WEST HILL ENERGY AND COMPUTING

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

Final Report

July 31, 2018

Prepared For

The Vermont Department of Public Service

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Table of Contents

Appendices

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 submit 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.

The Department contracted with West Hill Energy and Computing 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 a statistical analysis, site-specific M&V and overall evaluation of each efficiency portfolio.

This report describes the evaluation of EVT's program year 2016 (PY2016) 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 in Section 16.2 of 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, 2016 until the completion of the next evaluation cycle.

The realization rates presented in this document were provided to Efficiency Vermont in May of 2016, 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 EVT's 2016 Annual Report.[2]

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[1] *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources Manual M-MVDR*, Revision: 6, Effective Date: June 1, 2014
[2] *https://www.efficiencyvermont.com/Media/Default/docs/plans-reports-highlights/2016/efficiency-vermont-annual-report-2016.pdf*

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, and an appropriate verification approach applied/approved, balancing stringent precision targets with time and budget constraints. The portfolio was divided according to the source of the coincidence factors. The evaluation categories and associated verification strategies are summarized in Table 1. Each of the evaluation categories are discussed in subsequent sections.

TABLE 1: FCM VERIFICATION STRATEGY BY EVT INITIATIVE

EVT Initiative	Sampling Approach	ISO M&V Option
C&I and Multifamily		
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[3]	Option A
Smartlight Program	Sample selected per ISO standards[4]	Option A
Upstream HVAC	No sampling necessary	Option A
Streetlights	Sample selected per ISO standards[5]	Option A
Residential		
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
AMI Analysis	Census attempt; no sampling necessary	Option C

2.1   Custom C&I and Multifamily

All of EVT's custom projects were categorized as either retrofit or new construction (NC)/market opportunity (MOP). Within each of these categories, projects were sorted into four strata based on magnitude of maximum peak demand savings. This component of the evaluation involved drawing a sample of projects then performing site-specific M&V in accordance with the ISO-NE MMVDR. A summary of savings by programs is provided below.

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[3] The realization rate from PY2012 Stipulated Study was applied to all PY2016 stipulated lighting measures.

[4] The realization rate from PY2015 Smartlight Program Evaluation was applied to all PY2016 Smartlight measures.

[5] The realization rate from PY2015 Smartlight Program Evaluation was applied to all PY2016 Smartlight measures.

TABLE 2: SUMMARY OF C&I PROJECTS

Group	Number of Sites	Energy Savings (kWh)	Winter Demand Savings (kW)	Summer Demand Savings (kW)
Retrofit	669	25,144,159	4,645	2,767
NC/MOP	2,290	22,094,139	2,894	3,123
Upstream Programs	5,690	16,616,280	2,617	2,511
Municipal Streetlights	33	986,022	221	0
Total C&I Portfolio	8,682	64,840,600	10,377	8,401

2.1.1   Sampling

The same sampling plan used for FCM PY2015 impact evaluation was applied to the PY2016 evaluation. The assumption behind applying the PY2015 stratification plan to the PY2016 C&I custom portfolio was that the savings for the underlying projects are similarly distributed. An analysis of the PY2016 data supported this assumption.

As was done in PY2015, the smallest custom C&I projects (winter and summer peak kW of less than 0.80 kW) were excluded from the sample frame since these projects, in aggregate, represented less than 2% of EVT's portfolio savings but would be just as costly to verify as other larger projects. The savings-weighted average realization rate from the C&I Retrofit and NC/MOP components was applied to these measures.

The main features of the PY2016 sampling process for the C&I projects are summarized below.

- o   The same stratification scheme and strata cutoffs used for the FCM PY2015 impact evaluation were applied to the PY2016 evaluation for two broad program types-- Retrofit and MOP/New Construction. Multifamily projects were included with the C&I projects.
- o   The primary sampling unit was the program type/site ID, within each broad program type (Retrofit and MOP/New Construction). All measures associated with the site and program types were included.
- o   The primary variable for establishing the size strata was the maximum of the winter and summer peak kW reduction.
- o   For strata 1 through 3, the results from the PY2015 FCM evaluation were applied.
- o   For stratum 4 (containing the largest projects), all measures were evaluated including lighting measures using stipulated coincidence factors.
- o   Expansion weights were calculated based on the number of completed site reviews.

2.1.2   Summary of Sites

All of the custom C&I and multifamily sites were separated into the two major categories: Retrofit and New Construction/MOP. This distinction was made because of the different approaches to establishing the baseline between the two categories (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. As is consistent with the PY2015 sampling plan, 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. This sampling variable was selected to develop a sample that would provide robust estimators of the realization rates for both winter and summer peak kW reduction.

