



Report to Verify Efficiency Vermont 2019 Savings Claim

Submitted July 1, 2020

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Acknowledgements

Cadmus thanks Barry Murphy at the Vermont Department of Public Service for his guidance throughout the project, as well as all who contributed on behalf of Efficiency Vermont at the Vermont Energy Investment Corporation.

Executive Summary

On April 1, 2020, Vermont Energy Investment Corporation (VEIC), who administers Efficiency Vermont (EVT) under an order of appointment by the Public Utility Commission (PUC) to provide energy efficiency services to Vermont, submitted its “Savings Claim Summary 2019” to document its preliminary savings claim for year 2019 activities. To certify achieved savings towards VEIC’s performance goals, the PUC requires the Vermont Department of Public Service (PSD) to verify the energy, coincident peak, and total resource benefit savings claimed by EVT. This report documents the findings of this verification of the 2019 EVT savings claim along with Cadmus’ recommendations.

This report summarizes the evaluation of savings claimed for the entire EVT portfolio, including programs within the commercial and industrial, multifamily, and single-family residential sectors. Table 1 provides portfolio-wide realization rates for energy saved (kWh), winter peak demand reduction (kW), and summer peak demand reduction (kW).

Table 1. Portfolio Electric Adjustments

Program Group	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Portfolio Total	111,248,715	98.7%	18,896	100.9%	12,747	101.5%

Cadmus reviewed project files and an extensive database of measure data to accomplish the following:

- Verify that savings values and calculations had been applied correctly
- Calculate evaluated savings that incorporate any necessary corrections

Table 2 provides energy savings (kWh), winter peak demand savings (kW), and summer peak demand savings (kW) by program group.

Cadmus found some errors that resulted in higher-than-claimed savings and found some errors that resulted in lower-than-claimed savings. Total claimed energy savings equaled 111.2 GWh, with a realization rate of 98.7%.

The EVT portfolio’s 98.7% realization rate speaks well for EVT and for the efforts of VEIC, its implementer, in estimating and documenting savings. This is a comparable realization rate to the review of the 2018 claimed energy savings that equaled 127.1 GWh, with a realization rate of 97.7%.

At the 90% confidence level, the relative precision of the realization rates for energy savings (kWh) is $\pm 2.0\%$ for Commercial and Industrial/Multifamily (C&I/Multifamily) Custom Retrofit projects and $\pm 5.9\%$ for C&I/Multifamily Custom New Construction and Market Opportunity (NC/MOP) projects. The relative precision for the portfolio as a whole is $\pm 1.0\%$.

Table 2. Electric Adjustment by Program Group

Program Group	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
C&I and Multifamily						
Custom Retrofit ^a	18,934,938	97.6%	2,192	106.5%	2,032	108.9%
Custom NC/MOP ^a	17,583,085	94.4%	2,305	99.9%	2,200	97.8%
Prescriptive Lighting	3,763,381	99.8%	721	100.0%	557	100.0%
Prescriptive Non-Lighting	152,283	98.2%	23	98.7%	18	98.0%
Efficient Products	7,958,003	100.0%	726	100.2%	1,475	99.9%
Smartlight	19,263,119	100.0%	2,178	101.4%	3,043	102.0%
Upstream HVAC	1,284,683	100.0%	184	100.0%	50	100.2%
C&I Subtotal	68,939,493	97.9%	8,330	102.0%	9,375	102.0%
Residential						
Efficient Products	24,824,644	100.0%	6,580	100.0%	2,509	99.9%
Residential Retrofit/Low-Income Single-Family (LISF)	2,365,243	99.9%	519	100.2%	213	100.0%
Home Performance with ENERGY STAR (HPwES) ^{a,b}	212,594	100.0%	29	100.0%	0	100.0%
Residential New Construction	412,473	99.0%	67	99.3%	10	96.9%
Smartlight	7,628,393	100.0%	1,839	100.0%	387	99.8%
Upstream HVAC (with heat pump water heaters)	6,865,875	100.0%	1,532	99.4%	253	100.0%
Residential Subtotal	42,309,222	100.0%	10,566	99.9%	3,372	99.9%
Portfolio Total	111,248,715	98.7%	18,896	100.9%	12,747	101.5%

^a These totals exclude any contributions from thermal energy and process fuels (TEPF)-funded measures.

^b Claimed savings for the Home Performance with ENERGY STAR program already include adjustments taken from a prior-year impact study. Applied realization rates are 79.8% for kWh and 36.5% for kW values.

Table 3 summarizes the reductions in fossil fuel MMBtu and water savings—the two total resource benefit components. Realization rates fluctuate across program groups, but the overall realization rate remains high at 97.8%. The overall water savings realization rate is 91.8%.

Table 3. Total Resource Benefit Adjustments by Program Group

Program Group	MMBtu Saved		Water Saved	
	EVT Gross Claimed MMBtu	Realization Rate	EVT Gross Claimed CCF	Realization Rate
C&I and Multifamily				
Custom Retrofit ^a	6,081	100.0%	22,404	100.0%
Custom NC/MOP ^a	24,388	92.7%	7,977	12.4%
Prescriptive Lighting	-1,309	99.8%	0	N/A
Prescriptive Non-Lighting	1,158	91.5%	1,292	98.4%
Efficient Products	-5,127	100.0%	18	100.0%
Smartlight	-10,819	100.0%	0	N/A
Upstream HVAC	-46	100.0%	0	N/A
C&I/Multifamily Subtotal	14,326	86.9%	31,691	77.9%
Residential				
Efficient Products	16,929	99.7%	40,802	101.2%
Residential Retrofit/LISF	8,436	100.0%	14,423	96.3%
HPwES ^b	10,222	100.0%	0	N/A
Residential New Construction	3,112	99.3%	470	69.1%
Smartlight	-41	100.0%	0	N/A
Upstream HVAC (with heat pump water heaters)	36,280	100.0%	0	N/A
Residential Subtotal	74,938	99.9%	55,694	99.6%
Portfolio Total	89,264	97.8%	87,385	91.8%

^a These totals exclude any contributions from TEPF-funded measures.

^b Claimed savings for the HPwES program already include adjustments taken from a prior-year impact study. The applied realization rate is 55.1% for MMBtu savings.

Introduction

The annual EVT savings claim verification addresses several needs, but the primary purpose was to calculate realization rates for energy savings (kWh) and for winter and summer peak demand reduction (kW). After Cadmus submits final realization rates, EVT applies these realization rates to its claimed savings numbers to arrive at actual gross savings estimates, which it uses to calculate net savings and, ultimately, cost-effectiveness.

