlight ISR Adjustment

Measure Type	TRM	Evaluated
LED – Residential	0.870	0.760
LED – Commercial	0.898	0.799
Reduced Wattage T8	0.900	
Reduced Wattage T5		
Reduced Wattage MH		
Reduced Wattage CFL		

2. HVAC Equipment Replacement

Adjustments were not made to the HVAC equipment replacement measures. EVT has improved its data collection system to include the serial number for the installed equipment. Only small adjustments to the measures were made as part of FCM13, indicating that many of the issues from previous years have been successfully addressed. As the HVAC is only 0.4% of the portfolio and savings estimations have shown great improvement, any adjustments would be likely to be small and have an infinitesimal impact on the overall portfolio as a whole. Therefore, a 100% realization rate was applied to this group.

C. Residential Initiatives

The DPS concentrated its review on the major components of EVT's portfolio. The Efficient Products Program accounts for 93% of EVT's claimed energy savings in the residential sector, with all of the remaining initiatives (Low Income Single Family, Home Performance, Residential New Construction, and Upstream) accounting for the remaining 7% (approximately 3% of total portfolio savings). Thus, the Department's review focused most intensively on the Efficient Product Program.

1. Efficient Products Program

Only a few discrepancies were found between the TRM values and the entries in EVT's database. The measures and per unit savings by measure can be found in Table 17. EVT did not apply the ISR adjustment correctly for the LED bulbs. Upon adjusting these measures to match the TRM values, the total energy savings decreased by 20.702 MWh and the kW savings for winter and summer decreased by 2.13 kW and 4.23 kW, respectively.

Table 17: Efficient Products Energy and Demand Adjustments

Measure ID	Measure Description	EVT Per Unit			TRM per Unit		
		kWh	kW Winter	kW Summer	kWh	kW Winter	kW Summer
LBLLEDSC	LED - SSL Directionals	59.4	0.006	0.012	50.9	0.015	0.005
LBLLEDSC	LED - SSL Directionals	112.3	0.012	0.023	96.3	0.029	0.010
LBLLEDSC	LED - SSL Directionals	101.0	0.010	0.021	86.6	0.026	0.009
LBLLEDSC	LED - SSL Directionals	66.2	0.007	0.014	56.8	0.017	0.006

2. Home Performance Program

Prior to SV14, members of the DPS Evaluation Team were engaged to complete a separate impact evaluation of EVT’s Home Performance with ENERGY STAR® Program.⁹ This evaluation, the first comprehensive impact evaluation of EVT's residential retrofit programs, covered the 2008-2010 period and was intended to provide a benchmark for future program and evaluation activities. The evaluation used billing analysis and a participant survey to establish first year gross energy electric and unregulated fossil fuel savings and estimate the savings realization rate, i.e., the ratio of the evaluated gross savings to the HPwES program reported gross savings. Verified unregulated fossil fuel savings were estimated based on annualized consumption. All results were weather normalized as appropriate.

This rigorous impact evaluation found a realization rate of 86% +/- 12% for electric savings and 51% +/- 13% for fossil fuels. Because this impact evaluation represents a more in-depth evaluation of such projects than the short time frame of SV would permit, the Home Performance with ENERGY STAR® savings should reflect these impact evaluation results.

EVT made a number of improvements to program performance in 2012. Although it is not possible to quantify the results of these changes without further impact evaluation, the DPS and EVT have agreed to apply a realization rate of 60% for unregulated fuels and 86% for electric in acknowledgement of EVT’s efforts to improve the program savings. EVT applied these realization rates to PY 2013 projects prior to finalizing the savings claim. Therefore, no further adjustments were required.

