

**Verification of
Efficiency Vermont's
Energy Efficiency Portfolio
for the ISO-NE
Forward Capacity Market**

**Prepared for the
Vermont Department of
Public Service**

July 14, 2015

**Prepared by
West Hill Energy and Computing, Inc.
205 Main Street
Brattleboro, VT**

**with Lexicon Energy Consulting,
Cx Associates, GDS Associates and Energy Resource Solutions**

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1 Introduction

In 2006, the Independent System Operator of the New England electric grid (ISO-NE) created a Forward Capacity Market (FCM) to ensure that the region has sufficient capacity to meet its peak demand needs. This market-based initiative allows for demand resources, including energy efficiency, to compete directly with generation resources to provide capacity. In order to participate in the market, providers of energy efficiency resources must demonstrate that their efficiency savings are verified in compliance with the ISO-NE standards established for this purpose.¹

Efficiency Vermont (EVT) and Burlington Electric Department (BED) bid their respective efficiency program portfolios into the FCM, and submitted measurement and verification (M&V) plans stating that the evaluation process in Vermont will comply with ISO-NE standards. In both evaluation plans, the Vermont Department of Public Service (Department or DPS) was charged with conducting the independent evaluation required by the ISO-NE standards.

The methods available to the Department to evaluate EVT and BED's FCM claims are defined by both the ISO-NE standards and the EVT and BED M&V plans. These standards are designed to result in a high degree of reliability for the resources purchased through the FCM and represent a rigorous level of evaluation.

West Hill Energy and Computing was retained by the Department to provide independent verification of the custom commercial and industrial (C&I) efficiency initiatives for EVT and BED within the context of the FCM. With the assistance of four engineering firms, Cx Associates, GDS Associates, Lexicon Energy Consulting and Energy Resource Solutions, West Hill Energy has implemented the FCM impact evaluation, including providing statistical analysis, site-specific M&V and overall evaluation of each efficiency portfolio.

This report describes the evaluation of EVT's program year 2013 (PY2013) FCM bid and the results of this verification process. It also provides the documentation to support the Annual Certification of Accuracy of Measurement and Verification Documents, as specified Section 14.2 in the ISO Manual (M-MVDR, Revision 4, June 1, 2012) and in Section 12-B of EVT's M&V Plan (9106 ExCap M&V Plan Update Sept 15, 2010 and 2845_FCA5_M&VPlan, 10/15/2010).

The evaluation was designed to determine the appropriate realization rates to be applied to EVT's estimated savings. When applied, the resulting savings represent EVT's verified savings. The realization rates given in this document will be used to adjust EVT's savings reported to ISO-NE for the FCM from July 1, 2015 until the completion of the next evaluation cycle.

The realization rates presented in this document were provided to Efficiency Vermont in May of 2015, and have been in use since that time. The remainder of this report is divided into three sections: methods, results and conclusions. Additional detail about the components of EVT's portfolio can be found in in EVT's 2013 Annual Report.²

¹ ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources Manual M-MVDR, Revision: 4, Effective Date: June 1, 2012, pg. INT-3

² Efficiency Vermont Annual Report 2013, November, 2014; available at www.encyvermont.com.

2 Methods

Efficiency Vermont bid its entire portfolio of energy efficiency initiatives into the FCM. Each component of EVT's portfolio was reviewed by the DPS evaluation team, with the appropriate verification approach balancing stringent precision targets with the time and budget constraints. An overview of the initiatives is provided below. The different initiatives and the verification strategy for each are summarized in Table 1.

Table 1: FCM Verification Strategy by EVT Initiative

EVT Initiative	Sampling Approach	ISO M&V Option
<i>C&I and Multifamily</i>		
Custom Retrofit	Sample selected per ISO standards	Options A through D
Custom NC/MOP	Sample selected per ISO standards	Options A through D
Stipulated Lighting	Sample selected per ISO standards	Option A
<i>Residential</i>		
Prescriptive Lighting	Prescriptive assumptions, no sampling necessary	Option A
Prescriptive HVAC	Prescriptive assumptions, no sampling necessary	Option A
Prescriptive Other eShapes	Prescriptive assumptions, no sampling necessary	Option A
Prescriptive Other non-eShapes	Prescriptive assumptions, no sampling necessary	Option A
Custom Residential	No sampling necessary	Option C
<i>Upstream Initiatives</i>		
Smartlight Program	Sample selected per ISO standards	Option A
HVAC	No sampling necessary	Option C

C&I Custom Retrofit: This category includes projects associated with EVT's retrofit initiatives in the business and multifamily sectors. Projects were sorted into five strata based on maximum peak demand savings (see **Error! Reference source not found.**, below). For stratum 1 through 4, measures using coincidence factors stipulated from the recent C&I Lighting loadshape study completed by KEMA were removed from the sample frame.³ For stratum 5, the largest projects, all measures (including those using stipulated coincidence factors) were evaluated.

