FINAL REPORT

Vermont Energy Efficiency Potential Study for Oil, Propane, Kerosene and Wood Fuels

Prepared for the

Vermont Department of Public Service

January 16, 2007

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ACKNOWLEDGEMENTS

This technical report was prepared for the Vermont Department of Public Service (VDPS) by GDS Associates, Inc. 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 John Becker, Veronica Metzner, and TJ Poor of the VDPS, who were instrumental in reviewing detailed data developed by GDS relating to energy consumption forecasts for oil, propane, kerosene and wood, and reviewing energy efficiency measure costs, energy savings and useful lives.

This report provides valuable and up-to-date energy efficiency potential information for oil, propane, kerosene and wood fuels for decision-makers in the State of Vermont. This report will be useful to 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 oil, propane, kerosene and wood fuel consumption in Vermont and the economic costs and benefits of such energy efficiency programs. Clearly there is significant cost effective energy savings potential remaining to be tapped in Vermont for these four fuels.

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January 16, 2007

TABLE OF CONTENTS

APPENDICES

Appendix A – Residential Sector Data

Appendix B – Commercial Sector Data

Appendix C – Industrial Sector Data

Appendix D – Cumulative Annual Energy Savings Potential by Fuel for the Achievable Cost Effective Potential Base Case Scenario based upon Societal Test screening

Appendix E – Program Administrator and Participant Budgets

Appendix F – Assumptions for Discount Rate, Inflation Rate, Societal Test Adders, Line Loss Factors, and Emissions Factors

Appendix G – Avoided Costs for Electricity, Natural Gas, Distillate Fuel Oil, Propane, Kerosene, Wood, Water

Appendix H – Energy Consumption Forecasts for Vermont for Oil, Propane, Kerosene and Wood,

1.0 EXECUTIVE SUMMARY – ENERGY EFFICIENCY SAVINGS POTENTIAL IN VERMONT FOR OIL, PROPANE, KEROSENE AND WOOD FUELS

This study was prepared in response to Vermont Legislative Act 208 (H.859) of 2006, Sec.18, directing the Department of Public Service (VDPS) to analyze the "costs and benefits of establishing a coordinated and comprehensive program to maximize cost-effective energy efficiency savings in all buildings, regardless of a particular building's source of fuel and regardless of the income of the building owner." The legislation also requires the study to consider program options to reduce consumption of oil, kerosene, propane, and other fuels not provided by regulated utilities.

This study estimates the achievable cost effective potential for energy savings from energy-efficiency measures for oil, propane, kerosene and wood fuels in Vermont over the ten-year period from 2007 through 2016. The results of this study, shown in Table 1-1 below, indicate that there is significant energy savings potential in Vermont for cost effective energy-efficiency savings for each fuel in each sector. The total achievable cost effective energy savings potential (savings as a percent of the forecast of fuel consumption) by the year 2016 is 14% for fuel oil; 8% for propane; 6% for kerosene and 14% for wood. On a combined MMBTU basis after ten-years of program activity the study estimates a 12% reduction in total fuel consumption annually in the residential, commercial, and industrial sectors from these four fuel categories.

Table 1-1: Energy Efficiency **Achievable Cost Effective** Potential by Sector by Fuel Type

Year	Sector	Oil	Propane	Kerosene	Wood
2016	RES	10.2%	5.6%	3.3%	18.3%
2016	COMM	24.2%	21.7%	21.9%	16.0%
2016	IND	10.2%	6.7%	10.2%	9.7%
2016	TOTAL	14.0%	8.0%	5.9%	14.2%

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 results of this study indicate that fuel oil provides the greatest amount of energy savings over the ten-year period. Of the total amount of energy savings the study estimates is cost effectively achievable, fuel oil provides 72% of these savings, propane 16%, kerosene 4%, and wood 8%. The study analyzed many energy efficiency measures; in the residential and commercial sectors the measures primarily consisted of building shell improvements, and space and water heating equipment upgrades. In the industrial sector energy efficiency improvements in industrial boilers, process heating, and space heating were studied.

In the residential and commercial sectors the greatest savings are available through building shell improvements. Building shell improvements account for

63% of total savings. In the industrial sector boiler improvements provided the greatest savings opportunities with 65% of the savings.

In developing the base case estimates of achievable cost effective energy efficiency savings potential, GDS focused its consideration of savings opportunities on market driven energy efficiency program strategies (those strategies that involved strategic interventions at the time of equipment retirement or replacement – sometimes referred to as "replace-on-burnout"). The base case projection for the achievable cost effective potential energy savings is based upon cost effectiveness screening[1]. The net present savings for the State of Vermont for long-term implementation of energy efficiency programs for oil, propane, kerosene and wood throughout the State over the next decade (2007 to 2016) is $486 million.

The costs to implement the energy efficiency program modeled in the study would be $149 million in nominal dollars, or approximately $14.9 million per year from 2007 to 2016. In addition to the program costs, there are participant costs associated with making the investment in the actual efficiency measure. This study estimates the participant costs to total $92 million over the next decade (2007 to 2016).

A notable difference between energy efficiency programs targeting unregulated fuels versus regulated fuels are differences in 'system benefits' (those benefits that accrue to both participants and non-participants). Regulated fuels rely disproportionately on common infrastructure elements and market products that are paid for by all ratepayers collectively and are recovered through cost-based rates. Energy efficiency programs help avoid these additional common costs and effectively provide a system financial benefit to all ratepayers. Unregulated fuels may rely on some common infrastructure and avoid some system costs, but energy efficiency programs targeted at oil, propane, kerosene and wood occur under market conditions that may or may not result in financial gain to other ratepayers.

Tables 1-2 and 1-3 below show the cumulative annual achievable cost effective energy savings by fuel type by sector for the period 2007 to 2016 in MMBTU and gallons respectively. Table 1-4 illustrates the cumulative annual emissions reductions for CO_2, methane (CH_4), and NO_2 based on the potential energy efficiency savings for fuel oil, propane, kerosene, and wood discussed in this report.

[1] The Vermont Societal Test was used as the primary test for screening, but 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. A cost effectiveness screening analysis using the Participant test was also evaluated.

Table 1-2: Summary of Cumulative **Annual Fuel Savings** for the Achievable Cost Effective Potential Scenario for Vermont (in mmbtu)

Year	Total for **All Sectors** - Cumulative Annual Fuel Savings				
	Fuel Oil	Propane	Kerosene	Wood	Total Cumulative Annual mmbtu savings
2007	334,630	75,056	16,948	35,850	462,484
2008	670,067	150,526	33,895	71,785	926,273
2009	1,006,309	226,417	50,843	107,806	1,391,375
2010	1,343,374	302,721	67,791	143,859	1,857,746
2011	1,681,246	379,447	84,738	180,052	2,325,482
2012	2,019,915	456,585	101,686	216,223	2,794,409
2013	2,359,390	534,138	118,633	252,481	3,264,642
2014	2,699,671	612,112	135,581	288,824	3,736,187
2015	3,040,758	690,499	152,529	325,252	4,209,038
2016	3,380,002	768,833	169,476	361,727	4,680,037
Total	18,535,362	4,196,334	932,120	1,983,857	25,647,673

Note: The numbers in this table are cumulative annual fuel savings numbers. The numbers listed for the year 2016 are the achievable cost effective potential by the year 2016.

Table 1-3: Summary of Cumulative **Annual Fuel Savings** for the Achievable Cost Effective Potential Scenario for Vermont (Gallons & Cords)

Year	Total for **All Sectors** - Cumulative Annual Fuel Savings			
	Fuel Oil (Gal.)	Propane (Gal.)	Kerosene (Gal.)	Wood (Cord)
2007	2,421,348	819,391	124,068	1,630
2008	4,848,530	1,643,300	248,135	3,263
2009	7,281,543	2,471,801	372,203	4,900
2010	9,720,510	3,304,819	496,270	6,539
2011	12,165,309	4,142,429	620,338	8,184
2012	14,615,881	4,984,557	744,406	9,828
2013	17,072,285	5,831,203	868,473	11,476
2014	19,534,522	6,682,441	992,541	13,128
2015	22,002,592	7,538,196	1,116,609	14,784
2016	24,457,320	8,393,369	1,240,676	16,442
Total	134,119,841	45,811,507	6,823,719	90,175

Note: The numbers in this table are cumulative annual fuel savings numbers. The numbers listed for the year 2016 are the achievable cost effective potential by the year 2016.

Table 1-4: Summary of Cumulative **Annual Emissions Savings** for the Achievable Cost Effective Potential Scenario for Vermont - **All Sectors**

	Cumulative Annual Emissions Savings Derived from Energy Savings (Tons)			
Year	Total Cumulative Annual mmbtu savings	CO2 Emissions Reduction (tons)	Methane (CH4) Emissions Reduction (tons)	NO2 Emissions Reduction (tons)
2007	462,484	33,255	12.5	0.4
2008	926,273	66,603	25.0	0.9
2009	1,391,375	100,045	37.5	1.3
2010	1,857,746	133,581	50.1	1.7
2011	2,325,482	167,210	62.7	2.2
2012	2,794,409	200,932	75.3	2.6
2013	3,264,642	234,747	88.0	3.0
2014	3,736,187	268,655	100.7	3.5
2015	4,209,038	302,656	113.4	3.9
2016	4,680,037	336,506	126.2	4.4
Total	25,647,673	1,844,189	691.3	23.9

Note: The numbers in this table listed for 2007 to 2016 are cumulative annual savings numbers. The numbers listed for the year 2016 are the achievable cost effective potential by the year 2016.

1. Complete Sources for Emissions Savings Factors can be found in Appendix E

The results of this study demonstrate that there is significant cost effective potential for an oil, kerosene, propane, and wood fuels energy efficiency program. Table 1-5 below shows the present value[2] ($2007) of benefits and costs associated with implementing the achievable potential energy savings in Vermont using the Vermont Societal Test.[3] The overall Vermont Societal Test benefit/cost ratio for the achievable cost effective potential scenario is 4.03.

[2] 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.
[3] Vermont Participant Test results are described in Chapter 2, Table 2-3

Table 1-5: Vermont Societal Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for **All** Sectors in Vermont

Energy Efficiency Savings by Fuel Source	NPV of BENEFITS	NPV of COSTS	NPV SAVINGS ($2007)	B/C Ratio VT Societal Test
Oil	$433,041,956	$107,651,232	$325,390,724	4.02
Propane	$150,027,617	$35,883,950	$114,143,667	4.18
Kerosene	$22,354,386	$6,542,484	$15,811,902	3.42
Wood	$40,476,594	$10,011,226	$30,465,368	4.04
Grand Total - All Sectors	$645,900,553	$160,088,893	$485,811,661	**4.03**

Four key assumptions were made in order to determine achievable cost effective potential energy efficiency savings:

- A program administrator structure similar to Efficiency Vermont is used to design and implement new energy efficiency programs to achieve energy savings for the four fuels considered in this study.
- The costs for program administration, design, management, data tracking and reporting are assumed to be equivalent to those experienced by Efficiency Vermont.
- Financial incentives paid to program participants are assumed to be fifty percent of energy efficiency measure costs.
- A “replace on burnout” programmatic strategy is the main method used to acquire the achievable cost effective potential savings in order to get the most savings at the lowest cost. Selected retrofit programs are included for measures such as insulation and air sealing.

This study shows that there is significant potential to reduce the consumption of oil, kerosene, propane, and wood fuels in Vermont. The remainder of this report is organized as follows:

- Section 2: Energy Efficiency Savings Potential in Vermont For Oil, Propane, Kerosene and Wood Fuels
- Section 3: Historical and Forecast Oil, Propane, Kerosene and Wood Energy Consumption Trends in Vermont
- Section 4: Methodology for Determining Energy Savings Potential
- Section 5: Energy Efficiency Potential – Residential Sector
- Section 6: Energy Efficiency Potential – Commercial Sector
- Section 7: Energy Efficiency Potential – Industrial Sector

2.0 ENERGY EFFICIENCY SAVINGS POTENTIAL IN VERMONT FOR OIL, PROPANE, KEROSENE AND WOOD FUELS

2.1 Energy Savings Potential in Vermont for Oil, Propane, Kerosene and Wood Fuels

This study estimates the achievable cost effective potential for energy savings from energy-efficiency measures for oil, propane, kerosene and wood fuels in Vermont. This report presents cost effectiveness screening results for Vermont based on two tests:

- the Vermont Societal Test,[4] and
- the Participant Test

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 energy-efficiency measures for saving oil, propane, kerosene and wood fuels. The estimates of achievable cost effective potential energy savings by fuel type by 2016 are shown below in Table 2-1.

Table 2-1: Energy Efficiency **Technical** Potential by Sector by Fuel Type as a Percent of Total Fuel Type Energy Consumption in 2016

Year	Sector	Oil	Propane	Kerosene	Wood
2016	RES	30.0%	15.7%	9.2%	45.9%
2016	COMM	35.2%	32.4%	32.4%	24.0%
2016	IND	15.3%	10.0%	15.3%	14.6%
2016	TOTAL	29.7%	17.7%	12.0%	29.7%

Table 2-1: Energy Efficiency **Achievable** Potential by Sector by Fuel Type as a Percent of Total Fuel Type Energy Consumption in 2016

Year	Sector	Oil	Propane	Kerosene	Wood
2016	RES	10.9%	5.6%	3.5%	18.5%
2016	COMM	24.2%	21.7%	21.9%	16.0%
2016	IND	10.2%	6.7%	10.2%	9.7%
2016	TOTAL	14.5%	8.0%	6.0%	14.3%

Table 2-1: Energy Efficiency **Achievable Cost Effective** Potential by Sector by Fuel Type as a Percent of Total Fuel Type Energy Consumption in 2016

Year	Sector	Oil	Propane	Kerosene	Wood
2016	RES	10.2%	5.6%	3.3%	18.3%
2016	COMM	24.2%	21.7%	21.9%	16.0%
2016	IND	10.2%	6.7%	10.2%	9.7%
2016	TOTAL	14.0%	8.0%	5.9%	14.2%

[4] 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.

The total achievable cost effective energy savings potential (savings as a percent of the forecast of fuel consumption) by the year 2016 is 14% for fuel oil; 8% for propane; 6% for kerosene and 14% for wood. In developing the base case estimates of achievable cost effective savings potential, GDS considered savings opportunities mainly from market-driven energy efficiency program strategies.

2.2 Present Value of Savings and Costs (in $2007)

The base case projection for the achievable cost effective potential savings is based upon cost effectiveness screening using the Vermont Societal Test. The Vermont Societal Test is calculated as specified by the Vermont Public Service Board in its final order in Docket No. 5270. The base case projection assumes that a program administrator 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 for oil, propane, kerosene and wood throughout the State over the next decade (2007 to 2016) is $486 million. The overall Vermont Societal Test benefit/cost ratio for the achievable cost effective potential scenario is 4.03. The Participant Test, which measures the quantifiable benefits and costs to program participants, has a ratio of 7.9. The results of this study demonstrate that there is significant cost effective potential for an oil, kerosene, propane, and wood fuels energy efficiency program. The base year for this study is 2007, and for the cost effectiveness calculations, all benefits and costs used in benefit/cost ratio calculations are presented in 2007 dollars.

Table 2-2 on the following page shows the present value[5] of Societal Test benefits and costs associated with implementing the achievable cost effective potential energy savings in Vermont. Table 2-3 shows the present value of Participant Test benefits and costs associated with implementing the achievable cost effective potential energy savings in Vermont.

Tables 2-2 and 2-3 also provide 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 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 sector with the highest Societal Test benefit/cost ratio is the industrial sector.

[5] 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.

Table 2-2: Vermont Societal Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Residential Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Oil	RES	$236,440,495	$20,283,214	$29,636,537	$23,709,230	$73,628,981	$162,811,515	3.21
#2	Propane	RES	$97,215,514	$8,350,852	$12,187,148	$9,749,719	$30,287,719	$66,927,795	3.21
#3	Kerosene	RES	$12,034,070	$1,528,845	$2,238,620	$1,790,896	$5,558,362	$6,475,708	2.17
#4	Wood	RES	$25,252,948	$2,383,591	$3,481,680	$2,785,344	$8,650,615	$16,602,333	2.92
	Residential Sector Total		$370,943,028	$32,546,502	$47,543,986	$38,035,188	$118,125,677	$252,817,351	3.14

Table 2-2: Vermont Societal Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Commercial Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Oil	COMM	$179,534,327	$5,675,475	$14,759,359	$11,807,488	$32,242,322	$147,292,005	5.57
#2	Propane	COMM	$48,544,535	$938,071	$2,439,502	$1,951,602	$5,329,175	$43,215,360	9.11
#3	Kerosene	COMM	$5,896,517	$139,170	$361,920	$289,536	$790,625	$5,105,892	7.46
#4	Wood	COMM	$5,731,073	$160,936	$418,522	$334,818	$914,276	$4,816,796	6.27
	Commercial Sector Total		$239,706,452	$6,913,653	$17,979,303	$14,383,443	$39,276,399	$200,430,053	6.10

Table 2-2: Vermont Societal Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Industrial Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Oil	IND	$17,067,134	$949,379	$461,417	$369,133	$1,779,929	$15,287,205	9.59
#2	Propane	IND	$4,267,568	$142,443	$69,230	$55,384	$267,056	$4,000,511	15.98
#3	Kerosene	IND	$4,423,799	$103,207	$50,161	$40,129	$193,497	$4,230,302	22.86
#4	Wood	IND	$9,492,573	$238,066	$115,705	$92,564	$446,335	$9,046,238	21.27
	Industrial Sector Total		$35,251,074	$1,433,096	$696,512	$557,210	$2,686,817	$32,564,256	13.12

Table 2-2: Vermont Societal Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for All Sectors in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Oil	ALL	$433,041,956	$26,908,068	$44,857,313	$35,885,851	$107,651,232	$325,390,724	4.02
#2	Propane	ALL	$150,027,617	$9,431,366	$14,695,880	$11,756,704	$35,883,950	$114,143,667	4.18
#3	Kerosene	ALL	$22,354,386	$1,771,223	$2,650,700	$2,120,560	$6,542,484	$15,811,902	3.42
#4	Wood	ALL	$40,476,594	$2,782,593	$4,015,907	$3,212,726	$10,011,226	$30,465,368	4.04
	Grand Total - All Sectors		$645,900,553	$40,893,251	$66,219,801	$52,975,841	$160,088,893	$485,811,661	4.03

*Other resource benefits include electric and water benefits for certain measures

Table 2-3: Participant Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Residential Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Oil	RES	$216,123,373	$35,247,983	$0	$0	$35,247,983	$180,875,390	6.13
#2	Propane	RES	$92,706,700	$13,447,823	$0	$0	$13,447,823	$79,258,877	6.89
#3	Kerosene	RES	$11,243,298	$2,162,786	$0	$0	$2,162,786	$9,080,512	5.20
#4	Wood	RES	$24,988,902	$3,481,680	$0	$0	$3,481,680	$21,507,222	7.18
	Residential Sector Total		$345,062,273	$54,340,272	$0	$0	$54,340,272	$290,722,002	6.35

Table 2-3: Participant Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Commercial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Oil	COMM	$152,433,887	$14,741,046	$0	$0	$14,741,046	$137,692,841	10.34
#2	Propane	COMM	$42,605,639	$2,287,745	$0	$0	$2,287,745	$40,317,893	18.62
#3	Kerosene	COMM	$5,109,110	$356,210	$0	$0	$356,210	$4,752,900	14.34
#4	Wood	COMM	$5,359,766	$418,522	$0	$0	$418,522	$4,941,244	12.81
	Commercial Sector Total		$205,508,402	$17,803,523	$0	$0	$17,803,523	$187,704,879	11.54

Table 2-3: Participant Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Oil	IND	$13,729,057	$415,275	$0	$0	$415,275	$13,313,782	33.06
#2	Propane	IND	$3,864,324	$62,307	$0	$0	$62,307	$3,802,017	62.02
#3	Kerosene	IND	$2,881,847	$45,145	$0	$0	$45,145	$2,836,702	63.84
#4	Wood	IND	$6,285,716	$104,134	$0	$0	$104,134	$6,181,582	60.36
	Industrial Sector Total		$26,760,943	$626,861	$0	$0	$626,861	$26,134,082	42.69

Table 2-3: Participant Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for All Sectors in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Oil	ALL	$382,286,317	$50,404,304	$0	$0	$50,404,304	$331,882,013	7.58
#2	Propane	ALL	$139,176,663	$15,797,875	$0	$0	$15,797,875	$123,378,788	8.81
#3	Kerosene	ALL	$19,234,255	$2,564,140	$0	$0	$2,564,140	$16,670,115	7.50
#4	Wood	ALL	$36,634,384	$4,004,337	$0	$0	$4,004,337	$32,630,047	9.15
	Grand Total - All Sectors		$577,331,619	$72,770,656	$0	$0	$72,770,656	$504,560,963	7.93

*Other resource benefits include electric and water benefits for certain measures

2.3 Study Scope

The objective of the study was to estimate the achievable cost effective potential for energy savings for oil, propane, kerosene and wood fuels over the ten-year period from 2007 through 2016 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 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 term "achievable" refers to efficiency measure penetration, and means that the GDS Team has based our estimates of energy efficiency savings potential on the realistic penetration level that can be achieved by 2016.

- **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 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 for the four fuels analyzed in this study.

The main outputs of this study are summary data tables and graphs reporting the total cumulative annual achievable cost effective potential for energy efficiency savings by fuel type over the ten-year period from 2007 through 2016.

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 developing estimates of energy savings potential in existing residential, commercial and industrial facilities in Vermont.

2.4 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.[6] 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.
- The Southwest Energy Efficiency Project potential study assumed incentive levels of 15% to 25% of measure costs.
- 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%.
- The July 2006 electric energy efficiency potential study completed by the Vermont Department of Public Service (VDPS) for Vermont used an incentive level of 50% of incremental measure costs.

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 this 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. As noted

[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.

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 completed by Optimal Energy in 2006 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.[7] 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.

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.

It is important to note that 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.

2.5 Key Assumptions for Cost Effectiveness Screening

This new study of the energy efficiency potential in Vermont for oil, propane, kerosene and wood fuel savings is based upon an updated forecast of consumption for these fuels in Vermont for the period 2007 to 2016, and a December 2005 Avoided Energy Supply Component Study Group forecast of avoided costs for these fuels.

- For this study, GDS developed energy consumption forecasts for these four fuels by sector and end use for the period 2007 to 2016.

[7] 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 benefit/cost screening analyses in this report uses the forecast of avoided costs of fossil fuels published in December 2005 by the New England Avoided Energy Supply Component Study Group.
- This study uses the very recent and detailed market assessment studies for all sectors in Vermont prepared in 2005 and 2006 by KEMA.
- 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.

2.6 Implementation Costs

Realizing the achievable cost effective energy efficiency savings potential by 2016 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 fuel savings in Vermont assumes that a program administrator pays financial incentives equivalent to fifty percent of measure incremental costs.[9] 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.

GDS developed cost estimates for program planning, administration, marketing, reporting based upon actual historical spending experience at Efficiency Vermont for 2005, as well as financial incentives to consumers in order to realize the achievable cost effective potential savings. Table 2-4 presents the annual program budgets for financial incentives[10], program planning, administration, marketing reporting necessary to realize the achievable cost effective potential for oil, propane, kerosene and wood energy savings in Vermont, but excludes costs for a fiscal agent, a contract administrator, and VDPS monitoring and evaluation functions. Based on experience with Efficiency Vermont's programs to provide a fiscal agent, a contract administrator, and VDPS monitoring and evaluation functions for an all fuels energy efficiency program based on the model analyzed in this study would add an additional \$300,000 to \$500,000 annually depending on the level of program evaluation desired.

