Vermont Electric Energy Efficiency Potential Study

Final Report

January 2007

Prepared for the Vermont Department of Public Service

Prepared and Submitted by:

GDS Associates, Inc.
Engineers and Consultants

GDS Associates, Inc. • 1850 Parkway Place • Suite 800 • Marietta, GA 30067 • www.gdsassociates.com
Marietta, GA • Austin, TX • Auburn, AL • Manchester, NH • Madison, WI

Table of Contents

List of Appendices

ACKNOWLEDGEMENTS

This technical report was prepared for the Vermont Department of Public Service (VDPS) by GDS Associates, Inc and the American Council for an Energy Efficient Economy. GDS would like to acknowledge the many helpful data sources and the technical support provided by the VDPS staff and staff of Efficiency Vermont. GDS would like to give special recognition to Riley Allen, David O'Brien, Carole Welch, Dave Lamont and Doug Thomas of the VDPS, all of whom were instrumental in reviewing detailed data developed by GDS relating to electric load forecasts, electric energy efficiency measure costs, energy savings and useful lives. Neal Elliott of the American Council for an Energy Efficient Economy was also helpful in contributing data sources and analytical support for the industrial sector potential analysis. GDS also appreciates the detailed review of draft versions of this report provided to the Vermont Department of Public Service by staff of Efficiency Vermont, the Vermont Public Interest Research Group, the Conservation Law Foundation, the Burlington Electric Department, the Associated Industries of Vermont, and other interested stakeholders.

It is important to note that the base case scenario in this final report includes an assessment of the benefits and costs of electric space heat, electric water heater, and electric dryer fuel conversion in the residential sector.

This final report provides valuable and up-to-date electric energy efficiency potential information for decision-makers in the State of Vermont, and it will also be useful to electric energy efficiency program designers and implementers in other States who need a template for their own energy efficiency potential studies. This report includes a thorough and up-to-date assessment of the impacts that energy efficiency measures and programs can have on electricity use in Vermont, the economic costs and benefits of such electric DSM programs, the rate impacts of such programs, and the environmental benefits of the achievable cost effective energy efficiency programs identified by this study. Clearly there is significant cost effective electricity savings remaining to be tapped in Vermont.

Richard F. Spellman, President
GDS Associates, Inc.
January 2007

1.0 EXECUTIVE SUMMARY – ELECTRIC ENERGY EFFICIENCY POTENTIAL

This study estimates the achievable cost effective potential for electric energy and peak demand savings from energy-efficiency and fuel conversion measures in Vermont. The primary cost effectiveness test used for screening of energy efficiency measures is the Vermont Societal Test.[1] Energy-efficiency opportunities typically are physical, long-lasting changes to buildings and equipment that result in decreased energy use while maintaining the same or improved levels of energy service. The study shows that there is still significant savings potential in Vermont for cost effective electric energy-efficiency and fuel conversion measures. The technical potential savings for electric energy efficiency measures in Vermont is 35 percent of projected 2015 kWh sales in the State, and the cost effective achievable potential is 19 percent of projected 2015 kWh sales.[2]

Based on cost effectiveness screening using the Vermont Societal Test, capturing the achievable cost effective potential for energy efficiency in Vermont would reduce electric energy use by 19 percent (1,287 GWh annually) by 2015.[3] The magnitude of the potential savings is higher than results reported for recent studies for many other States (see Table 1-7 for the results of other recent studies). Load reductions from load management and demand response measures, which were not analyzed in this study, would be in addition to these energy efficiency savings. Table 1-1 below provides a summary of the achievable cost effective energy efficiency and fuel conversion potential savings for Vermont by the year 2015. In developing the estimates of achievable cost effective savings potential, GDS considered savings opportunities from market driven, retrofit, early retirement[4] and fuel conversion energy efficiency program strategies. This report also presents estimates of the achievable cost effective potential based upon screening using the Total Resource Cost Test, the Utility Test, and the Participant Test.

[1] While the Vermont Societal Test was used as the primary test for screening, the results are robust relative to the choice of tests and would vary little had the Total Resource Cost Test been used as the primary test.

[2] A prior energy efficiency potential study for Vermont completed by Optimal Energy in January 2003 found that the maximum achievable potential savings in Vermont for electric energy efficiency measures was 30.8% by 2012. The title of this 2003 study was “Electric and Economic Impacts of Maximum Achievable Statewide Efficiency Savings, 2003 to 2012, Results and Analysis Summary”.

[3] The stated annual mWh savings targets in the Efficiency Vermont contract for 2006, 2007, and 2008 are 58,000 mWh, 68,000 mWh and 78,000 mWh respectively.

[4] GDS has also examined an additional scenario where equipment replacements are done using an early retirement programmatic strategy. The results of this additional scenario are provided in Appendix G of the final report.

Table 1-1: Achievable Cost Effective Electric Energy Efficiency Potential By 2015 in Vermont			
Sector	Achievable Cost Effective kWh Savings by 2015 from Electric Energy Efficiency Measures/Programs for Vermont (Cost Effective According to Societal Test)	2015 kWh Sales Forecast for This Sector	Percent of Sector 2015 kWh Sales Forecast
Residential Sector	567,511,161	2,659,831,768	21.3%
Commercial Sector	450,383,577	2,115,167,148	21.3%
Industrial Sector	268,928,672	1,851,792,067	14.5%
Total	1,286,823,410	6,626,790,983	19.4%

1.1 Level of Financial Incentives for the Achievable Potential Base Case Scenario

In the base case developed for this Vermont Energy Efficiency Potential Report, GDS selected a target incentive level of 50 percent of energy efficiency measure costs as the incentive level necessary in order to achieve high rates of program participation necessary to achieve the savings potential. This incentive level assumption is based upon a thorough review by GDS of numerous energy efficiency potential studies recently conducted in the US, and a review of the December 2004 National Energy Efficiency Best Practices Study.[5] Examples of the energy efficiency potential studies reviewed by GDS are listed in Table 1-7 of this report. The incentive levels utilized in these other energy efficiency potential studies are described below.

- In February 2006, Quantum Consulting completed an analysis of the maximum achievable cost effective electricity savings for the Los Angeles Department of Water and Power (LAWPD). For the maximum achievable electricity savings potential scenario, this analysis assumed incentives covering 50 percent, on average, of incremental measure costs, and marketing expenditures sufficient to create maximum market awareness over the forecasting period.
- The 2002 California "Secret Surplus" Report examined savings potential scenarios based on incentive levels (incentives as a percent of measure costs) of 33%, 66% and 100% of measure costs.
- The June 2004 Connecticut Energy Conservation Management Board (ECMB) electric energy efficiency potential study assumed incentive levels ranging from 50% to 70% of measure costs.

[5] See "National Energy Efficiency Best Practices Study, Volume NR5, Non-Residential Large Comprehensive Incentive Programs Best Practices Report", prepared by Quantum Consulting for Pacific Gas and Electric Company, December 2004, page NR5-51.

- The Southwest Energy Efficiency Project potential study assumed incentive levels of 15% to 25% of measure costs.
- The January 2003 Vermont energy efficiency potential study assumed an incentive level of 100% of full measure costs for retrofit programs, and 100% of incremental costs for retail and new construction programs.
- The 2005 Big Rivers Electric Cooperative (Kentucky) potential study assumed an incentive level of 50% of incremental measure costs.
- The 2005 Georgia potential study examined scenarios with incentive levels of 25%, 50% and 100%.
- A recent electric energy efficiency achievable potential study in New York state performed by Optimal Energy assumed incentive levels in the range of 20% to 50%.

There are several reasons why an incentive level of 50% of measure costs (and not 100% of measure costs) was assumed for the base case for this study:

1. First, the incentive level of 50% of measure costs assumed in the Vermont Energy Efficiency Potential study for the base case scenario is a reasonable target based on a thorough review by GDS of incentive levels used in other recent technical potential studies. The incentive levels used in the studies reviewed by GDS as well as actual experience with incentive levels in the Northeast and other regions of the country confirm that an incentive level assumption of 50% is commonly used for program planning and implementation. As noted above, the very recent study (February 2006) conducted by Quantum Consulting for the Los Angeles Water and Power Department assumed incentives of 50% of measure costs for its maximum achievable savings scenario. Also, the majority of energy efficiency programs offered by NYSERDA offer no incentives to consumers. In addition, the NYSERDA electric energy efficiency achievable potential study performed by Optimal Energy assumed incentive levels in the range of 20% to 50%.

2. Second, and most important, the highly recognized and recently published National Energy Efficiency Best Practices Study concludes that use of an incentive level of 100% of measure costs **is not recommended as a program strategy**.[6] This national best practices study concludes that it is very important to **limit** incentives to participants so that they do not exceed a pre-determined portion of average or customer-specific incremental cost estimates. The report states that this step is critical to avoid grossly overpaying for energy savings. This best practices report also notes that if incentives are set too high, free-ridership problems will increase significantly. Free riders dilute the market impact of program dollars.

[6] See "National Energy Efficiency Best Practices Study, Volume NR5, Non-Residential Large Comprehensive Incentive Programs Best Practices Report", prepared by Quantum Consulting for Pacific Gas and Electric Company, December 2004, page NR5-51.

3. Third, financial incentives are only one of many important programmatic marketing tools. Program designs and program logic models also need to make use of other education, training and marketing tools to maximize consumer awareness and understanding of energy efficient products. A program manager can ramp up or down expenditures for the mix of marketing tools to maximize program participation and savings.

While this new Vermont Energy Efficiency Potential Study provides an estimate of the budget increase that would be necessary if the incentive level were raised to 100% of measure costs, this study does not recommend an incentive level of 100% of measure costs for the above reasons. Furthermore, actual program experience has shown that very high levels of market penetration can be achieved with aggressive energy efficiency programs that combine education, training and other programmatic approaches along with incentive levels in the 50% range.

Appendices A, B, and C of this report provide detailed information on the costs, savings and useful lives of the electric energy efficiency measures examined in this study. Year-by-year information on mWh savings by sector and winter and summer peak demand (MW) savings are provided in Appendix D of this report. Appendix E lists assumptions for the discount rate, inflation rate, line loss factors, electric generation reserve margin, and power plant emissions factors. Appendix F lists avoided costs for electricity and natural gas; retail rate projections for fuel oil, natural gas, propane, kerosene, and water. Appendix G provides information on the benefits and costs of an early replacement programmatic strategy.

One of the factors causing the electricity savings potential to be lower than in the 2003 Vermont energy efficiency potential study is the enactment of new Federal and state standards for energy efficiency. Another factor contributing to lower savings potential than in the 2003 study is the large amount of energy efficiency savings already captured by Efficiency Vermont over the past six years. The most recent Efficiency Vermont Annual Report states that its programs have saved 261.7 million kWh[7] on a cumulative annual basis as of December 31, 2005. These actual savings are 4% of 2005 annual kWh sales in Vermont.

The cost effectiveness screening is based upon a long-term forecast for the rate of inflation of 2.25%[8], and a nominal discount rate of 7.975% provided to GDS by VDPS staff.

Table 1-2 below shows the technical potential, achievable potential, and the achievable cost effective potential for electricity savings in Vermont by 2015. The table provides these results for the major sectors combined, and broken down by sector.

[7] Efficiency Vermont, 2005 Annual Report Summary, from Efficiency Vermont web site.
[8] This long-term inflation rate was obtained from the December 2005 Avoided Energy Supply Component Study Group Report titled “Avoided Energy Supply Costs in New England”.

Table 1-2: Summary of Overall Electric Energy Efficiency Potential in Vermont for all Sectors (Residential, Commercial and Industrial Combined)		
	Estimated Cumulative Annual Savings by 2015 (kWh)	Savings in 2015 as a Percent of Total 2015 Industrial Sector kWh Sales
Technical Potential	2,294,594	34.6%
Achievable Potential	1,463,126	22.1%
Achievable Cost Effective Potential	1,286,824	19.4%

Summary of Residential Sector Only Energy Efficiency Potential in Vermont		
	Estimated Cumulative Annual Savings by 2015 (mWh)	Savings in 2015 as a Percent of Total 2015 Industrial Sector kWh Sales
Technical Potential	1,057,749	39.8%
Achievable Potential	677,894	25.5%
Achievable Cost Effective Potential	567,511	21.3%

Summary of Commercial Sector Only Energy Efficiency Potential in Vermont		
	Estimated Cumulative Annual Savings by 2015 (mWh)	Savings in 2015 as a Percent of Total 2015 Industrial Sector kWh Sales
Technical Potential	854,144	40.4%
Achievable Potential	516,303	24.4%
Achievable Cost Effective Potential	450,384	21.3%

Summary of Industrial Sector Only Energy Efficiency Potential in Vermont		
	Estimated Cumulative Annual Savings by 2015 (mWh)	Savings in 2015 as a Percent of Total 2015 Industrial Sector kWh Sales
Technical Potential	382,700	20.7%
Achievable Potential	268,929	14.5%
Achievable Cost Effective Potential	268,929	14.5%

The base case projection for the achievable cost effective potential electricity savings is based upon cost effectiveness screening using the Vermont Societal Test and assumes that Efficiency Vermont pays financial incentives equivalent to fifty percent of measure incremental costs. The net present savings for the State of Vermont for long-term implementation of energy efficiency programs throughout the State over the next decade are **$964 million.** The Societal Test[9] benefit/cost ratio for the achievable cost effective potential scenario is 3.45.

[9] According to the Final Order in Vermont Public Service Board Docket No. 5270, the Societal Test calculation in Vermont includes a 5 percent adder to program electric energy benefits for non-energy benefits (for environmental benefits), and a 10% reduction to program costs to account for the risk diversification benefits of energy efficiency measures and programs. The

This new study of the electric energy efficiency potential in Vermont is based upon data and forecasts that are different than those relied upon in the study published by Optimal Energy for Vermont in 2003:

- This 2006 study is based upon a new electric energy and peak load growth rate assumption for the State of Vermont provided to GDS by the Vermont Department of Public Service in April 2006. Before the impacts of energy efficiency programs are considered, the VDPS is assuming that annual kWh sales in Vermont will grow at an average annual rate of 1.5% for the period 2006 to 2015.
- The new ISO-New England load forecast for Vermont (the forecast after DSM impacts are reflected) is projecting slower load growth (only 1% a year) than occurred during the prior decade. From 1994 to 2004, annual kWh sales grew slightly faster, at 1.3% per year.
- The benefit/cost screening analyses in this report use a new forecast of avoided costs of electricity and fossil fuels just published in December 2005 by the New England Avoided Energy Supply Component Study Group. The new forecast of electric avoided costs is substantially higher than the forecast used in the 2003 study.
- As of April 2006, Efficiency Vermont has been in business for over five years and has already captured a significant portion of the available energy efficiency potential, more than had been captured by the beginning of 2003 when the Optimal Energy potential study for Vermont was published. The most recent Efficiency Vermont Annual Report states that its programs have saved 266.7 million kWh[10] on a cumulative annual basis as of December 31, 2005. These actual savings are 4% of 2005 annual kWh sales in Vermont.
- This 2006 study is based upon very recent and detailed market assessment studies for all sectors in Vermont prepared in 2005 by KEMA.
- This 2006 study uses a lower discount rate (a 5.6% discount rate in real terms in the new study instead of the 6.8% real discount rate used in the 2003 study). This study uses a forecast for the long-term general rate of inflation of 2.25%.
- The 2006 study uses well documented end use load shapes for residential electric space heat, electric water heating, refrigerators and other end uses obtained from Central Maine Power Company and other electric utilities in the region.[11]

Board subsequently adopted an environmental adder of $.0070 per kWh saved (in $2000). In this report, GDS has used the definition of the Societal Test calculation as specified by the Vermont Pubic Service Board in its final order in Docket No. 5270, and has used the $.0070 adder for environmental benefits, adjusted to current year dollars.

[10] Efficiency Vermont, Preliminary Annual Report for 2005, from Efficiency Vermont web site.

[11] Central Maine Power Company, Market Research and Forecasting Department, “Residential End Use Metering Project Report”, August 1988. Provided to GDS Associates in April 2006 by John Davulis of Central Maine Power Company. Richard Spellman of GDS, a former CMP employee, directed this end use metering project while employed at CMP in the 1980’s.

.

1.1 Study Scope

The objective of the study was to estimate the achievable cost effective potential for energy efficiency resources over the ten-year period from 2006 through 2015 in Vermont. The definitions used in this study for energy efficiency potential estimates are the following:

- **Technical potential** is defined in this study as the complete and immediate penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective.

- **Achievable potential** is defined as the achievable penetration of an efficient measure that would be adopted given aggressive funding, and by determining the achievable market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market interventions. The State of Vermont would need to undertake an extraordinary effort to achieve this level of savings. The term "achievable" refers to efficiency measure penetration, and means that the GDS Team has based our estimates of efficiency potential on the realistic penetration level that can be achieved by 2015.

- **Achievable cost effective potential** is defined as the potential for the realistic penetration over time of energy efficient measures that are cost effective according to the Vermont Societal Test, and would be adopted given aggressive funding levels, and by determining the level of market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market interventions. As demonstrated later in this report, the State of Vermont would need to continue to undertake an aggressive effort to achieve this level of savings.

The main outputs of this study are summary data tables and graphs reporting the total cumulative achievable cost effective potential for electric energy efficiency over the ten-year period, and the annual incremental achievable potential and cumulative potential, by year, for 2006 through 2015.

This study makes use of over 200 existing studies conducted in Vermont and throughout the US on the potential energy savings, costs and penetration of energy efficiency measures. These other existing studies provided an extensive foundation for estimates of electric energy savings potential in existing residential, commercial and industrial facilities.

1.2 Implementation Costs

Realizing the achievable cost effective energy efficiency savings by 2015 would require programmatic support. Programmatic support includes financial incentives to customers, marketing, administration, planning, and program evaluation activities provided to ensure the delivery of energy efficiency products and services to consumers. As noted above, the base case projection for the achievable cost effective potential electricity savings in Vermont assumes that Efficiency Vermont pays financial incentives equivalent to fifty percent of measure incremental costs.[12] This incentive level assumption is based upon a review of numerous energy efficiency potential studies recently conducted in the US and a review by GDS of the December 2004 National Energy Efficiency Best Practices Study. Examples of the energy savings potential studies from Vermont and other states reviewed by GDS are listed in Table 1-7.

GDS developed cost estimates for program planning, administration, marketing, reporting and evaluation ("other program costs") based upon historical experience at Efficiency Vermont for the period 2002 to 2005, as well as financial incentives to electric consumers in order to realize the achievable cost effective potential savings. It is clear that to realize all of the achievable cost effective savings, Efficiency Vermont would have to undertake steps to add staffing (either in-house staff or contractors), and Efficiency Vermont would have to spend approximately $348 million in today's dollars (this figure includes financial incentives, but excludes the Fiscal Agent, the Contract Administrator and the VDPS Monitoring and Evaluation functions) over the next decade to achieve such results (or $34.8 million a year in 2006 dollars, assuming the EVT pays 50% of measure incremental costs).[13]

If Efficiency Vermont had to pay 100% of measure incremental or full costs to obtain achievable cost effective potential savings levels, then this $34.8 million annual Efficiency Vermont budget for the base case scenario would increase by at least $16.5 million a year.

A significant portion of this average annual budget of $34.8 million over the next decade is for conversion of residential electric space heating and water heating systems and electric dryers to alternative fuels. Table 1-3 below shows that approximately 22 percent of the total annual budget (the total budget for residential, commercial and industrial programs) would be for fuel conversion programs, where electric end uses are converted to fossil fuels.

[12] The January 2003 Optimal Energy potential study for Vermont assumed that Efficiency Vermont paid 100 percent of incremental measure costs.
[13] This cost estimate is based on the key assumption that Efficiency Vermont pays at least 50% of the incremental costs of energy efficiency measures.

Table 1-3: Annual Energy Efficiency Utility Budget for the Base Case Scenario And Other Budgets (Includes Burlington Electric Department)					
	Column 1	Column 2	Column 3	Column 4	Column 5
Year	Annual Program Budget for Conversion of Electric End Uses to Fossil Fuels	Percent of Total Vermont Program Budget	Total Annual Energy Efficiency Utility Budget for Vermont (Including Burlington Electric Department)	Annual Budget for Fiscal Agent, Contract Agent, and VDPS Monitoring and Evaluation	Total Energy Efficiency Utility Budget Including Fiscal Agent, Contract Agent and M&E
2006	$7,282,076	23%	$31,537,767	$897,000	$32,434,767
2007	$7,333,022	23%	$32,174,445	$917,183	$33,091,627
2008	$7,385,115	22%	$32,864,503	$937,819	$33,802,322
2009	$7,438,380	22%	$33,638,628	$958,920	$34,597,548
2010	$7,492,843	22%	$34,436,453	$980,496	$35,416,949
2011	$7,548,532	22%	$34,946,938	$1,002,557	$35,949,495
2012	$7,605,474	21%	$35,787,372	$1,025,114	$36,812,486
2013	$7,663,696	21%	$36,653,612	$1,048,179	$37,701,791
2014	$7,723,229	21%	$37,546,453	$1,071,764	$38,618,216
2015	$7,784,102	20%	$38,466,711	$1,095,878	$39,562,590
Sum	$75,256,468	22%	$348,052,882	$9,934,910	$357,987,792
Average annual budget	$7,525,647	22%	$34,805,288	$993,491	$35,798,779
NPV of annual budgets	$54,333,622	22%	$249,005,011	$7,106,024	$256,111,035

1.3 Present Value of Savings and Costs (in $2006)

The results of this study demonstrate that energy-efficiency resources could play an expanded role in the Vermont resource mix over the next decade. Table 1-4 below shows the present value[14] of benefits and costs associated with implementing the achievable potential energy savings in Vermont. Benefit/cost screening results for the base case are shown for the Vermont Societal test, the Total Resource Cost Test, the Utility Test, and the Participant Test. The Vermont Societal Test net present savings to the State of Vermont for long-term implementation of energy efficiency programs throughout the State are **$964 million.** The overall Vermont Societal Test benefit/cost ratio for the achievable cost effective potential scenario is 3.45, higher than the Vermont Societal Test ratio from the 2003 energy efficiency potential study.[15] The net present value savings to Vermonters for the Total Resource Cost (TRC) Test are significantly lower, $776 million. The net present value savings of the Vermont Societal Test are 24% higher than the net present value savings of the TRC Test.

[14] The term "present value" refers to a mathematical technique used to convert a future stream of dollars into their equivalent value in today's dollars.
[15] The Societal Test benefit/cost ratio in the 2003 Optimal Energy Study was 2.31. This benefit/cost ratio is listed in Table 5 of the 2003 study.

Table 1-4: VERMONT SOCIETAL TEST - ACHIEVABLE COST EFFECTIVE ELECTRICITY SAVINGS POTENTIAL SCENARIO FOR VERMONT (July 21, 2006)

Column #	1	2	3	4	5	6
	Present Value of Total Resource Benefits ($2006)	Present Value of Total Measure Incremental Costs ($2006)	Present Value of Vermont Implementation Costs (Staffing, Marketing, Data Tracking & Reporting, etc., $2006)	Present Value Of Total Costs (Col 2 + Col 3)	Net Present Value savings ($2006)	Vermont Societal Test Benefit/Cost Ratio
Residential Sector	$659,181,397	$149,440,570	$51,914,527	$201,355,097	$457,826,300	3.27
Commercial Sector	$409,669,646	$135,407,577	$26,488,747	$161,896,324	$247,773,322	2.53
Industrial Sector	$289,612,700	$15,021,343	$15,721,632	$30,742,975	$258,869,725	9.42
Total	$1,358,463,742	$299,869,489	$94,124,907	$393,994,396	$964,469,346	3.45

TOTAL RESOURCE COST TEST - ACHIEVABLE COST EFFECTIVE ELECTRICITY SAVINGS POTENTIAL SCENARIO FOR VERMONT

Column #	1	2	3	4	5	6
	Present Value of Total Resource Benefits ($2006)	Present Value of Total Measure Incremental Costs ($2006)	Present Value of Vermont Implementation Costs (Staffing, Marketing, Data Tracking & Reporting, etc., $2006)	Present Value Of Total Costs (Col 2 + Col 3)	Net Present Value savings ($2006)	TRC Test Benefit/Cost Ratio
Residential Sector	$543,049,183	$139,894,604	$49,550,574	$189,445,178	$353,604,005	2.87
Commercial Sector	$354,807,342	$141,923,347	$26,488,747	$168,412,094	$186,395,248	2.11
Industrial Sector	$268,618,432	$16,690,381	$15,721,632	$32,412,013	$236,206,419	8.29
Total	$1,166,474,957	$298,508,331	$91,760,953	$390,269,285	$776,205,672	2.99

UTILITY COST TEST - ACHIEVABLE COST EFFECTIVE ELECTRICITY SAVINGS POTENTIAL SCENARIO FOR VERMONT

Column #	1	2	3	4	5	6
	Present Value of Total Resource Benefits ($2006)	Present Value of Total Measure Incremental Costs ($2006)	Present Value of Vermont Implementation Costs (Staffing, Marketing, Data Tracking & Reporting, etc., $2006)	Present Value Of Total Costs (Col 2 + Col 3)	Net Present Value savings ($2006)	Utility Cost Test Benefit/Cost Ratio
Residential Sector	$606,347,177	$89,623,458	$53,603,353	$143,226,811	$463,120,366	4.23
Commercial Sector	$354,806,685	$70,961,673	$26,488,747	$97,450,420	$257,356,264	3.64
Industrial Sector	$268,618,432	$7,461,331	$15,721,632	$23,182,963	$245,435,469	11.59
Total	$1,229,772,293	$168,046,462	$95,813,733	$263,860,195	$965,912,099	4.66

PARTICIPANT TEST - ACHIEVABLE COST EFFECTIVE ELECTRICITY SAVINGS POTENTIAL SCENARIO FOR VERMONT

Column #	1	2	3	4	5	6
	Present Value of Total Resource Benefits ($2006)	Present Value of Total Measure Incremental Costs ($2006)	Present Value of Vermont Implementation Costs (Staffing, Marketing, Data Tracking & Reporting, etc., $2006)	Present Value Of Total Costs (Col 2 + Col 3)	Net Present Value savings ($2006)	Participant Test Benefit/Cost Ratio
Residential Sector	$489,389,745	$96,531,256	$0	$96,531,256	$392,858,489	5.07
Commercial Sector	$332,378,629	$70,961,673	$0	$70,961,673	$261,416,956	4.68
Industrial Sector	$181,200,949	$8,345,190	$0	$8,345,190	$172,855,759	21.71
Total	$1,002,969,323	$175,838,120	$0	$175,838,120	$827,131,203	5.70

Table 1-4 also provides the benefit/cost ratios for each major market sector (residential, commercial and industrial sectors). One factor causing the Societal Test benefit/cost ratio calculation to differ among sectors is differences in the incremental costs of energy efficient equipment by sector. It is common for benefit/cost ratios to differ by sector. The Societal Test is a standard benefit-cost test used by public utilities commissions and energy efficiency organizations in the US and other energy efficiency organizations to compare the value of the avoided energy production and power plant construction to the costs of energy-efficiency measures and program activities necessary to deliver them. The value of both energy savings and peak demand reductions are incorporated into the Societal Test (a full description of this and other cost effectiveness tests is provided in Section 1.4 below). The sector with the highest Societal Test benefit/cost ratio is the industrial sector.