C&I Custom NC/MOP: Projects associated with EVT's new construction and market opportunities initiatives in the business and multifamily sectors are covered in this component of

³ *C&I Lighting Loadshape Project FINAL Report*. Prepared for the Northeast Energy Efficiency Partnerships' Regional Evaluation, Measurement and Verification Forum by KEMA, Middletown, CT. July 19, 2011

EVT's portfolio. Verification followed the same process as described above for the C&I retrofit component of EVT's portfolio.

The smallest custom C&I projects (winter and summer peak kW of less than 0.80 kW) were excluded from the sample frame given that these projects in aggregate represented less than 1% of EVT's portfolio and would be just as costly to verify as other projects. The weighted average realization rate from the C&I Retrofit and NC/MOP components was applied these measures.

Stipulated Lighting: This component of the portfolio includes custom and prescriptive lighting measures in commercial building types covered by the 2011 C&I Lighting Loadshape study.⁴ As part of the FCM impact evaluation for PY2012, the DPS Evaluation Team conducted an evaluation of the lighting measures using coincidence factors from the KEMA study. As the coincidence factors were already established in the KEMA study, this evaluation focused on the other key inputs used to calculate savings. Three assumptions were identified as important to improving the estimated savings for stipulated lighting measures 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 projects with stipulated coincidence factors were divided into three groups: retrofit, market opportunity and new construction. This approach was adopted to address the different baselines and methods used for each of these groups. For the retrofit projects, baseline was the existing equipment prior to the installation. Standard practice is the baseline for MOP, as the Vermont energy code typically does not apply to these applications. The new construction baseline is the Vermont Commercial Building Energy Standards (CBES). Sampling was conducted separately within each of these three groups, following the guidelines laid out in the M-MVDR.

For the retrofit and MOP projects, the study included a telephone survey in January 2014 to collect key information regarding the number of efficient lighting products purchased and in use, the type of facility and the hours of operation. Site visits were completed in February and March of 2014 for a subset of the telephone survey population to verify the specifications of the installed products, ascertain the type of facility and operating hours and establish a site specific ISR. For the new construction projects, only site visits were conducted. Information obtained from the telephone surveys and site visits was combined with secondary data, such as manufacturers' specifications, and with EVT's detailed project-level data to find the evaluated peak kW reduction at each site.

The in-service rate (ISR) was estimated by comparing the actual number of fixtures found on site to the number of fixtures used to estimate EVT's program reported savings. The ISR was calculated only for the retrofit and MOP projects as new construction projects were evaluated on the basis of lighting power density (LPD).

⁴ *C&I Lighting Loadshape Project FINAL Report. Prepared for the Northeast Energy Efficiency Partnerships' Regional Evaluation, Measurement and Verification Forum by KEMA, Middletown, CT. July 19, 2011*

The reduction in kW load for retrofit and MOP projects was calculated on a fixture-by-fixture basis as the difference between baseline and efficient case wattage. The reduction in kW load for new construction projects was based on the reduction in LPD as compared to code-maximum for each space type.

In addition, the stipulated load shape for the business type applied by EVT was reviewed in the context of facility. If the load profile was found to be inappropriate, the stipulated load shape for the business type that most closely met the facility was substituted or a custom load shape was calculated based on customer reported information.

Complete details of the methods and results can be found in the final study report provided in Appendix D.⁵ As the study was a recent ISO-NE compliant evaluation of this particular component of EVT's portfolio, these realization rates were applied to the PY2013 savings claim to find PY2013 evaluated savings.

Upstream Initiatives: 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. There are two major upstream initiatives: Smartlight, which covers efficient lighting, and the heating, ventilation and air conditioning (HVAC) equipment incentive program. EVT periodically receives aggregated incentive claims from distributors and enters each as a single upstream "project." The approach to verifying each of these initiatives is discussed below.

Smartlight

In PY2013 there were 365 Smartlight "projects," accounting for the purchase of more than 166,000 efficient lamps by hundreds of end users. As part of the Smartlight program, a variety of lamps are sold by distributors to both residential and commercial end users. Different assumptions and calculations apply to each group. As a result, five analyses were completed to evaluate savings attributable to the Smartlight program:

1. Residential/Commercial Split
2. Residential End User kW Analysis
3. Free Bulb Adjustment
4. Commercial End User kW Reduction
5. Commercial Overlap Review

Data from all Smartlight projects were aggregated into one dataset, reviewed, and regrouped by end user. These end users were identified as either commercial or residential customers and different approaches were used for each.

The residential/commercial split refers to EVT's strategy of applying different savings assumptions to lighting products based on whether they were installed in residential as opposed to commercial locations. EVT's estimate of the percent of lighting products installed in residential locations was updated based on the information provided in the distributors' spreadsheets.