The savings claim evaluation also results in realization rates used to calculate total resource benefits, which comprises annual savings in fossil fuels and wood fuel (in MMBtu) and in water savings in hundreds of cubic feet (CCF).

Process

Work on the project began in February 2020, after EVT began providing Cadmus with project files for the largest custom C&I/Multifamily sector projects. By mid-March, EVT provided a database documenting savings for the entire portfolio. Cadmus queried this database to generate datasets needed to evaluate each program. Cadmus sampled projects as necessary and requested files for the sampled projects.

Cadmus provided savings reports as they were completed for each C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom New Construction/Market Opportunity projects. This allowed EVT adequate time to provide relevant feedback within the short timeline of the evaluation.

The final version of this report, submitted by the July 1, 2020, deadline, documents all findings.

Scope

The evaluation scope was a desk review of EVT's energy efficiency activities. Cadmus reviewed project files and an extensive database of claimed measure data to verify that savings values and calculations had been applied correctly, and to calculate evaluated savings that incorporated any necessary corrections. The evaluation did not include conducting surveys or site visits to verify the installation or correct operation of products or to verify baseline conditions. Similarly, no metering was performed, although Cadmus used available advanced metering infrastructure data or other metering data to verify and adjust savings where practical for evaluated custom commercial and industrial projects.

The verification evaluated only gross savings at the meter. Factors such as freeridership, spillover, and line losses fall beyond the scope of this evaluation and were not considered.

Evaluating the methods used in the Vermont Technical Reference User Manual (TRM) also extended beyond the project's scope, as did a rigorous review of EVT's implementation of TRM methods and any rigorous review of the EVT database itself. That said, Cadmus notified EVT during the project of any errors found in the TRM or its application by EVT. Cadmus also provided high-level recommendations (see this report's *Recommended Improvements* section).

Program Groups

The project organizes EVT programs in nine program groups. This report presents findings within the program groups and program components shown below:

- C&I/Multifamily Custom Retrofit
- C&I/Multifamily Custom NC/MOP
- C&I/Multifamily Prescriptive
 - Prescriptive Lighting
 - Prescriptive Non-Lighting
- C&I/Multifamily Efficient Products
- C&I/Multifamily Upstream
 - Smartlight
 - Upstream HVAC
- Residential Efficient Products
- Residential Retrofit/LISF
 - Retrofit/LISF
 - HPwES
- Residential New Construction
- Residential Upstream
 - Smartlight
 - Upstream HVAC and Heat Pump Water Heaters

Project Funding Considerations

Evaluating savings across the EVT portfolio required making choices about how to treat measures and projects funded by sources other than EVT.

As with the 2016 through 2018 savings claims verifications, this evaluation report excludes all TEPF-funded measures from C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP projects. These measures often fundamentally differ from measures funded by the Electric Energy Efficiency Charge (EEC), focusing on MMBtu savings and offering little or no energy (kWh) savings or peak demand (kW) reduction. Including such measures in this analysis might have made realization rates less accurate for EEC-funded measures. Accordingly, the PSD requested that the evaluation team analyze the savings for TEPF-funded measures separately, by evaluating the savings of separate stratified samples. Cadmus has included a summary of savings and realization rates for these C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP TEPF-funded savings in *Appendix A*.

Methods

Cadmus used a range of methods to calculate evaluated savings and realization rates for each program group and component. This chapter describes the overall approach used for each program group. This section also documents methodologies used for sampling and for calculating realization rates for sampled program groups.

Commercial and Industrial/Multifamily Custom Retrofit

C&I/Multifamily Custom Retrofit projects accounted for 27% of the C&I/Multifamily sector's evaluated kWh savings and 17% of the total portfolio's evaluated kWh savings. This program comprised 220 complex projects with non-TEPF-funded savings in at least one evaluated savings category. Projects ranged from relatively simple lighting retrofits to complex industrial processes.

Given the complexity and size of these custom projects, evaluating savings within the budget and timeline required sampling. Cadmus designed a sample to yield at least 15% relative precision at the 90% confidence level customary for program evaluations; the design resulted in the selection of 24 projects. Cadmus applied realization rates calculated based on this sample to the population of 220 projects to estimate population total savings. Additional details follow in the *Sampling* section.

The evaluation process for each project involved reviewing project files provided by EVT. Cadmus examined calculation inputs, assumptions, methods, and documentation to assess whether the savings estimates were reasonable. For some projects with available electric metering data, analysts compared pre- and post-installation energy usage to assess the accuracy of savings estimates.

Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity

C&I/Multifamily Custom NC/MOP projects showed strong growth in savings in 2019, accounting for 25% of the C&I/Multifamily sector evaluated kWh savings and 15% of the total portfolio evaluated kWh savings. (In 2018, the program contributed 16% of the C&I/Multifamily sector evaluated savings and 11% of the total portfolio savings.) Electric energy savings increased from 13.7 GWh in 2018 to 17.6 GWh in 2019. The program group included 213 projects meeting the evaluation criteria. As with the C&I/Multifamily Custom Retrofit category, C&I/Multifamily Custom NC/MOP projects varied considerably in complexity and size, with the largest projects comprising hundreds of measures.

Cadmus used a sampling approach for this program group similar to that used for C&I/Multifamily Custom Retrofit: the team selected a random sample of 23 projects for evaluation and estimated the population's total savings by applying the resulting realization rates to the population of 213 projects.

The evaluation process for each C&I/Multifamily Custom NC/MOP project also closely resembled that used for C&I/Multifamily Custom Retrofit projects, though pre- and post-installation metering data were not available for new construction.

Commercial and Industrial/Multifamily Prescriptive

Claimed savings for the C&I/Multifamily Prescriptive program group fell from 13.8 GWh in 2018 to 3.9 GWh in 2019, primarily because of a large reduction in lighting savings. The 2019 C&I/Multifamily Prescriptive projects account for 6% of the C&I/Multifamily sector kWh evaluated savings and 4% of the total portfolio's evaluated kWh savings, down from 17% and 11% in 2018, respectively.