The Vermont Department of Public Service developed an Excel spreadsheet model to determine the rate impacts of various budget scenarios for energy efficiency spending in Vermont. Over the period 2006 to 2009, the average annual rate impact (levelized) of the base case scenario for energy efficiency spending is over 2.0%. Over the period 2006 to 2009, the average annual rate impact (levelized) of the early retirement scenario for energy efficiency spending is over 7.2%.

1.4 Definitions of Benefit Cost Tests

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 and October 2001.[16] 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

Table 1-5 below summarizes the major components of these five benefit/cost tests. Examining this table is useful when trying to understand the differences among the five benefit/cost tests.

[16] California Public Utilities Commission and California Energy Commission, Standard Practice Manual, Economic Analysis of Demand-Side Programs and Projects, 1987 and 2001.

Table 1-5
Components of Energy Efficiency Benefit/Cost Tests

	PARTICIPANT TEST	RATE IMPACT MEASURE 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			

The five cost-benefit tests are defined by the California Standard Practice Manual as follows:

1.4.1 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.[17]

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

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

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.

1.4.2 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.[18] 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.

1.4.3 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 program implementation 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.[19] 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.

As noted above, the Vermont Department of Public Service developed an Excel spreadsheet model to determine the rate impacts of various budget scenarios for

[18] Ibid., page 9.
[19] Ibid., page 17.

energy efficiency spending in Vermont. VDPS staff used this model to calculate the year-by-year rate impacts of the base case and other scenarios examined for this study.

1.4.4 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.[20] This test compares the utility's costs for an energy efficiency program to the utility's avoided costs for electricity and/or gas. It is important to remember that the Utility Cost Test ignores participant costs. This means that a measure could pass the Utility Cost Test but not be cost effective from a more comprehensive perspective.

1.4.5 The Societal Test

The Societal Cost Test is structurally similar to the Total Resource Cost Test. 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 utility and its ratepayers). 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.[21] An example of societal benefits is reduced emissions of carbon, nitrous and sulfur dioxide and particulates from electric utility power plants.[22] 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 F of this report.

According to the Final Order in Vermont Public Service Board Docket No. 5270, the Societal Test calculation in Vermont includes a 5 percent adder to program electric energy benefits for non-energy benefits (for environmental benefits), and 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 Pubic 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

[20] Ibid., page 33.
[21] Ibid., page 27.
[22] 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).

calculations of the Vermont Societal Test. Finally, the VDPS provided GDS with environmental adders relating to fossil fuel savings, and GDS has reflected these adders in the calculation of benefit/cost ratios for the Societal Test.

1.5 Definition of Electric 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.).

Second, it is very important to note that the electricity avoided costs used in the Total Resource Cost (TRC) 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.

1.6 Spending Per Customer on Energy Efficiency Programs

The Vermont Department of Public Service asked GDS to identify data sources for data on annual spending per customer on energy efficiency programs by various energy efficiency organizations. GDS examined data from US electric utilities available on the Energy Information Administration web site (www.eia.doe.gov) relating to kWh and kW savings from electric utility energy efficiency programs, and data on utility spending on energy efficiency programs. Listed below in Table 1-6 is data on utility spending per customer on energy efficiency by the top 20 DSM utilities in the US and for Efficiency Vermont. The top 20 are defined as those US electric utilities that have saved the largest percentage of annual kWh sales by 2004 with energy efficiency programs. The average spending per customer by the top 20 DSM utilities on energy efficiency programs ranges from $1.01 to $47.16 per customer. These twenty utilities had the highest kWh savings based on energy efficiency savings as a percent of annual kWh sales in 2004.

Table 1-6: 2004 US Electric Utility Annual Spending Per Customer on Energy Efficiency Programs			
Name of Electric Utility or Energy Efficiency Organization	**2004 Dollars spent on Energy Efficiency**	**Number of Customers In Service Area**	**2004 Spending per Customer**
Vermont	$16,200,000	342,142	$47.35
Seattle City of	$17,474,000	370,499	$47.16
Western Mass. Elec Company	$9,043,000	203,223	$44.50
Burlington City of	$846,000	19,696	$42.95
Eugene City of	$3,397,000	83,118	$40.87
United Illuminating Co	$12,968,000	320,800	$40.42
Connecticut Light & Power Co	$45,130,000	1,165,140	$38.73
Massachusetts Electric Co	$46,295,000	1,198,696	$38.62
Avista Corp	$3,846,000	110,293	$34.87
Boulder City City of	$246,000	7,580	$32.45
City of Redding	$1,216,000	42,080	$28.90
Granite State Electric Co	$1,090,000	39,785	$27.40
Wisconsin Power & Light Co	$11,401,000	431,669	$26.41
Northern States Power Co	$31,944,000	1,352,175	$23.62
Minnesota Power Inc	$3,105,000	135,649	$22.89
Puget Sound Energy Inc	$20,869,000	990,020	$21.08
Sacramento Municipal Util Dist	$11,238,000	560,991	$20.03
Southern California Edison Co	$68,922,000	4,597,577	$14.99
City of Tallahassee	$799,000	95,604	$8.36
Northern States Power Co	$1,285,000	238,065	$5.40
City of Springfield	$70,000	69,082	$1.01

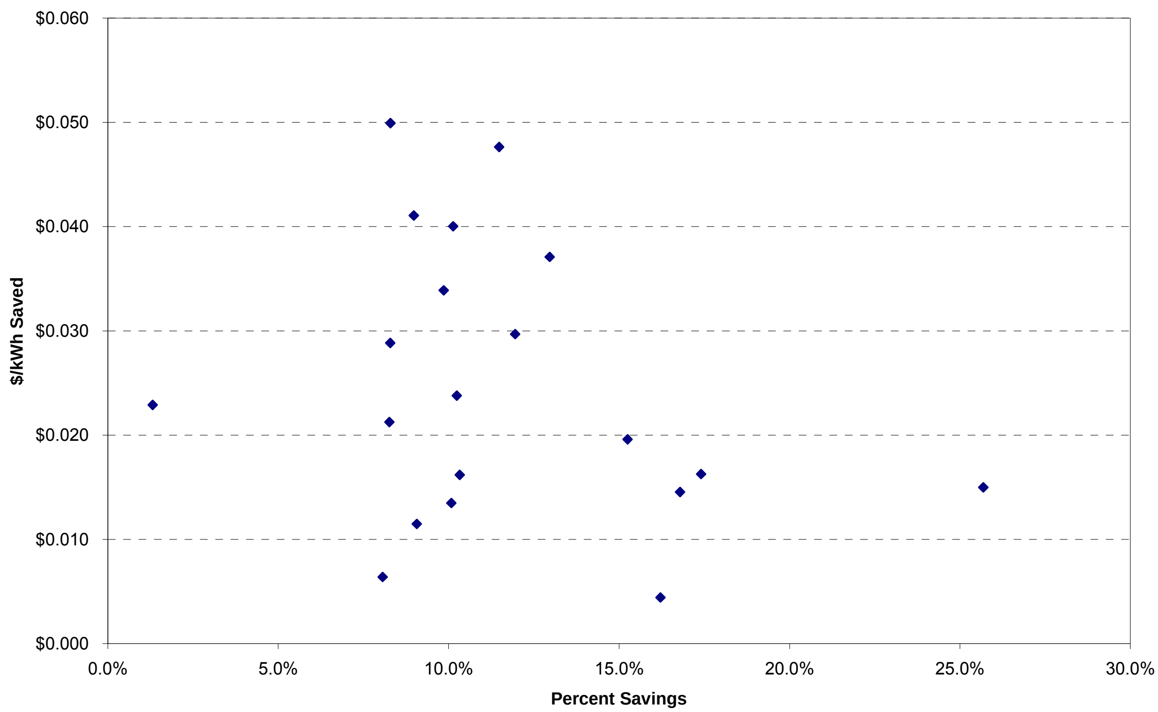
According to the Vermont Public Service Board Order in Docket, the total energy efficiency program budget in Vermont in 2004 was $16.2 million.[23] This $16.2 million budget included energy efficiency spending for Efficiency Vermont and the Burlington Electric Department. There were 342,142 electric utility customers in Vermont in 2004.[24] Thus the average annual budget per utility customer in Vermont in calendar year 2004 was $47.35, higher than the top twenty energy efficiency utilities in the US. In 2005 and 2006, the annual budget has been increased to $17.5 million per year.[25]

GDS has also examined data for these top 20 energy efficiency utilities on their actual cost per kWh saved versus the percent of annual kWh sales saved through energy efficiency programs. Figure 1-1 shows a graph of this data for these twenty utilities. There does not appear to be a distinctly clear relationship or clear correlation for these 20 utilities for the cost per kWh saved and the yield

[23] See the Board's Order in Docket 6874 at http://www.state.vt.us/psb/orders/2003/files/6874ord2004rates.pdf
[24] GDS obtained the number of electric utility customers in Vermont for 2004 from the Vermont Department of Public Service web site at http://publicservice.vermont.gov/electric/electric-utilities.html.
[25]To see the text in Docket 6987 relating to the $17.5 million budget, see www.state.vt.us/psb/orders/2004/files/6987finalrates.pdf

of their programs (yield in terms of the percent of annual kWh sales saved with energy efficiency programs).

Figure 1-1: Cumulative Cost Per kWh Saved Versus Percent of Annual kWh Sa;es saved



In fact, it appears that the four utilities that have saved the largest percent of their annual kWh sales (these are the four utilities that have saved more than 15% of annual kWh sales) rank relatively low on the cost per kWh saved for their energy efficiency programs. Thus it is apparent that higher savings levels are not simply a product of higher budgets.

1.7 Comparison of Results to Other Energy Efficiency Potential Studies

Table 1-7 presents a comparison of the results of this study to other recent electric energy efficiency potential studies. As shown in this table, the achievable cost effective potential for electricity savings ranges from 6 percent by 2023 in the service area of Puget Sound Energy to 24 percent in Massachusetts by 2007. Five of the thirteen studies listed in Table 1-7 report achievable cost effective potential in the range of 9 to 13 percent of annual electricity sales. It is very interesting to note that the incentive level assumptions for these thirteen studies range from a low of 15% to a high of 100% of measure costs.

Table 1-7: Comparison of Potential Electrcity Savings from Recent Studies in Other States

Percent of Total Electricity (GWh) Sales

Sector	Conn. 2012(1)	California 2011(2,3)	Vermont 2012(4,5)	Mass. 2007(4,5)	Southwest 2020(6)	Big Rivers (KY) 2015(7)	Georgia 2015(8)	New York 2012(9)	Oregon 2013(10)	Puget Sound (WA) 2023(11)	NJ/NH/ PA 2011(12)	Wisconsin 2015
Technical Potential												
Residential	21%	21%			26%	26%	33%	37%	28%			
Commercial	25%	17%			37%		33%	41%	32%			
Industrial	20%	13%			33%	11%	17%	22%	35%			
Total	***24%***	***19%***			***33%***		***29%***	***37%***	***31%***			
Maximum Achievable Potential												
Residential	17%	15%	30%			18%	21%	26%		17%	35%	
Commercial	17%	13%	32%				22%	38%		7%	35%	
Industrial	17%	12%	32%			9%	15%	16%		0%	41%	
Total	***17%***	***14%***	***31%***				***20%***	***30%***		***12%***		
Maximum Achievable Cost Effective Potential												
Residential	13%	10%		31%		16%	9%			7%		4.9%
Commercial	14%	10%		21%		10%	10%			6%		4.8%*
Industrial	13%	11%		21%		9%	7%			0%		
Total	***13%***	***10%***		***24%***		***12%***	***9%***			***6%***		**9.2%**

Incentive Level as a Percent of Incremental Cost

Percentage	51%-70%	25%, 40%, 55%, 100%	N/A	N/A	15%-25%	50%	25%, 50%, 100%	20% - 50%	N/A			

1.8 Impacts of Early Replacement Programmatic Approach

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). 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 did examine the electric rate impacts of an "early replacement" scenario. In this early replacement scenario, GDS assumed that all energy efficiency potential would be captured over a four-year period, instead of using a "replace-on-burnout" programmatic approach. For this scenario, GDS assumed that the Program Administrator would pay an incentive equivalent to 50% of the full cost of energy efficiency measures. Table 1-8 provides a comparison of the impacts of the replace-on-burnout scenario to the "early replacement" scenario.

Table 1-8: Comparison of Impacts of "Replace-On-Burnout" and "Early Replacement" Programmatic Strategies

	Replace-On-Burnout	Early Replacement
Cumulative Annual MWh Savings by 2015	1,286,824	1,166,144
Cumulative Annual Winter MW Savings by 2015	400	389
Cumulative Annual Summer MW Savings by 2015	243	244
VT Societal Test Ratio	3.45	3.18
NPV of Incentives Paid to Participants	$154,879,104	$290,457,037
Percent Rate Impact Over first four years of program	2.00%	7.20%
Societal Test NPV Savings	$964,469,346	$1,148,841,435

The impacts of the ‘early replacement” scenario are interesting. Using an early replacement programmatic approach results in an incentive budget that is higher by $136 million. By the year 2015, cumulative annual kWh and summer peak kW savings are lower than in the “replace-on-burnout” approach. The VT Societal Test benefit/cost ratio is lower for the early replacement scenario. On the other hand, the net present value savings for the early replacement approach is $184.3 million higher than in the replace-on-burnout base case. Overall, the early replacement programmatic approach results in lower kWh and summer peak kW savings by 2015, and this approach has a lower Societal Test benefit/cost ratio.

2.0 INTRODUCTION

The main objective of this energy efficiency potential assessment is to update the assessment of the potential for achievable and cost-effective electric energy efficiency measures for residential, commercial and industrial electric customers in Vermont. The main outputs of this study include the following deliverables:

- A concise, fully documented report on the work performed and the results of the analysis of opportunities for achievable, cost effective electric energy efficiency in Vermont.
- An overview of the impacts that energy efficiency measures and programs can have on electric use in Vermont.
- A summary of the economic costs and benefits of potential energy efficiency measures and programs for the achievable cost effective potential scenario.
- An assessment of the environmental and other non-energy benefits of the achievable cost effective electric energy efficiency options examined in this study.
- An assessment of the long-term rate impacts of the achievable cost effective potential scenario.

2.1 Summary of Approach

A comprehensive discussion of the study methodology is presented in Section 4. GDS first developed estimates of the technical potential and the achievable potential for electric energy efficiency opportunities for the residential, commercial and industrial sectors in Vermont. The GDS analysis utilized the following models and information:

(1) an existing GDS electric and natural gas energy efficiency potential spreadsheet model[26];

(2) detailed information relating to the current and potential saturation of electric energy efficiency measures in Vermont; and

(3) available data on electric energy efficiency measure costs, saturations, energy savings, and useful lives.

The technical potential for electric energy efficiency was based upon calculations that assume one hundred percent penetration of all energy efficiency measures analyzed in applications where they were deemed to be technically feasible from an engineering perspective.

---

[26] GDS has developed an Excel spreadsheet model and used it to estimate the energy efficiency potential for electric energy efficiency measures in Vermont. It operates on a PC platform using the Microsoft Windows operating system, is documented, and can be followed by a technician with expertise. GDS has provided this model to the Vermont Department of Public Service as a deliverable of this project.

The achievable potential for electric energy efficiency was estimated by determining the highest realistic level of penetration of an efficient measure that would be adopted given aggressive funding, and by determining the highest realistic level of market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market intervention.

The third level of energy efficiency examined is the achievable cost effective potential. The calculation of the cost effective achievable potential is based, as the term implies, on the assumption that energy efficiency measures/bundles will only be included in Vermont electric efficiency programs when it is cost effective to do so.

All cost effectiveness calculations for electric energy efficiency measures and programs were done using a GDS spreadsheet model that operates in Excel and that has been approved by regulators in several states.

2.2 Report Organization

The remainder of this report is organized as follows:

- Section 3 – Electric Usage – Overview of Vermont Electric Sales and Peak Load Forecast
- Section 4 – Methodology for Determining Energy Savings Potential
- Section 5 – Electric Energy Efficiency Potential – Residential Sector
- Section 6 – Electric Energy Efficiency Potential – Commercial Sector
- Section 7 – Electric Energy Efficiency Potential – Industrial Sector
- Section 8 – Environmental and Other Non-Energy Benefits of Electric Energy Efficiency Programs
- Section 9 – Summary of Findings

3.0 CHARACTERIZATION OF CUSTOMER BASE, ELECTRIC USAGE, AND LOAD FORECAST FOR THE STATE OF VERMONT

This section of the report provides a description of the latest available electric load forecast for the State of Vermont from ISO-New England, and the latest available load growth forecast assumption provided by the Vermont Department of Public Service. This section also provides information on economic, demographic, geographic and appliance saturation characteristics of the State. 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 625,371 persons in 2005, and 303,000 housing units.[27]

3.1 Vermont Geographic 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[28]. 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 38,531[29] in 2005 according the US Census Bureau.

[27] Data obtained by GDS from the Scan USA forecast for the State of Vermont published in the summer of 2005.
[28] Vermont's population density of 65.8 persons per square mile is higher than the population density in Maine (41.3), but it is much lower than the other four New England states. For more detailed information, see http://www.answers.com/topic/list-of-u-s-states-by-population-density.
[29] US Census Bureau, 2005 population estimate for Burlington, Vermont.

3.2 Vermont Map

3.3 Economic/Demographic Forecast Vermont

The Vermont Department of Public Service prepares an annual Electric Plan for the state. The Department's January 2005 Plan noted that the rate of growth in the Vermont economy is slowing. Vermont and the nation experienced recessions in 1990 - 1991 and in 2001 - 2002 that severely impacted personal income, although the National Bureau of Economic Research declared the 2001 –2002 recession over. The Plan also noted that the current economic climate (as of January 2005) in Vermont is significantly improved and Vermont currently enjoys the lowest unemployment rate in the nation. The January 2005 VDPS forecast accounts for the effects of the recessions of 1990 – 1991 and 2001 – 2002. The latest VDPS economic forecast for the State does not project any further recession in the near term, although there is the probability of occurrence given the nature of economic cycles. The VDPS, however, does anticipate that the rate of economic growth in Vermont will decline in the future. This declining growth rate in the Vermont economy in the January 2005 VDPS forecast mirrors that of the U.S. economy and is based mostly on demographic and other long-term changes.

3.3 Historical kWh Sales and Electric Customers in Vermont

Table 3-1 and 3-2 show historical Vermont data for annual kWh sales and electric customers by class of service.[30] Total annual kWh sales in Vermont grew at an annual rate of 1.3% from 1992 to 2004. As one can see from the kWh sales data, the commercial/industrial sector kWh sales grew the fastest from 1994 to 2004 (at 1.7% per year on average),[31] while the residential sector annual kWh sales only grew at 0.6% per year.

Table 3-1: Vermont Sales to Ultimate Customers by Customer Class (kWh)

	Residential	Commercial	Industrial	Other	Total
1992	2,052,047,563	1,528,585,391	1,440,803,001	42,187,090	5,063,623,045
1993	2,010,568,418	1,566,230,573	1,431,005,318	40,023,999	5,047,828,308
1994	2,016,298,354	1,585,438,898	1,425,881,728	40,094,343	5,067,713,323
1995	1,978,870,333	1,600,952,885	1,476,087,147	39,415,838	5,095,326,203
1996	2,005,686,276	1,643,056,833	1,531,469,272	38,357,533	5,218,569,914
1997	1,986,463,698	1,672,972,257	1,608,999,823	38,194,860	5,306,630,638
1998	1,951,303,712	1,853,216,919	1,514,355,515	38,929,921	5,357,806,067
1999	1,993,990,616	1,897,409,767	1,593,169,050	38,650,293	5,523,219,726
2000	2,034,714,985	1,900,823,062	1,652,162,500	40,504,752	5,628,205,299
2001	2,009,278,870	1,920,846,814	1,611,750,379	41,181,682	5,583,057,745
2002	2,046,101,168	1,943,752,256	1,592,436,197	41,575,991	5,623,865,612
2003	2,128,701,848	1,911,511,710	1,561,371,381	41,504,526	5,643,089,465
2004	2,141,488,094	1,926,615,690	1,638,953,742	41,366,336	5,748,423,862
Annual Rate of Growth-1998 to 2004	1.6%	0.6%	1.3%	1.0%	1.2%
Annual Rate of Growth-1994 to 2004	0.6%	2.0%	1.4%	0.3%	1.3%

Table 3-2: Number of Customers by Customer Class - Vermont

	Residential	Commercial	Industrial	Other	Total
1992	264,762	36,371	1,019	NA	302,152
1993	267,284	36,727	1,147	NA	305,158
1994	269,549	37,043	1,167	NA	307,759
1995	272,519	37,474	1,160	NA	311,153
1996	274,779	37,905	1,139	NA	313,823

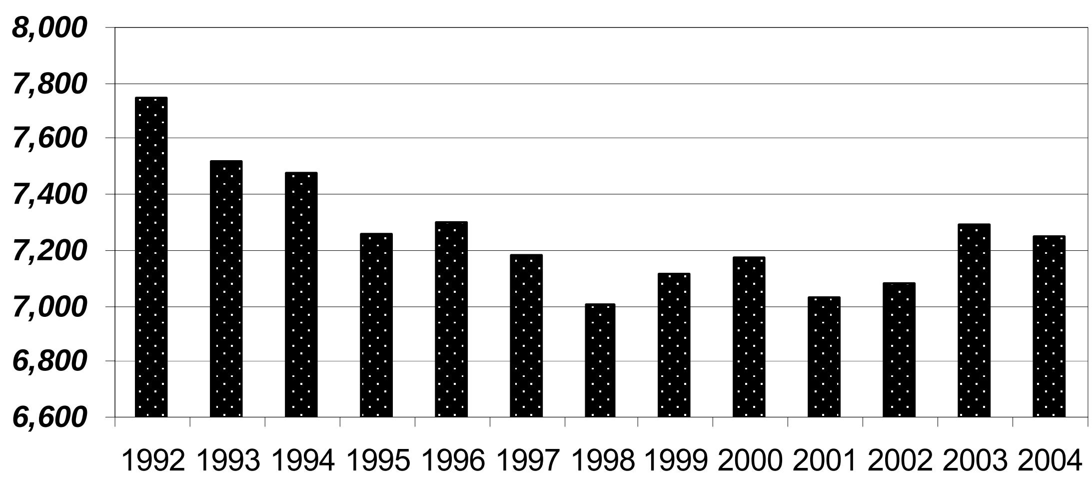
[30] This historical kWh sales data for Vermont was provided to GDS via email on February 17, 2006 by Riley Allen of the Vermont Department of Public Service.

[31] Reclassification of industrial customers to the commercial class in 1998 requires that the two classes be combined for purposes of the growth measurement.

1997	276,447	38,487	1,134	NA	316,068
1998	278,511	39,593	436	NA	318,540
1999	280,312	40,148	441	NA	320,901
2000	283,494	41,125	388	NA	325,007
2001	285,905	42,435	412	NA	328,752
2002	288,966	43,066	455	NA	332,487
2003	292,031	43,783	468	NA	337,826
2004	295,505	44,743	554	NA	342,142

Figure 3-1 shows historical data for average annual kWh use per residential customer for the period 1992 to 2004. There has been a gradual downward trend in electric use per residential customer since 1992. Average annual use per customer in 2004 was 6.5 percent lower than in 1992. Average annual kWh use per residential customer in Vermont is below the New England average and below the US average. Vermont has operated energy efficiency programs throughout this historical period from 1992 to 2004.

FIgure 3-1: Residential Sector Average Annual kWh Use Per Customer



3.4 Latest ISO New England Forecast of kWh Sales and Peak Demand for the State of Vermont

The latest ISO New England (ISO-NE) load forecast for Vermont (forecast after DSM impacts) was completed in January 2006 and is available on the public ISO-NE web site. The ISO-New England load forecast for Vermont is shown below in Tables 3-3 and 3-4. ISO New England does not develop or publish a load forecast by sector, and only develops a forecast of total kWh sales. The ISO-New England load forecast by sector shown in this report in Tables 3-3 and 3-4 was developed by GDS with the assistance of VDPS staff. VDPS staff provided GDS with a preliminary load forecast by class of service for the State of Vermont.[32] GDS then developed allocation factors (for sector kWh sales as a percent of total annual kWh sales) based on the preliminary load forecast provided by VDPS staff, and then GDS applied these allocation factors to the ISO-NE load forecasts for Vermont to obtain forecasts of kWh sales by sector (e.g., residential, commercial, industrial).

The new ISO-NE load forecast for Vermont[33] (after inclusion of DSM impacts provided by Efficiency Vermont) projects that total kWh sales in the State will grow slowly over the next decade, at a compound average annual growth rate of 1.0% a year. The residential sector is projected to grow at 1.6% a year, the commercial sector at .48% per year, and the industrial sector at 1.54% per year. It is important to note that the commercial and the industrial market shares are expected to decline over time, while the residential market share is expected to increase.