Savings attributable to residential end users were evaluated based on the realization rates determined from an ISO-NE compliant survey of residential participants in the PY2012

⁵ West Hill Energy & Computing. "Verification of Efficiency Vermont's Stipulated Lighting Portfolio for the ISO-NE Forward Capacity Market." Prepared for VT DPS, March, 2015.

Smartlight program.⁶ An adjustment was made to remove two projects that claimed savings for residential end users based on free bulb giveaways at company events. As the delivery mechanism is different than other Smartlight projects, the findings of the earlier study would not be expected to apply to these lamps.

Savings attributable to commercial end users were based on site visits conducted at a sample of 27 participating businesses. Each site visit included a customer survey and visual inspection to determine the ISR. Follow up telephone surveys were carried out as needed to assess overlap between the Smartlight program and other EVT initiatives.

Complete details of the methods and results can be found in the final combined project report “Evaluation of Efficiency Vermont’s Smartlight Program for PY13” in Appendix E.

Upstream HVAC

Similar to the Smartlight program, the upstream HVAC incentive program involves the purchase of compliant high efficiency air-conditioning packaged equipment through qualified distributors and manufacturers. In PY2013, EVT reported 547 sales through the program, 125 of which were claimed under other initiatives and removed from the upstream HVAC savings claim to avoid double-counting.

A comprehensive review of the information provided by the distributors, including model numbers and efficiency ratings, was undertaken to determine total demand reduction from this initiative. The distributors’ records were reviewed to confirm systems efficiencies and remove any units that may have been counted under a different initiative. Stipulated load shapes from the 2011 C&I Unitary HVAC Load Shape Project Final Report⁷ were applied to calculate the summer peak demand savings. Winter demand savings for water source heat pumps were based on an engineering analysis, as per section 5.4.1 Engineering Calculations and Audit Results of the M-MVDR.

Complete details of the methods and results can be found in the final combined project report “Upstream HVAC Projects” in Appendix B.

Residential Prescriptive Lighting: This component represents the lighting products sold through the Efficient Products Program. The source of the coincidence factors is the RLW Analytics lighting study.⁸ A fraction of these products are assumed to be purchased by commercial establishments, which typically have air conditioning. Savings for this fraction of the lighting were calculated using coincidence factors from the KEMA C&I Load Shape study,⁹ which account for the lower cooling consumption due to reduction in internal gains from the efficient lighting.

⁶ See “Smartlights” in appendix B of West Hill Energy & Computing. “Verification of Efficiency Vermont's Energy Efficiency Portfolio for the ISO-NE Forward Capacity Market.” Prepared for VT DPS, July 2014.

⁷ *C&I Unitary HVAC Loadshape Project Final Report Version 1.1*. Prepared for the Northeast Energy Efficiency Partnerships’ Regional Evaluation, Measurement and Verification Forum by KEMA. July 2, 2011.

⁸ *Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures*. Prepared for NE State Program Working Group (SPWG) by RLW Analytics, Middletown, CT. Spring, 2007

⁹ *C&I Lighting Load Shape Project FINAL Report*. Prepared for the Regional Evaluation, Measurement and Verification Forum by KEMA Inc. July 19, 2011.

Residential Prescriptive HVAC: Efficient air conditioners are also offered through the Efficient Products initiatives. The source of the coincidence factors is the RLW Analytics residential HVAC study.¹⁰

Residential Prescriptive Other eShapes: The Efficient Products initiative also includes a range of other Energy Star appliances and electronics, such as dishwashers, clothes washers, and refrigerators. In addition, some prescriptive measures are installed through the residential custom initiatives, including hot water conservation measures and fuel switches. For these measures, the coincidence factors were developed from Itron's eShapes 8760 load profile data, based on detailed analyses of approximately 20,000 homes in the 1990's.¹¹ While the load profiles are based on older data, the extensive nature of the data collection would be extremely costly to reproduce for measures that represent about 3% of EVT's portfolio.

Residential Prescriptive Other non-eShapes: These measures include a few other miscellaneous products offered through the Efficient Products initiative (such as dehumidifiers), as well as a limited number of items installed through the residential custom initiatives, such as DHW pipe insulation and tank wraps. These coincidence factors are based on engineering estimates; they were reviewed and found to be reasonable. Similar to the eShapes discussed above, these measures constitute a small percentage of EVT's overall portfolio (approximately 5%).

2.1 C&I Initiatives

This component of the evaluation involved drawing a sample of projects, identifying the most efficient option for verifying savings in accordance with the ISO-NE M-MVDR, gathering data, and conducting the analysis. Upper level stratification was conducted of EVT's C&I portfolio. All C&I measures were grouped into 5 major initiative categories. A summary of savings by programs is provided below.