Table 2 reports savings for two components—Prescriptive Lighting and Prescriptive Non-Lighting. Prescriptive Non-Lighting includes a variety of measures, such as HVAC, refrigeration, and compressed air. Savings fell for both components relative to 2018, with the great majority of the reduction coming from the lighting component. This is due in part to program realignment, which moved savings to other categories, as well as to reductions in baseline consumption as a response to federal lighting standards updates, which have been adopted by Vermont.

All measures in this program group were prescriptive. To evaluate claimed savings, Cadmus generated savings estimates using equations and assumptions defined for each measure by the Vermont TRM, along with necessary equipment-specific values provided in the measures tracking data (for example, lamp wattage or equipment efficiency). Where EVT relied on deemed values provided by the TRM for energy savings (kWh), demand reduction (kW), MMBtu savings, and/or water savings (rather than TRM methods requiring more inputs), Cadmus used the same deemed values.

As with all prescriptive measures (whether using deemed values or equations with more inputs), the 2019 TRM also identifies a load shape to use for each C&I/Multifamily Prescriptive measure; Cadmus applied the winter and summer coincidence factors from each load shape to the appropriate load reduction for each measure to calculate winter and summer coincident peak demand reduction.

Commercial and Industrial/Multifamily Efficient Products

The C&I/Multifamily Efficient Products program group also accounted for a much lower percentage of savings in 2019, with 12% of the C&I/Multifamily sector's kWh savings and 7% of the total portfolio kWh savings; in contrast, in 2018 the program group contributed 20% of the C&I/Multifamily sector kWh savings and 13% of the total portfolio's kWh savings.

EVT added numerous non-lighting measures to this relatively new program group in 2019, including appliances, advanced thermostats, and heat pump water heaters. Even so, lighting accounted for 99% of kWh savings for the C&I/Multifamily Efficient Products in 2019.

As with the C&I/Multifamily Prescriptive program group, all C&I/Multifamily Efficient Products measures were prescriptive. For the Efficient Products measures, EVT relied on deemed values defined by the TRM (rather than TRM methods requiring more inputs), and Cadmus used the same deemed values.

Commercial and Industrial/Multifamily Upstream

Claimed savings for the C&I/Multifamily Upstream program group increased to 20.5 GWh in 2019 from 16.9 GWh in 2018, with 94% of savings resulting from Smartlight measures. Table 2 reports claimed savings for the group's two components—Smartlight and Upstream HVAC. The program accounted for

30% of the C&I/Multifamily sector kWh savings and 19% of the total portfolio's kWh savings. As in 2018, the Upstream HVAC component comprised several measures, including cold climate heat pumps, heat pump water heaters, brushless permanent magnet motor circulator pumps, condensing units, and others.

As with the C&I/Multifamily Prescriptive and C&I/Multifamily Efficient Products program groups, all C&I/Multifamily Upstream measures were prescriptive. Cadmus generated savings estimates using methods the Vermont TRM defines for each measure. For the Upstream measures, EVT relied on deemed values defined by the TRM (rather than TRM methods requiring more inputs), and Cadmus used the same deemed values.

Residential Efficient Products

With evaluated energy savings of 24.8 GWh, claimed savings for 2019 Residential Efficient Products accounted for more savings than any other program group, even though savings were substantially lower than the program group's 2018 claimed savings of 36.6 GWh. Residential Efficient Products provided 59% of the evaluated kWh savings for the residential sector and 23% of the total portfolio's evaluated kWh savings.

All Residential Efficient Products measures were prescriptive, with 76% of savings provided by LED fixtures and replacement lamps. Other measures included home energy kits, ENERGY STAR appliances, heat pump water heaters, thermostats, and others. Cadmus generated savings estimates using methods defined for each measure by the Vermont TRM. For the Residential Efficient Products measures, EVT relied on deemed values defined by the TRM (rather than TRM methods requiring more inputs), and Cadmus used the same deemed values.

Residential Retrofit/Low-Income Single-Family

The Residential Retrofit/LISF program group encompasses three program tracks: Residential Single-Family Retrofit, LISF, and HPwES. Table 2 reports combined savings for Residential Single-Family Retrofit and LISF, and reports savings for HPwES separately. Claimed savings for the three tracks combined was 2.6 GWh for 2019, up from 1.3 GWh in 2018. Savings accounted for 6% of the residential sector's evaluated kWh savings and 2% of the total portfolio evaluated kWh energy savings.

For prescriptive measures, Cadmus estimated savings using methods defined for each measure in the Vermont TRM. Where EVT relied on deemed values defined by the TRM (rather than TRM methods requiring more inputs), Cadmus used the same deemed values. Consistent with the approach used in previous years, Cadmus accepted savings from custom measures in this program group at a 100% realization rate.

The HPwES program is funded primarily by TEPF and comprised only custom measures (such as insulation and air sealing). Prior to claiming savings, EVT applied an 79.8% realization rate, taken from a previous-year's impact study, to all HPwES kWh savings and a 36.5% realization rate to kW savings. EVT applied a 55.1% realization rate to MMBtu savings. Because these realization rates were applied before

EVT claimed savings and to remain consistent with previous-year evaluations, Cadmus passed through HPwES claimed savings at a 100% realization rate.

Residential New Construction

Residential New Construction accounted for 1% of the residential sector's evaluated kWh and rounded to 0% of the total portfolio savings. Custom thermal measures such as insulation generated 94% of energy savings for the program in 2019. As mandated by the Vermont TRM, savings for these measures were determined by comparing the results of a REM/*Rate* model of the house as built with those from a model corresponding to a house constructed to code. To evaluate claimed savings, Cadmus generated REM/*Rate* results using inputs (such as insulation levels) provided by EVT.

Approximately 6% of Residential New Construction kWh savings resulted from prescriptive measures, such as ENERGY STAR appliances. Cadmus produced evaluated savings estimates using methods defined for each measure in the Vermont TRM.

Residential Upstream

Table 2 shows Residential Upstream savings for two program components: Smartlight and Upstream HVAC (with heat pump water heaters). Claimed savings for residential Smartlight increased from 4.7 GWh in 2018 to 7.6 GWh in 2019, an increase of 62%. Smartlight measures accounted for 53% of claimed savings for the Residential Upstream.

In the Upstream HVAC and Heat Pump Water Heaters component, cold climate heat pumps continued to show strong savings in 2019, accounting for 71% of Upstream HVAC and Heat Pump Water Heater energy savings. Heat pump water heaters also showed strong savings, contributing 24% of Residential Upstream HVAC and Heat Pump Water Heater savings.