TABLE 3: SUMMARY OF C&I AND MULTIFAMILY PROJECTS

	Projects	EVT Program Reported Max kW Savings	Percent of EVT C&I Program Reported kW Max Savings
Retrofit	669	4,884	62%
NC/MOP	2,290	2,943	38%
Totals	2,959	7,827	100%

2.1.3   Stipulated Lighting

A substantial portion of the savings from C&I lighting projects have stipulated lighting profiles, i.e., the DPS and EVT have agreed to use a rigorous, regional study as the source of the coincidence factors.[6] The stipulated lighting profiles are applied by business type, such as retail, office, etc.

Although the coincidence factors are stipulated, there are other sources of error that could have an impact on the magnitude of the savings:
1. The in-service rate (ISR), defined as the percentage of program reported efficient lighting products that were actually installed
2. The reduction in kW load due to the installation of the efficient lighting
3. The use of an incorrect stipulated lighting profile, *i.e.*, using the office profile for a retail space

Consequently, the DPS Evaluation Team conducted an evaluation of stipulated lighting for PY2012.

The projects with stipulated coincidence factors were divided into three groups, *i.e.*, retrofit, market opportunity and new construction, in order to accommodate the different baselines and methods used for each of these groups. Sampling was conducted independently for each of these three groups, following the guidelines laid out in the M-MVDR.

For the retrofit and MOP projects, telephone surveys were conducted, followed by site visits to the surveyed businesses. For new construction projects, only site visits were conducted. Information obtained from the telephone surveys and site visits was combined with secondary

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[6] "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

data (such as manufacturers' specifications) and EVT's detailed project-level data to calculate the peak kW reduction at each site.

Complete details of the methods and results can be found in Appendix C, which contains the ISO-NE-compliant evaluation report for this particular component of EVT's portfolio.[7] The realization rates in the Appendix C study were applied to the PY2016 savings claim to calculate the PY2016 evaluated savings.

2.2 Upstream Projects

EVT's upstream initiatives are intended to promote energy efficiency by offering incentives to distributors who pass on the benefit to customers as a product discount. EVT has two major upstream initiatives:

1. Smartlights, which covers efficient lighting
2. 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 DPS Evaluation Team's approach to verifying each of these initiatives is discussed below.

2.2.1 Smartlight

The Smartlight program is a contract between Efficiency Vermont (EVT) and several distributors by which efficient lighting is made more affordable to households and businesses in Vermont through discounting qualifying products at the point of sale.

A comprehensive review of all Smartlight projects was carried out as part of the FCM 2013 impact evaluation, which included the following components:

- Data from all Smartlight projects were aggregated into one dataset, reviewed, and tabulated by end-user.
- End-users were defined as either commercial or residential customers and different approaches were used for each.
- Site visits were conducted at 27 randomly-selected participating businesses. Each site visit included a customer survey administered in person and a visual inspection to determine the ISR.
- Follow-up telephone surveys were carried out as needed to assess potential overlap between the Smartlight program and other EVT initiatives.

The residential/commercial split reflects EVT's strategy of applying sector-specific savings assumptions to its lighting program. EVT's estimate of the percent of lighting products installed in residential locations was updated based on the information provided in the distributors' spreadsheets.

Complete details of the methods and results of this effort can be found in the final combined project report, "Evaluation of Efficiency Vermont's Smartlight Program for PY13" in Appendix D, an ISO-NE compliant evaluation of this component of EVT's portfolio. The realization rates

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

from the Appendix D study were applied to the program reported PY2016 savings to calculate the evaluated savings.

2.2.2 Upstream HVAC

Similar to the Smartlight program, the upstream HVAC incentive program incentivizes the consumer purchase of high-efficiency air-conditioning equipment through qualified distributors and manufacturers. In PY2016, EVT reported 687 unit sales of evaporator fan motors. In addition, there were a small number of corrections for air-conditioners and heat pumps. As these sales accounted for only 57 kW of winter and summer peak demand savings (about 0.3% of the portfolio total, these units were given a realization of 100%.

2.2.3 Municipal Streetlight Projects

In PY15, EVT completed a large number of municipal streetlight projects. The characteristics of these projects differ from many EVT custom projects. When these projects were included in the custom C&I sample, they represented a disproportionate part of the winter peak kW reduction. Consequently, municipal streetlighting was separated into its own upper level stratum. The review included assessing baseline and efficient case assumptions and a visual inspection of a sample of the streetlights. Details on the sampling, projects and results are in Appendix E.