Table 3-3: ISO-New England Load Forecast for Vermont After DSM Impacts (Energy KWH)

Year	Residential	Commercial	Industrial	Other	Total
2006	2,383,766,273	2,097,005,947	1,793,244,945	45,982,835	6,320,000,000
2007	2,425,052,895	2,109,528,944	1,808,671,172	46,746,988	6,390,000,000
2008	2,470,515,892	2,125,104,084	1,826,789,509	47,590,516	6,470,000,000
2009	2,512,542,190	2,137,146,032	1,841,945,077	48,366,701	6,540,000,000
2010	2,551,061,959	2,145,705,545	1,854,158,157	49,074,338	6,600,000,000
2011	2,584,060,685	2,149,216,207	1,862,048,266	49,674,842	6,645,000,000
2012	2,627,081,654	2,160,624,275	1,876,827,047	50,467,024	6,715,000,000
2013	2,672,429,906	2,173,403,110	1,892,864,217	51,302,767	6,790,000,000
2014	2,712,222,173	2,181,159,899	1,904,587,179	52,030,749	6,850,000,000
2015	2,752,326,884	2,188,721,661	1,916,187,765	52,763,691	6,910,000,000
Compound Average Annual Growth Rate	1.61%	0.48%	0.74%	1.54%	1.00%

Table 3-4: ISO-New England Load Forecast for Vermont After DSM Impacts (Energy KWH): Percent of Total Sales by Sector

Year	Residential	Commercial	Industrial	Other	Total
2006	37.7%	33.2%	28.4%	0.7%	100.0%
2007	38.0%	33.0%	28.3%	0.7%	100.0%
2008	38.2%	32.8%	28.2%	0.7%	100.0%
2009	38.4%	32.7%	28.2%	0.7%	100.0%
2010	38.7%	32.5%	28.1%	0.7%	100.0%
2011	38.9%	32.3%	28.0%	0.7%	100.0%
2012	39.1%	32.2%	27.9%	0.8%	100.0%
2013	39.4%	32.0%	27.9%	0.8%	100.0%
2014	39.6%	31.8%	27.8%	0.8%	100.0%
2015	39.8%	31.7%	27.7%	0.8%	100.0%

[32] This preliminary electric load forecast for the State of Vermont for the years 2006 to 2015 was provided by email to Richard Spellman of GDS in February 2006 by Riley Allen of the VDPS.
[33] See ISO-NE Table titled "2006 CELT & RSP Forecast Detail: ISO-NE Control Area, New England States and RSP Sub Areas". This load forecast is at the VELCO level of delivery.

3.4 Latest VDPS Assumption for Future Growth of Vermont kWh Sales and Peak Demand

VDPS staff developed assumptions for use by GDS for growth in kWh sales and peak load for the period 2006 to 2015 before and after DSM impacts are reflected in the numbers. This "before" DSM load growth planning assumption of 1.5% growth per year in kWh sales is listed below in Table 3-5, and the "after" DSM load growth planning assumption is listed above in Table 3-3. It is necessary to use a load forecast before DSM (as shown in Table 3-5) as the starting point for this study for two reasons: (1) in order to be able to determine the achievable electricity savings that could be captured over the next decade and (2) to avoid double-counting of electric energy efficiency savings potential. The GDS energy efficiency potential estimates for Vermont are based on the "before" DSM load growth assumption shown below in Table 3-5.

Table 3-5: VDPS Load Forecast for Vermont Before DSM Impacts (Energy KWH)

Year	Residential	Commercial	Industrial	Other	Total
2006	2,202,847,417	1,937,851,117	1,657,144,427	42,492,912	5,840,335,872
2007	2,249,698,007	1,956,989,504	1,677,886,672	43,366,726	5,927,940,910
2008	2,297,488,146	1,976,267,977	1,698,846,486	44,257,414	6,016,860,024
2009	2,346,235,303	1,995,686,873	1,720,025,472	45,165,276	6,107,112,924
2010	2,395,957,245	2,015,246,524	1,741,425,234	46,090,615	6,198,719,618
2011	2,446,672,036	2,034,947,253	1,763,047,381	47,033,743	6,291,700,412
2012	2,498,398,047	2,054,789,375	1,784,893,523	47,994,974	6,386,075,918
2013	2,551,153,957	2,074,773,199	1,806,965,274	48,974,627	6,481,867,057
2014	2,604,958,761	2,094,899,025	1,829,264,249	49,973,028	6,579,095,063
2015	2,659,831,768	2,115,167,148	1,851,792,067	50,990,506	6,677,781,489
Compound Average Annual Growth Rate	2.12%	0.98%	1.24%	2.05%	1.50%

VDPS Load Forecast for Vermont Before DSM Impacts (Energy KWH) - Percent of Total Annual kWh Sales by Sector

Year	Residential	Commercial	Industrial	Other	Total
2006	37.7%	33.2%	28.4%	0.7%	100.0%
2007	38.0%	33.0%	28.3%	0.7%	100.0%
2008	38.2%	32.8%	28.2%	0.7%	100.0%
2009	38.4%	32.7%	28.2%	0.7%	100.0%
2010	38.7%	32.5%	28.1%	0.7%	100.0%
2011	38.9%	32.3%	28.0%	0.7%	100.0%
2012	39.1%	32.2%	27.9%	0.8%	100.0%
2013	39.4%	32.0%	27.9%	0.8%	100.0%
2014	39.6%	31.8%	27.8%	0.8%	100.0%
2015	39.8%	31.7%	27.7%	0.8%	100.0%

The VDPS January 2005 Electric plan states that the demand for electricity in Vermont will increase modestly in the future. Electric demand in Vermont increased from 4,961 GWh in 1990 to 5,628 GWh in 2000, a compound annual growth rate of 1.3 percent between 1990 and 2000. Between 2000 and 2003, the growth rate further dampened to a rate of only 0.3% growth per year (partially due to an economic recession in the state during that time period). The VDPS plan projected that the compound annual growth rate in electric demand would be about 1% from 2005 to 2020.[34]

The VDPS plan noted that, within Vermont, the growth in the demand for electricity will vary by region where some regions may see much higher growth rates. On a statewide basis, however, areas showing faster growth are offset by slower growth areas of the state to produce an overall projected growth rate of only 1% throughout the forecast period. A persistent trend of higher growth in the Northwest section of the state is an ongoing challenge for utility managers and regulators. As discussed in the VDPS 2005 Plan, growth in electric demand is occurring fastest in and around Chittenden County and some of the winter recreational communities in central and southern Vermont. A comparison of population density growth correlates closely with areas that are experiencing the transmission and distribution constraints for which Distributed Utility Planning (DUP) is targeting Area Specific Collaboratives (ASC).

3.5 Appliance Saturation Data for Vermont

During 2005 the VDPS completed a Residential Appliance Saturation Survey (RASS). This survey collected information on appliance holdings, fuel shares, and other energy related characteristics from a sample of residential customers in Vermont. The survey data were used to develop penetration and saturation rates for heating and cooling equipment, appliances, and other plug loads. Listed below is a summary of the appliance saturation data that was collected. Most of this data has been used by GDS in developing up-to-date estimates for the remaining potential for electricity savings in Vermont. While this survey information provides a timely and useful snapshot of the State, there are notable differences between statewide data and the City of Burlington.[35] Table 3-7 provides a summary of key residential appliance saturation data for Vermont.

[34] The VDPS load forecast in the January 2005 plan includes the impacts of DSM.
[35] In comments to the Public Service Board presented in a May 3, 2006 memo, BED notes, for example, that electric hot water penetration is 37% statewide, but only 15 to 20% in Burlington. Only about 10% of their hot water tanks could be cost effectively fuel switched. The housing ownership characteristics of Burlington are also different than the state as a whole. Statewide, approximately 70% of residences are owner-occupied. In Burlington, approximately 60% are rental units. Memo from Chris Burns, BED, to the Public Service Board dated May 3, 2006.

Table 3-7
2005 Appliance Penetration and Saturation Data for Vermont

Equipment Type	Penetration (N = 600)	Saturation (N = 600)
Electric Space Heat	2%	2%
Electric Water Heat	37%	37%
Electric Central Air Conditioning	4%	4%
Electric Clothes Washers	92%	92%
Electric Clothes Dryers	74%	74%
Dishwashers	57%	57%
Refrigerators	100%	113%
Freezers	42%	44%
Prog. Thermostats (Elec. Space Heat)	4.2%	4.2
Fans		
Kitchen Range Vent Fan	71%	72%
Bathroom Fan	63%	93%
Ceiling Fan	58%	114%
Portable Fan	56%	119%
Attic or Whole-House Fan	11%	15%
Radon mitigation fans or pumps	1%	2%
Pumps		
Electric pump for well water	44%	45%
Swimming pool pump	11%	*
Aquarium with a pump	7%	7%
Whirlpool bathtub	7%	*
Heaters, Hot Tubs, and Saunas		
Hot tub or spa	6%	*
Heat pump water heater	4%	4%
Heated waterbed	3%	3%
Swimming pool heater	2%	2%
Instant hot water dispenser	2%	2%
Sauna	1%	*
Other Plug Loads		
Cordless telephones	86%	134%
Portable appliances or tools	63%	136%
Dehumidifier	29%	30%
Humidifier	25%	28%
Backup portable generator	14%	15%
Electronic household air cleaner	13%	15%

4.0 OVERALL APPROACH TO ASSESS ACHIEVABLE POTENTIAL FOR ENERGY EFFICIENCY MEASURES IN VERMONT

This section of the report presents an overview of the approach and methodology that was used to determine the achievable cost-effective potential for electric energy efficiency measures in the State of Vermont. The three key calculations that have been undertaken to complete this assessment are described below. Following the descriptions, the three stages of potential energy savings are shown graphically in a Venn diagram[36] in Figure 4-1.

The first step was to estimate the technical potential for electric energy efficiency savings in Vermont. **Technical potential** is defined as the complete penetration of all measures analyzed in applications where they are deemed to be technically feasible from an engineering perspective. The total technical potential for electric energy efficiency for each sector was developed from estimates of the technical potential of individual energy efficiency measures applicable to each sector (energy efficient space heating, energy efficient water heating, etc.). For each energy efficiency measure, GDS calculated the electricity 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).

- The second step was to estimate the achievable energy efficiency potential. **Achievable potential** is defined as the achievable penetration of an efficient measure that would be adopted given aggressive funding, and by determining the achievable market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market interventions. The State of Vermont would need to undertake an extraordinary effort to achieve this level of savings. The term "achievable" refers to efficiency measure penetration, and means that the GDS Team has based our estimates of efficiency potential on the realistic penetration level that can be achieved by 2015.

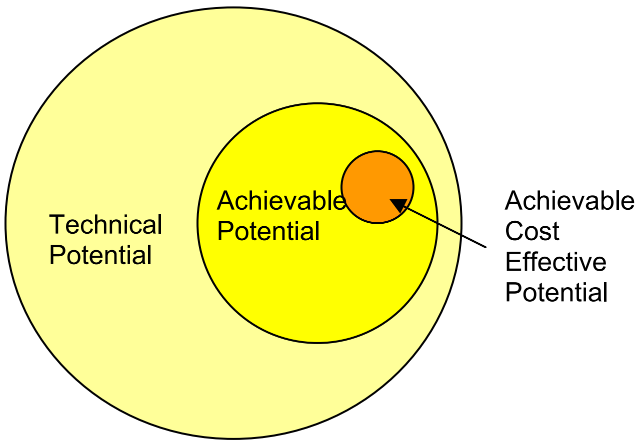
- **Achievable cost effective potential** is defined as the potential for the realistic penetration of energy efficient measures that are cost effective according to the Vermont Societal Test, and would be adopted given aggressive funding levels, and by determining the highest level of realistic market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market interventions. As demonstrated later in this report, the State of Vermont would need to continue to undertake an aggressive effort to achieve this level of savings.

To develop the cost effective achievable potential, the GDS Team only retained those electric energy efficiency measures in the analysis that were found to be cost effective (according to the Vermont Societal Test) based on the individual

[36] A Venn diagram is a graph that employs circles to represent logical relations between sets and subsets.

measure cost effective analyses conducted in this Study. Energy efficiency measures that are not cost effective were excluded from the estimate of cost effective achievable electric energy efficiency potential. Figure 4-1 below shows these three stages of the electric energy savings potential (this Venn diagram figure is for illustrative purposes only and does not reflect actual data for Vermont).

Figure 4-1 – Venn Diagram of the Stages of Energy Savings Potential



4.1 Overview of Methodology

Our analytical approach began with a careful assessment of the existing level of electric energy efficiency that has already been accomplished in Vermont. For each electric energy efficiency measure, this analysis assessed how much energy efficiency has already been accomplished as well as the remaining potential for energy efficiency savings for a particular electric end use. For example, if 100 percent of the homes in Vermont had electric lighting, and 30 percent of light bulbs were already high efficiency compact fluorescent bulbs (CFLs), then the remaining potential for energy efficiency savings is the 70 percent of light bulbs in the residential sector that are not already high efficiency fluorescent bulbs.

The general methodology used for estimating the potential for electric energy efficiency in the residential, commercial and industrial sectors of Vermont included the following steps:

1. Identification of data sources for electric energy efficiency measures.
2. Identification of electric energy efficiency measures to be included in the assessment.
3. Determination of the characteristics of each energy efficiency measure including its incremental cost, electric energy savings, operations and maintenance savings, current saturation, the percent of installations that are already energy efficient, and the useful life of the measure.

4. Calculation of initial cost-effectiveness screening metrics (e.g., the Societal Test benefit cost ratio) and sorting of measures from least-cost to highest cost per kWh saved.
5. Collection and analysis (where data was available) of the baseline and forecasted characteristics of the electric end use markets, including electric equipment saturation levels and consumption, by market segment and end use over the forecast period.
6. Integration of measure characteristics and baseline data to produce estimates of cumulative costs and savings across all measures (supply curves).
7. Determination of the cumulative technical and achievable potentials using supply curves.
8. Determination of the annual achievable cost effective potential for electricity savings over the forecast period.

A key element in this approach is the use of energy efficiency supply curves. The advantage of using an energy efficiency supply curve is that it provides a clear, easy-to-understand framework for summarizing a variety of complex information about energy efficiency technologies, their costs, and the potential for energy savings. Properly constructed, an energy-efficiency supply curve avoids the double counting of energy savings across measures by accounting for interactions between measures. The supply curve also provides a simplified framework to compare the costs of electric energy efficiency measures with the costs of electric energy supply resources.

The supply curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Measures are 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. There are a number of other advantages and limitations of energy-efficiency supply curves (see, for example, Rufo 2003).[37]

4.2 General Methodological Approach

This section describes the calculations used to estimate the electric energy efficiency potential in the residential, commercial, and industrial sectors. There is a core equation, shown in Tables 4-1 and 4-2, used to estimate the technical potential for each individual electric efficiency measure and it is essentially the same for each sector. However, for the residential sector, the equation is applied

[37] Rufo, Michael, 2003. *Attachment V – Developing Greenhouse Mitigation Supply Curves for In-State Sources*, *Climate Change Research Development and Demonstration Plan,* prepared for the California Energy Commission, Public Interest Energy Research Program, P500-03-025FAV, April. http://www.energy.ca.gov/pier/reports/500-03-025fs.html

to a "bottom-up" approach where the equation inputs are displayed in terms of the number of homes or the number of high efficiency units (e.g., compact fluorescent light bulbs, high efficiency air conditioning systems, programmable thermostats, etc.). For the commercial and industrial (C&I) sectors, a "top-down" approach was used for developing the technical potential estimates. In this case, the data is displayed in terms of energy rather than number of units or square feet of floor area.[38] For the commercial and industrial sectors, GDS used Vermont specific equipment saturation and electric end use data wherever such data was available. The core equations used by GDS are very similar to the equations used in the prior Vermont energy efficiency potential study completed in January 2003.

4.2.1 Core Equation for Estimating Technical Potential

The core equation used to calculate the electric energy efficiency technical potential for each individual efficiency measure for the residential sector is shown below in Table 4-1.

Table 4-1 – Core Equation for Residential Sector

Technical Potential of Efficient Measure	=	Total Number of Residential Households	X	Base Case Equipment End Use Intensity (annual kWh use per home)	X	Base Case Factor	X	Remaining Factor	X	Convertible Factor	X	Savings Factor

where:

- **Number of Households** is the number of residential electric customers in the market segment.

- **Base-case equipment end use intensity** is 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 purposes only, if the efficient measure were 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** is the fraction of the end use electric energy that is applicable for the efficient technology in a given market segment. For

[38] It is important to note that square-foot based saturation assumptions cannot be applied to energy use values without taking into account differences in energy intensity (e.g., an area covered by a unit heater may represent two percent of floor space but a larger percent of space heating energy in the building because it is likely to be less efficient than the main heating plant).

example, for residential lighting, this would be the fraction of all residential electric customers that have electric lighting in their household.

- **Remaining factor** is 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.

- **Convertible factor** is the fraction of the applicable dwelling 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 in a home).

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

The core equation used to calculate the electric energy efficiency technical potential for each individual efficiency measure for the commercial and industrial sectors is shown below in Table 4-2.

Table 4-2 – Core Equation for C&I Sectors

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)** is 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** is 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** is 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** is 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** is the percentage reduction in electricity consumption resulting from application of the efficient technology.

Technical electric energy efficiency savings potential 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 are 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.

4.2.2 Rates of Implementation for Energy Efficiency Measures

For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction. For existing buildings, determining the annual rate of availability of savings is more complex. 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). 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 the market driven measures, we 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. For the retrofit measures, savings can theoretically be captured at any time; however, in practice it takes many years to retrofit an entire stock of buildings, even with the most aggressive of efficiency programs.

As noted above, a special retrofit case is “**early retirement**” of electrical equipment that is still functioning well, and replacing such equipment with high efficiency equipment. For early retirement energy efficiency measures, GDS assumed that the measure would be replaced early, at least five years prior to reaching the end of its expected lifetime. Therefore, for the first five years, 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. Over the long-term (longer than five years), the energy savings from an early retirement scenario in most cases are very similar to the market driven (replace on burnout) scenario. On the other hand, the implementation costs for an early retirement scenario are much higher in the near term, because total resource costs are based on the full cost of purchasing a new appliance or piece of energy efficient equipment, not the incremental cost. GDS notes that in modeling early retirement scenarios, it is also appropriate to reflect a deferred cost credit for the energy efficient equipment to reflect the purchase cost avoided at the time the participant would have purchased new equipment in the absence of the early retirement program. It is also necessary, however, to reflect reduced energy savings, beginning at the same time that the deferred cost credit is recognized.

GDS has developed a special "early retirement" scenario for this report where all residential appliances are replaced during the four-year period from 2006 to 2009, and similar early replacements are made in the commercial sector. The results of this scenario are presented in Appendix G, and show that the financial incentive budget for Efficiency Vermont increases dramatically, by several hundred million dollars as compared to a replace on burnout programmatic strategy. The cumulative annual mWh and mW savings are similar to the replace on burnout approach, but the budget impact of the early retirement approach is dramatic.

Example for Early Retirement of a Refrigerator

To understand the impacts of an early retirement strategy, GDS prepared a case study for a single refrigerator. The findings of this case are very interesting. Both the early retirement replacement strategy and the replace-on burnout replacement strategy pass the Vermont Societal Test. While both strategies result in identical cumulative annual kWh and kW savings by 2015, the early retirement strategy costs the State of Vermont $535 more per refrigerator because it is necessary to pay an incentive equal to 50% of the full cost of the refrigerator, or $550 per participant, instead of a $15 incentive for the replace-on-burn-out strategy (the total incremental cost of an Energy Star refrigerator is only $30). With the replace on burnout strategy, you get the same kWh and kW savings by 2015, but the State of Vermont only has to pay an incentive of $15 per home. There are 228,000 inefficient refrigerators that can be replaced. If the early retirement strategy is used, and if the incentive necessary to get participation for the early retirement strategy is 50% of the full cost of a refrigerator, then the State of Vermont would have to pay $125.4 million in incentives instead of $3.4 million.[39]

There is one more cost that needs to be considered for the early replacement programmatic approach. Using the case study example for one refrigerator noted above, 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.[40] 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.

[39] The societal costs increase significantly as well; early retirement means that the stream of capital plant replacement expenditures that would otherwise occur over time is substantially advanced. For purposes of the analysis, it would be advanced by 5 years adding significantly to the capital costs of the energy efficiency on any of the relevant economic tests.

[40] 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.

In the case of a refrigerator with a useful life of 13 years that is replaced five years early, this additional cost is equal to 5/13th of the full cost of the new high efficiency refrigerator, or $423. GDS includes this additional cost when considering the cost effectiveness of the early retirement programmatic approach.

4.2.3 Development of Achievable Cost Effective Potential Estimates for Energy Efficiency

To develop the **achievable cost effective potential** for electric energy efficiency, energy efficiency measures that were found to be cost effective (according to the Societal Test) were retained in the energy efficiency supply curves. Electric energy efficiency measures that were not cost effective (such as the "turn in" program for room air conditioners in single-family homes) were excluded from the estimate of achievable cost effective energy efficiency potential.

4.2.4 Free-Ridership and Free-Driver Issues

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.[41]

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 by ISO-New England. 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 GDS energy efficiency supply curve analysis. GDS 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.

---

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

Adjustments to Savings for the Residential Sector

As noted above, GDS used a “bottom-up” approach to estimate potential kWh savings remaining in the residential sector in Vermont. Because a detailed residential end use forecast for electricity sales in Vermont was not available to GDS for this study, GDS and VDPS staff examined whether it would be necessary to adjust projected electricity savings for free-ridership, spillover and other market effects. GDS 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 for the residential sector to capture the impacts reflected in realization rates and net to gross ratios for this sector. 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 claimed by NYSERDA. 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.

4.3 Basis for Long Term Achievable Market Penetration Rate for High Efficiency Equipment and Building Practices

This section explains the basis used in this study for the achievable penetration rate that cost effective electric energy efficiency programs can attain over the long-term (ten years) with well-designed programs and aggressive funding. GDS is using an achievable penetration rate of **80 percent** by 2015 for the residential, commercial and industrial sectors in Vermont.

The achievable electric energy efficiency potential for the residential, commercial and industrial sectors is a subset of the technical potential estimates. The GDS Team has based the estimates of efficiency potential on the highest realistic penetration that can be achieved by 2015 (ten years from now) based on aggressive funding and an incentive level equal to 50% of measure costs.

The achievable potential estimate for energy efficiency defines the upper limit of savings from market interventions. For each sector, the GDS Team developed the initial year (2006) and terminal year (2015) penetration rate that is likely to be achieved over the long term for groups of measures (space heating equipment, water heating equipment, etc.) by end use for the “naturally occurring scenario” and the “aggressive programs and unlimited funding” scenario. GDS reviewed penetration rate forecasts from other recent energy efficiency technical potential studies, actual penetration experience for electric and natural gas energy efficiency programs operated by energy efficiency organizations (Efficiency Vermont, Efficiency Maine, Pacific Gas and Electric, KeySpan Energy Delivery, NEEP, NYSERDA, Northwest Energy Efficiency Alliance, BPA, Wisconsin, Focus on Energy, other electric and gas utilities, etc.), and penetration data from other sources (program evaluation reports, market progress reports, etc.) to estimate terminal penetration rates in 2015 for the achievable scenario. In addition, the GDS Team conducted a survey of nationally recognized energy efficiency experts requesting their estimate of the achievable penetration rate over the long-term for a state or region, assuming implementation of aggressive programs and assuming aggressive funding. The terminal year (2015) penetration estimates used by GDS in this study are based on the information gathered through this process. Based on a thorough review of all of this information, GDS used an achievable penetration rate of **80 percent** by 2015 for Vermont's residential, commercial and industrial sectors.

4.3.1 Examples of US Efficiency Programs with High Market Penetration

GDS collected information on electric and gas energy efficiency programs conducted during the past three decades where high penetration has been achieved. Examples of such programs are listed below:

1. The Residential Multifamily/Low-Income Program in Vermont achieved a market share of over 90 percent for new construction and nearly 30 percent for existing housing.[42]
2. The residential water heater bundle-up program conducted by Central Maine Power Company has achieved a market penetration of over 80 percent of residential electric water heaters in the Company's service area. This program has been operated by CMP since the 1980's.
3. The Northwest Energy Efficiency Alliance reported that the market share of ENERGY STAR windows in the Northwest reached 75 percent by mid-2002 and is continuing to increase.[43]
4. Vermont Gas Systems' reported that 68 percent of new homes in their service territory were ENERGY STAR Homes in 2002.[44]
5. Gaz Metro in Quebec reported that the national market share of high efficiency furnaces in Canada has reached 40 percent due to years of energy efficiency programs.[45]

---

[42] York, Dan; Kushler, Martin; America's Best: Profiles of America's Leading Energy Efficiency Programs," published by the American Council for an Energy Efficient Economy, March 2003. Report Number U032.
[43] Id.
[44] American Council for an Energy Efficient Economy, "America's Best Gas Energy Efficiency Programs", 2003.

6. Residential weatherization and insulation programs implemented by electric and gas utilities in New England have achieved high participation rates.
7. In the State of Wisconsin, a natural gas energy efficiency program to promote high efficiency gas furnaces attained a penetration rate of over 90 percent.[46]
8. KeySpan Energy Delivery's high efficiency residential furnace program has achieved a market share of approximately 70 percent over eight years (1997-2005).[47]

GDS finds that the actual market penetration experience from electric and gas energy efficiency programs in Vermont and in other States is useful and pertinent information that should be used as a basis for developing long-term market penetration estimates for electric energy efficiency programs in Vermont. In addition, recent technical potential studies in such states as California, Connecticut, Florida, Georgia, Kentucky, New Mexico, and Utah also have used a maximum achievable penetration rate of 80 percent.

4.3.2 Lessons Learned from America's Leading Efficiency Programs

GDS also reviewed program participation and penetration data included in ACEEE's March 2003 report on America's leading energy efficiency programs.[48] The information presented in this ACEEE report clearly demonstrates the wide range of high-quality energy efficiency programs that are being offered in various areas of the United States today. A common characteristic of the programs profiled in this ACEEE report is their success in reaching customers with their messages and changing behavior, whether regarding purchasing of new appliances, designing new office buildings, or operating existing buildings. GDS considered this information in the development of assumptions for maximum penetration rates achievable over the long term with aggressive programs.

4.4 Bundling of Efficiency Measures Into Programs

In addition to performing cost effectiveness screening at the measure level, GDS completed cost effectiveness screening of programs. For the program level

---

[45] Id.