Upstream HVAC and Heat Pump Water Heaters accounted for 41% of the MMBtu savings of the portfolio (not including C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP project savings funded by TEPF, which are not included in the main body of this report). These Upstream HVAC and Heat Pump Water Heaters MMBtu savings resulted from TEPF-funded measures for space heating and water heating, such as the installation of heat pump water heaters and wood pellet stoves.

For Residential Upstream measures, EVT relied on deemed values defined by the TRM (rather than TRM methods requiring more inputs), and Cadmus used the same deemed values.

Sampling

Cadmus developed a sampling plan for the C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP groups, as described below, based on the Uniform Methods Project Sample Design and Cross-Cutting Protocols chapter.¹

Sample Frame

Cadmus used project numbers to identify the population and sampling units for C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP. The evaluation examined the projects' total reported non-TEPF-sponsored kWh savings to determine projects eligible for sampling. Cadmus removed projects from the sample frame if they exhibited zero non-TEPF-funded kWh, winter kW, summer kW, MMBtu, and water savings.

Stratified Random Sample

Cadmus used a stratified random sample design for this evaluation, similar to that used for the previous evaluation. Table 4 provides an overview of sample design for each program group. Cadmus defined stratum boundaries according to the projects' total reported non-TEPF-sponsored kWh savings. Table 4 lists the savings range for each stratum as the population minimum and maximum kWh. Cadmus calculated the coefficient of variation within each stratum based on the mean and standard deviation of reported energy savings. Cadmus then calculated sample sizes based on the coefficient of variation, the population size, and the 80% confidence and $\pm 20\%$ precision targets within each stratum. For each program group as a whole, the minimum confidence and precision target was 90%/ $\pm 15\%$.

The sample design yielded samples of 24 C&I/Multifamily Custom Retrofit projects and 23 C&I/Multifamily Custom NC/MOP projects. To focus evaluation resources on projects that produced the highest savings and contributed the most to program totals, Cadmus evaluated a census of projects within the largest projects strata (Stratum 4) and evaluated no projects in the strata with the smallest projects (Stratum 0). Overall, sampled projects accounted for 47% of the total C&I/Multifamily Custom Retrofit kWh savings and 54% of the total C&I/Multifamily Custom NC/MOP kWh savings.

¹ Cadmus (M. Sami Khawaja, Josh Rushton, and Josh Keeling). April 2013. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. "Chapter 11: Sample Design Cross-Cutting Protocols." Prepared for the National Renewable Energy Laboratory. NREL/SR-7A30-53827. <https://www.energy.gov/sites/prod/files/2013/11/f5/53827-11.pdf>

Table 4. Overview of the Sample

Program Group	Stratum	Pop. Min kWh	Pop. Max kWh	Total Projects ^a	Projects in Sample	Sample kWh Total	Pop. kWh Total	% Sample kWh per Stratum Pop.
C&I/ Multifamily Custom Retrofit	0	-5,632	42,089	134	0	0	1,609,295	0%
	1	42,090	106,461	34	3	161,492	2,087,180	8%
	2	106,462	217,946	22	4	660,458	3,482,572	19%
	3	217,947	357,581	18	5	1,633,337	5,323,151	31%
	4	357,582	790,609	12	12	6,432,740	6,432,740	100%
Subtotal				220	24	8,888,027	18,934,938	47%
C&I/ Multifamily Custom NC/MOP	0	254	41,996	138	0	0	1,729,005	0%
	1	41,997	114,821	32	4	302,791	2,263,068	13%
	2	114,822	188,054	19	4	523,755	2,716,781	19%
	3	188,055	318,088	13	4	913,165	3,157,762	29%
	4	318,089	1,777,528	11	11	7,716,469	7,716,469	100%
Subtotal				213	23	9,456,180	17,583,085	54%
Total				433	47	18,344,207	36,518,024	50%

^a This represent the number of projects with non-zero kWh, winter peak demand reduction, summer peak demand reduction, MMBtu, or water savings not provided by TEPF-funded measures

Calculation of Realization Rates

Table 5 shows the sample weights calculated for each sample stratum. Cadmus applied these weights to savings for each sampled project to estimate population total savings. The expansion weights equal the ratio of the total number of projects in each stratum to the number of sampled projects in that stratum. For example, for Stratum 1 in the NC/MOP program group, the expansion weight of 8.00 results from dividing 32 by 4.

Table 5. Expansion Weight by Stratum

Program Group	Stratum	Total Number of Projects ^a	Projects in Sample	Expansion Weight
C&I/Multifamily Custom Retrofit	0	134	0	0
	1	34	3	11.33
	2	22	4	5.50
	3	18	5	3.60
	4	12	12	1.00
C&I/Multifamily Custom NC/MOP	0	138	0	0
	1	32	4	8.00
	2	19	4	4.75
	3	13	4	3.25
	4	11	11	1.00

^a This represents the number of projects with non-zero kWh, winter peak demand reduction, summer peak demand reduction, MMBtu, or water savings not provided by TEPF-funded measures.

Using the following equation, Cadmus calculated realization rates for the population's total savings (based on the expansion weights), evaluated savings for each sampled project, and claimed savings for each sampled project:

$$\text{Realization Rate} = \frac{\sum_{\text{sample}} w_{h(i)} * y_i}{\sum_{\text{sample}} w_{h(i)} * x_i}$$

Where:

Realization Rate = The ratio of evaluated savings to claimed savings

h = Stratum number

i = Project number

$w_{h(i)}$ = Expansion weight of stratum for project 'i'

y_i = Evaluated savings for project 'i'

x_i = Claimed savings for project 'i'

Cadmus used the equation provided above to calculate the realization rate for each savings component (such as kWh, winter demand reduction, and summer demand reduction) of each program group (C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP).

To avoid interactions of negative and positive MMBtu savings, Cadmus applied the equation above separately to projects with negative MMBtu savings and positive MMBtu savings. Cadmus then applied the realization rate for projects with negative MMBtu savings to the claimed MMBtu values of all such projects in the population to estimate total negative evaluated MMBtu savings. Cadmus applied the realization rate for projects with positive MMBtu savings to the claimed MMBtu values for all projects with positive savings to estimate the total positive evaluated MMBtu savings. Finally, the team calculated the overall realization rate for each program group by summing the total estimated negative and positive evaluated savings and dividing that sum by the total negative and positive claimed MMBtu savings.

Adjustments

Cadmus identified necessary adjustments in each program group, though realization rates for all savings categories remained close to 100% for the portfolio as a whole. This section summarizes adjustments made within each program group.