¹⁰ *Coincidence Factor Study Residential Room Air Conditioners*. Prepared for NE State Program Working Group (SPWG) by RLW Analytics, Middletown, CT. June 23, 2008

¹¹ About half of the roughly 20,000 audits were conducted on site, with the remainder based on a mail survey. Building simulations were performed based on the data collected through the audits to determine the load profiles. Overall, audits were distributed nationwide, although some states and utilities had more audit activity than others.

Table 2: Summary of C&I Projects

	Sites	EVT Program Reported MWh Savings	EVT Program Reported Winter Peak Savings	EVT Program Reported Summer Peak Savings
Retrofit	687	21,102	3,379	1,892
New Construction /MOP	1,636	19,051	3,081	1,868
Upstream	350	8,404	1,317	1,429
Stipulated Lighting	863	6,097	868	1,281
Unregulated Fuels	116	37	18	1
Totals	3652	54,690	8,663	6,470

The remainder of this section covers the sampling strategies used for each of these program categories.

2.1.1 Retrofit and NC/MOP

During the review of the program data, the DPS Evaluation Team found that many site ID's had multiple projects; sampling by site ID was adopted to allow the DPS evaluation team to consider all measures installed at the site and assess the potential for interactive effects among the measures. The same sampling process was used for sites in both the Retrofit and NC/MOP program types. The guidelines for the PY2013 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 included.
- The primary variable for establishing the size strata was the maximum of the winter and summer peak kW reduction.
- The sample size for each program category of sites was set at a level designed to exceed the minimum required to estimate savings at the 80/10 confidence/precision level at the portfolio level using an error ratio of 0.50, based on previous FCM impact evaluations. This meets the criteria as outlined in the Chapter 7, Section 2 of the ISO-NE MMVDR¹². Stratification by size was conducted, resulting in four size strata for each of the two broad program types.
- A census of the sites with the highest savings in each major 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.
- Sites with a maximum winter or summer kW reduction of 0.80 kW or lower were removed from the sampling frame, as they are too small to verify and have little impact on the overall savings.

¹² ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources Manual M-MVDR, Revision: 5, Effective Date: November 8, 2013, pg. 7-3.

- Stipulated lighting measures were removed from the sample frame, as a separate evaluation of these measures was conducted.

Differences between the PY10 and PY13 Sampling Plan

In past evaluations, the EVT project was used as the primary sampling unit. During the review of the PY2013 portfolio, it became clear that multiple EVT projects were frequently occurring at one site. In order to be able to account for interactive effects at a particular site, all projects at a site must be reviewed. Therefore, the site is a more appropriate sampling unit for PY13.

Including the upstream projects in the NC/MOP initiative category has proved problematic in past evaluations. The evaluation strategies used for these projects is different from those used for the site specific NC/MOP projects. Therefore, these projects were separated into a different initiative category for PY13 and evaluated separately.

Summary of Sites

All of the sites were separated into the two major categories: Retrofit and MOP/New Construction. This distinction was made due to the different approach to establishing the baseline (previous equipment vs. state energy code). Table 3 below shows the number of sites in each of these categories and the maximum demand savings within each stratum. The primary sampling variable was defined as the higher value of the winter or summer kW; this value is referenced as “kW max” throughout the rest of this document.

Table 3: Summary of C&I and Multifamily Projects

	Projects	EVT Program Reported kW Max Savings	Percent of EVT C&I Program Reported kW Max Savings
Retrofit	681	3,787	51%
MOP/NC	1,615	3,634	49%
Totals	2,296	7,421	100%

Sampling was conducted separately for the retrofit and MOP/NC sites. The size cut offs for each stratum were calculated according to the methodology presented in the *California Framework* (Framework)¹³. Using the methods described in the Framework, the number of projects selected from each stratum should be equal. 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 Framework.

¹³ 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.

2.1.2 Upstream Projects

Cluster sampling was used to select the sample to maximize the efficiency of completing the site visits. The distributor data included lamps installed in 142 towns in Vermont. However, towns with fewer than twenty end users were excluded due to concerns that a sufficient sample size could not be achieved. A sample of five towns (clusters) was randomly selected with a target sample size of six end users selected at random. Additional sampling information is provided in the table below.

Table 2: Site Visit Cluster Sampling

Town	End User Population	Completed Site Visits
Colchester	46	5
Williston	38	6
Essex	28	5
Center Rutland	48	5
Saint Johnsbury	20	6

2.1.3 Stipulated Lighting

Sampling was not conducted for projects in this category. The results from a stipulated lighting evaluation will be applied to all projects in this category. Additional information about the sampling strategy used for this evaluation can be found in the report.

2.1.4 Unregulated Fuels

Sampling was not conducted for these projects. Projects in this category represent less than 1% of the C&I winter demand savings and have no summer demand savings.