[46] Hewitt, David. C., "The Elements of Sustainability", paper presented at the 2000 ACEEE Summer Study on Energy Efficiency in Buildings. Washington: American Council for an Energy Efficient Economy. Pages 6.179-6.190. The Wisconsin furnaces case study data can be found in the 2000 ACEEE Summer Study Proceedings on pages 6.185-6.186.

[47] American Council for an Energy Efficient Economy, "America's Best Gas Energy Efficiency Programs", 2003.

[48] York, Dan; Kushler, Martin; "America's Best: Profiles of America's Leading Energy Efficiency Programs," published by the American Council for an Energy Efficient Economy, March 2003, Report Number U032.

screening, GDS bundled measures targeting specific end uses into a program portfolio. Table 4-3 below shows how measures were bundled for residential programs for purposes of this study. Then GDS performed cost effectiveness screening at the program level for all programs. It is important to note that this final version of this report does include an assessment of electric savings potential from electric space heat, electric water heater, and electric dryer fuel switching in the residential sector.

Table 4-3: Bundling of Measures Into Programs – Residential Sector

Number	Program	Measures Included
1	Residential Lighting (Bulbs and Fixtures)	Compact fluorescent lightbulbs, fixtures, torchieres, Energy Star ceiling fans
2	Weatherization and Insulation	Attic insulation, wall insulation, floor insulation, caulking, weather-stripping for homes with electric space heat
3	Programmable Thermostats	Programmable Thermostats
4	Residential Energy Star Appliances	Energy Star Refrigerators, Freezers, Dishwashers, Clothes Washers
5	Low Income Weatherization Program	Attic insulation, wall insulation, floor insulation, caulking, weather-stripping
6	Energy Star Windows (retrofit measure)	High efficiency windows for existing homes with electric space heat
7	Appliance pick-up program	Old refrigerators, room air conditioners, freezers
8	Energy Star Homes Program	Efficient building practices and Energy Star Appliances for New Homes
9	Electric Water Heater Efficiency Measures	Water heater insulation jacket, faucet aerators, low flow showerheads, pie wrap for hot water pipes
10	Electric Water Heater Fuel Conversion	Conversion of electric water heaters to non-electric fuels (natural gas, #2 fuel oil, kerosene, propane, wood, etc.)
11	Solar Water Heating	Conversion of existing electric water heaters to solar water heating
12	Electric space heat fuel conversion	Conversion of electric space heating systems to alternate fueled systems
13	Electric dryer fuel conversion	Conversion of electric dryers to alternate fueled dryers
14	High efficiency swimming pool pumps	Efficient swimming pool pumps
15	High efficiency furnace fans	High efficiency electric fans for forced hot air heating systems

4.5 Development of Program Budgets

GDS obtained the latest available accounting data from Efficiency Vermont for actual costs related to administration, marketing, staffing, and evaluation for each existing Efficiency Vermont program. These costs, excluding incentives paid to participants or market actors, will be referred to as "overhead administrative costs" throughout the remainder of this report. Then GDS calculated two ratios for each program as follows:

Ratio 1 = Overhead administrative costs/first year kWh savings for a program

Ratio 2 = Overhead administrative costs/number of program participants for that year

These ratios for Efficiency Vermont's residential programs are listed below in Table 4-4. GDS selected one of these ratios for each program as the basis for developing overhead administrative costs.

BASIS FOR PROGRAM ADMINISTRATIVE, MARKETING, IMPLEMENTATION AND EVALUATION COSTS

Number	Program Name	Basis for Non-Incentive Budget	Data Source	Pg.	Implementation $ per kWh
1-2	Appliance Buy-Back Program (Refrigerators & Freezers)	Per participant data	United Illuminating		$92.53/part
3	Appliance Buy-Back Program (Room ACs w/ Replacement)	Per participant data	United Illuminating		$117.53/part
4	Appliance Buy-Back Program (Room ACs w/o Replacement)	Per participant data	United Illuminating		$107.53/part
5-14	Energy Star Appliances	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
15	Standby Power	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
16	Pool Pump & Motor	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
17	Programmable Thermostat	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
18	Central Air Conditioning	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
19-20	Residential Lighting	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
21-26	Residential Water Heating (Non-Fuel Switch Measures and Equipment)	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
27-29	Efficiency Furnace Fan	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
30	Energy Star Windows	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	47	$0.342396/kWh
31	Weatherization - Low Income	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	47	$0.342396/kWh
32	Energy Star Homes	Per participant data	EVT 2005 Data from the EVT Q1 2006 Performance Report	37	$2319.62/part
33	Weatherization - Non Low Income	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	47	$0.342396/kWh
34-55	All Water Heater Fuel Switching	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh
56	Space Heating Fuel Switching	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	47	$0.342396/kWh
57	Clothes Dryer Fuel Switching	$ per kWh saved	EVT 2005 Data from the EVT Q1 2006 Performance Report	42	$0.033903/kWh

Then GDS used these ratios to develop program budgets for the next ten years (2006 to 2015) for "overhead administrative costs" for each program. Using this methodology to develop program budgets ensures that the budgets are tied directly to actual cost experience at Efficiency Vermont.[49]

[49] GDS was not able to obtain historical data on actual expenditures and kWh savings separately for the residential lighting component of Efficiency Vermont's residential lighting program. While GDS was able to obtain actual cost and savings data for residential programs that included several measures, GDS was not able to obtain this data just for the Efficiency Vermont Residential Lighting Program. GDS was able, however, to obtain historical residential lighting program cost and savings data from the Efficiency Maine residential lighting program.

5.0 RESIDENTIAL SECTOR ELECTRIC EFFICIENCY POTENTIAL IN VERMONT

This section of the report presents the estimates of electric technical, achievable and achievable cost effective energy efficiency potential for the existing and new construction market segments of the residential sector in Vermont. According to this analysis, there is still a large remaining potential for electric energy efficiency savings in this sector. Table 5-1 below summarizes the technical, achievable and maximum achievable cost effective savings potential by the year 2015.

Table 5-1: Summary of Residential Electric Energy Efficiency Savings Potential in Vermont

	Estimated Cumulative Annual Savings by 2015 (kWh)	Savings in 2015 as a Percent of Total 2015 Residential Sector Electricity Sales
Technical Potential	**1,057,749,267**	**39.8%**
Maximum Achievable Potential	**677,893,631**	**25.5%**
Achievable Cost Effective Potential	**567,511,161**	**21.3%**

The achievable cost effective potential in the residential sector is 567,511 mWh, or 21.3 percent of the Vermont residential sector kWh sales forecast in 2015.

5.1 Residential Sector Electric Energy Efficiency Programs

Fifty-seven residential electric energy efficiency programs or measures were included in the analysis for the residential sector. In order to develop the list of energy efficiency measures to be examined, GDS reviewed the January 2003 Vermont Energy Efficiency Potential Study as well as other electric energy efficiency technical potential studies that have been conducted in the US. The set of electric energy efficiency programs or measures considered was pre-screened to only include those measures that are currently commercially available. Thus, emerging technologies were not included in the analysis (residential sector emerging technologies are discussed in Appendix A). Tables 5-2, 5-3, and 5-4 below list the residential sector electric energy efficiency programs or measures included in the technical, achievable, and achievable cost effective potential analyses. The portfolio of measures includes retrofit, early retirement and replace on burnout programmatic approaches to achieve energy efficiency savings. To obtain up-to-date appliance saturation data, GDS made extensive use of the recent residential market assessment study for Vermont that was completed in December 2005 by KEMA.

Characteristics of Energy Efficiency Measures

GDS collected data on the energy savings, incremental costs, useful lives and other key "per unit" characteristics of each of the residential electric energy efficiency measures. Estimates of the size of the eligible market were also developed for each efficiency measure. For example, electric water heater efficiency measures are only applicable to those homes in Vermont that have electric water heaters.

For the residential new construction market segment, GDS obtained a forecast of the number of new homes estimated to be built each year from a national forecasting firm (Scan US).[50] The sizes of various end-use market segments were based on saturation estimates provided in the December 2005 KEMA residential market assessment report for Vermont.

As discussed in Section 1 of this report, achievable market penetrations were estimated assuming that consumers would receive a financial incentive equal to 50% of the incremental cost of the measure in most programs.

In the residential new construction market, market penetration in the near term was based on actual penetration data for the ENERGY STAR Homes Program in Vermont (20%). It was assumed that the penetration rate for this program would reach 80% by 2015 (a decade from now).

In this report we also present the technical achievable potential results in the form of electric supply curves. The supply curve for residential electric energy efficiency savings is shown in Figure 5-1, found after Tables 5-1 through 5-4. This analysis is based on the most recent residential electric sales forecast for Vermont the years 2006 to 2015.[51] Energy-efficiency measures were analyzed for the most important electric consuming end uses in the residential sector:

- space heating
- water heating
- refrigeration
- dish washing
- clothes washing
- clothes drying
- air conditioning
- lighting

[50] The source of this economic/demographic forecast for Vermont is Scan US. GDS Associates purchases the Scan US forecast. The forecast for Vermont was released during the summer of 2005. Scan US updates their economic/demographic forecast for Vermont once a year.

[51] This residential sector load forecast was provided to GDS in February 2006 by staff of the Vermont Department of Public Service.

Table 5-2: Total Cumulative Annual Technical Potential kWh Savings for Electric Energy Efficiency In Vermont By Residential Sector - Market Driven and Retrofit Savings

1	2	3	4	5
Measure #	**Measure Description**	**Single-Family**	**Multi-Family**	**Total**
1	Refrigerator Turn-in	10,037,178	1,841,139	11,878,317
2	Freezer Turn-in	1,544,232	283,262	1,827,494
3	Room AC Turn-in without Replacement	0	0	0
4	Room AC Turn-in with ES Replacement	0	0	0
5	Energy Star Single Room Air Conditioner	2,758,414	505,981	3,264,395
6	Energy Star Compliant Top Freezer Refrigerator	12,005,083	2,202,116	14,207,199
7	Energy Star Compliant Bottom Mount Freezer Refrigerator	1,627,975	298,623	1,926,598
8	Energy Star Compliant Side-by-Side Refrigerator	5,618,836	1,030,674	6,649,510
9	Energy Star Compliant Upright Freezer (Manual Defrost)	2,776,443	509,288	3,285,731
10	Energy Star Compliant Chest Freezer	2,332,032	427,769	2,759,801
11	Energy Star Built-In Dishwasher (Electric)	8,302,900	1,523,017	9,825,917
12	Energy Star Clothes Washers with Electric Water Heater	7,611,453	1,396,184	9,007,637
13	Energy Star Clothes Washers with Non-Electric Water Heater	3,915,185	718,170	4,633,355
14	Energy Star Dehumidifier (40 pt)	12,310,932	2,258,218	14,569,150
15	Standby-Power	57,684,636	10,581,205	68,265,841
16	Pool Pump & Motor	18,739,468	1,299,367	20,038,835
17	Energy Star Compliant Programmable Thermostat	2,813,281	516,046	3,329,327
18	High Efficiency Central AC	2,528,151	463,744	2,991,895
19	CFL's: Homes with partial CFL installation	93,800,965	17,206,094	111,007,059
20	CFL's: Homes without CFL installation	103,865,433	19,052,239	122,917,672
21	Water Heater Blanket	0	0	0
22	Low Flow Shower Head	0	0	0
23	Pipe Wrap	0	0	0
24	Low Flow Faucet Aerator	0	0	0
25	Solar Water Heating	0	0	0
26	Efficient Water Heating	0	0	0
27	Efficient Furnace Fan Motor (Fuel Oil)	18,900,714	2,170,046	21,070,760
28	Efficient Furnace Fan Motor (Natural Gas)	3,993,109	1,953,237	5,946,346
29	Efficient Furnace Fan Motor (Propane)	5,462,572	867,237	6,329,809
30	Energy Star Windows - Electric Heat and no AC	0	0	0
31	Insulation and Weatherization - Electric Heat and no AC	0	0	0
32	Residential New Construction	49,261,080	0	49,261,080
33	Low Income Insulation & Weatherization - Elec. Heat & No AC	0	0	0
34	Water Heater-Elec. To Natural Gas (1 Bedroom)	407,097	533,021	940,118
35	Water Heater-Elec. To Natural Gas (2 Bedroom)	2,823,594	1,165,764	3,989,358
36	Water Heater-Elec. To Natural Gas (3 Bedroom)	8,132,292	1,039,426	9,171,718
37	Water Heater-Elec. To Natural Gas (4 Bedroom)	4,701,030	299,868	5,000,898
38	Water Heater-Elec. To Natural Gas (5+ Bedroom)	1,676,297	60,150	1,736,447
39	Water Heater-Elec. To Fuel Oil (1 Bedroom)	4,152,385	5,436,815	9,589,200
40	Water Heater-Elec. To Fuel Oil (2 Bedroom)	28,800,663	11,890,790	40,691,453
41	Water Heater-Elec. To Fuel Oil (3 Bedroom)	82,949,380	10,602,147	93,551,527
42	Water Heater-Elec. To Fuel Oil (4 Bedroom)	47,950,502	3,058,657	51,009,159
43	Water Heater-Elec. To Fuel Oil (5+ Bedroom)	17,098,225	613,525	17,711,750
44	Water Heater-Elec. To Propane (1 Bedroom)	1,139,870	1,492,459	2,632,329
45	Water Heater-Elec. To Propane (2 Bedroom)	7,906,064	3,264,138	11,170,202
46	Water Heater-Elec. To Propane (3 Bedroom)	22,770,418	2,910,393	25,680,811
47	Water Heater-Elec. To Propane (4 Bedroom)	13,162,883	839,631	14,002,514
48	Water Heater-Elec. To Propane (5+ Bedroom)	4,693,630	168,419	4,862,049
49	Water Heater-Elec. To Kerosene (1 Bedroom)	1,302,709	1,705,667	3,008,376
50	Water Heater-Elec. To Kerosene (2 Bedroom)	9,035,502	3,730,444	12,765,946
51	Water Heater-Elec. To Kerosene (3 Bedroom)	26,023,335	3,326,164	29,349,499
52	Water Heater-Elec. To Kerosene (4 Bedroom)	15,043,295	959,579	16,002,874
53	Water Heater-Elec. To Kerosene (5+ Bedroom)	5,364,149	192,479	5,556,628
54	WH Fuel Switching (Electric to Kerosene- Stand Alone)	0	0	0
55	WH Fuel Switching (Electric to Wood)	40,592,005	6,905,878	47,497,883
56	Space Heating (Fuel Switching)	102,436,646	9,395,077	111,831,723
57	Clothes Dryer (Fuel Switching)	36,644,098	8,358,979	45,003,077
	Total kilowatt hours (kWh)	912,696,141	145,053,126	1,057,749,267
	Forecast 2015 Vermont Residential kWh Sales			2,659,831,768
	As a percent of forecasted residential sales 2015			39.8%

Note: Technical potential kWh savings were obtained from Appendix A column 29

The forecast of annual Vermont residential kWh sales was obtained by applying a percentage breakdown of sales by sector (received from VDPS) to the overall forecasts for Vermont published by ISO-New England for the 2006 CELT Report.

Table 5-3: Total Cumulative Annual Achievable Potential kWh Savings for Electric Energy Efficiency In Vermont By 2015

Residential Sector - Market Driven and Retrofit Savings

1	2	3	4	5
Measure #	**Measure Description**	**Single-Family**	**Multi-Family**	**Total**
1	Refrigerator Turn-in	7,287,266	1,336,717	8,623,983
2	Freezer Turn-in	1,083,268	198,706	1,281,974
3	Room AC Turn-in without Replacement	0	0	0
4	Room AC Turn-in with ES Replacement	0	0	0
5	Energy Star Single Room Air Conditioner	1,622,596	297,636	1,920,232
6	Energy Star Compliant Top Freezer Refrigerator	7,159,471	1,313,276	8,472,747
7	Energy Star Compliant Bottom Mount Freezer Refrigerator	970,875	178,090	1,148,965
8	Energy Star Compliant Side-by-Side Refrigerator	3,350,905	614,663	3,965,568
9	Energy Star Compliant Upright Freezer (Manual Defrost)	1,950,394	357,765	2,308,159
10	Energy Star Compliant Chest Freezer	1,638,204	300,499	1,938,703
11	Energy Star Built-In Dishwasher (Electric)	6,200,900	1,137,443	7,338,343
12	Energy Star Clothes Washers with Electric Water Heater	5,310,316	974,082	6,284,398
13	Energy Star Clothes Washers with Non-Electric Water Heater	2,731,524	501,049	3,232,573
14	Energy Star Dehumidifier (40 pt)	8,154,677	1,495,828	9,650,505
15	Standby-Power	30,878,246	5,664,057	36,542,303
16	Pool Pump & Motor	9,969,145	691,246	10,660,391
17	Energy Star Compliant Programmable Thermostat	2,181,083	400,080	2,581,163
18	High Efficiency Central AC	1,034,916	189,837	1,224,753
19	CFL's: Homes with partial CFL installation	58,396,197	10,711,728	69,107,925
20	CFL's: Homes without CFL installation	76,427,839	14,019,308	90,447,147
21	Water Heater Blanket	0	0	0
22	Low Flow Shower Head	0	0	0
23	Pipe Wrap	0	0	0
24	Low Flow Faucet Aerator	0	0	0
25	Solar Water Heating	0	0	0
26	Efficient Water Heating	0	0	0
27	Efficient Furnace Fan Motor (Fuel Oil)	8,166,975	937,674	9,104,649
28	Efficient Furnace Fan Motor (Natural Gas)	1,725,417	843,991	2,569,408
29	Efficient Furnace Fan Motor (Propane)	2,360,371	374,732	2,735,103
30	Energy Star Windows - Electric Heat and no AC	0	0	0
31	Insulation and Weatherization - Electric Heat and no AC	0	0	0
32	Residential New Construction	26,108,372	0	26,108,372
33	Low Income Insulation & Weatherization - Elec. Heat & No AC	0	0	0
34	Water Heater-Elec. To Natural Gas (1 Bedroom)	250,521	328,013	578,534
35	Water Heater-Elec. To Natural Gas (2 Bedroom)	1,737,597	717,393	2,454,990
36	Water Heater-Elec. To Natural Gas (3 Bedroom)	5,004,487	639,647	5,644,134
37	Water Heater-Elec. To Natural Gas (4 Bedroom)	2,892,941	184,534	3,077,475
38	Water Heater-Elec. To Natural Gas (5+ Bedroom)	1,031,567	37,015	1,068,582
39	Water Heater-Elec. To Fuel Oil (1 Bedroom)	3,321,908	4,349,452	7,671,360
40	Water Heater-Elec. To Fuel Oil (2 Bedroom)	23,040,531	9,512,632	32,553,163
41	Water Heater-Elec. To Fuel Oil (3 Bedroom)	66,359,504	8,481,718	74,841,222
42	Water Heater-Elec. To Fuel Oil (4 Bedroom)	38,360,402	2,446,925	40,807,327
43	Water Heater-Elec. To Fuel Oil (5+ Bedroom)	13,678,580	490,820	14,169,400
44	Water Heater-Elec. To Propane (1 Bedroom)	701,459	918,436	1,619,895
45	Water Heater-Elec. To Propane (2 Bedroom)	4,865,270	2,008,701	6,873,971
46	Water Heater-Elec. To Propane (3 Bedroom)	14,012,565	1,791,011	15,803,576
47	Water Heater-Elec. To Propane (4 Bedroom)	8,100,236	516,696	8,616,932
48	Water Heater-Elec. To Propane (5+ Bedroom)	2,888,388	103,642	2,992,030
49	Water Heater-Elec. To Kerosene (1 Bedroom)	0	0	0
50	Water Heater-Elec. To Kerosene (2 Bedroom)	0	0	0
51	Water Heater-Elec. To Kerosene (3 Bedroom)	0	0	0
52	Water Heater-Elec. To Kerosene (4 Bedroom)	0	0	0
53	Water Heater-Elec. To Kerosene (5+ Bedroom)	0	0	0
54	WH Fuel Switching (Electric to Kerosene- Stand Alone)	37,112,690	6,313,946	43,426,636
55	WH Fuel Switching (Electric to Wood)	32,473,604	5,524,703	37,998,307
56	Space Heating (Fuel Switching)	40,974,658	3,758,031	44,732,689
57	Clothes Dryer (Fuel Switching)	20,939,485	4,776,559	25,716,044

Achievable kWh Savings by 2015	582,455,350	95,438,281	677,893,631
Forecast 2015 Vermont Residential kWh Sales			2,659,831,768
As a percent of forecasted residential sales 2015			25.5%

Note: Technical potential kWh savings were obtained from Appendix A of this report, column 32

Table 5-4: Total Annual Achievable Cost-Effective Potential kWh Savings for Electric Energy Residential Sector - Market Driven and Retrofit Savings

1	2	5	6	7
Measure #	Measure Description	Measure Level Societal Test Ratio SF	Measure Level Societal Test Ratio MF	Total Cumulative Annual kWh Savings by 2015
1	Refrigerator Turn-in	3.22	3.22	8,623,983
2	Freezer Turn-in	3.04	3.04	1,281,974
3	Room AC Turn-in without Replacement	0.79	0.79	0
4	Room AC Turn-in with ES Replacement	0.30	0.30	0
5	Energy Star Single Room Air Conditioner	5.95	5.95	1,920,232
6	Energy Star Compliant Top Freezer Refrigerator	3.33	3.33	8,472,747
7	Energy Star Compliant Bottom Mount Freezer Refrigerator	3.62	3.62	1,148,965
8	Energy Star Compliant Side-by-Side Refrigerator	3.96	3.96	3,965,568
9	Energy Star Compliant Upright Freezer (Manual Defrost)	1.84	1.84	2,308,159
10	Energy Star Compliant Chest Freezer	1.74	1.74	1,938,703
11	Energy Star Built-In Dishwasher (Electric)	3.01	3.01	7,338,343
12	Energy Star Clothes Washers with Electric Water Heater	3.08	3.08	6,284,398
13	Energy Star Clothes Washers with Non-Electric Water Heater	3.27	3.27	3,232,573
14	Energy Star Dehumidifier (40 pt)	>1	>1	9,650,505
15	Standby-Power	5.13	5.13	36,542,303
16	Pool Pump & Motor	2.14	2.14	10,660,391
17	Energy Star Compliant Programmable Thermostat	20.94	20.94	2,581,163
18	High Efficiency Central AC	4.39	4.39	1,224,753
19	CFL's: Homes with partial CFL installation	5.12	5.12	69,107,925
20	CFL's: Homes without CFL installation	5.64	5.64	90,447,147
21	Water Heater Blanket	17.33	17.33	0
22	Low Flow Shower Head			0
23	Pipe Wrap			0
24	Low Flow Faucet Aerator			0
25	Solar Water Heating	0.67	0.67	0
26	Efficient Water Heating	4.92	4.92	0
27	Efficient Furnace Fan Motor (Fuel Oil)	3.38	3.38	9,104,649
28	Efficient Furnace Fan Motor (Natural Gas)	3.38	3.38	2,569,408
29	Efficient Furnace Fan Motor (Propane)	3.38	3.38	2,735,103
30	Energy Star Windows - Electric Heat and no AC	>1	>1	0
31	Insulation and Weatherization - Electric Heat and no AC	13.04	6.52	0
32	Residential New Construction	12.05	N/A	26,108,372
33	Low Income Insulation & Weatherization - Elec. Heat & No AC	13.04	6.52	0
34	Water Heater-Elec. To Natural Gas (1 Bedroom)	3.63	3.63	578,534
35	Water Heater-Elec. To Natural Gas (2 Bedroom)	4.54	4.54	2,454,990
36	Water Heater-Elec. To Natural Gas (3 Bedroom)	5.45	5.45	5,644,134
37	Water Heater-Elec. To Natural Gas (4 Bedroom)	6.81	6.81	3,077,475
38	Water Heater-Elec. To Natural Gas (5+ Bedroom)	8.17	8.17	1,068,582
39	Water Heater-Elec. To Fuel Oil (1 Bedroom)	0.75	0.75	0
40	Water Heater-Elec. To Fuel Oil (2 Bedroom)	0.94	0.94	0
41	Water Heater-Elec. To Fuel Oil (3 Bedroom)	1.12	1.12	74,841,222
42	Water Heater-Elec. To Fuel Oil (4 Bedroom)	1.40	1.40	40,807,327
43	Water Heater-Elec. To Fuel Oil (5+ Bedroom)	1.69	1.69	14,169,400
44	Water Heater-Elec. To Propane (1 Bedroom)	0.57	0.57	0
45	Water Heater-Elec. To Propane (2 Bedroom)	0.71	0.71	0
46	Water Heater-Elec. To Propane (3 Bedroom)	0.85	0.85	0
47	Water Heater-Elec. To Propane (4 Bedroom)	1.07	1.07	8,616,932
48	Water Heater-Elec. To Propane (5+ Bedroom)	1.28	1.28	2,992,030
49	Water Heater-Elec. To Kerosene (1 Bedroom)	1.09	1.09	1,604,467
50	Water Heater-Elec. To Kerosene (2 Bedroom)	1.37	1.37	6,808,505
51	Water Heater-Elec. To Kerosene (3 Bedroom)	1.64	1.64	15,653,066
52	Water Heater-Elec. To Kerosene (4 Bedroom)	2.05	2.05	8,534,866
53	Water Heater-Elec. To Kerosene (5+ Bedroom)	2.46	2.46	2,963,534
54	WH Fuel Switching (Electric to Kerosene- Stand Alone)	0.43	0.60	0
55	WH Fuel Switching (Electric to Wood)	0.17	0.48	0
56	Space Heating (Fuel Switching)	2.72	1.36	44,732,689
57	Clothes Dryer (Fuel Switching)	1.97	1.97	25,716,044

Achievable Cost Effective kWh Savings		567,511,161
Forecast 2015 Vermont Residential kWh Sales		2,659,831,768
Savings as a percent of forecasted residential sales in 2015		21.3%

The Societal Test Benefit/Cost ratios show above in Table 5-4 were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The kWh savings shown above in Table 5-4 were obtained from Table 5-3, and kWh savings in the last column in Table 5-4 are greater than zero only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

Figures 5-2 to 5-8 provide information on the potential electric savings in the residential sector. About thirty-eight percent of the technical potential savings by 2015 is for fuel switching of electric water heating load to alternative fuels, twenty-two percent is for high efficiency lighting, and eleven percent is for fuel switching of space heating load to alternative fuels. Figure 5-9 and 5-10 presents the cost of conserved energy (CCE) for residential electric energy efficiency measures included in this study. Note that the CCE figures shown in Figures 5-10 and 5-11 only include electric savings, and do not include savings of other fuels (gas, oil, wood, etc.) or water. Note that Figures 5-10 and 5-11 are not supply curves; rather, these figures simply provide a picture of the relative cost of conserved energy for the electric energy efficiency and fuel shifting measures examined in this study. Note that there are **ten** residential energy efficiency measures having a cost of conserved energy less than $.02 per kWh saved.