Commercial and Industrial/Multifamily Custom Retrofit

As shown in Table 6, savings adjustments resulted in lower evaluated kWh savings and higher evaluated winter and summer kW reduction within the C&I/Multifamily Custom Retrofit program group.

Table 6. Commercial and Industrial/Multifamily Custom Retrofit Adjustments

Program Group	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed MWh ^a	Realization Rate	EVT Gross Claimed kW ^a	Realization Rate	EVT Gross Claimed kW ^a	Realization Rate
Custom Retrofit	18,935	97.6%	2,192	106.5%	2,032	108.9%

^a These totals exclude any contributions from TEPF-funded measures.

Table 7 lists all sampled C&I/Multifamily Custom Retrofit projects that Cadmus identified as requiring project-specific adjustments and includes a summary of those adjustments. Three large, Stratum 4 projects with extremely high realization rates for winter and summer peak demand reduction drove the high realization rates for the peak demand reduction values. With these projects, EVT had mistakenly entered the coincidence factors for winter and summer as 1% rather than 100%, causing claimed winter and summer kW reduction to be roughly 1% of the intended values.

Cadmus provided detailed reports for all projects in the largest-savings stratum to PSD and EVT during the evaluation process. As described in this report's *Sampling* section, the team then used evaluated and claimed savings for each project in the sample to calculate realization rates for the program group as a whole.

Table 7. Sampled Commercial and Industrial/Multifamily Custom Retrofit Projects with Adjustments

EVT Project ID	Stratum	Gross Claimed kWh	kWh RR	Winter kW RR	Summer kW RR	Reason for Adjustment
463680	4	481,198	94.9%	68.1%	68.8%	Reduced savings because of insufficient documentation; reported savings appear to have used wrong load reduction value.
464080	4	545,118	41.4%	77.9%	77.9%	Adjusted motor load and runtime assumptions using operational data
466393	4	887,267	119.8%	113.2%	80.5%	Used custom calculations instead of TRM deemed values
467362	4	568,526	95.2%	68.9%	68.9%	Eliminated double-counted savings for pressure reduction
469903	4	944,658	78.2%	93.6%	89.3%	Reduced lighting hours of use and percentage savings from heater controls

EVT Project ID	Stratum	Gross Claimed kWh	kWh RR	Winter kW RR	Summer kW RR	Reason for Adjustment
469904	4	449,211	78.5%	95.7%	91.0%	Eliminated anti-sweat heater control savings because of lack of documentation
472772	4	478,784	101.1%	81.2%	76.9%	Adjusted peak demand savings based on pre- and post-installation metering data
475294	4	790,609	87.8%	91.0%	81.9%	Reduced savings of door heater controls and reduced lighting savings because of insufficient documentation
475816	4	491,160	94.5%	100.1%	99.0%	Reduced annual operating hours for lighting based on 15-minute interval electric meter data
475817	4	628,727	83.2%	95.9%	98.6%	Reduced hours of use for lighting based on screenshots of the lighting control panel and reduced savings because of insufficient documentation
485339	4	632,930	94.7%	96.8%	92.7%	Adjusted fixture wattages and the number of fixtures controlled by occupancy sensors
488053	4	532,013	100.0%	46.7%	46.7%	Corrected the baseline condition used for calculating coincident peak demand reduction
492665	4	507,830	104.0%	104.2%	104.3%	Adjusted the post-installation lighting trim from 80% to 70% based on project documentation
493578	4	546,531	98.8%	797.3%	5139.6%	Claimed savings used lighting coincidence factors of 1% instead of 100%, because of a data entry error
493579	4	524,584	100.0%	837.5%	5118.1%	Claimed savings used lighting coincidence factors of 1% instead of 100%, because of a data entry error
493580	4	417,682	100.0%	823.7%	5089.7%	Claimed savings used lighting coincidence factors of 1% instead of 100%, because of a data entry error
463682	3	322,111	100.0%	116.6%	109.8%	Adjusted lighting coincidence factors to 100% based on business hours of operation
481080	3	313,166	100.0%	101.0%	98.1%	Used a more precise method to determine load reduction and applied lighting coincidence factors of 100%, based on business hours of operation
482045	1	55,546	70.9%	70.9%	64.8%	Adjusted baseline for the heat recovery ventilation system not to use winter assumptions throughout the year

Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity

As shown by the realization rates in Table 8. Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity Adjustments

, adjustments to the C&I/Multifamily Custom NC/MOP program group resulted in lower evaluated kWh savings and lower evaluated winter and summer demand reduction.

Table 8. Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity Adjustments

Program Group	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed MWh ^a	Realization Rate	EVT Gross Claimed kW ^a	Realization Rate	EVT Gross Claimed kW ^a	Realization Rate
Custom NC/MOP	17,583	94.4%	2,305	99.9%	2,200	97.8%

^a These totals exclude any contributions from TEPF-funded measures.

Table 9. Sampled Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity Projects with Adjustments

lists all sampled C&I/Multifamily Custom NC/MOP projects that Cadmus identified as requiring project-specific adjustments. The table includes a summary of adjustments for each project.

Cadmus provided PSD and EVT with detailed reports for all projects in the largest-savings stratum during the evaluation process. As described in this report's *Sampling* section, the team used evaluated and claimed savings for each project in the sample to calculate realization rates for the program group as a whole.

Table 9. Sampled Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity Projects with Adjustments

EVT Project ID	Stratum	Gross Claimed kWh	kWh RR	Winter kW RR	Summer kW RR	Reason for Adjustment
449781	4	1,777,529	88.7%	86.5%	79.2%	Adjusted full load motor load, corrected peak demand analysis, and adjusted compressor run-time and loading based on project documentation
432039	4	1,595,966	98.2%	139.4%	91.9%	Corrected inputs to calculation tools and used ERV tool to calculate demand savings
472722	4	658,848	95.7%	158.1%	119.2%	Corrected adjustment factors and load shapes and reduced savings because of insufficient documentation
478779	4	583,517	99.0%	123.9%	122.6%	Used day-type methodology to calculate actual summer and winter demand during peak hours
481947	4	364,265	24.5%	24.5%	14.9%	Made multiple corrections to savings calculations and eliminated MMBtu savings

