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ELECTRIC ENERGY EFFICIENCY POTENTIAL FOR VERMONT

Final Report

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1 EXECUTIVE SUMMARY

In October 2010, the Vermont Department of Public Service ("VDPS") commissioned GDS Associates, Inc. to conduct a study of the potential for electric energy efficiency to reduce electric consumption and peak demand throughout the State of Vermont. The most recent electric load forecast available from the Vermont Electric Company (VELCO) predicts total electricity sales and summer peak demand in the state to increase at average annual growth rates of 0.64% and 1.04% respectively for the period from 2012 through 2031.[1] Improving energy efficiency and lowering electric demand in homes, businesses, and industries can be a cost effective way to address the challenges of increasing energy costs and the increasing demand for energy in the state. Consequently, energy efficiency potential studies are important and helpful tools for identifying those energy efficiency measures that are the most cost effective and that have the most significant electricity savings potential.[2] 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 cost less than new power supply resources are considered to be cost effective.

This detailed report presents results from the evaluation of opportunities for energy efficiency programs in the service areas of Vermont's two energy efficiency utilities (EEU).[3] 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 2012-2031 (a 20-year period) are provided for the residential and commercial/industrial (C&I) sectors. Results from three (3) resource portfolios scenarios are under development to estimate the portion of the achievable potential that might be achieved given a specific funding level and program design. The results for these three resource portfolios will be made available in a subsequent report prepared by the GDS Associates/Cadmus Group team.

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. To help inform these models, up-to-date measure saturation data were primarily obtained from the following recent studies:

1. Vermont Department of Public Service, "Analysis of On-Site Audits of Existing Homes in Vermont", June 2009

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[1] The most recent electric load forecast for the State of Vermont was prepared for the Vermont Electric Company (VELCO) by Itron, and provided to Efficiency Vermont and the VDPS through the auspices of the Vermont System Planning Committee (VSPC). GDS received this load forecast from Walter Poor of the VDPS via email on January 4, 2011. The growth rates presented here reflect a load forecast that does not include the impacts of energy efficiency efforts undertaken by Efficiency Vermont during the forecast period. More detailed information on the electric load forecast for Vermont and sub-regions are provided in Section 4 of this report.

[2] The avoided electric supply costs used in this study include avoided electric generation capacity and energy costs as well as avoided electric transmission and distribution costs.

[3] The December 20, 2010 Vermont Public Service Board Order of Appointment states on page 2 that "The Board shall appoint one or more EEUs to undertake demand-side efficiency resource acquisition initiatives in place of utility-specific programs developed pursuant to 30 V.S.A. § 218c." .

2. Vermont Department of Public Service "Overall Report, Vermont Residential New Construction Study, Final Report", July 2009
3. Vermont Department of Public Service, "Business Sector Market Assessment and Baseline Study – Existing Commercial Buildings", July 2009
4. Vermont Department of Public Service, "Business Sector Market Assessment and Baseline Study – Commercial New Construction", October 2009
5. Vermont Department of Public Service, "Business Sector Market Assessment and Baseline Study – Existing Industrial Facilities", September 2009
6. Burlington Electric Department, 2005 Residential Appliance Saturation Survey

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 most cost effective and have the greatest potential kWh and kW savings. The data used for this report were the best available at the time this analysis was developed. As building and appliance codes and energy efficiency standards change, and as energy prices fluctuate, additional opportunities for energy efficiency may occur while current practices may become out-dated.

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 2012 through 2031.

The study had the following main objectives:

- Evaluate the electric energy efficiency technical potential savings in the overall State of Vermont, as well as in the EVT and BED service areas;
- Calculate the Vermont Societal Test ("VT SCT") benefit-cost ratio for the achievable potential for electric energy efficiency measures and programs and determine the electric energy efficiency economic potential savings for Vermont homes and businesses;
- Evaluate the potential for maximum achievable savings through electric efficiency programs over a twenty-year horizon (2012-2031);
- Estimate resource plan scenario savings over a twenty-year period from the delivery of a portfolio of example energy efficiency programs based on specific funding levels or savings targets.

The scope of this study distinguishes among four types of energy efficiency potential; (1) technical, (2) economic, (3) maximum achievable, and (4) resource plan scenarios. 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.[4]

- **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.[5]

- **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.[6]

- **Resource Plan Scenarios -** Results from three (3) resource portfolios scenarios are under development to estimate the portion of the achievable potential that might be achieved given specific funding levels and program designs. The results of these resource plan scenarios will be presented in a supplemental report.

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

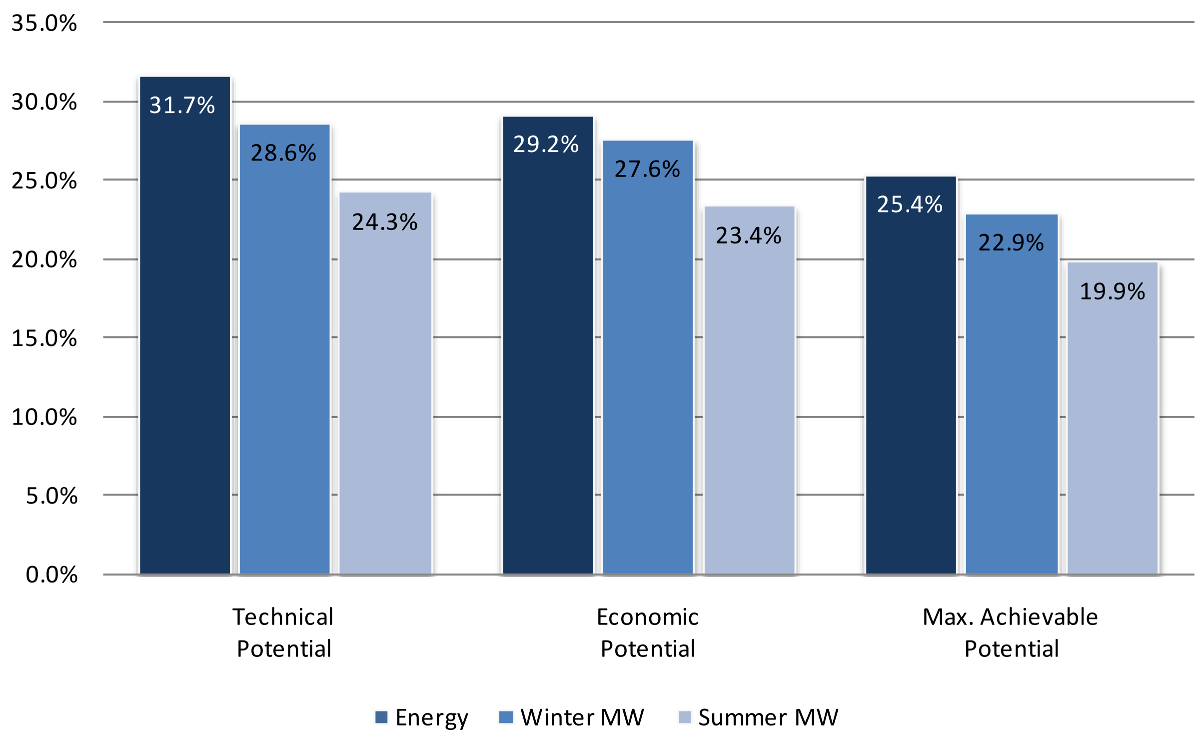
While the authors have sought to use the best available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different results. Furthermore, while the lists of measures examined in this study represent most commercially available measures, these measure lists are not exhaustive. Finally there was no attempt to place a dollar value on some difficult to quantify benefits arising from installation of some measures, such as increased comfort or increased safety, which may in turn support some personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

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

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 31.7% of forecasted kWh sales in 2031, twenty years from now.[7] The energy efficiency economic and achievable potential in 2031 are 29.2% and 25.4% of forecasted kWh sales in 2031. The technical, economic and achievable electric demand savings for the state as a whole are 28.6%, 27.6% and 23.4% (respectively) of forecasted winter peak demand in 2031. The technical, economic and achievable electric demand savings for the state as a whole are 24.3%, 23.4% and 19.9% (respectively) of forecasted summer peak demand in 2031.

Figure 1-1: 2031 DSM Potential Savings Summary for State of Vermont (DSM Potential as a Percent of Forecasted Vermont kWh Sales in 2031)



This study examined over 400 energy efficiency measure permutations in the residential, commercial and industrial sectors combined.

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 6 and 7 of this report.

[7] All energy and demand savings presented in this report are at the end-consumer (meter) level unless specifically noted otherwise in this report. See Section 5.10 of this report for information on the assumptions used in this study for free-ridership and spillover.

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

	Energy		Demand			
	Energy (MWh)	% of 2031 Sales	Winter MW	% of 2031 Winter Peak	Summer MW	% of 2031 Summer Peak
ALL SECTORS COMBINED						
State-wide						
Technical Potential	1,791,525	31.7%	278.5	28.6%	264.2	24.3%
Economic Potential	1,651,605	29.2%	268.6	27.6%	255.0	23.4%
Achievable Potential	1,435,673	25.4%	223.1	22.9%	216.3	19.9%
EVT Territory						0
Technical Potential	1,670,541	31.8%	262.7	28.7%	246.7	24.4%
Economic Potential	1,540,843	29.3%	253.5	27.7%	238.5	23.6%
Achievable Potential	1,338,255	25.5%	210.3	23.0%	202.0	20.0%
BED Territory						
Technical Potential	120,985	30.0%	15.8	27.6%	17.5	22.6%
Economic Potential	110,762	27.5%	15.1	26.3%	16.4	21.2%
Achievable Potential	97,418	24.1%	12.8	22.4%	14.3	18.4%
RESIDENTIAL SECTOR						
State-wide						
Technical Potential	1,011,825	42.4%	215.6	46.0%	159.2	36.8%
Economic Potential	966,837	40.6%	211.9	45.2%	158.5	36.7%
Achievable Potential	819,382	34.4%	172.2	36.7%	129.5	30.0%
EVT Territory						
Technical Potential	965,853	42.2%	205.6	45.5%	151.6	36.5%
Economic Potential	921,663	40.2%	202.0	44.7%	151.2	36.4%
Achievable Potential	780,993	34.1%	164.0	36.3%	123.3	29.7%
BED Territory						
Technical Potential	45,972	49.1%	10.0	57.4%	7.6	46.1%
Economic Potential	45,174	48.3%	9.9	56.7%	7.4	44.6%
Achievable Potential	38,389	41.0%	8.2	46.7%	6.1	37.1%
COMMERCIAL/INDUSTRIAL SECTOR						
State-wide						
Technical Potential	779,700	23.8%	62.9	12.5%	105.1	16.0%
Economic Potential	684,768	20.9%	56.6	11.2%	96.4	14.7%
Achievable Potential	616,291	18.8%	51.0	10.1%	86.8	13.2%
EVT Territory						
Technical Potential	704,688	23.8%	57.1	12.3%	95.2	16.0%
Economic Potential	619,180	20.9%	51.4	11.1%	87.4	14.7%
Achievable Potential	557,262	18.8%	46.3	10.0%	78.6	13.2%
BED Territory						
Technical Potential	75,013	24.2%	5.8	14.6%	9.9	16.3%
Economic Potential	65,588	21.2%	5.2	13.0%	9.1	14.8%
Achievable Potential	59,029	19.0%	4.7	11.7%	8.2	13.4%

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 ratio for the overall state of 2.6 to 1. This means that for every dollar spent by Vermont ratepayers on energy efficiency programs, $2.60 of benefits are returned to ratepayers.

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

	Benefits				Costs			
	Electric	Non-Electric (in millions)	Non-Energy	Total Benefits	Measure	Admin in millions	Total Costs	B/C Ratio
State-wide								
NPV $2012	$2,051.1	$307.6	$45.3	$2,404.0	$637.8	$304.6	$942.4	2.6
EVT Territory								
NPV $2012	$1,909.7	$295.6	$42.5	$2,247.8	$601.4	$283.7	$885.1	2.5
BED Territory								
NPV $2012	$141.3	$12.1	$2.8	$156.2	$36.4	$20.9	$57.4	2.7

2 GLOSSARY OF TERMS[8]

The following list defines many of the key energy efficiency terms used throughout this study.

Achievable potential: 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 efficient 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.

Applicability factor: the fraction of the applicable dwelling units or businesses that is technically feasible for conversion to the efficient technology from an *engineering* perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket in a home).

Base Case Equipment End-Use Intensity: the electricity used per customer per year by each base-case technology in each market segment. This is the consumption of the electric energy using equipment that the efficient technology replaces or affects. For example, if the efficient measure is a high efficiency light bulb (CFL), the base end-use intensity would be the annual kWh use per bulb per household associated with an incandescent light bulb that provides equivalent lumens to the CFL.

Base Case Factor: the fraction of the market that is applicable for the efficient technology in a given market segment. For example, for residential lighting, this would be the fraction of all residential electric customers that have electric lighting in their household.

Coincidence factor: the fraction of connected load expected to be "on" and using electricity coincident with the system peak period.

Cost-effectiveness: a measure of the relevant economic effects resulting from the implementation of an energy efficiency measure. If the benefits are greater than the costs, the measure is said to be cost-effective.

Cumulative annual: refers to the overall annual savings occurring in a given year from both new participants and annual savings continuing to result from past participation with measures that are still in place. Cumulative annual does not always equal the sum of all prior year incremental values as some measures have relatively short lives and, as a result, their savings drop off over time.

Early replacement: refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units

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

[8] Potential definitions taken from "National Action Plan for Energy Efficiency (2007). Guide for Conducting Energy Efficiency Potential Studies. Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc.

themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.

End-use: a category of equipment or service that consumes energy (*e.g.*, lighting, refrigeration, heating, process heat, cooling).

Energy efficiency: using less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. Sometimes "conservation" is used as a synonym, but that term is usually taken to mean using less of a resource even if this results in a lower service level (*e.g.*, setting a thermostat lower or reducing lighting levels).

Free Driver: individuals or businesses that adopt an energy efficient product or service because of an energy efficiency program, but are difficult to identify either because they do not receive an incentive or are not aware of the program. Nonparticipant spillover is defined as savings from efficiency projects implemented by those who did not directly participate in a program, but which nonetheless occurred due to the influence of the program. Participant spillover is defined as additional energy efficiency actions taken by program participants as a result of program influence, but actions that go beyond those directly subsidized or required by the program.[9]

Free Rider: participants in an energy efficiency program who would have adopted an energy efficiency technology or improvement in the absence of a program or financial incentive.

Gross Savings: Gross energy (or demand) savings are the change in energy consumption or demand that results directly from program-promoted actions (e.g., installing energy-efficient lighting) taken by program participants regardless of the extent or nature of program influence on their actions.

Incremental: savings or costs in a given year associated only with new installations happening in that specific year.

Lost-opportunity: refers to an energy efficiency measure or energy efficiency program that seeks to encourage the selection of higher-efficiency equipment or building practices than would typically be chosen at the time of a purchase or design decision.[10]

Measure: any action taken to increase energy efficiency, whether through changes in equipment, changes to a building shell, implementation of control strategies, or changes in consumer behavior. Examples are higher-efficiency central air conditioners, occupancy sensor control of lighting, and retro-commissioning. In some cases, bundles of technologies or practices may be modeled as single measures. For example, an ENERGY STAR® ™ home package may be treated as a single measure.

MW: a unit of electrical output, equal to one million watts or one thousand kilowatts. It is typically used to refer to the output of a power plant.

MWh: one thousand kilowatt-hours, or one million watt-hours. One MWh is equal to the use of 1,000,000 watts of power in one hour.

[9] The definitions of participant and nonparticipant spillover were obtained from the National Action Plan for Energy Efficiency Report titled "Model Energy Efficiency Program Impact Evaluation Guide", November 2007, page ES-4.
[10] In Vermont, it is common practice to refer to this as "market opportunity".

Net-to-gross ratio: a factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts

Net Savings: Net energy or demand savings refer to the portion of gross savings that is attributable to the program. This involves separating out the impacts that are a result of other influences, such as consumer self-motivation. Given the range of influences on consumers' energy consumption, attributing changes to one cause (i.e., a particular program) or another can be quite complex.

Portfolio: Either a collection of similar programs addressing the same market, technology, or mechanisms; or the set of all programs conducted by one energy efficiency organization or utility.

Program: a mechanism for encouraging energy efficiency that may be funded by a variety of sources and pursued by a wide range of approaches (typically includes multiple measures).

Remaining factor: the fraction of applicable units that have not yet been converted to the electric energy efficiency measure; that is, one minus the fraction of units that already have the energy efficiency measure installed.

Replace-on-burnout: a DSM measure is not implemented until the existing technology it is replacing fails. An example would be an energy efficient water heater being purchased after the failure of the existing water heater.

Retrofit: refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units (also called "early retirement") or the installation of additional controls, equipment, or materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, low flow devices, lighting occupancy controls, economizer ventilation systems).

Savings factor: the percentage reduction in electricity consumption resulting from application of the efficient technology used in the formulas for technical potential screens.

Technical potential: 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.

Total Resource Cost Test: The TRC measures the net benefits of the energy efficiency program for a region or service area as a whole. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. The benefits included are the avoided costs of energy and capacity.

Vermont Societal Test ("VT SCT") Test: includes all of the costs and benefits of the TRC test, but it also includes environmental and other non-energy benefits that are not currently valued by the market. The SCT may also include non-energy costs, such as reduced customer comfort levels.[11] See Section 5.9 for a full discussion of the costs and benefits included in the calculation of the Vermont Societal Test.

[11] In this study, non-energy costs for reduced custom comfort levels have not been reflected in any of the calculations of the Vermont Societal Test.

Useful Life: The number of years (or hours) that the new energy efficient equipment is expected to function. Useful life is also commonly referred to as "measure life."

3 INTRODUCTION

This report assesses the potential for energy efficiency programs to assist Vermont in meeting future energy service needs. This section of the report provides the following information:

- defines the term "energy efficiency",
- describes the general benefits of energy efficiency programs
- provides results of similar energy efficiency potential studies conducted in other New England states
- presents the organization of this report

3.1 INTRODUCTION TO ENERGY EFFICIENCY

Efficient energy use, often referred to as energy efficiency, is using less energy to provide the same level of energy service. An example would be insulating a home or business to use less heating and cooling energy to achieve the same inside temperature. Another example would be installing fluorescent lighting in place of incandescent lights to attain the same level of illumination. Energy efficiency can be achieved through more efficient technologies and/or processes as well as through changes in individual behavior.

3.1.1 GENERAL BENEFITS OF ENERGY EFFICIENCY

There are a number of benefits that accrue to the State of Vermont due to energy efficiency programs. These benefits include avoided energy and capacity cost savings, non-electric benefits such as water and fossil fuel savings, environmental benefits, economic stimulus, job creation, risk reduction, and energy security.

Avoided electric energy and capacity costs are based upon the costs an electric utility would incur to construct and operate new electric power plants or to purchase power from another source. These avoided costs of electricity include both fixed and variable costs that can be directly avoided through a reduction in electricity usage. The energy component includes the costs associated with the production of electricity, while the capacity component includes costs associated with the capability to deliver electric energy during peak periods. Capacity costs consist primarily of the costs associated with building peaking generation facilities. The electric and other fuel avoided costs used in this study are ones developed for the region and adopted by the Vermont Public Service Board.[12]

At the consumer level, energy efficient products often cost more than their standard efficiency counterparts, but this additional cost is balanced by lower energy consumption and lower energy bills. Over time, the money saved from energy efficient products will pay consumers back for their initial investment as well as save them money. Although some energy efficient technologies are complex and expensive, such as installing new high efficiency windows or a high efficiency boiler, many are simple and inexpensive. Installing compact fluorescent lighting or low-flow water devices can be done by most individuals.

Although the reduction in energy and capacity costs is the primary benefit to be gained from investments in energy efficiency, the utility, its consumers, and society as a whole can also benefit in other ways. Many electric efficiency measures also deliver non-energy benefits. For example, low-flow water devices

[12] Avoided Energy Supply Component Study Group, report titled "Avoided Energy Supply Costs in New England: 2009 Report", dated October 23, 2009.

and efficient clothes washers also reduce water consumption.[13] Similarly, weatherization measures that improve the building shell not only save on air conditioning costs in the summer, but also can save the customer money on space heating fuels, such as natural gas or propane. Reducing electricity consumption also reduces harmful emissions, such as SO_X, NO_X, CO_2 and particulates into the environment.[14] The Burlington Electric Department's 2009 Annual Energy Efficiency Report states that the environmental impacts avoided by decreasing the need for electricity are of increasing importance to the ratepayers of Burlington. The energy savings (5,470 MWh) generated by BED's energy efficiency programs in 2009 alone will have avoided the release of about 45,872 tons of carbon dioxide (CO2); the equivalent of removing about 1,265 cars from U.S. highways each year for the next 12 years.[15]

Energy efficiency programs create both direct and indirect jobs. The manufacture and installation of energy efficiency products involves the manufacturing sector as well as research and development, service, and installation jobs. These are skilled positions that are not easily outsourced to other states and countries. The indirect jobs are more difficult to quantify, but result from households and businesses experiencing increased discretionary income from reduced energy bills. These savings produce multiplier effects, such as increased investment in other goods and services driving job creation in other markets.

Energy efficiency reduces risks associated with fuel price volatility, unanticipated capital cost increases, environmental regulations, supply shortages, and energy security. Aggressive energy efficiency programs can help eliminate or postpone the risk associated with committing to large investments for generation facilities a decade or more before they are needed.[16] Energy efficiency is also not subject to the same supply and transportation constraints that impact fossil fuels. Finally, energy efficiency reduces competition between states and utilities for fuels, and dependence on fuels imported from other states or countries to support electricity production. Energy efficiency can help meet future demand increases and reduce dependence on out-of-state or overseas resources. The Vermont Societal Test includes an environmental adder of $.0070 per kWh saved (in $2000) and a 10% reduction to costs to account for the risk diversification benefits of energy efficiency measures and programs

3.2 The Vermont Context

3.2.1 Continuing Customer Growth

The annual kWh sales and electric peak loads for the areas served by BED and EVT are growing. From 2000 to 2009, the number of Vermont electric utility customers grew at a rate of approximately 1% annually. The latest available Vermont Electric Company (VELCO) load forecast for the State of Vermont projects that the number of electric consumers in Vermont will continue to increase at an average annual growth rate of approximately 1% from 2012 through 2031 (the timeframe for this study)

[13] The ENERGY STAR web site (www.energystar.gov) states that "ENERGY STAR qualified clothes washers use about 37% less energy and use over 50% less water than regular washers".

[14] The 2009 ENERGY STAR Annual Report states that "2009 was another banner year for EPA's climate protection partnerships. More than 19,500 organizations across the country have partnered with EPA and achieved outstanding results: (1) Preventing 83 million metric tons (in MMTCE2) of GHGs—equivalent to the emissions from 56 million vehicles (see Figure 4, p. 6)—and net savings to consumers and businesses of about $18 billion in 2009 alone. (2) Preventing more than 1,200 MMTCE of GHGs cumulatively and providing net savings to consumers and businesses of more than $250 billion over the lifetime of their investments." See page 2 of this Annual Report.

[15] Burlington Electric Department, 2009 Annual Energy Efficiency Report, page 3.

[16] According to the Final Order in Vermont Public Service Board Docket No. 5270, the Societal Test calculation in Vermont includes a 10% reduction to costs to account for the risk diversification benefits of energy efficiency measures and programs.

creating further growth in system electricity sales and demand. This report assesses the potential for energy efficiency programs to assist Vermont in meeting future energy service needs.

3.2.2 ENERGY EFFICIENCY ACTIVITY

Making homes and buildings more energy efficient is seen as a key strategy for addressing energy security, reducing reliance on fossil fuels from other countries, assisting consumers to lower energy bills, and addressing concerns about climate change. Faced with rapidly increasing energy prices, constraints in energy supply and demand, and energy reliability concerns, states are turning to energy efficiency as the most reliable, cost-effective, and quickest resource to deploy.[17] The State of Vermont has been a pioneer in developing and implementing effective energy efficiency programs. Vermont was the first state in the US to have an energy efficiency utility (EEU).

3.2.3 RECENT ENERGY EFFICIENCY POTENTIAL STUDIES

In January 2007, the Vermont Department of Public Service released a study on the achievable potential for electricity savings in Vermont.[18] Overall, the study found that substantial potential savings remain: the achievable energy efficiency savings potential was estimated at 19% of total Vermont electric consumption by 2015. Table 3-1, below, provides the results from a GDS review of recent energy efficiency potential studies conducted throughout New England.

