GDS Associates, Inc.
Engineers and Consultants

# 2013 VERMONT ENERGY EFFICIENCY POTENTIAL STUDY UPDATE

## FINAL REPORT

***Prepared for:***
**VERMONT PUBLIC SERVICE DEPARTMENT**

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# 1 EXECUTIVE SUMMARY

The Vermont Public Service Department (PSD) commissioned GDS Associates, Inc. to conduct a limited update to the 2011 study[1] of the potential for electric energy efficiency to reduce electric consumption and peak demand throughout the State of Vermont. The 2013 edition of the study incorporates several updates, including updates to the load forecasts, avoided costs and energy efficiency measure assumptions. This energy efficiency potential study provides reliable estimates of how much of Vermont's future electric service needs could be met through energy efficiency. The authors of this report emphasize that only energy efficiency measures that have a benefit-cost ratio of greater than or equal to 1.0 under the Vermont societal test are considered to be cost effective.

This technical memorandum presents results from the evaluation of opportunities for energy efficiency programs in the service areas of Vermont's two energy efficiency utilities. The Vermont Public Service Board (Board) has appointed the Burlington Electric Department (BED) as the EEU for the City of Burlington, and the Board has appointed the Vermont Energy Investment Corporation as the EEU for the remainder of the State, under the name "Efficiency Vermont" (EVT). For purposes of this report, "BED" will be used to refer to the area served by the Burlington Electric Department, and "EVT" will be used to refer to the area served by VEIC.

Estimates of technical potential, economic potential, and maximum achievable potential from 2014-2033 (a 20-year period) are provided for the residential and commercial/industrial (C&I) sectors. All results were developed using customized residential and commercial/industrial (C&I) sector-level potential assessment computer models and Vermont-specific cost effectiveness criteria including the most recent Vermont avoided cost projections for electricity and other fuels. The study relied heavily on recent Vermont market assessment reports of residential and commercial building and equipment characteristics. These market assessment reports provided valuable insight regarding the current saturation of electrical equipment and baseline levels of energy efficiency throughout the state of Vermont.

The results of this study provide detailed information on energy efficiency measures that are cost effective and have potential kWh and kW savings. The data used for this report were the best available at the time this analysis was developed.

## 1.1 STUDY SCOPE

The study examines the potential to reduce electric consumption and peak demand through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities. The study assessed energy efficiency potential throughout the EVT and BED service areas over twenty years, from 2014 through 2033.

The study had the following main objectives:

- Update the load forecasts;
- Update the avoided costs;
- Update measure lists and assumptions;
- Review market assessment studies to update baseline saturation data

[1] http://publicservice.vermont.gov/sites/psd/files/Topics/Energy_Efficiency/Energy%20Efficiency%20Potential%202011.pdf

- Re-evaluate the maximum achievable potential for the 2014-2033 timeframe

The scope of this study distinguishes among three types of energy efficiency potential; (1) technical, (2) economic, and (3) maximum achievable. The definitions used in this study for energy efficiency potential estimates are as follows:

- **Technical Potential** is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.[2]
- **Economic potential** refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.[3]
- **Achievable potential** is the amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficiency equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[4] The achievable potential for this study is a maximum achievable potential because the incentives are assumed to be 100% of the measure incremental cost.

*Limitations to the scope of study:* As with any assessment of energy efficiency potential, this study necessarily builds on a large number of assumptions, including the following:

- Energy efficiency measure lives, measure savings and measure costs
- The discount rate for determining the net present value of future savings
- Projected penetration rates for energy efficiency measures
- Projections of electric generation avoided costs for electric capacity and energy
- Projections of avoided costs for externalities (e.g. carbon)
- Projections of avoided costs for other fuels (heating oil, natural gas, propane)
- Electric transmission and distribution avoided costs
- Project budgetary limitations prevented GDS from performing a full-scale update

[2] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies", page 2-4.
[3] Id.
[4] Id.

While the authors have sought to use the best available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different results. Furthermore, while the lists of measures examined in this study represent most commercially available measures, as well as several measures that are considered emerging technologies, these measure lists are not exhaustive.

## 1.2 RESULTS OVERVIEW

Figure 1-1, presented below, shows that cost effective electric energy efficiency resources can play a significantly expanded role in the Vermont energy resource mix over the next 20 years. For the total State of Vermont, the technical potential for energy efficiency is 30.0% of forecasted kWh sales in 2033, twenty years from now.[5] The energy efficiency economic and achievable potential in 2033 are 27.7% and 23.4% of forecasted kWh sales in 2033. The technical, economic and achievable electric demand savings for the state as a whole are 22.4%, 21.3% and 17.8% respectively, of forecasted winter peak demand in 2033. The technical, economic and achievable electric demand savings for the state as a whole are 23.1%, 22.2% and 18.1%, respectively, of forecasted summer peak demand in 2033.

**Figure 1-1: 2033 DSM Potential Savings Summary for State of Vermont**
**(DSM Potential as a Percent of Forecasted Vermont kWh Sales in 2033)**

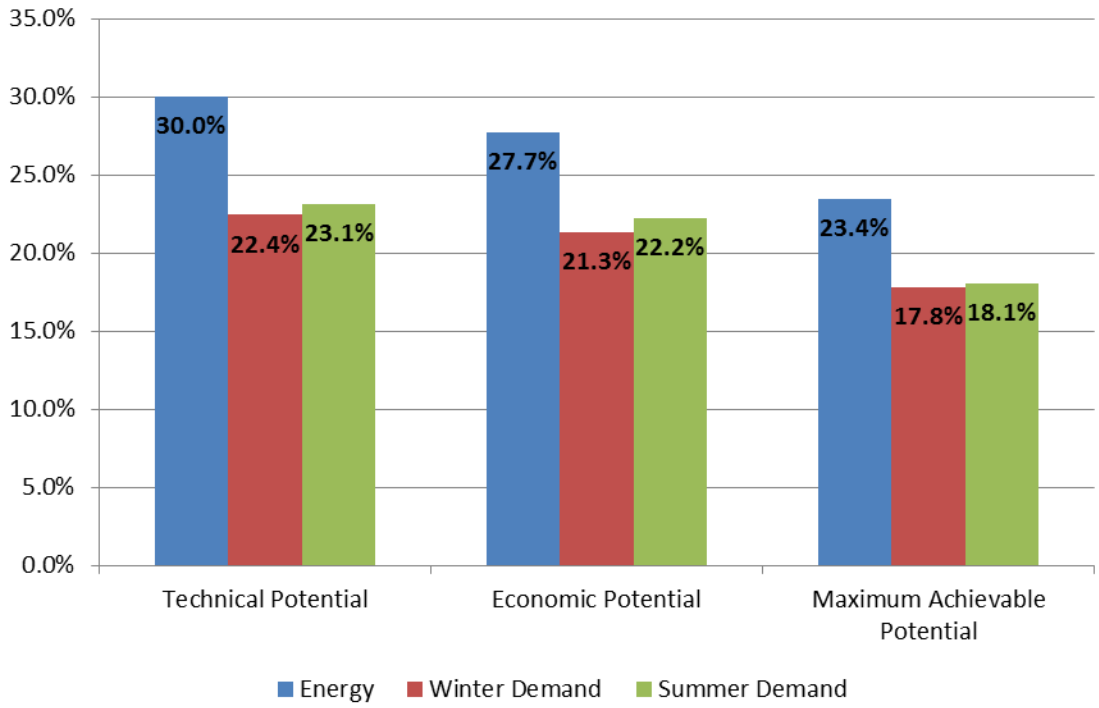



Table 1-1 below presents detailed information on the technical, economic and achievable energy efficiency savings potential for all sectors combined for the BED service area, for the EVT service area, and for the BED and EVT service areas combined. Further information on the energy efficiency potential by sector is provided in Sections 3 and 4 of this memorandum.

[5] All energy and demand savings presented in this report are at the end-consumer (meter) level unless specifically noted otherwise in this report.

**Table 1-1: DSM Potential Savings Detail (by Region and Customer Class)**

| | MWh | % of 2033 MWh Sales | Winter MW | % of 2033 Winter Peak | Summer MW | % of 2033 Summer Peak |
|---|---|---|---|---|---|---|
| **All Sectors Combined** | | | | | | |
| ***State-wide*** | | | | | | |
| Technical Potential | 1,857,938 | 30.0% | 248 | 22.4% | 296 | 23.1% |
| Economic Potential | 1,713,770 | 27.7% | 235 | 21.3% | 285 | 22.2% |
| Maximum Achievable Potential | 1,450,000 | 23.4% | 197 | 17.8% | 232 | 18.1% |
| ***EVT*** | | | | | | |
| Technical Potential | 1,736,976 | 30.2% | 232 | 22.4% | 279 | 23.2% |
| Economic Potential | 1,602,098 | 27.8% | 221 | 21.3% | 268 | 22.3% |
| Maximum Achievable Potential | 1,351,816 | 23.5% | 184 | 17.7% | 218 | 18.1% |
| ***BED*** | | | | | | |
| Technical Potential | 120,962 | 28.4% | 15 | 23.3% | 18 | 21.3% |
| Economic Potential | 111,673 | 26.2% | 15 | 22.4% | 17 | 20.5% |
| Maximum Achievable Potential | 98,184 | 23.0% | 12 | 19.1% | 14 | 17.5% |
| **Residential Sector** | | | | | | |
| ***State-wide*** | | | | | | |
| Technical Potential | 992,767 | 40.4% | 166 | 33.3% | 183 | 40.1% |
| Economic Potential | 914,996 | 37.2% | 156 | 31.2% | 174 | 38.1% |
| Maximum Achievable Potential | 723,116 | 29.4% | 124 | 24.8% | 131 | 28.7% |
| ***EVT*** | | | | | | |
| Technical Potential | 948,381 | 40.0% | 158 | 33.0% | 175 | 39.9% |
| Economic Potential | 873,819 | 36.9% | 148 | 30.9% | 166 | 38.0% |
| Maximum Achievable Potential | 689,083 | 29.1% | 117 | 24.5% | 125 | 28.5% |
| ***BED*** | | | | | | |
| Technical Potential | 44,387 | 49.1% | 8 | 41.2% | 8 | 45.2% |
| Economic Potential | 41,177 | 45.6% | 8 | 39.0% | 8 | 42.6% |
| Maximum Achievable Potential | 34,033 | 37.7% | 6 | 31.4% | 6 | 33.3% |
| **Commercial/Industrial Sector** | | | | | | |
| ***State-wide*** | | | | | | |
| Technical Potential | 865,171 | 22.2% | 82 | 13.5% | 114 | 13.7% |
| Economic Potential | 798,774 | 20.5% | 80 | 13.2% | 111 | 13.4% |
| Maximum Achievable Potential | 726,884 | 18.6% | 73 | 12.0% | 101 | 12.2% |
| ***EVT*** | | | | | | |
| Technical Potential | 788,596 | 22.1% | 75 | 13.4% | 104 | 13.7% |
| Economic Potential | 728,278 | 20.4% | 73 | 13.1% | 102 | 13.3% |
| Maximum Achievable Potential | 662,733 | 18.6% | 67 | 11.9% | 92 | 12.1% |
| ***BED*** | | | | | | |
| Technical Potential | 76,575 | 22.8% | 7 | 15.3% | 10 | 14.8% |
| Economic Potential | 70,495 | 21.0% | 7 | 14.9% | 9 | 14.5% |
| Maximum Achievable Potential | 64,151 | 19.1% | 6 | 13.6% | 9 | 13.2% |

Table 1-2 below presents the results of the Vermont Societal Test calculations for the achievable potential for three areas: the BED service area, the EVT service area, and the combined service areas of EVT and BED. It is clear that the level of kWh and kW savings represented by the achievable potential is very cost effective, with a Societal Test benefit/cost ratio for the overall state of 3.6 to 1. This means that for every dollar spent by Vermont ratepayers on energy efficiency programs, approximately $3.60 of societal benefits are accrued.

**Table 1-2: VT Societal Test Benefits & Costs (Achievable Potential - All Sectors Combined)**

| | Benefits (in Millions) | Cost (in Millions) | B/C Ratio |
|---|---|---|---|
| **Statewide** | | | |
| NVP $2014 | $4,240.6 | $1,188.9 | 3.6 |
| **EVT Territory** | | | |
| NVP $2014 | $4,001.5 | $1,116.1 | 3.6 |
| **BED Territory** | | | |
| NVP $2014 | $239.1 | $72.8 | 3.3 |

# 2 KEY UPDATES TO THE 2013 VERMONT ELECTRIC ENERGY EFFICIENCY POTENTIAL STUDY

This section briefly discusses the key updates to the 2013 potential study. The load forecasts, avoided costs and other general modeling assumptions, measure lists and measure assumptions, and sector analysis methodologies have been revised and updated to varying degrees since the release of the previous potential study in 2011.

## 2.1 LOAD FORECAST UPDATE

The PSD and BED each provided load forecasts, for the state as a whole and the BED service area, respectively, that assume no future energy efficiency programs. The compound annual average growth rate for total annual kWh sales under these hypothetical "no-DSM" forecasts is hovering just over 1% growth annually over the study timeframe. The expected growth rate for kWh sales is slightly higher for the state overall compared to the BED service area. For more details regarding the new statewide load forecast, refer to the separate load forecast update memo which compares the 2011 forecast to the current forecast. This document is included as Attachment A.

It is important to note that the load forecast for the state includes the OMYA portion of the forecast. GDS understands that the OMYA energy efficiency potential will not count towards any statewide goals, but the forecast includes the OMYA load forecast in order to allow for the calculation of the total cost to achieve the non-residential energy efficiency potential in the state of Vermont. Section 4.4 of the memo provides the estimates of non-residential energy efficiency potential, and includes a discussion of the OMYA contribution to the total non-residential sector energy efficiency potential.

## 2.2 AVOIDED COSTS UPDATE

The avoided electric and non-electric supply costs for this Vermont energy efficiency potential study consist of the electric supply costs avoided due to the implementation of electric energy efficiency programs. These assumptions have been revised since 2011. For example, the avoided costs of non-electric fuels now include benefits for avoided carbon emissions (previously only the electric avoided costs factored in avoided carbon emissions). GDS factored the avoided carbon emissions into the avoided costs at the direction of the PSD. For more details regarding the new revised avoided costs and other general modeling assumption revisions, refer to the separate avoided cost update memo GDS which compares the 2011 assumptions to the 2013 assumptions. This document is included as Attachment B.

## 2.3 MEASURE LIST UPDATE

Energy efficiency measure lists were based savings listed in the latest Vermont Technical Reference Manual[6] as well as the analysis team's existing knowledge and current databases of electric end-use technologies and energy efficiency measures, and were supplemented as necessary to include other technology areas of interest to the PSD staff, VEIC and BED. The study scope included measures and practices that are currently commercially available as well as emerging technologies. The commercially available measures should be of most immediate interest to energy efficiency program planners.

[6] Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, November 4, 2013.

Per the scope of the study, GDS generally limited the measure list update to updating measures listed in the TRM and to be consistent with the previous potential study. GDS did perform research on several emerging technologies such as cold-climate ductless mini-split heat pumps, solar water heaters, and smart thermostats to identify new savings opportunities and to update previous assumptions with more current estimates of savings.

## 2.4 MEASURE CHARACTERIZATION UPDATE

### 2.4.1 Savings, costs, and Useful Lives

The measure characterization update was primarily focused on updating the modeling assumptions from the previous potential study which were from the TRM. VEIC provided an updated version of the TRM which GDS used to perform these updates. GDS also researched TRMs from other states and evaluation reports to help populate the database with the most current assumptions possible that are relevant in the state of Vermont. GDS updated the modeled energy savings for several weatherization and HVAC equipment measures based on updated information on housing characteristics in the state which were identified through the most recent and available statewide baseline studies. The costs and useful lives were reviewed and updated as necessary.