EVT Project ID	Stratum	Gross Claimed kWh	kWh RR	Winter kW RR	Summer kW RR	Reason for Adjustment
						and efficient defrost strategy savings, which were not supported by product documentation
465733	4	363,223	89.4%	81.3%	80.3%	Adjusted fixture wattages based on invoices and specification sheets
487454	4	344,587	65.8%	57.0%	65.8%	Adjusted baseline efficiency of one system, eliminated ineligible savings for floating head pressure control, and used different methodology for calculating peak coincident demand reduction
487258	4	326,718	99.6%	99.7%	N/A	Corrected weighted average efficiency of the air compressors used to make snow
489724	4	325,403	90.5%	80.1%	79.8%	Changed the control type of baseline compressor based on product documentation, and used a more precise method of calculating coincident peak demand reduction
468342	3	266,582	120.3%	134.4%	120.8%	Used custom calculations and modeled the expected post-installation demand
479453	3	262,437	95.0%	95.0%	95.0%	Reduced savings because of insufficient documentation
482955	3	191,928	101.1%	99.9%	99.8%	Adjusted efficiency of refrigeration-system compressor
434662	2	167,791	45.8%	36.7%	93.0%	Claimed savings calculated baseline exterior wattage at the perimeter of a facility using the facility square footage of the facility instead of linear feet of the perimeter
480829	2	116,188	89.1%	87.4%	93.8%	Used TRM savings for correct fan horsepower, used peak demand reduction from ERV calculator, corrected input error for water savings, and reduced savings because of insufficient documentation
481134	2	116,400	140.3%	406.7%	406.7%	Adjusted assumptions for baseline compressor and used a different methodology to estimate peak coincident demand reduction
454267	1	45,548	94.6%	42.8%	42.4%	Removed peak demand reduction for the smart defrost measure and reduced savings because of insufficient documentation
481098	1	112,775	100.0%	100.8%	99.0%	Used more significant digits than claimed savings calculations.

Commercial and Industrial/Multifamily Prescriptive

In the C&I/Multifamily Prescriptive program group, evaluated savings tracked closely with reported savings for lighting and non-lighting. Table 10 summarizes adjustments to kWh and winter and summer kW.

Table 10. Commercial and Industrial/Multifamily Prescriptive Adjustments

Program Component	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Prescriptive Lighting	3,763,381	99.8%	721	100.0%	557	100.0%
Prescriptive Non-Lighting	152,283	98.2%	23	98.7%	18	98.0%
Total	3,915,664	99.7%	744	100.0%	575	99.9%

Adjustments to non-lighting measures resulted mostly from claimed savings calculations using higher deemed savings than provided in the TRM for one variant of commercial refrigerator.

Cadmus provided information about measure-level adjustments to PSD and EVT as part of the evaluation and quality control processes.

Commercial and Industrial/Multifamily Efficient Products

Realization rates for C&I/Multifamily Efficient Products measures stayed close to 100% for each savings component. Table 11 summarizes adjustments to kWh and winter and summer kW.

Table 11. Commercial and Industrial /Multifamily Efficient Products Adjustments

Program Group	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Efficient Products	7,958,003	100.0%	726	100.2%	1,475	99.9%

Notable adjustments were necessary to only two measures with relatively low quantities—LED outdoor fixtures and advanced thermostats. With LED outdoor fixtures, claimed savings calculations used coincidence factor from an indoor load shape with cooling bonus instead of coincidence factor for commercial outdoor lighting. With two advanced thermostat variants, claimed savings calculations used a smaller demand load value or different coincidence factor values than provided in the TRM.

Cadmus provided information about measure-level adjustments to PSD and EVT as part of the evaluation and quality control processes.

Commercial and Industrial/Multifamily Upstream

As shown in Table 12, evaluated savings for the C&I/Multifamily Upstream measures tracked closely with claimed savings, with an energy realization rate of 100.0% and winter and summer peak demand reduction realization rates of just above 100%.

Table 12. Commercial and Industrial/Multifamily Upstream Adjustments

Program Component	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Smartlight	19,263,119	100.0%	2,178	101.4%	3,043	102.0%
Upstream HVAC	1,284,683	100.0%	184	100.0%	50	100.2%
Total	20,547,803	100.0%	2,363	101.2%	3,093	101.9%

The realization rate for Smartlight winter and summer peak demand reduction were greater than 100% because claimed savings for several measures used lower demand reduction (kW load) values than provided in the 2019 TRM.

As part of the evaluation and quality control processes, Cadmus provided information about measure-level adjustments to PSD and EVT.

Residential Efficient Products

Realization rates also remained close to 100% for the Lighting and Non-Lighting components of Residential Efficient Products. Table 13 summarizes the necessary adjustments.

Table 13. Residential Efficient Products Electric Adjustments

Program Component	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Lighting	18,781,195	100.0%	5,666	100.0%	1,555	99.8%
Non-Lighting	6,043,449	100.1%	915	100.0%	954	100.0%
Total	24,824,644	100.0%	6,580	100.0%	2,509	99.9%

For the Lighting component, the only notable adjustment involved LED agricultural grow lights. With some variants labeled as having unknown cycles, claimed savings used a deemed value for four cycles; Cadmus applied a more conservative value that assumes two to three cycles. Non-lighting measures requiring adjustments included some advanced thermostat variants, for which claimed savings calculations applied coincidence factors from the wrong load shapes.

Cadmus provided information about measure-level adjustments to PSD and EVT as part of the evaluation and quality control processes.

Residential Retrofit/Low-Income Single-Family

Only a small percentage of Residential Retrofit/LISF project measures required adjustments for energy savings or demand reduction. Most discrepancies between claimed and evaluated savings appeared to result from rounding error. In one case, claimed savings calculations used a demand reduction value for the remaining life of the early replacement refrigerator rather than for the first three years. Table 14 summarizes the necessary adjustments.

Table 14. Residential Retrofit/Low Income Single Family Adjustments

Program Component	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Residential Retrofit/LISF	2,365,243	99.9%	519	100.2%	213	100.0%
HPwES	212,594	100.0%	29	100.0%	0	100.0%
Total	2,577,837	99.9%	548	100.2%	213	100.0%

EVT applied a 79.8% realization rate to energy savings and a 36.5% realization rate to demand reduction for all HPwES projects before claiming savings. Cadmus accepted those claimed savings with a 100% realization rate.

As shown in Table 15, the HPwES program component accounted for most Residential Retrofit/LISF MMBtu savings. EVT applied a 55.1% realization rate to MMBtu savings for all HPwES projects before claiming savings. Measures in the Residential Retrofit and LISF tracks accounted for all water savings.