2.1.5 Analysis and Calculation of Realization Rates

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 project number
- n is the total number of verified projects in the sample
- w_i is the expansion weight for project i

y_i is the verified savings for project i
 x_i is the original claimed savings for project i

The basis for these calculations and the method for calculating the variance are provided in *The California Evaluation Framework*.¹⁴ The sampling weights were adjusted for non-response and the realization rates were applied to the population based on the percent of the kW peak savings in each stratum.¹⁵

2.1.6 Attrition

Of the projects in the census stratum, 14 of the 17 projects were verified. The reasons that the remaining projects were found to be unverifiable are given in Table 4 below.

Table 4: Reasons for Very Large Project Attrition

Site ID	Project Title	Reasons not Verified
1241	Smugglers Notch Resort	Fire occurred on site and as a result EVT was unable to schedule a meter deployment.
46690	Stowe Mountain Resort - Mountain Upgrades 2013	Insufficient data was gathered on site to complete the analysis.
1526	Agri-Mark	Changes at the plant between the pre- and post-installation periods made it impossible to determine the baseline for the installed measures.

The proportion of unverified savings for winter and summer kW are 7% and 2%, respectively, in comparison to the savings for all projects in the census strata. Consequently, the differences in realization rates between the verified and unverified projects would have to be quite large to have an impact on the realization rate for the overall portfolio and the three unverified projects are unlikely to introduce bias into the portfolio level results.

In addition, five projects in the lower stratum were unable to be verified due to a variety of issues. Reasons projects were unverifiable included that the participant was unresponsive to inquiries from both the department and EVT or operational difficulties at a site precluded participation in the evaluation. However, there were a sufficient number of projects verified in these randomly-selected strata to meet the required precision target.

2.2 Residential Initiatives

The residential sector savings are almost entirely prescriptive and are calculated using assumptions that have been reviewed by the DPS and included in EVT’s “Technical Reference Manual” (TRM). The TRM contains engineering algorithms for prescriptive savings developed

¹⁴ 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.

¹⁵ *Sampling: Design and Analysis*. Lohr, Sharon L. Duxbury Press, 1999, pages 268-269.

based on relevant studies and EVT data on measures installed by past program participants. Verification of these prescriptive measures involved checking that all measures used the correct assumptions and algorithms as prescribed in the TRM. As all measures were verified, no sampling was necessary.

The “residential custom” category, including EVT’s Home Performance with ENERGY STAR® Program, accounts for a very small fraction of EVT’s overall portfolio: 1.3% and 0.3% of claimed winter and summer peak savings, respectively. The realization rates from a recent, rigorous impact evaluation were applied, as discussed in more detail in section 3.3.2 Residential Custom Measures.

3 Results

The realization rates and relative precision for all components of EVT's portfolio are provided in Table 5 and Table 11. The ISO standards require sampling precision at the 80/10 confidence/precision level for the entire portfolio. The relative precision of EVT's portfolio is 6% for winter peak kW reduction and 4% for the summer peak at the 80% confidence level, exceeding the ISO requirement.

Table 5: Realization Rates and Sampling Precision for Winter Peak kW Reduction

	Original EVT Claimed Peak kW Reduction	Realization Rate	Savings as % of Total Portfolio	Relative Precision
C&I and Multifamily				
Custom Retrofit Projects	3,330	71.0%	18%	12%
Custom NC/MOP Projects	2,877	77.0%	15%	10%
Stipulated Lighting	867	88.0%	5%	6%
Smartlight	1,292	92.2%	7%	10%
Upstream HVAC	24	95.7%	0%	0%
Retrofit Not Verified	66	71.0%	0%	12%
NC/MOP Not Verified	204	77.0%	1%	10%
Residential				
Prescriptive Lighting	7,999	99.8%	43%	12%
Prescriptive Lighting w/Cooling Bonus	957	100.2%	5%	6%
Prescriptive HVAC	0	100.0%	0%	0%
Prescriptive Other eShapes ¹	628	97.5%	3%	50% ^a
Prescriptive Other non-eShapes ¹	482	98.9%	3%	0%
Totals	18,727	89.7%	100.0%	6%

¹ Home Performance with ENERGY STAR (HPwES) program savings represent a small percentage of total savings in the portfolio. Savings from this program were grouped by load profile and included in this analysis.

^a There is no information about the precision of the sample for the eShapes load profiles and 50% was used as a worst case scenario.