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[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".
[9] The January 2003 Optimal Energy potential study for Vermont assumed that Efficiency Vermont paid 100 percent of incremental measure costs.
[10] This cost estimate is based on the key assumption that a program administrator pays incentives to consumers of at least 50% of the incremental costs of energy efficiency measures.

Table 2-4: **Annual Budget** by Sector for **Oil, Propane, Kerosene, and Wood** Efficiency Programs Included in the Base Case Scenario				
Year	Residential	Commercial	Industrial	Total
2007	$10,110,943	$3,351,463	$276,927	$13,739,332
2008	$10,339,453	$3,371,099	$280,997	$13,991,549
2009	$10,573,234	$3,391,177	$285,159	$14,249,570
2010	$10,805,762	$3,411,706	$289,414	$14,506,883
2011	$11,055,529	$3,432,698	$293,766	$14,781,992
2012	$11,301,776	$3,454,162	$298,215	$15,054,153
2013	$11,553,842	$3,476,109	$302,764	$15,332,715
2014	$11,811,893	$3,498,549	$307,416	$15,617,858
2015	$12,074,352	$3,521,495	$312,172	$15,908,019
2016	$12,341,345	$3,544,957	$317,035	$16,203,337
Sum	$111,968,129	$34,453,414	$2,963,864	$149,385,408

In addition to the program costs, there are participant costs associated with making the investment in the actual efficiency measure. Table 2-5 presents the annual participant costs that would be required to realize the achievable cost effective energy savings potential estimated in this study.

Table 2-5: **Annual Participant Budget** by Sector for **Oil, Propane, Kerosene, and Wood** Efficiency Programs Included in the Base Case Scenario				
Year	Residential	Commercial	Industrial	Total
2007	$6,220,963	$2,478,746	$96,026	$8,795,734
2008	$6,306,963	$2,478,746	$96,026	$8,881,734
2009	$6,393,463	$2,478,746	$96,026	$8,968,234
2010	$6,476,463	$2,478,746	$96,026	$9,051,234
2011	$6,566,963	$2,478,746	$96,026	$9,141,734
2012	$6,652,463	$2,478,746	$96,026	$9,227,234
2013	$6,738,463	$2,478,746	$96,026	$9,313,234
2014	$6,824,963	$2,478,746	$96,026	$9,399,734
2015	$6,910,963	$2,478,746	$96,026	$9,485,734
2016	$6,996,463	$2,478,746	$96,026	$9,571,234
Sum	$66,088,125	$24,787,458	$960,258	$91,835,840

If the Program Administrator had to pay 100% of measure incremental or full costs to obtain achievable cost effective potential savings levels, then the Program Administrator budget would more than double in size.

2.6.1 Implementation and Funding Mechanisms for Energy Savings Programs for Oil, Propane, Kerosene and Wood Fuels

There are many mechanisms that could be used to implement and fund a bold and aggressive energy efficiency program in Vermont to acquire significant cost effective energy savings for oil, propane, kerosene and wood fuels. For this study to analyze the benefits and costs, and establish program budgets a program implementation strategy similar to the one used by Efficiency Vermont was assumed. One way to fund the program model presented in this study is to use an Energy Efficiency Charge (EEC) on fuels similar to how the State's electric energy efficiency program is funded. However this is not the only option, other options are available to deliver energy efficiency programs in which costs and results may differ from those presented. While the benefits and costs were not analyzed in this study other program delivery options for an all-fuels energy efficiency program that should be considered by decision makers in Vermont include the following:

1. **Tax incentives**: the State of Vermont Legislature could consider new tax incentives for the purchase and installation of high efficiency equipment that will save oil, propane, kerosene or wood fuels. Such new tax incentives would be over and above any existing tax incentives that are currently in effect.
2. **Equipment efficiency standards**: the State of Vermont Legislature could consider enacting legislation to create higher equipment efficiency standards for new equipment sold in the State that consumes oil, propane, kerosene, or wood. Such new standards would ratchet standards higher than those currently in effect in Vermont.
3. **Building efficiency standards**: another option is for the State of Vermont Legislature to consider enacting legislation to create higher building efficiency standards for new homes and businesses constructed in the State. Such new standards would ratchet standards higher than the building standards currently in effect in Vermont.
4. **Sales tax holiday**: One method used in states such as Wisconsin and Maine to promote purchases of energy efficient equipment is a sales tax holiday. Under this method, the State declares a sales tax holiday for a specific period, and during this period no sales tax is levied on purchases of specific high efficiency equipment.
5. **Prescriptive rebate programs**: The State of Vermont could offer a prescriptive rebate program to provide incentives for the purchase and installation of high efficiency equipment that will save oil, propane, kerosene or wood fuels.
6. **Time-of-Sale minimum energy requirements**: The State of Vermont could enact legislation requiring buildings to meet a certain minimum energy standard at the time of sale. A similar program for rental properties is in effect in the City of Burlington Vermont.
7. **Energy efficiency financing mechanisms**: The State of Vermont in coordination with private industry could develop new financing mechanisms to help building owners fund energy efficiency improvements.

2.7 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.[11] It was based

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

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

In this study only two of these five perspectives are examined, the Vermont Societal Test and the Participant Test. These tests are described in more detail below.

2.7.1 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.[12] 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 out-of-pocket costs.

2.7.2 The Societal Test

The Societal Cost Test is structurally similar to the Total Resource Cost Test[13]. 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 or administrator 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. An example of a societal benefit is reduced emissions of carbon, nitrous and sulfur dioxide and

[12] California Public Utilities Commission and California Energy Commission, Standard Practice Manual, Economic Analysis of Demand-Side Programs and Projects, 1987 and 2001. page 9.

[13] 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 (or program administrator's) costs. The benefits calculated in the Total Resource Cost Test include the avoided fuel supply costs for the periods when there is a reduction in energy use, as well as savings of other resources such as electricity 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 program administrator 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 included in this test.

particulates.[14] 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, wood, and water used in this study are provided in Appendix F of this report. The Societal Test calculation for this study was performed as specified by the Vermont Public Service Board in Docket No. 5270.

2.8 Definition of Avoided Costs

The avoided supply costs for this Vermont energy efficiency potential study consists of the electric or fossil fuel supply costs avoided due to the implementation of energy efficiency programs. The electric system costs that are avoided depend on the amount of energy that is saved, and when it is saved (in peak heating season periods, seasonal or annual, etc.).

2.9 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 oil, propane, kerosene and wood 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 energy efficiency potential spreadsheet model[15];
(2) detailed information relating to the current saturation of oil, propane, kerosene and wood space and water heating equipment in Vermont; and
(3) available data on oil, propane, kerosene and wood energy efficiency measure costs, saturations, energy savings, and useful lives.

The technical potential for 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.

The achievable potential for energy efficiency for these four fuels 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.

[14] 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).

[15] GDS has developed an Excel spreadsheet model and used it to estimate the energy efficiency potential for 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.

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 efficiency programs when it is cost effective to do so.

All cost effectiveness calculations for 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.

3.0 HISTORICAL AND FORECAST FUEL CONSUMPTION DATA AND TRENDS FOR VERMONT

This section of the report describes historical data and trends for Vermont for consumption of oil, propane, kerosene and wood. This section also provides a forecast for energy consumption for each of these fuels for the period 2007 to 2016.

3.1 Historical Fuel Consumption

Vermont energy consumption data by sector is available for the period 1960 – 2003 from the U.S. Department of Energy, Energy Information Administration. Over the last 20 years, total energy consumption in Vermont has grown at an average compound rate of 0.8% per year. This is lower than the previous 20 years in which total energy consumption grew at a rate of 2.5% per year. In the future, larger homes and increasing appliance stock will cause energy consumption in the residential building sector to increase. Improvements in overall appliance and home energy efficiency will have a dampening effect on energy consumption.

The residential sector historically uses the highest share of total energy in the state, averaging about a 45% share over the most recent 10 years. Over the most recent 15 years, the industrial and commercial sectors have both averaged between a 25% and 30% share in total consumption. Figure 3-1 below summarizes market share data for each sector in Vermont from 1960 to 2003.

Figure 3-1
Total Energy Market Share by Sector

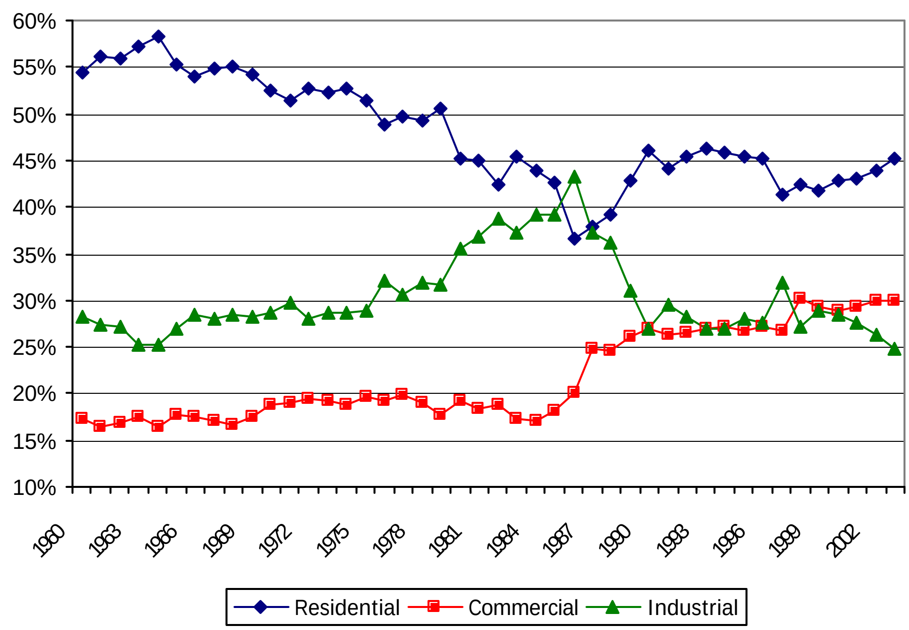
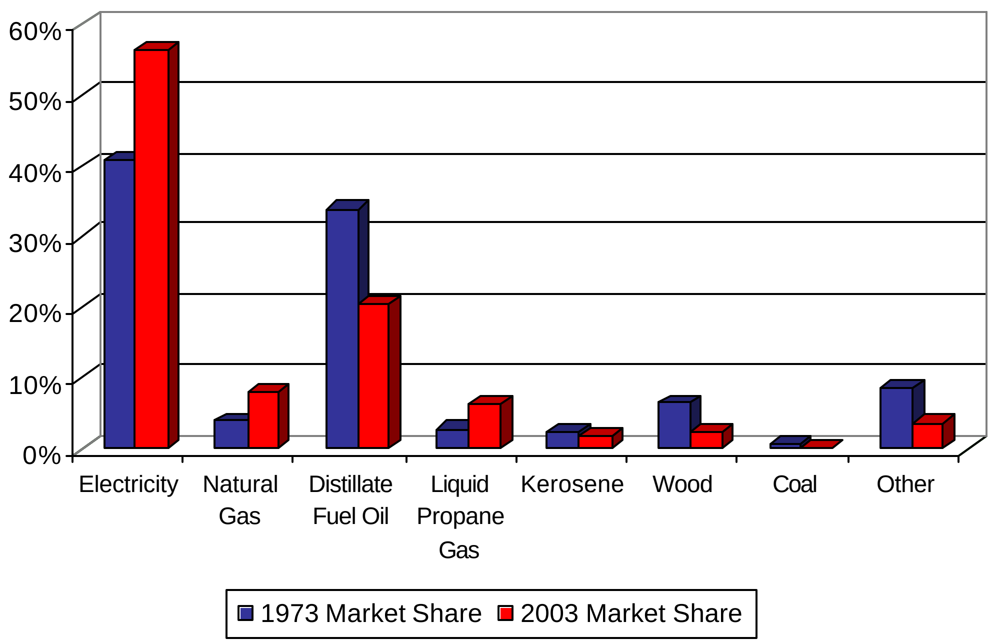


Figure 3-2 shows market share by fuel type for Vermont energy consumption as a whole in 1973 and 2003. In 2003, the top three fuels (electricity, natural gas, and fuel oil) accounted for over 85% of total energy consumption. Distillate fuel oil consumption accounted for approximately 20 percent of total energy consumption in the State in 2003. Natural gas is not available in much of the rural areas in the state, but some penetration has occurred in recent years. Still, electricity and oil are expected to be the primary fuels consumed the most in Vermont in the near future.

This section discusses electricity and natural gas consumption to provide an overview of total energy consumed in these sectors. This study's main focus is on fuel oil, propane, kerosene, and wood energy efficiency. In July 2006 the VDPS completed an electrical energy efficiency study, and Vermont Gas System's Integrated Resource Plan (IRP) completed in 2004 examines energy efficiency potential for their natural gas system.

Figure 3-2
Vermont Total Energy Market Share by Fuel, 1973 and 2003.



Residential Sector Energy Consumption

In 2003, the residential sector consumed 45.1% of the total energy consumption in Vermont. Consumption market share steadily decreased through the 1960's and 1970's and was quite volatile in the 1980's. Market share has been relatively stable since 1990. Figure 3-3 shows the breakdown of residential consumption by fuel in 2003. Table 3-1 shows historical energy consumption data and growth trends by fuel type for the residential sector.

Figure 3-3
Residential Consumption by Fuel, 2003

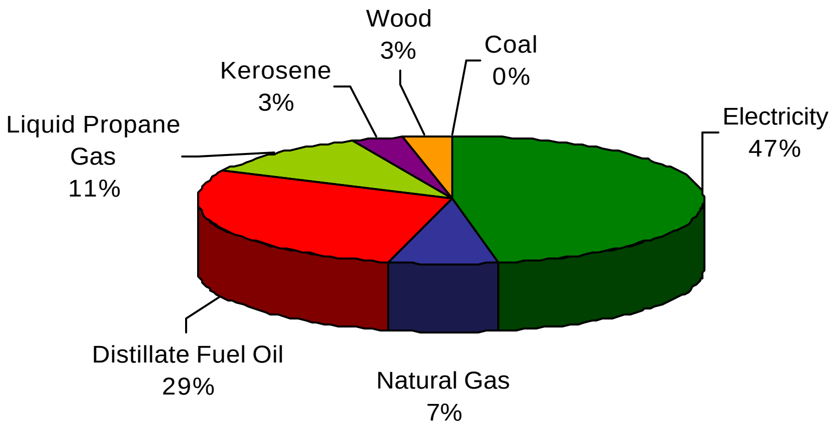


Table 3-1
Historical Residential Consumption of Key Fuels (Trillion BTU)

Year	Distillate Fuel Oil	Avg. Growth	Kerosene	Avg. Growth	LPG	Avg. Growth	Wood	Avg. Growth
1963	16.29		3.61		0.97		3.08	
1973	23.84	3.9%	1.93	-6.1%	1.73	5.9%	1.98	-4.3%
1983	11.67	-6.9%	1.22	-4.5%	1.79	0.3%	4.36	8.2%
1993	14.73	2.4%	1.33	0.9%	4.34	9.3%	2.28	-6.3%
2003	13.40	-0.9%	1.57	1.6%	5.32	2.0%	1.38	-4.9%

Distillate Fuel Oil

Distillate Fuel Oil is most commonly used for space and water heating in residential households. In 2003 distillate fuel oil accounted for 28.5% of total residential energy use in Vermont. Its use in the residential sector has declined in the past 10 years at an average rate of 0.9% per year. In the past 20 years, however, distillate fuel oil saw an increase of 0.7% per year. Residential oil use is projected by GDS to grow at 0.5% per year from 2003-2023.

Kerosene

In Vermont, kerosene is used primarily in outdoor fuel tanks (as a fuel for space heating) because it does not gel in outside tanks in cold weather like regular heating fuel oil. It is also used in stand-alone space heaters and to blend with off-road fuel to prevent gelling in cold weather. Kerosene makes up only about 3% of Vermont's residential energy consumption. However, its use has grown in the past ten years at a compound growth rate of 1.6% annually and is expected to grow at 2.8% per year from 2003-2013.

Liquefied Propane Gas

In 2003 liquefied propane gas (LPG) made up 11% of the residential fuel consumption market. In addition to space and water heating, LPG is used as a fuel for many cooking appliances, like gas grills and stoves. It is sometimes used as a fuel in cars and construction vehicles and as a heat source in recreational vehicles. Historically, LPG has had very strong growth and in the past ten years has grown at 2.0% per year in the residential sector. From 2003 to 2013, LPG is projected to grow at a compound rate of 3.0%.

Wood

The use of wood as a fuel in homes has decreased steadily since 1979. In the past ten years consumption has decreased at almost 5% per year. However, it still accounts for almost 3% of residential energy consumption. Wood consumption is projected to decrease by 1.8% per year over the forecast period. Wood is used as a main source and also as a supplemental source for space heating.

Commercial Sector

In 2003, the commercial sector consumed 30% of the total energy consumed in Vermont. The commercial sector's market share was consistently between 15% and 20% from 1960 through the mid-1980s, when it jumped to 25%. It has been steadily increasing ever since. This is illustrated in Figure 3-1, above. The commercial sector energy consumption is overwhelmingly electric, with distillate fuel oil and natural gas making up the rest of the top three fuels. Figure 3-4 shows a breakdown of the total commercial sector energy use by fuel.

Figure 3-4
Commercial Consumption by Fuel, 2003

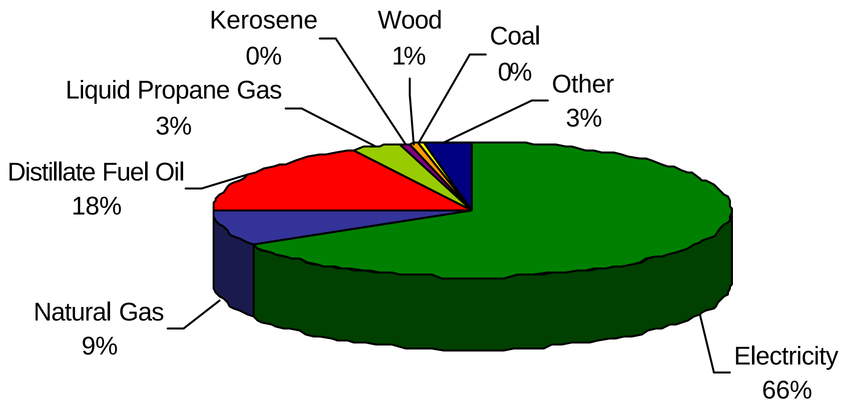


Table 3-2
Historical Commercial Consumption of Key Fuels (Trillion BTU)

Year	Distillate Fuel Oil	Avg. Growth	Kerosene	Avg. Growth	LPG	Avg. Growth	Wood	Avg. Growth
1963	3.33		0.22		0.17		0.06	
1973	4.87	3.9%	0.12	-6.1%	0.30	5.9%	0.04	-4.3%
1983	2.46	-6.6%	0.05	-8.3%	0.32	0.3%	0.10	10.3%
1993	4.64	6.5%	0.19	14.3%	0.77	9.3%	0.31	11.9%
2003	5.49	1.7%	0.12	-4.5%	0.94	2.0%	0.24	-2.3%

Distillate Fuel Oil

Distillate fuel oil is used as fuel for engines and for space and water heating. Distillate fuel oil represented 18% of the total commercial sector consumption in 2003 and its market share has been between 15% and 20% since 1980. Distillate fuel oil used by the commercial class has been growing at a compound average annual rate of 1.7% from 1993-2003. Usage is projected to grow at 1.6% per year over the next 10 years.

Kerosene

Kerosene is used in the same way as distillate fuel oil in cold weather because of its resistance to gelling. Kerosene holds only 0.4% of the commercial energy consumption market share and use is expected to decrease at a rate of 5.3% per year from 2003-2013. Historically, kerosene consumption in the commercial sector has been very erratic, with average annual changes in consumption of 67%.

Liquefied Propane Gas

LPG makes up 3% of the commercial consumption market share. In the commercial sector, LPG can be used for heating, cooling, and refrigeration needs. From 1993-2003 consumption grew at 2.0% annually and is projected to grow at 3.4% from 2003-2013.

Wood

The market share for wood consumption in the commercial sector has been relatively stable, with a large increase in 1989 due to PURPA standards that required electric utilities to purchase power from independent power producers. Wood accounts for only 1% of the commercial energy consumption market share. Wood is used mostly in wood furnaces and boilers for space and water heating. From 1993-2003, wood consumption decreased by 2.3% and is being held at 230 billion BTUs per year for the remainder of the forecast period.

Industrial Sector

The industrial sector represents 25% of the total energy consumption in Vermont. The industrial market share has been quite volatile, but has been steadily decreasing for the five years prior to 2003. In 1986, the market share for the industrial sector fuel consumption climbed as high as 43%, but has remained fairly steady and below 30% almost every year since 1990, as shown on the first page of this section in Figure 3-1. Total industrial consumption is probably erratic in part because of sensitivity to the activities of a small number of large manufacturing facilities. Figure 3-5 shows that most of the industrial energy market share is dominated by electric power consumption, with distillate fuel oil, natural gas, and all other fuels having significant shares of fuel consumption.

Figure 3-5
Industrial Consumption by Fuel, 2003

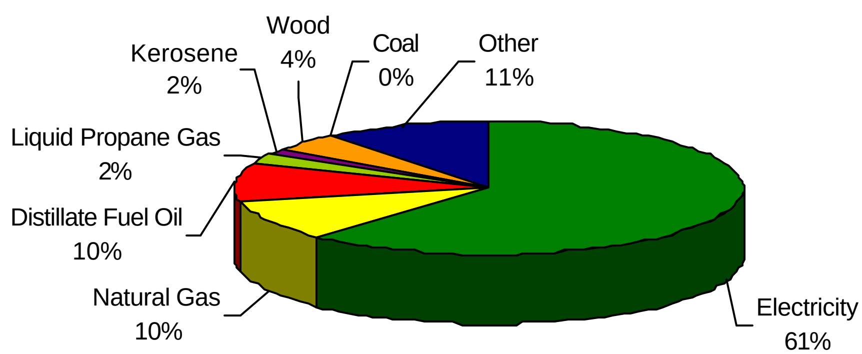


Table 3-3
Historical Industrial Consumption of Key Fuels (Trillion BTU)

Year	Distillate Fuel Oil	Avg. Growth	Kerosene	Avg. Growth	LPG	Avg. Growth	Wood	Avg. Growth
1963	1.70		0.39		0.27		3.63	
1973	2.73	4.9%	0.37	-0.4%	0.53	7.0%	4.13	1.3%
1983	1.68	-4.8%	0.19	-6.3%	1.00	6.6%	10.06	9.3%
1993	3.18	6.6%	0.05	-13.4%	0.78	-2.4%	2.56	-12.8%
2003	2.52	-2.3%	0.40	24.3%	0.51	-4.3%	1.10	-8.1%

Distillate Fuel Oil

Industrial consumption of distillate fuel oil has decreased 2.3% per year in the past ten years. In 2003, it held 10% of the industrial energy consumption market share. The econometric forecast predicts that the consumption of fuel oil in the industrial sector will increase 1.3% per year from 2003-2013 and slow to 0.2% over 2013-2023.

Kerosene

Kerosene holds 1.6% of the industrial energy market share at 403 billion BTU in 2003. Kerosene consumption has been very volatile over the historical period.