### 2.4.2 Residential Lighting

In the 2011 study, residential energy efficiency savings potential took into account scheduled federal upgrades to the energy efficiency of incandescent lighting. These energy efficiency standards assumed required improvements to incandescent technology beginning in both 2013 as well as 2020. The 2011 study assumed that the required 2020 improvements to federal lighting standards would shift the market so that CFL bulbs would become the new baseline. In addition, the 2011 study used the latest available declining cost projections for LED lighting at that time.

The 2013 study modified the lighting input assumptions to account for more up-to-date cost projections for LED lighting through 2020. The 2013 analysis also incorporates an annual shift in LED bulb purchases compared to CFL bulbs over the next two decades. The 2013 update assumed LED sales will be approximately equal to CFL bulb purchases beginning in 2017, and will be the dominant bulb type for all installations in subsequent years. Finally, the 2013 study includes LED specialty bulbs as an alternative to CFL-specialty bulbs.

### 2.4.3 Equipment Saturation

In order to assess the amount of energy efficiency savings still available, estimates of the current saturation of baseline equipment and energy efficiency measures are necessary. It is important to note that GDS utilized the same method that was used for the previous study to account for the stock of existing efficient equipment and its effect on the energy efficiency savings potential. GDS evaluated the energy efficiency potential assuming that naturally occurring energy savings are already largely reflected in the electricity sales forecast used in this study. Therefore, the approach recognizes the current saturation of energy efficient equipment as the portion of the market that is not likely to be impacted by future DSM program efforts[7].

**Residential:**
Where possible, EVT baseline equipment and energy efficient equipment saturations were updated from the 2009 Nexus Market Research reports, "Analysis of Onsite Audits in Existing Homes in Vermont

[7] Section 5.11 of the final report provided to the PSD in March 2011 includes a full discussion of this issue as well as the implications of this approach on the energy efficiency potential estimates.

FINAL" (June 2009) and "Overall Report Vermont Residential New Construction Study" (July 2009), to the 2012 Nexus Market Research reports "Vermont Single-Family Existing Homes Overall Report" (June 2013), "Survey Analysis of Owners of Existing Homes in Vermont" (Feb. 2013), "Vermont Multifamily Onsite Report" (June 2013), and the "Vermont Residential New Construction Baseline Study Analysis of On-Site Audits" (June 2013) report. In addition to these documents, GDS also relied on more up-to-date ENERGY STAR unit shipment data reports for select consumer electronic energy efficient equipment saturations.

The BED territory is in the process of completing an updated appliance saturation study. The results of this update were not available at the time of the GDS analysis. As a result, the baseline and energy efficient equipment saturations relied primarily on the prior appliance study conducted for BED by KEMA in 2005. In order to recognize the rapidly changing consumer electronics end-use and efficient lighting market shares, GDS updated the majority of the 2005-vintage consumer electronic and lighting saturations to reflect the results of the 2012 NMR statewide baseline studies.

**Commercial:**
The statewide baseline equipment and energy efficient equipment saturations from the 2011 study were updated in accord with the findings from Navigant's 2011 Vermont Market Characterization and Assessment Studies for Business Sector for Existing Buildings and New Construction. The energy efficient equipment measures were reviewed to incorporate changes in baseline and efficient equipment in the Efficiency Vermont Technical Reference Manual 2013-83 in comparison to the 2010-64 version used in the 2011 potential study.

## 2.5 METHODOLOGICAL UPDATES

In addition to updating the avoided costs, load forecasts, and measure-specific assumptions, the 2013 update also reflects select revisions and refinements to the methodology employed to calculate electric savings potential. As in 2011, the residential sector employed a "bottom-up" approach to calculate potential while the non-residential sector used a "top-down" approach that disaggregates the load forecast in building types, end-uses, and measure-level savings. A full discussion of the methodology to calculate potential savings can be found in the 2011 report. Modifications to the methodology are discussed below.

### 2.5.1 Maximum Achievable Market Adoption

Maximum Achievable Potential describes the economic potential that could be achieved over a given time period under the most aggressive program scenario. Achievable potential takes into account barriers that hinder consumer adoption of energy efficiency measures such as financial, political and regulatory barriers, the administrative and marketing costs associated with efficiency programs, and the capability of programs and administrators to ramp up activity over time.

**Residential:**
In the maximum achievable scenario, achievable potential represents the attainable savings if the market penetration of high efficiency electric appliances and equipment reaches 80%-90% of the eligible market from 2014-2033. The 90% target achievable penetration was assumed for the appliances, appliances/WH, consumer electronics, HVAC (Equipment), and Water Heating end-uses. A target market adoption rate of 80% was assumed for fuel-switching measures, lighting, HVAC (Envelop) and other end-uses. The target market adoption rates assume incentives that are equal to 100% incremental cost (replace-on-burnout, or 100% of the full install cost (retrofit and/or early replacement/retirement). These assumptions were consistent with the 2011 analysis.

The 2013 update does, however, modify the calculated timing for reaching the ultimate market adoption rate. In 2011, the targeted maximum adoption rate was not fully realized until the final year of the analysis (i.e. installations occurred annually, but the full 80%-90% of the remaining eligible market was not achieved until the final year of the analysis). In 2013, the updated model calculates the expected annual turnover of all remaining eligible equipment, and the targeted adoption rate is achieved over the course of the natural replacement of the inefficient equipment.[8] This approach accelerates the achievement of the target market adoption rate for those measures with an effective useful life (EUL) less than the 20-year study period. For example, an energy efficiency measure with a useful life of 10 years would achieve the targeted maximum adoption rate over the initial decade of the analysis in this updated approach. Installations in the second decade of the analysis would serve to maintain the assumed maximum achievable adoption.

**Commercial:**
In the maximum achievable scenario, achievable potential represents the attainable savings if the market penetration of high efficiency electric appliances and equipment reaches 90% of the eligible market from 2014-2033. The target market adoption rates assume incentives that are equal to 100% incremental cost (replace-on-burnout, or 100% of the full install cost (retrofit and/or early replacement/retirement). These assumptions were consistent with the 2011 analysis.

### 2.5.2 Behavioral Program Impacts/Program Lift

Absent energy efficiency impacts through improvements to federal codes and standards, a consumer's choice is critical to market acceptance of energy efficient technologies. Behavioral programs can not only impact a customer's routine behavior (i.e. turning off lights/energy conservation), but can also engage consumers and impact behavior when making purchasing decisions.

**Residential**:
In 2011, behavioral program impacts were analyzed as energy efficiency measure options that would provide additional savings (through conservation) above and beyond the savings achieved through the installation of energy efficiency measures. The 2011 analysis assumed traditional installation of energy efficient technologies would reduce household consumption by ~30% and that behavioral programs could achieve an additional savings of ~1%-3% of annual consumption through conservation savings.

In the 2013 update the Vermont PSD requested that behavior program impacts be quantified based on their ability to educate and encourage Vermont electric consumers to purchase and install additional hard-wired energy efficiency measures (program lift) rather than the potential savings associated with increased conservation associated with changes in human behavior (such as turning off the lights). The PSD indicated to GDS that it is not considering behavioral measures to offer a "real" long term direct resource for energy savings at the present time. For the 2013 update, the PSD indicated that GDS should model the energy efficiency potential using the assumption that program lift associated with behavioral programs would increase the maximum achievable market adoption rate of hard-wired measures by 1% beyond what could be attained solely through the offering of 100% incentives. The logic behind this assumption is that 100% incentives could encourage up to 90% adoption of measures in most end uses, and that behavioral programs could encourage an additional 1% adoption of measures which would not otherwise be realized.

[8] There are two exceptions to this methodology. The methodology was edited to allow all retrofit measure opportunities with a useful life greater than 25 years to be installed over the 20 year period. Additionally, the methodology was edited to allow early retirement opportunities (i.e. secondary refrigerators) to occur over the entire duration of the 20-year analysis time frame.

In an effort to recognize the costs associated with behavioral programs, GDS assumed an average annual cost of $10 per Vermont residential consumer. These costs assume a large-scale rollout that can be directed to nearly all Vermont homeowners versus a more limited or focused approach (i.e. in-home energy displays) that may be more costly to implement. Still, these assumed costs are largely dependent on the scale of a behavioral feedback program roll-out, and may be larger (or smaller) in practice. All costs associated with additional measure installations were included at the specific measure/end-use level.

Additional detail about the impact of behavioral programs/program lift can be found in Section 3.4.

**Commercial**:
The behavioral programs were addressed consistently with the 2011 study. The commercial model is derived from end-use energy allocation and the feedback measures allocate savings to each end-use. The increased equipment adoption due to behavioral program would need to be considered outside the full technical potential modeling.

### 2.5.3 Early Replacement

In the 2011 study, the majority of measures were analyzed under both the replace-on-burnout and early replacement option. In general, 50% of the eligible remaining market was reserved for early replacement. The remaining pool of measures was replaced over the course of a natural replacement cycle, when a piece of equipment is at the end of its useful life. GDS employed the same approach for the 2013 analysis (50/50 early replacement vs. replace on burnout). However, GDS narrowed the list of energy efficiency measures applicable for early replacement to only those included in the Vermont TRM. In the residential sector, early replacement measures were limited to refrigerators, freezers, and clothes washers. In the commercial sector, early replacement was applicable to room air conditioners (list any other measures).

### 2.5.4 Non-Incentive Costs

As noted above, incentives in 2011 and 2013 were assumed to be equal to 100% of the measure cost. In addition, an overall non-incentive or administrative cost per first-year kWh-saved was assigned to each measure in order to determine overall program budgets required to achieve the maximum achievable savings and calculate overall cost-effectiveness. Administrative costs in the 2011 analysis were determined based on the 2007-2009 average of non-incentive costs reported by EVT in their annual report filings[9]. In all subsequent years, the administrative costs per first-year kWh-saved were escalated by the annual rate of inflation. It is important to note that non-incentive costs refer to the Total Efficiency Vermont Cost reported by EVT net of all incentives to participants and/or trade allies. It does not include participant or other third party costs.

**Residential:**
Non-incentive costs for the 2013 update were calculated using the same approach as the 2011 analysis, but were based on the latest available annual report (2012)[10]. Overall, non-incentive costs are slightly

[9] Non-incentive costs refer to the Total Efficiency Vermont Costs reported by EVT net of all incentives to participants and/or trade allies. It does not include participant or other third party costs. Performance incentives and operations fees, along with evaluation budgets are additional costs to deliver programs that are not included in this calculation.
[10] Only 2012 data was utilized because of a change in VEIC accounting practices beginning in 2012. Reliance on non-incentive cost data provided in earlier annual reports would inaccurately reflect the non-incentive portion of Efficiency Vermont's resource acquisition costs.

lower in the 2013 update compared to 2011. A non-incentive cost of $1.36 per first-year kWh-saved was used for all new construction measures based on 2012 annual report for EVT's current Residential New Construction Program (compared to $0.82 in the 2011 study). Appliances, electronics, lighting, and select easy-to-install retrofit measures were assigned an administrative cost of $0.05 per first-year kWh-saved based on the 2012 annual report for the current Residential Efficient Products Program (also ~$0.05 in 2011). All other measures were assigned an administrative cost per first-year kWh-saved of $0.67 based on the latest 2012 annual report for the Residential Existing Building Program (compared to $0.48 in 2011).

**Commercial:**
Non-incentive costs for the 2013 update were calculated using the same approach as the 2011 analysis, but were based on the latest available annual report (2012). The non-incentive costs are $0.13 per first-year kWh-saved for new construction and $0.09 per first-year kWh for existing buildings.

### 2.5.5 Net-to-Gross Assumptions

For this potential study update, GDS utilized the same approach with respect to estimates of free ridership and spillover that were used for the previous study. GDS has assumed a NTG ratio of 1.0 for the non-residential sector. GDS has assumed a NTG ratio of 1.0 for all residential measures with the exception of two lighting measures. GDS has assumed a NTG ratio of 0.6 for standard CFL lighting measures, and a NTG ratio of 0.8 for specialty CFL lighting measures. These estimates are based on a 2013 EVT document titled "Gross-to-Net Factors 2012.[11]"

[11] Section 5.12 of the final report provided to the PSD in March 2011 includes a full discussion of net-to-gross issues.

# 3 RESIDENTIAL ENERGY EFFICIENCY POTENTIAL ESTIMATES (2014 TO 2033)

This section of the report presents the estimates of electric technical, economic, and maximum achievable potential for the state of Vermont as well as the EVT and BED territories separately.

Figure 3-1 and Table 3-1 presented below, summarize the technical, economic, and achievable savings potential (as a % of forecast sales) for the Vermont service area by 2033. The maximum achievable potential estimates are based primarily on a market penetration scenario that targets the installation of energy efficient equipment in 80-90% of the remaining eligible market by 2033. If the targeted market penetration for all remaining eligible cost-effective measures can be reached over the next two decades, the maximum achievable potential for electric energy efficiency savings in this sector is approximately 29.4% of projected residential sales (723,116 MWh). Energy efficiency measures and programs can also serve to lessen peak demand, creating a reduction of roughly 25% of the 2033 residential winter peak (28.7% of the summer peak) in the maximum achievable potential scenario.

**Figure 3-1: Summary of Residential Energy Efficiency Potential as a % of 2033 Forecast – VT Statewide**

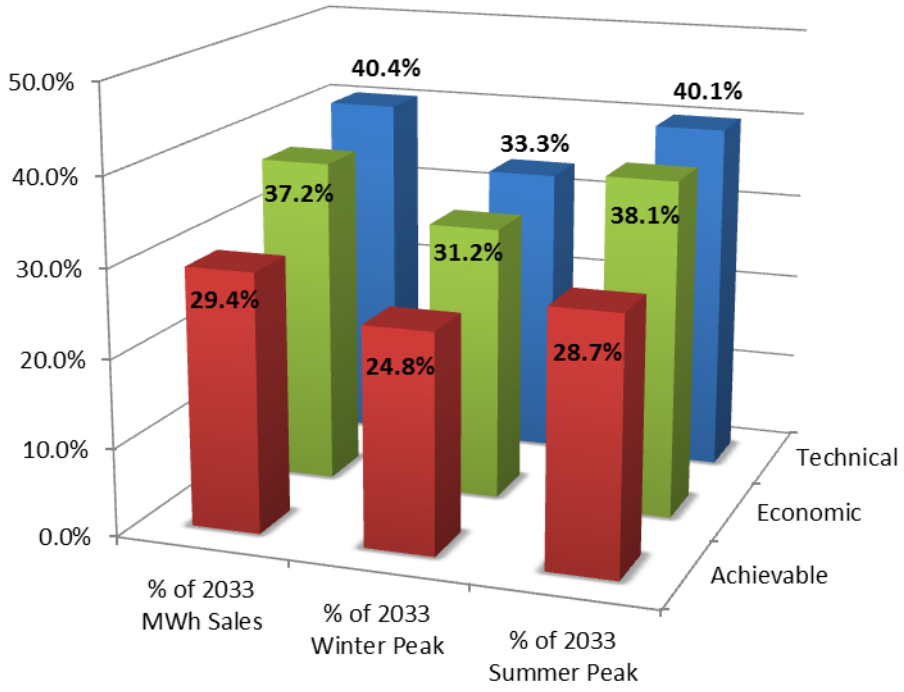



Table 3-1 also presents the separate technical, economic, and maximum achievable estimates for the EVT and BED service territories. In general the BED territory had slightly higher estimates of technical, economic, and achievable potential.[12] Of the combined 723,116 MWh of achievable potential energy

[12] Higher estimates of achievable potential are likely a result of several contributing factors. The BED saturation study was completed in 2005 and may not capture the most recent market changes in energy efficiency measure saturation compared to the 2011 NMR saturation data used in the EVT Territory. In addition, the BED residential load forecast has a lower annual growth rate than the growth rate found in the EVT residential forecast. As a result, the BED energy and demand savings potential appear larger relative to the 2033 BED forecast sales.

savings, the BED territory achievable electric energy savings was 34,033 MWh (37.7% of 2033 BED sales). The EVT territory was estimated to have a maximum achievable potential of 689,083 MWh (29.1% of 2033 EVT territory sales).