Table 15. Residential Retrofit/ Low-Income Single-Family Total Resource Benefit Adjustments

Program Component	MMBtu Saved		Water Saved	
	EVT Gross Claimed MMBtu	Realization Rate	EVT Gross Claimed CCF	Realization Rate
Residential Retrofit/LISF	8,436	100.0%	14,423	96.3%
HPwES	10,222	100.0%	0	N/A
Total	18,658	100.0%	14,423	96.3%

Cadmus provided information about measure-level adjustments to PSD and EVT as part of the evaluation and quality control processes.

Residential New Construction

As shown in Table 16, Residential New Construction received only minor adjustments to energy savings and demand reduction overall.

Table 16. Residential New Construction Adjustments

Program Group	Energy Saved		Winter Demand Reduction		Summer Demand Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Residential New Construction	412,473	99.0%	67	99.3%	10	96.9%

Custom thermal measures (such as insulation and air sealing) produced 94% of energy savings for the Residential New Construction program group in 2019. As shown in Table 17, adjustments to prescriptive measures accounted for all net adjustments in energy savings and winter demand reduction for the Residential New Construction program group. With custom domestic water heater measures, claimed savings incorrectly applied winter peak demand reduction to summer peak demand reduction, which led to the 98.8% summer kW reduction realization rate for custom measures.

Savings adjustments for prescriptive measures resulted primarily from eliminating claimed savings for faucet aerators, which were not identified in the TRM as a new construction measure, and from correcting unit energy savings values for a different measure.

Table 17. Residential New Construction Adjustments by Measure Type

Measure Type	Energy Saved		Winter Demand Reduction		Summer Demand Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Residential New Construction Prescriptive	23,131	83.0%	6	92.1%	3	93.1%
Residential New Construction Custom	389,342	100.0%	61	100.0%	7	98.8%
Total	412,473	99.0%	67	99.3%	10	96.9%

As shown in Table 18, custom thermal measures accounted for nearly all Residential New Construction MMBtu savings, while prescriptive measures generated all water savings.

Table 18. Residential New Construction Total Resource Benefit Adjustments

Measure Type	MMBtu Saved		Water Saved	
	EVT Gross Claimed MMBtu	Realization Rate	EVT Gross Claimed CCF	Realization Rate
Residential New Construction Prescriptive	75	70.0%	470	69.1%
Residential New Construction Custom	3,037	100.0%	0	n/a
Total	3,112	99.3%	470	69.1%

Cadmus provided information about measure-level adjustments to PSD and EVT as part of the evaluation and quality control processes.

Residential Upstream

Table 19 provides energy savings and demand reduction realization rates for the two Residential Upstream program group components: Smartlight and Upstream HVAC measures and Heat Pump Water Heaters.

Table 19. Residential Upstream Adjustments

Program Component	Energy Saved		Winter kW Reduction		Summer kW Reduction	
	EVT Gross Claimed kWh	Realization Rate	EVT Gross Claimed kW	Realization Rate	EVT Gross Claimed kW	Realization Rate
Smartlight	7,628,393	100.0%	1,839	100.0%	387	99.8%
Upstream HVAC	6,865,875	100.0%	1,532	99.4%	253	100.0%
Total	14,494,268	100.0%	3,371	99.8%	640	99.9%

Notable adjustments were required for only two categories of measures in Residential Upstream—one in each component. In the Smartlight component, Cadmus applied coincidence factors from a residential

outdoors load shape to residential LED HID replacement measures instead of applying the residential indoor load shape used for claimed savings. In the Upstream HVAC and Heat Pump Water Heaters component, Cadmus corrected a load reduction value to be negative for replacing a wood stove with a pellet stove, as indicated in the TRM.

No adjustments were necessary for MMBtu savings, summarized in Table 20.

Table 20. Residential Upstream Total Resource Benefit Adjustments

Program Component	MMBtu Saved		Water Saved	
	EVT Gross Claimed MMBtu	Realization Rate	EVT Gross Claimed CCF	Realization Rate
Smartlight	-41	100.0%	0	n/a
Upstream HVAC	36,280	100.0%	0	n/a
Total	36,239	100.0%	0	n/a

As part of the evaluation and quality control processes, Cadmus provided information about measure-level adjustments to PSD and EVT.

Recommended Improvements

The 98.7% energy (kWh) realization rate for the EVT portfolio speaks well for EVT and for the efforts of its implementer, VEIC, in estimating and documenting savings.

Cadmus understands that, as a company entrusted with implementing energy efficiency programs on behalf of Vermonters, EVT strives for continual improvements in its methods and processes. We provide the following recommendations in the spirit of contributing to that effort. While some of these recommendations have been made previously and resulted in improvements overall, Cadmus believes that more progress is possible in addressing these issues.

Custom Commercial, Industrial, and Multifamily Projects

Cadmus performed detailed evaluations of non-TEPF funded measures for 47 custom projects, based on extensive project files submitted by EVT. Individual project reports included recommendations related to calculating savings from specific types of equipment, such as variable frequency drives, snowmaking systems, and refrigerators. The following discussion and recommendations apply to a broader range of technologies and projects.

Consistently collect invoices for installed equipment.

Cadmus continues to strongly encourage EVT to require invoices for all installed equipment to provide support for savings calculations and adequate information for third-party verification. Verification of installed equipment requires itemized invoices for all equipment, as well as submittals and/or detailed and comprehensive equipment photos where practical to document the installed equipment and any relevant control settings. Blueprints and design specifications document the basis of design only and are not sufficient for verification. Where invoices or other necessary documentation for a given project or measure were missing and could not be provided by EVT, Cadmus reduced savings or denied savings altogether.

Consistently document baseline equipment and operating conditions.

Cadmus again stresses the importance of documenting the existing equipment—the equipment in use before installation of the energy-efficient equipment—as well as baseline operating conditions. Documentation of baseline equipment should include photos of the manufacturer nameplates where possible. Reasonable effort should be put into documenting operational characteristics such as hours of use, loading, pressure (with compressed air, for example), and other details.

If baseline equipment runtime or other relevant operational data in doubt, pre-installation metering should be performed, particularly for projects expected to provide large savings. For projects with inadequate documentation of baseline conditions, Cadmus relied on baseline assumptions provided in the TRM where appropriate and used experience and engineering judgement to make reasonable

assumptions. In some cases where savings could not be estimated with reasonable confidence, Cadmus reduced savings by a nominal percentage to account for uncertainty.