From 1993-2003 consumption averaged growth of 23% annually, however, in the ten-year period before that, kerosene consumption fell an average of 13% per year. It is forecasted to grow at 1.3% per year from 2003-2013 and 2.6% from 2013-2023.

Liquefied Propane Gas

In the industrial sector, LPG is used in space and process heating, as a fuel to drive equipment such as forklifts, to power industrial ovens, and many other uses. In 2003, it comprised 2.0% of the total industrial energy market and is projected to grow at 3.0% from 2003 to 2013. The historical consumption has been quite unpredictable, with annual growth rates of up to 1,047% and the average swing in either direction being 87%. This is due, in part, to the low volume of sales and the ability of a few accounts to have a substantial impact on the market.

Wood

The historical growth for wood fuel consumption has been pretty consistent. In 2003, wood consumption held 4.3% of the industrial market share. Growth was level in the 1980s, but in 1989 and 1990, consumption dropped from almost 9 trillion BTUs to under 3 billion BTUs annually. This was repeated on a lesser scale in 2002 when consumption dropped to 1.2 trillion BTUs. In the interim, consumption has been stable. Thus, consumption is projected to stay at the 2003-2004 level over the forecast period. In 2003, wood held 4.3% of the industrial market share.

3.2 Forecasted Fuel Consumption

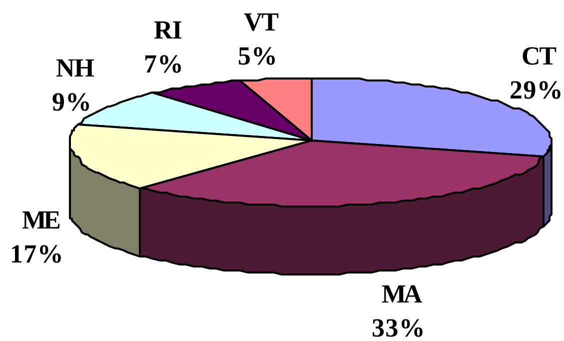
A forecast of fuel consumption by fuel type, sector and end-use was developed by GDS as a component of this overall energy efficiency potential study to assist in the development and validation of estimates for technical and achievable potential for fuel energy savings. The fuels included in this forecast include distillate fuel oil, kerosene, liquid propane gas, and wood.

The forecast is a “top-down” approach in which projections for total fuel consumption by sector (residential, commercial, industrial) at the state level are developed and then broken down to the end-use level. Primary data sources utilized in the development of the forecasts include the Energy Information Administration (“EIA”), the Regional Economic Models Inc. (REMI) economic forecast projections, and surveys completed by the Vermont Department of Public Service (“VDPS”).

Total Fuel Consumption Projections

An initial forecast of state consumption for each fuel was completed by modeling state consumption as a function of regional (New England) consumption. The EIA provides historical consumption for the state and region, and the EIA *Annual Energy Outlook* for 2006 includes projections at the New England level. The benefit of this approach is that the forecast ties entirely to EIA projections, which tend to be reliable at the national and regional levels. One of the implicit assumptions of the regional models methodology, however, is that the historical relationships quantified in the models are assumed to hold into the future. Upon further reflection of the projected consumption for New England as a whole and Vermont specifically, GDS and VDPS staff concluded that this assumption is invalid. Regional oil consumption is projected by the EIA to decline over the next 20 years. This is a reasonable assumption for parts of the region that have a high availability of competitive fuels such as natural gas. However, the availability of natural gas in many areas in Vermont is still limited, even though it is growing. The New England data is significantly influenced by the presence of Massachusetts, giving more weight in the regional forecast to the residential, commercial, and industrial characteristics of consumers in Boston where natural gas is readily available. Figure 3-6 provides the percent contribution to residential oil consumption for each state in 2004.

Figure 3-6
2004 New England Residential Oil Consumption



Given the weight that Massachusetts has on the regional oil projections, and that declining oil consumption (as projected by the EIA for New England) is a more likely scenario in metropolitan areas rather than predominately rural Vermont, the regionally-based EIA forecast for oil, propane, kerosene and wood fuel consumption were not selected for use in projecting state fuel consumption.

The next approach developed by GDS was to create simple econometric models to project consumption for Vermont. These models are simple in that they use a single high-level economic variable to project fuel consumption by sector. Data from the REMI model was used to provide economic projections of the following three variables utilized in the model specifications:

Total Households – Used to project residential energy consumption by fuel
Commercial Employment – Used to represent general commercial activity in the state and to project commercial energy consumption by fuel. Commercial

employment is represented by total non-farm employment net of manufacturing/industrial employment.

Real Gross State Product – Used to represent overall manufacturing output in the state and to project industrial consumption by fuel.

These variables represent the very basic drivers of fuel consumption activity for each sector. The simple linear regression models developed using the econometric approach are preferable to simple linear trends or averaging because they do allow definition of an economic driver of fuel consumption. The models provide reasonable projections for all fuels and have suitable diagnostic statistics, which are detailed in tables included in the appendices of this report. Although R^2 statistics tend to be low, this is attributable to the high level of variation in historical consumption patterns and cannot be a sole standard for rejection of the models. This is particularly true in fuels with low total usage in the commercial and industrial sectors. For instance, Industrial kerosene has very low use in the state historically, and it is very possible that the activities of a small group of industrial consumers impact overall sector consumption patterns. In nearly all cases, F-tests provide a level of significance of 90% or greater, indicating a relationship is present and that the model provides a better prediction than averaging.

Industrial LPG historical consumption is very low, eclipsing 1 trillion BTU only once in the past 20 years, and is highly volatile. This combination makes development of a statistical model for Industrial LPG difficult. Although the F-test is only significant at the 60% level, we believe the model provides a more reasonable forecast than a simple historical average, and the model incorporates the impacts of gross state product, which is a key measure of industrial production. Wood consumption for both the commercial and industrial sectors could not be modeled to any reasonable level of significance, so averages of recent historical consumption are used to project consumption of wood for commercial and industrial.

Appendix H summarizes the fuel consumption projections by sector and fuel using the simple econometric methodology.

End-Use Analysis

The above projections were further broken down into end-use level projections. Residential end-use projections were based on a combination of:

Households Primarily Utilizing Each Fuel – Derived from projected households in Vermont (from REMI Economic Forecast) and Appliance Unit Market Share (from "Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs" for Vermont Department of Public Service).

Energy Consumption per Household – Data is for New England region and was obtained from “2001 Residential Energy Consumption Survey" by the Energy Information Administration.

Projected Efficiency – National data is from the Energy Information Administration's Annual Outlook 2006.

Based on the above data, projections were made through the forecast period. Results are summarized below, in Table 3-4, and in more detail in Appendix H.

Table 3-4
Residential End-Use Consumption (Trillion BTU)

Description	2005	2010	2015	2020
Distillate Fuel Oil	13.93	14.20	14.51	14.73
Space Heating	12.05	12.27	12.54	12.73
Market Share	87%	86%	86%	86%
Water Heating	1.87	1.92	1.97	2.00
Market Share	13%	14%	14%	14%
Other	0	0	0	0
Market Share	0%	0%	0%	0%
Kerosene	1.73	1.92	2.14	2.29
Space Heating	1.00	1.01	1.03	1.05
Market Share	58%	52%	48%	46%
Water Heating	0.03	0.03	0.03	0.03
Market Share	2%	2%	1%	1%
Other	0.70	0.88	1.08	1.21
Market Share	40%	46%	50%	53%
Liquefied Propane Gas	5.99	6.65	7.43	7.96
Space Heating	3.10	3.12	3.20	3.27
Market Share	52%	47%	43%	41%
Water Heating	0.84	0.84	0.86	0.88
Market Share	14%	13%	12%	11%
Other	2.04	2.68	3.36	3.81
Market Share	34%	40%	45%	48%
Wood	1.64	1.43	1.20	1.04

The forecast of commercial fuel consumption was allocated to end-uses for space and water heating consumption based on a phone survey of local Vermont fuel and service providers conducted by GDS Associates. Space heating consumption was then further broken down into furnace, boiler, and unit heater subcategories and water heating consumption was broken down into boiler, water heater, tankless water heater, dish washing, and clothes washing subcategories. These results are summarized below in Table 3-5 and in further detail, including subcategories, in Appendix H.

Table 3-5
Commercial End-Use Consumption (Trillion BTU)

Description (Market Share)	2005	2010	2015	2020
Distillate Fuel Oil	5.97	6.19	6.58	7.01
Space Heating (84%)	5.01	5.20	5.53	5.89
Water Heating (16%)	0.95	0.99	1.05	1.12
Kerosene	0.17	0.19	0.21	0.24
Space Heating (84%)	0.14	0.16	0.18	0.20
Water Heating (16%)	0.03	0.03	0.03	0.04
Liquefied Propane Gas	1.07	1.23	1.37	1.52
Space Heating (84%)	0.90	1.03	1.15	1.28
Water Heating (16%)	0.17	0.20	0.22	0.24
Wood	0.23	0.23	0.23	0.23
Space Heating (84%)	0.20	0.20	0.20	0.20
Other (16%)	0.04	0.04	0.04	0.04

Industrial consumption projections were broken down into direct, indirect, and other uses. Direct uses included process heating and non-process direct uses. Indirect use is fuel for boilers. A summary of Industrial end-use consumption with allocation factors for each end-use and fuel is depicted in Table 3-6. A more detailed table is located in Appendix H.

Table 3-6
Industrial End-Use Consumption (Trillion BTU)

Description (Market Share)	2005	2010	2015	2020
Distillate Fuel Oil	3.18	2.86	2.86	2.88
Indirect Use (56.3%)	1.79	1.61	1.61	1.62
Direct Uses-Process Heating (25%)	0.80	0.72	0.71	0.72
Direct Uses-Non-Process (6.3%)	0.20	0.18	0.18	0.18
Other Uses (12.5%)	0.39	0.35	0.35	0.36
Kerosene	0.36	0.41	0.49	0.55
Direct Uses-Process Heating (50%)	0.18	0.21	0.24	0.28
Direct Uses-Non-Process (50%)	0.18	0.21	0.24	0.28
Liquefied Propane Gas	0.61	0.67	0.69	0.72
Direct Uses-Process Heating (50%)	0.30	0.33	0.35	0.36
Direct Uses-Non-Process (50%)	0.30	0.33	0.35	0.36
Wood	1.16	1.16	1.16	1.16
Direct Uses-Process Heating (50%)	0.58	0.58	0.58	0.58
Direct Uses-Non-Process (50%)	0.58	0.58	0.58	0.58

4.0 METHODOLOGY

This section presents an overview of the approach and methodology used for this analysis to determine the achievable cost-effective potential for energy savings for fuel oil, kerosene, propane and wood energy efficiency measures in the State of Vermont. The key formulas and calculations used to complete this assessment are described in this section. Three levels of potential energy savings were assessed in this study: technical potential; achievable potential; and achievable cost effective potential.

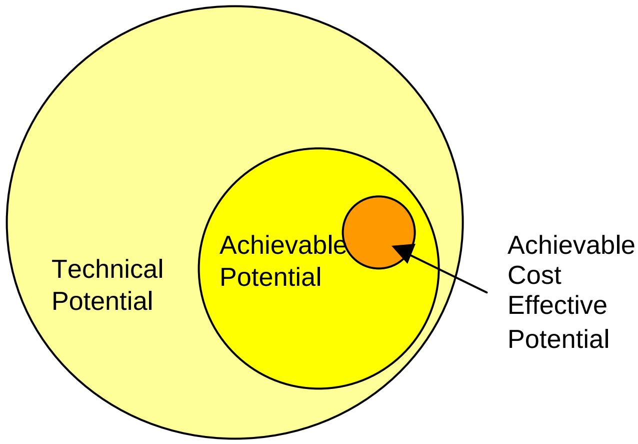
- **Technical potential** is defined as the complete and immediate penetration of all measures analyzed in applications where they are deemed to be technically feasible from an engineering perspective. The total technical potential for energy efficiency savings for each sector was developed from estimates 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 energy savings that could be captured if 100 percent of inefficient equipment is replaced instantaneously (where such installations are deemed to be technically feasible).

- **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.

- **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. The State of Vermont would need to undertake an aggressive effort to achieve this level of savings.

To develop the cost effective achievable potential, the GDS Team only retained those energy efficiency measures in the analysis that were found to be cost effective (according to the Vermont Societal Test) based on the individual measure cost effective analyses conducted in this Study. Energy efficiency measures that were not cost effective were excluded from the estimate of cost effective achievable energy efficiency potential. Figure 4-1 below shows these three stages of the 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 begins with a careful assessment of the existing level of energy efficiency that has already been accomplished in Vermont. For each 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 end use. For example, if 100 percent of the homes in Vermont had oil furnaces, and 30 percent of these furnaces were already high efficiency furnaces, then the remaining technical potential for energy efficiency savings is the 70 percent of furnaces in the residential sector that are not already high efficiency units.

The general methodology used for estimating the potential for fuel oil, kerosene, propane and wood energy efficiency in the residential, commercial and industrial sectors of Vermont included the following steps:

1. Identification of data sources for energy efficiency measures.
2. Identification of energy efficiency measures to be included in the assessment.
3. Determination of the characteristics of each energy efficiency measure including its incremental cost, energy savings, and useful life.
4. Collection of data relating to operation and maintenance savings, current saturation, and the percent of installations that are already energy efficient.
5. Calculation of initial cost-effectiveness screening metrics (e.g., the Vermont Societal Test benefit cost ratio) and sorting of measures from least-cost to highest cost per unit of energy saved.
6. Collection and analysis (where data was available) of the baseline and forecasted characteristics of the end use markets, including equipment

saturation levels and energy consumption, by market segment and end use over the forecast period.

7. Integration of measure characteristics and baseline data to produce estimates of cumulative costs and savings across all measures (supply curves).
8. Determination of the cumulative technical and achievable potentials using supply curves.
9. Determination of the annual achievable cost effective potential for energy 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 energy efficiency measures with the costs of energy per mmbtu.

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).[16]

4.2 General Methodological Approach for Determining Energy Savings Potential

This section describes the calculations used to estimate the 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 energy efficiency measure and it is essentially the same for each sector. However, for the residential sector, the equation is applied 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., high efficiency oil furnaces, programmable thermostats, weatherization and insulation of existing homes, etc.). For the commercial and industrial (C&I) sectors, a "top-down"

[16] 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

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.[17] For the commercial and industrial sectors, GDS used Vermont specific equipment saturation and end use data wherever such data was available. The core equations used by GDS for this study are identical to the equations used in the July 21, 2006 Vermont electric energy efficiency potential study completed by GDS.

4.2.1 Core Equation for Estimating Technical Potential

The core equation for calculating the 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 energy 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 households in the market segment.

- **Base-case equipment end use intensity** is the energy used per customer per year by each base-case technology in each market segment. This is the consumption of the energy using equipment that the efficient technology replaces or affects. For example purposes only, if the efficient measure were a residential high efficiency furnace, the base end use intensity would be the annual energy use per household associated with a standard efficiency furnace (a furnace that meets existing appliance efficiency standards for furnace equipment).

- **Base Case factor** is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, for the residential oil heating market, this would be the fraction of all residential housing units that have oil space heating in their household.

[17] 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).

- **Remaining factor** is the fraction of applicable households that have not yet been converted to the 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 households that is technically feasible for conversion to the efficient technology from an *engineering* perspective (e.g., it may not be possible to install high efficiency furnaces in all homes because the high efficiency furnace might not fit every home).

- **Savings factor** is the percentage reduction in energy consumption resulting from application of the high efficiency technology.

An example of the core equation for calculating the energy efficiency technical potential for each individual efficiency measure for the commercial and industrial sectors is shown below in Table 4-2. This equation is the same as the one used in the electric energy efficiency potential study completed for Vermont in July 2006.

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

Technical Potential of Efficient Measure	=	Total End Use Energy By Fuel Type by Sector	X	Base Case Factor	X	Remaining Factor	X	Convertible Factor	X	Savings Factor

where:

- **Total end use energy by fuel type by sector (by segment)** is the forecasted level of energy consumption by fuel type by sector for a given end-use (e.g., space heating, water heating, cooking, etc.) in the commercial or industrial sectors.

- **Base Case factor** is the fraction of the end use energy by fuel type by sector that is applicable for the efficient technology. For example, for high efficiency oil furnaces, this would be the fraction of all end use oil energy used for space heating in the commercial sector that is associated with oil furnaces.

- **Remaining factor** is the fraction of applicable oil used for space heating by fuel type by sector that is associated with equipment that has not yet been converted to a high 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 high efficiency oil furnaces in every possible application in a given market segment).

- **Savings factor** is the percentage reduction in energy consumption resulting from application of the high efficiency technology.

Technical energy efficiency savings potential was calculated in two steps. In the first step, all measures were treated *independently*; that is, the savings of each measure were not reduced or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics can be 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 due to measure interaction effects. 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 sector, GDS addressed the new construction market as a separate market segment, with energy efficiency measures 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 oil, propane, kerosene and wood energy 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 this study, GDS did include retrofit measures, such as insulation and weatherization programs, but GDS did not include any "early replacement" scenarios for measures that could be replaced-on-burnout.[18]

For the market driven measures, GDS assumed that existing equipment was replaced with high efficiency equipment at the time a consumer is shopping for new 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.

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[18] 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 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 replacement 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 replacement strategy is used, and if the incentive necessary to get participation for the early replacement 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.[18]

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.[18] 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.

4.2.3 Development of Achievable Cost Effective Potential Estimates for Energy Efficiency

To develop the achievable cost effective potential for 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. Energy efficiency measures that were not cost effective 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.[19]

The issue of free-riders and free-drivers is important. Where a top-down modeling approach is used to estimate energy savings potential, free-riders can usually be accounted for through the energy demand forecast. Energy demand forecasts usually already include the impacts of naturally occurring energy efficiency (including impacts from vintaging of appliances, price impacts, and appliance and building efficiency standards). Because naturally occurring energy savings is reflected in the demand forecasts used in this study for the commercial and industrial sectors, these energy savings are not 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 in the commercial and industrial sectors. 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, North Carolina and Utah.

<u>Adjustments to Savings for the Residential Sector</u>

As noted above, GDS used a “bottom-up” approach to estimate potential energy savings remaining in the residential sector in Vermont. GDS collected data on energy efficiency program realization rates from programs at NYSERDA, National Grid, Wisconsin Focus on Energy and other large energy efficiency organizations in the US. GDS used this literature review as a basis for developing realistic factors to account for free-ridership and naturally-occurring

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

energy efficiency in Vermont in the residential sector. Listed below are definitions of terms that are relevant to this literature search.

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.

A May 2006 NYSERDA Program evaluation study relied upon by GDS for residential net-to-gross ratios and realization rates is available on the NYSERDA web site at www.nyserda.org (at the New York Energy $mart program evaluation section of this web site). GDS obtained the adjustment factor to allow for actual realization rates, free-ridership and spill-over from the May 2006 NYSERDA Program Evaluation Report titled "New York Energy $mart Program Evaluation and Status Report, Report to the Systems Benefits Charge Advisory Group, May 2006", pages 5-6 and 5-7. NYSERDA's Measurement and Verification (M&V) contractor assessed the energy and peak demand savings reported for its residential programs. Methods used in this assessment included on-site verification of equipment installation and functionality, and review of NYSERDA's files for reasonableness and accuracy. Based on this review, the M&V contractor adjusted the savings reported by NYSERDA. In turn, the Market Characterization, Assessment and Causality/Attribution (MCAC) contractor further adjusted these figures to account for free-ridership and spillover. A summary of the energy savings from the Residential Programs is presented in Table 5-2, Table 5-3, and Table 5-4 of this May 2006 Report. These numbers show the savings after adjustments by the M&V and MCAC evaluation contractors. Annual MWh savings before adjustment for realization, free-ridership and spillover were 305,698 MWh. Savings after adjustment for realization, free-ridership and spillover were 324,384 MWh annually. The overall adjustment factor is thus 1.06 times gross reported savings. GDS has used an adjustment factor of 1.0 for this study for the Vermont residential sector.

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 energy efficiency programs can attain over the long-term (ten years) with well-designed programs and aggressive funding. GDS used an achievable penetration rate of 80 percent by 2016 for the residential, commercial and industrial sectors in Vermont.

The achievable 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 2016 (ten years from now) based on aggressive funding and an incentive level equal to 50% of energy efficiency incremental measure costs.

The achievable potential estimate for energy efficiency defines the upper limit of savings from market interventions. For each sector, GDS developed the initial year (2007) and terminal year (2016) 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 has reviewed penetration rate forecasts from other recent energy efficiency technical potential studies, actual penetration experience for energy efficiency programs operated by numerous 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 2016 for the achievable potential scenario. In addition, GDS 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 (2016) 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 2016 for Vermont’s residential, commercial and industrial sectors across all fuel types.

4.3.1 Examples of US Efficiency Programs with High Market Penetration

GDS has already collected information on 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.[20]
2. The residential water heater bundle-up program conducted by Central Maine Power Company has achieved a market penetration of over 80

[20] 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.

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.[21]
4. Vermont Gas Systems' reported that 68 percent of new homes in their service territory were ENERGY STAR Homes in 2002.[22]
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.[23]
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.[24]
8. KeySpan Energy Delivery's high efficiency residential furnace program has achieved a market share of approximately 70 percent over eight years (1997-2005).[25]

GDS recommends to VDPS staff that the actual market penetration experience from 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 fuel oil, kerosene, propane, and wood energy efficiency programs in Vermont. In addition, recent technical potential studies in such states as California, Connecticut, Florida, Georgia, Kentucky, New Mexico, North Carolina 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.[26]

[21] Id.
[22] American Council for an Energy Efficient Economy, "America's Best Gas Energy Efficiency Programs", 2003.
[23] Id.
[24] 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.
[25] American Council for an Energy Efficient Economy, "America's Best Gas Energy Efficiency Programs", 2003.
[26] 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.

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 our recommendations of the 80% penetration rate over the long term with aggressive programs.

4.4 Development of Program Budgets

GDS developed program budgets for program administration, marketing, and program management using an approach similar to the one used in the July 21, 2006 electric energy efficiency potential study completed by GDS for Vermont.[27] Using the program budget data in the July 21, 2006 report for the VDPS, GDS calculated program budgets for these implementation activities as a percent of measure costs for each sector (residential, commercial and industrial). Then GDS applied these factors to derive program budgets for oil, propane, kerosene and wood energy efficiency programs.

[27] Vermont Department of Public Service, "Vermont Electric Energy Efficiency Potential Study, Final Report", July 21, 2006, prepared for the VDPS by GDS Associates, Inc.

5.0 RESIDENTIAL SECTOR ENERGY EFFICIENCY POTENTIAL IN VERMONT FOR OIL, PROPANE, KEROSENE, AND WOOD

This section of the report presents the estimates of technical, achievable and achievable cost effective energy efficiency potential for oil, propane, kerosene and wood fuel savings in Vermont. According to this analysis, there is still a large remaining potential for savings of these fuels in the residential sector. Over the period 2007 to 2016, the net present value savings for additional energy savings of oil, propane, kerosene and wood energy efficiency is $253 million. Table 5-1 below summarizes the residential sector achievable cost effective energy savings potential by fuel type by the year 2016 by fuel type.