Table 6: Realization Rates and Sampling Precision for Summer Peak kW Reduction

	Original EVT Claimed Peak kW Reduction	Realization Rate	Savings as % of Total Portfolio	Relative Precision
C&I and Multifamily				
Custom Retrofit Projects	1,879	76.2%	16.2%	7.4%
Custom NC/MOP Projects	1,809	80.0%	15.6%	9.1%
Stipulated Lighting	1,281	86.0%	11.1%	5.3%
Smartlight	1,392	80.7%	12.0%	11.3%
Upstream HVAC	37	105.5%	0.3%	0.0%
Retrofit Not Verified	13	76.2%	0.1%	7.4%
NC/MOP Not Verified	59	80.0%	0.5%	9.1%
Residential				
Prescriptive Lighting	2,198	99.5%	19.0%	12.4%
Prescriptive Lighting w/Cooling Bonus	1,897	100.0%	16.4%	5.3%
Prescriptive HVAC	33	14.4%	0.3%	10.4%
Prescriptive Other eShapes ¹	370	98.8%	3.2%	50.0% ^a
Prescriptive Other non-eShapes ¹	617	99.2%	5.3%	0.0%
Totals	11,584	88.6%	100.0%	3.8%

¹ Home Performance with ENERGY STAR (HPwES) program savings represent a small percentage of total savings in the portfolio. Savings from this program were grouped by load profile and included in this analysis.

^a There is no information about the precision of the sample for the eShapes load profiles and 50% was used as a worst case scenario.

For the C&I custom sample, the relative precision was calculated from the sample. The three studies done by KEMA (formerly RLW Analytics) each included information on the relative precision for the coincidence factors. In some cases, the relative precision was estimated based on the available information, as discussed below.

- The coincidence factors for the stipulated lighting were taken from the recent KEMA C&I loadshapes study; the relative precision shown in the tables above was the highest value for the various business types.
- The coincident factors for a variety of small residential measures were based on Itron's eShapes 8760 load profile data. The relative precision could not be determined, so a proxy value of 0.50 was used. Given the large sample size, this proxy value is assumed as a worst case scenario.
- For a few other residential measures, the load profiles were based on engineering assumptions and the relative precision could not be determined. Since no sampling was conducted, there is no sampling error associated with these measures.

The residential lighting savings are composed of three components with values derived from two different studies (NMR, 2004 and RLW, 2007). Each component has a relative precision associated with it. The in-service rate (ISR) and delta Watts were estimated from the same sample, and thus the worst-case precision was estimated as if the factors were perfectly correlated, i.e., the combined precision was additive. The RLW and NMR studies were sampled

independently, allowing the combined precision from the NRM and RLW studies to be calculated by the following formula:

$$p = \sqrt{(p_{NMR}^2 + p_{RLW}^2)}$$

The relative precision in the NMR study was reported at the 90% confidence level. These values were assumed to be a worst case scenario for the FCM requirement of precision at the 80% confidence level.¹⁶

The combined precision for the ISR and delta Watts from the NMR study was 11%. The precision for the RLW coincidence factors was reported to be 5% and 6% at the 80% confidence level for winter and summer, respectively.¹⁷ Thus, the combined relative precision for the prescriptive residential lighting was calculated to be 12% and 12% for winter and summer peak demand reductions.

The remainder of this section summarizes custom C&I results, C&I stipulated lighting results, and residential results.

3.1 Custom C&I Results

The distribution of PY2013 projects in EVT's portfolio, along with claimed and verified savings and realization rates are provided below in Table 7 through Table 10. Stratum 1 contains the smallest projects and Stratum 4 the largest.

Table 7: Realization Rates for Custom C&I Retrofit for Winter kW Peak

Size Stratum	Total # of 2012 Projects	Evaluated Projects	Mean of EVT Claimed kW	Mean of DPS Verified kW	Realization Rate
1	248	9	2.47	1.23	0.50
2	54	8	12.65	13.46	1.06
3	22	8	30.37	22.75	0.75
4	8	6	180.71	111.16	0.62
Total	332	31			0.66

¹⁶ In some cases a single value was selected where the NMR report had the results broken out into segments by technology. The selected value was chosen as a conservative estimate of the precision for the combined applications.

¹⁷ RLW Lighting Study, 2007, pages 13 and 14.

Table 8: Realization Rates for C&I MOP/New Construction for Winter kW Peak

Size Stratum	Total # of 2012 Projects	Evaluated Projects	Mean of EVT Claimed kW	Mean of DPS Verified kW	Realization Rate
1	297	9	1.83	0.95	0.52
2	92	10	5.57	5.93	1.07
3	25	10	26.57	24.68	0.93
4	9	8	119.78	78.59	0.66
Total	423	37			0.72

Table 9: Realization Rates for Custom C&I Retrofit for Summer kW Peak

Size Stratum	Total # of 2012 Projects	Evaluated Projects	Mean of EVT Claimed kW	Mean of DPS Verified kW	Realization Rate
1	248	9	0.14	0.16	1.11
2	54	8	9.95	6.80	0.68
3	22	8	32.67	22.85	0.70
4	8	6	72.22	64.36	0.89
Total	332	31			0.82

Table 10: Realization Rates for C&I MOP/New Construction for Summer kW Peak

Size Stratum	Total # of 2012 Projects	Evaluated Projects	Mean of EVT Claimed kW	Mean of DPS Verified kW	Realization Rate
1	297	9	0.81	0.31	0.39
2	93	10	4.60	3.98	0.86
3	25	10	25.40	22.76	0.90
4	8	8	78.76	64.31	0.82
Total	423	37			0.83

As can be seen in the tables above, the realization rates for the C&I market sectors vary from 39% to 111%. Some of the common reasons for the difference in realization rates are listed below.