**Table 3-1: 2033 Summary of Residential Energy and Demand Savings Potential**

| | Energy | | Demand | | | |
|---|---|---|---|---|---|---|
| | MWh | % of 2033 MWh Sales | Winter MW | % of 2033 Winter Peak | Summer MW | % of 2033 Summer Peak |
| ***State-wide*** | | | | | | |
| Technical Potential | 992,767 | 40.4% | 166 | 33.3% | 183 | 40.1% |
| Economic Potential | 914,996 | 37.2% | 156 | 31.2% | 174 | 38.1% |
| Maximum Achievable Potential | 723,116 | 29.4% | 124 | 24.8% | 131 | 28.7% |
| ***EVT*** | | | | | | |
| Technical Potential | 948,381 | 40.0% | 158 | 33.0% | 175 | 39.9% |
| Economic Potential | 873,819 | 36.9% | 148 | 30.9% | 166 | 38.0% |
| Maximum Achievable Potential | 689,083 | 29.1% | 117 | 24.5% | 125 | 28.5% |
| ***BED*** | | | | | | |
| Technical Potential | 44,387 | 49.1% | 8 | 41.2% | 8 | 45.2% |
| Economic Potential | 41,177 | 45.6% | 8 | 39.0% | 8 | 42.6% |
| Maximum Achievable Potential | 34,033 | 37.7% | 6 | 31.4% | 6 | 33.3% |

## 3.1 ENERGY EFFICIENCY MEASURES EXAMINED

Seventy energy efficiency programs or measures were included in the energy savings analysis for the residential sector.[13] Below, Table 3-2 provides a brief listing of the various residential energy efficiency programs or measures considered in this analysis. The list of energy efficiency measures examined was developed based on a review of the measures and programs included by other technical potential studies and measures included in the Vermont TRM.

**Table 3-2: Measures and Programs Included in the Residential Sector Analysis**

| End Use Type | End-Use Description | Measures/Programs Includes |
|---|---|---|
| **Appliances** | General Home Appliances | * Dehumidifiers<br>* Refrigerators<br>* Freezers<br>* Refrigerator/Freezer Turn-In |
| **Appliances/WH** | Kitchen/Laundry | * Clothes Washers<br>* Heat Pump Dryers<br>* Dishwashers |
| **Electronics** | Home Electronics | * Controlled Power Strips<br>* Internal Power Supplies<br>* Laptops<br>* Computer Monitors<br>* Televisions (LED, LCD, Plasma)<br>* Set Top Boxes<br>* Misc. Consumer Electronics |
| **HVAC (Envelope)** | Building Envelope Upgrades | * Weatherization<br>* Insulation Package<br>* Energy Star Windows |

[13] After accounting for adjustments to different building types, replacement approaches, and housing characteristics, particularly for measures targets the space heating and cooling end use, the number grew to 330 measure permutations.

| End Use Type | End-Use Description | Measures/Programs Includes |
|---|---|---|
| | | * Comprehensive Shell Measures (New Construction) |
| **HVAC (Equipment)** | Heating/Cooling /Ventilation Equipment | * Efficient Central AC<br>* Efficient Room AC<br>* Ductless mini-split heat pump<br>* Efficient Furnace Fan Motors<br>* Exhaust Fans |
| **Lighting** | Indoor/Outdoor Lighting | * Specialty CFL bulbs (<=15W)<br>* Specialty CFL bulbs (>15W)<br>* Standard CFL bulbs<br>* Specialty LED bulbs<br>* Standard LED bulbs<br>* Indoor Lighting Controls<br>* Outdoor Lighting Controls<br>* Common Area – CFL Fixture (MF only)<br>* Common Area – LED Fixture (MF only)<br>* Common Area – Fluorescent Fixture (MF only) |
| **Other** | Miscellaneous Efficiency Measures | * Pool Pump Timer<br>* 2-speed Pool Pump Motor<br>* Variable speed Pool Pump Motor<br>* Behavioral Measures[14] |
| **Water Heating** | Domestic Hot Water | * Heat Pump WH<br>* Solar WH (w/ Electric Back Up) – Emerging Tech.<br>* Tank Wrap<br>* Hot water Pipe Wrap<br>* Low Flow Showerheads<br>* Low Flow Faucet Aerators<br>* Reverse Cycle Chillers – Emerging Tech. (MF Only)<br>* Drain Water Heat Recovery Device (MF Only) |
| **Fuel Switching** | Miscellaneous | * Clothes Dryer - Fuel Switch<br>* Electric Water Heater - Fuel Switch (LP, Nat Gas, Oil)<br>* Primary Space Heat - Fuel Switch (MF Only), (Gas, LP, Oil) |

## 3.2 RESIDENTIAL SECTOR SAVINGS METHODOLOGY OVERVIEW

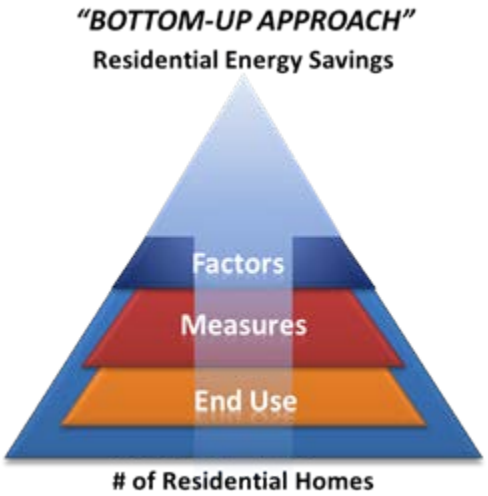
The portfolio of measures includes retrofit, early retirement, and replace-on-burnout programmatic approaches to achieve energy efficiency savings. In the residential sector, a retrofit measure refers to the application of supplemental measures (such as the addition of a low-flow device to a showerhead); early retirement includes the replacement of operational equipment before the end of its remaining useful life.

Existing homes were divided into single family and multi-family home markets in order to account for differing equipment saturations and heating/cooling consumption. New homes were also included in the analysis. The analysis of the potential for energy efficiency savings is based on the most recent residential electric sales forecasts for the EVT and BED service territories for the years 2014 through 2033.

The residential sector analysis was modeled using what is considered a "bottom-up approach." The methodology is illustrated in Figure 3-2 below:

[14] Refer to Section 2.5.2 for full discussion of the treatment of behavioral program impacts

**Figure 3-2: Residential Sector Savings Methodology - Bottom-Up Approach**




As shown in this figure, the methodology started at the bottom based on the number of residential customers (splitting them into single-family and multi-family customers as well as existing vs. new construction). From that point, estimates of the size of the eligible market were developed for each efficiency measure. For example, energy efficiency measures that affect electric water heating are only applicable to those homes in the EVT and BED territories that have electric water heating.

The core equation used in the residential sector energy efficiency technical potential analysis for each individual efficiency measure is shown below in Equation 3-1 below.

**Equation 3-1: Core Equation for Residential Sector Technical Potential**


In instances where there were two (or more) competing technologies for the same electric end use, such as storage water heater tank wraps, heat pump water heaters and solar water heaters, a percent of the available population was assigned to each measure using the applicability factor. In the event that one of the competing measures was not found to be cost-effective, the homes assigned to that measure were transitioned over to the cost effective alternative (if any).

Fuel-switching was analyzed in this analysis for electric water heating, electric drying and primary space heating.[15] These measures consist of replacement of electric equipment in favor of natural gas, oil, or propane units. Fuel switching was treated as a competing measure to other electric efficiency options. Therefore not all of the total eligible homes were included in the fuel switch options.

[15] Primary space heat fuel switching was reserved for the multi-family sector only. The baseline saturation of primary electric space heat in the single family sector was deemed insignificant based on the results of the most recent end-use saturation studies.

## 3.3 RESIDENTIAL MAXIMUM ACHIEVABLE SAVINGS POTENTIAL

By 2033 the total residential energy efficiency maximum achievable potential is 723,116 MWh, or 29.4% of forecast residential sales in 2033. The maximum achievable potential scenario also achieves 124 MW of residential winter peak savings, or 24.8% of the 2033 residential winter peak forecast. Summer peak savings are estimated at 131 MW, or 28.7% of the residential summer peak forecast.

**Table 3-3: Maximum Achievable Energy and Demand Potential and % Share of Residential Forecast Energy Sales and Summer/Winter Peak Demand in 2033**

| | Achievable Potential | | |
|---|---|---|---|
| | Energy (MWh) | Winter Peak Demand (MW) | Summer Peak Demand (MW) |
| Water Heating | 92,485 | 12.9 | 7.0 |
| Lighting | 92,899 | 30.6 | 5.7 |
| Consumer Electronics | 78,454 | 9.4 | 9.2 |
| Appliances/WH | 14,660 | 4.4 | 2.6 |
| Other | 35,633 | 0.0 | 24.4 |
| HVAC (Envelope) | 99,623 | 13.4 | 36.1 |
| HVAC (Equipment) | 89,384 | 22.6 | 20.3 |
| Appliances | 51,618 | 4.8 | 6.4 |
| Fuel Switching | 103,901 | 18.2 | 11.5 |
| Early Replacement | 64,458 | 7.5 | 7.6 |
| **TOTAL** | **723,116** | **124** | **131** |
| *% of 2033 Residential Sales* | *29.4%* | *24.8%* | *28.7%* |

Figures 3-3 and 3-4 show the maximum achievable potential by end-use in the years 2020 and 2033, respectively. Lighting is the leading share (24.4%) of the total 2020 maximum potential. As noted earlier, in 2020 new federal lighting standards go into increase the baseline energy standards for lighting technology in the U.S. The result is a significant drop-off in the potential for lighting savings in the residential. By 2033, lighting has decreased from 24.4% to 12.8% of the total maximum achievable potential. During this time, other end-uses such as consumer electronics and HVAC savings measures increase their share of the total maximum achievable potential.

Table 3-4 through Table 3-6 depict the cumulative annual energy and demand savings, by end-use, for the residential sector. Table 3-7 provides the incremental annual energy savings, by end-use, for the residential sector. In addition to the statewide maximum achievable potential, the maximum achievable potential for the EVT and BED service territories are also included.

**Figure 3-3: Residential Sector End-Use Savings as a % of 2020 Maximum Achievable Potential**

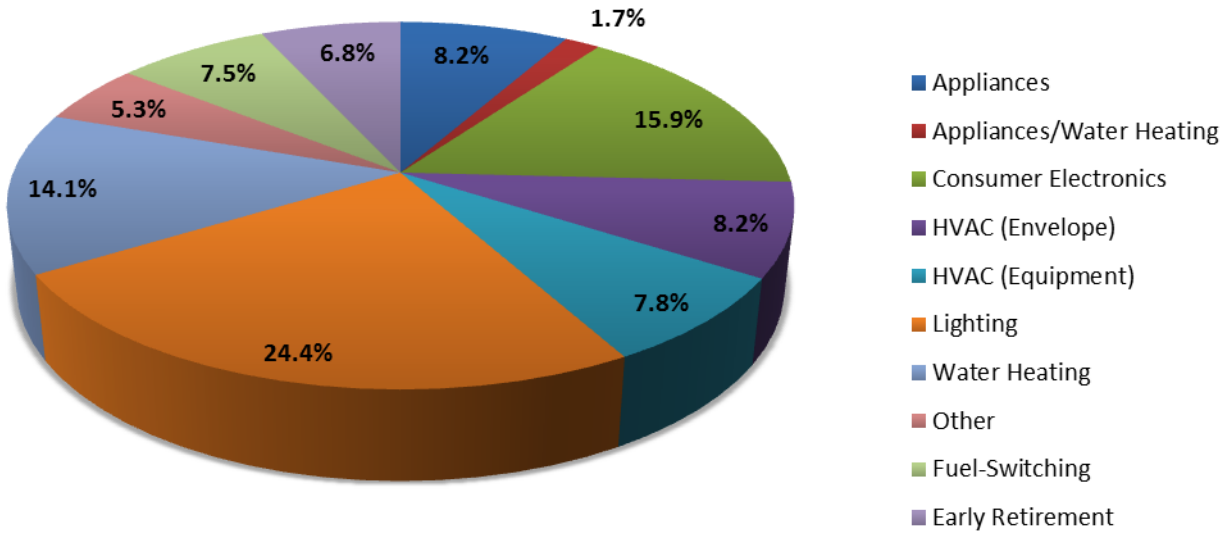
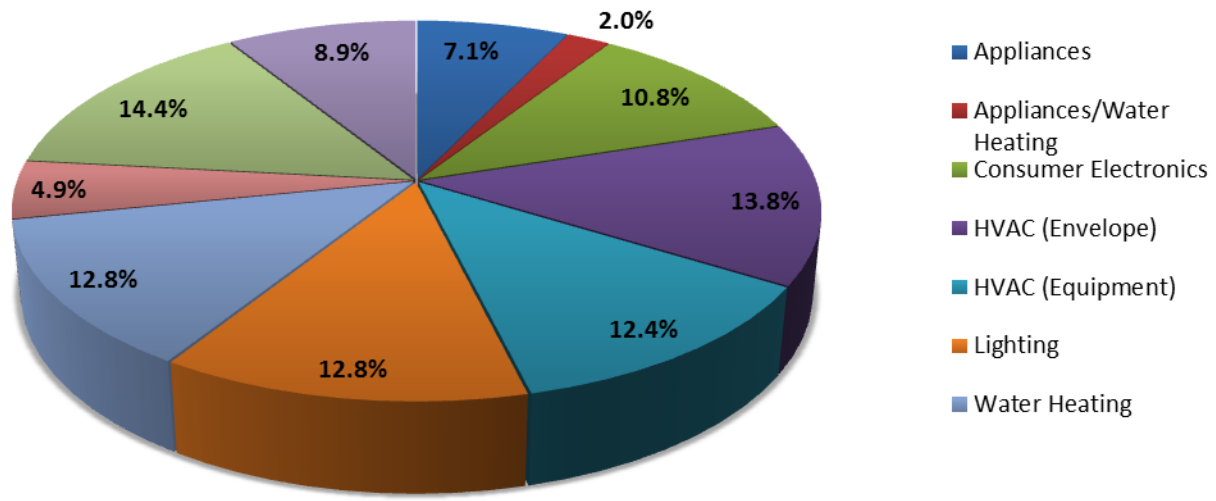