The realization rate from this PY2015 analysis was applied to the PY2016 streetlight projects.

2.3 Residential Projects

EVT's program reported residential sector savings are almost entirely prescriptive and 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 from relevant studies and EVT's own data on measures installed by past program participants.

The "residential custom" category includes EVT's Home Performance with ENERGY STAR® Program, as well as hot water, and electric space heat measures. These measures account for a small fraction of EVT's overall portfolio: 2.0% and 0.3% of program reported winter and summer peak savings, respectively.

2.3.1 Residential Prescriptive Lighting

This component of the evaluation covers the lighting products sold through EVT's Efficient Products Program. All individual measures in this category were verified. Coincidence factors were taken from the NMR lighting study.[8] It was assumed that a fraction of these lighting products were purchased by commercial establishments, which were also assumed to have air conditioning. Savings for this fraction of the lighting measures were calculated using

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[8] "Northeast Residential Lighting Hours-of-Use Study (R3)". Prepared by NMR Group Inc. and DNV GL, Somerville, MA. May 5, 2014

coincidence factors from the KEMA C&I Load Shape study,[9] which exhibits lower cooling consumption because of lower heat transmission from more efficient lighting.

2.3.2   Residential Prescriptive HVAC

Efficient air conditioners are also offered through EVT's Efficient Products Program. Coincidence factors were taken from the RLW Analytics residential HVAC study.[10]

2.3.3   Residential Prescriptive Other eShapes

The Efficient Products Program also includes a range of other Energy Star appliances, such as dishwashers, clothes washers, and refrigerators. For these measures, the coincidence factors were developed from Itron's eShapes 8760 load profile data, which were derived from detailed analyses of approximately 20,000 homes in the 1990's.[11]

2.3.4   Residential Prescriptive Other non-eShapes

This measure category includes a few miscellaneous products offered through the Efficient Products Program (such as dehumidifiers), as well as a limited number of items installed through the residential custom initiatives, such as DHW pipe insulation and electronics. Coincidence factors are based on engineering estimates that were reviewed and found to be reasonable. Similar to the eShapes discussed above, these measures constitute a small percentage of EVT's overall portfolio (less than 2% of the winter and approximately 5% of the summer peak kW reduction).

2.3.5   AMI Analysis

The Efficient Products Program includes some prescriptive measures, such as hot water conservation measures, heating equipment replacement, envelope measures, hot water, and heating fuel switches. The Department conducted a separate analysis of the savings for space heat fuel and hot water fuel switches using AMI data under a whole building approach in 2015 and the results were applied to this year. Additional AMI analysis was conducted on heat pump water heater, AMI data was collected for 27 homes and savings were estimated from a pre-/post-analysis of use during the ISO-NE peak hours. More details are provided in Appendices F and G.

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[9] "C&I Lighting Load Shape Project FINAL Report." Prepared for the Regional Evaluation, Measurement andVerification Forum by KEMA Inc. July 19, 2011.

[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. While these load profiles are somewhat dated, the data collection effort necessary to update coincidence factors for these products is not warranted by the small contribution of this program to EVT's savings portfolio (less than 3%).

2.4 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 program reported savings for project *i*

The basis for these calculations and the method for calculating variances are provided in *The California Evaluation Framework*.[12] 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.[13]

2.5 Attrition

Of the projects in the census stratum, all 14 were verified. No projects were dropped from the analysis.

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[12] "The California Evaluation Framework." Project Number: K2033910. Prepared by TecMarket Works, et. al. for the California Public Utilities Commission and the Project Advisory Group, June, 2004, 327 to 339 and 361 to 384.
[13] "Sampling: Design and Analysis". Lohr, Sharon L. Duxbury Press, 1999, pages 268-269.

3 Results

The realization rates and relative precision for all components of EVT's portfolio are provided in Tables 4 and 5. The FCM 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 and 5% for summer peak reduction at the 80% confidence level, exceeding the FCM requirement.