Table 3-1: Results of Recent Energy Efficiency Potential Studies in New England

State	Study Year	Author	Study Period	# of Years	Achievable Potential
Connecticut	2009	KEMA	2009-2018	10	20.3%
New Hampshire	2009	GDS	2009-2018	10	20.5%
Rhode Island	2008	KEMA	2009-2018	10	9.0%
Vermont	2007	GDS	2006-2015	10	19.4%

A 2010 report by the American Council for an Energy Efficient Economy (ACEEE) offers information regarding the current savings and spending related to energy efficiency by state.[19] Based on self-reported data, the top states spend more than 2% of electric sales revenue on energy efficiency programs. Five of the six New England states (including Vermont) rank in the top ten states on the ACEEE scorecard. In addition, the top states are currently achieving annual energy efficiency savings of roughly 1% of total electric sales.

[17] The December 2008 National Action Plan for Energy Efficiency (NAPEE) "Vision for 2025: A Framework for Change" states that "the long-term aspirational goal for the Action Plan is to achieve all cost-effective energy efficiency by the year 2025. Based on studies, the efficiency resource available may be able to meet 50 percent or more of the expected load growth over this time frame, similar to meeting 20 percent of electricity consumption and 10 percent of natural gas consumption. The benefits from achieving this magnitude of energy efficiency nationally can be estimated to be more than $100 billion in lower energy bills in 2025 than would otherwise occur, over $500 billion in net savings, and substantial reductions in greenhouse gas emissions."

[18] Vermont Department of Public Service, "Vermont Electric Energy Efficiency Potential Study, Final Report", prepared for the Department by GDS Associates, Inc., January 2007.

[19] American Council for an Energy Efficient Economy, "The 2010 State Energy Efficiency Scorecard", Report #E107, October 2010.

Vermont ranks #1 of the 50 states in terms of annual kWh savings as a percent of total retail kWh sales in a state. In the ACEEE scorecard report, Vermont is reported as spending 4.4% of revenue in 2009 on energy efficiency programs, and saving 2.6% of kWh sales (in 2008) from energy efficiency programs. Vermont ranked #1 on spending on energy efficiency of the 50 states (annual energy efficiency spending as a percent of annual electric revenues).

3.3 PURPOSE OF THIS STUDY

This study provides an analysis of the technical, economic and achievable potential for electric energy efficiency resources in Vermont. This study has examined a full array of energy efficiency technologies and building practices that may be deemed technically achievable, including measures that aren't available currently but are expected to be on the market within the study timeline, such as measures enabled by advanced metering infrastructure, that address both annual energy and peak demand.

3.4 REPORT ORGANIZATION

The remainder of this report is organized in the following seven sections as follows:

Section 4: Characterization of EVT and BED Service Areas provides an overview of the EVT and BED service areas and a brief discussion of the historical and forecasted electric energy sales as well as peak demand.
Section 5: Overall Project Implementation Approach details the development of technical, economic, and achievable potential for energy efficiency savings
Section 6: Residential Energy Efficiency Potential Estimates (2012-2031) provides a breakdown of the technical, economic, and maximum achievable potential in the residential sector
Section 7: Commercial and Industrial Energy Efficiency Potential Estimates (2012-2031) provides a breakdown of the technical, economic, and achievable potential in the C&I sectors
Section 8: Conclusions presents the final discussion regarding potential for energy efficiency savings through 2031.

4 CHARACTERIZATION OF TOTAL STATE, EVT AND BED SERVICE AREAS

Energy efficiency potential studies and other market assessment studies are valuable sources of information for planning energy efficiency programs. In order to develop estimates of electricity savings potential, it is important to understand the extent to which electricity is used by households and businesses in Vermont, as well as in the EVT and BED service areas.[20] This section provides a brief overview of the economic/demographic characteristics of the State of Vermont and the EVT and BED service areas. Data are also presented for the historical and forecasted electric energy sales and system peak demand, and the on-going energy efficiency efforts of EVT and BED.

4.1 EVT AND BED MEMBER SERVICE TERRITORIES

This section provides information on economic, demographic, geographic and appliance saturation characteristics of the State of Vermont. In order to develop estimates of electricity savings potential, it is important to understand how electricity is used by households and businesses in Vermont. Vermont is a rural state with a population of approximately 625,741 persons in 2010, and 314,246 housing units.[21] The State's population only grew 2.8% between 2000 and 2010, whereas the population in the entire US grew 9.1%. That rate of growth was Vermont's slowest since the Great Depression era, when the state's population fell 0.1 percent. According to the U.S. Census Bureau, 14.5% of the population in Vermont was 65 or older in 2009.

4.1.1 VERMONT GEOGRAPHIC AND DEMOGRAPHIC CHARACTERISTICS

Vermont is the second largest state (in terms of surface area) in New England after Maine. Dominating the state's geography are the Green Mountains, one of the oldest mountain ranges in the world. The nation's sixth largest lake, Lake Champlain, runs along the state's western border.

In comparison with the other forty-nine states, Vermont is small in total area (9,609 square miles). Delivering energy efficiency services in a small state like Vermont presents different challenges than in larger states like Alaska, California and Texas. The State is bordered by Canada, New York, Massachusetts, and New Hampshire. It is 157.4 miles in length, 90.3 miles wide at the Canadian border, and 41.6 miles along the Massachusetts border. The Connecticut River forms the eastern boundary, while the western boundary runs down the middle of Lake Champlain for more than half of its length. Burlington is the largest of Vermont's 255 communities, and it had an estimated population of 38,647[22] in 2009 according to the US Census Bureau.

As of the census of 2000, the population density for Burlington was 3,682 people per square mile (1,421.9/km²). There were 16,395 housing units in Burlington at an average density of 1,552.3 units per square mile (599.4/km²). As of 2000, there were 15,885 households in Burlington out of which 21.3% had children under the age of 18 living with them, 31.4% were married couples living together, 10.0% had a female householder with no husband present, and 55.6% were non-families. 35.6% of all households were made up of individuals and 8.2% had someone living alone who was 65 years of age or older. The average household size was 2.19 and the average family size was 2.86.

[20] The Vermont Public Service 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.
[21] The Vermont population data for 2010 was obtained from US Census Bureau.
[22] US Census Bureau, 2009 population estimate for Burlington, Vermont.

In Burlington the population was spread out with 16.3% under the age of 18, 25.4% from 18 to 24, 31.0% from 25 to 44, 16.8% from 45 to 64, and 10.5% who were 65 years of age or older. The median age was 29 years. For every 100 females there were 93.2 males. For every 100 females age 18 and over, there were 90.7 males.

The demographic data for the remainder of the state show the more rural nature of this area. There are 3,683 persons per square mile in the City of Burlington, whereas there are only 63 persons per square mile in the remainder of the state (the region outside of Burlington. Thus the region served by EVT has significantly fewer persons per square mile than the region served by BED. It is also interesting that Vermont has a greater percentage of the population age 65 and older (13.8%) than the US as a whole (12.6%).

The economic/demographic data for a state or service area are important to understand when developing estimates of energy efficiency potential. For example, one needs to know how many housing units there are in a service area in order to estimate the number of appliances that are plugged into the electric grid in an area. In addition, the composition (age breakdowns, etc.) of the population is important for the development of marketing strategies for different types of energy efficiency programs.

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Figure 4-1: Map of Vermont

4.1.2 HISTORICAL ELECTRIC SALES AND ELECTRIC CUSTOMERS IN VERMONT

Tables 4-1 and 4-2 show historical Vermont data for annual kWh sales and electric customers by class of service. From 2000 to 2009, MWh sales to ultimate electric customers in Vermont decreased at a rate of -0.19 percent per year. From 2000 to 2009, the number of ultimate electric customers increased at a rate of 1 percent per year.

According to 2009 historical sales data, the residential sector accounts for approximately 86% of total customers and nearly 38% of total energy sales while the commercial and industrial sectors account for 36% and 25%, respectively. Although the residential sector constitutes the greatest portion of total kWh sales, the industrial sector consumes the most energy on a per customer basis. The average industrial facility consumes roughly 5.9 million kWh annually. Comparatively, the average commercial consumer uses approximately 40,500 kWh per year, while the residential consumers use 6,905 kWh per year on average.

Table 4-1: Historical Vermont MWh Sales to Ultimate Customers by Customer Class (MWh) – 2001 to 2009

Year	Residential	Commercial	Industrial	Total
2001	2,009,279	1,920,847	1,611,750	5,541,876
2002	2,046,101	1,943,752	1,592,436	5,582,290
2003	2,128,702	1,911,512	1,561,371	5,601,585
2004	2,141,488	1,926,616	1,638,954	5,707,058
2005	2,190,529	2,037,152	1,619,651	5,847,333
2006	2,140,470	2,015,444	1,598,664	5,754,577
2007	2,168,978	2,080,318	1,567,484	5,816,780
2008	2,133,399	2,049,198	1,526,493	5,709,090
2009	2,120,949	1,969,121	1,368,903	5,458,973
Compound Annual Average Rate of Growth	*0.68%*	*0.31%*	*-2.02%*	*-0.19%*

Table 4-2: Historical Number of Customers by Customer Class - 2001 to 2009

Year	Residential	Commercial	Industrial	Total
2001	285,735	42,303	413	328,451
2002	288,966	43,066	455	332,487
2003	292,031	43,783	468	336,282
2004	295,505	44,743	554	340,802
2005	298,480	45,822	314	344,616
2006	302,809	46,733	324	349,866
2007	305,070	47,601	232	352,903
2008	306,494	48,051	326	354,871
2009	307,127	48,636	231	355,994
Compound Annual Average Rate of Growth	*0.91%*	*1.76%*	*-7.01%*	*1.01%*

4.2 LOAD FORECASTS EXCLUDING SALES AND PEAK LOAD OF IBM

For purposes of this study, the future sales and peak load associated with IBM have been excluded from the sales and peak load forecasts. IBM, which represents approximately 7% of the state's annual kWh sales and 5% of system peak load, no longer pays the energy efficiency charge, nor participates in EVT programs. Thus, their sales and contribution to system peak load have been excluded from the sales forecast for the EVT service area and from the load forecast for the State as a whole.

4.3 FORECAST OF ENERGY SALES & PEAK DEMAND (2012-2031)

The new VELCO load forecast for Vermont projects that total kWh sales in the State will grow slowly over the next two decades, at a compound average annual growth rate of 0.64% a year (sales at the customer meter level of the utility grid).[23] The residential sector is projected to grow at 0.70% a year, the commercial sector at 0.74% per year, and the industrial sector at 0.28% per year. Summer peak load is expected to grow 1.04% per year, and winter peak load is expected to grown 0.57% per year. Table 4-3 presents the MWH sales forecast for the State of Vermont, and Table 4-4 presents the summer and winter peak load forecasts for the State of Vermont. The numbers shown in Tables 4-3 and 4-4 exclude the impacts of Efficiency Vermont programs in 2012-2031. Tables 4-5 through 4-8 provide the energy and demand forecasts for the EVT and BED service territories.

[23] The annual energy sales and peak demand forecasts have been adjusted to account for the impacts of DSM related activities for the 2010 and 2011 program years but do include any future year DSM impact.

Table 4-3: VELCO MWh Sales Forecast for the State of Vermont (Without Future DSM Impacts)

	MWh Sales					
Year	Residential	Commercial	Industrial	Other	Total	@ Generation
2012	2,088,223	1,966,785	923,456	37,753	5,016,217	5,495,061
2013	2,075,006	1,996,753	928,986	38,001	5,038,746	5,519,675
2014	2,081,217	2,018,714	932,508	38,125	5,070,565	5,554,471
2015	2,092,597	2,035,186	935,180	38,188	5,101,150	5,587,930
2016	2,111,873	2,048,429	937,517	38,220	5,136,039	5,626,062
2017	2,119,315	2,061,591	939,873	38,236	5,159,015	5,651,194
2018	2,134,056	2,075,034	942,190	38,244	5,189,523	5,684,571
2019	2,149,011	2,088,186	944,498	38,248	5,219,941	5,717,842
2020	2,171,165	2,101,157	946,869	38,250	5,257,441	5,758,806
2021	2,178,760	2,114,352	949,321	38,251	5,280,683	5,784,260
2026	2,275,764	2,188,817	961,795	38,252	5,464,626	5,985,680
2031	2,384,227	2,260,788	974,692	38,252	5,657,959	6,197,527
Compound Annual Average Rate of Growth	*0.70%*	*0.74%*	*0.28%*	*0.07%*	*0.64%*	*0.64%*

Table 4-4: VELCO Peak Load Forecast for State of Vermont (Without Future DSM Impacts)

	Summer Peak Load					Winter Peak Load				
Year	Residential	Comm.	Ind.	Other	Total	Residential	Comm.	Ind.	Other	Total
2012	329	410	157	0	896	429	290	147	8	874
2013	332	417	159	0	908	422	295	148	8	872
2014	338	421	160	0	919	421	299	148	8	876
2015	344	425	161	0	929	422	302	148	8	880
2016	350	428	161	0	939	425	305	148	8	886
2017	355	432	161	0	948	426	307	148	8	889
2018	361	436	161	0	958	429	310	148	8	894
2019	367	441	161	0	968	431	313	147	8	898
2020	373	445	161	0	978	433	316	147	7	904
2021	377	449	161	0	987	434	319	147	7	907
2026	408	472	161	0	1,040	451	335	145	7	939
2031	432	493	164	0	1,089	469	349	147	7	972
Compound Annual Average Rate of Growth	*1.45%*	*0.98%*	*0.24%*	*0.00%*	*1.04%*	*0.47%*	*0.97%*	*0.03%*	*0.00%*	*0.57%*

Table 4-5: 2012-2031 Forecast MWh Sales for the EVT Service Area (Without Future DSM Impacts)

	MWh Sales					
Year	**Residential**	**Commercial**	**Industrial**	**Other**	**Total**	**@ Generation**
2012	2,003,547	1,774,607	853,745	33,899	4,665,799	5,132,379
2013	1,989,659	1,803,175	858,757	34,147	4,685,738	5,154,312
2014	1,995,274	1,823,269	861,588	34,272	4,714,404	5,185,844
2015	2,006,107	1,838,067	863,639	34,334	4,742,147	5,216,362
2016	2,024,399	1,849,267	865,220	34,366	4,773,252	5,250,577
2017	2,031,607	1,861,009	867,050	34,382	4,794,047	5,273,452
2018	2,045,904	1,872,735	868,730	34,390	4,821,759	5,303,935
2019	2,060,227	1,884,229	870,425	34,394	4,849,275	5,334,202
2020	2,081,301	1,894,778	871,899	34,396	4,882,374	5,370,611
2021	2,088,996	1,906,637	873,856	34,397	4,903,887	5,394,275
2026	2,183,971	1,972,289	883,066	34,398	5,073,724	5,581,096
2031	2,290,682	2,036,345	893,031	34,398	5,254,457	5,779,902
Compound Annual Average Rate of Growth	*0.71%*	*0.73%*	*0.24%*	*0.08%*	*0.63%*	*0.63%*

Table 4-6: 2012-2031 Forecast Peak Load (MW) for the EVT Service Area (Without Future DSM Impacts)

	Summer Peak Load					Winter Peak Load				
Year	**Residential**	**Comm.**	**Ind.**	**Other**	**Total**	**Residential**	**Comm.**	**Ind.**	**Other**	**Total**
2012	315	369	145	0	828	414	264	139	7	824
2013	318	375	146	0	840	406	269	140	7	822
2014	324	380	147	0	851	406	272	140	7	825
2015	329	383	148	0	860	407	275	140	7	829
2016	336	386	147	0	869	410	278	140	7	835
2017	340	390	147	0	877	410	280	140	7	837
2018	346	393	147	0	887	413	283	140	7	842
2019	352	397	147	0	897	415	285	139	7	846
2020	357	401	147	0	906	417	288	139	7	851
2021	362	405	147	0	914	418	291	139	6	854
2026	392	426	146	0	965	434	306	137	6	884
2031	416	446	150	0	1,012	451	319	139	6	915
Compound Annual Average Rate of Growth	*1.47%*	*1.01%*	*0.20%*	*0.00%*	*1.06%*	*0.46%*	*1.00%*	*-0.02%*	*0.00%*	*0.55%*

Table 4-7: 2012-2031 Forecast MWh Sales for the BED Service Territory (Without Future DSM Impacts)

	MWh Sales					
Year	Residential	Commercial	Industrial	Other	Total	@ Generation
2012	84,676	192,178	69,710	3,854	350,418	362,682
2013	85,347	193,578	70,229	3,854	353,008	365,363
2014	85,943	195,445	70,920	3,854	356,161	368,627
2015	86,490	197,119	71,540	3,854	359,003	371,568
2016	87,474	199,161	72,297	3,854	362,787	375,484
2017	87,708	200,583	72,823	3,854	364,968	377,742
2018	88,152	202,300	73,459	3,854	367,764	380,636
2019	88,783	203,957	74,073	3,854	370,667	383,640
2020	89,864	206,379	74,970	3,854	375,068	388,195
2021	89,764	207,714	75,465	3,854	376,796	389,984
2026	91,792	216,528	78,729	3,854	390,903	404,584
2031	93,545	224,443	81,660	3,854	403,502	417,625
Compound Annual Average Rate of Growth	*0.53%*	*0.82%*	*0.84%*	*0.00%*	*0.75%*	*0.75%*

Table 4-8: 2012-2031 Forecast Peak Load (MW) for the BED Service Area (Without Future DSM Impacts)

	Summer Peak Load					Winter Peak Load				
Year	Residential	Comm.	Ind.	Other	Total	Residential	Comm.	Ind.	Other	Total
2012	14	41	13	0	67	15	26	7	1	50
2013	14	41	13	0	68	15	27	8	1	50
2014	14	42	13	0	69	15	27	8	1	51
2015	14	42	13	0	69	16	27	8	1	51
2016	14	43	13	0	70	16	27	8	1	51
2017	15	43	13	0	71	16	28	8	1	52
2018	15	43	13	0	71	16	28	8	1	52
2019	15	43	13	0	71	16	28	8	1	53
2020	15	43	13	0	72	16	28	8	1	53
2021	15	44	14	0	73	16	28	8	1	54
2026	16	46	14	0	75	17	29	8	1	56
2031	16	47	14	0	78	17	30	9	1	57
Compound Annual Average Rate of Growth	*0.90%*	*0.68%*	*0.68%*	*0.00%*	*0.73%*	*0.78%*	*0.75%*	*0.77%*	*0.00%*	*0.75%*

4.4 CURRENT EEU DSM OFFERINGS

The two Vermont Energy Efficiency Utilities (EEU) offer several energy efficiency programs for homes and businesses in the State. For the City of Burlington, these programs are delivered by the Burlington Electric Department (BED). For the remainder of the state, these programs are delivered by Efficiency Vermont (EVT).

4.4.1 CURRENT EFFICIENCY VERMONT PROGRAMS

Efficiency Vermont offers several energy efficiency programs for homes and businesses.

Residential Programs

Efficiency Vermont offers programs to help residential consumers save energy in their homes. These programs cover efficiency improvements for space heating, space cooling, water heating, lighting and other uses of energy.

Energy Efficient Lighting

EVT offers programs to provide information to consumers about the benefits of energy efficient CFL and LED light bulbs. CFLs are now available in many different shapes and styles for every socket, indoors and outdoors. CFLs use up to 75% less energy than incandescent bulbs and can last 6 to 10 times longer. The types and sizes of LED bulbs have expanded dramatically over the past three years. EVT uses several marketing and delivery strategies to make these bulbs available in Vermont at discounted prices.

Energy Audits and Home Improvements

EVT supports a network of Home Performance with ENERGY STAR® contractors certified to perform energy audits; diagnose building problems such as moisture, mold, and ice dams; and install recommended energy efficiency improvements that can reduce household energy consumption by up to 30%. Using a certified contractor provides assurance that the project will lead to real energy savings and be done safely. EVT also provides web-based information to help consumers find a certified contractor as well as information on financial incentives to help pay for qualified energy efficiency improvements.

Energy Efficient Appliances

ENERGY STAR appliances use 10% to 50% less energy and water than standard efficiency models or older appliances. Older appliances can consume so much energy that in some circumstances it may make sense to retire them early, even if they still work. EVT offers rebates on select ENERGY STAR appliances (clothes washers, refrigerators, freezers) and seasonal rebates on room A/Cs and dehumidifiers. Efficiency Vermont also offers incentives for early retirement of older refrigerators.

Home Electronics

Home electronics, like TVs, DVD players, computer monitors, and laptops, can account for more than 15% of household electricity use. Some electronics use energy even when they're turned off, to power features like clock displays and remote controls. When buying home electronics, EVT recommends that consumers look for ENERGY STAR® labeled products, which use much less energy than standard electronics. Using the EVT web site, EVT provides information to consumers on the energy savings of ENERGY STAR® labeled home electronics, and information on the energy savings that can be achieved using advanced power strips. An Advanced Power Strip uses smart technology to cut the power to certain electronics when they're not in use, saving you energy and money automatically. This study does examine the energy efficiency potential from such advanced power strips and ENERGY STAR® labeled home electronics.

DIY - Do It Yourself

EVT recommends using a certified Home Performance with ENERGY STAR® contractor to make major energy efficiency improvements. If a consumer wishes to make some improvements on his/her own, Efficiency Vermont has created a Home Heating Help section on the EVT website. This resource provides information on home energy topics including; sealing air leaks, attic insulation, heating equipment and energy-efficient appliances.

Meter Loan Program

A good way to understand the connection between a home's energy use and energy costs is to know how much electricity home electronics and appliances are using. A consumer can measure electricity usage of an appliance with a "Watts Up" Electric Meter. Efficiency Vermont offers this meter to electric customers in Vermont free of charge for a period of three weeks. Once the consumer identifies where electricity is used the most, a consumer can make changes to energy usage that will have the greatest impact on the electric bill.

Education on the ENERGY STAR® Logo

EVT provides information to consumers about the ENERGY STAR® Logo**.** ENERGY STAR is a national program that helps consumers save money and protect the environment through energy efficient products and practices. There are national ENERGY STAR programs for residential construction on new and existing homes. The ENERGY STAR label can be found on more than 60 types of products including lighting, appliances, home electronics and heating and cooling equipment. Consumers will also see a yellow EnergyGuide label on most new appliances. This label estimates how much energy the appliance uses compared to similar products, and shows the consumer approximately how much it will cost to use each year to help the consumer compare different models when shopping for a new appliance.

EVT Programs for the Commercial and Industrial Sectors

Listed below are short descriptions of the energy efficiency programs that are currently offered by EVT for commercial and industrial facilities.

Energy Efficient Lighting

newLIGHT is a program promoting the replacement of T12 and HID High-Bay lighting in commercial and industrial facilities with more efficient technology. EVT is offering businesses significantly enhanced rebates for upgrading their old T12 fluorescent and HID high-bay lighting systems to more efficient equipment - from 50 to 90% of the equipment cost. To qualify for enhanced rebates offered through the newLIGHT program, commercial and industrial organizations must work with a contractor, distributor, or other lighting professional who will evaluate their facilities and submit a "Project Pre-Approval Form" to Efficiency Vermont on their behalf. Projects eligible for the newLIGHTEnhanced Rebate Program include:

- T12 Upgrades and Controls
- HID High-Bay Upgrades and Controls
- Exit Sign Upgrades

High Efficiency HVAC Equipment

EVT provides rebates for the purchase of high efficiency HVAC equipment. Energy-efficient HVAC equipment lowers a business' overhead costs by decreasing energy costs while increasing reliability of the equipment. EVT also provides information about HVAC systems typically found in Vermont, about actions one can take to lower energy costs, and about available financial incentives for energy-efficient equipment that will improve the bottom line.

In order to be eligible for a financial incentive, efficient HVAC equipment must be new and meet certain minimum efficiencies as well as other requirements. Pre-approval is required from Burlington Electric Department for all new construction projects in their territory, regardless of size. Split AC systems (including evaporator and condensing coils) must be AHRI tested and rated matched or paired systems. Ductless mini-split AC systems do not qualify for rebates. Dual enthalpy economizer controls are eligible for rebates only when installed with new, qualifying equipment. Rebates exceeding $2,500 require pre-approval by Efficiency Vermont prior to purchase.

Building Performance Program

Building Performance incentives are available from EVT to assist small business and rental property owners in improving the insulation and comfort of their buildings, and boosting bottom lines. The available incentives can reduce the cost of audits and insulation upgrades. Building Performance incentives are available to help Vermont's small business and rental property owners improve the energy efficiency of their buildings. EVT offers up to $7,500 in incentives per building to help pay for energy efficiency improvements completed by a participating BPI certified contractor. These independent contractors are certified by the Building Performance Institute to perform energy audits, diagnose building problems such as moisture, mold, and ice dams, and install the recommended energy efficiency improvements. Efficiency Vermont provides contractor training, quality assurance, and customer incentives.

EVT also provides for energy audits. An energy audit typically includes the following:

- A comprehensive evaluation of your building's air tightness and insulation effectiveness and windows;
- Identification of energy efficiency opportunities with mechanical systems, lighting, and appliances;
- Installation of energy-saving products such as efficient light bulbs and water conservation products;
- An audit report and scope of work for recommended energy efficiency improvements.