3. Residential Retrofit/Low Income Single Family

⁹ "Efficiency Vermont's Home Performance with ENERGY STAR® Program Impact Evaluation Final Report," prepared for Vermont Department of Public Service by West Hill Energy and Computing with GDS Associates, June 2013

For prescriptive measures, several minor discrepancies were found between EVT’s tracking database and values prescribed in the TRM. The measures and per unit savings by measure can be found in Table 18. Upon adjusting these measures to match the TRM values, the total energy savings decreased by 5.146 MWh and the kW savings for winter and summer decreased by 0.73 kW and 1.13 kW, respectively.

Table 18: Residential Retrofit/Low Income Single Family

Measure ID	Measure Description	EVT Per Unit			TRM per Unit		
		kWh	kW Winter	kW Summer	kWh	kW Winter	kW Summer
LBLCFBLB	Compact fluorescent screw-base bulb	48.6	0.01024	0.00053	20.5	0.01024	0.00053
LBLCFSPD	Compact Fluorescent - Specialty Bulb - Direct Install	57.7	0.01214	0.00063	24.4	0.01214	0.00063
LBLCFSPD	Compact Fluorescent - Specialty Bulb - Direct Install	82.3	0.01733	0.00090	34.8	0.01733	0.00090
OTFYNGAS	Fuel switch, dryer natural gas	977.0	0.24400	0.18300	977.0	4.8000	0.21100

D. Comparison to Other Evaluation Activities

Since program years 2007/2008, the DPS has been conducting two evaluations of EVT’s savings: SV and the FCM impact evaluation. The SV process is started mid-March and completed in early July of the same year (less than four months from start to completion). The FCM impact evaluation is started in May and completed in July of the following year (about 15 months in duration). Due to the time line and scope of work, SV is a paper review process. In contrast, the FCM evaluation is a more rigorous impact evaluation that includes direct measurement for the C&I custom projects.

Comparing the realization rates for these two types of verification activities provides some insights into the potential impacts of relying exclusively on a paper verification for SV. However, the comparison can only be conducted for winter and summer peak kW, as kWh is not required for the FCM impact evaluation and evaluators have not been consistently verifying the kWh for all projects in the sample. Consequently, the results shown in the table below may not be directly applicable to energy savings.

For the peak kW savings, the realization rates from SV and from FCM were compared for program years 2010 through 2013. For the FCM evaluation, all custom C&I projects were evaluated for PY 2010, but only the census strata of large projects were verified for PYs 2011 and 2012. In the table below, the realization rates for PY 2011 and 2012 include only the census strata in order to be able to make a more reliable comparison.

Table 19: Comparison of Realization Rates from SV and FCM Evaluations

	Winter kW Realization Rate			Summer kW Realization Rate		
	SV	FCM	Difference	SV	FCM	Difference
PY 2013						
Retrofit	97%	71%	26%	98%	76%	22%
NC/MOP	93%	77%	16%	100%	80%	20%
PY 2012						
Retrofit	82%	84%	-2%	86%	77%	9%
NC/MOP	89%	58%	31%	83%	72%	11%
PY 2011						
Retrofit	59%	37%	22%	87%	70%	17%
NC/MOP	76%	66%	10%	77%	60%	17%
PY 2010						
Retrofit	90%	71%	19%	93%	69%	24%
NC/MOP	89%	52%	37%	95%	69%	26%

This analysis indicates that the FCM impact evaluation consistently results in lower realization rates for the kW reduction. The SV realization rate was lower than the FCM in only one of the sixteen comparisons, and the difference was quite small (2%). In all other cases, the FCM realization rate was lower, ranging from 9% to 37% lower.

This result is not unexpected. Paper reviews are necessarily limited in scope and the evaluators do not have the opportunity to go on site to see how the efficient equipment is performing. In a number of cases, contacting the participant after the completion of the SV process had revealed that the equipment was no longer in service. These situations are discouraging and EVT has no control over the actions of their participants. However, a realistic estimate of the actual savings achieved by the programs need to take into account the actual operating conditions of the equipment.