Table 5-1: Energy Efficiency **Achievable Cost Effective** Potential by Fuel Type as a Percent of Total Fuel Type Energy Consumption

Year	Oil	Propane	Kerosene	Wood
2007	1.03%	0.65%	0.40%	1.33%
2012	6.14%	3.54%	2.13%	9.48%
2016	10.16%	5.57%	3.28%	18.26%

5.1 Residential Sector Energy Efficiency Measures

GDS included twenty-four energy efficiency programs or measures in the analysis of residential sector energy savings potential for oil, propane, kerosene and wood fuels. Table 5-2 presents a list of these twenty-four energy efficiency measures and shows the measures examined for each fuel type.

In order to develop the list of energy efficiency measures to be examined, GDS reviewed the measures included in the July 21, 2006 Vermont Electric Energy Efficiency Potential Study as well as other energy efficiency technical potential studies that have been conducted in the US. This measure list was reviewed by VDPS staff. The set of 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. The portfolio of measures includes retrofit and replace-on-burnout programmatic approaches to achieve energy efficiency savings. Appendix A1 presents savings and cost assumptions by fuel type at the “measure” level, and presents annual energy savings that can be achieved at individual single-family or multi-family homes.

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 2005 by KEMA.

Table 5-2: List of Energy Efficiency Measures included in the Residential Sector of the Energy Efficiency Potential Savings Study

Row	Measure*	Brief Description	End-Use	Oil	Propane	Kerosene	Wood
1	Insulation & Weatherization Package (SF)	Insulation upgrades are applied to existing homes to attic, walls, floor, etc.	SH	X	X	X	X
2	Attic Insulation & Weatherization Pkg (MF)	Insulation upgrades are applied to existing homes in attic only	SH	X	X	X	X
3	ES Windows	Install energy efficient windows in existing homes	SH	X	X	X	X
4	Programmable Thermostat	Install a programmable thermostat to control home heating use	SH	X	X	X	X
5	Duct Sealing	Leaky and unsealed residential air ducts for furnaces are repaired and sealed	SH	X	X	X	
6	Efficient Furnace	Replace standard efficiency furnace with a high efficiency furnace	SH	X	X	X	
7	Efficient Wood Stove	Replace standard efficiency wood stove with a high efficiency wood stove	SH				X
8	Efficient Water Boiler	Replace standard efficiency water boilier with high efficiency water boiler	SH	X	X		
9	Modulate Water Temp	Control that modulate water temperature based on heating needs	SH	X	X		
10	Efficient Steam Boiler	Replace standard efficiency steam boiler with high efficiency steam boiler	SH	X	X		
11	Vent Damper		SH	X	X		
11	Improved Steam Vents	Improves efficiency of steam distribution	SH	X	X		
12	Mainline Air vent	Eliminates air from steam lines	SH	X	X		
13	Thermostatic vents	Balances distribution of steam heat through home	SH	X	X		
14	Pipe Wrap	Insulation is wrapped around pipes to/from water heater	WH	X	X		X
15	Lo-Flo Showerhead/Faucets	Existing showerhead/faucets with high flow rate are replaced with low flow units	WH	X	X		X
16	Efficient Oil WH (SH/WH Combo)	Replace standard efficiency Oil WH with a high efficiency Oil WH	WH	X			
17	Efficient Oil WH (Stand-Alone)	Replace standard efficiency Oil WH with a high efficiency Oil WH	WH	X			
18	Pump Controller (MF)	Automatically regulates the on and off periods of pump equipment	WH	X	X		
19	ES Clothes Washer	Replace standard efficiency CW with an Energy Star CW	WH	X	X		
20	ES Dishwasher	Replace standard efficiency DW with an Energy Star DW	WH	X	X		
21	Efficient Propane WH	Replace standard efficiency Propane WH with a tankless Propane WH	WH		X		
22	Solar WH w/ Backup	Install Solar WH unit in homes to serve as pre-heater for existing WH	WH	X	X		X
23	New Homes Construction	Build New Homes to be 20% more efficient than current 2004 EICC code	SH	X	X		X
24	Vacant Homes Package	Install high efficiency shell measures to existing vacant homes	SH	X	X	X	X

5.2 Characteristics of Energy Efficiency Measures and Savings Opportunities

GDS collected data on the energy savings, incremental costs, useful lives and other key "per unit" characteristics of each of the residential energy efficiency measures. Estimates of the size of the eligible market were also developed for each efficiency measure for each fuel type (i.e., oil, propane, kerosene or wood). For example, energy efficiency measures that affect oil space heating energy consumption are only applicable to those homes in Vermont that have oil space heating.

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).[28] The sizes of various residential end-use market segments were based on saturation estimates provided in the 2005 KEMA residential market assessment report for Vermont.

As discussed in Section 2 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 2016 (a decade from now).

In this report we also present the energy efficiency potential results in the form of supply curves. The analysis of the potential for energy savings is based on forecasts of energy consumption for oil, propane, kerosene and wood for Vermont for the years 2007 to 2016.[29] Energy-efficiency measures were analyzed for the most important energy consuming end uses in the residential sector: space heating and water heating.

5.2.1 Fuel Oil

Figure 5-1 and Table 5-3 below summarizes the technical, achievable, and achievable cost effective savings potential for fuel oil in the residential sector by the year 2016. The achievable cost effective potential for fuel oil is 4.36 TBTU or 10.2% of the Vermont residential sector fuel oil consumption forecast in 2016.

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[28] 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.

[29] See Section 4 of this report for a full description of the methodology used by GDS to develop these consumption forecasts for 2007 to 2016.

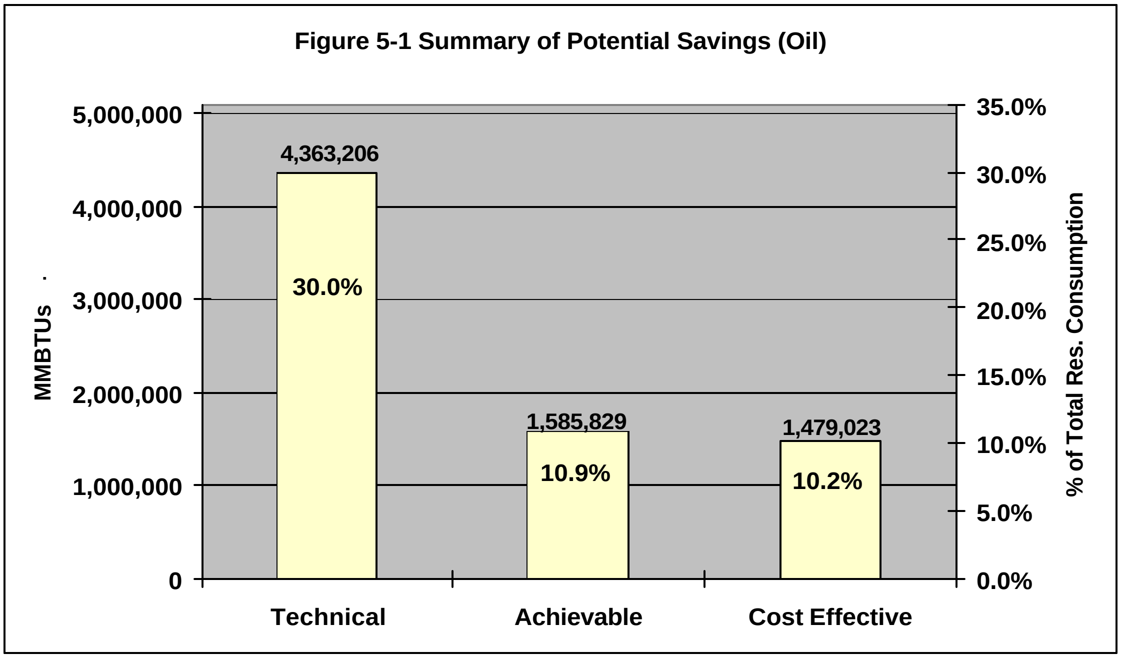


Table 5-3: Summary of Residential **Fuel Oil** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Fuel Oil Consumption
Technical Potential	4,363,206	30.0%
Achievable Potential	1,585,829	10.9%
Achievable Cost Effective Potential	1,479,023	10.2%

Tables 5-4 through 5-6 list the residential sector fuel oil energy efficiency programs or measures included in the technical, achievable, and achievable cost effective potential analyses. The Societal Test Benefit/Cost ratios shown in Table 5-6 were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheets. Only measures with a benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

The supply curve for residential fuel oil efficiency technical potential savings is shown in Figure 5-2, found after Tables 5-4 through 5-6. Figure 5-3 provides information on the achievable cost effective potential fuel oil savings by 2016 in the residential sector. About 60% of the achievable cost effective savings is from residential building shell energy efficiency measures, followed by heating equipment retrofits and upgrades, water heating retrofits and upgrades, energy efficient new construction, and energy efficient vacant homes. Figures 5-4 and 5-5 present the cost of conserved energy (CCE) for residential fuel oil energy efficiency measures included in the study. Note that the CCE figures only include fuel oil savings and do not include electric or water savings. These figures simply provide a picture of the relative cost of conserved fuel oil for the fuel oil efficiency measures examined in this study. Figure 5-4 displays all measures with a CCE below the 2007 $/MMBTU for fuel oil. Figure 5-5 displays all measures with a CCE above the 2007 $/MMBTU for fuel oil.

Table 5-4: Total Cumulative Annual Technical Potential MMBTU Savings for **Fuel Oil** Efficiency In Vermont By 2016

Residential Sector - Replace on Burnout and Retrofit Savings

1	2	3	4
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	716,863
2	ES Windows	SF	487,276
3	Insulation & Weatherization Package	SF	867,278
4	Programmable Thermostats	MF	15,995
5	Attic Insulation & Weatherization Pack.	MF	94,774
6	ES Windows	MF	32,651
7	Duct Sealing	SF	41,650
8	Efficient Oil Furnace	SF	109,114
9	Efficient Oil Furnace	MF	9,038
10	Modulate Water Temp.	SF	315,055
11	Efficient Water Boiler	SF	67,281
12	Modulate Water Temp.	MF	10,632
13	Efficient Water Boiler	MF	7,855
14	Vent Damper	SF	37,908
15	Improved Steam Vents	SF	22,997
16	Efficient Steam Boiler	SF	16,166
17	Mainline Vents	MF	7,252
18	Vent Damper	MF	3,916
19	Thermostatic Vents	MF	1,900
20	Efficient Steam Boiler	MF	1,699
21	Low Flow Showerhead/Faucets	SF	36,384
22	Pipe Wrap	SF	3,184
23	Efficient Oil Water Heater (SH/WH)	SF	0
24	Efficient Oil Water Heater (stand-alone)	SF	0
25	Solar WH w/ Oil Back Up	SF	1,097,273
26	ES Dishwasher	SF	9,691
27	ES Clothes Washer	SF	19,766
28	Pump Controller	MF	25,711
29	Low Flow Showerhead/Faucets	MF	6,654
30	Pipe Wrap	MF	571
31	Efficient Oil Water Heater (SH/WH)	MF	28,095
32	Efficient Oil Water Heater (stand-alone)	MF	5,216
33	ES Dishwasher	MF	891
34	ES Clothes Washer	MF	1,927
35	New Homes Construction	SF	106,733
36	New Homes Construction	MF	8,043
37	Vacant Homes Package	SF	139,366
38	Vacant Homes Package	MF	6,401

Total Technical Potential MMBTU Savings	4,363,206
Forecast 2016 Vermont Residential Fuel Oil Consumption	14,560,000
As a percent of forecasted residential fuel oil consumption 2016	30.0%

Note: Technical potential kWh savings were obtained from Appendix A2 (Table A2-3) of this report.
Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 5-5: Total Cumulative Annual Achievable Potential MMBTU Savings for **Fuel Oil** Efficiency In Vermont By 2016
Residential Sector - Replace on Burnout and Retrofit Savings

1	2		5
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	550,173
2	ES Windows	SF	81,244
3	Insulation & Weatherization Package	SF	173,599
4	Programmable Thermostats	MF	3,209
5	Attic Insulation & Weatherization Pack.	MF	73,161
6	ES Windows	MF	5,426
7	Duct Sealing	SF	20,813
8	Efficient Oil Furnace	SF	42,880
9	Efficient Oil Furnace	MF	3,567
10	Modulate Water Temp.	SF	240,952
11	Efficient Water Boiler	SF	21,153
12	Modulate Water Temp.	MF	2,118
13	Efficient Water Boiler	MF	2,484
14	Vent Damper	SF	22,745
15	Improved Steam Vents	SF	13,799
16	Efficient Steam Boiler	SF	5,083
17	Mainline Vents	MF	5,315
18	Vent Damper	MF	2,340
19	Thermostatic Vents	MF	946
20	Efficient Steam Boiler	MF	534
21	Low Flow Showerhead/Faucets	SF	22,022
22	Pipe Wrap	SF	2,026
23	Efficient Oil Water Heater (SH/WH)	SF	0
24	Efficient Oil Water Heater (stand-alone)	SF	0
25	Solar WH w/ Oil Back Up	SF	109,744
26	ES Dishwasher	SF	5,569
27	ES Clothes Washer	SF	10,836
28	Pump Controller	MF	17,129
29	Low Flow Showerhead/Faucets	MF	4,476
30	Pipe Wrap	MF	395
31	Efficient Oil Water Heater (SH/WH)	MF	7,138
32	Efficient Oil Water Heater (stand-alone)	MF	3,321
33	ES Dishwasher	MF	511
34	ES Clothes Washer	MF	1,058
35	New Homes Construction	SF	93,770
36	New Homes Construction	MF	7,064
37	Vacant Homes Package	SF	27,965
38	Vacant Homes Package	MF	1,264

Achievable MMBTU Savings by 2016	1,585,829
Forecast 2016 Vermont Residential Fuel Oil Consumption	14,560,000
As a percent of forecasted residential fuel oil consumption in 2016	10.9%

Note: Achievable potential MMBTU savings were obtained from Appendix A2 (Table A2-3) of this report

Table 5-6: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Fuel Oil** Efficiency In Vermont By 2016
Residential Sector - Replace on Burnout and Retrofit Savings

1	2		5	7
Measure #	Measure Description	SF/MF	Measure Level VT Societal Test Ratio	Total Cumulative Annual MMBTU Savings by 2016
1	Programmable Thermostats	SF	22.42	550,173
2	ES Windows	SF	5.14	81,244
3	Insulation & Weatherization Package	SF	3.86	173,599
4	Programmable Thermostats	MF	11.21	3,209
5	Attic Insulation & Weatherization Pack.	MF	5.17	73,161
6	ES Windows	MF	3.85	5,426
7	Duct Sealing	SF	3.20	20,813
8	Efficient Oil Furnace	SF	2.99	42,880
9	Efficient Oil Furnace	MF	2.99	3,567
10	Modulate Water Temp.	SF	8.46	240,952
11	Efficient Water Boiler	SF	0.97	0
12	Modulate Water Temp.	MF	4.23	2,118
13	Efficient Water Boiler	MF	0.97	0
14	Vent Damper	SF	7.86	22,745
15	Improved Steam Vents	SF	3.07	13,799
16	Efficient Steam Boiler	SF	0.97	0
17	Mainline Vents	MF	20.31	5,315
18	Vent Damper	MF	3.93	2,340
19	Thermostatic Vents	MF	2.89	946
20	Efficient Steam Boiler	MF	0.97	0
21	Low Flow Showerhead/Faucets	SF	31.75	19,820
22	Pipe Wrap	SF	0.90	0
23	Efficient Oil Water Heater (SH/WH)	SF	3.45	40,554
24	Efficient Oil Water Heater (stand-alone)	SF	0.51	0
25	Solar WH w/ Oil Back Up	SF	0.76	0
26	ES Dishwasher	SF	4.02	5,569
27	ES Clothes Washer	SF	3.40	10,836
28	Pump Controller	MF	22.56	17,129
29	Low Flow Showerhead/Faucets	MF	31.75	4,029
30	Pipe Wrap	MF	0.90	0
31	Efficient Oil Water Heater (SH/WH)	MF	3.45	7,168
32	Efficient Oil Water Heater (stand-alone)	MF	0.52	0
33	ES Dishwasher	MF	4.02	511
34	ES Clothes Washer	MF	3.40	1,058
35	New Homes Construction	SF	2.22	93,770
36	New Homes Construction	MF	2.22	7,064
37	Vacant Homes Package	SF	1.64	27,965
38	Vacant Homes Package	MF	1.97	1,264

Achievable Cost Effective MMBTU Savings		1,479,023
Forecast 2016 Vermont Residential Fuel Oil Consumption		14,560,000
Savings as a percent of forecasted residential fuel oil consumption in 2016		10.16%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 5-6 are from Table A2-4 (Appendix A2). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

Figure 5-2: Residential Fuel Oil Efficiency Supply Curve for VT

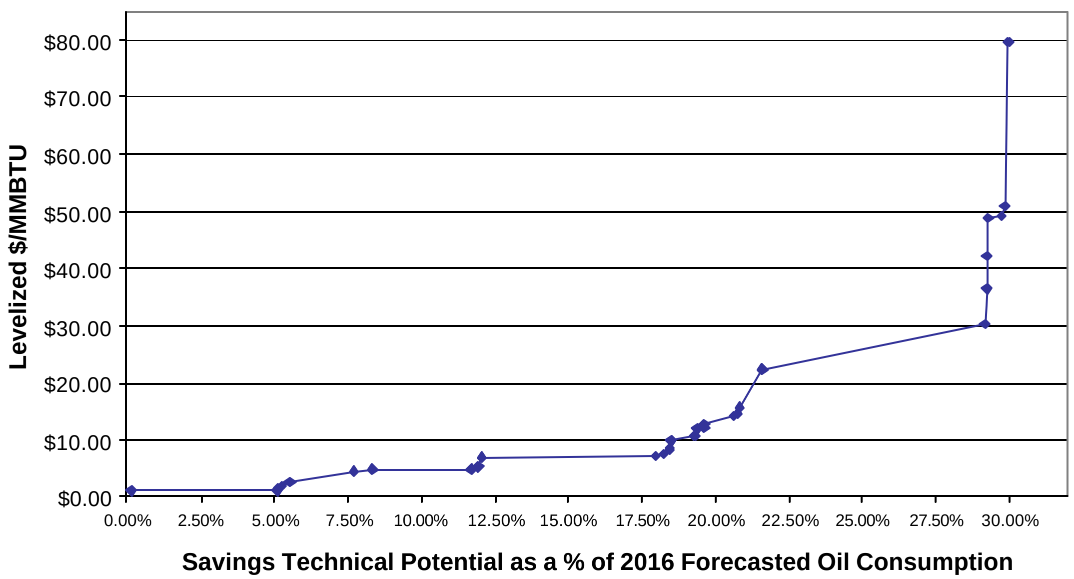


Figure 5-3: Residential Sector Cost Effective Fuel Oil MMBTU Savings by Measure Type

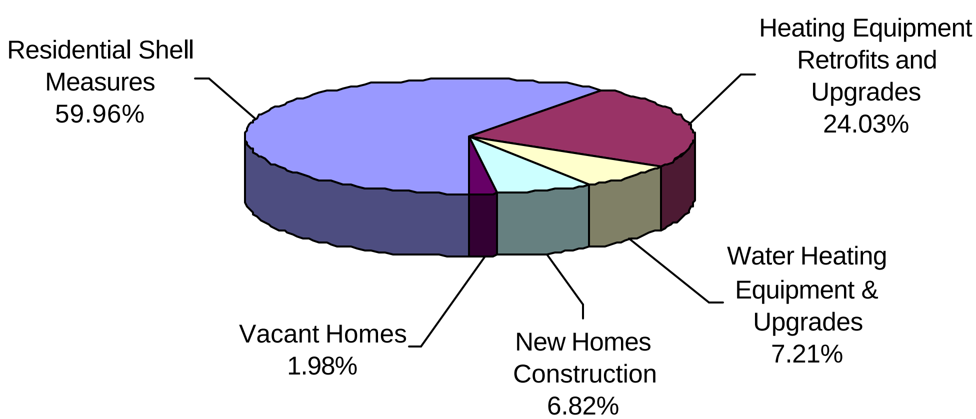
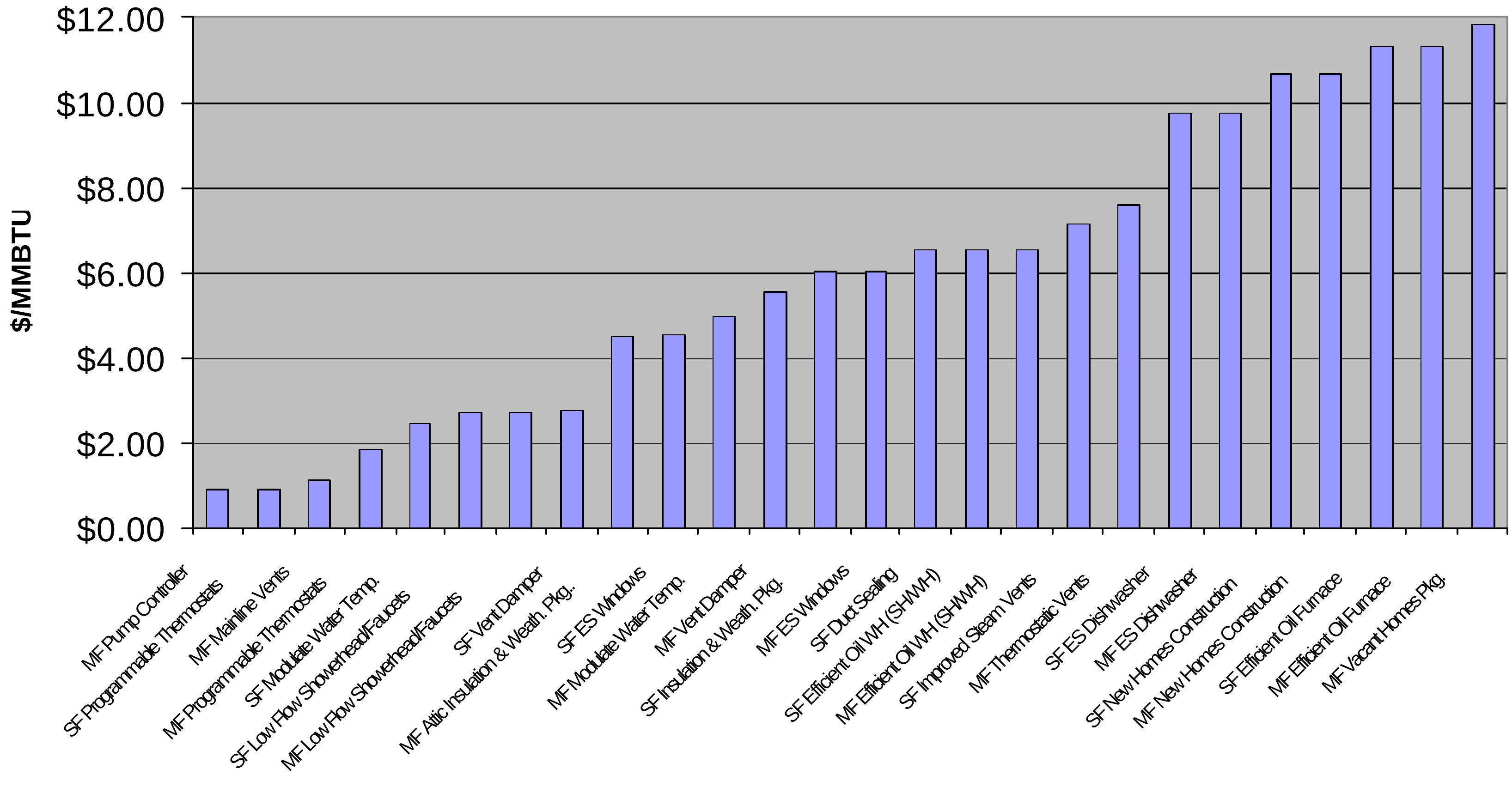