**Figure 3-4: Residential Sector End-Use Savings as a % of 2033 Maximum Achievable Potential**



## Table 3-4: Cumulative Annual Residential Energy (MWh) Savings Potential by End Use for VT (Statewide), EVT Territory, and BED Territory

| Cumulative Annual MWh Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 5,644 | 11,524 | 17,439 | 23,321 | 29,158 | 34,955 | 40,748 | 46,508 | 48,003 | 49,483 | 50,920 | 52,341 | 52,530 | 52,469 | 52,376 | 52,331 | 52,201 | 51,988 | 51,780 | 51,618 |
| Appliances/Water Heating | 1,097 | 2,362 | 3,651 | 4,917 | 6,152 | 7,358 | 8,562 | 9,742 | 10,899 | 12,045 | 13,161 | 14,006 | 14,817 | 15,605 | 15,560 | 15,375 | 15,168 | 14,958 | 14,789 | 14,660 |
| Consumer Electronics | 18,468 | 36,936 | 55,404 | 73,873 | 77,591 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 | 78,454 |
| HVAC (Envelope) | 4,716 | 10,913 | 17,322 | 23,525 | 29,452 | 35,130 | 40,782 | 46,218 | 51,451 | 56,588 | 61,455 | 66,230 | 70,825 | 75,242 | 79,668 | 83,747 | 87,804 | 91,641 | 95,579 | 99,623 |
| HVAC (Equipment) | 5,270 | 10,905 | 16,593 | 22,230 | 27,799 | 33,307 | 38,808 | 44,256 | 49,653 | 55,024 | 60,329 | 65,610 | 70,847 | 76,036 | 81,229 | 84,154 | 86,958 | 89,689 | 89,759 | 89,384 |
| Lighting | 15,116 | 32,521 | 50,459 | 68,276 | 85,789 | 103,134 | 120,625 | 54,969 | 59,360 | 63,969 | 68,687 | 73,514 | 77,252 | 80,738 | 84,119 | 87,509 | 89,206 | 90,508 | 91,686 | 92,899 |
| Water Heating | 10,082 | 20,322 | 30,586 | 40,827 | 51,038 | 61,222 | 69,928 | 78,612 | 87,273 | 92,148 | 92,353 | 92,405 | 92,413 | 92,422 | 92,461 | 92,460 | 92,449 | 92,430 | 92,446 | 92,485 |
| Other | 3,584 | 7,369 | 11,184 | 14,972 | 18,721 | 22,441 | 26,156 | 29,842 | 33,500 | 37,144 | 37,167 | 36,978 | 36,736 | 36,497 | 36,298 | 36,142 | 35,989 | 35,833 | 35,719 | 35,633 |
| Fuel-Switching | 5,148 | 10,476 | 15,830 | 21,160 | 26,456 | 31,721 | 36,984 | 42,220 | 47,434 | 52,634 | 57,802 | 62,959 | 68,094 | 73,208 | 78,323 | 83,449 | 88,573 | 93,670 | 98,779 | 103,901 |
| Early Retirement | 8,161 | 16,322 | 24,483 | 26,834 | 29,186 | 31,537 | 33,889 | 36,240 | 38,592 | 40,943 | 43,295 | 45,646 | 47,998 | 50,349 | 52,701 | 55,052 | 57,404 | 59,755 | 62,107 | 64,458 |
| **Total** | **77,286** | **159,651** | **242,951** | **319,935** | **381,341** | **439,261** | **494,935** | **467,060** | **504,617** | **538,433** | **563,622** | **588,142** | **609,965** | **631,020** | **651,189** | **668,674** | **684,205** | **698,925** | **711,096** | **723,116** |
| *% of Annual Forecast Sales* | *3.6%* | *7.4%* | *11.0%* | *14.3%* | *16.8%* | *19.1%* | *22.4%* | *20.7%* | *22.2%* | *24.4%* | *25.1%* | *25.9%* | *26.4%* | *27.0%* | *27.5%* | *28.5%* | *28.3%* | *28.8%* | *29.0%* | *29.4%* |

| Cumulative Annual MWh Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 5,530 | 11,296 | 17,097 | 22,866 | 28,591 | 34,275 | 39,956 | 45,602 | 47,037 | 48,457 | 49,834 | 51,196 | 51,370 | 51,296 | 51,190 | 51,131 | 50,990 | 50,781 | 50,576 | 50,417 |
| Appliances/Water Heating | 1,061 | 2,289 | 3,543 | 4,772 | 5,971 | 7,142 | 8,310 | 9,453 | 10,575 | 11,686 | 12,766 | 13,586 | 14,371 | 15,134 | 15,090 | 14,907 | 14,700 | 14,491 | 14,324 | 14,196 |
| Consumer Electronics | 17,572 | 35,144 | 52,715 | 70,287 | 73,811 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 | 74,631 |
| HVAC (Envelope) | 4,512 | 10,505 | 16,715 | 22,722 | 28,453 | 33,936 | 39,392 | 44,635 | 49,679 | 54,632 | 59,317 | 63,911 | 68,328 | 72,571 | 76,822 | 80,759 | 84,671 | 88,368 | 92,162 | 96,062 |
| HVAC (Equipment) | 4,862 | 10,090 | 15,372 | 20,605 | 25,770 | 30,873 | 35,969 | 41,014 | 46,011 | 50,982 | 55,889 | 60,771 | 65,611 | 70,405 | 75,202 | 77,953 | 80,582 | 83,142 | 83,208 | 82,844 |
| Lighting | 14,454 | 31,187 | 48,450 | 65,588 | 82,419 | 99,076 | 115,872 | 52,714 | 56,923 | 61,338 | 65,854 | 70,474 | 74,050 | 77,377 | 80,604 | 83,840 | 85,459 | 86,689 | 87,801 | 88,951 |
| Water Heating | 9,782 | 19,722 | 29,686 | 39,629 | 49,541 | 59,427 | 67,893 | 76,338 | 84,762 | 89,502 | 89,680 | 89,704 | 89,686 | 89,670 | 89,684 | 89,670 | 89,647 | 89,614 | 89,614 | 89,638 |
| Other | 3,489 | 7,180 | 10,901 | 14,594 | 18,249 | 21,875 | 25,495 | 29,087 | 32,650 | 36,200 | 36,223 | 36,034 | 35,792 | 35,553 | 35,354 | 35,198 | 35,044 | 34,889 | 34,775 | 34,689 |
| Fuel-Switching | 4,758 | 9,695 | 14,659 | 19,598 | 24,503 | 29,378 | 34,249 | 39,095 | 43,918 | 48,729 | 53,507 | 58,274 | 63,020 | 67,745 | 72,471 | 77,208 | 81,943 | 86,652 | 91,372 | 96,105 |
| Early Retirement | 7,769 | 15,539 | 23,308 | 25,558 | 27,807 | 30,057 | 32,306 | 34,556 | 36,805 | 39,055 | 41,304 | 43,554 | 45,803 | 48,053 | 50,302 | 52,552 | 54,801 | 57,051 | 59,300 | 61,549 |
| **Total** | **73,789** | **152,646** | **232,446** | **306,219** | **365,116** | **420,668** | **474,073** | **447,125** | **482,990** | **515,211** | **539,004** | **562,133** | **582,663** | **602,435** | **621,349** | **637,849** | **652,469** | **666,307** | **677,762** | **689,083** |
| *% of Annual Forecast Sales* | *3.6%* | *7.3%* | *11.0%* | *14.2%* | *16.7%* | *19.0%* | *22.4%* | *20.6%* | *22.1%* | *24.3%* | *25.0%* | *25.7%* | *26.3%* | *26.8%* | *27.3%* | *28.2%* | *28.0%* | *28.5%* | *28.7%* | *29.1%* |

| Cumulative Annual MWh Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 114 | 228 | 342 | 454 | 567 | 680 | 793 | 905 | 966 | 1,026 | 1,086 | 1,145 | 1,160 | 1,173 | 1,186 | 1,201 | 1,212 | 1,208 | 1,204 | 1,201 |
| Appliances/Water Heating | 36 | 73 | 109 | 145 | 181 | 217 | 253 | 288 | 324 | 359 | 395 | 420 | 446 | 471 | 470 | 469 | 468 | 466 | 465 | 464 |
| Consumer Electronics | 896 | 1,793 | 2,689 | 3,585 | 3,779 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 | 3,823 |
| HVAC (Envelope) | 204 | 408 | 607 | 803 | 999 | 1,195 | 1,390 | 1,583 | 1,771 | 1,956 | 2,138 | 2,319 | 2,497 | 2,671 | 2,846 | 2,989 | 3,133 | 3,273 | 3,417 | 3,561 |
| HVAC (Equipment) | 408 | 815 | 1,220 | 1,625 | 2,029 | 2,434 | 2,838 | 3,241 | 3,642 | 4,042 | 4,441 | 4,839 | 5,236 | 5,631 | 6,027 | 6,201 | 6,376 | 6,547 | 6,551 | 6,540 |
| Lighting | 662 | 1,334 | 2,009 | 2,688 | 3,369 | 4,058 | 4,753 | 2,255 | 2,438 | 2,631 | 2,833 | 3,040 | 3,202 | 3,360 | 3,515 | 3,668 | 3,747 | 3,818 | 3,884 | 3,948 |
| Water Heating | 300 | 601 | 899 | 1,198 | 1,496 | 1,795 | 2,034 | 2,274 | 2,511 | 2,646 | 2,673 | 2,701 | 2,726 | 2,752 | 2,778 | 2,790 | 2,802 | 2,816 | 2,831 | 2,847 |
| Other | 94 | 189 | 283 | 378 | 472 | 566 | 661 | 755 | 850 | 944 | 944 | 944 | 944 | 944 | 944 | 944 | 944 | 944 | 944 | 944 |
| Fuel-Switching | 391 | 781 | 1,172 | 1,563 | 1,953 | 2,344 | 2,734 | 3,125 | 3,516 | 3,905 | 4,295 | 4,685 | 5,074 | 5,463 | 5,852 | 6,241 | 6,629 | 7,018 | 7,407 | 7,796 |
| Early Retirement | 392 | 783 | 1,175 | 1,277 | 1,379 | 1,481 | 1,583 | 1,685 | 1,787 | 1,889 | 1,991 | 2,093 | 2,195 | 2,297 | 2,399 | 2,501 | 2,603 | 2,705 | 2,807 | 2,908 |
| **Total** | **3,498** | **7,005** | **10,505** | **13,715** | **16,225** | **18,593** | **20,862** | **19,935** | **21,627** | **23,222** | **24,618** | **26,009** | **27,302** | **28,586** | **29,839** | **30,826** | **31,735** | **32,618** | **33,334** | **34,033** |
| *% of Annual Forecast Sales* | *4.2%* | *8.1%* | *12.1%* | *16.0%* | *18.5%* | *21.2%* | *23.8%* | *22.9%* | *24.9%* | *26.7%* | *28.2%* | *29.8%* | *31.2%* | *32.5%* | *33.6%* | *34.7%* | *35.6%* | *36.4%* | *37.0%* | *37.7%* |

## Table 3-5: Cumulative Annual Residential Winter Peak Demand (MW) Savings by End Use for VT (Statewide), EVT Territory, and BED Territory

| Cumulative Annual MW Winter Peak Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 0.5 | 1.1 | 1.6 | 2.2 | 2.7 | 3.2 | 3.8 | 4.3 | 4.4 | 4.6 | 4.7 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Apliances/Water Heating | 0.4 | 0.8 | 1.2 | 1.6 | 2.0 | 2.4 | 2.8 | 3.2 | 3.6 | 4.0 | 4.3 | 4.4 | 4.5 | 4.6 | 4.6 | 4.6 | 4.5 | 4.5 | 4.4 | 4.4 |
| Consumer Electronics | 2.2 | 4.5 | 6.7 | 8.9 | 9.3 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 |
| HVAC (Envelope) | 0.6 | 1.5 | 2.4 | 3.3 | 4.1 | 4.9 | 5.7 | 6.5 | 7.2 | 7.9 | 8.6 | 9.2 | 9.8 | 10.4 | 11.0 | 11.5 | 12.0 | 12.4 | 12.9 | 13.4 |
| HVAC (Equipment) | 1.3 | 2.7 | 4.2 | 5.6 | 7.0 | 8.4 | 9.7 | 11.1 | 12.4 | 13.8 | 15.1 | 16.4 | 17.8 | 19.1 | 20.3 | 21.2 | 22.0 | 22.7 | 22.7 | 22.6 |
| Lighting | 5.7 | 12.0 | 18.3 | 24.5 | 30.4 | 36.2 | 41.9 | 20.0 | 21.2 | 22.5 | 23.8 | 25.2 | 26.4 | 27.5 | 28.6 | 29.7 | 30.1 | 30.2 | 30.4 | 30.6 |
| Water Heating | 1.4 | 2.8 | 4.3 | 5.7 | 7.1 | 8.5 | 9.8 | 11.0 | 12.2 | 13.0 | 13.1 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 12.9 | 12.9 | 12.9 | 12.9 |
| Other | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fuel-Switching | 0.9 | 1.8 | 2.8 | 3.7 | 4.6 | 5.6 | 6.5 | 7.4 | 8.3 | 9.2 | 10.1 | 11.0 | 11.9 | 12.8 | 13.7 | 14.6 | 15.5 | 16.4 | 17.3 | 18.2 |
| Early Retirement | 0.9 | 1.8 | 2.7 | 3.0 | 3.3 | 3.5 | 3.8 | 4.1 | 4.4 | 4.7 | 5.0 | 5.2 | 5.5 | 5.8 | 6.1 | 6.4 | 6.6 | 6.9 | 7.2 | 7.5 |
| **Total** | **14** | **29** | **44** | **58** | **71** | **82** | **93** | **77** | **83** | **89** | **94** | **99** | **103** | **107** | **112** | **115** | **118** | **120** | **122** | **124** |
| *% of Annual Forecast* | *3.2%* | *6.6%* | *9.9%* | *13.3%* | *15.9%* | *18.3%* | *20.6%* | *16.5%* | *17.9%* | *19.2%* | *19.8%* | *20.7%* | *21.6%* | *22.3%* | *23.0%* | *23.6%* | *24.1%* | *24.5%* | *24.7%* | *24.8%* |

| Cumulative Annual MW Winter Peak Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 0.5 | 1.0 | 1.6 | 2.1 | 2.6 | 3.2 | 3.7 | 4.2 | 4.4 | 4.5 | 4.6 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 |
| Apliances/Water Heating | 0.4 | 0.8 | 1.2 | 1.6 | 1.9 | 2.3 | 2.7 | 3.1 | 3.5 | 3.8 | 4.2 | 4.3 | 4.4 | 4.5 | 4.4 | 4.4 | 4.4 | 4.3 | 4.3 | 4.3 |
| Consumer Electronics | 2.1 | 4.2 | 6.4 | 8.5 | 8.8 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 | 8.9 |
| HVAC (Envelope) | 0.6 | 1.4 | 2.3 | 3.2 | 4.0 | 4.7 | 5.5 | 6.2 | 6.9 | 7.6 | 8.2 | 8.8 | 9.4 | 9.9 | 10.5 | 11.0 | 11.5 | 11.9 | 12.3 | 12.8 |
| HVAC (Equipment) | 1.2 | 2.5 | 3.8 | 5.1 | 6.4 | 7.7 | 9.0 | 10.2 | 11.5 | 12.7 | 13.9 | 15.1 | 16.4 | 17.5 | 18.7 | 19.5 | 20.2 | 21.0 | 20.9 | 20.8 |
| Lighting | 5.4 | 11.5 | 17.6 | 23.5 | 29.2 | 34.8 | 40.2 | 19.2 | 20.4 | 21.6 | 22.9 | 24.2 | 25.3 | 26.3 | 27.4 | 28.5 | 28.8 | 29.0 | 29.1 | 29.3 |
| Water Heating | 1.4 | 2.7 | 4.1 | 5.5 | 6.9 | 8.3 | 9.5 | 10.7 | 11.9 | 12.7 | 12.7 | 12.7 | 12.7 | 12.6 | 12.6 | 12.6 | 12.6 | 12.6 | 12.6 | 12.5 |
| Other | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fuel-Switching | 0.8 | 1.7 | 2.6 | 3.5 | 4.3 | 5.2 | 6.0 | 6.9 | 7.7 | 8.6 | 9.4 | 10.3 | 11.1 | 11.9 | 12.8 | 13.6 | 14.4 | 15.3 | 16.1 | 16.9 |
| Early Retirement | 0.9 | 1.7 | 2.6 | 2.8 | 3.1 | 3.4 | 3.6 | 3.9 | 4.2 | 4.4 | 4.7 | 5.0 | 5.2 | 5.5 | 5.8 | 6.0 | 6.3 | 6.6 | 6.8 | 7.1 |
| **Total** | **13** | **28** | **42** | **56** | **67** | **78** | **89** | **73** | **79** | **85** | **90** | **94** | **98** | **102** | **106** | **109** | **112** | **114** | **116** | **117** |
| *% of Annual Forecast* | *3.2%* | *6.6%* | *9.9%* | *13.2%* | *15.8%* | *18.2%* | *20.5%* | *16.4%* | *17.8%* | *19.1%* | *19.7%* | *20.5%* | *21.4%* | *22.1%* | *22.8%* | *23.4%* | *23.9%* | *24.2%* | *24.4%* | *24.5%* |

| Cumulative Annual MW Winter Peak Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Apliances/Water Heating | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Consumer Electronics | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| HVAC (Envelope) | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 |
| HVAC (Equipment) | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 |
| Lighting | 0.2 | 0.5 | 0.7 | 1.0 | 1.2 | 1.4 | 1.6 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | 1.3 |
| Water Heating | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 |
| Other | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fuel-Switching | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 1.0 | 1.0 | 1.1 | 1.2 | 1.2 | 1.3 |
| Early Retirement | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 |
| **Total** | **0.7** | **1.3** | **2.0** | **2.6** | **3.1** | **3.7** | **4.2** | **3.6** | **3.9** | **4.2** | **4.5** | **4.8** | **5.1** | **5.4** | **5.6** | **5.8** | **6.0** | **6.1** | **6.3** | **6.4** |
| *% of Annual Forecast* | *3.9%* | *7.6%* | *11.3%* | *14.7%* | *17.6%* | *20.3%* | *22.8%* | *19.0%* | *20.7%* | *22.3%* | *23.6%* | *24.8%* | *26.1%* | *27.4%* | *28.7%* | *29.4%* | *30.2%* | *30.9%* | *31.1%* | *31.4%* |