V. Ongoing Issues to be Addressed on a Prospective Basis

A. Improved Documentation

Inadequate documentation makes the verification process more difficult and has been identified in past verification reports as problematic. At a minimum, either copies of invoices or inspections should be provided for the installed equipment. As part of past evaluations, this documentation was not consistently provided. As a result, EVT was instructed by the Vermont Public Service Board (VPSB) to improve the documentation of projects.

The project documentation overall has improved. Almost all of the projects reviewed for PY14 either included copies of invoices or an inspection form. In the few cases where this information was missing, the site was contacted and the information was gathered.

There are still areas where confidence in savings could be greatly increased with some additional documentation. Complex industrial process upgrades can require additional documentation, above the minimum of invoices and basic installation inspections for savings to be verifiable. Post installation operating conditions can greatly influence the accuracy of the savings estimate and therefore verification of these conditions is important. For example, in order to achieve the EVT estimated savings as part of one of the PY14 projects, the system needed to be operated using a specific floating head pressure control strategy. Documentation that the set points had been achieved was not provided. As a result it is difficult to say whether savings are being achieved as estimated. The DPS requests that EVT provide documentation for post installation operational conditions in order to verify that savings are being achieved when appropriate.

B. Verification of Savings Claimed for Upstream Measures

EVT has increasingly been using a strategy of providing incentives for efficient technology at the market distributor level. Providing incentives to distributors is a potentially effective strategy of increasing the adoption of efficient technology in a cost effective manner. Unfortunately, this added layer makes it substantially more difficult to verify the savings.

In the past, the DPS identified the inconsistent collection of information about the eventual installation and use of the product as problematic. As part of PY14, EVT started collecting more information about where the lighting is being installed and more comprehensive contact information including telephone numbers. In addition to collecting more information, the data is being collected in a more consistent format which allows for easier interpretation. This additional information has increased the ease with which these programs can be verified.

However, issues associated with having distributors serve as an intermediary between EVT and the customers still persist. In order to gather data accurately, the distributor must be able to discern whether the product is being purchased directly by the customer and installed in the reported location, purchased and installed elsewhere, or purchased and put in storage for future replacement of existing lamps. While scheduling site visits for recent lighting studies, it became clear that there was variability as to how accurately the distributors were able to characterize the purchase. The DPS encourages EVT to work closely with distributors to ensure that the distributor staff collecting the information is aware of the nuances of how to collect this information.

C. Overreliance on the Technical Reference Manual

EVT's savings estimates rely heavily on assumptions documented in the Vermont Technical Reference Manual. It is appropriate to use these deemed savings for prescriptive and rebated measures where actual use of a product, such as a CFL, may not be known, and market studies provide suitable information concerning average use. Methodologies for many custom applications are now also documented in the TRM. While this provides a helpful reference for common values and assumptions, DPS evaluators note a tendency to cite 'TRM defaults' as justification even on custom project measures where site-specific data should be available. Savings estimates should reflect the best available information about the Vermont market and how specific technologies can be expected to operate in VT homes and businesses.

Assumptions need to have a real world basis and some, such as hours of use, vary wide from site to site. Custom projects involve a high level of customer engagement; as such it is expected EVT has the ability to obtain the site-specific information necessary to make savings estimates as accurate as possible. Future evaluation efforts should continue to test assumptions in the TRM.

D. TRM Lighting Categories

In the past, the DPS identified the LED lighting measure characterizations in the TRM as problematic due to a reliance on grouping lighting measures into wattage categories to estimate savings for a range of lamp wattages. All lamps within a bin were assumed to have the same savings and implicitly there is an assumption that the baseline technology has the same efficacy. This proves particularly problematic when the span of wattages is sufficiently wide that a technology threshold is crossed and as a result there is likely to be an increase in efficacy in the market baseline. If the baseline is unrealistically low for a portion of the measures in the category, the savings will be overestimated.

In response to this concern, EVT has been working to revise the LED measure characterizations. The revised characterizations group lighting by technology as well as lumen output. This is a more effective strategy as lighting is selected based on lumen output and variations in wattages for both the efficient and baseline can be accounted for when calculating a deemed value.