There is a fee for this service.

Other Rebates

EVT also offers a wide range of other rebates for high efficiency equipment, such as the following:

- commercial lighting equipment
- motors
- refrigeration equipment
- compressed air equipment
- vending machines
- agricultural equipment

4.4.2 Current Programs Offered by the Burlington Electric Department

Listed below are descriptions of the energy efficiency programs offered by the Burlington Electric Department.

Residential New Construction

This BED program aims to improve the efficiency of all new homes, and buildings undergoing substantial renovation. This includes single-family homes, multi-family homes and low income multi-family projects. This program addresses all major end uses: space heating, water heating, central cooling (if applicable), ventilation, major appliances and lighting for high use areas. Residential New Construction (RNC) encourages builders and consumers to build to the Vermont Energy Star Home standard. This standard specifies that homes meet the Energy Star performance standard (representing nearly 20% savings in heating, cooling and hot water consumption relative to the Vermont Residential Building Energy Standard (RBES). The standard also requires that at least four lighting fixtures in high use areas be energy efficient, three major appliances and efficient automatically controlled mechanical ventilation be installed. The Vermont Energy Star Homes (VESH) standard is promoted to developers, architects, builders, building supply centers, equipment suppliers and consumers through a combination of marketing, technical assistance to builders, provision of energy ratings, and a package of incentives for efficient lighting fixtures, major appliances and ventilation equipment.

Residential Existing Homes

This BED program aims to improve the efficiency of all existing residential buildings including low-income single family, market-rate single-family and all multi-family projects (market-rate and low-income). BED offers the same existing homes service as Efficiency Vermont (EVT) and also works closely with Vermont Gas Systems (VGS) and the Champlain Valley Weatherization Service (CVWS) on many of its projects. Low-income buildings are addressed by a partnership with the state's Low-income Weatherization Assistance Program (WAP). This partnership provides electric efficiency measures (including fuel switching of electric hot water and electric space heating) to Burlington's low-income electricity consumers. Electrical efficiency measures are delivered to income-eligible electric customers at the time they receive thermal shell, space heating and water heating improvements from CVWS. This service also works closely with high usage households for energy efficiency improvements that can significantly reduce their energy bills. On-site energy audits, customer education, appliance meter loans, technical assistance, project management and cash incentives are all part of this service. In some cases, the high usage is driven by electric domestic hot water and\or electric resistance space heating. The opportunity to convert to natural gas is available to the owners of some of these housing units, providing significant energy and cost savings.

Over the past few years, BED and EVT have been trying to work more successfully in the private (market-rate) rental housing market (customers not eligible for low-income energy services) to increase both participation and the depth of savings per participant. Traditionally, renters have not been strong participants and the same holds true for property-owners where the tenants pay the energy bills directly. The "Rental Properties Owners" service offers free tank wraps (electric tanks only), pipe insulation, water saving devices, enhanced rebates for the early retirement of eligible refrigerators, incentives for improving mechanical ventilation along with up to fifteen free screw-in CFL's per apartment. This service provides savings directly to the tenant but also water savings, and potentially maintenance savings to the property owner. This service allows us the opportunity to develop long-lasting relationships with property-owners to help identify further savings from refrigeration replacements, common area lighting and laundry equipment improvements, weatherization and ventilation. BED has also been working successfully with JUMP (Joint Urban Ministry Program) over the past few years by providing free CFL's and efficiency education and program information to families and individuals in need. The idea is for JUMP staff to inform participants (mostly all renters) about energy usage and bills and encourage them to participate in energy efficiency programs. JUMP staff makes direct referrals to CVWS for low-income weatherization services or to BED for assistance. JUMP also provides language translators to help with the African community within Burlington. This is particularly helpful when there are billing issues that can present a barrier to participation. The translators can also help with communications with rental property owners.

BED continues to offer a robust energy education service for customers that includes onsite energy audits, lending of appliance meters and custom billing history analysis. BED also continues to provide energy efficiency information in a variety of forums. BED staff has also visited several classrooms in the Burlington School District to discuss energy efficiency with faculty and schoolchildren. Also, starting in 2009, BED contracted with VGS to install CFL's and collect potential electrical energy efficiency savings information while performing normal VGS energy audits.

Retail Products

BED's Efficient Products Program (EP) aims to increase sales of DOE\EPA ENERGY STAR® qualified lighting products, Compact Fluorescent (CFL) screw-in bulbs, CFL hardwired fixtures, and ENERGY STAR® appliances such as clothes washers, refrigerators, freezers, and ceiling fans with lights, room air conditioners and dehumidifiers. This is accomplished primarily through retail stores with on-site and mail-in consumer rebates, but also by arranging retailer buy-downs and manufacturer mark-downs for CFL products. The program pursues this objective with extensive outreach to retailers, such as efforts to encourage Vermont lighting showrooms to increase the number and variety of energy efficient fixtures stocked and displayed. Field representatives personally visit every participating retail store at least three times per year; larger stores are visited more frequently. The program provides consumer rebates for ENERGY STAR® -qualified bulbs, fixtures, refrigerators, ceiling fans with lights, window AC units, clothes washers, dehumidifiers and freezers. These incentives are intended to entice consumers by lowering the cost of efficient products. The program uses a variety of marketing and promotion efforts in addition to its prominently displayed in-store rebate coupons including a catalog, and an on-line purchase web site in order to build consumer awareness and participation in the program.

Business New Construction

This program helps commercial and industrial builders and developers incorporate the most energy efficient products and systems possible when building or renovating. It is designed to help customers exceed the City of Burlington's required Guidelines for Energy Efficient Construction (which adopted the statewide CBES energy code as of January 1, 2007). By working directly and early in the process with designers and owners, BED assists in the choice of energy efficient systems and construction techniques that meet business and energy needs. The program offers prescriptive and custom tracks for Act 250 and non-Act 250 projects, providing financial incentives for the installation of cost effective efficiency measures. This includes a minimum package of efficiency criteria including lighting, motors and HVAC systems that all customers must include to be eligible to participate. Eligible participants gain technical assistance, verification services and financial incentives to help with efficient equipment costs. BED's Business New Construction service addresses all energy (especially electricity) consuming equipment, components or practices, including motors, lighting, heating, ventilation and air-conditioning (HVAC).

Business Existing Facilities

This program targets naturally occurring equipment changeovers in the business sector to secure energy savings in the equipment replacement market. Targeted equipment includes lighting, heating, ventilation, cooling, water heating, refrigeration, motors and drives, controls and industrial process applications. This program offers prescriptive and custom tracks, with technical assistance and financial incentives that encourage the adoption of cost effective, high efficiency alternatives to standard efficiency equipment. BED offers prescriptive incentives (fixed incentives for specific eligible measures) for building lighting, refrigeration economizers and controls, motors, unitary HVAC equipment and dual enthalpy economizers for unitary HVAC units. BED also participates in the Northeast Energy Efficiency Partnership to further the market transformation of motors, lighting and HVAC equipment. Incentives for above average energy efficient equipment are supplied to wholesalers, contractors, and customers at the time of equipment replacement. Non-prescriptive cost-effective measures or combinations of measures are eligible for custom incentives. Custom incentives are designed to capture as many potential lost opportunity resources as possible, while maximizing program delivery resources. BED staff and trade allies serving Burlington (including equipment vendors, manufacturers, suppliers, contractors, architects and engineers) market the program to potential participants.

5 OVERALL PROJECT IMPLEMENTATION APPROACH

This section describes the overall methodology used to conduct this study and explains the general steps and methods used at each stage of the analytical process necessary to produce the various estimates of energy efficiency potential. Specific changes in methodology from one sector to another have been noted throughout the report. Information has been provided to EVT and BED throughout the development of this report for feedback and comment.

Energy efficiency potential studies involve carrying out a number of analytical steps to produce estimates of each type of energy efficiency potential. This study utilizes the GDS Benefit/Cost Screening Tool, an Excel-based model that integrates technology-specific impacts and costs, customer characteristics, utility load forecasts, utility avoided cost forecasts and more. Excel was used as the modeling platform to provide transparency to the estimation process and allow for simple customization based on Vermont's unique characteristics and the availability of specific model input data.

5.1 MEASURE LIST DEVELOPMENT

Energy efficiency measure lists were based on the Vermont Technical Reference Manual[24] savings 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 VDPS 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.

In addition, this study includes measures that could be relatively easily substituted for or applied to existing technologies on a retrofit or replace-on-burnout basis. Replace-on-burnout applies to equipment replacements that are made normally in the market when a piece of equipment is at the end of its useful life. A retrofit measure is eligible to be replaced at any time in the life of the equipment or building. Replace-on-burnout measures are generally characterized by incremental measure costs and savings (*e.g.* the costs and savings of a high-efficiency versus standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g. the full costs and savings associated with retrofitting ceiling insulation into an existing attic) until that point when the equipment would have failed anyway.

5.2 MEASURE CHARACTERIZATION

A significant amount of data is needed to estimate the savings potential for individual energy efficiency measures or programs across the entire existing residential, commercial and industrial sectors. To this extent, considerable effort was expended to identify, review, and document all available data sources.[25] This review allowed development of reasonable assumptions regarding measure lives; installed incremental and full costs (where appropriate); and electric energy and demand savings for each measure included in the final lists of measures in this study.

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[24] Vermont Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions, June 14, 2010.

[25] The appendices to this report provide the data sources used by the GDS Team to obtain up-to-date data on measure costs, savings and useful lives.

Savings: Estimates of annual measure savings as a percentage of base equipment usage was taken foremost from the Vermont TRM and, when not available there, were developed from a variety of sources, including:[26]

- Building energy modeling software and engineering analyses
- Secondary sources such as the American Council for an Energy-Efficient Economy ("ACEEE"), Department of Energy ("DOE"), Energy Information Administration ("EIA"), Energy Star® and other technical potential studies
- Program evaluations conducted by other utilities and program administrators
- Customer meter data

Measure Costs: Measure costs represent either incremental or full cost, and typically include the cost of installation. For purposes of this study, nominal measures costs were held constant over time. This general assumption was made due to the fact that historically many measure costs (for example, CFL bulbs) have declined over time, while some measure costs have increased over time (fiberglass insulation). Cost estimates were taken foremost from the Vermont TRM and when not available derived from the following sources:

- Secondary sources such as ACEEE, Energy Star®, and other technical potential studies
- Retail store pricing and industry experts
- Evaluation reports

Measure Life: Represents the number of years (or hours) that energy-using equipment is expected to operate. Useful life estimates were taken foremost from the Vermont TRM and when not available derived from:

- Manufacturer data
- Savings calculators and Life-cycle cost analyses
- Secondary sources such as ACEEE, Energy Star®, and other technical potential studies
- The California Database for Energy Efficient Resources ("DEER") database
- Evaluation reports

Baseline and Efficient Technology Saturations: 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. Up-to-date measure saturation data were primarily obtained from the following recent studies:

- Vermont Department of Public Service, "Analysis of On-Site Audits of Existing Homes in Vermont", June 2009
- Vermont Department of Public Service "Overall Report, Vermont Residential New Construction Study, Final Report", July 2009
- Vermont Department of Public Service, "Business Sector Market Assessment and Baseline Study – Existing Commercial Buildings", July 2009
- Vermont Department of Public Service, "Business Sector Market Assessment and Baseline Study – Commercial New Construction", October 2009

[26] On a going forward basis, the energy and demand savings over baseline are assumed to remain consistent – as the baselines increase due to code and appliance standards, so does the high efficiency version.

- Vermont Department of Public Service, "Business Sector Market Assessment and Baseline Study – Existing Industrial Facilities", September 2009
- Burlington Electric Department, 2005 Residential Appliance Saturation Survey

Emerging technologies were selected based on existing research and discussions with DPS staff. Existing research sources included ACEEE, Bonneville Power Administration, and general knowledge of emerging technology trends. Technologies not applicable to Vermont's climate were rejected, while those included had savings estimates calculated for Vermont's climate and/or specific markets. For solar water heating, RETScreen was used to model the performance of a typical single family residential system in Vermont, with a performance and sizing extrapolated made to address multi-family systems. Energy conservation programs that produce energy savings through behavioral based changed in consumption habits were also included in this analysis and defined as emerging technologies due to their relatively unknown period of savings persistence.

The overall cost to purchase and install certain emerging technologies was reduced annually to reflect the likelihood of various factors (i.e. increased market competition, reduced production costs, or technology maturation) leading to a decrease in market prices over the period of study. For example, the install cost of residential solar water heating was reduced by 2% annually to account for any future reduction in purchase or installation costs and to gauge the impact of these reduced costs on the overall cost effectiveness of the measure.

Further detail regarding the development of measure assumptions for energy efficiency in the residential and commercial/industrial sectors can be found later in this report. Additionally, refer to the individual sector appendices for a comprehensive listing of all energy efficiency measure assumptions and sources assessed in this report.

5.3 Impacts of Early Replacement Programmatic Approach

This section explains the impacts of the early replacement programmatic approach. The GDS Team utilized the early replacement approach for fifty percent of the eligible measures during the twenty-year time period of this analysis (2012 to 2031). Energy efficiency potential in the existing stock of buildings can be captured over time through two principal processes:

1. as equipment replacements are made normally in the market when a piece of equipment is at the end of its useful life (we refer to this as the "market-driven" or "replace-on-burnout" case); and,
2. at any time in the life of the equipment or building (which we refer to as the "retrofit" case).

Market-driven measures are generally characterized by *incremental* measure costs and savings (e.g., the incremental costs and savings of a high-efficiency versus a standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g., the full costs and savings associated with retrofitting ceiling insulation into an existing attic). For the market driven measures, the study team assumed that existing equipment will be replaced with high efficiency equipment at the time a consumer is shopping for a new appliance or other energy using equipment, or if the consumer is in the process of building or remodeling. Using this assumption, equipment that needs to be replaced (replaced on burnout) in a given year is eligible to be upgraded to high efficiency equipment. A specialized retrofit case is often referred to as "early replacement" or "early retirement". This refers to a piece of equipment whose replacement is accelerated by several years, as compared to the market-driven assumption, for the purpose of capturing energy savings earlier than they would otherwise occur.

For this study, GDS utilized the "replace on burnout" programmatic approach for 50% of eligible measures, and utilized the "early replacement" approach for the remaining 50% of eligible measures. Thus these two approaches were utilized equally in this study. For replace-on-burnout and early replacement measures in the maximum achievable potential analysis, GDS assumed that the Program Administrator would pay an incentive equivalent to 100% of the incremental cost or full cost of energy efficiency measures.[27] In general, GDS finds that the early replacement approach can accelerate kWh and kW savings to earlier time periods, and can provide greater net present value savings. In the long run (more than 10 years), however, the early retirement and replace-on-burnout approaches often provide identical cumulative annual kWh and kW savings. The early replacement approach causes program budgets to be substantially higher than would occur with a replace-on-burnout approach, because costs are based on the full cost of purchasing a new appliance or piece of energy efficient equipment, not the incremental cost. However, these higher program costs can be mitigated by the net present value of the benefits achieved by the savings occurring sooner in time. These benefits can be significant in avoiding other, more costly, utility system expenditures such as transmission and distribution upgrades. Based on an a special analysis conducted for this study, GDS finds that both programmatic approaches pass the Vermont Societal test and are cost effective. GDS found that while the replace on burnout approach has a greater Vermont Societal Test benefit/cost ratio, the net present value savings for the early replacement approach are higher than with the replace on burnout approach.

For early retirement energy efficiency measures, the study team assumed that the measure would be replaced early, at most five years prior to reaching the end of its expected lifetime.[28] Therefore, for the first five years of the newly installed measure, the energy savings associated with the efficiency measure reflect the large savings that result from replacing an old, relatively inefficient measure with a new energy-efficient model (the energy savings are calculated as the difference between the old unit that is replaced and the new high efficiency unit that is installed). For the remaining life of the measure beyond year five, the energy savings associated with the measure reflects the incremental savings associated with installing an energy-efficient model rather than a new standard-efficiency model. While there are more substantial energy savings available in the first five years, continued savings at a lower level are captured for the remainder of the measure lifetime.

There is one more cost that needs to be considered in the Vermont Societal Cost Test for the early replacement programmatic approach. It is necessary to capture the additional costs to program participants of roughly five years of additional capital costs of equipment due to advancing the refrigerator replacement cycle by five years. Because the early replacement programmatic approach permanently advances the cycle of when the refrigerator will be replaced in the future, it is necessary to add this cost impact to the economic analysis.[29] The point is that by advancing a capital expense five years, you advance an entire stream of capital expenses over many years, and this has to be accounted for in the cost effectiveness screening analysis. It is also necessary to reflect reduced energy savings, beginning at the same time that the deferred cost credit is recognized. GDS has included this additional cost when considering the cost effectiveness of the early retirement programmatic approach.

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[27] Even with payment of an incentive equal to 100% of the measure incremental or full cost, GDS has assumed that only 90 percent of the available market will participate in programs. This is to acknowledge that some households and businesses will not participate in programs even when the EEU pays 100% of the incremental or full cost of measures.

[28] For purposes of this study, the study team used 5 years as the maximum remaining life at time of early replacement, with half the measure life as the remaining life for measures with EULs under 10 years.

[29] This cost is discussed on page 2 of a paper titled "Retrofit Economics 201: Correcting Common Errors in Demand-Side Management Cost-Benefit Analysis", by Rachel Brailove, John Plunkett, and Jonathan Wallach, Resource Insight, Inc. William Steinhurst of the Vermont Department of Public Service assisted in the derivation of this deferred replacement concept.

The authors of this report acknowledge that the early replacement programmatic approach also has other benefits that should be considered. There is a societal value due to the five years advancement in CO2 (and other emissions) reductions. There is a value to the five year advancement in employment effects, as energy efficiency programs create new jobs in Vermont. Furthermore, if accelerating energy efficiency measure installation delays or avoids utility system costs (particularly in capital costs that may represent a 20, 30 or even 50 year commitment), the 'societal' benefits will be strongly positive.

5.4 Potential Savings Overview

Potential studies often distinguish between three to four different types of efficiency potential: technical, economic, achievable, and program. However, because there are often important definitional issues between studies, it is important to understand the definition and scope of each potential estimate as it applies to this analysis.

Figure 5-1: Types of DSM Potential[30]

Not Technically Feasable	Technical Potential			
Not Technically Feasable	Not Cost Effective	Economic Potential		
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Achievable Potential	
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Program Design, Budget, Staffing, & Time Constraints	Program Potential

The first two types of potential, technical and economic, provide a theoretical upper bound for energy savings. Still, even the best designed portfolio of programs is unlikely to capture 100 percent of the technical or economic potential. Therefore, achievable potential and program potential attempt to estimate what may realistically be achieved, when it can be captured, and how much it would cost to do so. Figure 5.1 illustrates the four most common types of efficiency potential. In this report, achievable potential is referred to as maximum achievable potential as it assumes aggressive savings targets over the 20-year study time-frame. Estimates of program potential are not included as part of the current report. Rather, three resource plan scenarios will be examined as a supplement to this study that will analyze the potential for energy and demand savings given specific budget and other program parameters.

[30] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. ES EPA. Figure 2-1.

5.5 Technical Potential

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.[31]

In general, this study used a "bottom-up" approach in the residential sector to calculate the potential of an energy efficiency measure or set of measures. A bottom-up approach first starts with the savings and costs associated with replacing one piece of equipment with its efficient counterpart, and then multiplies these values by the number of measures available to be installed throughout the life of the program. The bottom-up approach is often preferred in the residential sector because of better data availability and greater homogeneity of the building and equipment stock to which measures are applied. However, this methodology was not able to be used in the C&I sector. The savings estimates per base unit were determined by comparing the high efficiency equipment to current installed equipment for existing construction retrofits or to current equipment code standards for replace-on-burnout and new construction scenarios.

5.5.1 Core Equation for the Residential Sector

The core equation used in the residential sector technical potential analysis for each individual efficiency measure is shown below in Figure 5-2.

Figure 5-2: Core Equation for the Residential Sector Technical Potential

Technical Potential of Efficient Measure	=	Total Number of Households or Buildings	X	Base Case Equipment End Use Intensity [kWh/unit]	X	Base Case Factor	X	Remaining Factor	X	Applicability Factor	X	Savings Factor

Where:

- Base Case Equipment End Use Intensity = the electricity used per customer per year by each base-case technology in each market segment. This is the consumption of the electric energy using equipment that the efficient technology replaces or affects.

- Base Case Factor = the fraction of the end use electric energy that is applicable for the efficient technology in a given market segment. For example, for residential lighting, this would be the fraction of all residential electric customers that have electric lighting in their household,

- Remaining Factor = the fraction of applicable dwelling units that have not yet been converted to the electric energy efficiency measure; that is, one minus the fraction of households that already have the energy-efficiency measure installed.

- Applicability Factor = the fraction of the applicable units that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket.)

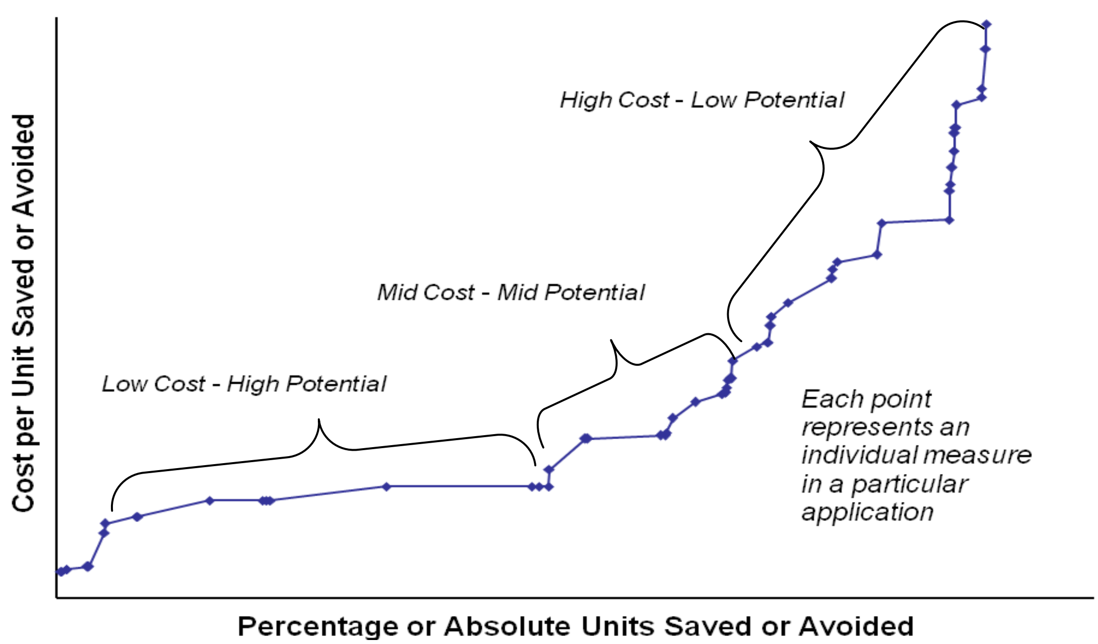
[31] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies", page 2-4

- Savings Factor = the percentage reduction in electricity consumption resulting from application of the efficient technology.

Technical energy efficiency potential in the residential sector was calculated in two steps. In the first step, all measures were treated *independently*; that is, the savings of each measure were not reduced or otherwise adjusted for overlap between competing or interacting measures. By analyzing measures independently, no assumptions were made about the combinations or order in which they might be installed in customer buildings. However, the cumulative technical potential cannot be estimated by adding the savings from the individual savings estimates because some savings would be double-counted. For example, the savings from a measure that reduces heat loss from a building, such as insulation, are partially dependent on other measures that affect the efficiency of the system being used to heat the building, such as a high-efficiency furnace; the more efficient the furnace, the less energy saved from the installation of the insulation.

In the second step, cumulative technical potential was estimated using an energy efficiency supply curve approach. This method eliminates the double-counting problem mentioned above. A generic example of a supply curve is shown in Figure 5-3. As shown in the figure, a supply curve typically consists of two axes; one that captures the cost per unit of saving a resource (e.g., dollars per kWh saved) and another that shows the amount of savings that could be achieved at each level of cost. The curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Savings measures were sorted on a least-cost basis and total savings are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., costs increase rapidly and savings decrease significantly at the end of the curve.

Figure 5-3: Generic Example of a Supply Curve



As noted above, the cost portion of this energy-efficiency supply curve is represented in dollars per unit of energy savings. Cost are annualized (often referred to as levelized) in supply curves. For example, energy-efficiency supply curves usually present levelized costs per kWh saved by multiplying the initial investment in an efficient technology or program by the capital recovery rate (CRR):

Therefore,

Levelized Cost per kWh Saved = Initial Cost x CRR/Annual kWh Savings

5.5.2 Core Equation for the Commercial and Industrial Sector

The core equation used in the commercial sector technical potential analysis for each individual efficiency measure is shown below in Figure 5-4.