Figure 5-1 Residential Electric Energy Efficiency Supply Curve for Vermont

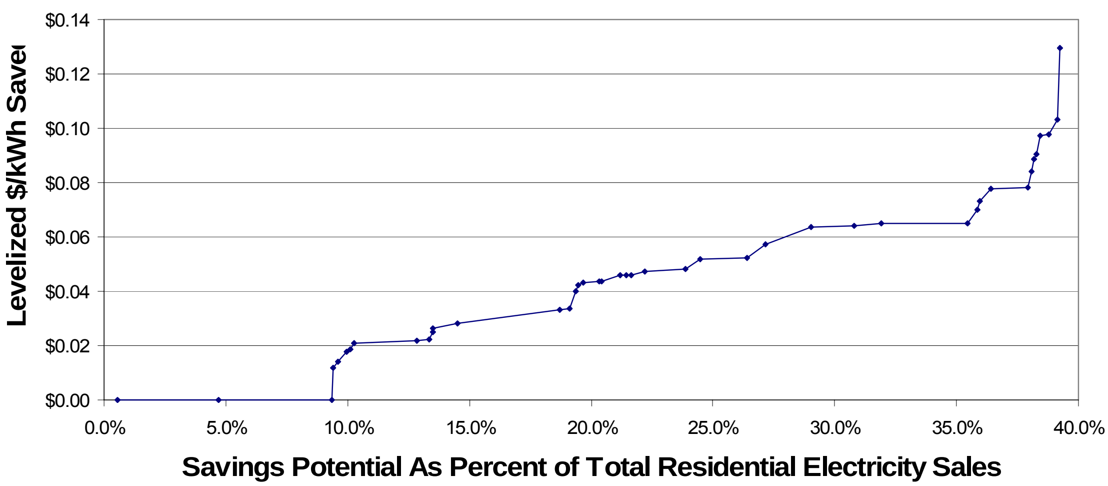


Figure 5-2 Summary of Potential Savings

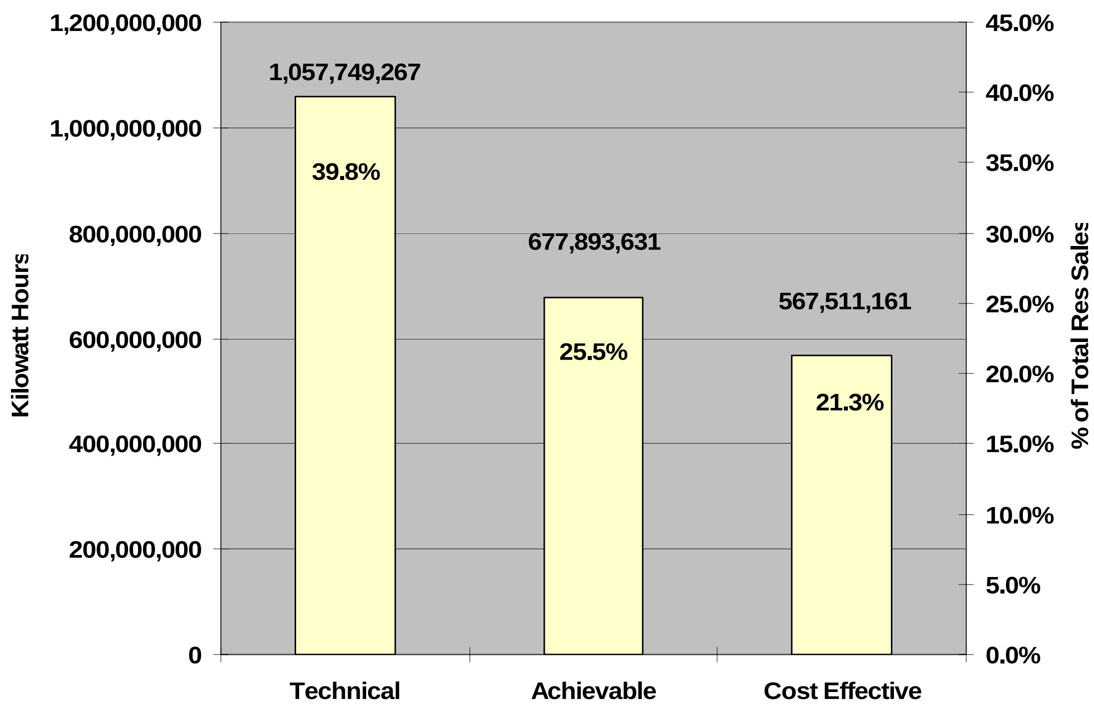


Figure 5-3 Residential Sector Technical Potential Savings By Measure Type - Kilowatt Hours

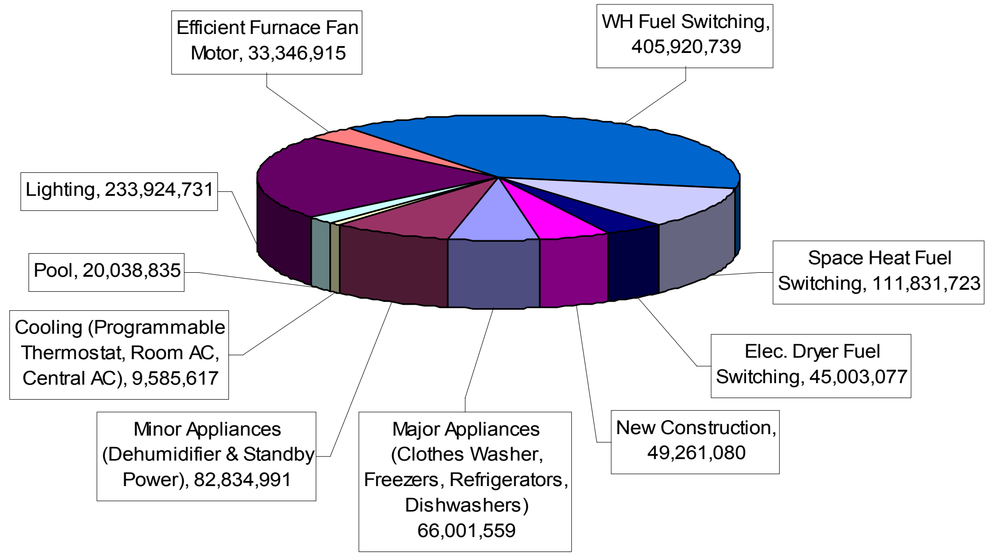


Figure 5-4 Residential Sector Technical Potential Savings By Measure Type - Percent of Total Savings

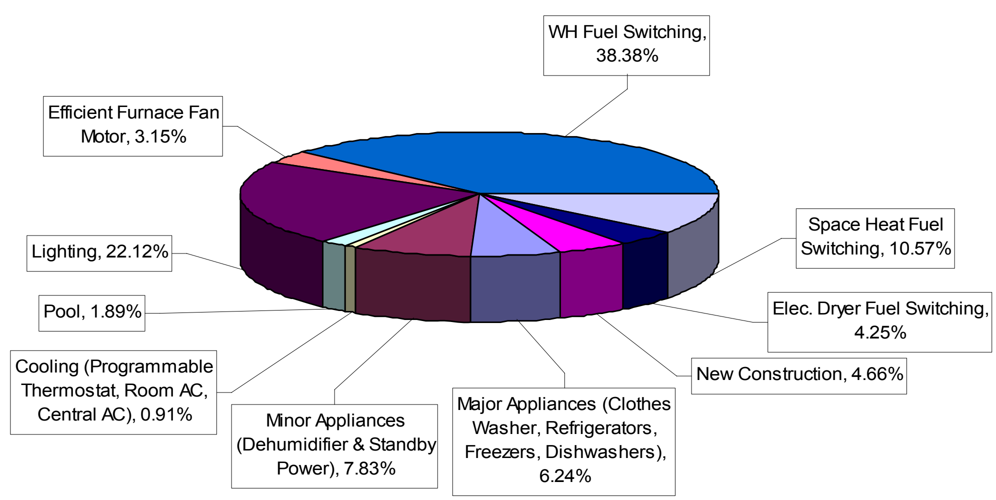


Figure 5-5 Residential Sector Achievable Savings By Measure Type - Kilowatt Hours

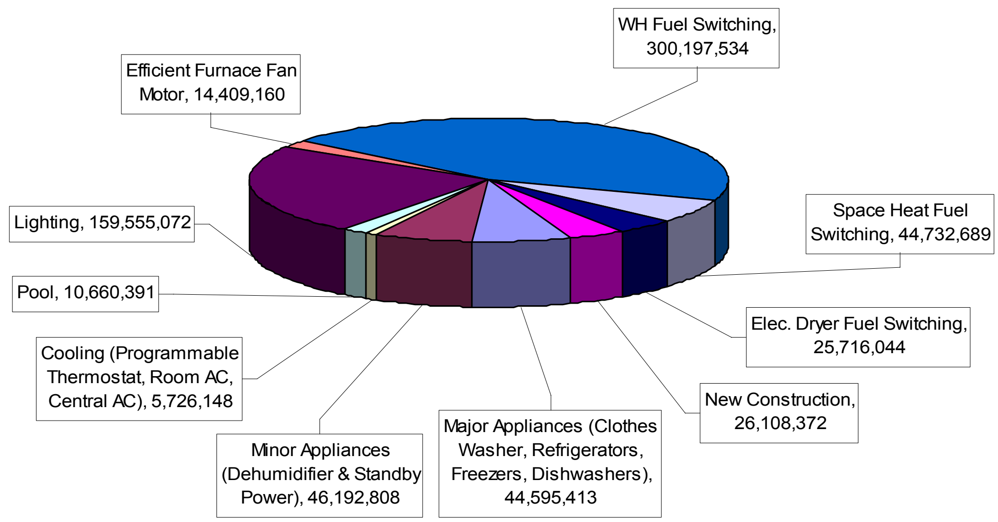


Figure 5-6 Residential Sector Achievable Savings by Measure Type - Percent of Total Savings

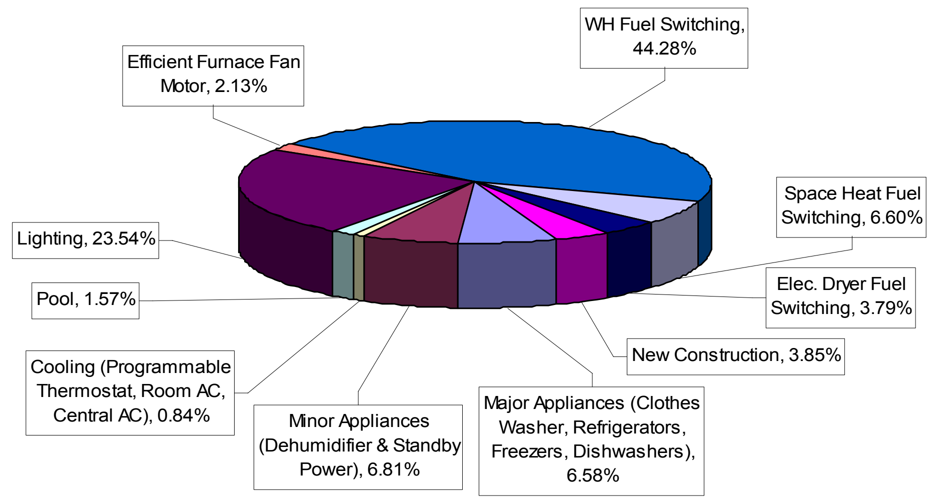


FIgure 5-7 Residential Sector Achievable Cost Effective Savings by Measure Type - Kilowatt Hours

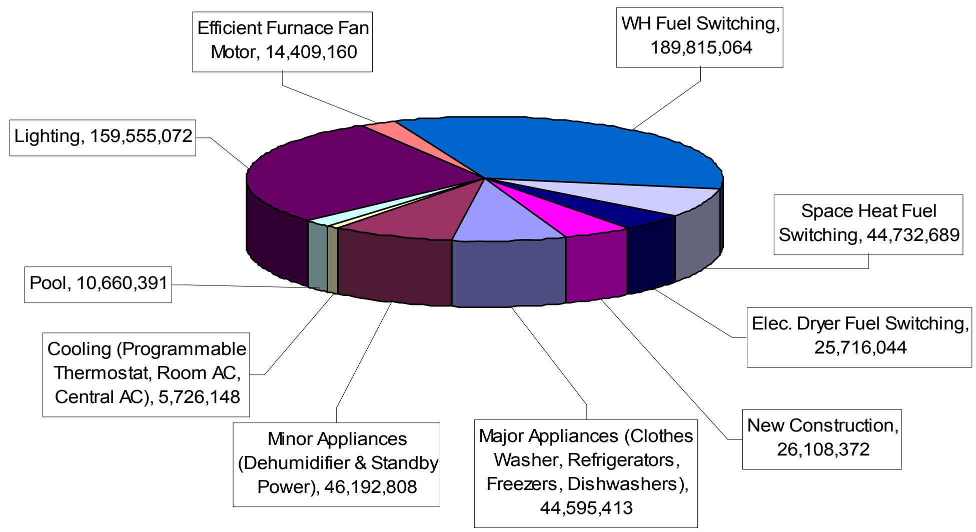


Figure 5-8 Residential Sector Achievable Cost Effective Savings by Measure Type - Percent of Total Savings

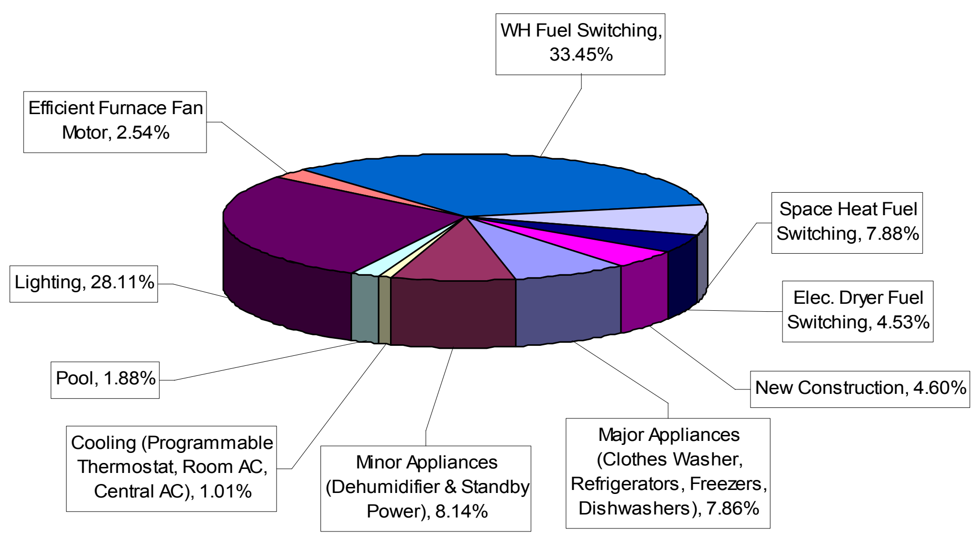


Figure 5-9
Cost of Conserved Energy - Residential Electric Energy Efficiency Measures (Measures under $.05 Per kWh Saved)

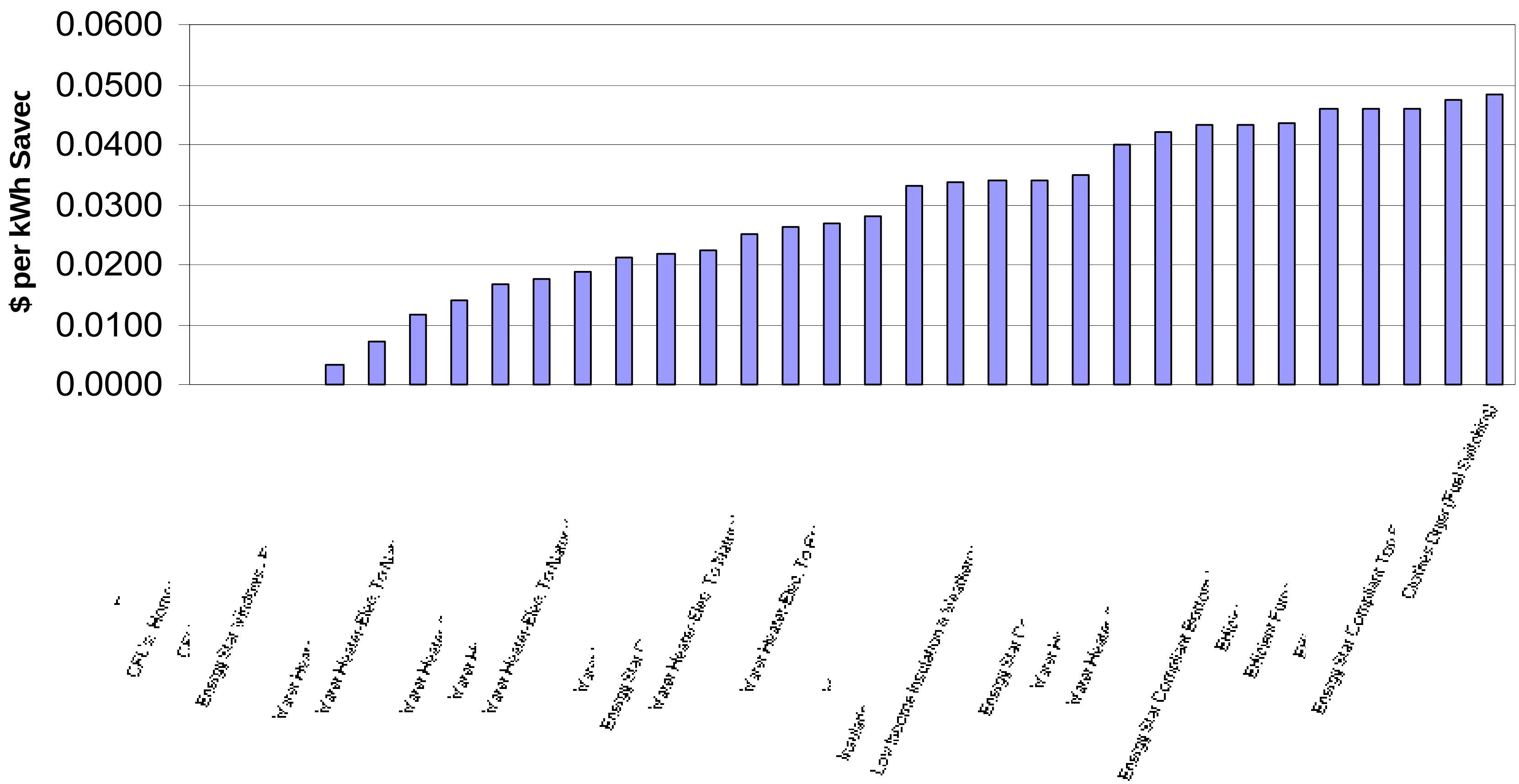
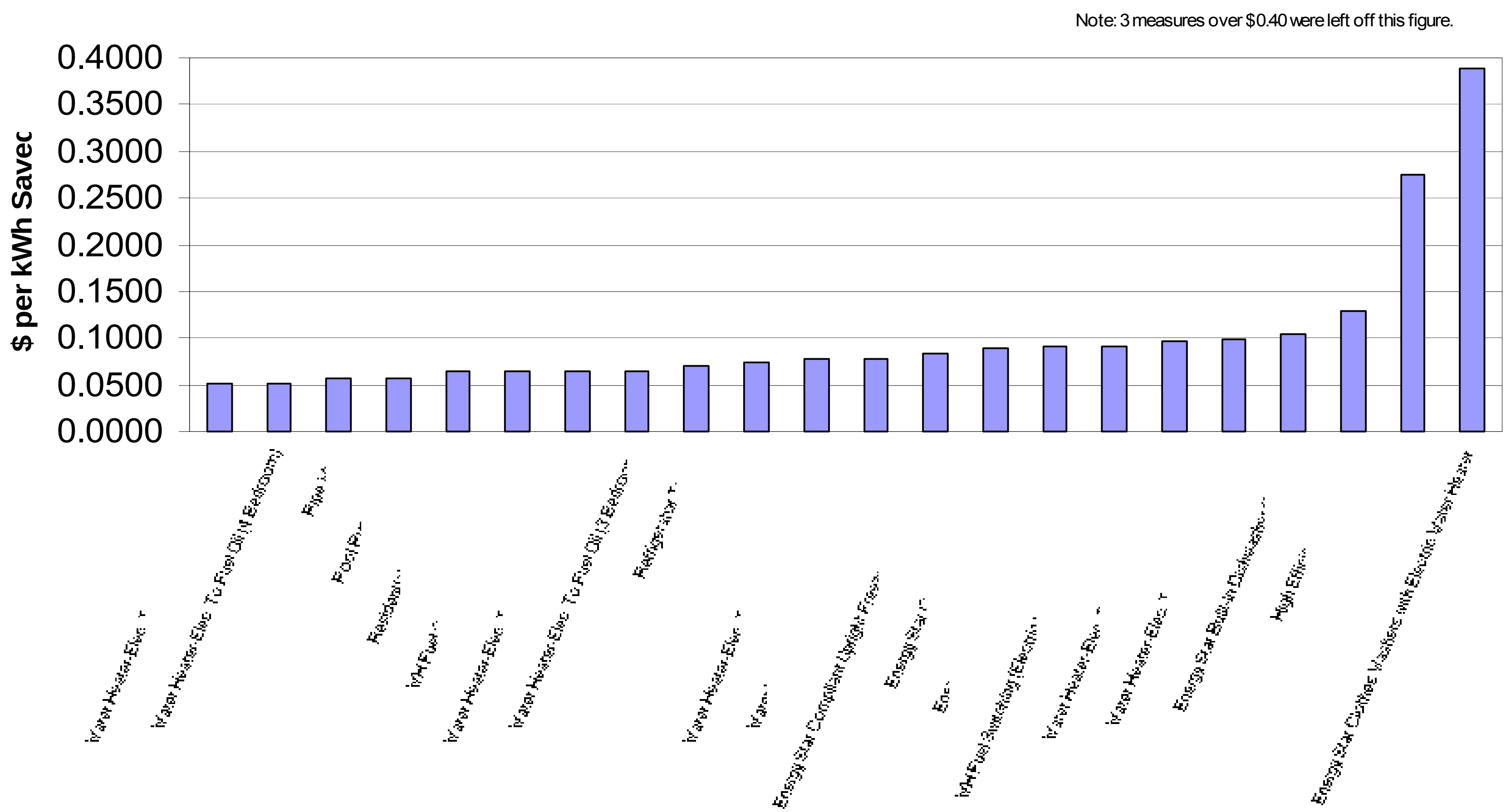


Figure 5-10
Cost of Conserved Energy - Residential Electric Energy Efficiency Measures (Measures over $.05 & under $.40 Per kWh Saved)



As shown in Table 5-5 below, the achievable electricity savings of 25.5% determined in this study is very close to the 30% determined in the January 2003 Vermont energy efficiency potential study.

Table 5-5: Comparison to 2006 Potential Savings Estimates to 2002 Estimates
Residential Sector

	Optimal Energy - 2002	GDS Associates- 2006
Technical Potential	NA	39.8%
Achievable Potential	30%	25.5%
Achievable Cost Effective Potential	NA	21.3%

6.0 COMMERCIAL SECTOR ENERGY EFFICIENCY POTENTIAL

6.1 Introduction

For the commercial sector in Vermont, the electric lighting end use still represents the largest savings potential in absolute terms for both energy and peak demand, despite the significant adoption of high-efficiency lighting throughout the 1990's. Refrigeration represents the second largest end-use category for kWh savings and space cooling makes up the second largest category for kW demand savings. The distribution of commercial sector savings by end use is shown in Figure 6-5 later in this section. It is important to note that GDS has used definitions for the commercial and industrial sectors provided by VDPS staff.[52]

This section of the report provides the estimates of technical, achievable and achievable cost effective energy efficiency potential for electric energy efficiency measures for the commercial sector in Vermont. The commercial sector as defined in this analysis is based on the kWh sales data provided by Central Vermont Public Service (CVPS) and is reported to be based on level of kWh sales and kW demand rather than building type. CVPS provided GDS with a summary of all industrial kWh sales by SIC code and this data was subtracted from the total commercial and industrial data to result in a commercial-only kWh sales estimate. Therefore, the commercial sector does include the smaller end of the manufacturing sector.

Technical electricity savings potential is estimated to be approximately 854,144,426 kWh by the year 2015. Achievable potential is estimated to be approximately 516,303,285 kWh and achievable cost effective potential is estimated to be 450,383,577 kWh by 2015. Table 6-1 shows the potential savings in cumulative annual kWh and in percentage terms for the existing buildings and new construction sector.

[52] Staff of the Vermont Department of Public Service provided historical Vermont data on commercial and industrial sector kWh sales and customers for the period 1992 to 2004. See Tables 3-1 and 3-2 in Section 3 of this report to see this historical kWh sales and customer data for the commercial and industrial sectors in Vermont. In the year 2004, there were 44,743 commercial sector electric customers, according to the historical data provided by Riley Allen of the VDPS.

Table 6-1: Summary of Commercial Sector Electric Savings Potential in Vermont		
	Estimated Cumulative Annual kWh Savings by 2015	**% Savings of 2015 Commercial Sector kWh Sales**
Technical Potential	**854,144,426**	**40.4%**
Existing Buildings	*844,261,646*	*40.5%*
New Construction	*9,882,780*	*31.4%*
Achievable Potential	**516,303,285**	**24.4%**
Existing Buildings	*509,105,415*	*24.4%*
New Construction	*7,197,870*	*22.9%*
Achievable Cost Effective Potential	**450,383,577**	**21.3%**
Existing Buildings	*444,282,285*	*21.3%*
New Construction	*6,101,292*	*19.4%*

The methodology used to develop these estimates of electricity savings is described in Section 4 of this report.