Upon completion of the 2014 TRM, EVT had not yet revised the measure characterizations for all of the LED lighting. For projects in the sample where savings were estimated using measure characterization that had not been updated, the DPS selected a custom baseline based on lumen output and photometric distribution of the product. EVT should continue to update these measure characterizations so that adjustments are not required in the future.

E. Residential New Construction Custom Measures

The savings claimed for these projects are calculated in reference to a user-defined base home RemRate model. A total of 327 projects were completed in 2014, with total claimed energy, winter peak, summer peak, and other resource savings of 449,766 kWh, 87.655 kW, 46.706 kW, and 8,397.9 MMBtu, respectively.

DPS evaluators were surprised to find that the energy savings claimed for a number of these homes were in excess of a typical home's annual energy use. It was not possible to identify the specific measures accounting for the savings from the EVT's central database. To try to determine where the savings were occurring, the DPS evaluation team reviewed billing data for the 15 projects that

accounted for 50% of the energy savings. Among these 15 projects, five (33%) had extensive billing covering the pre-installation period, suggesting whole-home gut rehab projects rather than new construction. Several homes showed a pattern of usage that suggests heat pump installation. Where existing homes are subject to gut renovations and the heating system changed from fossil fuel to electric, the DPS evaluation team feels the project would more accurately be characterized as a fuel switch. The appropriate baseline for these projects should be a subject of further discussion in TAG.

The DPS did not make adjustments for these issues as part of PY14 but will be conducting further investigation into whether these measure characterizations are accurate. The DPS requests EVT's cooperation in requests for additional details about the measures installed as part of this program.

F. Upstream solar hot water pilot

EVT provided incentives for the installation of 15 solar hot water heaters, flagged in project documentation as a pilot, during 2014. Prescriptive savings for this measure were developed and outlined in PIP #108, effective July 15, 2014. The savings claimed by EVT were reviewed and found to be in alignment with the prescriptive values. Comparing a sample of pre- and post-installation billing data for homes with electric DHW, however, it appears there is substantial variation in the savings being achieved by this measure. The DPS evaluation team recommends further analysis of the impact of this measure before scaling up installation and setting a date for future review of prescriptive savings assumptions in TAG.

G. Faulty CAT assumptions and input values

During the course of reviewing projects, several recurring issues were traced back to faulty assumptions or default values that are coded into the most recent version of the Comprehensive Analysis Tool (CAT) used by EVT to estimate measure savings for custom projects. The following issues were addressed on a project-by-project basis by the DPS evaluation team, but should be addressed globally when EVT next updates the CAT:

- Lighting controls savings factors (SVG) don't match the current TRM assumptions. The CAT tool contains default savings assumptions higher than the most recent deemed values agreed upon in the TRM, as shown in
- When a user selects a heat pump load profile plus another load profile, the CAT overestimates demand savings. Because heat pump load profiles include both heating and cooling, the CAT erroneously assigns winter cooling coincidence factors and summer heating coincidence factors. These are then averaged with the winter heating and summer cooling coincidence factors, producing inflated peak period savings claims. Note that this issue is avoided if only one load profile is assigned to the heat pump.

- Table 20 below.
- The calculation methodology used by the CAT to estimate heat pump savings differs from that outlined in the TRM in two respects. First, cooling capacity is used to calculate both heating and cooling savings. This is inaccurate as some heat pumps have heating capacities different than their rated cooling capacities. Second, the heat pump COP is used to calculate energy savings regardless of the size of the unit, rather than using HSPF as outlined in the TRM methodology. This is inaccurate as it fails to account for the part-load performance of the heat pumps, something taken into account by use of the HSPF.
- When a user selects a heat pump load profile plus another load profile, the CAT overestimates demand savings. Because heat pump load profiles include both heating and cooling, the CAT erroneously assigns winter cooling coincidence factors and summer heating coincidence factors. These are then averaged with the winter heating and summer cooling coincidence factors, producing inflated peak period savings claims. Note that this issue is avoided if only one load profile is assigned to the heat pump.