Figure 5-4: Core Equation for Commercial Sector Technical Potential

Technical Potential of Efficient Measure	=	Total End Use kWh Sales by Industry Type	X	Base Case Factor	X	Remaining Factor	X	Convertible Factor	X	Savings Factor

Where:

- Total end use kWh sales (by segment) = the forecasted level of electric sales for a given end-use (e.g., space heating) in a commercial or industrial market segment (e.g., office buildings).
- Base Case factor = the fraction of the end use electric energy that is applicable for the efficient technology in a given market segment. For example, for fluorescent lighting, this would be the fraction of all lighting kWh in a given market segment that is associated with fluorescent fixtures.
- Remaining factor = the fraction of applicable kWh sales that are associated with equipment that has not yet been converted to the electric energy efficiency measure; that is, one minus the fraction of the market segment that already have the energy-efficiency measure installed.
- Convertible factor = the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an *engineering* perspective (e.g., it may not be possible to install VFDs on all motors in a given market segment).
- Savings factor = the percentage reduction in electricity consumption resulting from application of the efficient technology.

Similar to the residential sector, technical electric energy efficiency savings potential in the C&I sector was calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics were analyzed without making assumptions about the order or combinations in which they might be implemented in customer buildings. However, the total technical potential across measures cannot be estimated by summing the individual measure potentials directly because some savings would be double-counted. For example, the savings from a weatherization measure, such as low-e ENERGY STAR® windows, are partially dependent on other measures that affect the efficiency of the system being used to cool or heat the building, such as high-efficiency space heating equipment or high efficiency air conditioning systems; the more efficient the space heating equipment or electric air conditioner, the less energy saved from the installation of low-e ENERGY STAR windows.

For the residential and commercial sectors, the GDS Team addressed the new construction market as a separate market segment, with a program targeted specifically at the new construction market. In the residential new construction market segment, for example, detailed energy savings estimates for the ENERGY STAR Homes program were used as a basis for determining electricity savings for this market segment in Vermont.

5.6 ECONOMIC POTENTIAL

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. The study team used the Vermont Societal test to determine whether measures were cost effective.

In practice, most technical and economic potential estimates produce similar results. The study team calculated the Vermont Societal test for each measure over a ten-year implementation period (2012 to 2021) to determine if each measure was cost effective. The cost effectiveness testing was done in this manner to ensure that all measures that were cost effective on average over the ten-year period were included in the estimates of economic and achievable potential. This procedure ensured that measures that were not cost effective in early years but became cost effective in later years were included in the estimates of economic and achievable potential. All measures that were not found to be cost-effective were excluded from future analysis.

5.7 MAXIMUM ACHIEVABLE POTENTIAL

Maximum Achievable Potential describes the economic potential that could be achieved over a given time period under the most aggressive program scenario.

Achievable potential is the amount of energy use that can realistically be expected to save assuming the most aggressive market penetration and funding scenarios. 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. For purposes on this study, the GDS team assumed that the EEU would pay incentives equal to 100 percent of measure costs. It was assumed that the combination of this level of incentives along with well-designed programs with effective education and outreach would generally result in an overall measure penetration rate of 90 percent.

5.8 RESOURCE PLAN SCENARIOS

The next phase of this study will also examine projected budgets and kWh and kW savings for three resource plan scenarios:

1. Acquiring all reasonably available cost effective efficiency potential over 20 years, through a reasonably flat budget
2. Acquiring 2% savings relative to annual energy consumption, ramping up to 3% in five years, then holding constant
3. The current budget adjusted for inflation

The results of these resource plan scenarios will be presented in a supplement of this study.

5.9 Determining Cost-Effectiveness

A standard methodology for energy efficiency program cost effectiveness analysis was published in California in 1983 by the California Public Utilities Commission and updated in December 1987, 2001 and 2002.[32] It was based on experience with evaluating conservation and load management programs in the late 1970's and early 1980's. This methodology examines five perspectives:

- the Total Resource Cost Test
- the Participant Test
- the Utility Cost Test (or Program Administrator Test)
- the Rate Impact Measure (RIM) Test
- the Societal Cost Test

Figure 5-5 below summarizes the major components of these five benefit/cost tests. Vermont uses the Societal Cost Test as described below.

Figure 5-5: Components of Energy Efficiency Benefit/Cost Tests

	Participant Test	Rate Impact Test	Total Resource Cost Test	Utility Cost Test	Societal Test
Benefits					
Reduction in Customer's Utility Bill	X				
Incentive Paid by Utility	X				
Any Tax Credit Received	X		X		
Avoided Supply Costs		X	X	X	X
Avoided Participant Costs	X		X		X
Participant Payment to Utility (if any)		X		X	
External Benefits					X
Costs					
Utility Costs		X	X	X	X
Participant Costs	X		X		X
External Costs					X
Lost Revenues		X			

[32]California Public Utilities Commission and California Energy Commission, Standard Practice Manual, Economic Analysis of Demand-Side Programs and Projects, 2002.

5.9.1 THE TOTAL RESOURCE COST TEST

The Total Resource Cost (TRC) test measures the net costs of a demand-side management or energy efficiency program as a resource option based on the total costs of the program, including both the participants' and the utility's costs.[33]

Benefits and Costs: The TRC test represents the combination of the effects of a program on both the customers participating and those not participating in a program. In a sense, it is the summation of the benefit and cost terms in the Participant and the Ratepayer Impact Measure tests, where the revenue (bill) change and the incentive terms intuitively cancel (except for the differences in net and gross savings).

The benefits calculated in the Total Resource Cost Test include the avoided electric supply costs for the periods when there is an electric load reduction, as well as savings of other resources such as fossil fuels and water. The avoided supply costs are calculated using net program savings, which are the savings net of changes in energy use that would have happened in the absence of the program.

The costs in this test are the program costs paid by the utility and the participants plus any increase in supply costs for periods in which load is increased. Thus all equipment costs, installation, operation and maintenance, cost of removal (less salvage value), and administration costs, no matter who pays for them, are included in this test. Any tax credits are considered a reduction to costs in this test.

5.9.2 THE PARTICIPANT TEST

The Participant Test is the measure of the quantifiable benefits and costs to program participants due to participation in a program. Since many customers do not base their decision to participate in a program entirely on quantifiable variables, this test cannot be a complete measure of the benefits and costs of a program to a customer.[34] This test is designed to give an indication as to whether the program or measure is economically attractive to the customer. Benefits include the participant's retail bill savings over time, and costs include only the participant's costs.

5.9.3 THE RATE IMPACT MEASURE TEST

The Ratepayer Impact Measure (RIM) Test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by a program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates or bills will go up if revenues collected after the program is implemented are less than the total costs incurred by the utility in implementing the program. This test indicates the direction and magnitude of the expected change in customer rate levels.[35] Thus, this test evaluates an energy efficiency program from the point of view of rate levels. The RIM test is a test of fairness or equity; it is not a measure of economic efficiency.

[33] California Public Utilities Commission, California Standard Practice Manual, Economic Analysis of Demand-Side Management Programs and Projects, October 2001, page 18.
[34] Ibid., page 9.
[35] Ibid., page 17.

5.9.4 THE UTILITY COST TEST

The Utility Cost Test measures the net costs of a demand-side management program as a resource option based on the costs incurred by the utility (including incentive costs) and excluding any net costs incurred by the participant. The benefits are similar to the Total Resource Cost Test benefits. Costs are defined more narrowly, and only include the utility's costs.[36] This test compares the utility's costs for an energy efficiency program to the utility's avoided costs for electricity and/or gas. This means that a measure could pass the Utility Cost Test but not be cost effective from a more comprehensive perspective that included participant costs.

5.9.5 THE VERMONT SOCIETAL TEST

The December 20, 2010 Vermont Public Service Board Order of Appointment states that "When assessing the cost-effectiveness of efficiency measures, an EEU shall utilize the Societal Test as described by the Board in its April 16, 1990 Order in Docket No. 5270, or other tests as may be approved by the Board".[37] All of the cost effectiveness screening and results for this study were determined using the Vermont Societal Test.

The Societal Cost Test is structurally similar to the Total Resource Cost Test.[38] It goes beyond the TRC test in that it attempts to quantify the change in total resource costs to society as a whole rather than to only the service territory (the energy efficiency utility service area). In taking society's perspective, the Societal Cost Test utilizes essentially the same input variables as the TRC test, but they are defined with a broader societal point of view.[39] An example of societal benefits is reduced emissions of carbon, nitrous and sulfur dioxide and particulates from electric utility power plants.[40] When calculating the Societal Cost Test benefit/cost ratio, future streams of benefits and costs are discounted to the present using a discount rate. The avoided costs of electricity, natural gas, propane, #2 fuel oil, kerosene and water used in this study are provided in Appendix 1 of this report.

According to the Final Order in Vermont Public Service Board Docket No. 5270, the Societal Test calculation in Vermont includes a 10% reduction to costs to account for the risk diversification benefits of energy efficiency measures and programs. The Board subsequently adopted an environmental adder of $.0070 per kWh saved (in $2000). This adder replaces the original 5% adder for environmental externalities. In this report, GDS has used the definition of the Societal Test calculation as specified by the Vermont Public Service Board in its final order in Docket No. 5270, and has used the $.0070 adder for environmental benefits, adjusted to current year dollars. GDS has also applied the 10% reduction to energy efficiency measure costs for all calculations of the Vermont Societal Test.

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[36] Ibid., page 33.

[37] Vermont Public Service Board Order of Appointment dated December 20, 2010, page 28.

[38] According to the November 2008 National Action Plan for Energy Efficiency Guide titled "Understanding Cost Effectiveness of Energy Efficiency Programs", the Societal Cost Test (SCT) includes all of the costs and benefits of the TRC test, but it also includes environmental and other non-energy benefits that are not currently valued by the market. The SCT may also include non-energy costs, such as reduced customer comfort levels. See page 6-7.

[39] California Public Utilities Commission, California Standard Practice Manual, Economic Analysis of Demand-Side Management Programs and Projects, October 2001, page 27.

[40] The Vermont Public Service Board Order in Docket No. 5270 cites the following as such societal benefits: reductions in acidic precipitation, carbon dioxide and other greenhouse gases, reduction in habitat destruction, and reduction in nuclear waste disposal risks.

5.10 AVOIDED COSTS

The avoided 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. The costs that are avoided depend on the amount electricity that is saved, and when it is saved (in peak heating season periods, seasonal or annual, etc.). The avoided costs used in this study were adopted by the Vermont Public Service Board and provided to the GDS/Cadmus study team by staff of the Vermont Department of Public Service.[41]

Second, it is very important to note that the electricity avoided costs used in the Vermont Societal (VT SCT) Test do not represent the retail rate for each customer class. While the actual retail rate is used in the calculation of the benefits for the Participant Test, the actual retail rate is not the avoided electric cost used in the calculation of the benefits for the Societal Test or the Total Resource Cost Test.

5.11 TREATMENT OF EXISTING EFFICIENT EQUIPMENT STOCK AND ITS EFFECT ON THE POTENTIAL STUDY

The Nexus Market Research and KEMA market characterization studies show that a certain percentage of existing equipment in Vermont is currently energy efficient. This potential study excluded equipment that is currently efficient from the energy efficiency potential found for the 2012-2031 period. The analysis recognizes these measures as the portion of the market that has already been transformed and accounted for in the most recent ITRON forecast. Because naturally occurring energy savings are already largely reflected in the electricity sales forecast used in this study, these electric savings are not available to be saved again through the study team's energy efficiency supply curve analysis.[42]

Just as with many of the assumptions made to develop energy efficiency potential in EEU service territories, one could make reasonable alternate assumptions regarding this issue. A contemporaneous *program* potential study completed by VEIC in 2010 recognizes the future potential for all current energy efficient equipment to become eligible for replacement during the 2012-2031 analysis. These increases in energy efficiency may be met by newer technologies or increased appliance efficiency standards over time. In place of the GDS/Cadmus approach that 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, VEIC instead assigned a unique free-ridership and spillover rate to the residential and commercial/industrial measures included in their study.[43] The impact of these free-ridership and spillover assumptions is also a decrease in the overall number of units eligible for participation over the designated time-period, but at a different rate than those utilized by the GDS/Cadmus team.

This analysis utilizes the above described GDS/Cadmus team method when reporting the long-term potential for energy efficiency savings, particularly because the commercial sector analysis utilizes a top-down approach to determine savings potential that is based upon the load forecast. The merit of unique free-ridership and spillover measures was considered for program planning purposes and reintroduced

[41] Avoided Energy Supply Component Study Group, report titled "Avoided Energy Supply Costs in New England: 2009 Report", dated October 23, 2009.

[42] It is not possible to discern exactly how much naturally occurring efficiency is included in the ITRON forecast. The forecast uses data on consumption trends from the Energy Information Administration that includes installation of efficient equipment, price effects, and other factors affecting customers' consumption.

[43] Although the VEIC approach may slightly overstate the potential for efficiency savings compared to predicted load through the inclusion of measures largely reflected in the sales forecast, it can be advantageous for program planning purposes. The use of historical and forecasted free-ridership and spillover rates allows the EEU to anticipate future budgets and expected net savings critical to the program planning process.

into the analysis of the resource plan scenarios that are to be provided to the Public Service Board subsequent to this report. The issue of free-ridership is discussed further in the following section.

5.12 FREE-RIDERSHIP VERSUS FREE-DRIVERS

Free-riders are defined as participants in an energy efficiency program who would have undertaken the energy-efficiency measure or improvement in the absence of a program or in the absence of a monetary incentive. Free-drivers are those who adopt an energy efficient product or service because of the intervention, but are difficult to identify either because they do not collect an incentive or they do not remember or are not aware of exposure to the intervention.[44]

The issue of free-riders and free-drivers is important. For the commercial and industrial sectors, where a top-down approach is used to estimate electric savings potential, free-riders are accounted for through the electric energy and peak demand forecast provided to the study team by staff of the Vermont Department of Public Service. This electric kWh sales forecast already includes the impacts of naturally occurring energy efficiency (including impacts from vintaging of electric appliances, electric price impacts, and electric appliance efficiency standards). Because naturally occurring energy savings are already reflected in the electricity sales forecast used in this study, these electric savings will not be available to be saved again through the study team's energy efficiency supply curve analysis. The study team used this process to ensure that there is no "double-counting" of energy efficiency savings. This technical methodology for accounting for free-riders for the commercial and industrial sectors is consistent with the standard practice used in other recent technical potential studies, such as those conducted in California, Connecticut, Florida, Georgia, Idaho, Kentucky, New Mexico and Utah.

Adjustments to Savings for the Residential Sector

As noted above, the study team used a "bottom-up" approach to estimate potential kWh savings remaining in the residential sector in Vermont. The study team examined whether it would be necessary to adjust projected electricity savings for free-ridership, spillover and other market effects. The study team collected data on energy efficiency program realization rates from programs at NYSERDA, National Grid and Wisconsin Focus on Energy. As a result of this review, and using NYSERDA's most recent data, GDS has used an adjustment factor of 1.0 at this time to capture the impacts reflected in realization rates and net to gross ratios for this sector, with one exception. Recognizing that CFL lighting technology in the residential sector has historically been evaluated with significantly lower net to gross ratios than other standard measures, residential CFL bulbs were assigned an annual net to gross ratio of 0.40 during the 20 year analysis period. The net to gross assumption for residential CFL lighting is based on forecast trends assumed by Efficiency Vermont.

The definitions of these terms are provided below.

net to gross ratio: this is an adjustment factor that accounts for the amount of energy savings, determined after adjusting for free ridership and spillover (market effects), attributable to the program.

realization rate: this factor is calculated as the energy or demand savings measured and verified divided by the energy or demand savings originally forecasted to occur by the EEU. A rate of 1.0 means that the savings measured and verified aligned exactly with the savings claimed. A rate greater than 1.0 means that the savings were under-reported, while a rate less than 1.0 means the savings were over-estimated.

[44] Pacific Gas and Electric Company, "A Framework for Planning and Assessing Publicly Funded Energy Efficiency Programs", Study ID PG&E-SW040, March 1, 2001.

6 RESIDENTIAL ENERGY EFFICIENCY POTENTIAL ESTIMATES (2012 TO 2031)

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 6-1 and Table 6-1 presented below, summarize the technical, economic, and achievable savings potential (as a % of forecast sales) for the Vermont service area by 2031. 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 2031. 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 34.4% of projected residential sales (819,382 MWh). Energy efficiency measures and programs can also serve to lessen peak demand, creating a reduction of roughly 37% of the 2031 residential winter peak (30% of the summer peak) in the maximum achievable potential scenario.

Figure 6-1: Summary of Residential Energy Efficiency Potential as a % of 2031 Forecast – VT Statewide

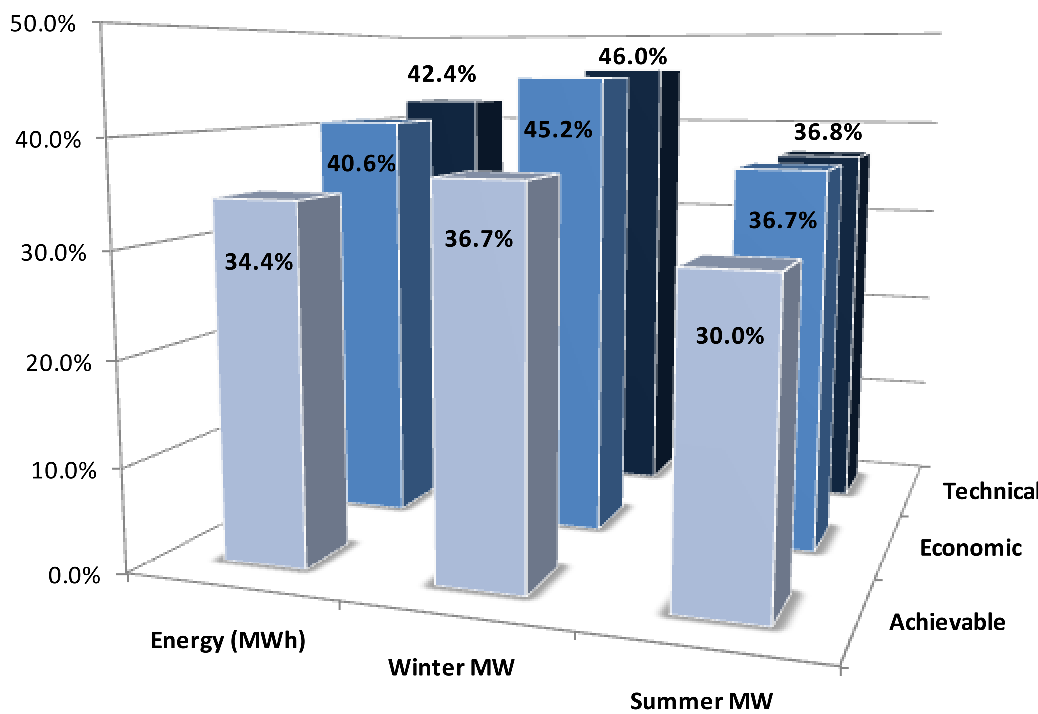


Table 6.1 also presents the separate technical, economic, and maximum achievable estimates for the EVT and BED service territories. In general the BED territory had slightly higher estimates of technical, economic, and achievable potential.[45] Of the combined 819,382 MWh of achievable potential energy savings, the BED territory achievable electric energy savings was 38,389 MWh (41% of 2031 BED sales).

[45] 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 2009 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 2031 BED forecast sales.

The EVT territory was estimated to have a maximum achievable potential of 780,993 MWh (34% of 2031 EVT territory sales).

Table 6-1: 2031 Summary of Residential Energy and Demand Savings Potential

	Energy		Demand			
	Energy (MWh)	% of 2031 Sales	Winter MW	% of 2031 Winter Peak	Summer MW	% of 2031 Summer Peak
State-wide						
Technical Potential	1,011,825	42.4%	215.6	46.0%	159.2	36.8%
Economic Potential	966,837	40.6%	211.9	45.2%	158.5	36.7%
Achievable Potential	819,382	34.4%	172.2	36.7%	129.5	30.0%
EVT Territory						
Technical Potential	965,853	42.2%	205.6	45.5%	151.6	36.5%
Economic Potential	921,663	40.2%	202.0	44.7%	151.2	36.4%
Achievable Potential	780,993	34.1%	164.0	36.3%	123.3	29.7%
BED Territory						
Technical Potential	45,972	49.1%	10.0	57.4%	7.6	46.1%
Economic Potential	45,174	48.3%	9.9	56.7%	7.4	44.6%
Achievable Potential	38,389	41.0%	8.2	46.7%	6.1	37.1%

6.1 Energy Efficiency Measures Examined

67 residential electric energy efficiency programs or measures were included in the energy savings analysis for the residential sector.[46] Below, Table 6-2 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.

Appendix 2 provides a brief discussion of each measure or program as well as the savings, useful life, cost assumptions, and VT SCT benefit-cost ratios at the "measure" level.

Table 6-2: Measures and Programs Included in the Residential Sector Analysis

End Use Type	End-Use Description	Measures/Programs Includes
Appliances	General Home Appliances	* Dehumidifiers * Refrigerators * Freezers * Refrigerator/Freezer Turn-In
Appliances/WH	Kitchen/Laundry	* Clothes Washers * Heat Pump Dryers * Clothes Dryer - Fuel Switch * Dishwashers
Electronics	Home Electronics	* Controlled Power Strips * Internal Power Supplies * Laptops * Computer Monitors * Televisions (LED, LCD, Plasma) * Set Top Boxes

[46] 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 approximately 379 measure permutations.

		* Misc. Consumer Electronics
HVAC (Envelope)	Building Envelope Upgrades	* Weatherization * Weatherization & Insulation Package * Energy Star Windows
HVAC (Equipment)	Heating/Cooling /Ventilation Equipment	* Efficient Central AC * Efficient Room AC * Efficient Furnace Fan Motors * Exhaust Fans * Primary Space Heat - Fuel Switch (MF Only) * Reverse Cycle Chillers – Emerging Tech. (MF Only)
Lighting	Indoor/Outdoor Lighting	* Incandescent to CFL * Incandescent to LED * CFL to LED * Specialty CFL bulbs (<=15W) * Specialty CFL bulbs (>15W) * Indoor Lighting Controls * Outdoor Lighting Controls
Other	Miscellaneous Efficiency Measures	* Pool Pump Timer * 2-speed Pool Pump Motor * Direct Feedback Devices (In Home Display Units) – Emerging Tech. * Indirect Energy Consumption Feedback – Emerging Tech.
Water Heating	Domestic Hot Water	* Efficient Storage Tank WH * Heat Pump WH * Solar WH (w/ Electric Back Up) – Emerging Tech. * Electric Water Heater - Fuel Switch * Tank Wrap * Pipe Wrap * Low Flow Showerheads * Faucet Aerators

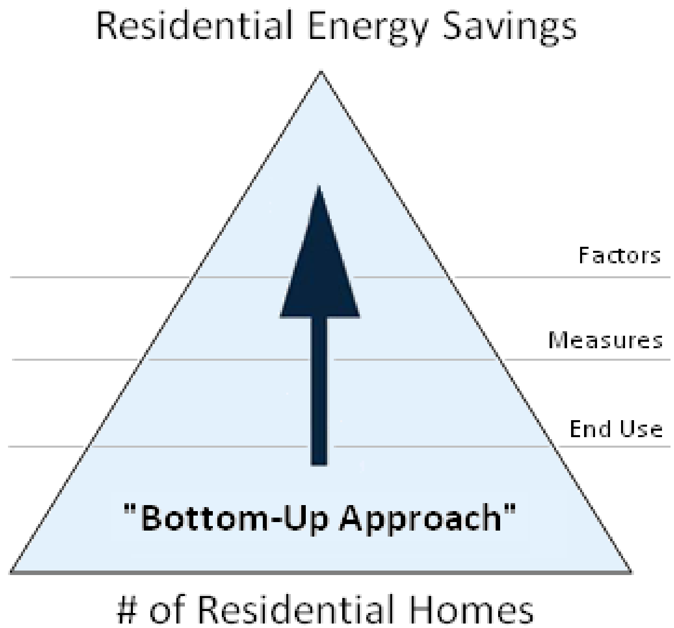
6.2 Residential Sector Savings Methodology Overview

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 based on a forecast of the number of new customers each year from VELCO. 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 2012 through 2031.

The residential sector analysis was modeled using what is considered a “bottom-up approach.” The methodology is illustrated in Figure 6-2 below:

Figure 6-2: 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.