TABLE 4: REALIZATION RATES AND SAMPLING PRECISION FOR WINTER PEAK kW REDUCTION

	EVT Program Reported Peak kW Reduction	Realization Rate	Evaluated Peak kW Reduction	Relative Precision
C&I and Multifamily				
Retrofit	4,429	71.9%	3,186	13.7%
NC/MOP	2,312	82.2%	1,900	8.4%
Stipulated Lighting	798	88.0%	702	6.0%
Smartlight	2,560	92.2%	2,360	10.0%
Upstream Fan Motor	57	100.0%	57	0.0%
Streetlighting	221	92.3%	204	0.0%
Residential				
Lighting Prescriptive	7,248	100.0%	7,252	11.7%
Lighting Prescriptive wCB	1,017	100.4%	1,021	6.0%
Prescriptive HVAC	(72)	101.1%	(73)	0.0%
Prescriptive Other eShapes	207	68.8%	142	50.0%
Prescriptive Other non-eShapes	311	98.6%	307	0.0%
Space Heating AMI	473	76.1%	360	22.0%
Direct Hot Water Fuel Switch AMI	329	243.8%	802	0.0%
Other Custom Residential	22	100.0%	22	0.0%
Totals	19,914	91.6%	18,243	5.5%

TABLE 5: REALIZATION RATES AND SAMPLING PRECISION FOR SUMMER PEAK kW REDUCTION

	EVT Program Reported Peak kW Reduction	Realization Rate	Evaluated Peak kW Reduction Savings	Relative Precision
C&I and Multifamily				
Retrofit	2,417	88.0%	2,127	10.5%
NC/MOP	2,189	85.0%	1,861	2.7%
Stipulated Lighting	1,284	86.0%	1,104	5.3%
Smartlight	2,454	80.7%	1,981	11.3%
Upstream Fan Motor	57	100.0%	57	0.0%
Streetlighting	0	100.0%	0	0.0%
Residential				
Lighting Prescriptive	1,972	100.3%	1,977	12.4%
Lighting Prescriptive wCB	1,862	100.4%	1,869	5.3%
Prescriptive HVAC	-1	221.5%	(3)	10.4%
Prescriptive Other eShapes	178	73.4%	130	50.0%
Prescriptive Other non-eShapes	663	99.3%	659	0.0%
Space Heating AMI	0	100.0%	-	27.0%
Direct Hot Water Fuel Switch AMI	168	226.6%	380	0.0%
Other Custom Residential	21	100.0%	21	0.0%
Totals	13,265	91.7%	12,165	3.6%

The relative precision for the C&I custom sample 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.

- o The coincidence factors for the stipulated lighting were taken from the recent KEMA C&I load shapes study; the relative precision shown in the tables above was the highest value for the various business types.
- o The streetlighting projects were analyzed in PY 2015 and the results were applied to this evaluation. Additional details can be found in Appendix E.
- o 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.
- o 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.
- o AMI analysis was carried out for residential hot water and space heating measures. There was no sampling conducted, hence there is no sampling error associated with these measures.

The reduction in Watts and in-service rates for the residential prescriptive lighting products are based on the Northeast Energy Efficiency Partnership (NEEP) Residential Lighting Strategy.[14] Verified lighting coincidence factors were based on the recent NMR lighting study (2014)[15].

Thus, the residential lighting savings are composed of three components, with values derived from two different studies (NEEP, 2012 and NMR, 2014). Each component has a relative precision associated with it. The relative precision from the 2014 NMR report was used as the overall precision for the residential lighting, as the NEEP study does not include this statistic. The relative precision in the NMR study was reported at the 90% confidence level. These values were used in the precision calculations, as this approach gives a conservative estimate of the precision at the 80% confidence level.[16]

The relative precision for the prescriptive residential lighting from the NMR study was about 12% for both winter and summer peak demand reductions at the 80% confidence level. The remainder of this section summarizes custom C&I results, C&I stipulated lighting results, and residential results.

3.1 C&I Custom Results

The distribution of PY2016 projects in EVT's portfolio, along with program reported and verified savings and realization rates are provided below in Table 6 through Table 9. Stratum 1 contains the smallest projects and Stratum 4 the largest.

TABLE 6: REALIZATION RATES FOR CUSTOM C&I RETROFIT FOR WINTER KW PEAK

Size Stratum	Total 2016 Projects	Evaluated Projects	Mean of EVT Program Reported kW	Mean of DPS Verified kW	Realization Rate
1	115	7	2.03	1.63	80%
2	39	7	13.37	4.66	35%
3	13	7	40.20	29.81	74%
4	8	8	281.52	232.84	83%
Total	175	29			

TABLE 7: REALIZATION RATES FOR C&I MOP/NEW CONSTRUCTION FOR WINTER KW PEAK

Size Stratum	Total 2016 Projects	Evaluated Projects	Mean of EVT Program Reported kW	Mean of DPS Verified kW	Realization Rate
1	499	7	0.55	0.56	102%
2	161	7	3.87	2.70	70%
3	53	7	17.52	12.48	71%
4	6	6	84.56	84.19	100%

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[14] "Northeast Residential Lighting Strategy", Prepared by Energy Futures Group for NEEP, March 2012

[15] NMR Lighting Study, 2014, page IX

[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.