6.2 Efficiency Measures Examined

In order to develop a list of commercial technologies to be included in this analysis, GDS reviewed several sources including the Efficiency Vermont Technical Resource Manual (TRM), the previous Vermont and New York potential savings analyses conducted by Optimal Energy, Inc., and the Connecticut potential savings study conducted by GDS. A preliminary list of measures was provided to the Vermont DPS for review and comment.

A total of 73 commercial electric measures were used in the analyses (7 cooling, 3 space heating, 6 whole building/controls, 5 water heating, 25 lighting, 14 refrigeration, 2 ventilation, and 11 miscellaneous). The total number of commercial technologies considered for inclusion was 93, however this was comprised of similar measures of varying sizes (i.e., 3, 7.5, and 15 ton packaged AC units). When running the savings potential analysis on the commercial sector using the top-down approach, which is based on kWh sales rather number of units, it is useful to select a prototypical unit size rather than including all sizes. This number of commercial technologies compares well with the 90 technologies that were analyzed in the 2003[53] Vermont statewide savings analysis conducted by Optimal Energy, Inc.

[53] This report is titled "Vermont Department of Public Service, Electric and Economic Impacts of Maximum Achievable Statewide Efficiency Savings, 2003 to 2012, Results and Analysis Summary", and this report is dated January 31, 2003. This report was prepared for the Department by Optimal Energy.

Table 6-2 lists the commercial electric energy efficiency measures included in the technical potential analysis as well as the savings estimates used for the major commercial building types. Measures were analyzed as either market driven replacements or retrofits. Replacement measures include incremental cost and savings assumptions whereas retrofit measures include full installed cost and total savings to go from the existing inefficient unit to the energy efficient model. Further discussion of market driven versus retrofit measures is included in Section 6.5.

Table 6-2 Commercial Sector Energy Efficiency Measures

Measure Name	Energy Savings Range[1]
Space Heating	
High Efficiency Heat Pump	8%
Hydronic Heating Pump	34%
Ground Source Heat Pump - Heating	29%
Integrated Building Design	40%
Double Pane Low Emissivity Windows	15%
Retrocommissioning	10%
Programmable Thermostats	3% - 10%
EMS install	10%
EMS Optimization	1% - 8%
Dual Enthalpy Economizer - from Fixed Damper	22%
Dual Enthalpy Economizer - from Dry Bulb	22%
Water Heating	
Heat Pump Water Heater	43%
Booster Water Heater	13%
Point of Use Water Heater	7%
Solar Water Heating System	60%
Solar Pool Heating	40%
Space Cooling	
Centrifugal Chiller, 0.51 kW/ton, 300 tons	15%
Centrifugal Chiller, Optimal Design, 0.4 kW/ton, 500 tons	33%
Chiller Tune Up/Diagnostics - 300 ton	8%
Packaged AC - 7.5 tons, Tier 2	14%
Ground Source Heat Pump - Cooling	36%
DX Tune Up/ Advanced Diagnostics	10%
Comprehensive Track Proper HVAC Sizing	5%
Ventilation	
Fan Motor, 5hp, 1800rpm, 89.5%	3%
Variable Speed Drive Control, 15 HP	30%
Motors	
Efficient Motors	1%
Variable Frequency Drives (VFD)	41%
Lighting	
Super T8 Fixture - from 34W T12 – *Early Replacement*	43%
Super T8 Fixture - from standard T8	20%
T5 Troffer/Wrap	27%
T5 Industrial Strip	27%
T5 Indirect	27%
Dairy Farm Vapor Proof T8 Fixture with Electronic Ballast	29%
Lighting Controls	30%
Bi-Level Switching	10%
Occupancy Sensors	30%
Daylight Dimming	35%
5% & 10% More Efficient Design	5% & 10%
15% & 30% More Efficient Design - New Construction	15% & 30%
T5 Fluorescent High-Bay Fixtures	49%

Measure Name	Energy Savings Range[1]
Electronic HID Fixture Upgrade	25%
CFL Fixture	71%
Halogen Infra-Red Bulb	20%
Integrated Ballast MH 25W	72%
Induction Fluorescent 23W	74%
CFL Screw-in	71%
Dairy Farm Hard-Wired Vapor-Proof CFL Fixture with Electronic Ballast	71%
Metal Halide Track	60%
Exterior HID	55%
LED Exit Sign	82%
LED Traffic / Pedestrian Signals	85%
Refrigeration	
Vending Miser for Soft Drink Vending Machines	46%
Refrigerated Case Covers	6%
Refrigeration Economizer	30%
Commercial Reach-In Refrigerators	26%
Evaporator Fan Motor Controls	30%
Permanent Split Capacitor Motor	4%
Zero-Energy Doors	20%
Door Heater Controls	55%
Discus and Scroll Compressors	7%
Floating Head Pressure Control	7%
Anti-sweat (humidistat) controls (refrigerator & freezer)	5%
Commercial Reach-In Freezer	9%
High Efficiency Ice Maker	6%
Commercial Ice-makers	6%
Miscellaneous	
EZ Save Monitor Power Management Software	15%
Compressed Air – Non-Controls	20%
Compressed Air – Controls	15%
Efficient Snow Making	80%
Water/Wastewater Treatment Improved equipment and controls	35%
Energy Star Transformers	44%
Dairy Farms	
VFDs for Milk Transfer & Vacuum Pumps	30%

[1] Range of energy savings indicates variability across building types and climate zones.

Estimated annual savings, and consequently the benefit/cost ratios, vary for some of the measures based on the type of building. Also, for certain niche technologies such as efficient snowmaking equipment and VFD's for dairy pumps, these savings values only apply to the specific market for which they are intended. Emerging technologies that are not yet commercially available were not included in this analysis.

The measure analysis was segmented into ten commercial building types for the Vermont service territory. The technical, achievable and achievable cost effective potential results are presented in aggregate in the form of electricity supply curves. We provide estimates of savings in both absolute kWh and percentage terms.

We based this technical, achievable and achievable cost effective potential energy savings analysis on Vermont's commercial sector electricity sales forecast for the period 2006 to 2015, as presented in Section 3. Electrical energy efficiency measures were analyzed for the most common and energy-intensive end uses.

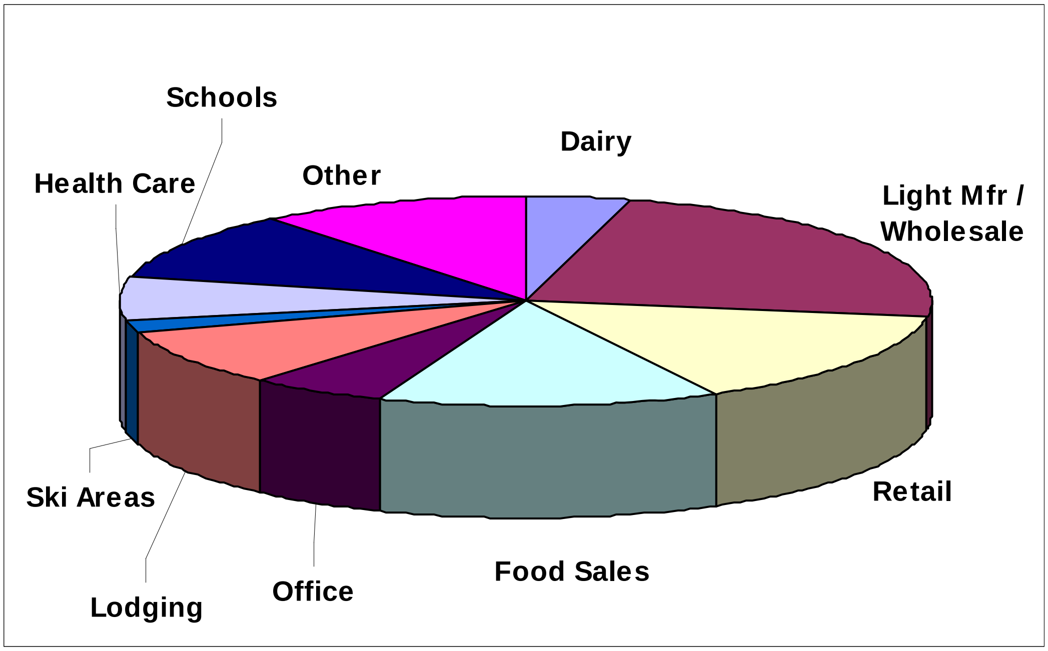
6.3 Commercial Sector Segmentation

Table 6-3 and Figure 6-1 illustrate the commercial sector electricity sales based segmentation. This segmentation is based on 2004 commercial sales data by SIC code as provided by Central Vermont Public Service (CVPS). The CVPS data is used as a proxy for the entire State of Vermont as state-wide sales data by SIC code was not available.

Table 6.3 Commercial Sector Segmentation

	Industry Type	Percent of kWh Sales	SIC Categories
1	Dairy	4%	024
2	Light Mfr / Wholesale	23%	20-39, 42, 50-51
3	Retail	15%	52-53, 55-57, 59, 72, 75-79
4	Food Sales	14%	54, 58
5	Office	6%	60-64, 66-67, 73, 81, 87-97
6	Lodging	9%	65, 70
7	Ski Areas	2%	799
8	Health Care	7%	80, 83
9	Schools	10%	82
10	Other	11%	01-09, 11-17, 40, 41, 44-49, 84-86, 99
	Total	100%	

Figure 6-1 Commercial Sector Segmentation



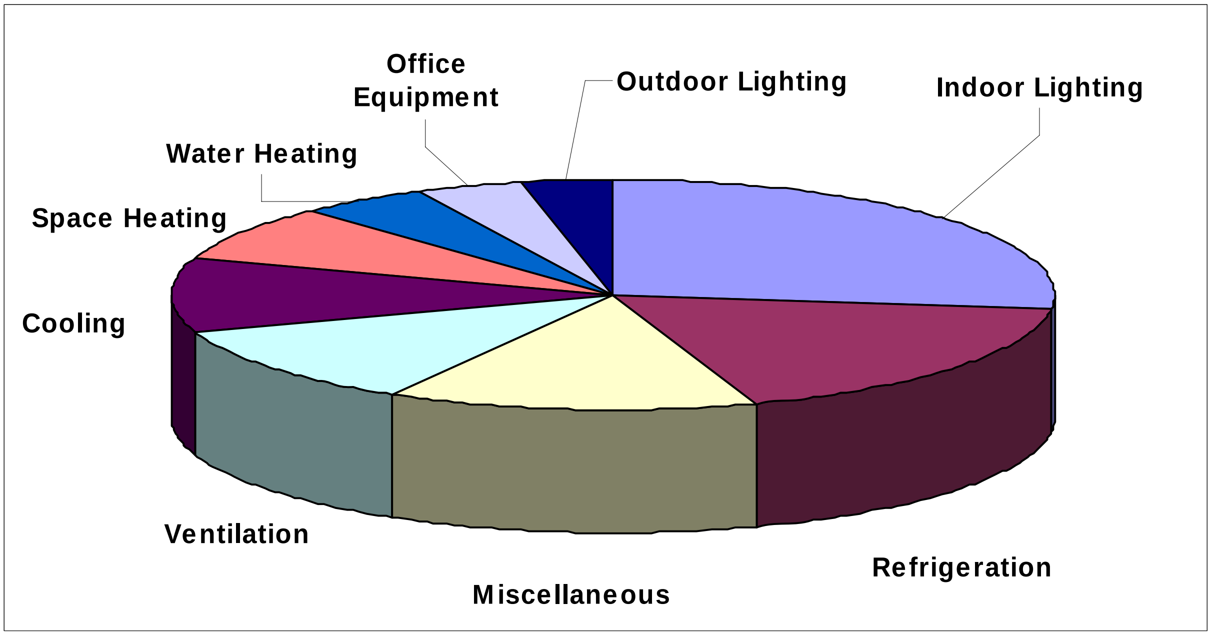
6.4 Commercial End Use Breakdown

A breakdown of commercial electricity use by end-use and industry type was developed based on data included in the 2003 New York Technical Potential Study. This study divided New York into regions and the Albany region (Region F) was used as a reasonable representation of the commercial sector in Vermont. Table 6.4 and Figure 6.2 show the resulting end use allocation used in this analysis.

Table 6.4 Commercial End Use Breakdown

End Use	Percent of Total
Indoor Lighting	27%
Refrigeration	18%
Miscellaneous	14%
Cooling	12%
Ventilation	10%
Space Heating	8%
Water Heating	5%
Office Equipment	4%
Outdoor Lighting	3%

Figure 6-2 Commercial End Use Breakdown



In order to estimate the level of commercial kWh sales that are associated with commercial new construction in Vermont, we used data provided by the VT DPS from the previous Vermont Technical Potential Study conducted by Optimal Energy. Given the very low load growth for the commercial sector in the current statewide load forecast, the percent of electric sales associated with commercial new construction was decreased from the forecast used in the 2002 study. The level of kWh associated with commercial new construction in 2015 is estimated to be 31,468 MWh.

6.5 Technical, Achievable, and Achievable Cost Effective Potential

This section presents technical, achievable, and the achievable cost effective savings potential estimates for the commercial sector for the year 2015. Following the presentation of the commercial sector results in terms of kWh and percent of commercial market, energy efficiency supply curves are presented for the each of the savings potential estimates.

Technical savings potential is estimated to be 854,144,426 kWh by 2015, achievable potential is estimated to be 516,303,285 kWh and achievable cost effective potential is estimated to be 450,383,577 kWh (or between 21 and 40 percent of expected commercial electricity consumption in the year 2015). Figure 6-3 illustrates the three values along with the associated percent of Vermont's commercial electricity sales in 2015.

Figure 6-3 Estimated Technical, Achievable, and Cost Effective Potential for Electric Energy Efficiency in Vermont in 2015 - Commercial Sector

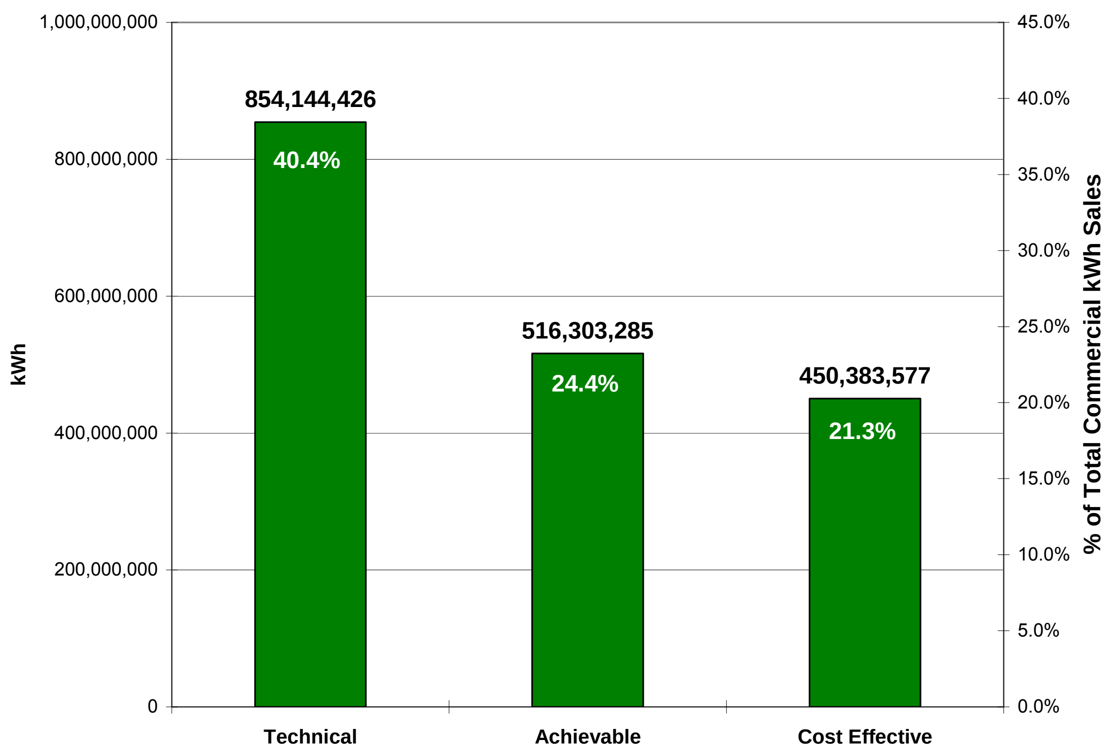


Table 6-5 and Figure 6-4 show the total achievable cost effective potential kWh savings for existing commercial buildings within each of the commercial end uses. Lighting accounts for the largest percentage of savings potential at 41 percent, with refrigeration being the second largest at 36 percent. Space cooling and related HVAC controls are third largest at 13 percent and water heating, space heating, motors, and miscellaneous loads represent the remaining 10 percent.

Table 6-5 Achievable Cost Effective kWh Savings by End Use for Existing Commercial Buildings

End Use Category	Total kWh Saved	% Savings
Lighting	182,922,974	41.17%
Refrigeration	159,062,625	35.80%
HVAC, Cooling	58,629,630	13.20%
Water Heating	16,922,824	3.81%
Motors, Pumping	13,127,712	2.95%
Space Heating	12,676,725	2.85%
Transformers	939,796	0.21%
Total Savings	**444,282,286**	**100%**

Figure 6-4 Achievable Cost Effective kWh Savings by End Use for Existing Commercial Buildings

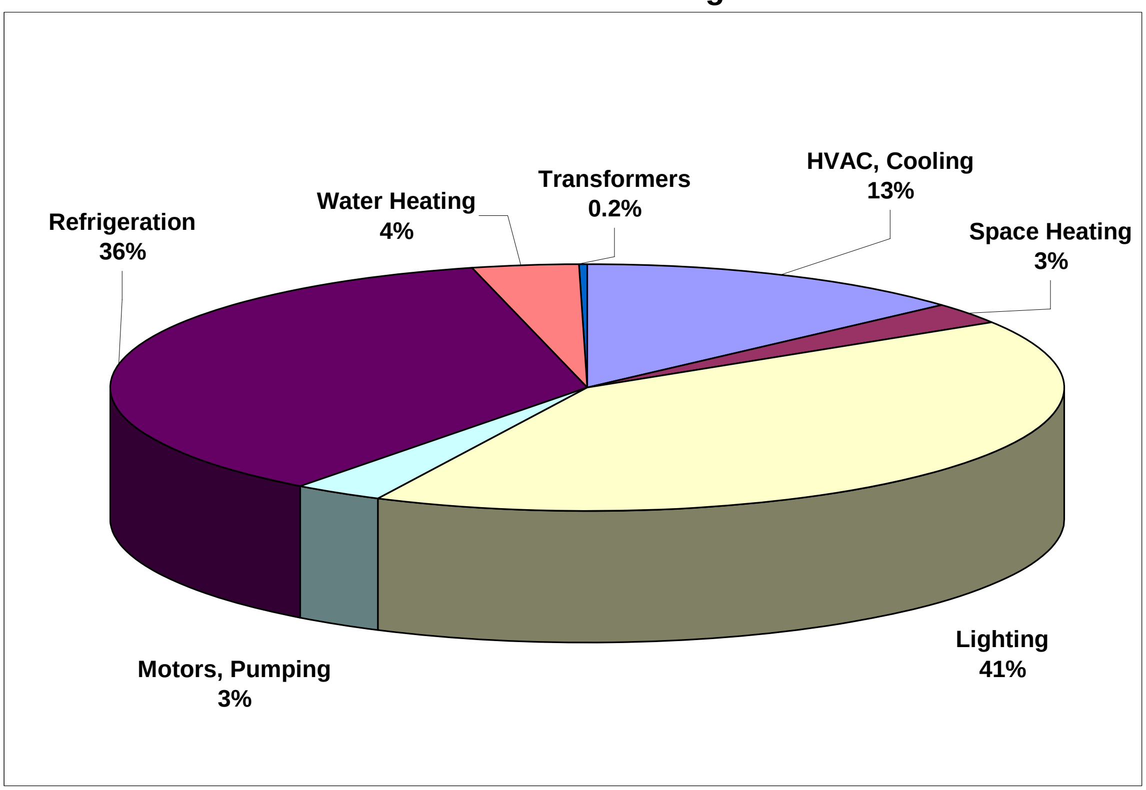


Table 6-6 and Figure 6-5 show the total achievable cost effective potential kWh savings associated with commercial new construction within each of the commercial end uses. For new construction, refrigeration measures account for the largest percentage of savings potential at 44 percent, with space cooling being a distant second at 17 percent. Lighting is next highest at 13 percent and space heating, motors, and water heating are lower at between 5 and 11 percent each.

Table 6-6 Achievable Cost Effective kWh Savings by End Use for Commercial New Construction

End Use Category	Total kWh Saved	% Savings
Refrigeration	2,673,414	43.82%
HVAC, Cooling	1,052,946	17.26%
Lighting	774,258	12.69%
Space Heating	665,546	10.91%
Motors, Pumping	569,592	9.34%
Water Heating	278,997	4.57%
Transformers, Misc.	86,540	1.42%
Total Savings	**6,101,292**	**100%**

Figure 6-5 Achievable Cost Effective kWh Savings by End Use for Commercial New Construction

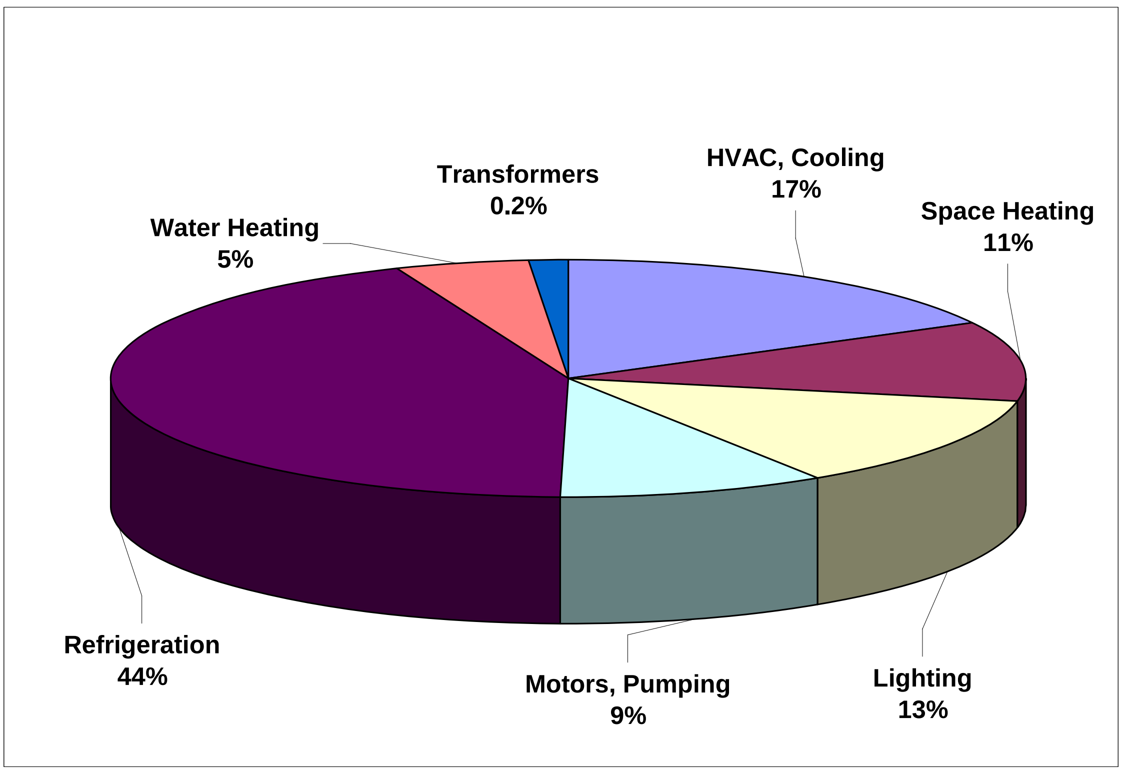


Table 6-7 and Figure 6-6 show the electric demand (kW) savings that is associated with the achievable cost effective potential savings level for existing buildings. Lighting technologies account for a large percentage of the kW savings potential at 40 percent. Refrigeration and space cooling measures make up the next two largest demand savings categories at 20 percent and 18 percent, respectively. Space heating represents 9 percent of the total demand savings and water heating, miscellaneous loads, and motors make up the remaining 14 percent

Table 6-7 Achievable Cost Effective kW Savings by End Use Existing Commercial Buildings

End Use Category	Total kW Saved	% Savings
Lighting	50,951.2	39.8%
Refrigeration	25,665.2	20.0%
HVAC, Cooling	22,789.2	17.8%
Space Heating	11,638.0	9.1%
Water Heating	7,262.5	5.7%
Miscellaneous	5,305.9	4.1%
Motors	4,433.4	3.5%
Total kW Savings	128,045.4	100.0%

Figure 6-6 Achievable Cost Effective kW Savings by End Use for Existing Commercial Buildings

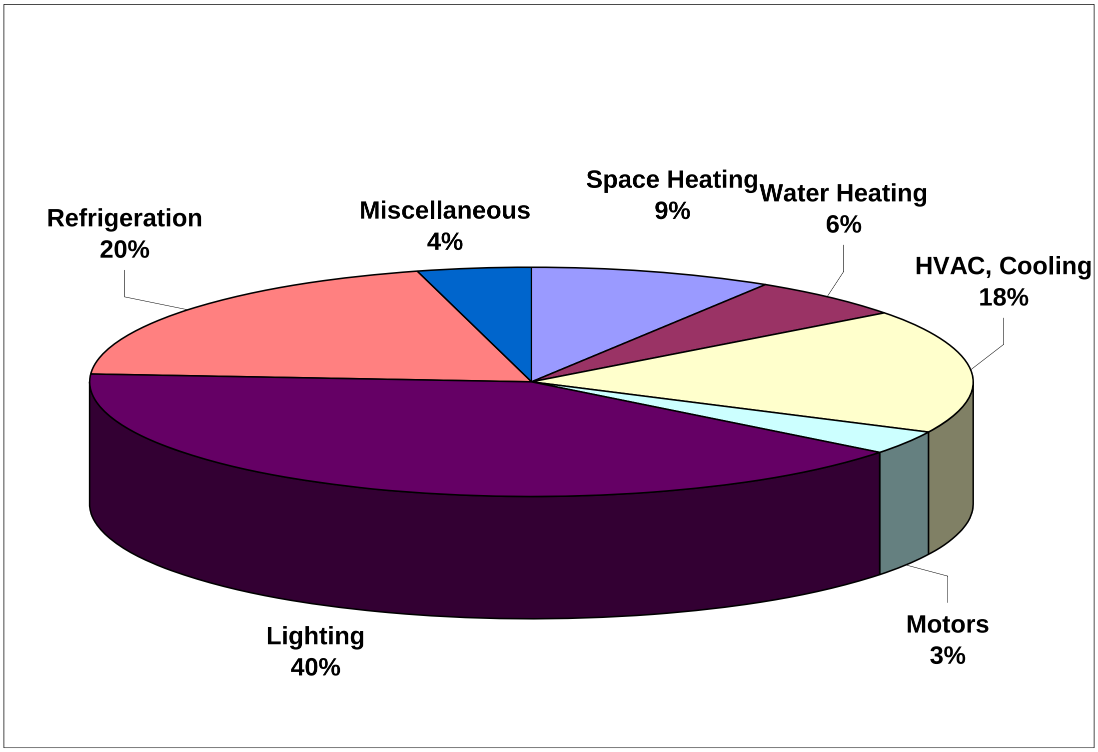
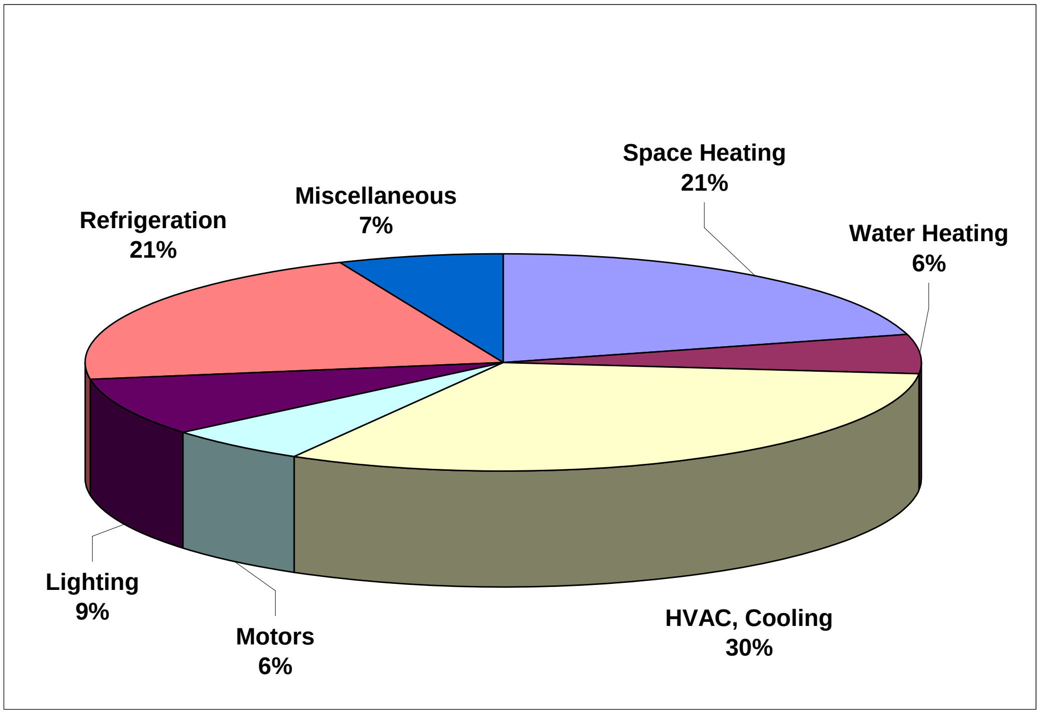


Table 6-8 and Figure 6-7 show the electric demand (kW) savings that is associated with the achievable cost effective potential savings level for commercial new construction. Space cooling technologies account for the largest percentage of the kW savings potential at 31 percent. Space heating and refrigeration make up the next largest demand savings categories at 21 percent each. Lighting, miscellaneous, water heating and motors make up remaining 27 percent, at between 6 and 9 percent each.