## Table 3-6: Cumulative Annual Residential Summer Peak Demand (MW) Savings by End Use for VT (Statewide), EVT Territory, and BED Territory

| Cumulative Annual MW Summer Peak Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 0.7 | 1.4 | 2.1 | 2.8 | 3.6 | 4.3 | 5.0 | 5.7 | 5.9 | 6.1 | 6.2 | 6.4 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.4 | 6.4 | 6.4 |
| Apliances/Water Heating | 0.2 | 0.5 | 0.7 | 0.9 | 1.2 | 1.4 | 1.6 | 1.9 | 2.1 | 2.3 | 2.5 | 2.6 | 2.7 | 2.8 | 2.8 | 2.7 | 2.7 | 2.7 | 2.7 | 2.6 |
| Consumer Electronics | 2.2 | 4.4 | 6.6 | 8.8 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 |
| HVAC (Envelope) | 1.7 | 3.9 | 6.1 | 8.3 | 10.4 | 12.4 | 14.4 | 16.4 | 18.3 | 20.1 | 21.9 | 23.7 | 25.3 | 27.0 | 28.6 | 30.2 | 31.7 | 33.1 | 34.6 | 36.1 |
| HVAC (Equipment) | 1.3 | 2.7 | 4.1 | 5.5 | 6.9 | 8.3 | 9.6 | 11.0 | 12.4 | 13.7 | 15.0 | 16.3 | 17.7 | 19.0 | 20.3 | 20.4 | 20.4 | 20.4 | 20.4 | 20.3 |
| Lighting | 1.4 | 2.9 | 4.5 | 6.0 | 7.5 | 8.9 | 10.3 | 4.0 | 4.2 | 4.4 | 4.6 | 4.8 | 4.9 | 5.1 | 5.2 | 5.3 | 5.4 | 5.5 | 5.6 | 5.7 |
| Water Heating | 0.8 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 5.4 | 6.1 | 6.7 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.0 | 7.0 | 7.0 |
| Other | 2.5 | 5.1 | 7.7 | 10.3 | 12.8 | 15.4 | 17.9 | 20.5 | 23.0 | 25.5 | 25.5 | 25.4 | 25.2 | 25.0 | 24.9 | 24.8 | 24.7 | 24.6 | 24.5 | 24.4 |
| Fuel-Switching | 0.6 | 1.2 | 1.8 | 2.4 | 2.9 | 3.5 | 4.1 | 4.7 | 5.3 | 5.9 | 6.4 | 7.0 | 7.6 | 8.1 | 8.7 | 9.3 | 9.8 | 10.4 | 10.9 | 11.5 |
| Early Retirement | 1.0 | 2.0 | 3.0 | 3.2 | 3.5 | 3.8 | 4.1 | 4.3 | 4.6 | 4.9 | 5.2 | 5.4 | 5.7 | 6.0 | 6.3 | 6.5 | 6.8 | 7.1 | 7.4 | 7.6 |
| **Total** | **12** | **26** | **39** | **51** | **62** | **72** | **82** | **84** | **92** | **99** | **104** | **108** | **112** | **116** | **119** | **122** | **124** | **127** | **129** | **131** |
| *% of Annual Forecast* | *3.4%* | *6.9%* | *10.4%* | *13.5%* | *16.0%* | *18.3%* | *20.6%* | *20.8%* | *22.5%* | *24.3%* | *25.1%* | *25.8%* | *26.4%* | *27.0%* | *27.5%* | *27.9%* | *28.0%* | *28.3%* | *28.5%* | *28.7%* |

| Cumulative Annual MW Summer Peak Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 0.7 | 1.4 | 2.1 | 2.8 | 3.5 | 4.2 | 4.9 | 5.5 | 5.7 | 5.9 | 6.1 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.2 | 6.2 |
| Apliances/Water Heating | 0.2 | 0.4 | 0.7 | 0.9 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.5 | 2.6 | 2.7 | 2.7 | 2.6 | 2.6 | 2.6 | 2.6 | 2.5 |
| Consumer Electronics | 2.1 | 4.2 | 6.3 | 8.4 | 8.7 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 |
| HVAC (Envelope) | 1.7 | 3.8 | 6.0 | 8.1 | 10.1 | 12.1 | 14.0 | 15.9 | 17.7 | 19.5 | 21.3 | 23.0 | 24.6 | 26.2 | 27.8 | 29.3 | 30.7 | 32.1 | 33.6 | 35.0 |
| HVAC (Equipment) | 1.2 | 2.5 | 3.8 | 5.0 | 6.3 | 7.5 | 8.8 | 10.0 | 11.2 | 12.5 | 13.7 | 14.9 | 16.1 | 17.2 | 18.4 | 18.5 | 18.6 | 18.6 | 18.5 | 18.5 |
| Lighting | 1.3 | 2.8 | 4.3 | 5.8 | 7.2 | 8.5 | 9.8 | 3.9 | 4.0 | 4.2 | 4.4 | 4.6 | 4.7 | 4.8 | 5.0 | 5.1 | 5.2 | 5.3 | 5.3 | 5.4 |
| Water Heating | 0.8 | 1.6 | 2.3 | 3.1 | 3.9 | 4.7 | 5.3 | 5.9 | 6.5 | 6.9 | 6.9 | 6.9 | 6.9 | 6.9 | 6.9 | 6.9 | 6.9 | 6.8 | 6.8 | 6.8 |
| Other | 2.4 | 4.9 | 7.5 | 10.0 | 12.5 | 15.0 | 17.5 | 19.9 | 22.4 | 24.8 | 24.8 | 24.7 | 24.5 | 24.4 | 24.2 | 24.1 | 24.0 | 23.9 | 23.8 | 23.8 |
| Fuel-Switching | 0.5 | 1.1 | 1.6 | 2.2 | 2.8 | 3.3 | 3.9 | 4.4 | 4.9 | 5.5 | 6.0 | 6.5 | 7.1 | 7.6 | 8.1 | 8.7 | 9.2 | 9.7 | 10.2 | 10.8 |
| Early Retirement | 0.9 | 1.9 | 2.8 | 3.1 | 3.3 | 3.6 | 3.8 | 4.1 | 4.4 | 4.6 | 4.9 | 5.2 | 5.4 | 5.7 | 5.9 | 6.2 | 6.5 | 6.7 | 7.0 | 7.3 |
| **Total** | **12** | **24** | **37** | **49** | **59** | **69** | **78** | **80** | **88** | **95** | **99** | **103** | **107** | **111** | **114** | **116** | **119** | **121** | **123** | **125** |
| *% of Annual Forecast* | *3.4%* | *6.9%* | *10.4%* | *13.5%* | *16.0%* | *18.3%* | *20.6%* | *20.8%* | *22.5%* | *24.3%* | *25.1%* | *25.8%* | *26.3%* | *26.9%* | *27.4%* | *27.7%* | *27.8%* | *28.1%* | *28.3%* | *28.5%* |

| Cumulative Annual MW Summer Peak Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Apliances/Water Heating | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Consumer Electronics | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| HVAC (Envelope) | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.1 |
| HVAC (Equipment) | 0.1 | 0.2 | 0.4 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.2 | 1.4 | 1.5 | 1.6 | 1.7 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| Lighting | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 |
| Water Heating | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Other | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Fuel-Switching | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 |
| Early Retirement | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 |
| **Total** | **0.6** | **1.1** | **1.7** | **2.2** | **2.6** | **3.0** | **3.4** | **3.5** | **3.8** | **4.2** | **4.4** | **4.7** | **4.9** | **5.1** | **5.4** | **5.5** | **5.6** | **5.7** | **5.8** | **5.9** |
| *% of Annual Forecast* | *3.7%* | *7.4%* | *10.9%* | *14.1%* | *16.7%* | *18.9%* | *21.1%* | *21.3%* | *23.1%* | *24.9%* | *26.3%* | *27.6%* | *28.8%* | *29.9%* | *31.2%* | *31.8%* | *32.3%* | *32.8%* | *33.0%* | *33.3%* |

## Table 3-7: Incremental Annual Residential Energy (MWh) Savings Potential by End Use for VT (Statewide), EVT Territory, and BED Territory

| Incremental Annual MWh Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 5,644 | 5,881 | 5,915 | 5,882 | 5,837 | 5,798 | 5,793 | 5,759 | 5,727 | 5,711 | 5,668 | 5,653 | 5,625 | 5,596 | 5,597 | 5,614 | 5,610 | 5,575 | 5,591 | 5,608 |
| Appliances/Water Heating | 1,097 | 1,264 | 1,290 | 1,266 | 1,235 | 1,207 | 1,204 | 1,180 | 1,157 | 1,146 | 1,116 | 1,106 | 1,086 | 1,065 | 1,066 | 1,077 | 1,075 | 1,050 | 1,061 | 1,073 |
| Consumer Electronics | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 | 18,468 |
| HVAC (Envelope) | 4,716 | 6,197 | 6,409 | 6,203 | 5,927 | 5,678 | 5,651 | 5,436 | 5,233 | 5,137 | 4,867 | 4,775 | 4,595 | 4,417 | 4,426 | 4,526 | 4,502 | 4,283 | 4,384 | 4,490 |
| HVAC (Equipment) | 5,270 | 5,636 | 5,687 | 5,638 | 5,569 | 5,508 | 5,501 | 5,448 | 5,397 | 5,371 | 5,305 | 5,281 | 5,237 | 5,189 | 5,193 | 5,218 | 5,211 | 5,155 | 5,182 | 5,208 |
| Lighting | 15,116 | 17,404 | 17,938 | 17,816 | 17,513 | 17,345 | 17,491 | 7,625 | 7,503 | 7,438 | 7,289 | 7,231 | 7,131 | 7,033 | 7,029 | 7,070 | 7,050 | 6,934 | 6,978 | 7,024 |
| Water Heating | 10,082 | 10,240 | 10,263 | 10,242 | 10,210 | 10,185 | 10,181 | 10,159 | 10,137 | 10,126 | 10,099 | 10,090 | 10,068 | 10,050 | 10,051 | 10,061 | 10,059 | 10,033 | 10,046 | 10,057 |
| Other | 3,584 | 3,785 | 3,815 | 3,787 | 3,750 | 3,720 | 3,715 | 3,687 | 3,657 | 3,644 | 3,606 | 3,596 | 3,574 | 3,548 | 3,551 | 3,564 | 3,561 | 3,531 | 3,543 | 3,559 |
| Fuel-Switching | 5,148 | 5,328 | 5,354 | 5,330 | 5,296 | 5,266 | 5,262 | 5,237 | 5,213 | 5,201 | 5,167 | 5,157 | 5,135 | 5,114 | 5,115 | 5,126 | 5,124 | 5,097 | 5,109 | 5,122 |
| Early Retirement | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 8,161 | 9,412 | 9,412 | 10,512 | 10,512 | 10,512 | 10,512 | 10,512 | 10,512 |
| **Total** | **77,286** | **82,365** | **83,301** | **82,793** | **81,966** | **81,335** | **81,427** | **71,159** | **70,654** | **70,404** | **69,748** | **69,518** | **70,330** | **69,893** | **71,009** | **71,236** | **71,173** | **70,640** | **70,874** | **71,122** |
| *% of Annual Forecast Sales* | *3.6%* | *3.8%* | *3.8%* | *3.7%* | *3.6%* | *3.5%* | *3.7%* | *3.2%* | *3.1%* | *3.2%* | *3.1%* | *3.1%* | *3.0%* | *3.0%* | *3.0%* | *3.0%* | *2.9%* | *2.9%* | *2.9%* | *2.9%* |

| Incremental Annual MWh Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 5,530 | 5,767 | 5,801 | 5,769 | 5,725 | 5,685 | 5,680 | 5,647 | 5,615 | 5,600 | 5,557 | 5,542 | 5,514 | 5,486 | 5,488 | 5,504 | 5,500 | 5,466 | 5,481 | 5,498 |
| Appliances/Water Heating | 1,061 | 1,228 | 1,253 | 1,230 | 1,199 | 1,171 | 1,168 | 1,144 | 1,121 | 1,111 | 1,081 | 1,070 | 1,051 | 1,030 | 1,031 | 1,043 | 1,040 | 1,015 | 1,026 | 1,038 |
| Consumer Electronics | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 | 17,572 |
| HVAC (Envelope) | 4,512 | 5,993 | 6,210 | 6,007 | 5,731 | 5,482 | 5,456 | 5,243 | 5,045 | 4,952 | 4,686 | 4,593 | 4,417 | 4,243 | 4,251 | 4,351 | 4,327 | 4,111 | 4,209 | 4,315 |
| HVAC (Equipment) | 4,862 | 5,228 | 5,282 | 5,233 | 5,165 | 5,103 | 5,096 | 5,045 | 4,996 | 4,972 | 4,907 | 4,882 | 4,840 | 4,794 | 4,797 | 4,822 | 4,815 | 4,763 | 4,786 | 4,812 |
| Lighting | 14,454 | 16,733 | 17,263 | 17,138 | 16,832 | 16,656 | 16,797 | 7,309 | 7,191 | 7,127 | 6,981 | 6,924 | 6,825 | 6,729 | 6,725 | 6,766 | 6,747 | 6,632 | 6,675 | 6,721 |
| Water Heating | 9,782 | 9,939 | 9,965 | 9,943 | 9,912 | 9,886 | 9,882 | 9,861 | 9,840 | 9,830 | 9,802 | 9,793 | 9,773 | 9,755 | 9,756 | 9,766 | 9,764 | 9,738 | 9,751 | 9,762 |
| Other | 3,489 | 3,691 | 3,721 | 3,693 | 3,656 | 3,625 | 3,620 | 3,593 | 3,563 | 3,550 | 3,512 | 3,502 | 3,479 | 3,454 | 3,457 | 3,469 | 3,466 | 3,437 | 3,449 | 3,464 |
| Fuel-Switching | 4,758 | 4,937 | 4,964 | 4,939 | 4,905 | 4,875 | 4,872 | 4,846 | 4,822 | 4,811 | 4,778 | 4,767 | 4,746 | 4,725 | 4,726 | 4,737 | 4,735 | 4,708 | 4,720 | 4,733 |
| Early Retirement | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 7,769 | 8,958 | 8,958 | 10,019 | 10,019 | 10,019 | 10,019 | 10,019 | 10,019 |
| **Total** | **73,789** | **78,857** | **79,800** | **79,293** | **78,464** | **77,824** | **77,912** | **68,027** | **67,535** | **67,294** | **66,644** | **66,415** | **67,174** | **66,745** | **67,822** | **68,049** | **67,985** | **67,461** | **67,687** | **67,935** |
| *% of Annual Forecast Sales* | *3.6%* | *3.8%* | *3.8%* | *3.7%* | *3.6%* | *3.5%* | *3.7%* | *3.1%* | *3.1%* | *3.2%* | *3.1%* | *3.0%* | *3.0%* | *3.0%* | *3.0%* | *3.0%* | *2.9%* | *2.9%* | *2.9%* | *2.9%* |

| Incremental Annual MWh Savings - Max. Achievable | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | 114 | 114 | 113 | 113 | 113 | 113 | 113 | 113 | 112 | 111 | 111 | 111 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| Appliances/Water Heating | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Consumer Electronics | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 | 896 |
| HVAC (Envelope) | 204 | 204 | 199 | 196 | 195 | 196 | 195 | 193 | 188 | 185 | 181 | 181 | 178 | 174 | 174 | 174 | 175 | 172 | 175 | 175 |
| HVAC (Equipment) | 408 | 408 | 405 | 405 | 405 | 405 | 405 | 403 | 401 | 400 | 399 | 398 | 397 | 396 | 396 | 396 | 396 | 392 | 396 | 396 |
| Lighting | 662 | 672 | 675 | 679 | 682 | 689 | 695 | 316 | 312 | 310 | 309 | 308 | 306 | 304 | 304 | 304 | 304 | 302 | 303 | 303 |
| Water Heating | 300 | 300 | 299 | 299 | 299 | 299 | 299 | 299 | 297 | 297 | 297 | 297 | 295 | 295 | 295 | 295 | 295 | 295 | 295 | 295 |
| Other | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 |
| Fuel-Switching | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 390 | 390 | 390 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 |
| Early Retirement | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 455 | 455 | 494 | 494 | 494 | 494 | 494 | 494 |
| **Total** | **3,498** | **3,507** | **3,500** | **3,500** | **3,502** | **3,510** | **3,515** | **3,132** | **3,118** | **3,110** | **3,104** | **3,102** | **3,156** | **3,148** | **3,187** | **3,187** | **3,188** | **3,179** | **3,187** | **3,187** |
| *% of Annual Forecast Sales* | *4.2%* | *4.1%* | *4.0%* | *4.1%* | *4.0%* | *4.0%* | *4.0%* | *3.6%* | *3.6%* | *3.6%* | *3.6%* | *3.6%* | *3.6%* | *3.6%* | *3.6%* | *3.6%* | *3.6%* | *3.5%* | *3.5%* | *3.5%* |

## 3.4 IMPACT OF BEHAVIORAL MEASURES ON RESIDENTIAL SAVINGS POTENTIAL

A small portion of the maximum achievable potential in the residential sector over the next 20 years is expected to be driven by behavioral programs. In total, approximately 1% of the residential maximum achievable potential (7,022 MWh) is assumed to be a result of the impact behavioral programs will have on driving program participation. There also exists the potential for "soft" behavior-based conservation energy savings from non-hard wired measures, though the quantification of those savings is not provided in this long term 20-year study due to the typically short one-year measure life and for the reasons provided in Section 2.5.2.