To obtain up-to-date appliance and end-use saturation data, the study made extensive use of the data collected during the residential on-site surveys conducted for the 2009 Existing Homes Report and 2009 Vermont Residential New Construction Study, both completed by Nexus Market Research, Inc. (NMR). For the BED territory, data collected during 2005 by KEMA was utilized to define baseline saturation characteristics. When available, estimates of energy efficient equipment saturations were also based on the on-site survey data. Additional estimates of energy efficient saturation were generated from regional or national data when needed.

The full formula to determine savings at the measure level is shown below.

Technical Potential of Efficient Measure	=	Total Number of Households or Buildings	X	Base Case Equipment End Use Intensity [kWh/unit]	X	Base Case Factor	X	Remaining Factor	X	Applicability Factor	X	Savings Factor

The goal of the formula is to determine how many households this measure applies to (base case factor), then of that group, the fraction of households which do not have the efficient version of the measure being installed (remaining factor). In instances where technical reasons did not permit the installation of the efficient equipment in all eligible households or competing technologies were eligible for a household, an applicability factor was used that limits the potential. The last factor to be applied was the savings factor, which is the percentage savings achieved from installing the efficient measure over a standard measure.

In developing the overall potential electricity savings, the analysis also took steps to account for the interactive effects of measures designed to impact the same end-use. For instance, if a home were to improve their air leakage rate, the overall space heating and cooling consumption in that home would decrease. As a result, the remaining potential for energy savings derived from additional thermal envelope efficiency measures and efficient heating/cooling equipment would be reduced.

In this analysis, it was assumed that for those measures designed to impact the same end-use, the measure or program with the highest current market penetration would typically be installed first, followed by the measure(s) with the next highest market penetration. Presumably, the measures with the highest market penetrations are perceived as the most attractive based on costs, savings, or ease of implementation. Ranking the installation order in this manner also mimics the pattern of installation that is already occurring in the current market.

In instances where there were two (or more) competing technologies for the same electric end use, such as heat pump water heaters and high efficiency electric storage 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 and primary space heating.[47] These measures consist of replacement electric water and/or space heating equipment in favor of natural gas, oil, or propane units. Fuel switching was treated as a competing measure to other electric efficiency options. As a result, only a fraction of the total eligible homes were included in the fuel switch options.

The majority of measures were analyzed under both the replace-on-burnout and early retirement option. In the technical potential, 50% of the eligible remaining market was reserved for early retirement and the remaining 50% of the eligible market was analyzed through the replace-on-burnout approach. If both measures proved to be cost effective, the 50/50 split remained through the economic and achievable potential scenarios. The assumption of a 50/50 split remained through the achievable potential to allow for overall linear participation, budgets, and savings in lieu of alternate periods of program growth and contraction. However, in the event that one replacement approach was not cost-effective, the remaining replacement approach received 100% of the eligible market.

Finally, the residential savings potential also takes into account scheduled federal upgrades to incandescent lighting. Recently enacted federal standards (*Energy Independence and Security Act of 2007*) require incandescent bulbs to be approximately 30% more efficient beginning in 2012.[48] These improvements to incandescent equipment performance result in decreased savings potential for CFL and LED technologies. While these new standards may shift the market even further towards wide-spread acceptance of CFL technologies, they do not necessary signal the end of incandescent bulbs. As a result, this analysis continues to include the potential savings from screw-in CFL bulbs from 2012-2019.[49]

[47] 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.

[48] The mandated increase in the efficiency of incandescent bulbs is phased in over a 3-year period: 100-watt bulbs must be 30% more efficient beginning in 2012, 75-watt bulbs in 2013, and 60-watt and 40-watt bulbs in 2014. To facilitate this analysis, GDS took the increased standards for incandescent lighting into account throughout the entire period of study (2012-2031).

[49] As referenced in Section 5.12, although the analysis continues to include the potential savings from CFL bulbs from 2012-2019, CFL bulbs were assigned a net to gross ratio of 0.40 to account for the wide-spread acceptance of CFL bulbs and the resulting increase in CFL bulb free-ridership.

In 2020, a second tier of lighting standards is expected to take effect and require bulbs to be 45% more efficient than today's incandescent bulbs. Although these standards do not ban the incandescent bulb, this study assumes the 2020 lighting standards will shift the market accordingly so that the standard new bulb has similar efficacy to a CFL bulb. As a result, all lighting savings from 2020-2031 are modeled as CFL to LED technology.

6.3 Technical and Economic Potential Savings

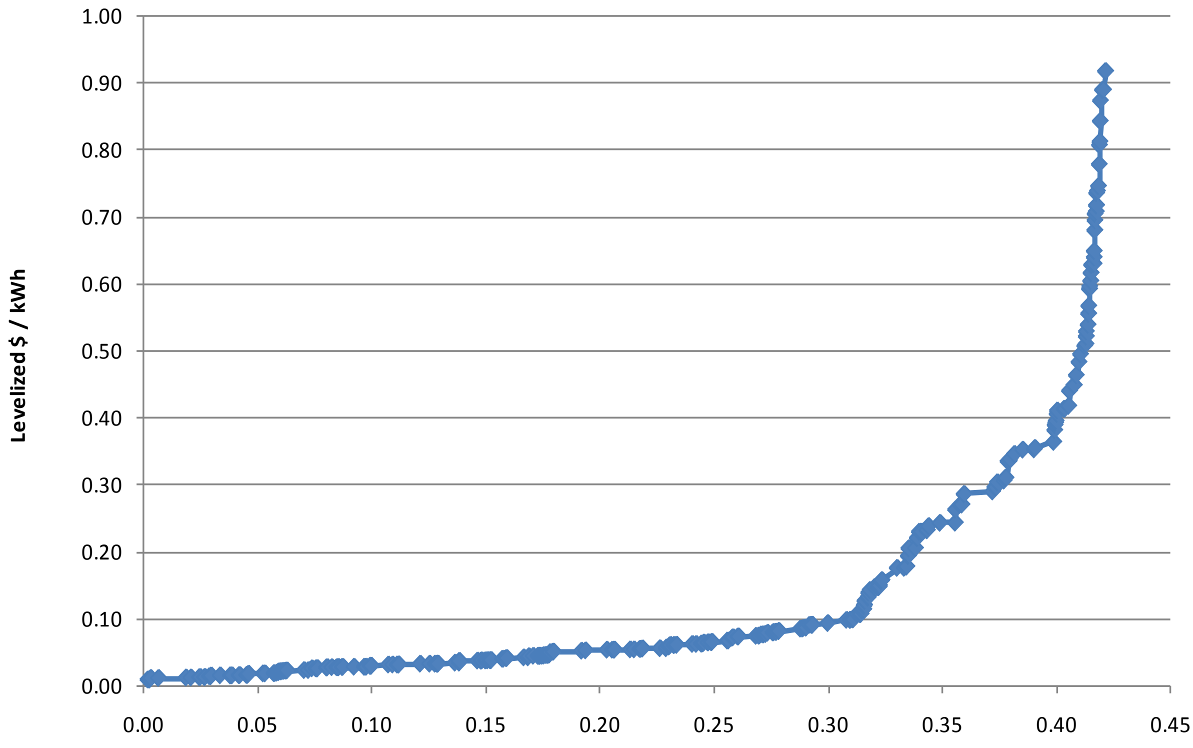
The technical potential represents the savings that could be captured if 100 percent of inefficient electric appliances and equipment were replaced instantaneously (where they are deemed to be technically feasible). As shown below in Table 6-3, total technical potential savings for the Vermont residential sector are 1,011,825 MWh, or 42.4% of forecast residential MWh sales in 2031. The technical potential for winter peak demand savings is 216 MW, or 46% of 2031 forecast winter peak demand. The potential for summer peak savings is approximately 159 MW (37% of the 2031 summer peak demand forecast).

Table 6-3: Technical Energy and Demand Potential and % Share of Residential Energy Forecast Sales and Summer/Winter Peak Demand in 2031

	Technical Potential		
End Use	**Energy (MWh)**	**Winter (MW)**	**Summer (MW)**
Water Heating	249,237	46	28
Lighting	194,429	74	17
Consumer Electronics	125,452	14	13
Appliances/WH	124,362	24	18
Other	107,221	16	34
HVAC (Envelope)	81,686	8	23
HVAC (Equipment)	79,093	20	12
Appliances	50,346	14	15
Total	**1,011,825**	**216**	**159**
% of 2031 Forecast	*42.4%*	*46.0%*	*36.8%*

Below, in Figure 6-3 presents the electric energy efficiency technical potential results for the residential sector in the form of a supply curve. The supply curve demonstrates the technical potential savings (as a % of 2031 forecast kWh sales) at varied levelized costs per lifetime kWh saved amounts. For example, roughly 31% savings can be achieved at a cost per lifetime kWh saved of $0.10 or less. To obtain increased electric energy from efficiency resources, it is necessary to move to the right on the curve and choose progressively more costly resources. It should be noted that the levelized costs are based on electric savings and do not factor in associated non-electric benefits, nor do they include program administrative costs.

Figure 6-3: Residential Electric Efficiency Supply Curve for Vermont



The economic potential calculations were made by incorporating the various measure assumptions (savings, cost, and useful life, etc) into the cost-effectiveness screening tool.[50] Any programmatic costs (e.g., marketing, analysis, and administration) were ignored in the economic potential analysis in order to screen whether energy efficient technologies were cost-effective on their own merit prior to any assistance or marketing endeavors from utilities or other organizations.

For the economic potential scenario, the study assumed 100% of all remaining cost-effective measures eligible for installation were installed. This produces an economic potential of 40.6% of forecast residential MWh sales in 2031. Economic winter peak demand savings are 212 MW, or 45.2% of forecast residential winter peak demand. Summer peak demand savings are approximately 159 MW, or 36.7% of the forecast residential summer peak.

[50] The cost-effectiveness of a measure is based on each measure's full savings potential, before any adjustments for interactive impacts. After identifying which measures passed screening, we made an additional adjustment for interactive effects in order to finalize estimates of overall economic potential.

Table 6.4: Economic Energy Potential and Percentage Share of Residential Forecast Energy Sales and Summer/Winter Peak Demand in 2030

	Economic Potential		
End Use	**Energy (MWh)**	**Winter (MW)**	**Summer (MW)**
Water Heating	205,432	42	29
Lighting	194,429	74	17
Consumer Electronics	125,112	14	13
Appliances/WH	124,310	24	18
Other	107,221	16	34
HVAC (Envelope)	81,441	8	23
HVAC (Equipment)	78,545	20	11
Appliances	50,346	14	15
Total	**966,837**	**212**	**159**
% of 2031 Forecast	*40.6%*	*45.2%*	*36.7%*

6.4 Maximum Achievable Potential Savings

The maximum achievable potential is a subset of the economic potential and is limited by various market and adoption barriers, including the assumed 50/50 split of replace-on-burnout and early retirement measures.

6.4.1 Estimating Maximum Achievable Savings in the Residential Sector

In the residential base 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 2012-2031. The 90% target achievable penetration was assumed for the appliances, appliances/WH, consumer electronics, HVAC (equipment) and water heating end-uses. 80% target market penetration was assumed for fuel-switching, emerging technologies, lighting, HVAC (envelope), and other end-uses[51].

The variation in target market penetration was utilized to account for increased barriers to measure adoption in certain end-uses. For example, homeowners may consider job length and personal inconvenience a greater barrier to implementation over the economics of the measure. Similarly, not all homes may have the appropriate building characteristics (orientation, shading, neighborhood codes) to be retrofitted with a solar hot water heating system (or other emerging technologies). For these reasons, this study assumed it was appropriate to assign a variable target market penetration across end-uses.

Once the total number of measures eligible to be installed over the 20-year analysis time frame was determined, one of four annual penetration curves (upward trending, bell curve, downward trending and flat) was assigned to each measure. In general, these curves were assigned based on measure cost and current market acceptance. For example, a measure with low cost or high market acceptance was assigned the downward trending curve, resulting in higher levels of penetration in early years, followed by a slow decline in incremental annual penetration during latter years. A measure with a high install cost

[51] Although lighting has historically been an end-use that is able to achieve high levels of market penetration relative to other end-uses, this analysis limited the remaining potential to 80% of the remaining market. In the short term, the remaining potential is limited by the success of current lighting efforts and reduced remaining potential. In the long term, the market penetration was set at 80% to account for unknown LED bulb costs and the uncertainty of the LED lighting to be appropriate in all residential applications.

or low market acceptance was assigned the upward trending penetration curve. Early retirement measures and new construction measures were assigned a flat penetration curve. All four curves were tailored to ensure that the full desired market penetration was reached by the end of the analysis time frame. Although this method simplifies what an adoption curve would look like in practice, it succeeds in providing a concise method for estimating achievable savings potential over a specific period of time.

Finally, the majority of savings measures possess a useful life less than the analysis time frame. For example, a clothes washer installed in 2012, with a measure life of ~12 years, might expire in 2024. In this analysis, expiring measures were reintroduced the following year. This allows the savings (and costs) to persist throughout the entire 20-year study. As noted earlier, this analysis acknowledges that measures reintroduced in later years may be impacted by future improvements to building or appliance codes and standards yet assumes that future energy and demand savings remain consistent through similar improvements to high efficiency measure standards over time.

6.4.2 Residential Maximum Achievable Savings Potential

By 2031 the total residential energy efficiency maximum achievable potential is 819,382 MWh, or 34.4% of forecast residential sales in 2031. The maximum achievable potential scenario also achieves 172 MW of residential winter peak savings, or 36.7% of the 2031 residential winter peak forecast. Summer peak savings are estimated at 129 MW, or 30% of the residential summer peak

Table 6-4: Maximum Achievable Energy and Demand Potential and % Share of Residential Forecast Energy Sales and Summer/Winter Peak Demand in 2031

	Achievable Potential		
End Use	**Energy (MWh)**	**Winter (MW)**	**Summer (MW)**
Water Heating	171,726	34	23
Lighting	125,522	59	14
Consumer Electronics	110,350	12	11
Appliances/WH	106,787	20	15
Other	85,773	12	27
Appliances	85,727	10	11
HVAC (Equipment)	67,723	17	10
HVAC (Envelope)	65,774	7	19
Total	**819,382**	**172**	**129**
% of 2031 Forecast	*34.4%*	*36.7%*	*30.0%*

Figures 6-4 and 6-5 are pie charts that show the maximum achievable potential by end-use and show the shifting flow of measure group share over time. In 2019, lighting is the dominant share (40%) of the total 2019 maximum potential. As noted earlier the section, in 2020 new federal lighting standards go into effect that are expected to effectively lead to CFL bulbs as the standard efficiency lighting technology in the U.S. The result is a significant drop-off in the potential for lighting savings in the residential. By 2031, lighting has decreased from 40% (~199,600 MWh) to 15% of the total maximum achievable potential (125,522 MWH). During this time, nearly all other end-uses have increased their share of the total maximum achievable potential.

Table 6-5 through Table 6-7 depict the cumulative annual energy and demand 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 6-4: Residential Sector End-Use Savings as a % of 2019 Maximum Achievable Potential

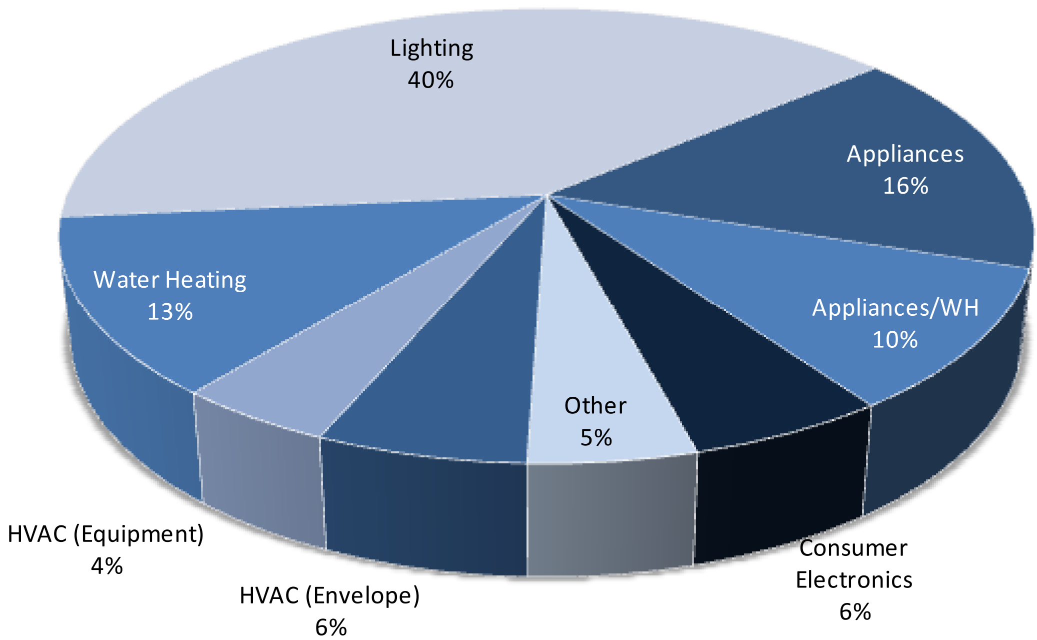


Figure 6-5: Residential Sector End-Use Savings as a % of 2031 Maximum Achievable Potential

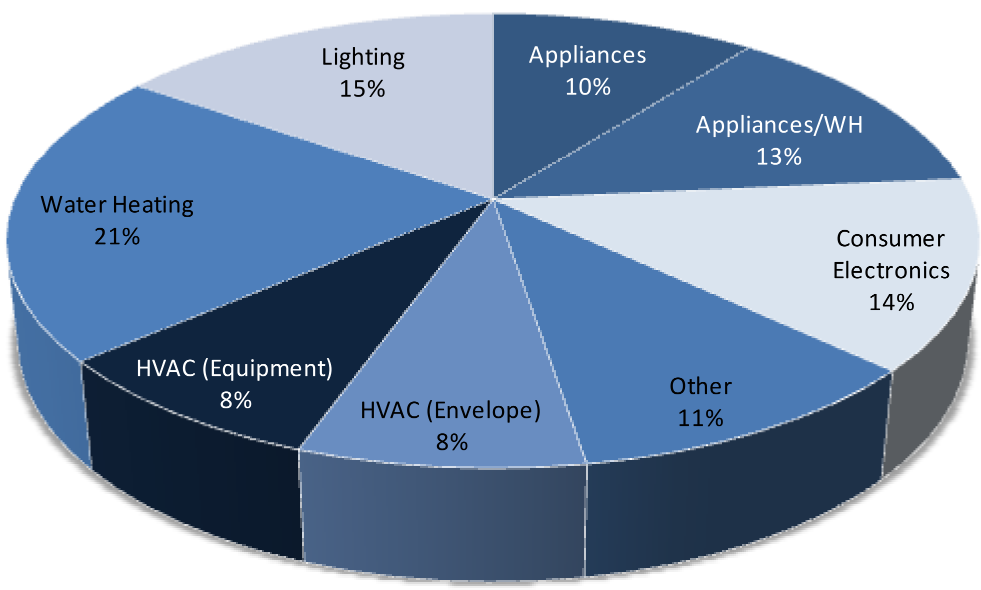


Table 6-5: Cumulative Annual Residential Energy (MWh) Savings Potential by End Use for VT (Statewide), EVT Territory, and BED Territory

Energy Savings (MWh) - Vermont (Statewide)																				
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Appliances	11,660	23,564	35,575	47,644	59,709	66,646	73,430	79,978	82,196	83,804	84,792	85,307	85,411	85,304	85,066	84,811	84,645	84,678	85,008	85,727
Appliances/WH	6,065	12,348	18,710	25,157	31,679	37,792	43,898	49,942	55,862	61,560	66,981	72,163	77,084	81,817	86,337	90,671	94,838	98,872	102,774	106,787
Consumer Electronics	2,877	5,807	8,845	12,045	15,461	19,145	23,153	27,538	32,463	37,927	44,038	50,687	57,768	65,172	72,792	80,519	88,246	95,865	103,269	110,350
HVAC (Envelope)	3,125	6,463	9,966	13,613	17,397	21,270	25,201	29,148	33,062	36,871	40,529	44,042	47,369	50,522	53,492	56,282	58,886	61,319	63,583	65,774
HVAC (Equipment)	2,430	4,964	7,526	10,164	12,946	15,789	18,756	21,890	25,202	28,686	32,365	36,197	40,155	44,176	48,239	52,300	56,281	60,196	64,018	67,723
Lighting	34,315	68,374	95,707	119,217	140,435	159,516	180,507	199,598	18,431	27,984	37,590	47,256	56,949	66,702	76,445	86,182	95,984	105,776	115,515	125,522
Other	2,557	5,165	7,802	10,533	13,409	16,457	19,734	23,275	27,190	31,449	36,131	41,175	46,498	52,045	57,727	63,471	69,203	74,864	80,370	85,773
Water Heating	6,813	13,883	21,229	28,852	36,760	44,864	53,238	61,874	70,804	79,962	89,348	98,882	108,474	118,059	127,571	136,926	146,071	154,952	163,496	171,726
Total	***69,842***	***140,567***	***205,360***	***267,224***	***327,796***	***381,480***	***437,917***	***493,242***	***345,209***	***388,243***	***431,775***	***475,709***	***519,710***	***563,798***	***607,668***	***651,163***	***694,154***	***736,521***	***778,034***	***819,382***
% of 2031 VT Sales	*3.3%*	*6.8%*	*9.9%*	*12.8%*	*15.5%*	*18.0%*	*20.5%*	*23.0%*	*15.9%*	*17.8%*	*19.7%*	*21.5%*	*23.2%*	*25.0%*	*26.7%*	*28.3%*	*29.8%*	*31.5%*	*32.9%*	*34.4%*

Energy Savings (MWh) - EVT Territory																				
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Appliances	11,133	22,500	33,970	45,496	57,020	63,678	70,189	76,473	78,592	80,126	81,064	81,546	81,635	81,520	81,281	81,025	80,842	80,853	81,148	81,823
Appliances/WH	5,756	11,720	17,755	23,868	30,055	35,847	41,630	47,351	52,950	58,333	63,450	68,336	72,973	77,431	81,687	85,768	89,670	93,447	97,103	100,878
Consumer Electronics	2,740	5,531	8,424	11,472	14,726	18,236	22,053	26,231	30,922	36,127	41,948	48,282	55,027	62,080	69,338	76,700	84,061	91,319	98,372	105,117
HVAC (Envelope)	2,975	6,151	9,482	12,949	16,544	20,224	23,959	27,705	31,422	35,037	38,508	41,839	44,993	47,985	50,806	53,455	55,926	58,233	60,380	62,463
HVAC (Equipment)	2,301	4,690	7,106	9,594	12,223	14,910	17,713	20,674	23,801	27,089	30,558	34,167	37,893	41,674	45,494	49,308	53,037	56,700	60,277	63,758
Lighting	32,689	65,139	91,196	113,623	133,883	152,113	172,161	190,404	17,640	26,761	35,932	45,156	54,403	63,707	73,001	82,287	91,608	100,918	110,179	119,711
Other	2,469	4,987	7,530	10,161	12,936	15,871	19,028	22,438	26,204	30,300	34,802	39,649	44,763	50,089	55,543	61,058	66,556	71,985	77,266	82,455
Water Heating	6,529	13,307	20,346	27,655	35,239	43,002	51,030	59,309	67,873	76,656	85,664	94,816	104,024	113,233	122,366	131,354	140,136	148,663	156,879	164,788
Total	***66,592***	***134,024***	***195,810***	***254,819***	***312,625***	***363,880***	***417,763***	***470,585***	***329,403***	***370,430***	***411,926***	***453,790***	***495,711***	***537,719***	***579,516***	***620,955***	***661,836***	***702,120***	***741,604***	***780,993***
% of 2031 EVT Sales	*3.3%*	*6.7%*	*9.8%*	*12.7%*	*15.4%*	*17.9%*	*20.4%*	*22.8%*	*15.8%*	*17.7%*	*19.6%*	*21.4%*	*23.1%*	*24.9%*	*26.5%*	*28.2%*	*29.6%*	*31.2%*	*32.7%*	*34.1%*