Figure 5-4: Cost of Conserved Energy - Residential Fuel Oil Efficiency Measures (Measures under Actual 2007 $/MMBTU of Oil)



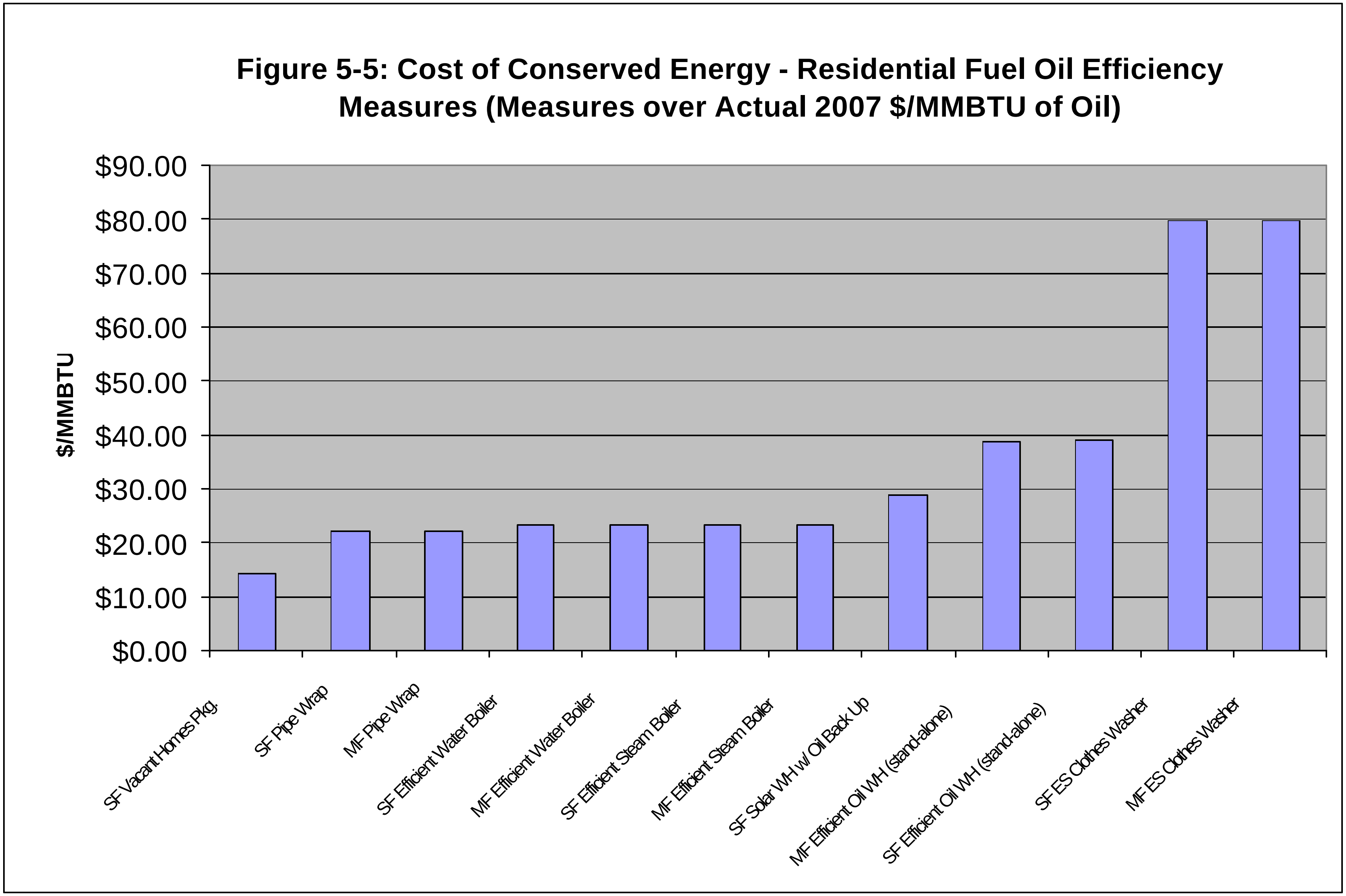


Figure 5-5: Cost of Conserved Energy - Residential Fuel Oil Efficiency Measures (Measures over Actual 2007 $/MMBTU of Oil)
$/MMBTU
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
SF Vacant Homes Pkg.
SF Pipe Wrap
MF Pipe Wrap
SF Efficient Water Boiler
MF Efficient Water Boiler
SF Efficient Steam Boiler
MF Efficient Steam Boiler
SF Solar WH w/ Oil Back Up
MF Efficient Oil WH (stand-alone)
SF Efficient Oil WH (stand-alone)
SF ES Clothes Washer
MF ES Clothes Washer

5.2.2 Propane

Figure 5-6 and Table 5-7 below summarizes the technical, achievable, and achievable cost effective savings potential for propane in the residential sector by the year 2016. The achievable cost effective potential for propane is 0.42 TBTU or 5.6% of the Vermont residential sector propane consumption forecast in 2016.

Figure 5-6 Summary of Potential Savings (Propane)

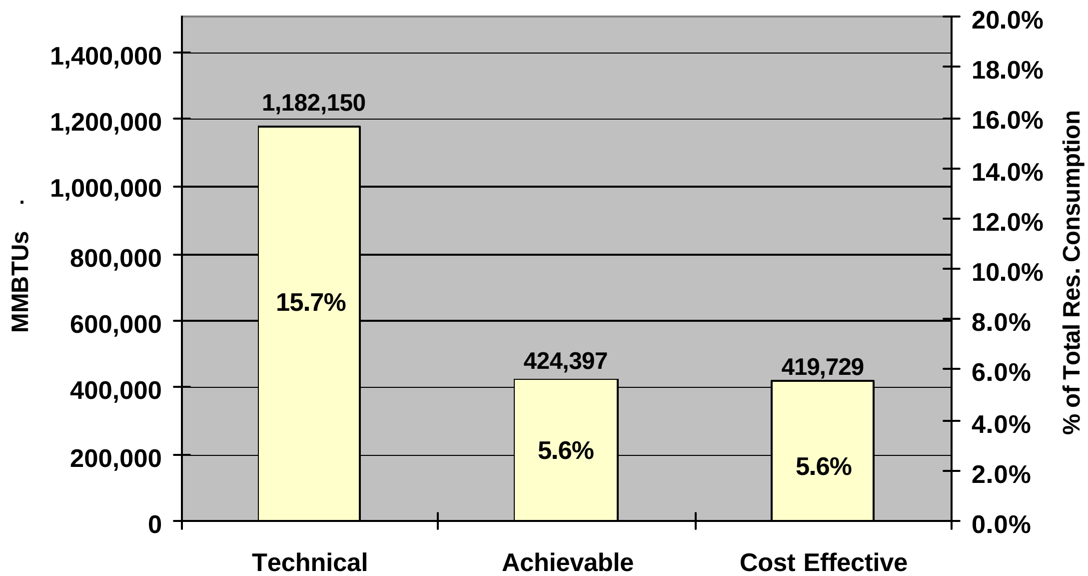


Table 5-7: Summary of Residential **Propane** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Propane Consumption
Technical Potential	1,182,150	15.7%
Achievable Potential	424,397	5.6%
Achievable Cost Effective Potential	419,729	5.6%

Tables 5-8 through 5-10 list the residential sector propane energy efficiency programs or measures included in the technical, achievable, and achievable cost effective potential analyses. The Societal Test Benefit/Cost ratios shown in Table 5-10 were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheets. Only measures with a benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

Table 5-8: Total Cumulative Annual Technical Potential MMBTU Savings for **Propane** Efficiency In Vermont By 2016
Residential Sector - Replace on Burnout and Retrofit Savings

1	2	3	4
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	146,025
2	ES Windows	SF	99,258
3	Insulation & Weatherization Pkg.	SF	176,665
4	Programmable Thermostats	MF	18,699
5	Attic Insulation & Weatherization Pkg.	MF	8,987
6	ES Windows	MF	10,871
7	Efficient Propane Furnace	SF	25,301
8	Duct Sealing	SF	9,125
9	Efficient Propane Furnace	MF	2,753
10	Modulate Water Temp.	SF	40,344
11	Efficient Water Boiler	SF	8,257
12	Modulate Water Temp.	MF	1,991
13	Efficient Water Boiler	MF	1,410
14	Vent Damper	SF	4,833
15	Improved Steam Vents	SF	2,932
16	Efficient Steam Boiler	SF	1,975
17	Mainline Vents	MF	1,362
18	Vent Damper	MF	735
19	Thermostatic Vents	MF	357
20	Efficient Steam Boiler	MF	306
21	Low Flow Showerhead/Faucets	SF	6,796
22	Efficient Propane Water Heater	SF	0
23	Solar WH w/ Propane Back Up	SF	453,653
24	ES Dishwasher	SF	6,235
25	ES Clothes Washer	SF	38,771
26	Pipe Wrap	SF	615
27	Pump Controller	MF	6,679
28	Low Flow Showerhead/Faucets	MF	828
29	Efficient Propane Water Heater	MF	13,465
30	ES Dishwasher	MF	382
31	ES Clothes Washer	MF	2,518
32	Pipe Wrap	MF	73
33	New Homes Construction	SF	55,265
34	New Homes Construction	MF	4,164
35	Vacant Homes Package	SF	28,389
36	Vacant Homes Package	MF	2,131

Total Technical Potential MMBTU Savings	1,182,150
Forecast 2016 Vermont Residential Propane Consumption	7,540,000
As a percent of forecasted residential propane consumption 2016	15.7%

Note: Technical potential kWh savings were obtained from Appendix A3 (Table A3-3) of this report.
Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 5-9: Total Cumulative Annual Achievable Potential MMBTU Savings for **Propane** Efficiency In Vermont By 2016 Residential Sector - Replace on Burnout and Retrofit Savings			
1	2		5
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	112,050
2	ES Windows	SF	16,551
3	Insulation & Weatherization Pkg.	SF	35,411
4	Programmable Thermostats	MF	14,441
5	Attic Insulation & Weatherization Pkg.	MF	1,820
6	ES Windows	MF	1,796
7	Efficient Propane Furnace	SF	9,950
8	Duct Sealing	SF	4,573
9	Efficient Propane Furnace	MF	1,091
10	Modulate Water Temp.	SF	30,859
11	Efficient Water Boiler	SF	2,594
12	Modulate Water Temp.	MF	408
13	Efficient Water Boiler	MF	443
14	Vent Damper	SF	2,893
15	Improved Steam Vents	SF	1,755
16	Efficient Steam Boiler	SF	623
17	Mainline Vents	MF	990
18	Vent Damper	MF	451
19	Thermostatic Vents	MF	182
20	Efficient Steam Boiler	MF	99
21	Low Flow Showerhead/Faucets	SF	4,115
22	Efficient Propane Water Heater	SF	84,030
23	Solar WH w/ Propane Back Up	SF	0
24	ES Dishwasher	SF	3,581
25	ES Clothes Washer	SF	21,250
26	Pipe Wrap	SF	391
27	Pump Controller	MF	4,462
28	Low Flow Showerhead/Faucets	MF	558
29	Efficient Propane Water Heater	MF	7,115
30	ES Dishwasher	MF	221
31	ES Clothes Washer	MF	1,375
32	Pipe Wrap	MF	51
33	New Homes Construction	SF	48,527
34	New Homes Construction	MF	3,654
35	Vacant Homes Package	SF	5,654
36	Vacant Homes Package	MF	435

Achievable MMBTU Savings by 2016	424,397
Forecast 2016 Vermont Residential Propane Consumption	7,540,000
As a percent of forecasted residential propane consumption in 2016	5.6%

Note: Achievable potential MMBTU savings were obtained from Appendix A3 (Table A3-3) of this report

Table 5-10: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Propane** Efficiency In Vermont By 2016 Residential Sector - Replace on Burnout and Retrofit Savings				
1	2		5	7
Measure #	Measure Description	SF/MF	Measure Level VT Societal Test Ratio	Total Cumulative Annual MMBTU Savings by 2016
1	Programmable Thermostats	SF	26.66	112,050
2	ES Windows	SF	6.09	16,551
3	Insulation & Weatherization Pkg.	SF	4.57	35,411
4	Programmable Thermostats	MF	13.35	14,441
5	Attic Insulation & Weatherization Pkg.	MF	6.13	1,820
6	ES Windows	MF	4.57	1,796
7	Efficient Propane Furnace	SF	11.33	9,950
8	Duct Sealing	SF	3.81	4,573
9	Efficient Propane Furnace	MF	11.33	1,091
10	Modulate Water Temp.	SF	10.06	30,859
11	Efficient Water Boiler	SF	0.79	0
12	Modulate Water Temp.	MF	5.03	408
13	Efficient Water Boiler	MF	0.77	0
14	Vent Damper	SF	9.33	2,893
15	Improved Steam Vents	SF	3.64	1,755
16	Efficient Steam Boiler	SF	0.79	0
17	Mainline Vents	MF	24.06	990
18	Vent Damper	MF	4.66	451
19	Thermostatic Vents	MF	3.43	182
20	Efficient Steam Boiler	MF	0.79	0
21	Low Flow Showerhead/Faucets	SF	27.56	3,703
22	Efficient Propane Water Heater	SF	2.69	84,030
23	Solar WH w/ Propane Back Up	SF	0.70	0
24	ES Dishwasher	SF	5.04	3,581
25	ES Clothes Washer	SF	3.57	21,250
26	Pipe Wrap	SF	0.40	0
27	Pump Controller	MF	20.95	4,462
28	Low Flow Showerhead/Faucets	MF	27.56	502
29	Efficient Propane Water Heater	MF	2.69	7,115
30	ES Dishwasher	MF	5.04	221
31	ES Clothes Washer	MF	3.57	1,375
32	Pipe Wrap	MF	0.40	0
33	New Homes Construction	SF	2.63	48,527
34	New Homes Construction	MF	2.63	3,654
35	Vacant Homes Package	SF	1.95	5,654
36	Vacant Homes Package	MF	2.33	435

Achievable Cost Effective MMBTU Savings		419,729
Forecast 2016 Vermont Residential Propane Consumption		7,540,000
Savings as a percent of forecasted residential propane consumption in 2016		5.57%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 5-10 are from Table A3-4 (Appendix A3). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

The supply curve for residential propane efficiency technical potential savings is shown in Figure 5-7, found after Tables 5-8 through 5-10. Figure 5-8 provides information on the achievable cost effective potential propane savings by 2016 in the residential sector. About 43% of the achievable cost effective savings is from residential “shell” efficiency measures, followed by water heating equipment retrofits and upgrades, space heating retrofits and upgrades, energy efficient new construction, and energy efficient vacant homes. Figures 5-9 and 5-10 present the cost of conserved energy (CCE) for residential propane energy efficiency measures included in the study. Note that the CCE figures only include propane savings and do not include electric or water savings. These figures simply provide a picture of the relative cost of conserved propane for the propane efficiency measures examined in this study. Figure 5-9 displays all measures with a CCE below the 2007 $/MMBTU for propane. Figure 5-10 displays all measures with a CCE above the 2007 $/MMBTU for propane.

Figure 5-7: Residential Propane Efficiency Supply Curve for VT

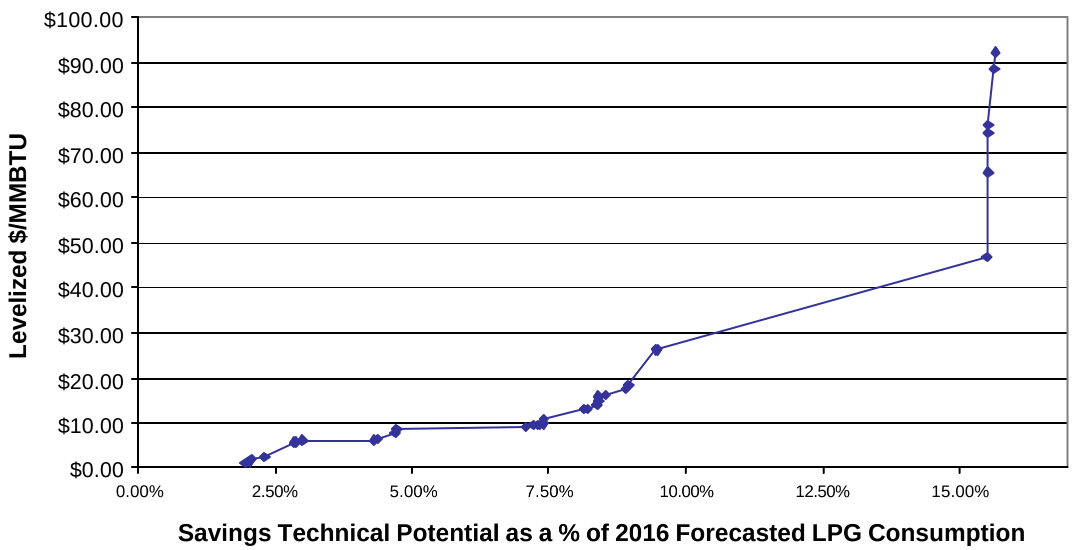


Figure 5-8: Residential Sector Cost Effective Propane MMBTU Savings by Measure Type

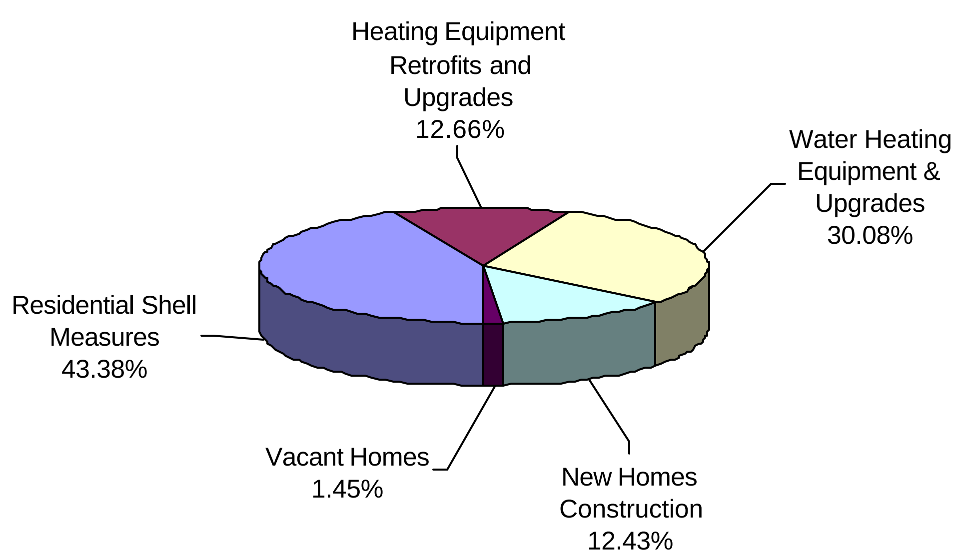
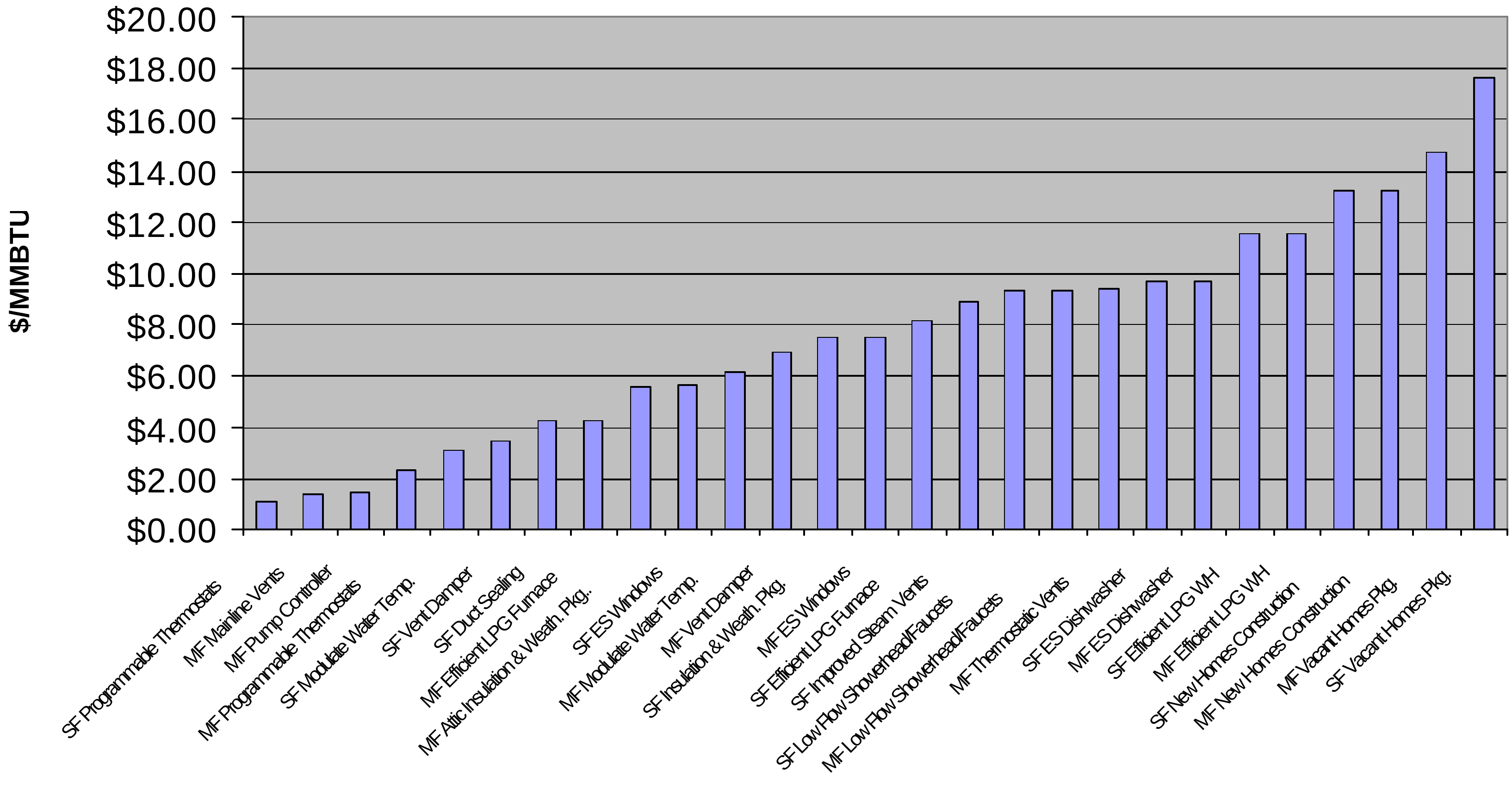


Figure 5-9: Cost of Conserved Energy - Residential Propane Efficiency Measures (Measures under Actual 2007 $/MMBTU of Propane)