Table 6-8 Achievable Cost Effective kW Savings by End Use Commercial New Construction

End Use Category	Total kW Saved	% Savings
HVAC, Cooling	635.1	31.4%
Space Heating	421.6	20.9%
Refrigeration	421.6	20.9%
Lighting	176.4	8.7%
Miscellaneous	131.7	6.5%
Water Heating	119.8	5.9%
Motors	115.3	5.7%
Total kW Savings	2,021.4	100.0%

Figure 6-7 Achievable Cost Effective kW Savings by End Use for Commercial New Construction



Retrofit, Market Driven, and Early Replacement Measures

For the commercial sector, retrofit, market driven (also referred to as replace-on-burnout), and early replacement (a specialized case of retrofit which is addressed in Appendix G) measures were considered. The primary difference between the types of measures is the timing of interaction with the program participant and the ramp-in rate of the measures over the ten year study period. Listed below is a description of the three types of equipment replacement approaches examined in this report.

- Retrofit and early replacement measures are assumed to be installed in an aggressive manner for the first five years of the period and then less so for the remaining five years. These measures are replaced before the end of the useful life of equipment.
- With a market driven approach, measures are replaced at the end of their useful lives or when they burn out. In this study, measures that are replaced at they time they burn out are ramped in on a linear basis at a rate that is dictated by the estimated life of the measure, in years. For example, for efficient motors with a measure life of 20 years, the motors are ramped-in at a linear ten percent per year but only half of the total potential savings can be captured in the ten year study period because only half of the motors would "burn out" in ten years.
- Early replacement refers to a piece of equipment whose replacement is accelerated by several years for the purposes of capturing energy and

peak demand savings earlier than would otherwise occur under a market driven scenario

For retrofit measures (including both early retirement and other retrofits), the ramp-in rate is independent of the estimated life of the measure so all potential savings can be captured in the ten year study period regardless of the measure life. For this study, retrofit measures were categorized as those that would not typically "burn out". For example, programmable thermostats are typically installed for their added features rather than because a standard thermostat "burned out". However, it is understood that in some cases, a programmable thermostat may be installed during a renovation or remodeling project. Similarly, control and system optimization measures such as retrocomissioning and the optimization of Energy Management Systems (EMS) were also considered on a retrofit basis.

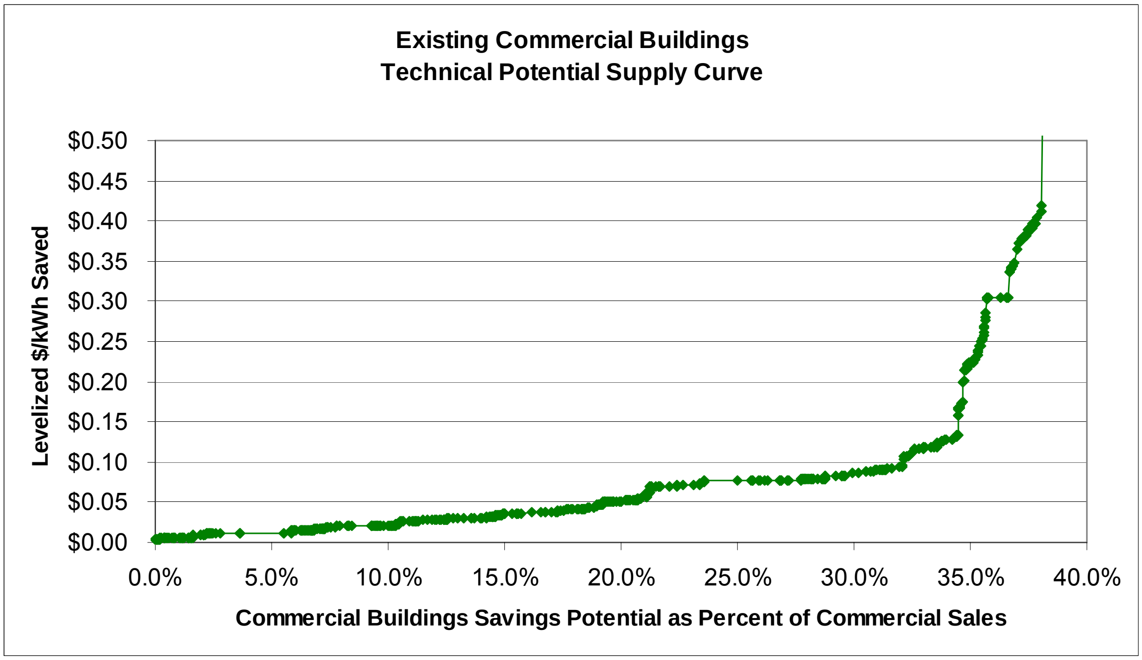
Early replacement measures are a specialized retrofit case. Early replacement refers to a piece of equipment whose replacement is accelerated by several years for the purposes of capturing energy and peak demand savings earlier than would otherwise occur under a market driven scenario. The modeling for early replacement measures differs from retrofit measures in that all of the measures are assumed to be installed in the initial four years of the study.

The achievable cost effective savings potential for existing buildings is made up of approximately 59 percent from market driven measures and 41 percent from retrofit measures. New construction measures are not bound by measure life because they are all measures being installed in a given year. For purposes of modeling, they are essentially viewed as retrofit, where the entire potential for each measure is available without regard to the measure life.

Energy Efficiency Supply Curves

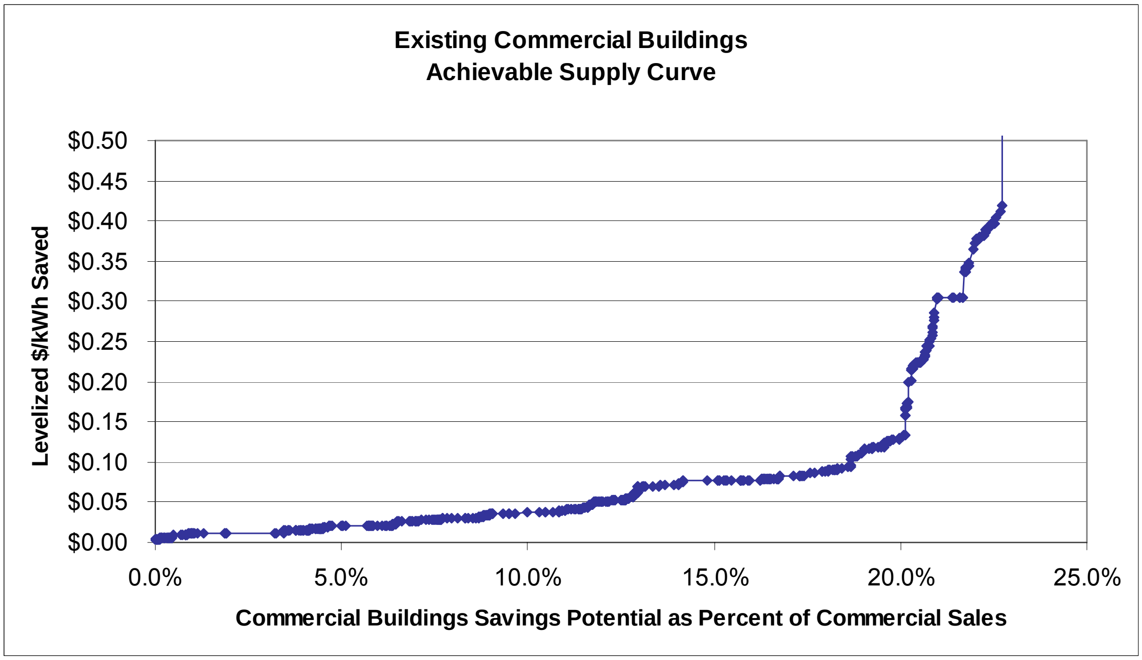
Figures 6-8 through 6-13 on the following pages illustrate the technical, achievable and achievable cost effective supply curves for the existing building and new construction components of the commercial sector. As can be seen in each of the supply curve graphs, much of the savings (nearly all in the case of the achievable cost effective scenario) can be achieved at less than $0.10 per kWh saved. It should be noted that due to the inclusion of non-electric benefits, which are not reflected in the supply curves, some measures with relatively high levelized cost per kWh values are included in the cost effective results.

Figure 6-8 Technical Potential Supply Curve for Existing Commercial Buildings



Note: Non-electric benefits are not reflected in the supply curve.

Figure 6-9 Achievable Potential Supply Curve for Existing Commercial Buildings



Note: Non-electric benefits are not reflected in the supply curve.

Figure 6-10 Achievable Cost Effective Potential Supply Curve for Existing Commercial Buildings

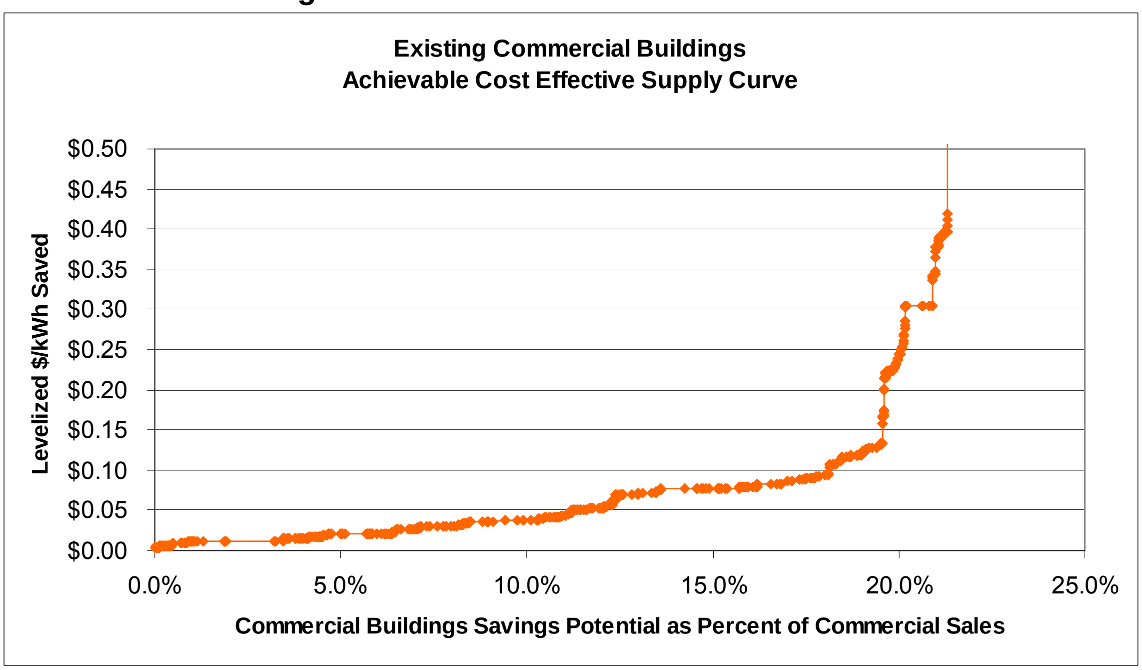
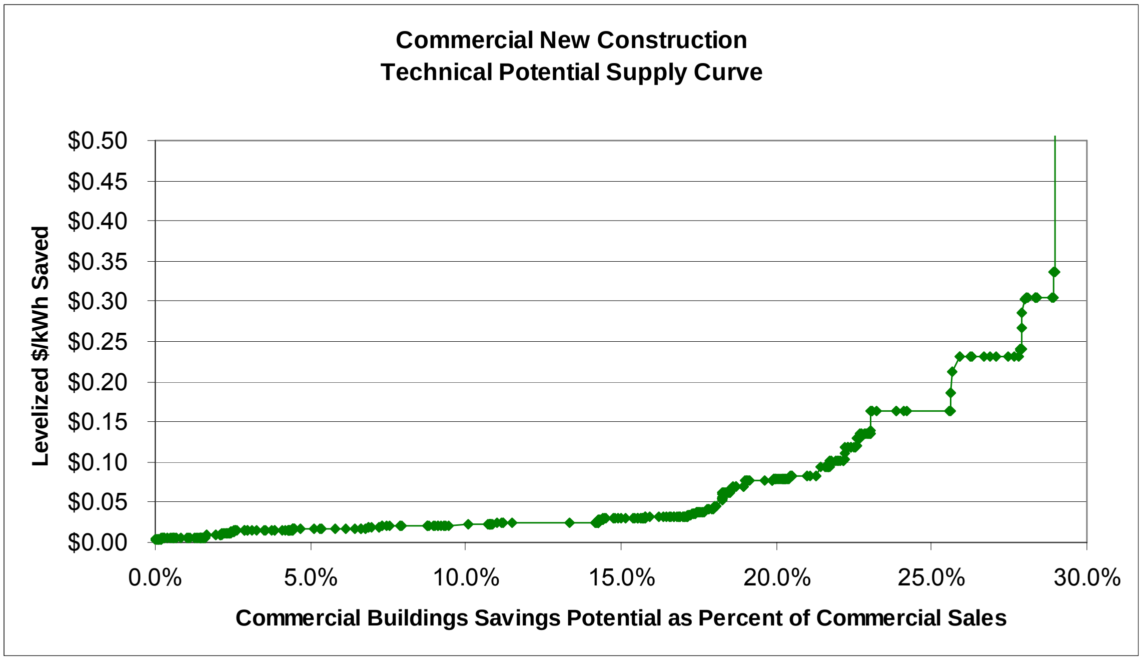
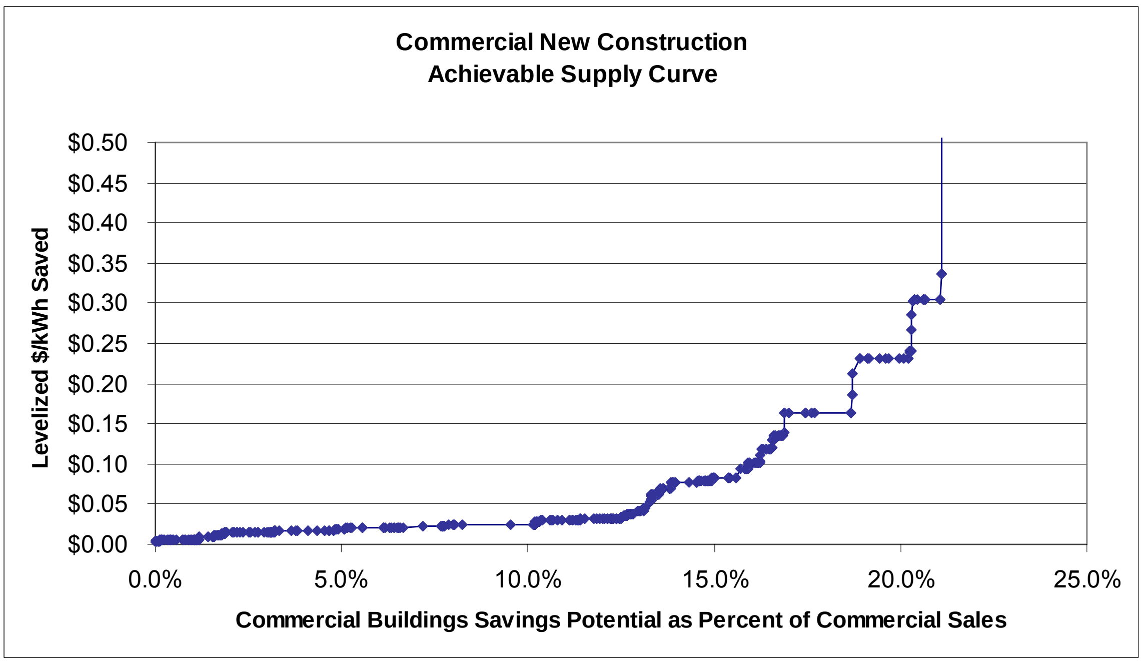


Figure 6-11 Technical Potential Supply Curve for Commercial New Construction



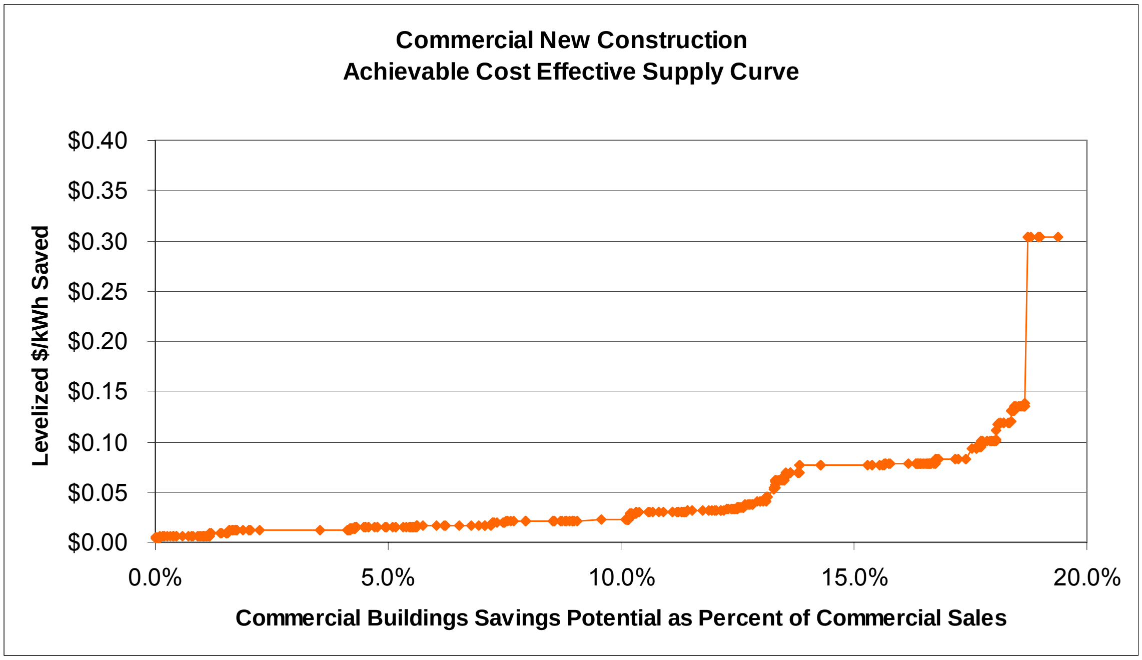
Note: Non-electric benefits are not reflected in the supply curve.

Figure 6-12 Achievable Potential Supply Curve for Commercial New Construction



Note: Non-electric benefits are not reflected in the supply curve.

Figure 6-13 Achievable Cost Effective Potential Supply Curve for Commercial New Construction



Note: Non-electric benefits are not reflected in the supply curve.

Table 6-9 illustrates how the current energy efficiency potential study compares to the study completed in 2002. The achievable savings of 24.4% by 2015 determined in this study is below the 31.5% determined in the January 2003 Vermont energy efficiency potential study.

Table 6-9: Comparison to 2006 Potential Savings Estimates to 2002 Estimates
Commercial Sector

	Optimal Energy - 2002	GDS Associates-2006
Technical Potential	NA	40.4%
Achievable Potential	31.5%	24.4%
Achievable Cost Effective Potential	NA	21.3%

7.0 LARGE INDUSTRIAL SECTOR ENERGY EFFICIENCY POTENTIAL IN VERMONT

As noted in Section 3 of this report, the industrial classification in Vermont represented 28% of total annual kWh sales in the State in 2004.[54] This sector includes large industrial customers in such industries as electrical and electronic equipment, pulp and paper and food manufacturing. There are approximately 500 electric customers in the industrial sector in Vermont. The number of consumers for the class is expected to remain level through 2015. As discussed in Section 3 of this report, annual kWh sales are projected to increase at an average annual compound rate of growth of 0.74% per year through 2015.

7.1 Introduction

This section of the report provides the estimates of technical, achievable, and achievable cost effective energy-efficiency potential for electric energy efficiency measures for the industrial sector in Vermont.

There are still significant electric savings opportunities in this sector. Technical electric energy savings potential is estimated to be approximately 382,700 MWH by 2015, or 21 percent of projected annual kWh sales in 2015. Achievable potential is estimated to be approximately 306,160 MWH and achievable cost effective potential is estimated to be 268,929 MWH by 2015. Thus the range of expected electricity savings is between 15% and 21% of projected industrial electric consumption (before DSM programs) in the year 2015. The electric energy efficiency potential estimates are based on a detailed analysis of the electric usage and potential savings for industrial customers.

Table 7-1 below summarizes the three types of electric energy efficiency savings potential for the industrial sector in Vermont by 2015. It is important to note that all of the energy efficiency measures examined for the industrial sector proved to be cost effective according to the Societal Test.

Table 7-1: Summary of Industrial Sector Energy Efficiency Potential in Vermont

	Estimated Cumulative Annual Savings by 2015 (mwWh)	Savings in 2015 as a Percent of Total 2015 Industrial Sector mWh Sales
Technical Potential	382,700	20.7%
Maximum Achievable Potential	268,929	14.5%
Maximum Achievable Cost Effective Potential	268,929	14.5%

[54] Staff of the Vermont Department of Public Service provided historical Vermont data on industrial sector kWh sales and customers for the period 1992 to 2004. See tables 3-1 and 3-2 in Section 3 of this report to see this historical data for the industrial sector in Vermont. In the year 2004, there were 554 industrial customers, according to the historical data provided by Riley Allen of the VDPS.

Overall Approach for the Industrial Sector

A literature review of several recent industrial electric potential studies indicates that due to the unique nature of industrial customers, the approach to develop savings potential generally is done on industrial sub-sectors (e.g. Food Processing, Paper, Computers, Agriculture, etc.) basis. The specific data sources used by GDS and the American Council for an Energy Efficient Economy (ACEEE) for the development of the industrial sector electric savings potential estimates are listed below. The detailed appendices of this report also provide detailed information on the costs, savings and useful lives of industrial sector electric energy efficiency technologies.

Steps to Develop Electric Energy Efficiency Potential for the Industrial Sector

ACEEE provided input to the GDS analysis of the electric energy efficiency potential in the industrial sector in Vermont. ACEEE provided the following data for the industrial sector to GDS:

1. ACEEE developed estimates of the disaggregated industrial sector electricity consumption at the three-digit North American Industrial Classification System (NAICS) code level based on state value of shipments data (Census 2005), national energy intensity data from EIA's *Manufacturing Energy Consumption Survey* (EIA 2005a). This estimate was then apportioned to the 2004 state industrial sector energy consumption reported by EIA (2005b).

2. ACEEE provided a break down of end-use electric energy-use at the three-digit NAICS code level based on a proprietary data analysis by ACEEE.