- The equipment was not operating as intended.
- Mischaracterization of schedule, operating parameters, or production levels.
- Baseline assumptions were found to be incorrect.

These types of adjustments are commonly found in the process of conducting an impact evaluation. The realization rates by project are provided in Appendix A and the project-specific reports are compiled in Appendix B.

3.2 C&I Stipulated Lighting Results

The overall realization rate for all stipulated lighting was 88% for winter and 86% for summer peak periods, with a relative precision of 3%. Additional details about the realization rate by project type are provided in the table below.

	Winter kW Realization Rate	Winter Relative Precision	Summer kW Realization Rate	Summer Relative Precision
Custom Retrofit	88%	7%	84%	6%
Prescriptive	88%	6%	87%	9%
New Construction	92%	8%	92%	9%
Total	88%	3%	86%	3%

3.3 Residential Results

The next two sections describe the adjustments made to the residential prescriptive and residential custom measures.

3.3.1 Residential Prescriptive Measures

The prescriptive residential measures in EVT's portfolio are characterized in the TRM. For the prescriptive lighting products, the reduction in Watts and in-service rates are based on the results of a market research conducted by Nexus Marketing Research.¹⁸ This was a regional study prepared for the New England Energy Efficiency Partnership (NEEP). Verified lighting coincidence factors were based on the RLW lighting study conducted in 2007 and A/C coincidence factors were based on the RLW study of residential room air conditions conducted in 2008.¹⁹

Errors in the application of the prescriptive assumptions were identified through the Department's annual savings verification process, and these corrections were incorporated into the realization rates. The most notable discrepancy involved use of TRM 2012 rather than TRM 2013 for some of the lighting, domestic hot water, television and energy efficient smart power kits measures. There were no adjustments made to the television category because the TRM

¹⁸ *Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs*. Nexus Market Research and RLW Analytics, 2004

¹⁹ *Coincidence Factor Study Residential Room Air Conditioners*. Prepared for the Northeast Energy Efficiency Partnerships' New England Evaluation and State Program Working Group by RLW Analytics, Middletown, CT. June 23, 2008

2012 only refers to LCD or Plasma televisions, while the 2013 TRM is based on ENERGY STAR 6.0 ratings. This difference in categories made it difficult to quantify the adjustment. Given that these measures have an extremely limited contribution to EVT's portfolio, the DPS evaluators did not make any adjustments to these measures.

Applying the correct TRM 2013 assumptions reduced summer and winter peak kW savings by 0.95% and 0.31% respectively for these measures. Table 11 identifies the measures where adjustments were made to EVT's savings and provides a comparison of the per unit values. The result of adjusting these measures to reflect prescriptive values from the TRM was to decrease verified winter and summer peak demand savings by 31.495 kW and 48.550 kW, respectively.

Table 11: Residential Prescriptive Adjustments

Measure Number	Measure Description	EVT per unit		DPS per unit (TRM)	
		Winter kW Reduction	Summer kW Reduction	Winter kW Reduction	Summer kW Reduction
LFHCNFFX	Compact fluorescent interior fixture, ceiling fan	0.060	0.118	0.048	0.013
LFHRDLED	LED Recessed Surface or Pendant Downlight Rx	0.018	0.035	0.020	0.037
EQPPWREK	EE-KIT Smart Power Strip	0.006	0.007	0.006	0.007
LBLCFBLB	Compact fluorescent screw-base bulb	0.010	0.003	0.009	0.002
HWEFAUCT	Faucet aerator/flow restrictor	0.001	0.001	0.001	0.001
HWEFAUCT	Faucet aerator/flow restrictor	0.001	0.000	0.001	0.000
HWESHWR	Low flow showerhead	0.006	0.003	0.006	0.003
LBLCFSPD	Compact Fluorescent - Specialty Bulb - Direct Install	0.014	0.004	0.013	0.003

3.3.2 Residential Custom Measures

Members of the DPS Evaluation Team completed a separate impact evaluation for the Home Performance with ENERGY STAR® initiative in 2013.²⁰ The evaluation covered program years 2008 to 2010. In addition to providing a realization rate for the Home Performance with ENERGY STAR®, the evaluation also provides 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. Results were weather normalized as appropriate.