## 3.5 RESIDENTIAL MAXIMUM ACHIEVABLE POTENTIAL BENEFITS & COSTS

The overall benefit/cost screening results for the residential sector maximum achievable potential are shown below in Table 3-8. The net present value costs to Vermont of roughly $779 million dollars represent both total measure costs as well as the associated costs (i.e. marketing, labor, monitoring, etc.) of administering energy efficiency programs between 2014 and 2033[16]. The net present value benefits of $2.4 billion represent the lifetime benefits of all measures installed during the same time period. In addition to the electric benefits received, the net present value benefit dollars include the impacts of reduced fuel consumption (or increased fuel consumption through fuel-switching efforts), water savings, other O&M benefits, and the VT Societal Test externality benefits. Although the maximum achievable potential estimates would require a substantial investment in energy efficiency over the long term, the resulting energy and demand savings would result in a net savings of nearly $1.7 billion dollars (present worth 2014).

**Table 3-8: NPV ($2014) Benefits and Costs Associated with the Maximum Achievable Potential Electric Savings in the Residential Sector in 2033**

| | Benefits (in Millions) | Cost (in Millions) | B/C Ratio |
|---|---|---|---|
| **Statewide** | | | |
| NVP $2014 | $2,438.4 | $779.0 | 3.1 |
| **EVT Territory** | | | |
| NVP $2014 | $2,344.7 | $744.1 | 3.2 |
| **BED Territory** | | | |
| NVP $2014 | $93.7 | $35.0 | 2.7 |

The annual incentive and administrative cost associated with the maximum achievable potential savings are presented in greater detail in Tables 3-9 through 3-11. Administrative costs range annually from 30.0%-35.5% of the total estimated annual dollars necessary to achieve the targeted maximum achievable potential. Because administrative costs are tied directly to first year kWh savings, administrative costs are sensitive to the number of measures being installed each year and are not a predetermined fraction of the total budget.

[16] The associated costs, or "non-incentive costs" refer to the Total Efficiency Vermont Costs reported by EVT net of all incentives to participants and/or trade allies. It does not include participant or other third party costs. Performance incentives and operations fees, along with evaluation budgets are additional costs to deliver programs that are not included in this calculation.

**Table 3-9 Incentive and Administrative Costs Associated with the Residential Maximum Achievable Potential (VT Statewide), ($ in millions)**

| Incentive Costs - Statewide | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | $1.7 | $1.9 | $2.0 | $1.9 | $1.9 | $1.9 | $1.8 | $1.8 | $1.8 | $1.8 | $1.7 | $1.7 | $1.7 | $1.7 | $1.7 | $1.7 | $1.7 | $1.6 | $1.7 | $1.7 |
| Appliances/Water Heating | $2.6 | $3.2 | $3.2 | $3.2 | $3.1 | $3.0 | $3.0 | $2.9 | $2.8 | $2.8 | $2.7 | $2.7 | $2.6 | $2.5 | $2.6 | $2.6 | $2.6 | $2.5 | $2.5 | $2.6 |
| Consumer Electronics | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 | $2.3 |
| HVAC (Envelope) | $10.7 | $15.3 | $15.9 | $15.3 | $14.4 | $13.7 | $13.6 | $12.9 | $12.3 | $12.0 | $11.2 | $10.9 | $10.3 | $9.8 | $9.8 | $10.1 | $10.0 | $9.4 | $9.7 | $10.0 |
| HVAC (Equipment) | $4.2 | $4.4 | $4.5 | $4.4 | $4.4 | $4.4 | $4.4 | $4.3 | $4.3 | $4.3 | $4.3 | $4.3 | $4.2 | $4.2 | $4.2 | $4.2 | $4.2 | $4.2 | $4.2 | $4.2 |
| Lighting | $4.7 | $4.9 | $4.8 | $4.4 | $4.2 | $4.1 | $4.0 | $4.2 | $4.0 | $3.8 | $3.6 | $3.4 | $3.2 | $3.0 | $2.9 | $2.8 | $2.7 | $2.6 | $2.5 | $2.5 |
| Water Heating | $3.0 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 |
| Other | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 |
| Fuel-Switching | $1.2 | $1.3 | $1.3 | $1.3 | $1.3 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 |
| Early Retirement | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $13.7 | $14.9 | $14.9 | $17.2 | $17.2 | $17.2 | $17.2 | $17.2 | $17.2 |
| Behavioral/Education | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| **Total** | **$44.9** | **$50.8** | **$51.5** | **$50.4** | **$49.1** | **$48.0** | **$47.8** | **$47.2** | **$46.2** | **$45.7** | **$44.4** | **$43.9** | **$44.3** | **$43.4** | **$45.6** | **$45.9** | **$45.7** | **$44.8** | **$45.1** | **$45.4** |
| **Non-Incentive Costs - Statewide** | | | | | | | | | | | | | | | | | | | | |
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | $0.6 | $0.9 | $1.0 | $0.9 | $0.9 | $0.8 | $0.9 | $0.8 | $0.8 | $0.8 | $0.7 | $0.7 | $0.7 | $0.6 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 |
| Appliances/Water Heating | $0.2 | $0.5 | $0.5 | $0.5 | $0.5 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 |
| Consumer Electronics | $0.9 | $0.9 | $1.0 | $1.0 | $1.0 | $1.0 | $1.0 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 | $1.2 | $1.2 | $1.2 | $1.2 | $1.3 | $1.3 | $1.3 | $1.3 |
| HVAC (Envelope) | $4.1 | $6.2 | $6.6 | $6.5 | $6.2 | $6.0 | $6.0 | $5.8 | $5.6 | $5.6 | $5.2 | $5.2 | $5.0 | $4.8 | $4.9 | $5.2 | $5.2 | $4.9 | $5.2 | $5.5 |
| HVAC (Equipment) | $3.5 | $4.0 | $4.2 | $4.2 | $4.2 | $4.2 | $4.2 | $4.2 | $4.2 | $4.3 | $4.3 | $4.3 | $4.3 | $4.3 | $4.4 | $4.6 | $4.6 | $4.6 | $4.8 | $4.9 |
| Lighting | $2.1 | $3.8 | $4.0 | $3.7 | $3.4 | $3.1 | $3.0 | $2.1 | $2.0 | $1.9 | $1.7 | $1.7 | $1.5 | $1.4 | $1.4 | $1.6 | $1.6 | $1.4 | $1.5 | $1.6 |
| Water Heating | $0.7 | $0.9 | $1.0 | $1.0 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.8 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $1.0 |
| Other | $0.4 | $0.7 | $0.7 | $0.7 | $0.7 | $0.6 | $0.7 | $0.6 | $0.6 | $0.6 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 |
| Fuel-Switching | $3.6 | $3.9 | $4.0 | $4.1 | $4.1 | $4.1 | $4.2 | $4.2 | $4.3 | $4.4 | $4.4 | $4.5 | $4.5 | $4.6 | $4.7 | $4.8 | $4.9 | $4.9 | $5.0 | $5.2 |
| Early Retirement | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.6 | $0.6 | $0.7 | $0.7 | $0.7 | $0.7 | $0.8 | $0.8 |
| Behavioral/Education | $2.8 | $2.9 | $2.9 | $2.9 | $2.9 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 | $3.1 |
| **Total** | **$19.2** | **$25.2** | **$26.3** | **$25.9** | **$25.2** | **$24.6** | **$24.8** | **$23.7** | **$23.3** | **$23.4** | **$22.7** | **$22.8** | **$22.5** | **$22.1** | **$22.6** | **$23.5** | **$23.8** | **$23.2** | **$24.1** | **$25.0** |

**Table 3-10: Incentive and Administrative Costs Associated with the Residential Maximum Achievable Potential (EVT), ($ in millions)**

| Incentive Costs - EVT Territory | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | $1.7 | $1.9 | $1.9 | $1.9 | $1.8 | $1.8 | $1.8 | $1.8 | $1.7 | $1.7 | $1.7 | $1.7 | $1.6 | $1.6 | $1.6 | $1.6 | $1.6 | $1.6 | $1.6 | $1.6 |
| Appliances/Water Heating | $2.5 | $3.1 | $3.1 | $3.1 | $3.0 | $2.9 | $2.9 | $2.8 | $2.7 | $2.7 | $2.6 | $2.6 | $2.5 | $2.4 | $2.5 | $2.5 | $2.5 | $2.4 | $2.4 | $2.5 |
| Consumer Electronics | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 | $2.2 |
| HVAC (Envelope) | $10.3 | $14.8 | $15.5 | $14.9 | $14.0 | $13.3 | $13.2 | $12.5 | $11.9 | $11.6 | $10.8 | $10.5 | $10.0 | $9.5 | $9.5 | $9.8 | $9.7 | $9.0 | $9.3 | $9.7 |
| HVAC (Equipment) | $3.9 | $4.1 | $4.1 | $4.1 | $4.1 | $4.1 | $4.0 | $4.0 | $4.0 | $4.0 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 |
| Lighting | $4.5 | $4.7 | $4.6 | $4.2 | $4.0 | $3.9 | $3.8 | $4.0 | $3.8 | $3.6 | $3.4 | $3.2 | $3.1 | $2.9 | $2.8 | $2.7 | $2.6 | $2.5 | $2.4 | $2.4 |
| Water Heating | $2.9 | $3.0 | $3.0 | $3.0 | $3.0 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 |
| Other | $0.7 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 |
| Fuel-Switching | $1.1 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 | $1.1 |
| Early Retirement | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $13.0 | $14.2 | $14.2 | $16.4 | $16.4 | $16.4 | $16.4 | $16.4 | $16.4 |
| Behavioral/Education | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| **Total** | **$42.8** | **$48.7** | **$49.5** | **$48.3** | **$47.0** | **$46.0** | **$45.8** | **$45.2** | **$44.2** | **$43.7** | **$42.4** | **$41.9** | **$42.3** | **$41.4** | **$43.6** | **$43.9** | **$43.7** | **$42.7** | **$43.0** | **$43.4** |
| **Non-Incentive Costs - EVT Territory** | | | | | | | | | | | | | | | | | | | | |
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | $0.5 | $0.9 | $0.9 | $0.9 | $0.9 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.7 | $0.7 | $0.7 | $0.6 | $0.6 | $0.7 | $0.7 | $0.6 | $0.7 | $0.7 |
| Appliances/Water Heating | $0.2 | $0.5 | $0.5 | $0.5 | $0.5 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 |
| Consumer Electronics | $0.9 | $0.9 | $0.9 | $0.9 | $1.0 | $1.0 | $1.0 | $1.0 | $1.0 | $1.0 | $1.1 | $1.1 | $1.1 | $1.1 | $1.2 | $1.2 | $1.2 | $1.2 | $1.3 | $1.3 |
| HVAC (Envelope) | $3.9 | $6.0 | $6.5 | $6.3 | $6.0 | $5.8 | $5.9 | $5.6 | $5.4 | $5.4 | $5.1 | $5.0 | $4.8 | $4.6 | $4.7 | $5.0 | $5.0 | $4.7 | $5.0 | $5.3 |
| HVAC (Equipment) | $3.2 | $3.7 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $3.9 | $4.0 | $3.9 | $4.0 | $4.0 | $4.0 | $4.1 | $4.2 | $4.3 | $4.3 | $4.4 | $4.5 |
| Lighting | $2.0 | $3.7 | $3.9 | $3.7 | $3.3 | $3.0 | $2.9 | $2.0 | $1.9 | $1.8 | $1.6 | $1.6 | $1.5 | $1.3 | $1.4 | $1.5 | $1.5 | $1.3 | $1.4 | $1.6 |
| Water Heating | $0.7 | $0.9 | $1.0 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.9 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.9 | $0.9 | $0.8 | $0.9 | $0.9 |
| Other | $0.4 | $0.7 | $0.7 | $0.7 | $0.7 | $0.6 | $0.6 | $0.6 | $0.6 | $0.6 | $0.5 | $0.5 | $0.5 | $0.4 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 | $0.5 |
| Fuel-Switching | $3.3 | $3.6 | $3.7 | $3.8 | $3.8 | $3.8 | $3.9 | $3.9 | $4.0 | $4.0 | $4.1 | $4.1 | $4.2 | $4.2 | $4.3 | $4.4 | $4.5 | $4.5 | $4.7 | $4.8 |
| Early Retirement | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.5 | $0.5 | $0.5 | $0.5 | $0.6 | $0.6 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 |
| Behavioral/Education | $2.7 | $2.7 | $2.7 | $2.8 | $2.8 | $2.8 | $2.8 | $2.8 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $2.9 | $3.0 | $3.0 | $3.0 | $3.0 | $3.0 |
| **Total** | **$18.2** | **$24.1** | **$25.3** | **$24.8** | **$24.1** | **$23.5** | **$23.7** | **$22.5** | **$22.2** | **$22.2** | **$21.5** | **$21.6** | **$21.3** | **$20.9** | **$21.4** | **$22.2** | **$22.5** | **$21.9** | **$22.8** | **$23.7** |

**Table 3-11: Incentive and Administrative Costs Associated with the Residential Maximum Achievable Potential (BED), ($ in millions)**

| Incentive Costs - BED Territory | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 |
| Appliances/Water Heating | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 |
| Consumer Electronics | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 |
| HVAC (Envelope) | $0.42 | $0.42 | $0.40 | $0.39 | $0.39 | $0.39 | $0.39 | $0.38 | $0.37 | $0.36 | $0.35 | $0.35 | $0.34 | $0.33 | $0.33 | $0.33 | $0.33 | $0.32 | $0.33 | $0.33 |
| HVAC (Equipment) | $0.33 | $0.33 | $0.33 | $0.33 | $0.33 | $0.33 | $0.33 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 | $0.32 |
| Lighting | $0.20 | $0.19 | $0.18 | $0.17 | $0.16 | $0.16 | $0.16 | $0.17 | $0.16 | $0.15 | $0.15 | $0.14 | $0.14 | $0.13 | $0.13 | $0.12 | $0.12 | $0.11 | $0.11 | $0.11 |
| Water Heating | $0.12 | $0.12 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 |
| Other | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 | $0.02 |
| Fuel-Switching | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 | $0.08 |
| Early Retirement | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.72 | $0.72 | $0.83 | $0.83 | $0.83 | $0.83 | $0.83 | $0.83 |
| Behavioral/Education | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| **Total** | **$2.09** | **$2.08** | **$2.06** | **$2.03** | **$2.02** | **$2.03** | **$2.02** | **$2.02** | **$2.00** | **$1.98** | **$1.96** | **$1.95** | **$2.00** | **$1.98** | **$2.08** | **$2.07** | **$2.07** | **$2.05** | **$2.06** | **$2.06** |
| **Non-Incentive Costs - BED Territory** | | | | | | | | | | | | | | | | | | | | |
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| Appliances | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Appliances/Water Heating | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Consumer Electronics | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| HVAC (Envelope) | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| HVAC (Equipment) | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 |
| Lighting | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| Water Heating | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Other | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Fuel-Switching | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 |
| Early Retirement | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Behavioral/Education | $0.1 | $0.1 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| **Total** | **$1.1** | **$1.1** | **$1.1** | **$1.1** | **$1.1** | **$1.1** | **$1.1** | **$1.2** | **$1.2** | **$1.2** | **$1.2** | **$1.2** | **$1.2** | **$1.2** | **$1.2** | **$1.2** | **$1.3** | **$1.3** | **$1.3** | **$1.3** |

# 4 COMMERCIAL AND INDUSTRIAL ENERGY EFFICIENCY POTENTIAL ESTIMATES (2014 TO 2033)

This section of the report presents the estimates of electric technical, economic, and maximum achievable potential for the state of Vermont as well as the EVT and BED territories separately.