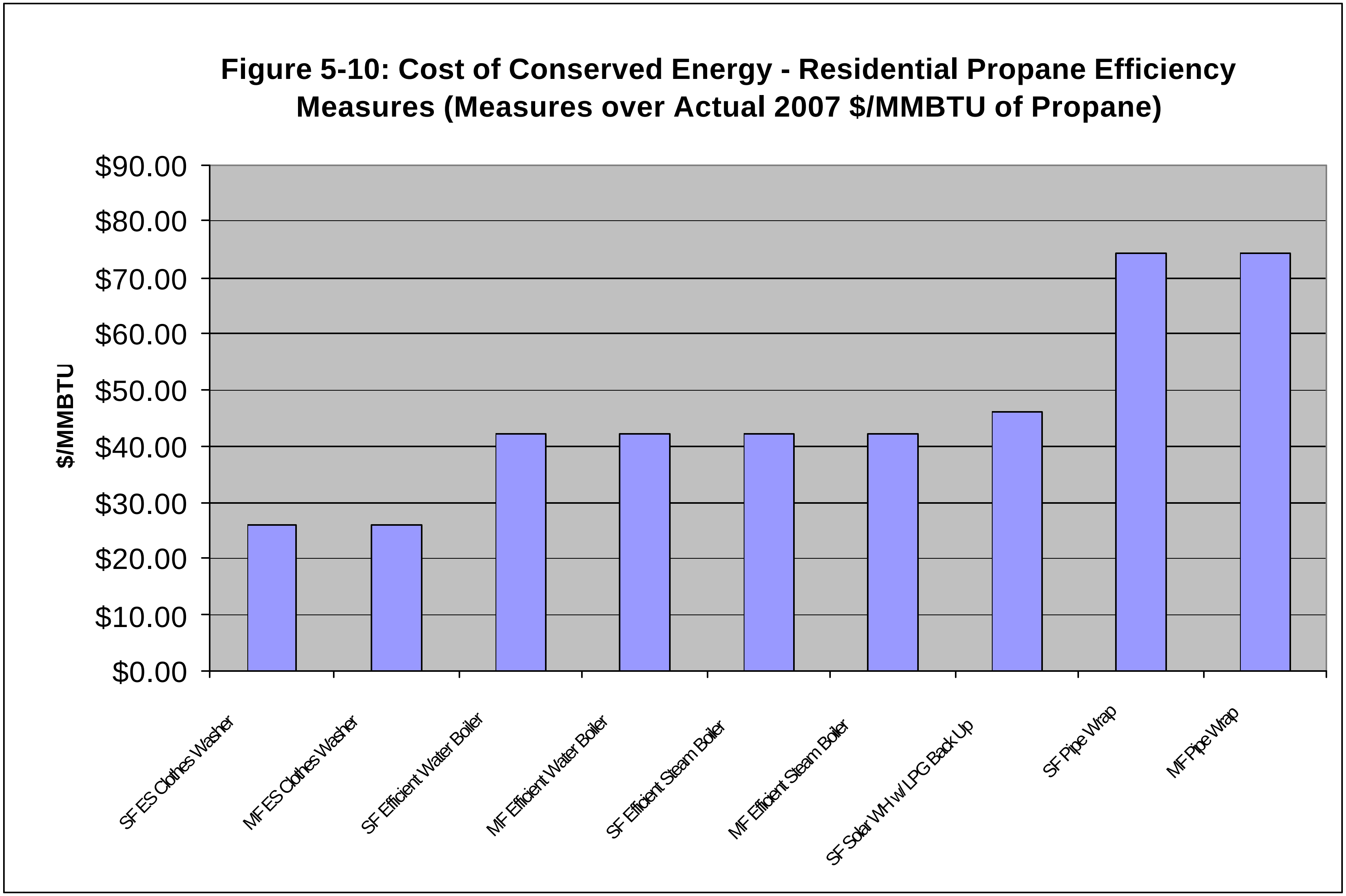


Figure 5-10: Cost of Conserved Energy - Residential Propane Efficiency Measures (Measures over Actual 2007 $/MMBTU of Propane)
$/MMBTU
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
SF ES Clothes Washer
MF ES Clothes Washer
SF Efficient Water Boiler
MF Efficient Water Boiler
SF Efficient Steam Boiler
MF Efficient Steam Boiler
SF Solar WH w/ LPG Back Up
SF Pipe Wrap
MF Pipe Wrap

5.2.3 Kerosene

Figure 5-11 and Table 5-11 below summarizes the technical, achievable, and achievable cost effective savings potential for kerosene in the residential sector by the year 2016. The achievable cost effective potential for kerosene is 0.071 TBTU or 3.3% of the Vermont residential sector kerosene consumption forecast in 2016.

Figure 5-11 Summary of Potential Savings (Kerosene)

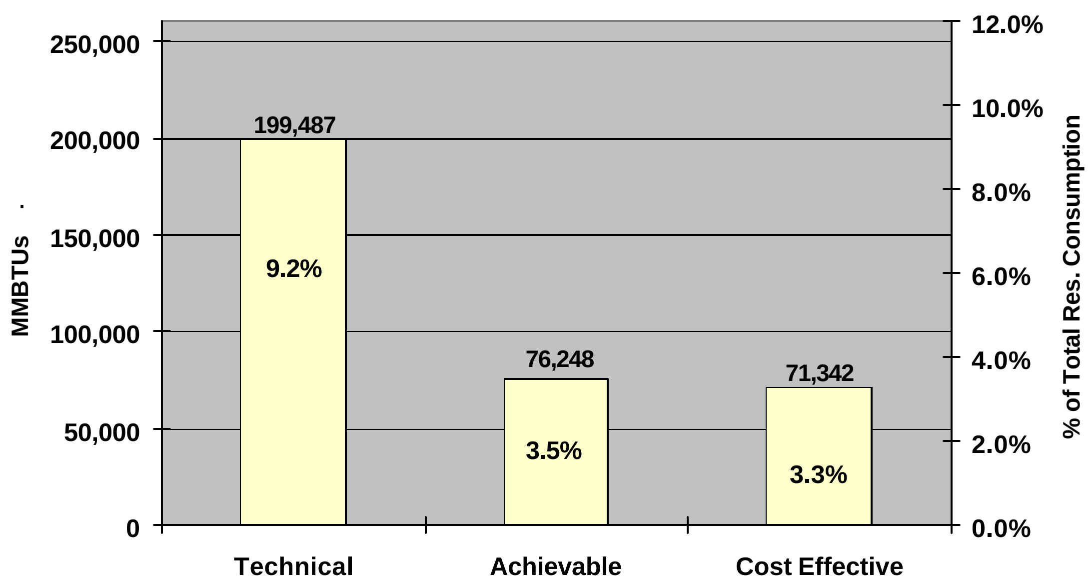


Table 5-11: Summary of Residential Kerosene Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Kerosene Consumption
Technical Potential	199,487	9.2%
Achievable Potential	76,248	3.5%
Achievable Cost Effective Potential	71,342	3.3%

Tables 5-12 through 5-14 list the residential sector kerosene energy efficiency programs or measures included in the technical, achievable, and achievable cost effective potential analyses. The Societal Test Benefit/Cost ratios shown in Table 5-10 were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheets. Only measures with a benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

Table 5-12: Total Cumulative Annual Technical Potential MMBTU Savings for **Kerosene** Efficiency In Vermont By 2016 Residential Sector - Replace on Burnout and Retrofit Savings			
1	2	3	4
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	57,072
2	ES Windows	SF	38,794
3	Insulation & Weatherization Pkg.	SF	69,047
4	Programmable Thermostats	MF	716
5	Attic Insulation & Weatherization Pkg.	MF	344
6	ES Windows	MF	416
7	Duct Sealing	SF	6,055
8	Efficient 'Kerosene' Furnace	SF	15,864
9	Vacant Homes Package	SF	11,096
10	Vacant Homes Package	MF	82

Total Technical Potential MMBTU Savings	199,487
Forecast 2016 Vermont Residential Kerosene Consumption	2,170,000
As a percent of forecasted residential kerosene consumption in 2016	9.2%

Note: Technical potential kWh savings were obtained from Appendix A4 (Table A4-3) of this report.
Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 5-13: Total Cumulative Annual Achievable Potential MMBTU Savings for **Kerosene** Efficiency In Vermont By 2016 Residential Sector - Replace on Burnout and Retrofit Savings			
1	2		5
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	43,786
2	ES Windows	SF	6,450
3	Insulation & Weatherization Pkg.	SF	13,818
4	Programmable Thermostats	MF	547
5	Attic Insulation & Weatherization Pkg.	MF	66
6	ES Windows	MF	75
7	Duct Sealing	SF	3,023
8	Efficient 'Kerosene' Furnace	SF	6,241
9	Vacant Homes Package	SF	2,212
10	Vacant Homes Package	MF	32

Achievable MMBTU Savings by 2016	76,248
Forecast 2016 Vermont Residential Kerosene Consumption	2,170,000
As a percent of forecasted residential kerosene consumption in 2016	3.5%

Note: Achievable potential MMBTU savings were obtained from Appendix A4 (Table A4-3) of this report

Table 5-14: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Kerosene** Efficiency In Vermont By 2016
Residential Sector - Replace on Burnout and Retrofit Savings

1	2		5	7
Measure #	Measure Description	SF/MF	Measure Level VT Societal Test Ratio	Total Cumulative Annual MMBTU Savings by 2016
1	Programmable Thermostats	SF	11.57	43,786
2	ES Windows	SF	2.46	6,450
3	Insulation & Weatherization Pkg.	SF	1.65	13,818
4	Programmable Thermostats	MF	5.77	547
5	Attic Insulation & Weatherization Pkg.	MF	2.48	66
6	ES Windows	MF	1.61	75
7	Duct Sealing	SF	0.89	0
8	Efficient 'Kerosene' Furnace	SF	1.56	6,569
9	Vacant Homes Package	SF	0.85	0
10	Vacant Homes Package	MF	1.01	32

Achievable Cost Effective MMBTU Savings		71,342
Forecast 2016 Vermont Residential Kerosene Consumption		2,170,000
Savings as a percent of forecasted residential kerosene consumption in 2016		3.29%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 5-14 are from Table A4-4 (Appendix A4). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

The supply curve for residential kerosene efficiency technical potential savings is shown in Figure 5-12, found after Tables 5-12 through 5-14. Figure 5-13 provides information on the achievable cost effective potential kerosene savings by 2016 in the residential sector. About 91% of the achievable cost effective savings is from residential "shell" efficiency measures, followed by space heating retrofits and upgrades and energy efficient vacant homes. Figures 5-14 and 5-15 present the cost of conserved energy (CCE) for residential kerosene energy efficiency measures included in the study. Note that the CCE figures only include kerosene savings and do not include electric or water savings. These figures simply provide a picture of the relative cost of conserved kerosene for the kerosene efficiency measures examined in this study. Figure 5-14 displays all measures with a CCE below the 2007 $/MMBTU for kerosene. Figure 5-15 displays all measures with a CCE above the 2007 $/MMBTU for kerosene.

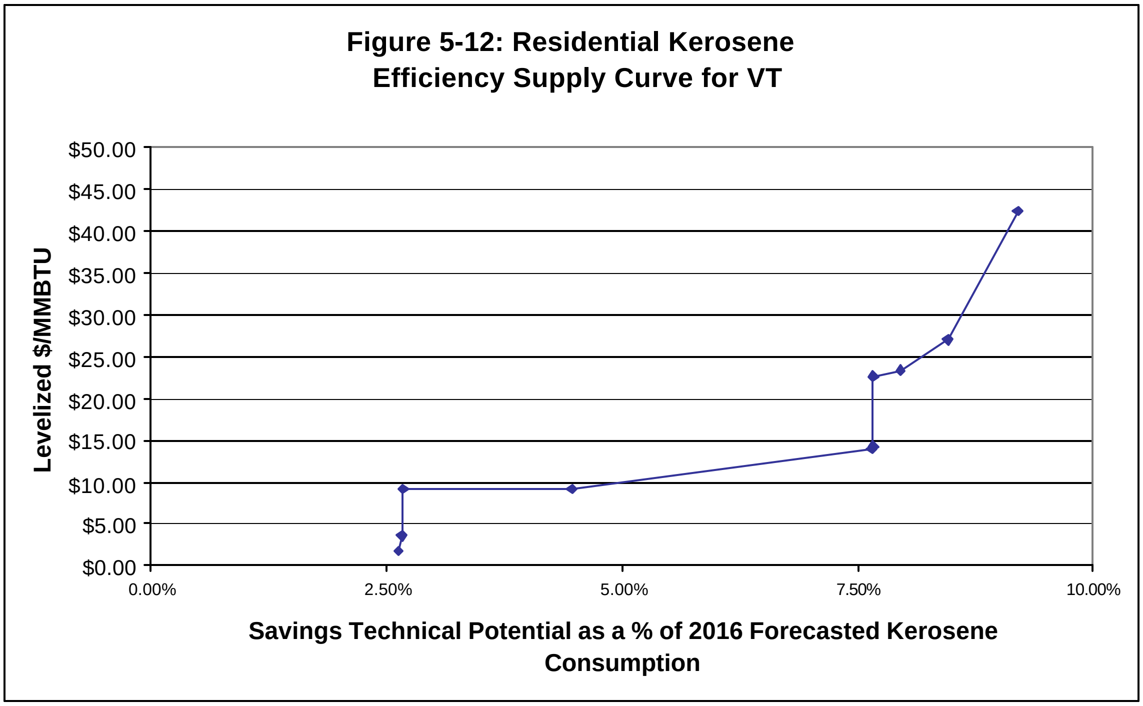


Figure 5-12: Residential Kerosene Efficiency Supply Curve for VT
Levelized $/MMBTU
$50.00
$45.00
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
0.00%
2.50%
5.00%
7.50%
10.00%
Savings Technical Potential as a % of 2016 Forecasted Kerosene Consumption

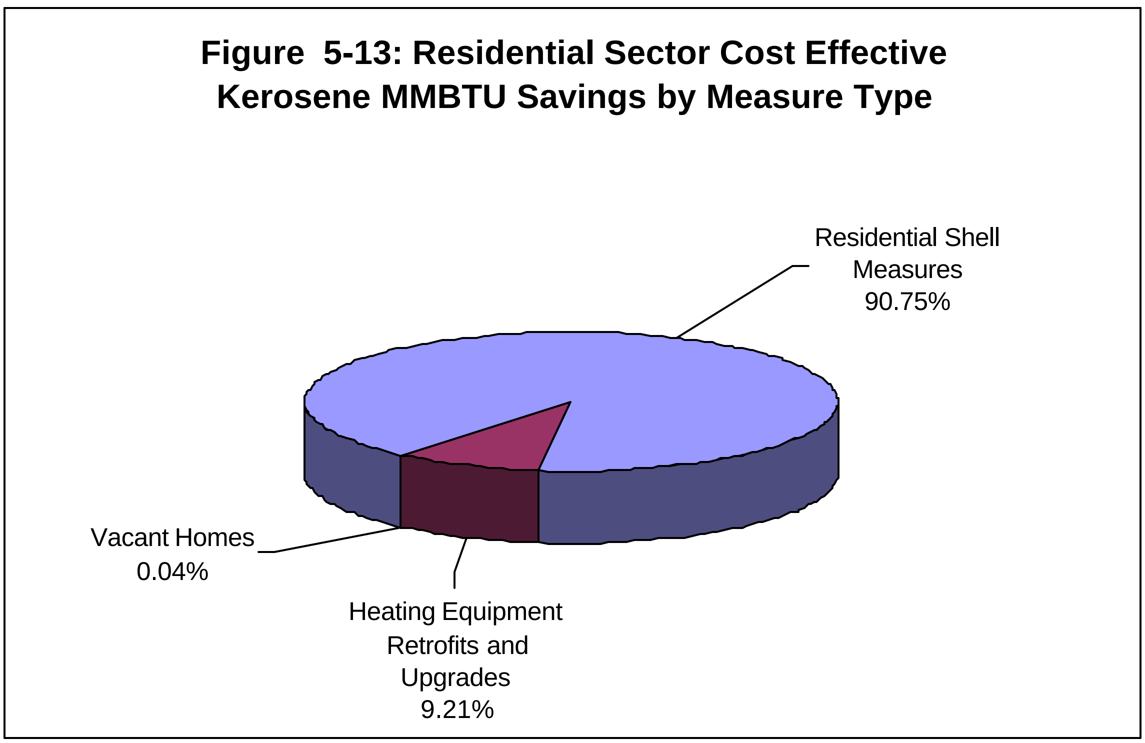
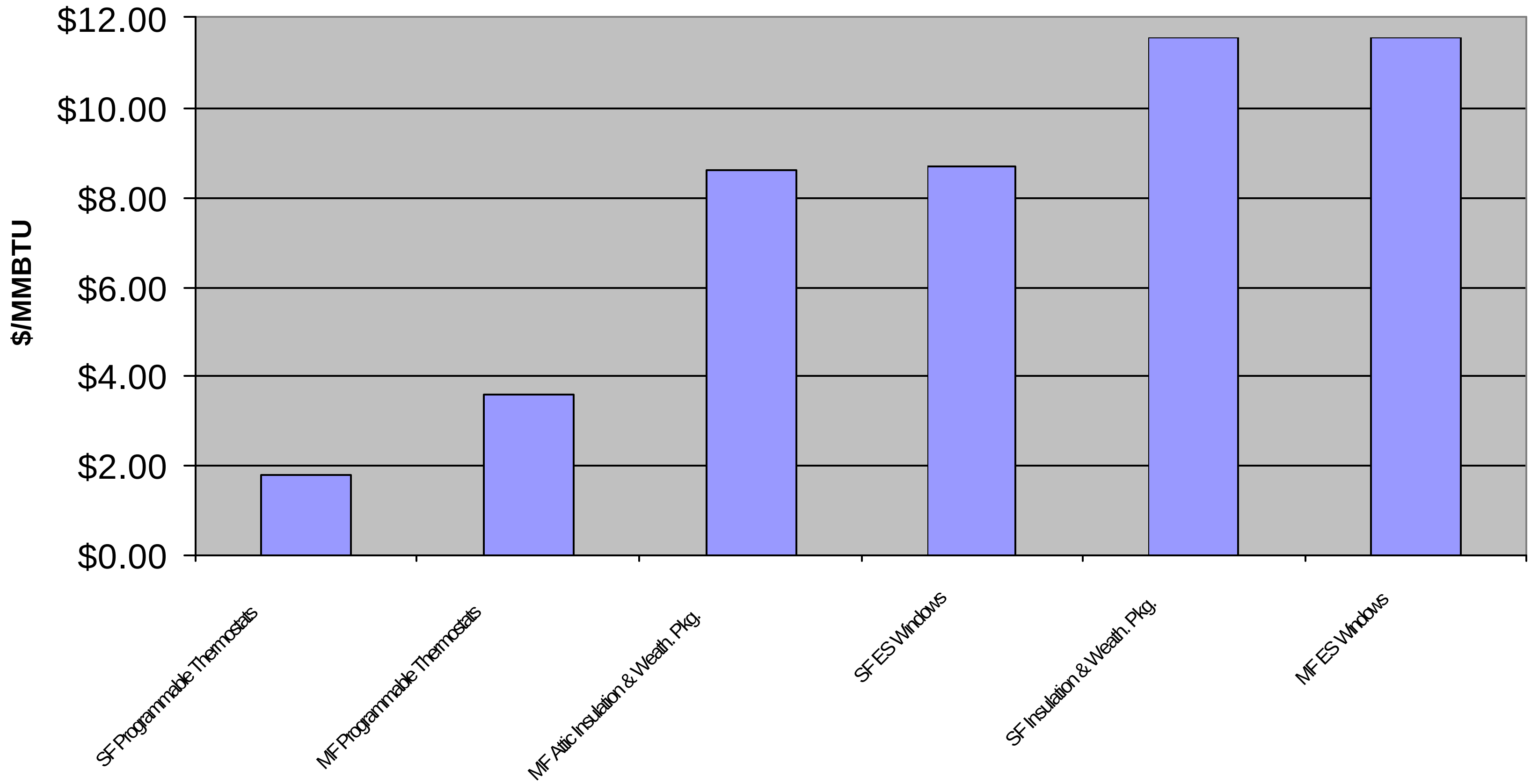


Figure 5-13: Residential Sector Cost Effective Kerosene MMBTU Savings by Measure Type
Residential Shell Measures 90.75%
Vacant Homes 0.04%
Heating Equipment Retrofits and Upgrades 9.21%

Figure 5-14: Cost of Conserved Energy - Residential Kerosene Efficiency Measures (Measures under Actual 2007 $/MMBTU of Kerosene)



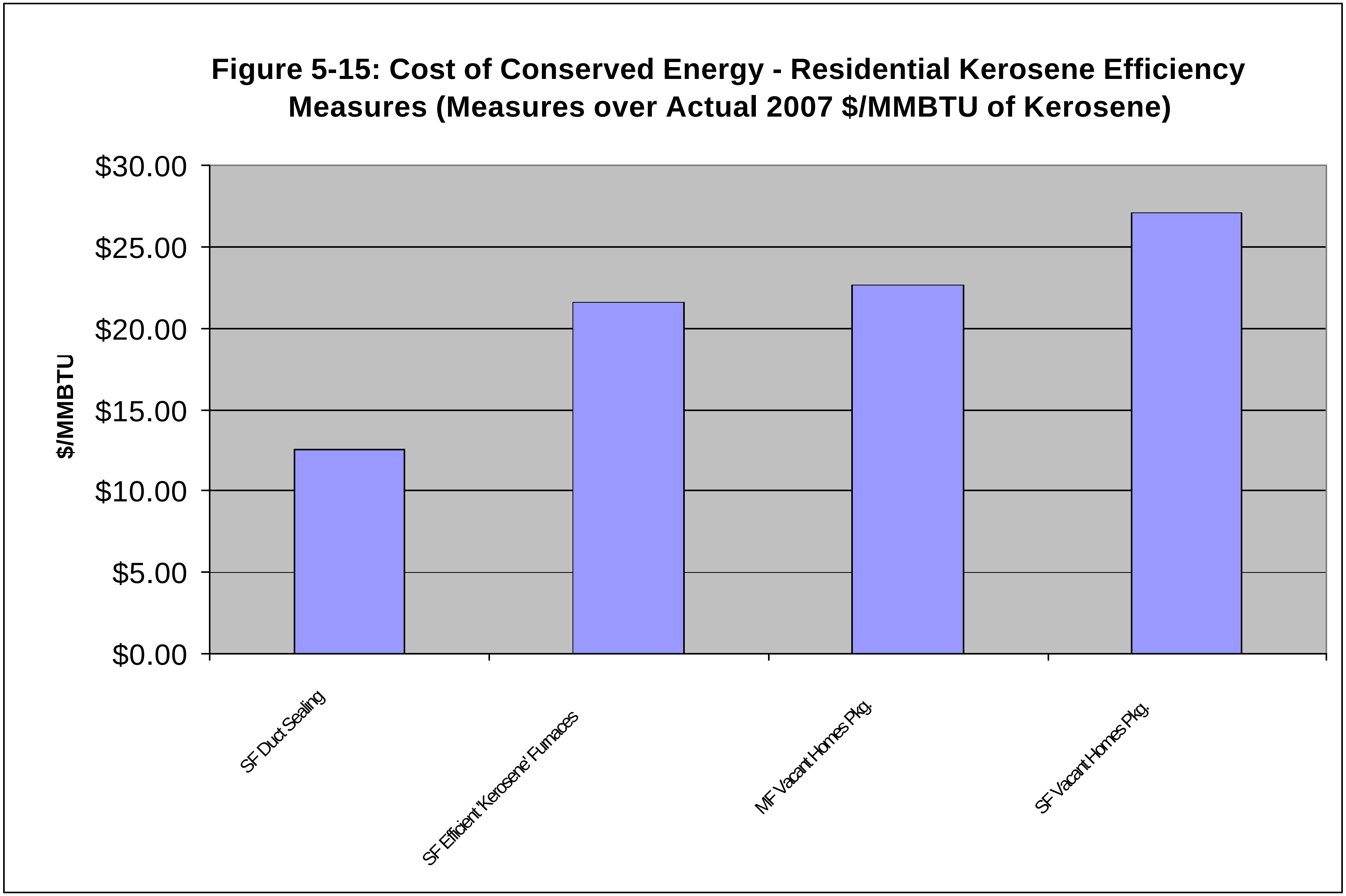


Figure 5-15: Cost of Conserved Energy - Residential Kerosene Efficiency Measures (Measures over Actual 2007 $/MMBTU of Kerosene)
$/MMBTU
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
SF Duct Sealing
SF Efficient 'Kerosene' Furnaces
MF Vacant Homes Pkg.
SF Vacant Homes Pkg.