Total	719	27			

TABLE 8: REALIZATION RATES FOR CUSTOM C&I RETROFIT FOR SUMMER KW PEAK

Size Stratum	Total 2016 Projects	Evaluated Projects	Mean of EVT Program Reported kW	Mean of DPS Verified kW	Realization Rate
1	115	7	2.39	0.94	39%
2	39	7	4.00	4.22	105%
3	13	7	35.58	31.67	89%
4	8	8	80.09	65.85	82%
Total	175	29			

TABLE 9: REALIZATION RATES FOR C&I MOP/NEW CONSTRUCTION FOR SUMMER KW PEAK

Size Stratum	Total 2016 Projects	Evaluated Projects	Mean of EVT Program Reported kW	Mean of DPS Verified kW	Realization Rate
1	499	7	0.37	0.25	69%
2	161	7	2.07	1.95	94%
3	53	7	16.89	13.51	80%
4	6	6	105.39	96.48	92%
Total	719	27			

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 5%. Additional details about the realization rate by project type are provided in the table below.

TABLE 10: REALIZATION RATES RESULTS

	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 custom measures.

3.3.1   Prescriptive Measures

The prescriptive residential measures in EVT's portfolio are characterized in the TRM. Reduction in Watts and in-service rates for prescriptive lighting products are based on the Northeast Energy Efficiency Partnership (NEEP) Residential Lighting Strategy.[17]   Verified lighting coincidence factors were based on the NMR lighting study conducted in 2014 and A/C coincidence factors were based on the RLW study of residential room air conditioners conducted in 2008.[18]

The DPS Evaluation Team compared EVT's program reported savings to the TRM for these measures. The realization rate was close to 100% for all residential lighting. The realization rate for prescriptive HVAC measures was based on the RLW study of residential room air conditioners conducted in 2008.[19]

3.3.2   Custom Measures

Results of AMI analysis from program year 2015 were applied to domestic hot water and heating fuel switch measures. The realization rates from this analysis are shown in In addition, the DPS Evaluation Team completed a separate impact evaluation for heat pump water heaters using AMI data analysis. This analysis suggests that the winter and summer peak reduction is substantially higher than reported by EVT, with realization rates of 244 and 227%, respectively. The details from this analysis are presented in Appendix G.

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[17] "Northeast Residential Lighting Strategy." Prepared by Energy Futures Group for NEEP, March 2012
[18] "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
[19] *Ibid*

Table 11 below. Detailed information on the results from this analysis can be found in Appendix F.

In addition, the DPS Evaluation Team completed a separate impact evaluation for heat pump water heaters using AMI data analysis. This analysis suggests that the winter and summer peak reduction is substantially higher than reported by EVT, with realization rates of 244 and 227%, respectively. The details from this analysis are presented in Appendix G.

TABLE 11: RESIDENTIAL CUSTOM

Custom Measure	EVT Winter kW	DPS Verified Winter kW	Winter Realization Rate	EVT Summer kW	DPS Verified Summer kW	Summer Realization Rate
Heat Pump Water Heaters	295.0	783.6	266%	149.3	366.9	246%
Hot Water Load Profile	31.1	18.0	58%	15.7	13.3	85%
Hot Water Loss Load Profile	2.7	<0.1	2%	2.7	<0.1	2%
Space Heat Load Profile	488.0	392.3	80%	0	0	N/A
Total			69%	31.6	30.2	97%

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.

4.1 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 TRM. The TRM was compiled and is regularly updated 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.

4.2 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 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 5% for both winter and summer peak reduction.

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

- o The estimated savings for residential prescriptive lighting measures are unlikely to be biased since the deemed savings are based on recent market studies.
- o The use of the coincidence factors from the recent KEMA C&I lighting load shape 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.

4.3   Section 10, Measurement Equipment Specifications

The DPS evaluation team verified that its metering equipment meets the FCM MMVDR.

4.4   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).

Option A was applied to the residential prescriptive measures, 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. For measures including heating replacement, envelope measures, and hot water and heating fuel switches, the Department conducted a separate analysis of the savings. Option A was applied using AMI data for a whole building approach and savings were estimated from a pre-/post-analysis of use during the ISO-NE peak hours.

The other measures used either Itron's eShapes or engineering estimates, as described previously. While the Itron eShapes are based on data 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 Itron's eShapes 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 were estimated from EVT's activity in PY2016. The M&V plan was followed and the results of the evaluation are consistent with the FCM standards, as specifically discussed in this document.

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