Since this impact evaluation represents an in-depth study of this program that meets the FCM guidelines, the DPS evaluation team applied the realization rate from the study to EVT's program reported savings for the Home Performance with ENERGY STAR® Program. The

²⁰ "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

impact evaluation found a realization rate of 86% for electric savings. As there were no documented program changes in 2012 as compared to 2008 through 2010, this realization rate was applied to EVT's program savings for PY2013.

Other residential custom initiatives (representing less than 0.5% of the winter and summer peak kW savings claim) were reviewed using the prescriptive assumptions included in the TRM as the evaluation costs to do otherwise would be substantial and the impact on the portfolio-level results is extremely small.

4 Compliance with ISO-NE Standards

This section covers the compliance of the verification results with the ISO-NE standards. For the residential prescriptive measures, the assumptions are supported by recent, statistically sound studies. For the custom C&I projects, an individual M&E plan was developed for each project that was consistent with the ISO requirements. Most of the ISO requirements are directly relevant to the C&I custom sample and are discussed in that context. The ISO requirements are listed in reference to the section in the M-MVDR.

Section 6, Establishing Baseline Conditions: As specified in the manual, the baseline conditions for retrofit projects are the pre-existing conditions. If the pre-existing conditions could not be determined, then the applicable state code, federal product efficiency standard or standard practice (if more stringent than the state or federal requirement) was used. For market opportunity projects, the baseline is the applicable state code, federal product efficiency standard or standard practice (if more stringent than the state or federal requirement).

These principles were consistently applied to the custom C&I projects and documented in the individual project reports. In a few cases, there was no clear code or standard. In these situations, the Department's evaluation team researched the standard practice and developed the baseline using the best available information.

The same principles were applied in developing the deemed savings values and standard savings estimation algorithms that have been incorporated in the Vermont Technical Reference Manual (TRM). The TRM has been compiled based on applicable state code, federal product efficiency standards, or standard practice through the work of the Technical Advisory Group (TAG), which includes representatives of the Department, EVT, and industry experts. Use of the TRM for establishing baseline information for prescriptive measures thus represents one means of meeting the requirements outlined in Section 6.

Section 7, Statistical Significance: For engineering-based, direct measurement, the ISO manual requires strategies to control for bias, such as the accuracy and calibration of the measurement tools, sensor placement bias, and sample selection bias or non-random selection of equipment and/or circuits to monitor. The site-specific M&V plans described the relevant issues for each project and discussed the methods used to mitigate bias. If the site-specific M&V approach required metering and there were too many circuits or measures to meter all, random sampling was conducted. These issues are described in more detail in the site-specific project reports.

In Section 7.2, the manual requires that the overall portfolio meet the 80/10 confidence/precision standard. As discussed above, the verification of EVT's portfolio exceeds that standard with a precision of 6% and 4% for winter and summer peak reduction, respectively.

Bias relating to the single largest component of EVT's portfolio, efficient lighting, is explored briefly below.

- The estimated savings for residential prescriptive lighting measures are unlikely to be biased since the deemed savings are based on recent market studies.
- The use of the coincidence factors from the recent KEMA C&I lighting loadshape study for the stipulated C&I lighting is appropriate since the sample studied included a similar broad range of applications. Thus, the application of coincidence factors found by the study to the stipulated C&I lighting projects would not be expected to introduce a bias.

Section 10, Measurement Equipment Specifications: The Department used RLW's *Review of ISO New England Measurement and Verification Equipment Requirements* (April 24, 2008) to identify the ISO-compliant metering equipment.

Section 5, Acceptable Measures and Verification Methodologies: This section describes the specific allowable methods, Options A through D. Engineering algorithms are permitted if supplemented with on-site data collection. Verifiable load shapes may be applied if based on "actual metering, load research, and/or simulation modeling" (Section 5.4.2).

For the residential prescriptive measures, Option A was applied, using verifiable load shapes and assumptions based on recent, statistically sound studies as discussed above. The recent KEMA studies for lighting and HVAC prepared for NEEP cover the vast majority of the residential prescriptive savings. The other measures used either Itron's eShapes or engineering estimates, as described previously. While the Itron eShapes are based on data that is over five years old, they also represent a highly detailed survey of residential use that would be impossible to duplicate within a reasonable time frame and budget. The kW reduction estimated by the use of engineering algorithms account for less than 3% of the total portfolio, and thus the greater uncertainty associated with the load profiles was considered to be acceptable.

5 Conclusions

The Department completed its independent verification of EVT's peak demand reduction. EVT's M&V plan as submitted to ISO-NE was the foundation for the sampling plan and verification activities conducted by the Department. The realization rates are based on EVT's activity in PY2013. The M&V plan was followed and the results of the evaluation are consistent with the ISO standards, as specifically discussed in this document.

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