5.2.4 Wood

Figure 5-16 and Table 5-15 below summarizes the technical, achievable, and achievable cost effective savings potential for wood in the residential sector by the year 2016. The achievable cost effective potential for wood is 0.21 TBTU or 18.3% of the Vermont residential sector wood consumption forecast in 2016.

Figure 5-16 Summary of Potential Savings (Wood)

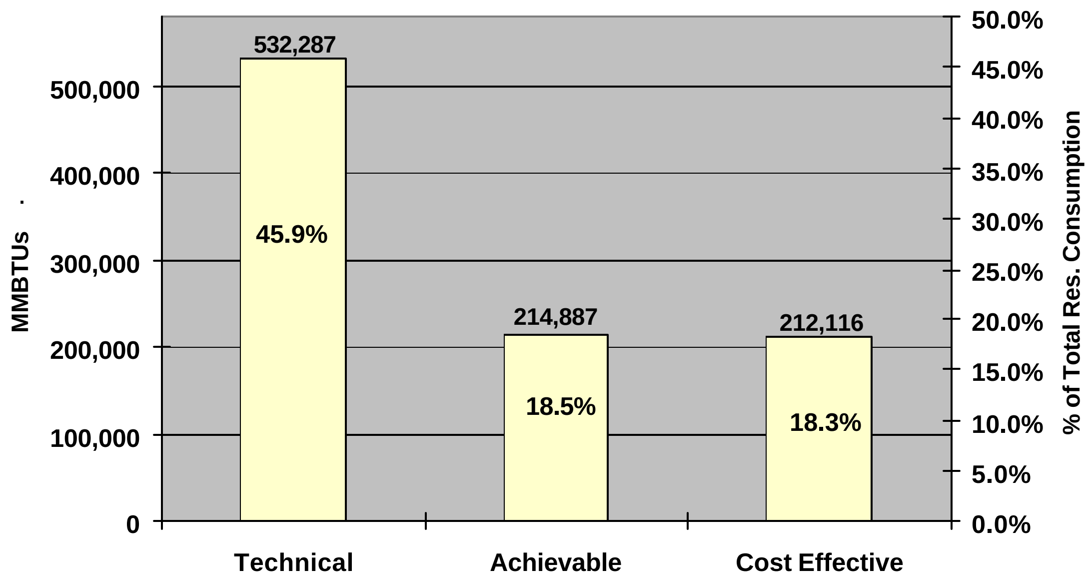


Table 5-15: Summary of Residential **Wood** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Wood Consumption
Technical Potential	532,287	45.9%
Achievable Potential	214,887	18.5%
Achievable Cost Effective Potential	212,116	18.3%

Tables 5-16 through 5-18 list the residential sector wood energy efficiency programs or measures included in the technical, achievable, and achievable cost effective potential analyses. The Societal Test Benefit/Cost ratios shown in Table 5-10 were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheets. Only measures with a benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

Table 5-16: Total Cumulative Annual Technical Potential MMBTU Savings for **Wood** Efficiency In Vermont By 2016 Residential Sector - Replace on Burnout and Retrofit Savings			
1	2	3	4
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	123,452
2	ES Windows	SF	83,915
3	Insulation & Weatherization Pkg.	SF	149,356
4	Programmable Thermostats	MF	3,253
5	Attic Insulation & Weatherization Pkg.	MF	1,563
6	ES Windows	MF	1,891
7	Efficient Wood Stoves	SF	102,888
8	Efficient Wood Stoves	MF	1,516
9	Low Flow Showerhead/Faucets	SF	435
10	Solar WH w/ Wood Back Up	SF	27,330
11	Pipe Wrap	SF	59
12	Low Flow Showerhead/Faucets	MF	108
13	Pipe Wrap	MF	14
14	New Homes Construction	SF	11,285
15	New Homes Construction	MF	850
16	Vacant Homes Package	SF	24,001
17	Vacant Homes Package	MF	371

Total Technical Potential MMBTU Savings	532,287
Forecast 2016 Vermont Residential Wood Consumption	1,160,000
As a percent of forecasted residential wood consumption 2016	45.9%

Note: Technical potential kWh savings were obtained from Appendix A5 (Table A5-3) of this report.
Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 5-17: Total Cumulative Annual Achievable Potential MMBTU Savings for **Wood** Efficiency In Vermont By 2016 Residential Sector - Replace on Burnout and Retrofit Savings			
1	2		5
Measure #	Measure Description	SF/MF	Total
1	Programmable Thermostats	SF	94,736
2	ES Windows	SF	14,001
3	Insulation & Weatherization Pkg.	SF	29,780
4	Programmable Thermostats	MF	2,513
5	Attic Insulation & Weatherization Pkg.	MF	299
6	ES Windows	MF	302
7	Efficient Wood Stoves	SF	53,922
8	Efficient Wood Stoves	MF	801
9	Low Flow Showerhead/Faucets	SF	262
10	Solar WH w/ Wood Back Up	SF	2,691
11	Pipe Wrap	SF	37
12	Low Flow Showerhead/Faucets	MF	72
13	Pipe Wrap	MF	10
14	New Homes Construction	SF	9,832
15	New Homes Construction	MF	751
16	Vacant Homes Package	SF	4,783
17	Vacant Homes Package	MF	95

Achievable MMBTU Savings by 2016	214,887
Forecast 2016 Vermont Residential Wood Consumption	1,160,000
As a percent of forecasted residential wood consumption in 2016	18.5%

Note: Achievable potential MMBTU savings were obtained from Appendix A5 (Table A5-3) of this report

Table 5-18: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Wood** Efficiency In Vermont By 2016
Residential Sector - Replace on Burnout and Retrofit Savings

1	2		5	7
Measure #	Measure Description	SF/MF	Measure Level VT Societal Test Ratio	Total Cumulative Annual MMBTU Savings by 2016
1	Programmable Thermostats	SF	17.65	94,736
2	ES Windows	SF	4.20	14,001
3	Insulation & Weatherization Pkg.	SF	3.15	29,780
4	Programmable Thermostats	MF	8.84	2,513
5	Attic Insulation & Weatherization Pkg.	MF	4.24	299
6	ES Windows	MF	3.15	302
7	Efficient Wood Stoves	SF	9.46	53,922
8	Efficient Wood Stoves	MF	4.73	801
9	Low Flow Showerhead/Faucets	SF	26.49	236
10	Solar WH w/ Wood Back Up	SF	0.53	0
11	Pipe Wrap	SF	0.43	0
12	Low Flow Showerhead/Faucets	MF	26.49	65
13	Pipe Wrap	MF	0.43	0
14	New Homes Construction	SF	1.83	9,832
15	New Homes Construction	MF	1.83	751
16	Vacant Homes Package	SF	1.34	4,783
17	Vacant Homes Package	MF	1.61	95

Achievable Cost Effective MMBTU Savings		212,116
Forecast 2016 Vermont Residential Wood Consumption		1,160,000
Savings as a percent of forecasted residential wood consumption in 2016		18.29%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 5-18 are from Table A5-4 (Appendix A5). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

The supply curve for residential wood efficiency technical potential savings is shown in Figure 5-17, found after Tables 5-16 through 5-18. Figure 5-18 provides information on the achievable cost effective potential wood savings by 2016 in the residential sector. About 67% of the achievable cost effective savings is from residential "shell" efficiency measures, followed by space heating retrofits and upgrades, energy efficient new homes, energy efficient vacant homes, and water heating retrofits. Figures 5-14 and 5-15 present the cost of conserved energy (CCE) for residential wood energy efficiency measures included in the study. Note that the CCE figures only include wood energy efficiency savings and do not include electric or water savings. These figures simply provide a picture of the relative cost of conserved wood for the wood efficiency measures examined in this study. Figure 5-14 displays all measures with a CCE below the 2007 $/MMBTU for wood. Figure 5-15 displays all measures with a CCE above the 2007 $/MMBTU for wood.

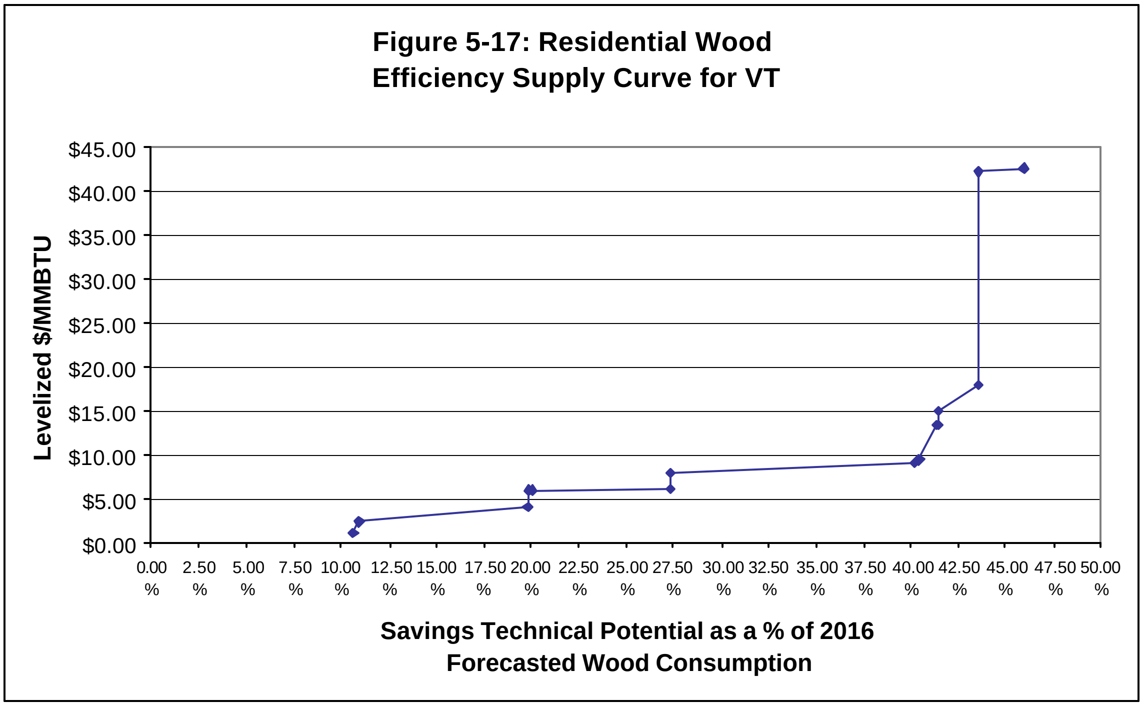


Figure 5-17: Residential Wood Efficiency Supply Curve for VT
Levelized $/MMBTU
$45.00
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
0.00 %
2.50 %
5.00 %
7.50 %
10.00 %
12.50 %
15.00 %
17.50 %
20.00 %
22.50 %
25.00 %
27.50 %
30.00 %
32.50 %
35.00 %
37.50 %
40.00 %
42.50 %
45.00 %
47.50 %
50.00 %
Savings Technical Potential as a % of 2016 Forecasted Wood Consumption

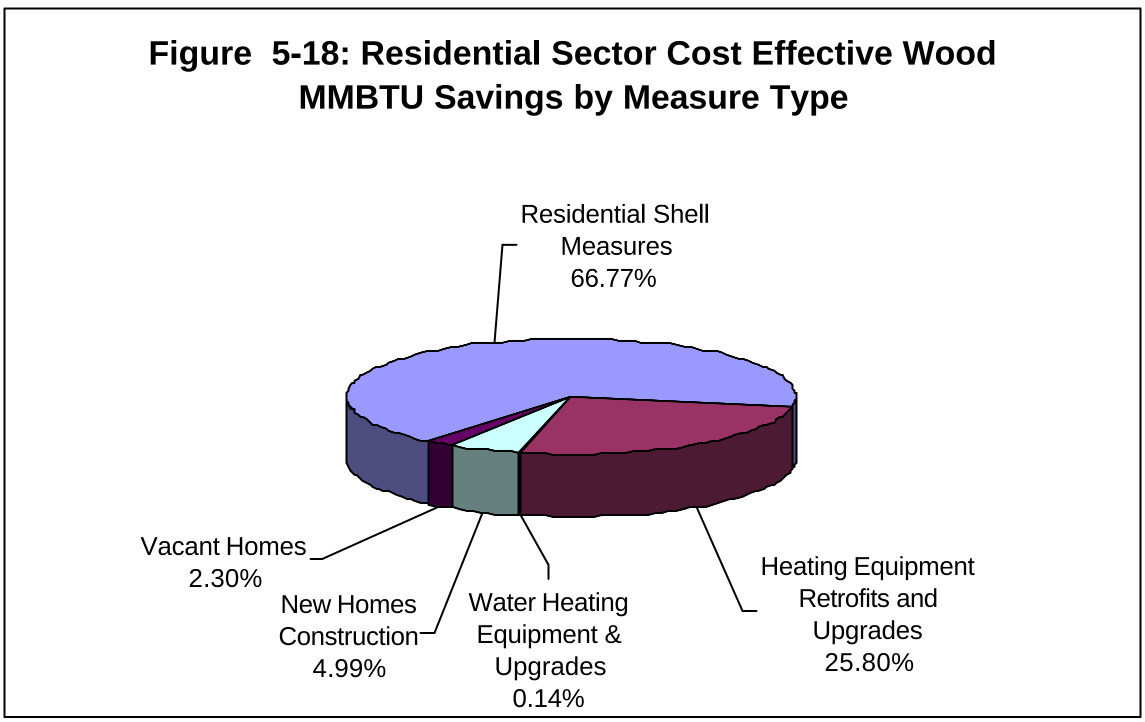


Figure 5-18: Residential Sector Cost Effective Wood MMBTU Savings by Measure Type
Residential Shell Measures 66.77%
Vacant Homes 2.30%
New Homes Construction 4.99%
Water Heating Equipment & Upgrades 0.14%
Heating Equipment Retrofits and Upgrades 25.80%

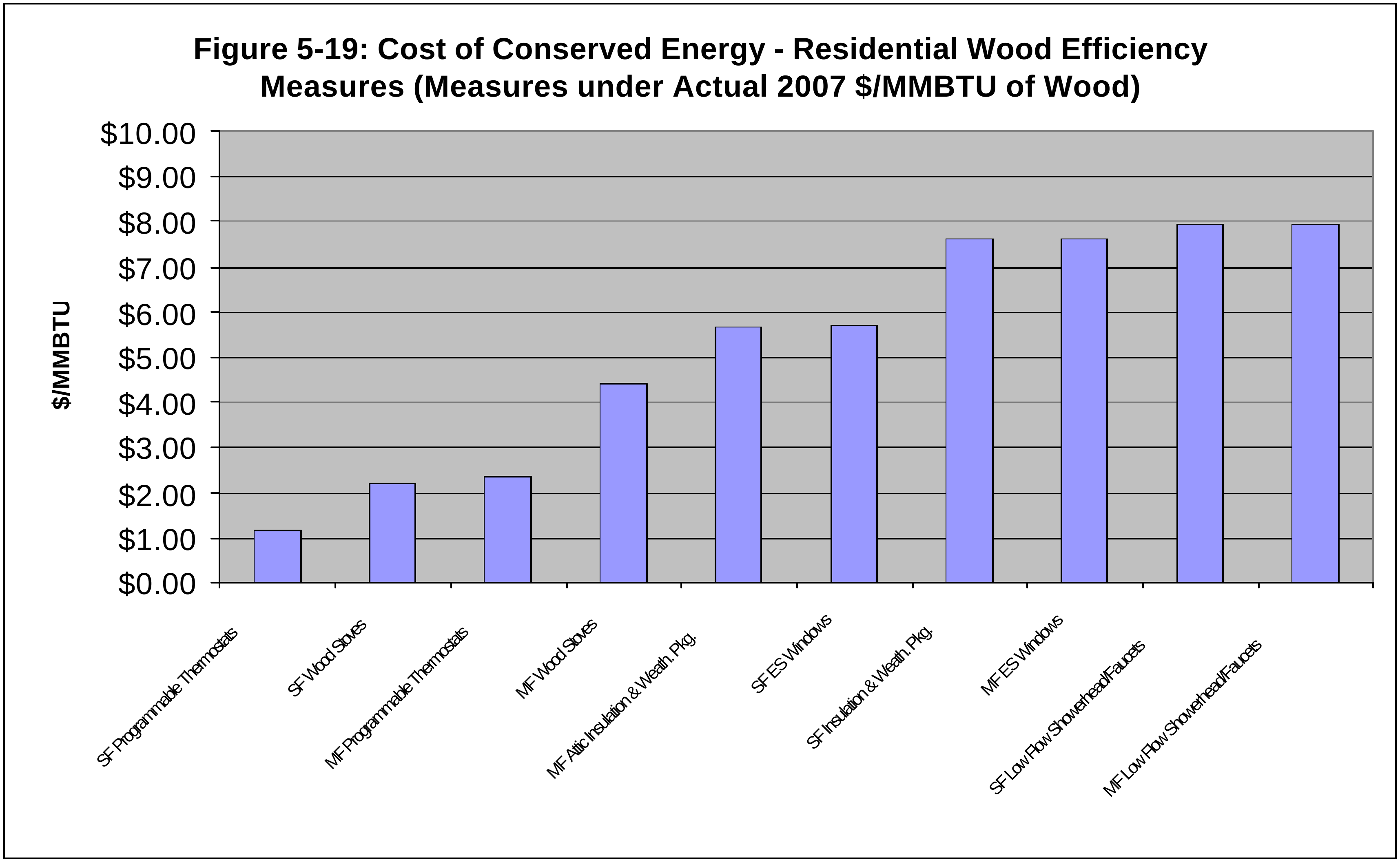


Figure 5-19: Cost of Conserved Energy - Residential Wood Efficiency Measures (Measures under Actual 2007 $/MMBTU of Wood)
$/MMBTU
$10.00
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
SF Programmable Thermostats
SF Wood Stoves
MF Programmable Thermostats
MF Wood Stoves
MF Attic Insulation & Weath. Pkg.
SF ES Windows
SF Insulation & Weath. Pkg.
MF ES Windows
SF Low Flow Showerhead/Faucets
MF Low Flow Showerhead/Faucets

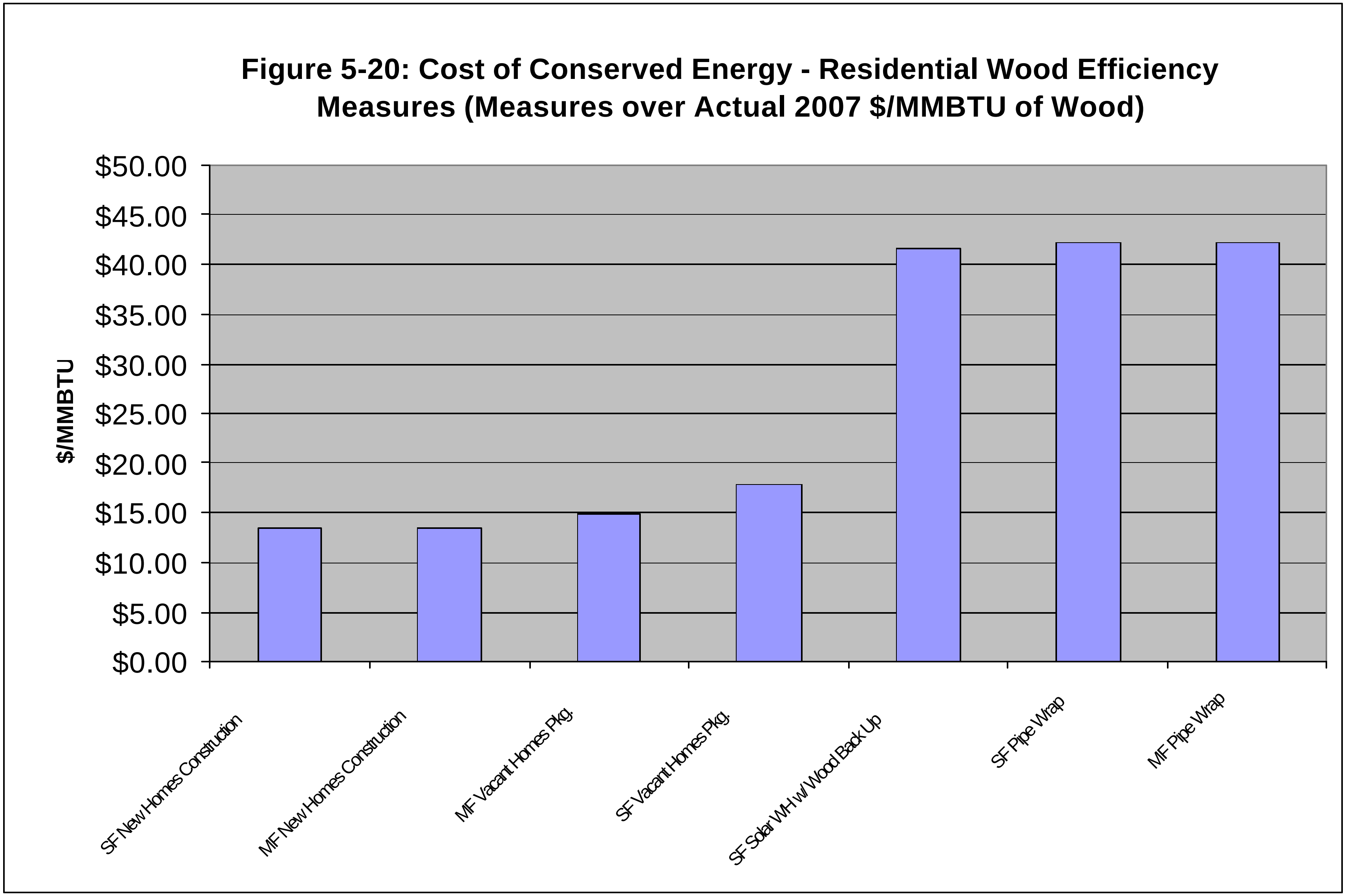


Figure 5-20: Cost of Conserved Energy - Residential Wood Efficiency Measures (Measures over Actual 2007 $/MMBTU of Wood)
$/MMBTU
$50.00
$45.00
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
SF New Homes Construction
MF New Homes Construction
MF Vacant Homes Pkg.
SF Vacant Homes Pkg.
SF Solar WH w/ Wood Back Up
SF Pipe Wrap
MF Pipe Wrap

5.3 Benefit/Cost Screening Results and Emissions Savings

The cumulative annual emissions savings for CO_2, methane (CH_4) and NO_2 in the residential sector are shown in Table 5-19 for the period 2007 to 2016. These cumulative annual savings figures represent the combined emission reductions from all four fuel types. The Societal Test Benefit/Cost screening results for the residential sector analyses are shown below in Tables 5-20 to 5-24. The Participant Test Benefit/Cost screening results for the residential sector analyses are shown below in Tables 5-25 to 5-29. These cost effectiveness screening calculations were obtained from the GDS Benefit/Cost Screening Model, from the Results worksheet.