Energy Savings (MWh) - BED Territory																				
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Appliances	527	1,064	1,605	2,148	2,689	2,968	3,242	3,504	3,604	3,678	3,728	3,761	3,776	3,784	3,785	3,787	3,802	3,825	3,860	3,904
Appliances/WH	308	629	955	1,289	1,624	1,946	2,268	2,592	2,912	3,227	3,531	3,827	4,112	4,387	4,650	4,904	5,168	5,424	5,671	5,909
Consumer Electronics	137	276	421	573	735	910	1,100	1,308	1,541	1,800	2,090	2,405	2,741	3,092	3,453	3,819	4,185	4,546	4,897	5,233
HVAC (Envelope)	150	312	484	664	853	1,047	1,242	1,443	1,640	1,833	2,021	2,203	2,377	2,537	2,686	2,828	2,960	3,086	3,204	3,311
HVAC (Equipment)	129	273	420	570	723	879	1,043	1,216	1,401	1,597	1,808	2,030	2,262	2,501	2,745	2,991	3,245	3,495	3,741	3,965
Lighting	1,627	3,235	4,510	5,594	6,553	7,403	8,346	9,193	791	1,222	1,658	2,100	2,546	2,995	3,444	3,894	4,376	4,857	5,336	5,811
Other	88	178	272	372	473	586	706	837	986	1,149	1,329	1,526	1,735	1,956	2,184	2,413	2,647	2,879	3,104	3,318
Water Heating	283	576	883	1,197	1,521	1,862	2,208	2,565	2,932	3,306	3,684	4,066	4,450	4,826	5,205	5,573	5,935	6,288	6,617	6,938
Total	***3,250***	***6,543***	***9,550***	***12,406***	***15,171***	***17,600***	***20,154***	***22,657***	***15,807***	***17,813***	***19,849***	***21,918***	***23,999***	***26,078***	***28,152***	***30,209***	***32,318***	***34,401***	***36,430***	***38,389***
% of 2031 BED Sales	*3.8%*	*7.7%*	*11.1%*	*14.3%*	*17.3%*	*20.1%*	*22.9%*	*25.5%*	*17.6%*	*19.8%*	*22.0%*	*24.2%*	*26.2%*	*28.5%*	*30.7%*	*32.8%*	*34.9%*	*37.0%*	*39.1%*	*41.0%*

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

Winter Peak Demand Savings (MW) - Vermont (Statewide)																				
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Appliances	1.4	2.8	4.2	5.7	7.1	7.9	8.7	9.5	9.8	10.0	10.1	10.2	10.2	10.2	10.1	10.1	10.1	10.1	10.1	10.2
Appliances/WH	1.1	2.2	3.4	4.6	5.8	6.9	8.0	9.1	10.2	11.3	12.3	13.3	14.3	15.2	16.0	16.9	17.7	18.5	19.2	20.0
Consumer Electronics	0.3	0.6	1.0	1.3	1.7	2.1	2.5	3.0	3.5	4.1	4.8	5.5	6.3	7.1	8.0	8.8	9.7	10.5	11.3	12.1
HVAC (Envelope)	0.4	0.7	1.1	1.5	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.7	5.1	5.4	5.6	5.9	6.2	6.4	6.6	6.8
HVAC (Equipment)	0.6	1.2	1.9	2.5	3.2	4.0	4.7	5.5	6.4	7.3	8.3	9.3	10.3	11.3	12.4	13.5	14.5	15.5	16.5	17.5
Lighting	10.7	21.5	30.3	38.0	45.2	51.9	59.4	66.3	9.5	13.9	18.3	22.7	27.1	31.6	36.1	40.6	45.1	49.6	54.1	58.7
Other	0.3	0.6	1.0	1.3	1.7	2.1	2.6	3.1	3.6	4.2	4.9	5.7	6.5	7.3	8.2	9.0	9.9	10.8	11.6	12.4
Water Heating	1.2	2.5	3.9	5.2	6.7	8.2	9.8	11.4	13.1	14.9	16.8	18.8	20.8	22.8	24.8	26.9	28.8	30.8	32.7	34.5
Total	***16.1***	***32.3***	***46.7***	***60.2***	***73.3***	***85.5***	***98.5***	***111.2***	***59.8***	***69.8***	***79.9***	***90.1***	***100.5***	***110.9***	***121.3***	***131.7***	***142.0***	***152.1***	***162.2***	***172.2***
% of 2031 VT Wtr Peak	*3.7%*	*7.7%*	*11.1%*	*14.3%*	*17.2%*	*20.1%*	*23.0%*	*25.8%*	*13.8%*	*16.1%*	*18.3%*	*20.5%*	*22.6%*	*24.8%*	*26.9%*	*28.9%*	*30.8%*	*32.9%*	*34.8%*	*36.7%*

Winter Peak Demand Savings (MW) - EVT Territory																				
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Appliances	1.3	2.7	4.0	5.4	6.8	7.6	8.4	9.1	9.4	9.5	9.7	9.7	9.7	9.7	9.7	9.6	9.6	9.6	9.7	9.7
Appliances/WH	1.0	2.1	3.2	4.3	5.4	6.5	7.6	8.6	9.7	10.7	11.6	12.6	13.5	14.3	15.1	15.9	16.7	17.4	18.1	18.8
Consumer Electronics	0.3	0.6	0.9	1.2	1.6	2.0	2.4	2.8	3.4	3.9	4.6	5.3	6.0	6.8	7.6	8.4	9.2	10.0	10.8	11.5
HVAC (Envelope)	0.3	0.7	1.1	1.5	1.9	2.3	2.7	3.1	3.5	3.8	4.2	4.5	4.8	5.1	5.4	5.6	5.9	6.1	6.3	6.5
HVAC (Equipment)	0.6	1.2	1.8	2.4	3.1	3.7	4.5	5.2	6.0	6.9	7.8	8.7	9.7	10.7	11.7	12.7	13.7	14.6	15.6	16.5
Lighting	10.2	20.5	28.9	36.3	43.1	49.5	56.7	63.3	9.1	13.3	17.5	21.7	25.9	30.2	34.5	38.8	43.1	47.3	51.6	56.0
Other	0.3	0.6	0.9	1.3	1.6	2.0	2.4	2.9	3.4	4.0	4.7	5.4	6.1	6.9	7.7	8.6	9.4	10.2	11.0	11.8
Water Heating	1.2	2.4	3.7	5.0	6.4	7.9	9.4	11.0	12.6	14.3	16.2	18.1	20.0	21.9	23.9	25.8	27.7	29.6	31.4	33.2
Total	***15.3***	***30.8***	***44.5***	***57.4***	***69.9***	***81.5***	***93.9***	***106.1***	***57.1***	***66.5***	***76.1***	***85.9***	***95.8***	***105.7***	***115.6***	***125.5***	***135.3***	***145.0***	***154.5***	***164.0***
% of 2031 EVT Wtr Peak	*3.7%*	*7.6%*	*11.0%*	*14.1%*	*17.1%*	*19.9%*	*22.8%*	*25.6%*	*13.7%*	*15.9%*	*18.1%*	*20.3%*	*22.4%*	*24.5%*	*26.6%*	*28.6%*	*30.5%*	*32.6%*	*34.5%*	*36.3%*

Winter Peak Demand Savings (MW) - BED Territory																				
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Appliances	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Appliances/WH	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2
Consumer Electronics	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6
HVAC (Envelope)	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
HVAC (Equipment)	0.0	0.1	0.1	0.1	0.2	0.2	0.3	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
Lighting	0.5	1.0	1.4	1.8	2.1	2.4	2.7	3.0	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.3	2.5	2.7
Other	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6
Water Heating	0.0	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.2	1.3
Total	***0.8***	***1.5***	***2.2***	***2.8***	***3.4***	***4.0***	***4.6***	***5.1***	***2.8***	***3.2***	***3.7***	***4.2***	***4.7***	***5.2***	***5.7***	***6.2***	***6.7***	***7.2***	***7.7***	***8.2***
% of 2031 BED Wtr Peak	*5.0%*	*9.9%*	*14.2%*	*18.1%*	*21.9%*	*25.0%*	*28.7%*	*32.1%*	*17.3%*	*19.9%*	*22.5%*	*25.2%*	*28.3%*	*30.9%*	*33.6%*	*36.2%*	*39.0%*	*41.7%*	*44.2%*	*46.7%*

Table 6-7: Cumulative Annual Residential Summer Peak Demand (MW) Savings by End Use for VT (Statewide), EVT Territory, and BED Territory

Summer Peak Demand Savings (MW) - Vermont (Statewide)

End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Appliances	1.4	2.9	4.4	5.9	7.4	8.3	9.1	9.9	10.2	10.4	10.5	10.6	10.6	10.6	10.6	10.5	10.5	10.5	10.6	10.6
Appliances/WH	0.8	1.7	2.5	3.4	4.3	5.1	5.9	6.8	7.6	8.4	9.2	9.9	10.6	11.3	11.9	12.5	13.1	13.7	14.3	14.9
Consumer Electronics	0.3	0.6	0.9	1.2	1.6	1.9	2.3	2.8	3.3	3.8	4.5	5.2	5.9	6.6	7.4	8.2	9.0	9.8	10.6	11.3
HVAC (Envelope)	0.8	1.7	2.6	3.6	4.5	5.6	6.6	7.7	8.8	9.9	11.0	12.0	13.0	14.0	14.9	15.7	16.6	17.3	18.0	18.8
HVAC (Equipment)	0.3	0.7	1.1	1.4	1.8	2.2	2.6	3.0	3.4	3.9	4.4	5.0	5.5	6.1	6.7	7.3	7.9	8.5	9.1	9.6
Lighting	2.9	5.7	8.1	10.1	12.0	13.8	15.7	17.5	1.8	2.8	3.9	5.0	6.1	7.1	8.2	9.3	10.4	11.4	12.5	13.6
Other	0.8	1.7	2.5	3.4	4.3	5.3	6.4	7.5	8.8	10.1	11.6	13.2	14.9	16.6	18.4	20.2	22.0	23.8	25.6	27.3
Water Heating	0.8	1.6	2.5	3.4	4.3	5.3	6.3	7.4	8.5	9.7	11.0	12.3	13.7	15.1	16.6	18.0	19.4	20.7	22.1	23.4
Total	***8.2***	***16.6***	***24.6***	***32.4***	***40.2***	***47.4***	***55.0***	***62.6***	***52.4***	***59.1***	***66.1***	***73.1***	***80.3***	***87.5***	***94.7***	***101.8***	***108.9***	***115.9***	***122.7***	***129.5***
% of 2031 VT Sum. Peak	*2.5%*	*5.0%*	*7.3%*	*9.4%*	*11.5%*	*13.4%*	*15.2%*	*17.1%*	*14.1%*	*15.7%*	*17.3%*	*18.8%*	*20.3%*	*21.8%*	*23.2%*	*24.6%*	*25.8%*	*27.3%*	*28.6%*	*30.0%*

Summer Peak Demand Savings (MW) - EVT Territory

End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Appliances	1.4	2.8	4.2	5.6	7.1	7.9	8.7	9.5	9.8	9.9	10.1	10.1	10.1	10.1	10.1	10.1	10.0	10.0	10.1	10.2
Appliances/WH	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	7.9	8.6	9.3	10.0	10.6	11.2	11.8	12.4	12.9	13.5	14.0
Consumer Electronics	0.3	0.6	0.8	1.2	1.5	1.8	2.2	2.7	3.1	3.7	4.3	4.9	5.6	6.3	7.1	7.8	8.6	9.3	10.1	10.8
HVAC (Envelope)	0.8	1.6	2.5	3.4	4.3	5.3	6.3	7.3	8.4	9.4	10.4	11.4	12.3	13.3	14.1	14.9	15.7	16.4	17.1	17.8
HVAC (Equipment)	0.3	0.7	1.0	1.3	1.6	2.0	2.4	2.8	3.2	3.6	4.1	4.6	5.1	5.6	6.2	6.7	7.3	7.8	8.3	8.8
Lighting	2.7	5.5	7.7	9.6	11.5	13.1	15.0	16.7	1.7	2.7	3.7	4.8	5.8	6.8	7.8	8.9	9.9	10.9	11.9	13.0
Other	0.8	1.6	2.5	3.3	4.2	5.2	6.2	7.3	8.5	9.8	11.2	12.7	14.4	16.0	17.8	19.5	21.2	23.0	24.6	26.3
Water Heating	0.8	1.6	2.4	3.2	4.1	5.1	6.1	7.1	8.2	9.4	10.6	11.9	13.2	14.6	16.0	17.3	18.7	20.0	21.3	22.5
Total	***7.8***	***15.9***	***23.4***	***30.9***	***38.4***	***45.2***	***52.4***	***59.7***	***50.0***	***56.4***	***63.0***	***69.7***	***76.5***	***83.4***	***90.3***	***97.1***	***103.8***	***110.4***	***116.9***	***123.3***
% of 2031 EVT Sum. Peak	*2.5%*	*5.0%*	*7.2%*	*9.4%*	*11.4%*	*13.3%*	*15.1%*	*17.0%*	*14.0%*	*15.6%*	*17.1%*	*18.7%*	*20.1%*	*21.6%*	*23.0%*	*24.4%*	*25.6%*	*27.0%*	*28.4%*	*29.7%*

Summer Peak Demand Savings (MW) - BED Territory

End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Appliances	0.1	0.1	0.2	0.3	0.3	0.4	0.4	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
Appliances/WH	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9
Consumer Electronics	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5
HVAC (Envelope)	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.0
HVAC (Equipment)	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.8
Lighting	0.1	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
Other	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0
Water Heating	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Total	***0.4***	***0.8***	***1.1***	***1.5***	***1.8***	***2.2***	***2.5***	***2.9***	***2.4***	***2.7***	***3.1***	***3.4***	***3.7***	***4.1***	***4.4***	***4.8***	***5.1***	***5.5***	***5.8***	***6.1***
% of 2031 BED Sum. Peak	*2.7%*	*5.5%*	*7.9%*	*10.3%*	*12.7%*	*14.9%*	*17.3%*	*19.5%*	*15.9%*	*17.9%*	*20.1%*	*22.2%*	*24.6%*	*26.3%*	*28.1%*	*30.0%*	*32.0%*	*33.8%*	*35.5%*	*37.1%*

6.4.3 Impacts of Fuel Switching in the Maximum Achievable Potential Scenario

A significant portion of the maximum achievable potential in the residential sector over the next 20 years is for conversion of residential electric water heating and/or space heating systems and electric dryers to alternative fuels. In total, approximately 16% of the residential maximum achievable potential (132,148 MWH) is a result of fuel conversion programs, where electric end-uses are converted to fossil fuels. The largest fraction of the fuel switching savings was a result of converting electric clothes dryers to fossil fuel alternatives (57,117 MWh). An additional 52,404 MWh and 22,627 MWh were estimated from water heating and space heating system fuel switching, respectively.

In the absence of fuel conversion programs, it would be possible to shift a significant portion of the savings currently attributed to fuel-switching into currently available competing technologies. For instance solar water heating or heat pump water heaters, which save 50%-60% compared to standard efficiency electric storage tank water heater, would be eligible to receive increased participation in lieu of fuel conversion. Similarly, heat pump dryers could increasingly contribute to the total maximum achievable potential in lieu of converting electric dryers to fossil fuel.

6.4.4 Maximum Achievable Potential Benefits & Costs

For the maximum achievable potential, the 80%-90% target market penetration assumes that consumers would receive a financial incentive equal to 100% of the measure cost. For the replace on burnout approach, the incentive was 100% of the incremental cost to bridge the gap between the cost of standard efficiency equipment and high efficiency equipment. For retrofit and early retirement measures, the incentive was equal to 100% of the full measure cost.

In addition, an overall non-incentive or administrative cost per first year kWh saved was assigned to each measure in order to calculate the achievable cost-effectiveness tests. Administrative costs in 2012 were determined based on the 2007-2009 average of non-incentive costs reported by EVT in their annual report filings.[52] In all subsequent years, the administrative cost per kWh was escalated by the annual rate of inflation (2.6%).

In 2012, a cost of ~ $0.82 per kWh was used for all new construction measures based on the three-year average non-incentive costs calculated for EVT's current Residential New Construction Program. Appliances, lighting, consumer electronics, and select easy-to-install retrofit measures were assigned an administrative cost of ~ $0.05 per kWh based on the three-year average non-incentive costs calculated for the current Residential Efficient Products Program. All other measures were assigned an administrative cost per kWh of ~$0.48 based on the Residential Existing Buildings Program.

The overall benefit/cost screening results for the residential sector maximum achievable potential are shown below in Table 6-8. The net present value costs to Vermont of roughly $628.5 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 2012 and 2031. The net present value benefits of $1.4 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,

[52] 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.

other O&M benefits, and the VT Societal Test externality benefits[53]. 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 benefit of over $802.5 million dollars (present worth 2012).

Table 6-6: NPV ($2012) Benefits and Costs Associated with the Maximum Achievable Potential Electric Savings in the Residential Sector

	Benefits				Costs			
	Electric	Non-Electric	Non-Energy	Total Benefits	Measure	Admin	Total Costs	B/C Ratio
		(in millions)				*in millions*		
State-wide								
NPV $2012	$1,093.1	$306.4	$31.5	$1,431.0	$477.4	$151.1	$628.5	2.3
EVT Territory								
NPV $2012	$1,042.5	$294.4	$30.1	$1,367.0	$456.7	$144.9	$601.6	2.3
BED Territory								
NPV $2012	$50.6	$12.0	$1.4	$63.9	$20.7	$6.2	$26.9	2.4

The annual incentive and administrative cost associated with the maximum achievable potential savings are presented in greater detail in Tables 6.7 – 6.9. In total, the $2012 NPV of incentives is $577.8 million from 2012-2031. Total incentive costs are greater than the NPV measure cost recorded in the VT societal test ($477.4 million) because incentives were calculated as 100% of the measure cost and do not include any future year cost adjustments for early retirement measures whereas the VT societal test has applied a 10% reduction to energy efficiency measure costs for all calculations and does include future year cost adjustments for measures being retired before the end of their useful life.

Administrative costs are $151.2 million and range annually from 18% - 25% 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. Additionally, administrative budgets are expected to increase at a more rapid pace in the 2nd decade as programs are expected to see new measures being installed on an annual basis as well as the reintroduction of measures installed during the 1st decade reach the end of their original useful life.

[53] See Section 5.9.5 for a discussion of the VT Societal Test externality benefits adder.

Table 6-7: Incentive and Administrative Costs Associated with the Residential Maximum Achievable Potential (VT Statewide)

Incentive Costs - VT Statewide																					
End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	NPV
Appliances	$8,301,844	$8,380,671	$8,376,219	$8,376,891	$8,372,041	$8,324,769	$8,280,006	$8,208,074	$8,108,276	$7,958,530	$7,789,753	$7,655,432	$7,516,754	$7,433,342	$7,343,301	$7,276,145	$7,356,916	$9,825,514	$9,856,500	$9,949,430	$85,117,517
Appliances/WH	$12,096,003	$12,271,814	$12,199,547	$12,137,534	$12,060,800	$11,866,605	$11,676,403	$11,413,281	$11,075,784	$10,610,265	$10,212,947	$9,800,736	$11,457,444	$11,210,119	$17,011,721	$16,878,367	$16,617,931	$16,409,390	$16,210,816	$16,274,578	$128,513,121
Consumer Electronics	$430,250	$437,847	$453,075	$475,963	$774,333	$885,785	$1,001,151	$1,073,812	$1,444,946	$1,561,033	$1,773,218	$1,916,175	$2,394,086	$2,548,877	$2,714,973	$2,939,127	$3,361,313	$3,499,352	$3,691,842	$3,799,517	$14,193,742
HVAC (Envelope)	$12,631,747	$13,364,920	$13,669,692	$14,043,836	$14,469,090	$14,647,035	$14,866,121	$14,917,762	$14,794,601	$14,328,594	$13,710,900	$13,151,048	$12,461,243	$11,908,484	$11,223,707	$11,509,732	$10,909,097	$10,402,225	$9,873,433	$10,216,612	$138,307,247
HVAC (Equipment)	$1,356,433	$1,392,010	$1,396,999	$1,431,315	$1,497,127	$1,555,804	$1,638,284	$1,735,417	$1,864,657	$1,976,432	$2,243,765	$2,364,650	$2,454,067	$2,731,935	$3,066,811	$3,093,903	$3,075,214	$3,058,236	$3,529,943	$3,537,913	$20,080,455
Lighting	$8,932,177	$8,842,409	$7,213,216	$6,550,651	$6,197,996	$5,710,875	$5,756,417	$7,811,919	$5,076,562	$5,045,142	$6,310,760	$6,324,073	$6,282,219	$6,264,483	$6,221,741	$6,163,160	$6,126,190	$6,059,426	$6,000,599	$6,169,061	$69,786,695
Other	$1,034,617	$1,103,516	$1,176,991	$1,721,561	$1,851,533	$2,010,129	$2,649,545	$2,882,081	$3,191,476	$3,965,471	$4,831,901	$5,265,502	$6,126,798	$6,576,376	$7,029,645	$7,902,207	$8,333,129	$8,748,402	$9,570,758	$9,940,476	$36,625,778
Water Heating	$6,380,224	$6,398,231	$6,479,693	$6,625,549	$6,841,789	$7,115,081	$7,546,014	$7,931,300	$8,483,231	$9,022,702	$10,231,990	$10,661,222	$11,056,959	$11,234,896	$11,253,060	$11,117,358	$10,863,207	$10,500,790	$10,172,773	$9,657,069	$85,169,544
Total	*$51,163,294*	*$52,191,418*	*$50,965,432*	*$51,363,300*	*$52,064,709*	*$52,116,083*	*$53,413,939*	*$55,973,647*	*$54,039,534*	*$54,468,169*	*$57,105,235*	*$57,138,838*	*$59,749,571*	*$59,908,513*	*$65,864,958*	*$66,879,999*	*$66,642,997*	*$68,503,335*	*$68,906,663*	*$69,544,656*	*$577,794,099*
Administrative Costs - VT Statewide																					
End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	NPV
Appliances	$1,004,064	$1,050,562	$1,045,789	$1,058,134	$1,081,437	$1,084,186	$1,103,431	$1,114,692	$1,115,900	$1,085,781	$1,051,202	$1,024,144	$998,311	$1,000,885	$986,777	$986,401	$1,012,882	$1,892,916	$1,951,834	$2,097,582	$11,569,550
Appliances/WH	$1,114,344	$1,170,003	$1,133,794	$1,134,209	$1,161,002	$1,155,791	$1,183,997	$1,204,254	$1,210,801	$1,168,917	$1,139,096	$1,105,445	$1,680,284	$1,717,294	$2,564,544	$2,601,173	$2,583,540	$2,603,949	$2,653,796	$2,968,171	$14,778,851
Consumer Electronics	$138,658	$144,914	$154,144	$166,575	$267,180	$315,607	$392,407	$431,282	$578,659	$642,046	$748,697	$825,399	$1,070,392	$1,166,996	$1,273,515	$1,412,566	$1,639,268	$1,750,069	$1,924,901	$2,029,244	$6,179,926
HVAC (Envelope)	$1,638,761	$1,788,939	$1,910,390	$2,030,210	$2,155,969	$2,255,014	$2,347,080	$2,415,320	$2,457,235	$2,447,860	$2,407,567	$2,356,605	$2,289,962	$2,228,908	$2,154,206	$2,310,903	$2,242,254	$2,181,887	$2,112,448	$2,152,822	$22,156,984
HVAC (Equipment)	$1,263,019	$1,348,733	$1,387,399	$1,456,183	$1,568,047	$1,661,190	$1,770,230	$1,906,770	$2,052,751	$2,195,129	$2,527,691	$2,667,532	$2,805,910	$2,919,836	$3,076,991	$3,151,532	$3,172,610	$3,207,390	$4,179,617	$4,253,453	$21,313,479
Lighting	$4,337,602	$4,489,214	$4,034,969	$3,834,757	$4,030,578	$3,900,793	$4,071,872	$7,393,540	$2,943,012	$2,925,744	$3,370,836	$3,387,041	$3,369,290	$3,432,276	$3,455,636	$3,497,087	$3,590,888	$3,701,929	$3,791,278	$4,314,525	$41,537,053
Other	$592,121	$627,125	$614,937	$649,997	$681,098	$700,235	$770,667	$819,870	$871,529	$928,016	$1,697,923	$1,778,615	$1,834,569	$1,912,023	$1,996,903	$2,104,057	$2,205,869	$2,328,436	$2,471,660	$2,710,311	$11,557,764
Water Heating	$1,462,770	$1,556,145	$1,647,651	$1,744,196	$1,843,162	$1,942,812	$2,068,746	$2,166,687	$2,260,891	$2,367,631	$2,630,887	$2,672,354	$2,740,564	$2,799,469	$2,821,699	$2,821,709	$2,820,823	$2,813,276	$2,853,191	$2,878,808	$22,054,888
Total	*$11,551,338*	*$12,175,636*	*$11,929,072*	*$12,074,261*	*$12,788,473*	*$13,015,628*	*$13,708,431*	*$17,452,415*	*$13,490,778*	*$13,761,124*	*$15,573,899*	*$15,817,135*	*$16,789,283*	*$17,177,687*	*$18,330,272*	*$18,885,427*	*$19,268,134*	*$20,479,853*	*$21,938,724*	*$23,404,916*	*$151,148,496*

Table 6-8: Incentive and Administrative Costs Associated with the Residential Maximum Achievable Potential (EVT Territory)