Figure 4-1 and Table 4-1 below summarize the technical, economic, and maximum achievable savings potential (as a % of forecast sales) for the Vermont service area by 2033. The maximum achievable potential presented here is for a market penetration scenario which assumes the installation of efficient measures in 90% of the available commercial and industrial (C&I) market. If 90% market penetration for all cost-effective measures can be reached over the next 20 years, the maximum achievable potential for electric energy efficiency savings in the commercial and industrial sector is 726,884 MWh (approximately 19% of projected commercial and industrial sales in 2033). Energy efficiency measures and programs can also serve to lessen summer and winter peak demand.

**Figure 4-1: 2033 Summaries of Commercial & Industrial Energy Efficiency Potential**

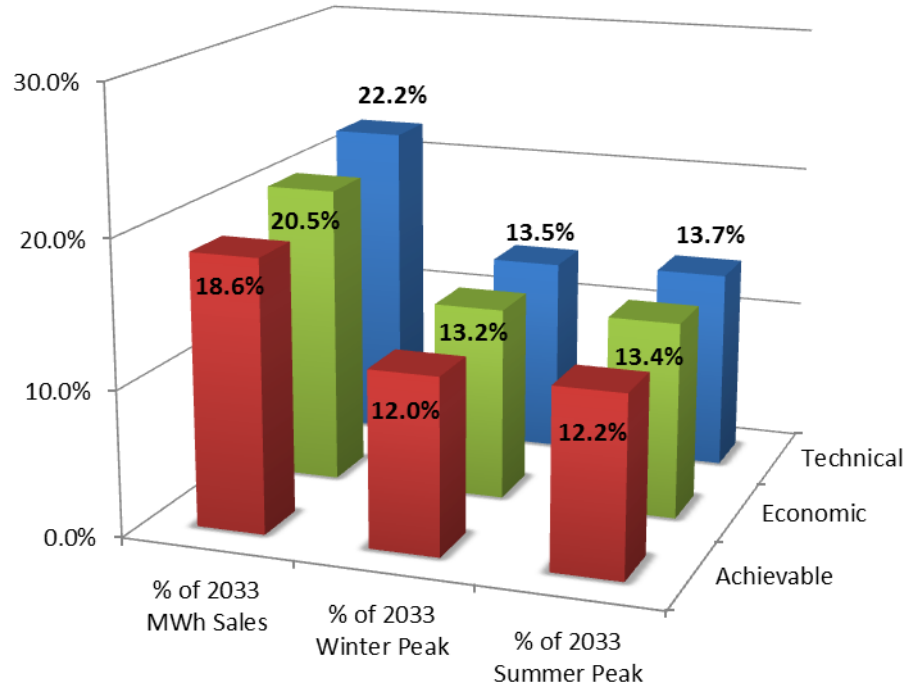



Table 4-1 also presents the separate technical, economic, and maximum achievable estimates for the EVT and BED service territories. In general the BED territory had slightly higher percentage estimates of technical, economic, and achievable potential energy savings. Of the combined 726,884 MWh of achievable potential energy savings, the BED territory achievable electric energy savings was 64,151 MWh (19.1% of 2033 BED sales). The EVT territory was estimated to have a maximum achievable potential of 662,733 MWh (18.6% of 2033 EVT territory sales).

**Table 4-1: 2033 Summary of C&I Energy and Demand Savings Potential**

| | Energy | | Demand | | | |
|---|---|---|---|---|---|---|
| | MWh | % of 2033 MWh Sales | Winter MW | % of 2033 Winter Peak | Summer MW | % of 2033 Summer Peak |
| ***State-wide*** | | | | | | |
| Technical Potential | 865,171 | 22.2% | 82 | 13.5% | 114 | 13.7% |
| Economic Potential | 798,774 | 20.5% | 80 | 13.2% | 111 | 13.4% |
| Maximum Achievable Potential | 726,884 | 18.6% | 73 | 12.0% | 101 | 12.2% |
| ***EVT*** | | | | | | |
| Technical Potential | 788,596 | 22.1% | 75 | 13.4% | 104 | 13.7% |
| Economic Potential | 728,278 | 20.4% | 73 | 13.1% | 102 | 13.3% |
| Maximum Achievable Potential | 662,733 | 18.6% | 67 | 11.9% | 92 | 12.1% |
| ***BED*** | | | | | | |
| Technical Potential | 76,575 | 22.8% | 7 | 15.3% | 10 | 14.8% |
| Economic Potential | 70,495 | 21.0% | 7 | 14.9% | 9 | 14.5% |
| Maximum Achievable Potential | 64,151 | 19.1% | 6 | 13.6% | 9 | 13.2% |

## 4.1 ENERGY EFFICIENCY MEASURES EXAMINED

Close to one hundred fifty (150) commercial and industrial electric energy efficiency measures were included in the original energy savings analysis for the C&I sector. Below, Table 4-2 provides a brief listing of the various commercial and industrial energy efficiency programs or measures considered in this analysis. The list of energy efficiency measures examined were reviewed based mainly on what was found in the Vermont TRM version 2013-83 and what is found in other studies and field experience.

**Table 4-2: Measures and Programs Included in the Commercial/Industrial Sector Analysis**

| End Use Type | Measures/Programs Includes |
|---|---|
| **Space Heating** | * Heat Pumps (Ground Source, Water Source, High Efficiency)<br>* HVAC Tune-Up / Optimization<br>* Insulation (Wall, Ceiling, etc.)<br>* Commissioning/Retro commissioning/Feedback |
| **Space Cooling** | * Heat Pumps (Ground Source, Water Source, High Efficiency)<br>* HVAC Tune-up/Optimization/Automated Diagnostics<br>* Economizers<br>* High-efficiency AC and Chillers<br>* Absorption Cooling |
| **Ventilation** | * Ventilation Variable Frequency Drives (VFDs)<br>* Stove Hood<br>* Energy Recovery System<br>* Diagnostic Controls / Feedback |
| **Water Heating** | * Heat Pump Water Heater<br>* Fuel Switching - DHW<br>* Low Flow Showerhead/Faucet Aerator<br>* High Efficiency Clothes Washers<br>* High Efficiency Tank and Booster Water Heaters<br>* Solar Assisted Water Heating System<br>* Reverse Cycle Chiller / Heat Recovery Unit |
| **Lighting** | * LED Lighting Systems (Indoor and Outdoor)<br>* Lighting Controls<br>* LED Exit Signs<br>* Refrigerated Case Lighting<br>* Commercial Direct Install CFL |

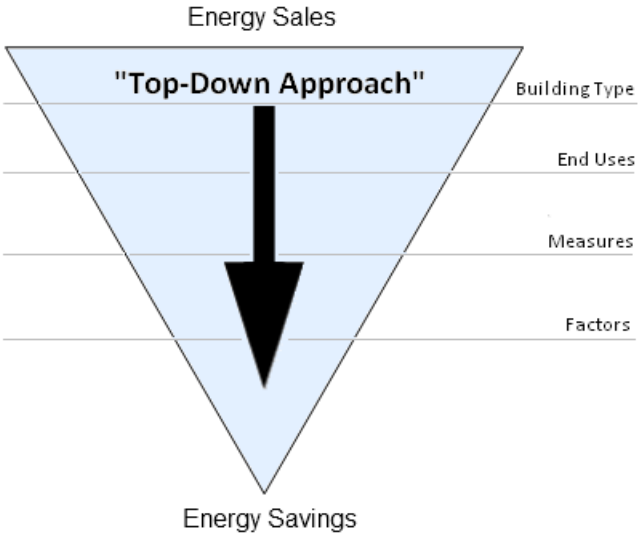
| End Use Type | Measures/Programs Includes |
|---|---|
| | * Lighting Design / Improvements |
| **Cooking** | * High Efficiency Cooking Equipment |
| **Refrigeration** | * Vending Machines<br>* Reach-In Freezers<br>* Covers for Display Cases / Zero Energy Doors<br>* Evaporator Fan Controls<br>* Economizer / ECM<br>* Commissioning/Retro commissioning/Feedback |
| **Office Equipment/Computers** | *Smart Power Strips<br>* Power Supplies<br>* LCD Monitors<br>* Energy Star Computers<br>* Network PC Power Management |
| **Process** | * Industrial Process<br>* Water/Wastewater Treatment Options |
| **Other** | * Efficient Televisions (Plasma, LCD)<br>* Energy Star Dehumidifiers<br>* Air Compressors<br>* Fuel Switch – Clothes Dryer<br>* Engine Block Timer / Maple Sap Vacuum Pump |

## 4.2 COMMERCIAL AND INDUSTRIAL SECTOR SAVINGS METHODOLOGY OVERVIEW

In all areas of the country, the residential sector has benefited from significantly more studies done on energy conservation related issues than any other sector. Hard data for many of the inputs needed for this analysis in the commercial and industrial sectors in Vermont was unavailable. In general, the preference for data sources in this study followed the order of: data provided by the PSD, EVT, and BED, TRM data, other Vermont-specific data, region specific data, national data, and engineering estimates. In the absence of better data, estimates had to be made based on the engineers' and analysts' judgment derived from experience elsewhere and an understanding of the types of factors that may influence the saturation of a specific measure one way or the other in Vermont.

In contrast to the residential sector analysis, the commercial and industrial sector analysis was modeled using what is called a "top-down" approach. As shown in Figure 4-2, the top-down potential estimate begins with a disaggregated energy sales forecast over the 2014-2033 time period, and then estimates what percentage of these sales a given efficiency measure will save.

**Figure 4-2: Commercial/Industrial Sector Methodology – Top-Down Approach**




The end-uses were then broken down into measure categories. After measures were examined and saturation data was gathered, the technical, economic and achievable cases were calculated using the equation below:

**Equation 4-1: Core Equation for Non-Residential Sector Technical Potential**


In instances where there were two (or more) competing technologies for the same electric end use, such as storage water heater tank wraps, heat pump water heaters and solar water heaters, a percent of the available population was assigned to each measure using the applicability factor. In the event that one of the competing measures was not found to be cost-effective, the homes assigned to that measure were transitioned over to the cost effective alternative (if any).

## 4.3 NON-RESIDENTIAL MAXIMUM ACHIEVABLE SAVINGS POTENTIAL

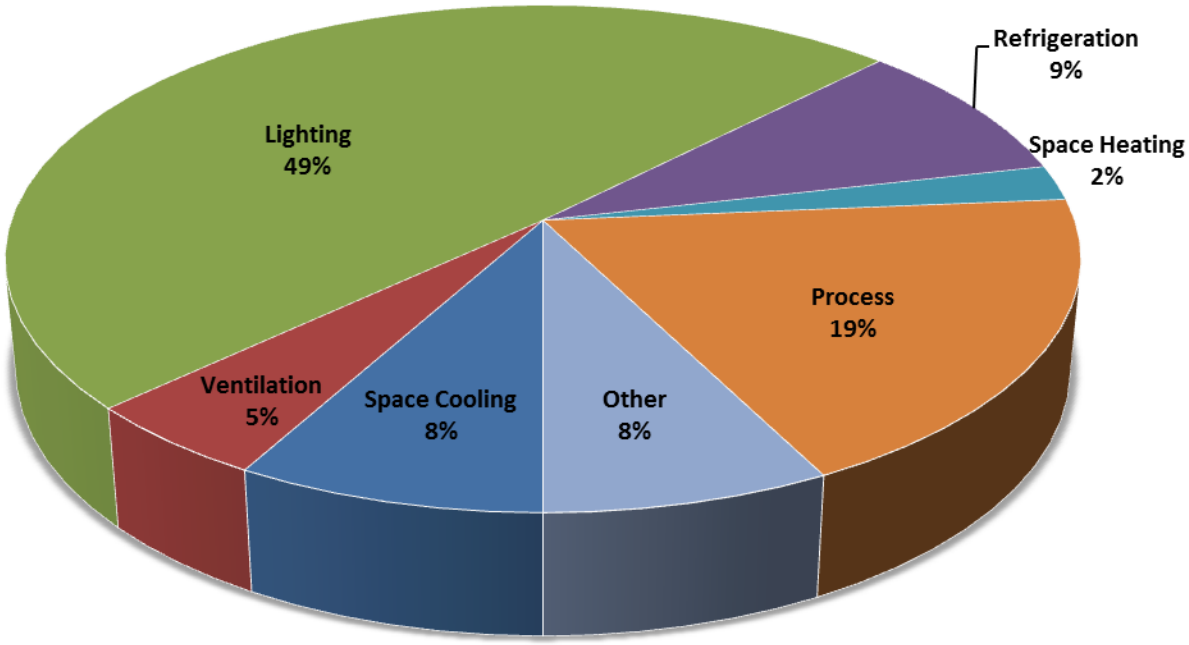
By 2033 the total non-residential energy efficiency maximum achievable potential is 726,884 MWh, or 18.6% of forecast non-residential sales in 2033. The maximum achievable potential scenario also achieves 73 MW of non-residential winter peak savings, or 12.0% of the 2033 non-residential winter peak forecast. Summer peak savings are estimated at 101 MW, or 12.2% of the non-residential summer peak forecast.

**Table 4-3: Maximum Achievable Energy and Demand Potential and % Share of Non-Residential Forecast Energy Sales and Summer/Winter Peak Demand in 2033**

| | Achievable Potential | | |
|---|---|---|---|
| | Energy (MWh) | Winter Peak Demand (MW) | Summer Peak Demand (MW) |
| Space Heating | 16,270 | 1.0 | 0.6 |
| Space Cooling | 58,747 | 0.0 | 11.7 |
| Ventilation | 36,326 | 3.7 | 9.3 |
| Water Heating | 5,988 | 0.4 | 0.4 |
| Lighting | 358,387 | 28.7 | 43.9 |
| Cooking | 671 | 0.1 | 0.1 |
| Refrigeration | 65,559 | 4.3 | 4.3 |
| Office Equipment | 7,283 | 0.1 | 0.1 |
| Computers | 26,105 | 0.5 | 0.7 |
| Process | 136,768 | 29.2 | 29.2 |
| Other | 14,779 | 4.9 | 0.7 |
| **TOTAL** | **726,884** | **73** | **101** |
| *% of 2033 Commercial/Industrial Sales* | *18.6%* | *12.0%* | *12.2%* |

For the maximum achievable scenario the achievable potential savings are 726,884 MWh or 18.6% of projected 2033 kWh sales. The base case scenario also achieves 101 MW summer peak demand savings, or 12.2% of the 2033 small and large commercial and industrial summer peak demand forecast. Figure 4-3 provides a breakdown of the electric end-use savings as a percent of the total maximum achievable energy savings potential. About 49% of the achievable cost effective savings is from high efficiency lighting, followed by processes and refrigeration. Lighting is usually the dominant end-use for achievable savings because every commercial and industrial customer has lighting, whereas only a small portion have upgraded to energy efficient systems.