Document existing equipment and operating conditions.

Similar to our recommendation just above, Cadmus strongly recommends collecting all existing equipment nameplates and operating parameters relevant to incentivized project energy savings calculations. For example, if a measure is expected to generate savings for space conditioning, then nameplate data (at minimum) should be collected for the relevant HVAC equipment. If a steam trap repair or replacement project results in steam savings, then the corresponding boiler nameplate, efficiency, and operating parameters should be collected to verify savings resulting from the repair. (Although the boiler is not part of the incentivized project, it has a direct impact on savings.) We recommend using actual auxiliary equipment efficiencies instead of TRM values for custom projects.

Avoid using TRM assumptions.

Cadmus encourages EVT to continue its efforts to reduce its reliance on TRM values for custom projects. Wherever practical, EVT should base calculations on actual input values rather than TRM assumptions and should document the source of those inputs. For custom projects, actual values should be readily available from equipment invoices, as-built drawings, cut sheets, nameplates, meter data, and other documentation. Similarly, using performance curves for the specific equipment involved is always preferable to using generic performance curves.

Improve post-installation verification and measurement practices.

EVT should continue to strengthen its use of post-installation metering and site visits to allow for a more accurate understanding of actual savings. Where such data are available, base claimed savings on analysis of the meter data rather than simply using the meter data for information purposes

Consistently provide thorough overview documentation.

Continue to work toward consistently providing thorough project overviews that include all information necessary for an experienced analyst to quickly understand the project scope, how savings were calculated, what inputs and assumptions informed those calculations, and what documentation supports those inputs and assumptions. Where including all this information in the overview proves impractical, the overview should reference additional project documents that provide the necessary information. For larger projects with more than 10 measures, create a summary document with a description and associated savings for each measure (or for each type of measure in a large C&I/Multifamily Custom NC/MOP project), along with a list of relevant documents. Where practical, organize all associated measure documents in individual folders in the online SharePoint site.

Improve online tracker calculation methods.

As discussed during the evaluation, Cadmus found several commercial and industrial custom projects for which incorrect coincidence factors were inadvertently used in the online tracker, causing significant deviations in kW savings. For example, for three projects a value of 1% was mistakenly entered for coincidence factors instead of 100%, resulting in unrealistically low claimed kW savings. Cadmus recommends implementing an automated quality control function in the online tracker to provide range checking for coincidence factors and other sensitive inputs.

Ensure consistency of saving calculation methods.

For steam trap projects (included in the stratified sample of TEPF-funded C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP projects), claimed savings calculations used equations based on Napier's law for some projects and on a DNV GL study for other projects. Some steam trap projects claimed water savings, and some did not. Similarly, for insulation measures, claimed savings used 3E Plus for some projects and a custom, unsourced workbook for others. In both examples, the different approaches resulted in different and inconsistent savings between the two methodologies. Cadmus recommends calculating energy savings with a consistent methodology for each type of measure. This will ensure comparable results across projects and reduce inefficiencies and errors that can result from using multiple evaluation methods for the same type of measures.

Prescriptive Measures

Most or all savings from seven of the nine program groups defined for this evaluation resulted from prescriptive measures. For prescriptive measures, the Vermont TRM documents deemed savings values per unit of product or measure installed, or it defines how savings should be calculated for each unit using available inputs. As indicated by a realization rate close to 100% for most prescriptive program groups, Cadmus found little room for overall improvements in calculating claimed savings for the prescriptive measures.

Evaluating the methods used in the Vermont TRM falls beyond the scope of this project, as does rigorous review of how EVT implements TRM methods to calculate claimed savings. The following recommendations identify a few areas in which the accuracy of claimed savings calculations may be improved using current methods:

Ensure database values that allow for as many significant digits as the TRM.

Ensure that the database per-unit values use the same number of significant digits as values provided in the TRM. Cadmus noted several remaining significant digit issues in the 2019 tracking data, most notably with values for water savings, MMBtu savings, load reduction (kW load), and summer kW coincidence factor.

Ensure that all measures use updated TRM values.

Cadmus noted several instances during the 2019 evaluation of claimed savings using values from a previous year's TRM. Continue efforts to ensure that values are updated as necessary each year for all measures.

Increase rigor in applying the TRM methods when practical.

Increase the use of TRM methods that account for differences in baseline conditions and the products themselves when practical and make less use of deemed values. In some cases, using more rigorous TRM methods would require collecting and managing more data about baseline conditions and the equipment installed.

Database Review and Dataset Generation

EVT provided database tables relevant to the evaluation early in the project cycle to allow Cadmus to construct analysis datasets. Cadmus applauds the extensive, high-quality documentation provided with the database, which easily proved sufficient to allow an experienced database analyst or developer to quickly understand the database content and structure.

Update database documentation.

Continually update documentation to keep it synced with the database structure. Modifying workflow to require documentation updates whenever there are planned changes prior to implementing those changes help ensure that documentation remains current.

Appendix A. Thermal Energy and Process Fuels Findings

A document that is available separately provides findings for C&I/Multifamily Custom Retrofit and C&I/Multifamily Custom NC/MOP savings that are funded by TEPF.

Appendix B. Commercial and Industrial/Multifamily Custom Retrofit Project Reports

A document that is available as a separate attachment provides a report for each census-stratum project that required adjustments in the C&I/Multifamily Custom Retrofit program group, in the sample of projects with savings funded by the Vermont energy efficiency charge

Appendix C. Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity Project Reports

A document that is available as a separate attachment provides a report for each census-stratum project that required adjustments in the C&I/Multifamily Custom NC/MOP program group, in the sample of projects with savings funded by the Vermont energy efficiency charge.

Appendix D. Commercial and Industrial/Multifamily Custom Retrofit Project Reports for Thermal Energy and Process Fuels Funding

A document that is available as a separate attachment provides a report for each census-stratum project that required adjustments in the C&I/Multifamily Custom Retrofit program group, in the sample of projects with savings funded by TEPF.

Appendix E. Commercial and Industrial/Multifamily Custom New Construction and Market Opportunity Project Reports for Thermal Energy and Process Fuels Funding

A document that is available as a separate attachment provides a report for each census-stratum project that required adjustments in the C&I/Multifamily Custom NC/MOP program group, in the sample of projects with savings funded by TEPF.