Incentive Costs - EVT Territory																					
End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	NPV
Appliances	$7,901,609	$7,977,497	$7,972,906	$7,973,684	$7,971,259	$7,927,419	$7,885,220	$7,816,693	$7,721,071	$7,577,665	$7,416,580	$7,287,607	$7,155,234	$7,075,297	$6,989,498	$6,925,141	$6,990,343	$9,345,076	$9,375,149	$9,468,690	$81,024,258
Appliances/WH	$11,550,286	$11,718,825	$11,645,948	$11,584,675	$11,514,328	$11,327,403	$11,145,360	$10,891,726	$10,566,854	$10,118,137	$9,735,364	$9,338,679	$10,947,085	$10,710,853	$16,233,469	$16,104,286	$15,826,487	$15,626,046	$15,439,293	$15,513,650	$122,630,697
Consumer Electronics	$409,036	$416,287	$430,817	$452,579	$736,243	$842,089	$951,982	$1,021,110	$1,373,995	$1,484,403	$1,685,970	$1,821,929	$2,276,547	$2,423,768	$2,581,722	$2,794,682	$3,196,115	$3,327,425	$3,510,647	$3,613,004	$13,496,288
HVAC (Envelope)	$12,128,394	$12,825,665	$13,100,467	$13,454,909	$13,860,645	$14,036,766	$14,244,132	$14,281,232	$14,164,003	$13,710,224	$13,121,117	$12,579,161	$11,912,234	$11,394,964	$10,746,152	$11,016,101	$10,404,310	$9,916,743	$9,413,805	$9,790,270	$132,467,138
HVAC (Equipment)	$1,268,878	$1,302,338	$1,305,631	$1,336,606	$1,399,313	$1,452,924	$1,528,115	$1,616,796	$1,733,965	$1,834,861	$2,082,478	$2,191,151	$2,271,642	$2,529,872	$2,829,456	$2,854,650	$2,827,114	$2,810,756	$3,256,264	$3,269,108	$18,655,242
Lighting	$8,520,435	$8,435,518	$6,884,375	$6,253,050	$5,919,355	$5,454,287	$5,496,400	$7,460,539	$4,845,961	$4,814,085	$6,023,827	$6,035,246	$5,993,433	$5,975,796	$5,935,231	$5,878,536	$5,832,437	$5,768,884	$5,712,520	$5,877,837	$66,590,314
Other	$992,551	$1,058,508	$1,127,148	$1,642,909	$1,768,213	$1,917,718	$2,524,790	$2,746,800	$3,040,010	$3,775,041	$4,608,961	$5,020,307	$5,837,216	$6,262,835	$6,694,259	$7,521,240	$7,929,401	$8,323,371	$9,102,512	$9,456,139	$34,906,139
Water Heating	$6,186,286	$6,199,178	$6,285,123	$6,426,900	$6,638,073	$6,891,756	$7,315,933	$7,691,445	$8,222,832	$8,748,288	$9,932,645	$10,344,574	$10,731,639	$10,910,434	$10,917,797	$10,785,444	$10,534,880	$10,184,001	$9,875,193	$9,370,240	$82,605,661
Total	*$48,957,475*	*$49,933,815*	*$48,752,414*	*$49,125,312*	*$49,807,429*	*$49,850,362*	*$51,091,932*	*$53,526,340*	*$51,668,691*	*$52,062,705*	*$54,606,941*	*$54,618,655*	*$57,125,030*	*$57,283,819*	*$62,927,583*	*$63,880,080*	*$63,541,087*	*$65,302,302*	*$65,685,382*	*$66,358,938*	*$552,375,739*
Administrative Costs - EVT Territory																					
End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	NPV
Appliances	$966,349	$1,011,707	$1,006,913	$1,019,407	$1,043,807	$1,047,419	$1,066,827	$1,077,753	$1,078,817	$1,049,611	$1,016,562	$990,318	$965,499	$968,016	$954,611	$954,111	$964,798	$1,816,690	$1,874,271	$2,019,528	$11,157,732
Appliances/WH	$1,078,681	$1,133,104	$1,098,596	$1,099,768	$1,128,788	$1,124,080	$1,153,190	$1,172,673	$1,179,803	$1,137,848	$1,109,431	$1,076,722	$1,641,901	$1,678,769	$2,490,738	$2,525,870	$2,486,942	$2,507,299	$2,559,169	$2,872,998	$14,344,355
Consumer Electronics	$132,053	$138,021	$146,830	$158,665	$254,484	$300,528	$373,769	$410,818	$551,204	$611,592	$713,048	$786,122	$1,019,606	$1,111,636	$1,213,118	$1,345,434	$1,561,384	$1,666,945	$1,833,595	$1,932,981	$5,886,402
HVAC (Envelope)	$1,564,986	$1,707,777	$1,821,556	$1,935,317	$2,053,624	$2,148,026	$2,236,173	$2,298,244	$2,339,150	$2,329,259	$2,289,641	$2,240,091	$2,175,607	$2,120,859	$2,050,619	$2,198,965	$2,132,952	$2,073,997	$2,007,709	$2,053,281	$21,102,487
HVAC (Equipment)	$1,198,978	$1,275,298	$1,311,742	$1,377,097	$1,485,721	$1,574,536	$1,677,149	$1,806,481	$1,942,897	$2,076,487	$2,390,767	$2,520,164	$2,649,089	$2,754,505	$2,899,845	$2,968,773	$2,976,006	$3,007,507	$3,926,515	$4,009,771	$20,135,473
Lighting	$4,199,116	$4,349,738	$3,916,019	$3,727,792	$3,929,306	$3,808,955	$3,977,822	$7,190,558	$2,847,030	$2,829,263	$3,262,138	$3,276,745	$3,258,710	$3,319,718	$3,343,784	$3,383,418	$3,439,535	$3,546,158	$3,631,202	$4,150,567	$40,275,955
Other	$582,636	$616,903	$603,819	$636,565	$668,661	$686,258	$753,841	$801,229	$850,322	$905,083	$1,661,678	$1,738,780	$1,789,369	$1,862,394	$1,945,749	$2,046,695	$2,138,456	$2,256,232	$2,392,527	$2,629,533	$11,282,276
Water Heating	$1,374,239	$1,463,287	$1,547,303	$1,640,742	$1,733,482	$1,824,259	$1,944,380	$2,035,031	$2,125,270	$2,224,916	$2,479,761	$2,519,968	$2,583,229	$2,643,563	$2,663,581	$2,666,679	$2,661,538	$2,653,095	$2,697,838	$2,722,605	$20,762,417
Total	*$11,097,037*	*$11,695,835*	*$11,452,778*	*$11,595,352*	*$12,297,873*	*$12,514,061*	*$13,183,151*	*$16,792,787*	*$12,914,493*	*$13,164,060*	*$14,923,026*	*$15,148,910*	*$16,083,010*	*$16,459,460*	*$17,562,044*	*$18,089,946*	*$18,361,612*	*$19,527,924*	*$20,922,825*	*$22,391,264*	*$144,947,096*

Table 6-9: Incentive and Administrative Costs Associated with the Residential Maximum Achievable Potential (BED Territory)

Incentive Costs - BED Territory																					
End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	NPV
Appliances	$400,235	$403,174	$403,313	$403,207	$400,782	$397,350	$394,786	$391,381	$387,205	$380,865	$373,173	$367,825	$361,520	$358,045	$353,803	$351,004	$366,573	$480,438	$481,351	$480,740	$4,093,258
Appliances/WH	$545,717	$552,990	$553,599	$552,859	$546,472	$539,202	$531,043	$521,555	$508,930	$492,128	$477,583	$462,057	$510,359	$499,266	$778,252	$774,081	$791,444	$783,344	$771,523	$760,928	$5,882,424
Consumer Electronics	$21,214	$21,560	$22,258	$23,384	$38,090	$43,696	$49,169	$52,702	$70,951	$76,630	$87,248	$94,246	$117,539	$125,109	$133,251	$144,445	$165,198	$171,927	$181,195	$186,513	$697,454
HVAC (Envelope)	$503,353	$539,255	$569,225	$588,927	$608,445	$610,270	$621,989	$636,530	$630,598	$618,370	$589,784	$571,886	$549,009	$513,520	$477,555	$493,631	$504,786	$485,483	$459,627	$426,342	$5,840,109
HVAC (Equipment)	$87,555	$89,673	$91,368	$94,709	$97,815	$102,880	$110,169	$118,622	$130,693	$141,571	$161,288	$173,499	$182,425	$202,064	$237,355	$239,254	$248,100	$247,480	$273,679	$268,805	$1,425,213
Lighting	$411,742	$406,891	$328,841	$297,601	$278,640	$256,589	$260,016	$351,381	$230,601	$231,057	$286,933	$288,827	$288,787	$288,687	$286,509	$284,624	$293,753	$290,542	$288,079	$291,224	$3,196,380
Other	$42,066	$45,008	$49,843	$78,652	$83,320	$92,411	$124,755	$135,281	$151,466	$190,430	$222,940	$245,195	$289,582	$313,541	$335,386	$380,967	$403,728	$425,031	$468,246	$484,337	$1,719,639
Water Heating	$193,938	$199,053	$194,571	$198,650	$203,717	$223,324	$230,081	$239,855	$260,399	$274,413	$299,345	$316,648	$325,320	$324,462	$335,263	$331,914	$328,327	$316,789	$297,580	$286,829	$2,563,884
Total	*$2,205,819*	*$2,257,604*	*$2,213,017*	*$2,237,988*	*$2,257,280*	*$2,265,721*	*$2,322,008*	*$2,447,306*	*$2,370,843*	*$2,405,465*	*$2,498,293*	*$2,520,182*	*$2,624,540*	*$2,624,694*	*$2,937,375*	*$2,999,920*	*$3,101,910*	*$3,201,033*	*$3,221,281*	*$3,185,718*	*$25,418,360*
Administrative Costs - BED Territory																					
End-Use	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	NPV
Appliances	$37,715	$38,854	$38,875	$38,727	$37,630	$36,767	$36,604	$36,939	$37,083	$36,170	$34,640	$33,826	$32,812	$32,869	$32,166	$32,290	$48,084	$76,226	$77,563	$78,054	$411,818
Appliances/WH	$35,663	$36,899	$35,198	$34,441	$32,214	$31,711	$30,807	$31,581	$30,998	$31,068	$29,665	$28,724	$38,383	$38,525	$73,806	$75,303	$76,597	$96,650	$94,627	$95,173	$434,497
Consumer Electronics	$6,604	$6,894	$7,314	$7,910	$12,696	$15,079	$18,639	$20,465	$27,454	$30,454	$35,650	$39,277	$50,786	$55,360	$60,398	$67,131	$77,884	$83,124	$91,306	$96,263	$293,525
HVAC (Envelope)	$73,775	$81,162	$88,834	$94,893	$102,345	$106,987	$110,907	$117,076	$118,086	$118,601	$117,926	$116,514	$114,356	$108,048	$103,588	$111,938	$109,302	$107,890	$104,739	$99,541	$1,054,497
HVAC (Equipment)	$64,040	$73,435	$75,657	$79,087	$82,326	$86,654	$93,081	$100,289	$109,854	$118,642	$136,924	$147,368	$156,820	$165,332	$177,146	$182,760	$196,604	$199,883	$253,102	$243,682	$1,178,006
Lighting	$138,486	$139,476	$118,950	$106,965	$101,272	$91,838	$94,050	$202,982	$95,982	$96,481	$108,697	$110,296	$110,580	$112,558	$111,852	$113,668	$151,353	$155,771	$160,076	$163,958	$1,261,098
Other	$9,485	$10,222	$11,119	$13,432	$12,437	$13,977	$16,826	$18,641	$21,207	$22,932	$36,245	$39,835	$45,200	$49,629	$51,154	$57,362	$67,413	$72,204	$79,132	$80,779	$275,488
Water Heating	$88,531	$92,858	$100,348	$103,454	$109,679	$118,553	$124,366	$131,656	$135,620	$142,715	$151,125	$152,385	$157,335	$155,906	$158,118	$155,030	$159,285	$160,181	$155,354	$156,202	$1,292,471
Total	*$454,301*	*$479,801*	*$476,294*	*$478,908*	*$490,600*	*$501,567*	*$525,280*	*$659,628*	*$576,285*	*$597,064*	*$650,873*	*$668,225*	*$706,273*	*$718,227*	*$768,228*	*$795,482*	*$906,522*	*$951,929*	*$1,015,899*	*$1,013,652*	*$6,201,400*

7 Commercial and Industrial Energy Efficiency Potential Estimates (2012 to 2031)

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 7-1 and Table 7-2 below summarize the technical, economic, and maximum achievable savings potential (as a % of forecast sales) for the Vermont service area by 2031. 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 616,291 MWh (approximately 19% of projected commercial and industrial sales in 2031). Energy efficiency measures and programs can also serve to lessen summer and winter peak demand.

Figure 7-1: 2031 Summary of C&I Energy Efficiency Potential

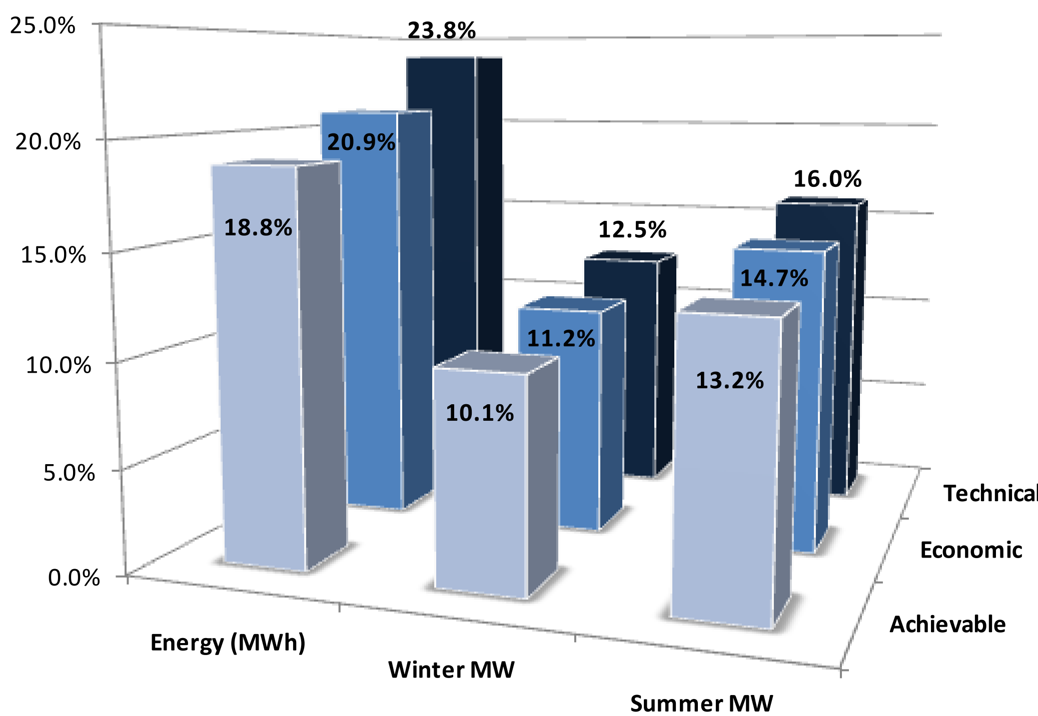


Table 6-1 also presents the separate technical, economic, and maximum achievable estimates for the EVT and BED service territories. In general the BED territory had slightly higher percentage estimates of technical, economic, and achievable potential. Of the combined 616,291 MWh of achievable potential energy savings, the BED territory achievable electric energy savings was 59,029 MWh (19.0% of 2031 BED sales). The EVT territory was estimated to have a maximum achievable potential of 557,262 MWh (18.8% of 2031 EVT territory sales).

Table 7-1: 2031 Summary of C&I Energy and Demand Savings Potential

	Energy		Demand			
	Energy (MWh)	% of 2031 Sales	Winter MW	% of 2031 Winter Peak	Summer MW	% of 2031 Summer Peak
State-wide						
Technical Potential	779,700	23.8%	62.9	12.5%	105.1	16.0%
Economic Potential	684,768	20.9%	56.6	11.2%	96.4	14.7%
Achievable Potential	616,291	18.8%	51.0	10.1%	86.8	13.2%
EVT Territory						
Technical Potential	704,688	23.8%	57.1	12.3%	95.2	16.0%
Economic Potential	619,180	20.9%	51.4	11.1%	87.4	14.7%
Achievable Potential	557,262	18.8%	46.3	10.0%	78.6	13.2%
BED Territory						
Technical Potential	75,013	24.2%	5.8	14.6%	9.9	16.3%
Economic Potential	65,588	21.2%	5.2	13.0%	9.1	14.8%
Achievable Potential	59,029	19.0%	4.7	11.7%	8.2	13.4%

7.1 Energy Efficiency Measures Examined

Close to one hundred fifty (150) commercial and industrial electric energy efficiency measures were included in the energy savings analysis for the C&I sector. Below, Table 7-2 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 was based mainly on what was found in the Vermont TRM and what is found in other studies and field experience.

Appendix 3 provides a brief discussion of each measure or program as well as the savings, useful life, cost assumptions, and VT SCT benefit-cost ratios at the "measure" level.

Table 7-2: 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) * HVAC Tune-Up * Insulation (Wall, Ceiling, etc) * EMS/Controls
Space Cooling	* Heat Pumps (Ground Source, Water Source, High Efficiency) * HVAC Tune-Up * Economizers * High-Efficiency AC and Chillers * Absorption Cooling * Demand Controlled Ventilation
Ventilation	* Ventilation Motors and Variable Frequency Drives (VFDs) * Stove Hood * Energy Recovery System * Demand Controlled Ventilation
Water Heating	* Heat Pump Water Heater * Fuel Switching * Low Flow Showerhead/Faucet Aerator * High Efficiency Clothes Washers * High Efficiency Tank and Booster Water Heaters
Lighting	* LED Lighting Systems (Indoor and Outdoor) * Lighting Controls * LED Exit Signs * Refrigerated Case Lighting

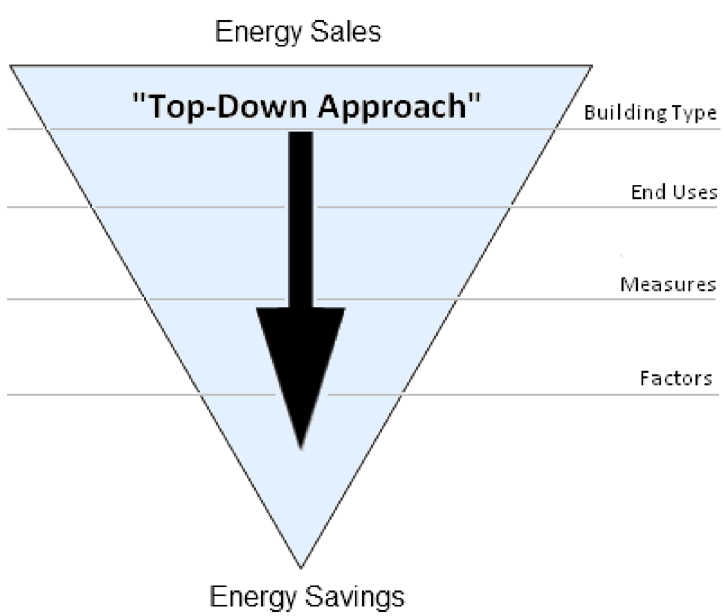
	* High Efficiency T8 and T5 Systems
Cooking	* High Efficiency Cooking Equipment
Refrigeration	* Vending Machines/Vending Misers * Reach-In Freezers * Covers for Display Cases * Evaporator Fan Controls
Office Equipment/Computers	*Smart Power Strips * Power Supplies * LCD Monitors
Process	* Industrial Process * Water/Wastewater Treatment Options
Other	* Efficient Televisions * Energy Star Dehumidifiers * Air Compressors

7.2 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 DPS, 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 7-2, the top-down potential estimate begins with a disaggregated energy sales forecast over the 2012-2031 time period, and then estimates what percentage of these sales a given efficiency measure will save.

Figure 7-2: Commercial/Industrial Sector Methodology – Top-Down Approach



As in comparable studies, the choice of building segments is driven by the need to facilitate the analysis and modeling of potential electrical efficiency improvements. Therefore, buildings designated into selected building segments need to be reasonably similar in terms of major design and operating considerations such as building size, mechanical and electrical systems, annual operating hours, etc. In this study, the sales data are broken down by building type and end-use (see Tables 7.3 and 7.4 below) before the savings percent factor is applied. The breakdown of energy use by building type was informed by data provided by Efficiency Vermont as well as the 2009 Vermont Commercial Market Characterization Study. New construction sales are based on forecasted load growth in the commercial sector from 2012 to 2031.

Table 7-3: 2031 Sales by Industry Type

	Industry Type	MWh Sales	% of MWh Sales
1	Office	491,052	15.0%
2	Retail	529,693	16.2%
3	Other	946,040	28.9%
4	New Construction	294,003	9.0%
5	Industrial	974,692	29.8%
6	Street Lighting	38,252	1.2%
	Total	**3,273,732**	**100.0%**

The next step in a top-down approach is to gather data on end-use consumption for each C&I building segment. Within each building type, sales were allocated to end uses based on data available from the EIA's 2003 Commercial Building Energy Consumption Survey and 2006 Manufacturing Energy Consumption Survey. Information is given by region; therefore the data that is used in this analysis includes Vermont and surrounding states. To adjust for Vermont-specific characteristics, commercial end use shares were then adjusted to match Vermont forecasted sales for heating, cooling, and other end uses. Below, Table 7-4 shows the percent breakdown of end-use by building segment.

Table 7-4: 2031 Sales by End-Use

	End-Use	MWh Sales	% of MWh Sales
1	Space Heating	47,557	1.5%
2	Space Cooling	223,124	6.8%
3	Ventilation	285,876	8.7%
4	Water Heating	33,667	1.0%
5	Lighting	1,111,165	33.9%
6	Cooking	12,735	0.4%
7	Refrigeration	295,053	9.0%
8	Office Equipment	58,123	1.8%
9	Computers	138,786	4.2%
10	Process	735,365	22.5%
11	Other	332,280	10.1%
	Total	**3,273,732**	**100.0%**

The end-uses were then broken down into measure categories, explained in section 7.3. After measures were examined and saturation data was gathered, the technical, economic and achievable cases were calculated using the formula below:

$$\text{Achievable Potential of C\&I Sector} = \text{Total End-Use MWh (by segment)} * \text{Base Case Factor} * \text{Remaining Factor} * \text{Convertible Factor} * \text{Savings Factor}$$

Where:

- **Total End-Use MWh** (by market segment) is the total annual electric energy used by electric end-use in each market segment. This is the end-use electricity consumption that the efficient technology replaces or affects. For example, if the efficient measure is a CFL, the total end-use MWh is all electricity used for lighting in the specific market segment.

- **Base Case factor** is the fraction of the end-use energy that is applicable for the efficient technology in a given market segment. For example, for a high-efficiency lighting technology, this would be the fraction of the energy use that is for fluorescent lighting.

- **Remaining factor** is the fraction of applicable dwelling units or floor space that has not yet been converted to the efficient measure; (*i.e.* one minus the fraction of households or floor space that already has the energy-efficiency measure installed).

- **Convertible factor** is the fraction of the applicable dwelling units (or floor space) that is technically feasible for conversion to the efficient technology from an *engineering* perspective (e.g., it may not be possible to apply water pipe insulation in all buildings due to access difficulties).

- **Savings factor** is the percentage reduction in end-use energy consumption resulting from application of the efficient technology.

In this analysis, it was assumed that for those measures designed to impact the same end-use, the measure or program with the highest current market penetration would typically be installed first, followed by the measure(s) with the next highest market penetration. Presumably, the measures with the highest market penetrations are perceived as the most attractive based on costs, savings, or ease of implementation. Ranking the installation order in this manner also mimics the pattern of installation that is already occurring in the current market.

In instances where there were two (or more) competing technologies for the same electric end use, such as heat pump water heaters and high efficiency electric storage water heaters, a percent of the available population was assigned to each measure using the applicability factor.

Fuel-switching was analyzed in this analysis for electric water heating and dryers. These measures consist of replacement electric water and/or drying equipment in favor of natural gas, oil, or propane units. Fuel switching was treated as a competing measure to other electric efficiency options. As a result, only a fraction of the total eligible facilities were included in the fuel switch options.

The majority of measures were analyzed under both the replace-on-burnout and early retirement option. In the technical potential, 50% of the eligible remaining market was reserved for early retirement and the remaining 50% of the eligible market was analyzed through the replace-on-burnout approach. If both measures proved to be cost effective, the 50/50 split remained through the economic and achievable potential scenarios. The assumption of a 50/50 split remained through the achievable potential to allow for overall linear participation, budgets, and savings in lieu of alternate periods of program growth and contraction.