**Figure 4-3: Sector End-use Savings as a % of Total Achievable Potential – 2033**




Tables 4-4 through Table 4-6 depict the cumulative annual energy and demand savings for the commercial/industrial sector. Table 4-7 provides the incremental annual energy savings for the non-residential sector. In addition to the statewide maximum achievable potential, the maximum achievable potential for the EVT and BED service territories are also included. It is important to note that measure participation in this study includes re-entry at the end of a measure's lifetime. This accounts for the continued participation of the customers who have an interest in energy efficient measures with utility program support. In this study, the participation for the non-residential sector was "front-loaded" to match the early years of the achievable potential to the level of participation experienced in recent years in the state. This early adoption causes a ripple effect of a high level of measure participation during the last few years due to the number of C&I new construction and retrofit measures that have a measure lifetime of less than twenty years and C&I early replacement measures that have a measure lifetime of less than fifteen years.

**Table 4-4: Cumulative Annual C&I (MWh) Savings Potential for VT (Statewide), EVT Territory, and BED Territory**

| Energy Savings (MWh) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| End-Use | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
| EVT Territory | 81,066 | 166,096 | 254,631 | 334,781 | 403,737 | 463,565 | 515,459 | 560,266 | 598,763 | 616,213 | 621,194 | 626,176 | 631,127 | 635,966 | 640,654 | 645,122 | 649,589 | 654,057 | 658,394 | 662,733 |
| BED Territory | 7,824 | 16,030 | 24,573 | 32,310 | 38,969 | 44,749 | 49,765 | 54,098 | 57,823 | 59,520 | 60,016 | 60,512 | 61,005 | 61,486 | 61,953 | 62,398 | 62,843 | 63,287 | 63,719 | 64,151 |
| **Total** | **88,890** | **182,126** | **279,204** | **367,091** | **442,706** | **508,315** | **565,225** | **614,364** | **656,586** | **675,733** | **681,210** | **686,687** | **692,132** | **697,452** | **702,608** | **707,520** | **712,432** | **717,344** | **722,113** | **726,884** |
| % of Annual Forecast Sales | 2.9% | 5.9% | 8.8% | 11.4% | 13.6% | 15.3% | 16.8% | 17.9% | 19.0% | 19.3% | 19.3% | 19.2% | 19.1% | 19.0% | 18.9% | 18.8% | 18.8% | 18.7% | 18.7% | 18.6% |

**Table 4-5: Cumulative Annual C&I Winter Peak Demand (MW) Savings Potential for VT (Statewide), EVT Territory, and BED Territory**

| Winter Peak Demand Savings (MW) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| End-Use | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
| EVT Territory | 8.5 | 17.4 | 26.6 | 35.0 | 42.2 | 48.4 | 53.9 | 58.3 | 62.1 | 63.7 | 64.1 | 64.4 | 64.7 | 65.0 | 65.3 | 65.6 | 65.9 | 66.1 | 66.4 | 66.7 |
| BED Territory | 0.8 | 1.6 | 2.4 | 3.2 | 3.9 | 4.4 | 4.9 | 5.3 | 5.7 | 5.8 | 5.9 | 5.9 | 5.9 | 6.0 | 6.0 | 6.0 | 6.0 | 6.1 | 6.1 | 6.1 |
| **Total** | **9.3** | **19.0** | **29.0** | **38.2** | **46.0** | **52.9** | **58.8** | **63.6** | **67.8** | **69.6** | **69.9** | **70.3** | **70.6** | **71.0** | **71.3** | **71.6** | **71.9** | **72.2** | **72.5** | **72.8** |
| % of Annual Forecast | 1.8% | 3.6% | 5.4% | 7.2% | 8.5% | 9.7% | 10.7% | 11.2% | 12.0% | 12.3% | 12.1% | 12.1% | 12.2% | 12.2% | 12.1% | 12.1% | 12.1% | 12.1% | 12.1% | 12.0% |

**Table 4-6: Cumulative Annual C&I Summer Peak Demand (MW) Savings Potential for VT (Statewide), EVT Territory, and BED Territory**

| Summer Peak Demand Savings (MW) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| End-Use | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
| EVT Territory | 11.4 | 23.3 | 35.6 | 46.8 | 56.5 | 64.9 | 72.3 | 78.4 | 83.7 | 86.1 | 86.8 | 87.5 | 88.1 | 88.8 | 89.4 | 90.1 | 90.7 | 91.3 | 91.9 | 92.4 |
| BED Territory | 1.0 | 2.1 | 3.3 | 4.3 | 5.2 | 6.0 | 6.7 | 7.2 | 7.7 | 7.9 | 8.0 | 8.1 | 8.1 | 8.2 | 8.3 | 8.3 | 8.4 | 8.5 | 8.5 | 8.6 |
| **Total** | **12.4** | **25.4** | **38.9** | **51.2** | **61.7** | **70.9** | **79.0** | **85.7** | **91.4** | **94.0** | **94.8** | **95.5** | **96.3** | **97.0** | **97.7** | **98.4** | **99.1** | **99.8** | **100.4** | **101.0** |
| % of Annual Forecast | 1.9% | 3.8% | 5.7% | 7.4% | 8.8% | 10.0% | 11.0% | 11.8% | 12.4% | 12.7% | 12.7% | 12.6% | 12.6% | 12.5% | 12.4% | 12.4% | 12.3% | 12.3% | 12.3% | 12.2% |

**Table 4-7: Incremental Annual C&I (MWh) Savings Potential for VT (Statewide), EVT Territory, and BED Territory**

| Energy Savings (MWh) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| End-Use | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
| EVT Territory | 81,066 | 85,030 | 88,535 | 80,758 | 73,173 | 66,440 | 60,370 | 53,653 | 51,354 | 31,185 | 31,170 | 33,989 | 41,769 | 41,859 | 54,681 | 83,528 | 86,053 | 82,024 | 76,305 | 64,704 |
| BED Territory | 7,824 | 8,206 | 8,544 | 7,797 | 7,081 | 6,442 | 5,864 | 5,217 | 5,010 | 3,071 | 3,089 | 3,412 | 4,233 | 4,203 | 5,190 | 8,049 | 8,285 | 7,914 | 7,386 | 6,267 |
| **Total** | **88,890** | **93,235** | **97,079** | **88,555** | **80,254** | **72,881** | **66,234** | **58,870** | **56,364** | **34,255** | **34,260** | **37,401** | **46,002** | **46,063** | **59,871** | **91,577** | **94,338** | **89,939** | **83,691** | **70,971** |
| % of Annual Forecast Sales | 2.9% | 3.0% | 3.1% | 2.8% | 2.5% | 2.2% | 2.0% | 1.7% | 1.6% | 1.0% | 1.0% | 1.0% | 1.3% | 1.3% | 1.6% | 2.4% | 2.5% | 2.3% | 2.2% | 1.8% |

## 4.4 IMPACT OF OMYA ON NON-RESIDENTIAL SAVINGS POTENTIAL

A significant portion of the maximum achievable potential in the non-residential sector over the next 20 years is expected to be energy efficiency measures installed by the industrial customer, OMYA. In total, approximately 3.6% of the non-residential maximum achievable potential (26,241 MWh) is assumed to be a result of the energy efficiency measures installed by this single customer. Within the industrial sector, OMYA represents 16% of the industrial sector maximum achievable potential (164,341 MWh).

The lifetime benefits associated with these industrial measures is $78.3 million, and the lifetime costs associated with these industrial measures is $6.1 million. The associated budget for the OMYA industrial measures is $695,550 in 2014 and $392,391 in 2033.

## 4.5 NON-RESIDENTIAL MAXIMUM ACHIEVABLE POTENTIAL BENEFITS & COSTS

The overall benefit/cost screening results for the commercial and industrial sector maximum achievable potential are shown below in Table 4-8. The net present value costs of roughly $410 million dollars represent total measure costs as well as the associated costs (i.e. marketing, labor, monitoring, etc.) of administering energy efficiency programs and participant costs between 2014 and 2033. The net present value benefits of more than $1,800 million represent the lifetime benefits of all measures installed during the same time period. In addition to the electric benefits received, the net present value benefit dollars include the impacts of increased fuel consumption, water savings, and other O&M benefits. Although the maximum achievable potential estimates would require a substantial investment in energy efficiency over the long term, the resulting energy and demand savings would result in a net savings of nearly $1.4 billion dollars (present worth 2014).

**Table 4-8: Overall Commercial and Industrial Sector Cost Effectiveness Screening Results ($ in millions)**

| | Benefits (in Millions) | Cost (in Millions) | B/C Ratio |
|---|---|---|---|
| **Statewide** | | | |
| NVP $2014 | $1,802.2 | $409.9 | 4.4 |
| **EVT Territory** | | | |
| NVP $2014 | $1,656.8 | $372.1 | 4.5 |
| **BED Territory** | | | |
| NVP $2014 | $145.4 | $37.8 | 3.8 |

The annual incentive and administrative cost associated with the maximum achievable potential savings are presented in greater detail in Table 4-9. Administrative costs range annually from 19% - 27% of the total estimated annual dollars necessary to achieve the targeted maximum achievable potential. Because administrative costs are tied directly to first year kWh savings, administrative costs are sensitive to the number of measures being installed each year and are not a predetermined fraction of the total budget.

**Table 4-9: Incentive and Administrative Costs Associated with the Commercial and Industrial Maximum Achievable Potential, ($ in millions)**

| Incentive Costs - VT Statewide | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| EVT Territory | 33.4 | 35.1 | 36.5 | 33.1 | 29.0 | 25.8 | 22.7 | 20.1 | 18.2 | 9.8 | 10.8 | 12.4 | 14.7 | 14.3 | 14.5 | 29.9 | 30.2 | 29.9 | 27.7 | 23.3 |
| BED Territory | 3.4 | 3.6 | 3.8 | 3.4 | 3.0 | 2.7 | 2.3 | 2.1 | 1.9 | 1.0 | 1.1 | 1.3 | 1.6 | 1.6 | 1.6 | 3.1 | 3.1 | 3.0 | 2.8 | 2.4 |
| **VT Statewide** | **36.9** | **38.7** | **40.3** | **36.5** | **32.0** | **28.5** | **25.1** | **22.2** | **20.0** | **10.8** | **11.9** | **13.7** | **16.3** | **15.9** | **16.0** | **33.0** | **33.3** | **32.9** | **30.6** | **25.7** |
| **Non-Incentive Costs - VT Statewide** | | | | | | | | | | | | | | | | | | | | |
| **End-Use** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** |
| EVT Territory | 7.8 | 8.2 | 8.5 | 7.8 | 7.1 | 6.5 | 5.9 | 5.2 | 5.0 | 3.1 | 3.1 | 3.4 | 4.2 | 4.2 | 5.4 | 8.2 | 8.4 | 8.0 | 7.5 | 6.4 |
| BED Territory | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.8 | 0.8 | 0.8 | 0.7 | 0.6 |
| **VT Statewide** | **8.6** | **9.0** | **9.4** | **8.5** | **7.8** | **7.1** | **6.5** | **5.7** | **5.5** | **3.4** | **3.5** | **3.7** | **4.6** | **4.6** | **5.9** | **8.9** | **9.2** | **8.8** | **8.2** | **7.0** |

# 5 OVERALL CONCLUSIONS AND RECOMMENDATIONS

## 5.1 DIFFERENCES BETWEEN THE 2013 AND 2011 VERMONT ELECTRIC ENERGY EFFICIENCY POTENTIAL STUDIES

Overall the estimates for maximum achievable electric energy efficiency potential in this study are slightly less than those reported in 2011.

**Table 5-1: Differences between 2013 and 2011 VT Electric Energy Efficiency Potential Studies**

| | 2011 Study | | 2013 Study | |
|---|---|---|---|---|
| | MWh | % | MWh | % |
| Max. Achievable Potential | 1,533,411 | 26.0% | 1,450,000 | 23.4% |

Although there are numerous similarities between the two studies, there are also specific differences that explain why the updated results yielded the lower estimates of potential found in Table 5-1. Some of these differences include:

- The treatment of behavioral measures in the residential sector. The conservation-based behavioral savings were removed from the analysis as requested by the PSD (see Section 2.5.2 for details)
- Tightened federal standards for technologies such as residential appliances and residential water heating measures
- Increased market saturation of efficient technologies such as CFL bulbs
- A reduced fuel switching market due to fuel switching conversions that took place since the last study was completed
- Reduced NTG assumptions for specialty CFL bulbs in the residential sector

The above points do not constitute a comprehensive list of all the changes which decreased the potential. The updated study also incorporates revised assumptions which increased the energy efficiency potential for some end-uses such as the residential HVAC (Envelope) end use. The overall load forecast used for this study was also slightly higher than the previous study, which mitigated the impact of all the various reductions to the energy efficiency potential, such as those caused by the factors listed above.

## 5.2 REVIEW OF MAXIMUM ACHIEVABLE RESULTS FOR THE STATE

In summary, the potential for electric energy efficiency in Vermont by 2033 is significant. The estimated maximum achievable potential electricity savings would amount to 1,450,000 MWh, which would represent a 23.4% reduction in projected 2033 MWh sales. Table 5-1 below summarizes the electricity savings potential in Vermont by 2033. It is important to note that the cumulative annual savings estimates below are based on the modeling results from the GDS analysis, but the cost-effectiveness of the maximum achievable potential is impacted by the "front-loading" of the non-residential achievable potential which has the effect of increased potential and measures being reintroduced in the final years of the study. The reintroduction of measures in the non-residential sector increases the estimates of both the benefits and costs of the maximum achievable potential.

**Table 5-2: Maximum Achievable Potential Summary**

| | Cumulative Annual MWh Savings, 2033 | Cumulative Winter MW Savings, 2033 | Cumulative Summer MW Savings, 2033 | NPV Benefits ($2014), millions | NPV Costs ($2014), millions | VT Societal B/C Ratio |
|---|---|---|---|---|---|---|
| Residential Sector | 723,116 | 124 | 131 | $ 2,438 | $ 779 | 3.1 |
| C/I Sector | 726,884 | 73 | 101 | $ 1,802 | $ 410 | 4.4 |
| All Sectors Combined | 1,450,000 | 197 | 232 | $ 4,241 | $ 1,189 | 3.6 |

The results of this study demonstrate that cost effective electric energy efficiency resources can play an expanded role in Vermont's energy resource mix over the next two decades. Table 5-2 also displays the present value of benefits and costs associated with implementing the maximum achievable potential energy savings in Vermont as well as the overall VT Societal Test benefit/cost ratio of 3.6. The potential net present savings to ratepayers in Vermont for implementation of cost effective electric energy efficiency programs over the next 20 years are approximately $3.6 billion in 2014 dollars.

Actual energy and demand savings will depend upon the level and degree of Vermont residences and business participation in the DSM programs offered by EVT and BED. Participation is driven by a host of factors. Focused marketing and education must coincide with sufficient incentives in order for Vermont to achieve continued success in acquiring energy efficiency savings. The estimated savings and budgets are based upon a current forecast of unconstrained budgets amounts for DSM programs over the 20 year period of 2014-2033. Actual budget amounts are subject to annual review and approval by the Vermont Public Service Board. Therefore, while the figures presented in this report represent the best current estimates of savings and costs, actual results will be different.