Table 20: Lighting Controls Savings Factor Discrepancy

Measure Description	Lighting Controls Percent Reduction	TRM Value	CAT Savings Overstatement
Remote-mounted occupancy sensor	30%	24%	6%
Wall-mounted occupancy sensor	30%	24%	6%
Fixture-mounted occupancy sensor	30%	24%	6%
Remote-mounted High-Bay Occupancy Sensor	30%	24%	6%
Fixture-mounted High-Bay Occupancy Sensor	30%	24%	6%
Fixture-mounted daylight sensor - with Operational testing	30%	28%	2%
Fixture-mounted daylight sensor - without Operational testing	30%	28%	2%
Remote-mounted daylight sensor - with Operational testing	30%	28%	2%
Remote-mounted daylight sensor - without Operational testing	30%	28%	2%
Refrigerator Case Controls	40%	40%	0%
Freezer Case Controls	40%	40%	0%
Exterior Occupancy Sensors - on/off	45%	41%	4%

H. Brushless Permanent Magnet (BLPM) Circulator Pump

In 2014, Efficiency Vermont performed a study to better understand run hours of high performance circular pumps. During the review of prescriptive residential measures, it was identified that the annual hours of operation assumption of 1,973 hours was problematic. EVT determined pump run time based on metered data and cumulative HDD base 65°F experienced by each site. The results for linear modeling were run hours as the dependent and HDD base 65°F as the independent variable. Following the TAG agreement, the DPS recommended that HDD be calculated at base 60°F as this temperature tends to reflect residential heating loads better than 65°F. The lower base HDD recognizes that heating systems do not tend to run during short periods of weather when the temperature difference is not large between the interior and exterior. There is a lag effect that needs to be accounted for as well as internal gains and other factors.

During TAG review, the DPS recommended forcing the intercept for the HDD versus runtime to zero because it is unclear what a non-zero intercept would represent in the correlation between runtime and HDD for pumps serving heating needs. EVT did not apply this adjustment in the run time analysis for first phase metered pumps.

EVT used a draft ISR of 80% based on the In-Service Rate (ISR) Study performed for the Upstream High Performance Circulator Pump (HPCP) program. The Vermont Department of Public Service agreed on an in-service rate of 90% for the circulator pumps and applied this ISR during the residential prescriptive review. The methodology used by EVT to obtain a final ISR value needs to be revisited.

I. Snowmaking

EVT has been working with the ski areas to improve the efficiency of the snowmaking operations for many years. These projects tend to be large with high savings. In past years, the inefficient snow guns assumed to be replaced by more efficient models were often left on the mountain and may have

been redeployed to other locations. In 2014, EVT's "Great Gun Round Up" was designed to ensure that the inefficient snow guns were taken out of service.

In aggregate, all of the snowmaking projects since 2007 were assumed to save about 35% of the total electricity used by the participating ski areas on average. Review of the ski area water, electric and snow making operational data suggests that the efficient guns are used to modify the timing of the snow making and increase the overall amount of snow. Billing records show annual variations in the usage level, but no clear declining trend since 2007. Correspondence with one of the ski area representatives clearly stated that the purpose of improving the efficiency of the snow guns is to make more snow earlier.

The limit on how much snow ski areas can make is determined by their water withdrawal permits. In some cases, the amount of water estimated to be used by the efficient snow guns in EVT's projects actually exceeds the average annual water withdrawal. This suggests that savings are being overstated for these measures, and some adjustments were made for this reason.

Overall, the Department recommends that EVT carefully review the future options for efficiency improvements at the ski areas to ensure that the claimed savings are reasonable and were not previously counted in earlier projects. It is possibly, even likely, that the efficiency resource from these types of projects has already been acquired.