7.3 TECHNICAL AND ECONOMIC POTENTIAL SAVINGS

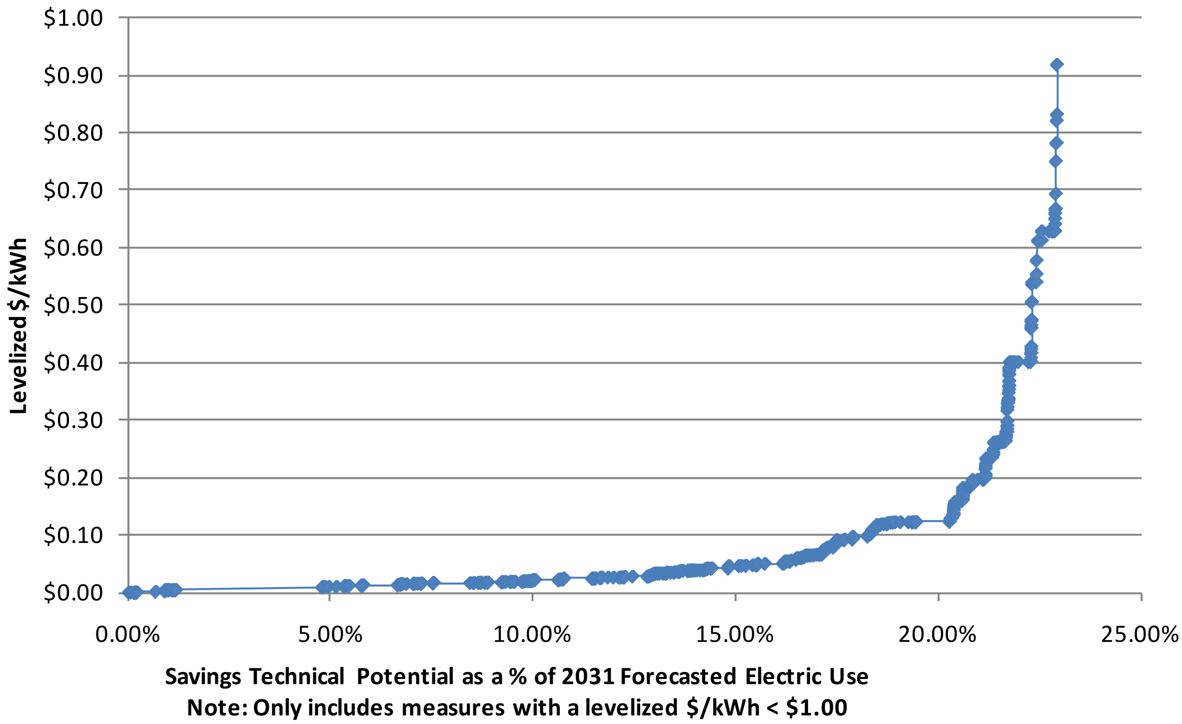
The technical potential represents the savings that could be captured if 100 percent of inefficient electric equipment were replaced instantaneously (where they are deemed to be technically feasible). As shown below in Table 7-5 the total technical potential savings for the Vermont commercial and industrial sector are 779,700 MWh, or 23.8% of forecast C&I MWh sales in 2031. The greatest share of energy savings technical potential is expected from lighting measures providing 44.4% of the technical potential savings. Industrial process measures are expected to constitute about 15.5% of the technical potential, while space cooling, refrigeration, and ventilation contribute around 10% each. The technical potential for winter peak demand savings is 63 MW, or 12.7% of 2031 forecast winter peak demand. The potential for summer peak savings is approximately 105 MW (16% of the 2031 summer peak demand forecast).

Table 7-5: Technical Energy and Demand Potential and Percentage Share of C&I Forecast Energy Sales and Peak Demand Savings in 2031

	Energy (MWh)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Lighting	346,315	40.3	22.5
Process	121,027	25.8	25.8
Ventilation	85,783	9.1	5.1
Refrigeration	77,277	4.2	4.2
Space Cooling	62,792	22.1	0.1
Computers	33,730	1.5	1.9
Other	20,305	1.6	1.4
Space Heating	15,190	0.0	1.2
Water Heating	8,362	0.3	0.4
Office Equipment	8,292	0.2	0.2
Cooking	628	0.1	0.1
TOTAL	**779,700**	**105**	**63**
% of 2031 Commercial/Industrial Sales	*23.8%*	*16.0%*	*12.5%*

Below, Figure 7-3 presents the electric energy efficiency technical potential results for the C&I sector in the form of a supply curve. The supply curve demonstrates the technical potential savings (as a % of 2031 forecast kWh sales) at varied levelized costs per lifetime kWh saved amounts. For example, more than 18% of savings can be achieved at a cost per lifetime kWh saved of $0.10 or less. To obtain increased electric energy from efficiency resources, it is necessary to move to the right on the curve and choose progressively more costly resources. It should be noted that the levelized costs are based on electric savings and do not factor in associated non-electric benefits, nor do they include program administrative costs.

Figure 7-3: Commercial/Industrial Electric Efficiency Supply Curve



The economic potential calculations were made by incorporating the various measure assumptions (savings, cost, and useful life, etc) into the cost-effectiveness screening tool.[54] Any programmatic costs (e.g., marketing, analysis, and administration) were ignored in the economic potential analysis in order to screen whether energy efficient technologies were cost-effective on their own merit prior to any assistance or marketing endeavors from utilities or other organizations.

For the economic potential scenario, the study assumed 100% of all cost-effective measures eligible for installation were installed. Cost-effectiveness was determined as all measures with a VT SCT benefit-cost ratio greater than or equal 1.0. As seen in Table 7-6 below, the economic potential, based on the result of the individual measure VT SCT tests is 684,767 MWh, or 20.9% of forecast commercial and industrial MWh sales in 2031. Economic summer peak demand savings is 96 MW, or 14.7% of forecast commercial and industrial peak demand.

[54] The cost-effectiveness of a measure is based on each measure's full savings potential, before any adjustments for interactive impacts. After identifying which measures passed screening, we made an additional adjustment for interactive effects in order to finalize estimates of overall economic potential.

Table 7-6: Economic Energy and Demand Potential and Percentage Share of C&I Forecast Energy Sales and Peak Demand in 2031

	Energy (MWh)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Lighting	332,361	38.5	21.2
Process	121,027	25.8	25.8
Refrigeration	67,184	3.5	3.6
Space Cooling	55,875	19.6	0.1
Ventilation	38,860	6.2	1.9
Computers	24,410	1.2	1.3
Other	15,420	1.2	1.0
Space Heating	14,129	0.0	1.1
Water Heating	7,781	0.3	0.4
Office Equipment	7,094	0.1	0.1
Cooking	628	0.1	0.1
TOTAL	**684,767**	**96**	**57**
% of 2031 Commercial/Industrial Sales	*20.9%*	*14.7%*	*11.2%*

7.4 MAXIMUM ACHIEVABLE POTENTIAL SAVINGS

The maximum achievable potential is a subset of the economic potential and is limited by various market and adoption barriers, including the assumed 50/50 split of replace-on-burnout and early retirement measures.

7.4.1 ESTIMATING ACHIEVABLE SAVINGS IN THE COMMERCIAL & INDUSTRIAL SECTOR

In the base case scenario, the commercial and industrial achievable potential represents the attainable savings if the market penetration of high efficiency electric equipment reaches 90% of the remaining eligible market between 2012 and 2031. The methodology for estimating energy efficiency measure adoption in the commercial and industrial sector each year from 2012 through 2031 is based on measure-specific ramping assumptions in each year. Because of the "top-down" methodology, the number of customers is difficult to determine. With new technologies, there is often low awareness of the technology among consumers and there may be a hesitancy to purchase the technology because of its newness. A program could then be designed to not only provide incentives, but to increase awareness and promote the technology's reliability. In contrast, a mature technology may already have high willingness and awareness values and, thus, the adoption curve would follow a flatter trend over time.

7.4.2 COMMERCIAL AND INDUSTRIAL MAXIMUM ACHIEVABLE SAVINGS POTENTIAL

The maximum achievable potential is a subset of the economic potential and is limited by two main factors:

1) The achievable potential for this study represents the attainable savings if the market penetration of high efficiency electric equipment reaches 90% of the remaining market by the year 2031 (where measures are deemed to be technically feasible).

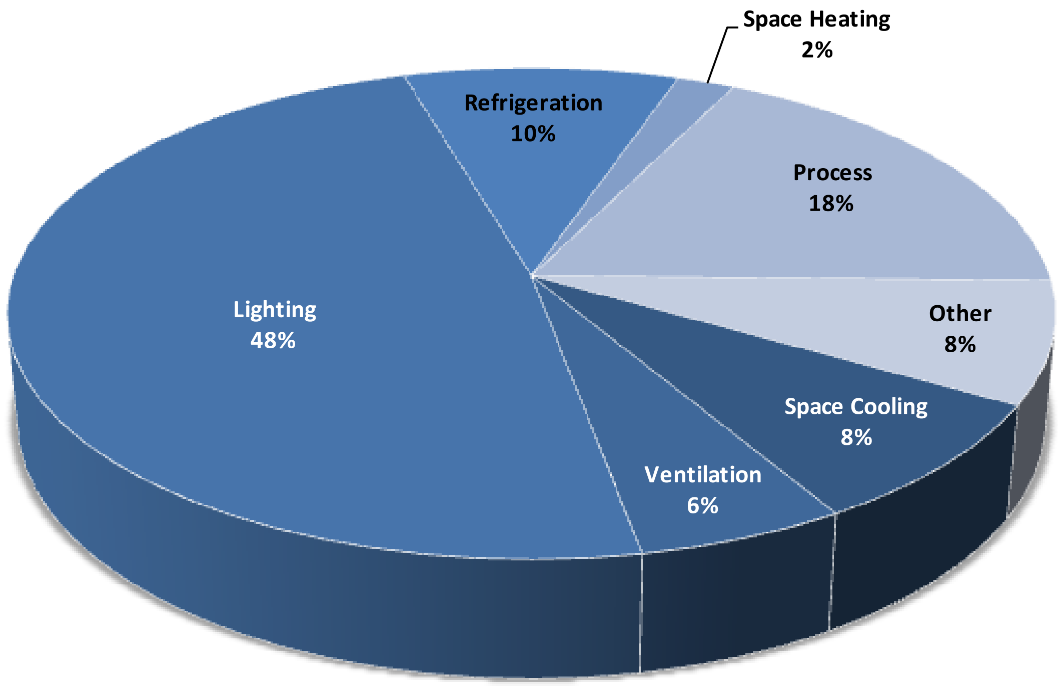
2) The 20 year program time period occasionally impacted the overall cost-effectiveness of a measure. Marginally cost-effective measures that were retained in the technical and economic potential screens (both of which assume immediate implementation) were excluded if the impacts of the discount rate, avoided costs forecast, and retail rate forecasts over the 20 year time period impacted a measure's cost-effectiveness in such a way that the 20 year costs were higher than the lifetime benefits under the VT SCT.

Table 7-7: Maximum Achievable Energy and Demand Potential and Percentage Share of Commercial and Industrial Forecast Energy Sales and Peak Demand in 2031

	Energy (MWh)	Summer Peak Demand (MW)	Winter Peak Demand (MW)
Lighting	299,124	34.7	19.1
Process	108,924	23.2	23.3
Refrigeration	60,465	3.1	3.2
Space Cooling	50,288	17.6	0.0
Ventilation	34,974	5.6	1.7
Computers	21,969	1.1	1.2
Other	13,878	1.0	0.9
Space Heating	12,716	0.0	1.0
Water Heating	7,003	0.3	0.3
Office Equipment	6,385	0.1	0.1
Cooking	565	0.1	0.1
TOTAL	**616,291**	**87**	**51**
% of 2031 Commercial/Industrial Sales	*18.8%*	*13.2%*	*10.1%*

For the maximum achievable scenario the achievable potential savings are 616,291 MWh or 18.8% of projected 2031 kWh sales. The base case scenario also achieves 87 MW summer peak demand savings, or 13.2% of the 2031 small and large commercial and industrial summer peak demand forecast. Figure 7-4 provides a breakdown of the electric end-use savings as a percent of the total maximum achievable energy savings potential. About 48% 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 7-4: Sector End-use Savings as a % of Total Achievable Potential – 2031



* "Other" category includes: Water Heating, Cooking, Office Equipment/Computers

Table 7-8 through Table 7-10 depict the cumulative annual energy and demand savings for the commercial/industrial sector. In addition to the statewide maximum achievable potential, the maximum achievable potential for the EVT and BED service territories are also included.

Table 7-8: Cumulative Annual C&I (MWh) Savings Potential for VT (Statewide), EVT Territory, and BED Territory

	Energy Savings (MWh)																			
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
EVT Territory	68,801	140,894	216,449	284,780	343,360	393,662	436,940	474,258	506,539	520,833	524,336	527,905	531,528	535,191	538,881	542,584	546,286	549,976	553,639	557,262
BED Territory	7,262	14,870	22,843	30,056	36,241	41,555	46,129	50,075	53,492	55,014	55,400	55,794	56,193	56,597	57,003	57,411	57,819	58,226	58,630	59,029
Total	***76,063***	***155,764***	***239,292***	***314,836***	***379,601***	***435,217***	***483,068***	***524,334***	***560,031***	***575,847***	***579,736***	***583,699***	***587,721***	***591,788***	***595,884***	***599,995***	***604,106***	***608,202***	***612,268***	***616,291***
% of 2031 VT Sales	*2.6%*	*5.3%*	*8.0%*	*10.5%*	*12.6%*	*14.3%*	*15.8%*	*17.1%*	*18.1%*	*18.6%*	*18.6%*	*18.6%*	*18.7%*	*18.7%*	*18.7%*	*18.7%*	*18.7%*	*18.8%*	*18.8%*	*18.8%*

Table 7-9: 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	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
EVT Territory	5.9	12.1	18.7	24.5	29.6	33.9	37.5	40.7	43.4	44.5	44.7	44.9	45.1	45.2	45.4	45.6	45.8	45.9	46.1	46.3
BED Territory	0.6	1.2	1.9	2.5	3.0	3.4	3.8	4.1	4.4	4.5	4.5	4.5	4.5	4.5	4.6	4.6	4.6	4.6	4.6	4.7
Total	***6.5***	***13.4***	***20.5***	***27.0***	***32.5***	***37.3***	***41.3***	***44.8***	***47.8***	***49.0***	***49.2***	***49.4***	***49.6***	***49.8***	***50.0***	***50.2***	***50.4***	***50.6***	***50.8***	***51.0***
% of 2031 VT Sales	*1.5%*	*3.0%*	*4.5%*	*5.9%*	*7.1%*	*8.1%*	*8.9%*	*9.6%*	*10.1%*	*10.4%*	*10.3%*	*10.3%*	*10.3%*	*10.3%*	*10.2%*	*10.2%*	*10.2%*	*10.2%*	*10.2%*	*10.1%*

Table 7-10: 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	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
EVT Territory	9.5	19.5	29.9	39.3	47.4	54.4	60.4	65.6	70.2	72.2	72.8	73.5	74.1	74.7	75.4	76.0	76.7	77.4	78.0	78.6
BED Territory	1.0	2.0	3.1	4.1	4.9	5.6	6.2	6.8	7.2	7.5	7.5	7.6	7.7	7.7	7.8	7.9	7.9	8.0	8.1	8.2
Total	***10.5***	***21.5***	***33.0***	***43.4***	***52.3***	***60.0***	***66.7***	***72.4***	***77.4***	***79.7***	***80.4***	***81.0***	***81.7***	***82.5***	***83.2***	***83.9***	***84.7***	***85.4***	***86.1***	***86.8***
% of 2031 VT Sales	*1.8%*	*3.7%*	*5.7%*	*7.4%*	*8.9%*	*10.1%*	*11.2%*	*12.0%*	*12.8%*	*13.1%*	*13.1%*	*13.1%*	*13.1%*	*13.2%*	*13.2%*	*13.2%*	*13.2%*	*13.2%*	*13.2%*	*13.2%*

7.4.3 MAXIMUM ACHIEVABLE POTENTIAL BENEFITS & COSTS

For the maximum achievable potential, the 80%-90% target market penetration assumes that consumers would receive a financial incentive equal to 100% of the measure cost. For the replace on burnout approach, the incentive was 100% of the incremental cost to bridge the gap between the cost of standard efficiency equipment and high efficiency equipment. For retrofit and early retirement measures, the incentive was equal to 100% of the full measure cost.

In addition, an overall non-incentive or administrative cost per first year kWh saved was assigned to each measure in order to calculate the achievable cost-effectiveness tests. Administrative costs in 2012 were determined based on the 2007-2009 average of non-incentive costs reported by EVT in their annual report filings.[55] In all subsequent years, the administrative cost per kWh was escalated by the annual rate of inflation (2.6%).

In 2012, a cost of ~ $0.15 per kWh was used for all new construction measures based on the three-year average non-incentive costs calculated for EVT's current Business New Construction Program. All other measures were assigned an administrative cost per kWh of ~$0.21 based on the Business Existing Buildings Program.

The overall benefit/cost screening results for the commercial and industrial sector maximum achievable potential are shown below in Table 7-11. The net present value costs of roughly $313.9 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 2012 and 2031. The net present value benefits of $973 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 reduced 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 over $659.1 million dollars (present worth 2012).

Table 7-11: Overall Commercial and Industrial Sector Cost Effectiveness Screening Results
(dollars in millions)

	Benefits				Costs			
	Electric	Non-Electric	Non-Energy	Total Benefits	Measure	Admin	Total Costs	
	(in millions)				*(in millions)*			B/C Ratio
State-wide								
NPV $2012	$958.0	$1.2	$13.9	$973.0	$160.5	$153.5	$313.9	3.1
EVT Territory								
NPV $2012	$867.2	$1.1	$12.5	$880.8	$144.7	$138.8	$283.5	3.1
BED Territory								
NPV $2012	$90.7	$0.1	$1.4	$92.2	$15.8	$14.7	$30.5	3.0

The annual incentive and administrative cost associated with the maximum achievable potential savings are presented in greater detail in Table 7-12. In total, the $2012 NPV of incentives is $185.2 million

[55] 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.

from 2012-2031. Total incentive costs are greater than the NPV measure cost recorded in the VT societal test ($160.5 million) because incentives were calculated as 100% of the measure cost whereas the VT societal test has applied a 10% reduction to energy efficiency measure costs for all calculations.

Administrative costs are $153.5 million. 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. Additionally, administrative budgets are expected to increase at a more rapid pace in the 2nd decade as programs are expected to see new measures being installed on an annual basis as well as the reintroduction of measures installed during the 1st decade reach the end of their original useful life.

Table 7-12: Incentive and Administrative Costs Associated with the Commercial and Industrial Maximum Achievable Potential

Incentive Costs - VT Statewide																					
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**NPV**
EVT Territory	$20,977,547	$21,974,159	$23,024,504	$20,867,722	$18,314,658	$16,394,317	$14,414,948	$12,768,255	$11,601,810	$6,368,422	$6,198,871	$6,717,701	$10,216,217	$10,179,903	$11,572,655	$19,289,220	$19,269,857	$18,646,219	$17,484,638	$14,755,768	$167,002,239
BED Territory	$2,283,505	$2,391,919	$2,506,185	$2,271,622	$1,994,485	$1,786,447	$1,571,360	$1,392,479	$1,266,138	$697,184	$674,536	$731,286	$1,113,784	$1,110,607	$1,248,002	$2,099,038	$2,097,326	$2,031,623	$1,907,126	$1,611,169	18,186,968.2
VT Statewide	*$23,261,051*	*$24,366,079*	*$25,530,689*	*$23,139,343*	*$20,309,143*	*$18,180,764*	*$15,986,308*	*$14,160,734*	*$12,867,948*	*$7,065,606*	*$6,873,407*	*$7,448,987*	*$11,330,001*	*$11,290,510*	*$12,820,658*	*$21,388,259*	*$21,367,183*	*$20,677,843*	*$19,391,764*	*$16,366,937*	*185,189,207.0*
Non-Incentive Costs - VT Statewide																					
End-Use	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**NPV**
EVT Territory	$14,208,731	$15,283,131	$16,441,350	$15,267,987	$14,068,325	$13,008,585	$11,947,066	$10,918,895	$10,643,610	$6,420,991	$6,288,301	$6,579,534	$9,445,403	$9,309,194	$13,364,014	$20,733,562	$21,913,344	$21,290,487	$20,417,488	$17,610,533	138,762,368.0
BED Territory	$1,498,951	$1,612,181	$1,734,250	$1,610,890	$1,487,864	$1,379,084	$1,269,081	$1,161,859	$1,136,839	$693,721	$687,977	$719,681	$1,019,140	$1,003,346	$1,375,989	$2,184,589	$2,311,214	$2,251,486	$2,167,431	$1,870,007	14,705,236.0
VT Statewide	*$15,707,682*	*$16,895,313*	*$18,175,600*	*$16,878,877*	*$15,556,189*	*$14,387,669*	*$13,216,147*	*$12,080,755*	*$11,780,449*	*$7,114,712*	*$6,976,278*	*$7,299,215*	*$10,464,543*	*$10,312,540*	*$14,740,003*	*$22,918,151*	*$24,224,558*	*$23,541,974*	*$22,584,919*	*$19,480,540*	*153,467,604.0*

8 OVERALL CONCLUSIONS AND RECOMMENDATIONS

In summary, the potential for electric energy efficiency in Vermont by 2031 is significant. The estimated maximum achievable potential electricity savings would amount to 1,435,673 MWh a year (a 25.4% reduction in projected 2031 MWh sales). Energy efficiency resources can also serve to reduce the overall winter peak over the same time period by 223 MW, or 23% of the forecasted 2031 winter peak. Achievable summer peak savings are 216 MW, or 20% of the summer peak. Table 8-1 below summarizes the electricity savings potential in Vermont by 2031.

Table 8-1: Maximum Achievable Potential Summary

	Cumulative Annual MWh Savings 2031	Cumulative Winter MW Savings 2031	Cumulative Winter MW Savings 2031	NPV Benefits $2012	NPV Costs $2012	VT Societal B/C Ratio
				$ in millions		
Residential Sector	819,382	172.2	129.5	$1,431	$629	2.3
Commercial/Industrial Sector	616,291	51.0	86.8	$973	$314	3.1
All Sectors Combined	***1,435,673***	***223.1***	***216.3***	***$2,404***	***$942***	***2.6***

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 8-1 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 2.6. 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 $1.46 billion in 2012 dollars.

8.1 DIFFERENCES BETWEEN THE 2011 AND 2006 VERMONT ELECTRIC ENERGY EFFICIENCY POTENTIAL STUDIES

Overall the estimates for maximum achievable electric energy efficiency potential in this study are greater than those reported in 2006.

Table 8-2: Differences between 2011 and 2006 VT Electric Energy Efficiency Potential Studies

	2006 Study		2011 Study	
	MWh	%	MWh	%
Max. Achievable Potential	1,286,824	19.4%	1,435,673	25.4%

Although there are numerous similarities between the two studies, there are also specific differences that were critical to the higher estimates of potential found in Table 8-2. Some of these differences include:

- The 2011 study included numerous additional measures compared to the 2006 study. For example, consumer electronics are treated as a comprehensive end use in the residential sector in the 2011 analysis yet were relatively absent in the 2006 study.
- Emerging technologies were included in greater detail in the 2011 analysis and included behavioral based energy conservation measures.
- The 2011 study targeted up to 90% of the remaining potential; the 2006 study targeted a cap of 80% of the total market. In 2006 a measure with that was already 40% energy efficient could

only capture an additional 40% of the market, whereas in the 2011 the maximum achievable potential was 90% of the remaining market.

- Avoided costs have changed over time. As a result, there may some additional cost effective measures in 2011 that were not found to pass the VT Societal benefit-cost test in 2006.
- The 2011 study places greater emphasis on an early replacement programmatic strategy and includes many more energy efficiency measures for the new construction market.
- The 2011 study assumes an incentive level for energy efficiency measures of 100% of measure cost. The 2006 study selected a target incentive level of 50% of energy efficiency measure cost. The greater incentive level in 2011 should allow for higher market penetration over the long term.

8.2 Concluding Thoughts

It is clear that electric energy efficiency programs could save residents of Vermont a substantial amount of electricity by 2031. The electric energy efficiency potential estimates and the VT Societal Test savings provided in this report are based upon the 2011 planning load forecast provided by VELCO as well as appliance saturation data, data on energy efficiency measure costs and savings, and measure lives available at the time of this study. Over time, additional technologies are likely to become available in the market that may serve to increase the potential for energy and demand savings and warrant additional attention.

Finally, 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. In addition, the estimated savings and budgets are based upon a current forecast of unconstrained budgets amounts for DSM programs over the 20 year period of 2012-2031. 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.