3. ACEEE provided data on Industrial energy efficiency measures, including measure life, technical savings potential and measure cost. ACEEE also developed up-to-date information on the end-uses that are applicable to each industry segment, and the fraction of applicable use energy that is eligible for each measure.

Using the data provided by ACEEE, GDS then completed the following steps to arrive at final estimates of potential electricity savings by industry sector by end use:

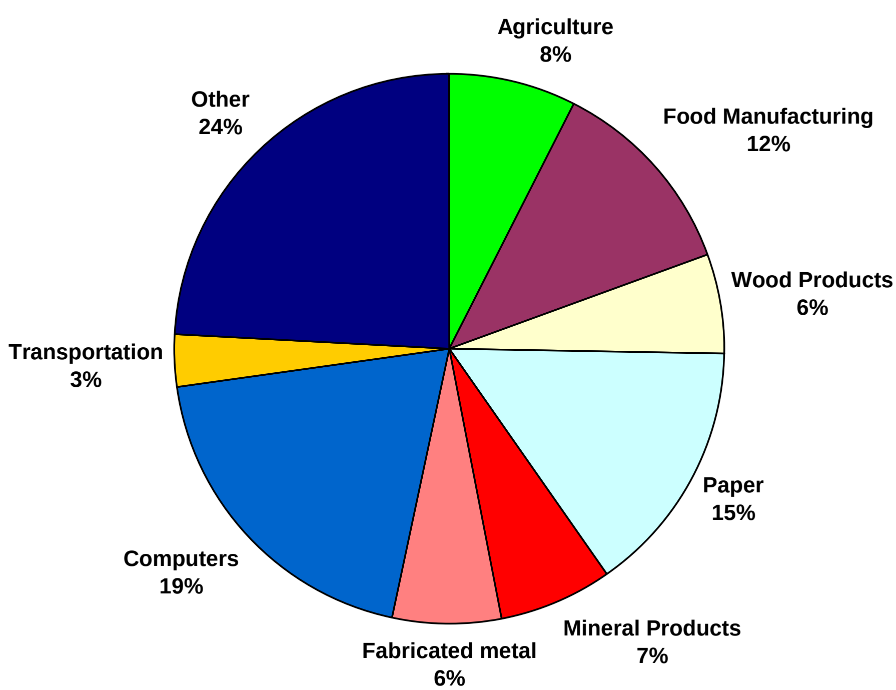
1. GDS then applied energy efficiency measures to applicable end-use electricity kWh sales for each industry group using eligibility factors to determine technical potential.
2. GDS then applied economic screening criteria to the estimates of the technical potential for electricity savings.

It is important to note that the estimates of the remaining potential for electricity savings for the Vermont industrial sector are based upon a “frozen” technology set as of 2006, though it does include some “emerging” technologies. While this assumption is probably not significant for a 10 year horizon, ACEEE has concerns about the value of projecting beyond 10 years because ACEEE does not capture emerging technologies that cannot be envisioned based on current market knowledge. See Nadel, Shipley and Elliott, 2004 for a further discussion of this issue.

Industrial Sector Characterization

Electricity use in Vermont is fairly balanced between the three primary sectors with residential using 37%, commercial at 35% and industrial at 28% of the state’s total 2004 kWh sales. Almost half of industrial electricity use can be accounted for in four industry groups (see Figure 7-1 below).

Figure 7-1 Estimates of the Distribution of 2004 Industrial Sector Electricity Consumption in Vermont



Within significant industry groups, there is limited diversity. Within food agriculture, dairy accounts for the overwhelming share of the electricity use. In food manufacturing, dairy products also accounts for the majority as would be expected. Within paper, four large paper mills account for most of the electricity use. Within computers, computer components dominate. In other significant sectors, sawmills appear to dominate the wood products, while cut stone appears to dominate mineral products.

Energy Efficiency Measures

ACEEE drew upon its past work to assemble a grouping of measures that ACEEE felt were relevant to the industrial sector in Vermont. ACEEE focused only on measures that would likely offer significant aggregate savings.

In agriculture ACEEE focused exclusively on dairy because of its dominance in the sector in the state. ACEEE identified five primary measures based on past research (Brown and Elliott 2005):

- Pumps
- Fans
- Compressed air/vacuum pumps
- Refrigeration
- Lighting

Because of the extensive work on energy efficiency with the dairy industry in the state by Efficiency Vermont and the investor-owned utilities, ACEEE feels that much of the efficiency opportunity in this market segment is already identified, and the existing programs are already realizing much of the potential.

We do not propose specific measures for mining or construction. Information on efficiency opportunities in hard rock mining is limited, though it is thought that motors are the dominant electrical load. ACEEE has not found viable measures for the construction industry because of the transient nature of industry, and energy's small fraction of operating costs.

For the manufacturing sector, we have focused on several crosscutting measures that we feel represent the majority of the savings potential:

- Sensor and Controls
- Advanced lubricants
- Electric supply system improvements
- Pump system efficiency improvements
- Advanced Air compressor Controls
- Industrial motor management
- Air compressor system management
- Fan system improvements
- Advanced motor designs
- Motor system optimization (including ASD)
- Transformers (NEMA Tier II)
- Efficient industrial lighting

Since this list is not comprehensive, due to budget and time constraints, the resulting savings should be viewed as a bounded technical potential. Industry and site specific opportunities clearly exist, but represent a small fraction of the total potential. Thus we focus on cross cutting measures.

The specific data sources used by GDS for industrial energy efficiency measures are listed below:

Brown, E. and R.N. Elliott. 2005. *Potential Energy Efficiency Savings in the Agriculture Sector*, http://aceee.org/pubs/ie053full.pdf. Washington, D.C.: American Council for an Energy-Efficient Economy.

[Census] Bureau of the Census. 2005. *2002 Economic Census Manufacturing Geographic Area Series: Vermont,* EC02-31A-VT (RV). Washington, D.C.: U.S. Department of Commerce.

2002 Economic Census Mining Geographic Area Series: Vermont, EC02-21A-VT. Washington, D.C.: U.S. Department of Commerce.

Elliott, R.N. 1994. Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector, ACEEE Report #IE942. Washington, D.C.: American Council for an Energy-Efficient Economy.

[EIA] Energy Information Administration. 2005a. *Manufacturing Energy Consumption Survey,* http://www.eia.doe.gov/emeu/mecs/contents.html. Washington, D.C.: U.S. Department of Energy.

Electric Sales, Revenue, and Average Price 2004, http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html. Washington, D.C.: U.S. Department of Energy.

Martin, N., et al. 2000. *Emerging Energy-Efficient Industrial Technologies*, ACEEE Report #IE003. Washington, D.C.: American Council for an Energy-Efficient Economy.

Nadel, S., A. Shipley and Elliott, R.N. 2004. "The Technical, Economic and Achievable Potential for Energy-Efficiency in the U.S. - A Meta-Analysis of Recent Studies," in the *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*, http://aceee.org/conf/04ss/rnemeta.pdf. Washington, D.C.: American Council for an Energy-Efficient Economy.

7.2 Technical and Maximum Achievable Economic Potential

This section presents estimates of the technical, achievable and achievable cost effective potential electricity savings for the industrial and agriculture sector for the year 2015.

Technical savings potential is estimated to be approximately 382,700 MWH by 2015, or 21% of projected annual kWh sales in the year 2015. Achievable potential is estimated to be approximately 268,929 MWH and achievable cost effective potential is estimated to be 268,929 MWH. Thus the achievable cost effective electricity savings potential in the industrial sector is 14.5% of projected industrial electric consumption in the year 2015. The savings level for the achievable and the achievable cost effective scenarios are identical for the industrial sector because all energy efficiency measures considered in the industrial sector analysis were cost effective (according to the Societal Test).

Figure 7-3 shows the percentage of total technical potential savings within each of the industrial end uses. Efficient lighting measures account for the largest percentage of technical potential at 34 percent, with motor systems improvements being second at 19 percent. Electric supply system improvements and pump system improvements provide 12 percent and 8 percent respectively of the technical potential electricity savings. These percentages are identical for the maximum achievable cost effective potential savings estimates.

Table 7-2 provides estimates of the technical savings potential by type of industrial energy efficiency measure in terms of potential kWh savings in the year 2015. The lighting and motors end uses have the largest technical savings potential in the industrial sector.

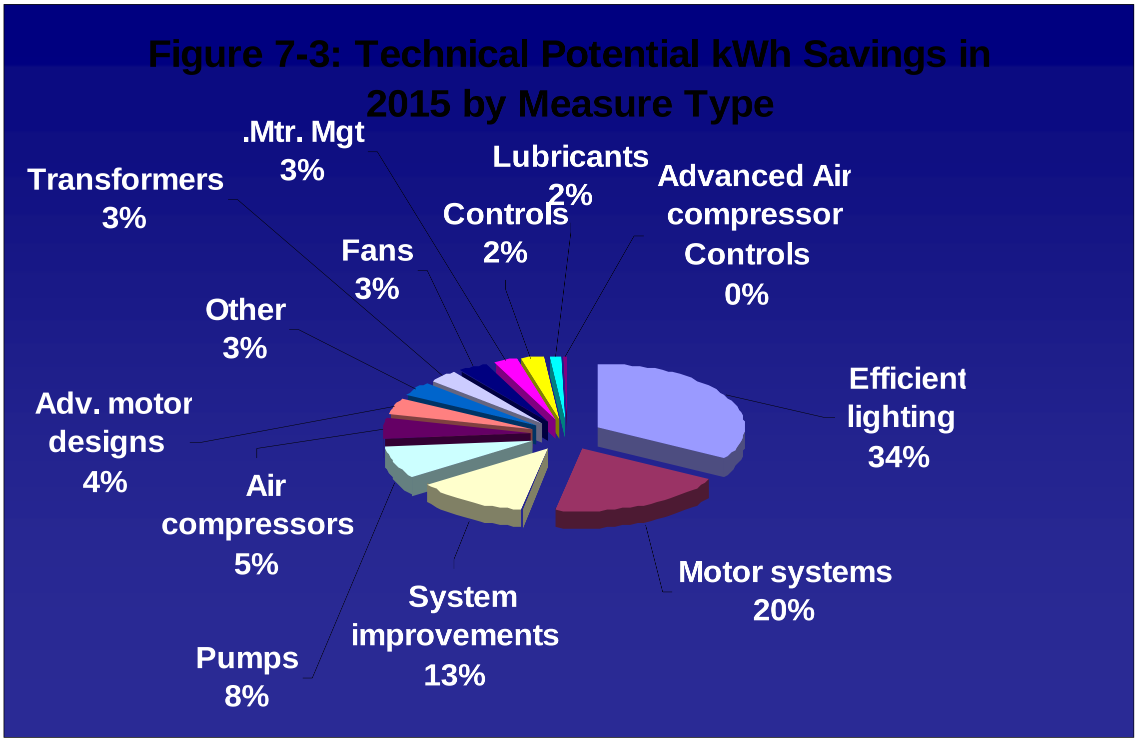


Table 7-2: Industrial Sector Technical Savings Potential (kWh) by Type of Energy Efficiency Measure By 2015			
Measure #	Industrial Energy Efficiency Measure	Technical Potential Savings by 2015 (annual kWh)	Percent of Total
1	Efficient industrial lamps and fixtures	127,754,709	33.4%
2	Motor system optimization (including ASD)	74,404,424	19.4%
3	Electric supply system improvements	47,830,845	12.5%
4	Pump system efficiency improvements	31,115,972	8.1%
5	Air compressor system management	20,484,776	5.4%
6	Advanced motor designs	16,704,811	4.4%
7	Other industrial energy efficiency measures	13,356,056	3.5%
8	Transformers (NEMA Tier II)	12,754,892	3.3%
9	Fan system improvements	12,731,080	3.3%
10	Industrial motor management	9,683,948	2.5%
11	Sensor and Controls	9,378,023	2.5%
12	Advanced lubricants	5,791,001	1.5%
13	Advanced Air compressor Controls	709,686	0.2%
	Total Industrial Sector Savings Potential	382,700,223	100.0%

In Table 7-3, we present estimates of achievable cost effective savings potential by type of energy efficiency measure in terms of potential kWh savings in the year 2015. These numbers are before adjustments are made to factor in the useful life of the measures. The lighting and motors end uses have the largest technical potential savings. When the useful life of industrial sector energy efficiency measures is factored in, the achievable cost effective potential declines to 268,929 mWh (due to the decay of savings over time). This is due to the fact that some of the industrial sector measures have useful lives of five years.

Table 7-3: Industrial Sector Maximum Achievable Cost Effective Savings Potential (kWh) by Type of Energy Efficiency Measure by 2015

Measure #	Industrial Energy Efficiency Measure	Technical Potential Savings by 2015 (annual kWh)	Percent of Total
1	Efficient industrial lamps and fixtures	102,203,767	33.4%
2	Motor system optimization (including ASD)	59,523,539	19.4%
3	Electric supply system improvements	38,264,676	12.5%
4	Pump system efficiency improvements	24,892,777	8.1%
5	Air compressor system management	16,387,821	5.4%
6	Advanced motor designs	13,363,848	4.4%
7	Other industrial energy efficiency measures	10,684,845	3.5%
8	Transformers (NEMA Tier II)	10,203,914	3.3%
9	Fan system improvements	10,184,864	3.3%
10	Industrial motor management	7,747,159	2.5%
11	Sensor and Controls	7,502,419	2.5%
12	Advanced lubricants	4,632,801	1.5%
13	Advanced Air compressor Controls	567,749	0.2%
	Total Industrial Sector Savings Potential	306,160,178	100.0%

Key Data Limitations Associated with Estimates of Industrial Electric Potential

- **End-use costs:** Estimates of aggregate measure costs for each end-use category were developed using several sources. While the sources used offer reasonable values for the end-use costs, GDS was unable (within the budget and schedule for this project) to gather end-use cost data specific to Vermont for every energy efficiency measure for the industrial sector.

- **End-use savings**. Estimates of aggregate measure savings for each end-use category were developed using several sources. While the sources used offer reasonable values for the end-use savings, GDS was unable (within the budget and schedule for this project) to gather energy savings data specific to Vermont for every industrial energy efficiency measure.

8.0 NON-ENERGY IMPACTS AND FAIRNESS ISSUE RELATED TO ELECTRIC ENERGY EFFICIENCY PROGRAMS

In addition to saving energy, electric energy efficiency programs can provide a variety of non-energy impacts.[55] Continuing to implement energy efficiency programs in Vermont will save electricity and will provide several other benefits to the State's economy.

Listed below are examples of non-energy impacts that will result from implementation of the electric energy efficiency measures included in this study:

- Electric energy efficiency programs can help reduce emissions of air pollutants[56] and greenhouse gases. Every mWh saved through an energy efficiency program in Vermont reduces power plant emissions by the following amounts of pounds[57]:
  - :SOX – 2.03 lbs per mWh saved
  - NOX – 0.54 lbs per mWh saved
  - C02 – 1102 lbs per mWh saved
- Electric energy efficiency programs can be more reliable than increasing the infrastructure of the electric generation supply system because electric energy efficiency measures are "distributed resources" and require no on-going fuel supply. As such, they are not subject to potential supply interruptions and/or fuel price increases.
- Electric energy efficiency can make homes and businesses more comfortable - less drafty, etc.
- Electric energy efficiency programs can help homes and businesses reduce operating costs and can make businesses in Vermont more competitive with businesses in other states and other countries.

[55] The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest, Southwest Energy Efficiency Project (SWEEP), November 2002.

[56] GDS uses the following definitions of these emissions: CO2 is the major green house gas; NOx contributes to ground level ozone, particulate matter, acid rain, visibility impairment and nitrogen deposition; and SO2 contributes visibility impairment, acid rain, and particulate matter.

[57] These marginal emissions rates for 2004 were provided by email to GDS by Dave Lamont of the VDPS staff on April 18, 2006. The original source of these emissions rates is the ISO New England web site, and these rates were listed in a presentation to the Power Planning Committee. It is, however, important to note that for SO2, and NOx are already capped under the Clear Air Act. The reductions here do not change the cap, but, more likely, can be expected to reduce the market clearing prices for SO2 and NOx under the cap and trade system. The same logic applies to reductions of CO2 beginning in 2009. For purposes of the analysis, a value of 0.7 cents per kWh (2000 dollars) was used to account for the externality benefits. These externality benefits are always the subject of controversy. The 0.7 cents per kWh value (2000 dollars) used here is the product of a settlement in a Vermont Public Service Board investigation in Docket 5980. For purposes of the analysis, the 0.7 cents per kWh is broad and encompasses the benefits for all externality values, especially those associated with categories of pollutants that remain uncapped..

8.1 Residential Sector Non Energy Benefits

Electric energy efficiency measures installed in homes or businesses can be more reliable than investments in electric supply-side resources. Unlike transmission and distribution lines, for example, the location of electric energy efficiency projects may not be as vulnerable to severe storms (ice storms, snow storms, hurricanes, wind storms, or hail storms) or spikes in the price of electricity. Contractors or homeowners, depending on the complexity of the measure, can easily install the electric energy efficiency measures. Energy efficiency measures are designed not only to save energy but also to improve the comfort of the occupant. Caulking, weather-stripping, insulation, ENERGY STAR windows, infiltration measures, CFLs and high efficiency air conditioners will reduce household and business operating costs and will decrease infiltration and heat loss.

The following impacts and benefits of energy efficiency programs have been noted in a recent evaluation report from the Wisconsin Focus on Energy Program[58]:

- Increased safety resulting from a reduction of gases emitted into the atmosphere, such as carbon monoxide.
- Fewer illnesses resulting from elimination of mold problems due to proper sealing, insulating and ventilation of a home
- Reduced repair and maintenance expense due to having newer, higher quality equipment
- Increased property values resulting from installation of new equipment

Non-energy impacts can play a key role for residential builders who promote energy efficiency in new home construction as seen in Wisconsin's Energy Star Home Program (WESH). Given that WESH homes are reported as selling at a higher price for 79 percent of homebuilders and the fact that 86 percent of homebuilders are more inclined to promote themselves as energy efficient builders, WESH homebuilders can view and market themselves as high-end homebuilders. WESH program implementers market the program by telling prospective homebuilders that they will be able to expand their business as a result of the WESH program. Also, given the frequency that comfort and safety improvements are cited as non-energy benefits associated with both WESH and Home Performance with Energy Star Program (HPWES), emphasizing these two non-energy benefits in program marketing efforts may help to increase program participation. In addition, increased durability and longevity of household

[58] State of Wisconsin Department of Administration Division of Energy, Focus on Energy Public Benefits Statewide Evaluation, Quarterly Summary Report: Contract Year 2, Second Quarter, March 31, 2003, Evaluation Contractor: PA Government Services Inc. Prepared by: Focus Evaluation Team.

equipment can be a selling point for the Wisconsin HPWES program, where 84 percent of contractors cite this as a non-energy benefit.[59]

8.2 Commercial Sector Non Energy Benefits

By utilizing electric energy efficiency programs, businesses in Vermont can become more efficient and lower their monthly utility bills. The energy and monetary savings from electric energy efficiency programs can provide businesses with additional capital to invest in business infrastructure. Electric energy efficiency programs can help businesses in Vermont become more competitive with other businesses in the United States and in other countries. Implementing electric energy efficiency measures may also increase productivity and afford the business with the opportunity to add new jobs, further bolstering the economy in Vermont.

Examples of Non Energy Benefits from The Wisconsin Focus on Energy Business Programs:[60]

- Increased productivity
- Improvement in morale
- Reduced repair and maintenance costs
- Reduced waste
- Reduced defect or error rates

8.3 Environmental and Price Impacts of Energy Efficiency Programs

Increased energy efficiency is in the public interest for environmental, economic and national security reasons. The production and use of energy causes a large portion of the nation's air pollution. Fossil fuel combustion and the resulting emissions can be harmful to public health in a variety of ways:

- by harming to ecological systems, especially by increasing the acidity of rainfall and water bodies, and
- by being a major source of greenhouse gases causing climate change.

A reduction in energy consumption through greater efficiency of energy use is a means to reduce all emissions from burning fossil fuels, including NO_x, SO_2, and CO_2.[61]

---

[59] State of Wisconsin Department of Administration, Division of Energy, Focus on Energy Statewide Evaluation, Non-Energy Benefits Cross-Cutting Report, Year 1 Efforts, *Evaluation Contractor: PA Government Services Inc., Prepared by: Nick Hall, TecMarket Works, Oregon, Wisconsin Under Contract To PA Consulting,* January 20, 2003

[60] Ibid.

[61] Energy Efficiency and Renewables Sources: A Primer, Prepared by the National Association of State Energy Officials Updated by Global Environment & Technology Foundation, October 2001.

Cost-effective energy efficiency actions are beneficial (1) to individual users of electricity by reducing consumer costs and (2) to the economy by increasing discretionary income. The implementation of energy efficiency measures can help consumers save money.[62]

A recent American Council for An Energy Efficient Economy (ACEEE) analysis found that modestly reducing both natural gas and electricity consumption and increasing the installation of renewable energy generation could dramatically affect natural gas price and availability. According to the ACEEE report, in just 12 months, nationwide efforts to expand energy efficiency and renewable energy could reduce wholesale natural gas prices by 20 percent and save consumers $15 billion/year in retail gas and electric power costs.[63] [64]

8.5 Non Energy Impacts of Low Income Weatherization and Insulation Programs

GDS also conducted a literature search on the non-energy benefits of energy efficiency programs targeted at low-income households. Such programs can help reduce low income customer account arrearages, and can help make the monthly electric bill affordable for low income households. One of the most comprehensive studies of low-income program non-energy benefits was recently completed for five investor-owned utilities in California.[65,66] This study identified over twenty non-energy benefits of energy efficiency programs targeted at low income households.

8.6 Other Impacts, Uncertainty and Equity

There are also other impacts, risks and equity issues associated with energy efficiency programs delivered through an efficiency utility type structure. Included among these impacts are the following:

---

[62] Ibid.

[63] The ACEEE study notes how natural gas energy efficiency programs can help reduce prices of natural gas.

[64] R. Neal Elliot, PH.D., P.E., et al., Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies, ACEEE, December 2003.

[65] TecMRKT Works, Skumatz Economic Research Associates, and Megdal & Associates, Low-income Public Purpose Test, (The LIPPT), Final Report, Up-Dated for LIPPT Version 2.0, A Report Prepared for the RRM Working Group's Cost Effectiveness Committee, April 2001. This report provides a description of each non-energy benefit included in the KeySpan analysis of non-energy benefits, and provides the methodology for calculating the value of each category of non-energy benefits.

[66] TecMRKT Works, Skumatz Economic Research Associates, and Megdal & Associates, User's Guide for California Utility's Low-Income Program Cost Effectiveness Model, The Low-Income Public Purpose Test, Version 2.0, A Microsoft Excel Based Model, Prepared for The RRM Cost Effectiveness Subcommittee, May 25, 2001.

- Higher electric rates and bills to non-participants – Despite the considerable savings identified in this analysis through these programs, there will always be consumers that have not participated and do not benefit from the programs of an efficiency utility, even where there are programs available to them. For such customers, rate impacts will translate into higher bills.
- Uncertainty over savings and costs – Despite the considerable experience with programs, savings estimates always require some degree of understanding of what would have happened but for the existence of the program. This is not simply a question of engineering calculations or metering, but of judgment for which reasonable persons may differ and certainty is never assured.
- New technologies bring with them new dimensions of service and quality that may require time for consumers and the markets to adjust. Early version of compact fluorescent bulbs, for example, provided different coloration that varied by installation and bulb, and those coloration issues were an annoyance to some consumers. Also, certain technologies, including CFLs, suffer from considerable variability in product quality by manufacturer, especially in the early stages of product development.
- Fuel switching programs that expose consumers to fossil fuel alternatives, also expose these retail consumers to the costs and price uncertainty of those alternatives.
- Utility concerns that energy efficiency erodes their financial incentives to perform efficiency programs and aggressive programs could undermine their financial health.

That said, there are analogous concerns with supply-side resources. Major supply resources and contracts present their own risks to utilities. Electricity prices in Vermont may also expose consumers to greater marketplace volatility as existing contracts and resources in Vermont expire and expose consumers to the new marketplace realities of electricity.

9.0 SUMMARY OF FINDINGS

In summary, the achievable cost effective potential for electric energy efficiency in Vermont by 2015 is significant. GDS estimates that the achievable cost effective potential electricity savings would amount to almost 1.3 billion kWh a year (a 19.4 percent reduction in projected 2015 kWh sales forecast in Vermont). Table 9-1 below summarizes the electricity savings potential in Vermont by 2015.

Table 9-1: Maximum Achievable Cost Effective Electric Energy Efficiency Potential By 2015 in Vermont

Sector	Maximum Achievable Cost Effective kWh Savings by 2015 from Electric Energy Efficiency Measures/Programs for Vermont (Cost Effective According to Societal Test)	2015 kWh Sales Forecast for This Sector	Percent of Sector 2015 kWh Sales Forecast
Residential Sector	567,511,161	2,659,831,768	21.3%
Commercial Sector	450,383,577	2,115,167,148	21.3%
Industrial Sector	268,928,672	1,851,792,067	14.5%
Total	1,286,823,410	6,626,790,983	19.4%

The results of this study demonstrate that cost effective electric energy-efficiency resources can play a significantly expanded role in Vermont's energy resource mix over the next decade. Table 1-3 in the Executive Summary shows the present value of benefits and costs associated with implementing the achievable cost effective potential energy savings in Vermont as well as the overall Societal Test benefit/cost ratio of 3.45 The potential net present savings to ratepayers in Vermont for implementation of cost effective electric energy efficiency programs over the next decade are approximately **$964 million** in 2006 dollars.

It is clear that electric energy efficiency programs could save Vermonters a significant amount of electricity by 2015. The electric energy efficiency potential estimates and the Societal Test savings provided in this report are based upon a planning load forecast for Vermont of 1.5% growth per year in annual kWh sales and peak load, appliance saturation data, economic forecasts, data on energy efficiency measure costs and savings, and energy efficiency measure lives available to GDS at the time of this study. All input assumptions and data have been reviewed by GDS and VDPS staff. GDS has conducted extra market research with energy services providers in Vermont to ensure that data for residential energy efficiency weatherization and insulation measure costs and savings are applicable and up to date.

There are also significant environmental benefits with the achievable cost effective scenario.