Table 5-19: Summary of Cumulative **Annual Emissions Savings** for the Achievable Cost Effective Potential Scenario for Vermont - **Residential**

	Cumulative Annual Emissions Savings Derived from Energy Savings (Tons)			
Year	Total Cumulative Annual mmbtu savings	CO2 Emissions Reduction (tons)	Methane (CH4) Emissions Reduction (tons)	NO2 Emissions Reduction (tons)
2007	212,648	14,884	8.7	0.2
2008	426,601	29,861	17.4	0.4
2009	641,867	44,931	26.1	0.6
2010	858,403	60,096	34.9	0.9
2011	1,076,303	75,354	43.7	1.1
2012	1,295,500	90,705	52.6	1.3
2013	1,516,004	106,149	61.5	1.5
2014	1,737,819	121,686	70.4	1.7
2015	1,960,940	137,316	79.4	2.0
2016	2,182,210	152,795	88.4	2.2
Total	11,908,295	833,777	482.9	12.0

Table 5-20: Vermont **Societal Test** Benefits and Costs for **Fuel Oil** Energy Efficiency Measures for the Residential Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	VT Societal Test
#1	Shell Measures (Space Heating)	RES	$122,358,654	$6,860,265	$10,045,180	$8,036,144	$24,941,589	$97,417,065	4.91
#2	Furnace Efficiency Measures	RES	$18,623,847	$2,996,826	$4,388,118	$3,510,494	$10,895,438	$7,728,409	1.71
#3	Hot Water Boiler Efficiency Measures	RES	$28,607,818	$2,403,132	$3,518,800	$2,815,040	$8,736,972	$19,870,846	3.27
#4	Steam Boiler Efficiency Measures	RES	$6,516,330	$882,597	$1,292,347	$1,033,878	$3,208,821	$3,307,509	2.03
#5	Water Heating Efficiency Measures - SF	RES	$32,160,987	$2,701,869	$3,956,226	$3,164,981	$9,823,076	$22,337,911	3.27
#6	Water Heating Efficiency Measures - MF	RES	$6,472,770	$391,020	$572,553	$458,043	$1,421,616	$5,051,153	4.55
#7	New Home Construction Energy Efficiency	RES	$16,683,276	$2,897,801	$4,179,853	$3,343,883	$10,421,536	$6,261,739	1.60
#8	Efficiency Measures for Vacant Homes	RES	$5,016,814	$1,149,704	$1,683,460	$1,346,768	$4,179,933	$836,881	1.20
	Residential Sector Total		$236,440,495	$20,283,214	$29,636,537	$23,709,230	$73,628,981	$162,811,515	3.21

Table 5-21: Vermont **Societal Test** Benefits and Costs for **Propane** Energy Efficiency Measures for the Residential Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	VT Societal Test
#1	Shell Measures (Space Heating)	RES	$36,122,892	$1,607,306	$2,353,507	$1,882,805	$5,843,618	$30,279,274	6.18
#2	Furnace Efficiency Measures	RES	$5,941,353	$364,092	$533,124	$426,499	$1,323,715	$4,617,638	4.49
#3	Hot Water Boiler Efficiency Measures	RES	$5,449,886	$385,764	$564,858	$451,886	$1,402,508	$4,047,378	3.89
#4	Steam Boiler Efficiency Measures	RES	$1,348,934	$147,916	$216,586	$173,269	$537,771	$811,163	2.51
#5	Water Heating Efficiency Measures - SF	RES	$30,708,835	$3,369,027	$4,933,116	$3,946,493	$12,248,635	$18,460,200	2.51
#6	Water Heating Efficiency Measures - MF	RES	$3,360,304	$312,822	$458,051	$366,441	$1,137,315	$2,222,989	2.95
#7	New Home Construction Energy Efficiency	RES	$12,741,174	$1,867,039	$2,693,189	$2,154,552	$6,714,780	$6,026,394	1.90
#8	Efficiency Measures for Vacant Homes	RES	$1,542,136	$296,886	$434,717	$347,774	$1,079,377	$462,758	1.43
	Residential Sector Total		$97,215,514	$8,350,852	$12,187,148	$9,749,719	$30,287,719	$66,927,795	3.21

Table 5-22: Vermont **Societal Test** Benefits and Costs for **Kerosene** Energy Efficiency Measures for the Residential Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	VT Societal Test
#1	Shell Measures (Space Heating)	RES	$8,587,198	$881,891	$1,291,313	$1,033,051	$3,206,255	$5,380,943	2.68
#2	Homes with 'Kerosene' Furnaces	RES	$3,441,547	$644,963	$944,391	$755,513	$2,344,867	$1,096,679	1.47
#3	Vacant Homes	RES	$5,326	$1,991	$2,916	$2,333	$7,240	-$1,914	0.74
	Residential Sector Total		$12,034,070	$1,528,845	$2,238,620	$1,790,896	$5,558,362	$6,475,708	2.17

Table 5-23: Vermont **Societal Test** Benefits and Costs for **Wood** Energy Efficiency Measures for the Residential Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	VT Societal Test
#1	Shell Measures (Space Heating)	RES	$16,956,437	$1,271,108	$1,861,226	$1,488,981	$4,621,315	$12,335,122	3.67
#2	Homes with Wood Stoves	RES	$5,641,515	$481,989	$705,755	$564,604	$1,752,347	$3,889,168	3.22
#3	Homes with Wood Water Heating	RES	$286,995	$4,109	$6,017	$4,813	$14,939	$272,056	19.21
#4	New Homes Construction	RES	$1,606,119	$383,291	$552,730	$442,184	$1,378,204	$227,915	1.17
#5	Vacant Homes	RES	$761,881	$243,095	$355,953	$284,762	$883,810	-$121,928	0.86
	Residential Sector Total		$25,252,948	$2,383,591	$3,481,680	$2,785,344	$8,650,615	$16,602,333	2.92

*Other resource benefits include electric and water benefits for certain measures

Table 5-24: Vermont **Societal Test** Benefits and Costs for **Oil, Propane, Kerosene and Wood** Energy Efficiency Measures for the Residential Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	VT Societal Test
#1	Oil	RES	$236,440,495	$20,283,214	$29,636,537	$23,709,230	$73,628,981	$162,811,515	3.21
#2	Propane	RES	$97,215,514	$8,350,852	$12,187,148	$9,749,719	$30,287,719	$66,927,795	3.21
#3	Kerosene	RES	$12,034,070	$1,528,845	$2,238,620	$1,790,896	$5,558,362	$6,475,708	2.17
#4	Wood	RES	$25,252,948	$2,383,591	$3,481,680	$2,785,344	$8,650,615	$16,602,333	2.92
	Residential Sector Total		$370,943,028	$32,546,502	$47,543,986	$38,035,188	$118,125,677	$252,817,351	3.14

*Other resource benefits include electric and water benefits for certain measures

Table 5-25: **Participant Test** Benefits and Costs for **Oil** Energy Efficiency Measures for the Residential Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Shell Measures (Space Heating)	RES	$106,665,884	$10,045,180	$0	$0	$10,045,180	$96,620,704	10.62
#2	Furnace Efficiency Measures	RES	$16,927,229	$4,388,118	$0	$0	$4,388,118	$12,539,111	3.86
#3	Hot Water Boiler Efficiency Measures	RES	$28,182,121	$7,903,059	$0	$0	$7,903,059	$20,279,063	3.57
#4	Steam Boiler Efficiency Measures	RES	$6,456,908	$2,387,830	$0	$0	$2,387,830	$4,069,079	2.70
#5	Water Heating Efficiency Measures - SF	RES	$32,762,959	$4,066,441	$0	$0	$4,066,441	$28,696,518	8.06
#6	Water Heating Efficiency Measures - MF	RES	$6,194,766	$594,042	$0	$0	$594,042	$5,600,724	10.43
#7	New Home Construction Energy Efficiency	RES	$14,556,173	$4,179,853	$0	$0	$4,179,853	$10,376,320	3.48
#8	Efficiency Measures for Vacant Homes	RES	$4,377,332	$1,683,460	$0	$0	$1,683,460	$2,693,871	2.60
	Residential Sector Total		$216,123,373	$35,247,983	$0	$0	$35,247,983	$180,875,390	6.13

Table 5-26: **Participant Test** Benefits and Costs for **Propane** Energy Efficiency Measures for the Residential Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Shell Measures (Space Heating)	RES	$33,744,210	$2,353,507	$0	$0	$2,353,507	$31,390,704	14.34
#2	Furnace Efficiency Measures	RES	$5,577,207	$533,124	$0	$0	$533,124	$5,044,083	10.46
#3	Hot Water Boiler Efficiency Measures	RES	$5,753,065	$1,573,767	$0	$0	$1,573,767	$4,179,298	3.66
#4	Steam Boiler Efficiency Measures	RES	$1,417,861	$468,351	$0	$0	$468,351	$949,509	3.03
#5	Water Heating Efficiency Measures - SF	RES	$29,648,742	$4,933,116	$0	$0	$4,933,116	$24,715,627	6.01
#6	Water Heating Efficiency Measures - MF	RES	$3,218,535	$458,051	$0	$0	$458,051	$2,760,483	7.03
#7	New Home Construction Energy Efficiency	RES	$11,906,012	$2,693,189	$0	$0	$2,693,189	$9,212,823	4.42
#8	Efficiency Measures for Vacant Homes	RES	$1,441,068	$434,717	$0	$0	$434,717	$1,006,351	3.31
	Residential Sector Total		$92,706,700	$13,447,823	$0	$0	$13,447,823	$79,258,877	6.89

Table 5-27: **Participant Test** Benefits and Costs for **Kerosene** Energy Efficiency Measures for the Residential Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Shell Measures (Space Heating)	RES	$7,467,910	$1,033,051	$0	$0	$1,033,051	$6,434,860	7.23
#2	Homes with 'Kerosene' Furnaces	RES	$3,445,318	$931,335	$0	$0	$931,335	$2,513,983	3.70
#3	Vacant Homes	RES	$330,070	$198,400	$0	$0	$198,400	$131,669	1.66
	Residential Sector Total		$11,243,298	$2,162,786	$0	$0	$2,162,786	$9,080,512	5.20

Table 5-28: **Participant Test** Benefits and Costs for **Wood** Energy Efficiency Measures for the Residential Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Shell Measures (Space Heating)	RES	$16,956,437	$1,861,226	$0	$0	$1,861,226	$15,095,211	9.11
#2	Homes with Wood Stoves	RES	$5,641,515	$705,755	$0	$0	$705,755	$4,935,761	7.99
#3	Homes with Wood Water Heating	RES	$22,812	$6,017	$0	$0	$6,017	$16,795	3.79
#4	New Homes Construction	RES	$1,606,256	$552,730	$0	$0	$552,730	$1,053,526	2.91
#5	Vacant Homes	RES	$761,881	$355,953	$0	$0	$355,953	$405,929	2.14
	Residential Sector Total		$24,988,902	$3,481,680	$0	$0	$3,481,680	$21,507,222	7.18

*Other resource benefits include electric and water benefits for certain measures

Table 5-29: **Participant Test** Benefits and Costs for **Oil, Propane, Kerosene and Wood** Energy Efficiency Measures for the Residential Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test
#1	Oil	RES	$216,123,373	$35,247,983	$0	$0	$35,247,983	$180,875,390	6.13
#2	Propane	RES	$92,706,700	$13,447,823	$0	$0	$13,447,823	$79,258,877	6.89
#3	Kerosene	RES	$11,243,298	$2,162,786	$0	$0	$2,162,786	$9,080,512	5.20
#4	Wood	RES	$24,988,902	$3,481,680	$0	$0	$3,481,680	$21,507,222	7.18
	Residential Sector Total		$345,062,273	$54,340,272	$0	$0	$54,340,272	$290,722,002	6.35

*Other resource benefits include electric and water benefits for certain measures

6.0 COMMERCIAL SECTOR ENERGY EFFICIENCY SAVINGS POTENTIAL IN VERMONT FOR OIL, PROPANE, KEROSENE, AND WOOD

This section of the report presents the estimates of commercial sector technical, achievable and achievable cost effective energy efficiency savings potential for oil, propane, kerosene and wood fuels in Vermont. According to this analysis, there is still a large remaining potential for savings of these fuels in the commercial sector. Over the period 2007 to 2016, the net present value savings for additional energy savings of oil, propane, kerosene and wood energy efficiency in this sector is $200 million. Table 6-1 below summarizes the commercial sector cumulative annual achievable cost effective energy savings potential by fuel type for the years 2007, 2012 and 2016.

Table 6-1: Energy Efficiency Achievable **Cost Effective Potential** by Fuel Type by 2016 as a Percent of Total Fuel Type Energy Consumption in 2016 - Commercial Sector

Year	Oil	Propane	Kerosene	Wood
2007	2.30%	1.96%	1.98%	1.60%
2012	14.17%	12.45%	12.54%	9.61%
2016	24.18%	21.68%	21.87%	16.02%

6.1 Commercial Sector Energy Efficiency Measures

GDS examined nineteen energy efficiency measures in the analysis of commercial sector energy savings potential for oil, propane, kerosene and wood fuels. Table 6-2 presents a list of these nineteen energy efficiency measures and shows the measures examined for each fuel type.

In order to develop the list of commercial sector energy efficiency measures to be examined, GDS reviewed the measures included in the July 21, 2006 Vermont Electric Energy Efficiency Potential Study, the Efficiency Vermont Technical Resource Manual, other energy efficiency technical potential studies, and GDS conducted interviews with heating equipment distributors in Vermont. This measure list was then reviewed and expanded by VDPS staff. The set of energy efficiency programs or measures considered was pre-screened to only include those measures that are currently commercially available. The Tables in Appendices B1 to B4 list the specific commercial sector energy efficiency programs or measures included in the technical, achievable, and achievable cost effective potential savings analyses. These tables also summarize measure costs, energy savings and useful life data. The portfolio of measures includes retrofit, and replace-on-burnout programmatic approaches to achieve energy efficiency savings. The data shown in these tables are presented at the "measure" level, and represent energy savings that can be achieved at an individual commercial building.

Table 6-2: List of Commercial Sector Energy Efficiency Measures

Row	Measure*	Brief Description	End-Use	Oil	Propane	Kerosene	Wood
1	Efficient Furnace	Replace a standard efficiency furnace with a high efficiency furnace.	SH	X	X	X	X
2	Setback Controls	Install a setback control in order to set back in rooms not in use.	SH	X	X	X	X
3	Efficient Boiler	Replace a standard efficiency boiler with a high efficiency boiler.	SH	X	X	X	X
4	Boiler Tune-up	Tune up boiler to enhance the performance, safety and efficiency.	SH	X	X	X	X
5	Boiler Water Temp Reset Control	adjusts boiler water temperature based on outside temperature	SH	X	X	X	X
6	Roof Insulation	Roof insulation upgrades for more efficiency.	SH	X	X	X	X
7	Energy Star Windows	Install energy efficient windows in commercial buildings.	SH	X	X	X	X
8	Efficient Unit Heaters	Replace a standard efficiency unit heater with a high efficiency unit heater.	SH	X	X	X	
9	Heat Recovery Vent	Install energy and heat recovery ventilators	SH	X	X	X	X
10	Duct Sealing	Seal air ducts with one of several various compounds or aerosol product	SH	X	X	X	
11	Insulation Package	Add insulation to walls, floors, ceilings, doors, windows, or other openings	SH	X	X	X	X
12	Retrocommisioning	Recalibrate and tune-up all heating, DHW, and process systems including EMS.	SH	X	X	X	
13	Pipe Insulation	Insulation is wrapped around pipes to/from water heater.	WH	X	X	X	
14	Efficient Boiler	Replace a standard efficiency boiler with a high efficiency boiler.	WH	X	X	X	
15	Pump Controller	Automatically regulates the on and off periods of pump equipment.	WH	X	X	X	
16	Efficient Water Heater	Replace standard efficiency WH with a high efficiency WH.	WH	X	X	X	
17	Low Flow Pre-Rinse	Low flow nozzle place before commercial dishwasher or over sinks.	WH	X	X	X	
18	Commercial Clothes Washer	Commercial-grade clothes washer meeting minimum qualifying efficiency standar	WH	X	X	X	
19	Instantaneous Water Heater	Replace traditional water heaters with tankless water heaters	WH	X	X	X	

6.2 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 commercial sector energy efficiency measures. Estimates of the size of the eligible market were also developed for each efficiency measure for each fuel type (i.e., oil, propane, kerosene or wood). The sizes of various end-use market segments were primarily based on saturation estimates provided in the 2005 KEMA commercial sector market assessment report for Vermont.

As discussed in Section 2 of this report, achievable market penetrations were estimated assuming that Vermont businesses would receive a financial incentive equal to 50% of the incremental cost of the measure in most programs.

In this report we also present the technical achievable potential results in the form of supply curves. The supply curve for commercial sector energy efficiency savings is shown in Figure 6-1. The analysis of the potential for energy savings is based on forecasts of energy consumption for oil, propane, kerosene and wood for Vermont for the years 2007 to 2016.[30] Energy-efficiency measures were analyzed for the most important energy consuming end uses in the commercial sector: space heating and water heating.

6.2.1 Fuel Oil

Figure 6-1 and Table 6-3 below summarizes the technical, achievable, and achievable cost effective savings potential for fuel oil in the commercial sector by the year 2016. The achievable cost effective potential for fuel oil is 1.61 TBTU or 24.2% of the Vermont commercial sector fuel oil consumption forecast in 2016.

[30] See Section 3 of this report for a full description of the methodology used by GDS to develop these consumption forecasts for 2007 to 2016.

Figure 6-1 Summary of Potential Savings **(Oil)**

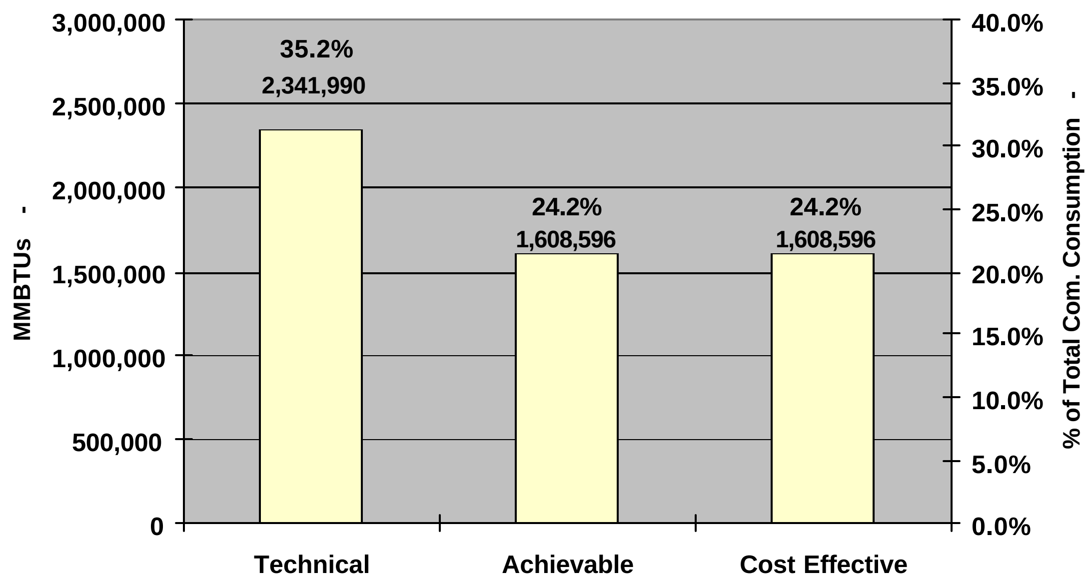


Table 6-3**:** Summary of Commercial **Fuel Oil** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Fuel Oil Consumption
Technical Potential	2,341,990	35.2%
Achievable Potential	1,608,596	24.2%
Achievable Cost Effective Potential	1,608,596	24.2%

Tables 6-4 through 6-6 list the results of the commercial sector technical, achievable, and achievable cost effective potential analyses for fuel oil. The Societal Test Benefit/Cost ratios shown in Table 6-6 were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheets. Only measures with a Societal Test benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

The supply curve for commercial fuel oil efficiency technical potential savings is shown in Figure 6-2, found after Tables 6-4 through 6-6. Figures 6-3 provides information on the achievable cost effective potential fuel oil savings by 2016 in the commercial sector. About 69% of the achievable cost effective savings is from commercial "shell" efficiency measures, followed by heating equipment retrofits and upgrades, water heating retrofits and upgrades, energy efficient new construction. Figures 6-4 and 6-5 present the cost of conserved energy (CCE) for commercial fuel oil energy efficiency measures included in the study. Note that the CCE figures only include fuel oil savings and do not include electric or water savings. These figures simply provide a picture of the relative cost of conserved fuel oil for the fuel oil efficiency measures examined in this study. Figure 6-4 displays all measures with a CCE below the 2007 $/MMBTU for fuel oil. Figure 6-5 displays all measures with a CCE above the 2007 $/MMBTU for fuel oil.

Table 6-4: Total Cumulative Annual Technical Potential MMBTU Savings for **Fuel Oil** Efficiency In Vermont By 2016
Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total**
10	Duct Sealing	392,278
9	Heat Recovery Vent	393,786
6	Roof Insulation	160,665
11	Wall Insulation	255,386
7	Energy Star Windows	177,958
12	Retrocommisioning	143,984
8	Efficient Unit Heaters	101,909
5	Boiler Water Temp Reset Control	48,043
4	Boiler Tune-up	19,435
3	Efficient Boiler (SH)	24,618
2	Setback Controls	91,718
1	Efficient Furnace	186,842
14	Commercial Clothes Washer	238,595
15	Low Flow Pre-Rinse Nozzle	3,510
18	Pipe Insulation	1,916
13	Efficient Storage Water Heater	48,884
19	Efficient Instantaneous Water Heater	5,460
16	Pump Controller	45,190
17	Efficient Boiler (WH)	1,814

Total Technical Potential MMBTU Savings	2,341,990
Forecast 2016 Vermont Commercial Fuel Oil Consumption	6,652,380
As a percent of forecasted commercial fuel oil consumption 2016	35.2%

Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 6-5: Total Cumulative Annual Achievable Potential MMBTU Savings for **Fuel Oil** Efficiency In Vermont By 2016

Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total**
10	Duct Sealing	313,822
9	Heat Recovery Vent	315,029
6	Roof Insulation	142,813
11	Wall Insulation	204,309
7	Energy Star Windows	52,728
12	Retrocommisioning	80,631
8	Efficient Unit Heaters	42,909
5	Boiler Water Temp Reset Control	42,705
4	Boiler Tune-up	8,638
3	Efficient Boiler (SH)	7,878
2	Setback Controls	81,527
1	Efficient Furnace	74,737
14	Commercial Clothes Washer	151,489
15	Low Flow Pre-Rinse Nozzle	1,560
18	Pipe Insulation	1,533
13	Efficient Storage Water Heater	43,452
19	Efficient Instantaneous Water Heater	2,184
16	Pump Controller	40,169
17	Efficient Boiler (WH)	484

Achievable MMBTU Savings by 2016	1,608,596
Forecast 2016 Vermont Commercial Fuel Oil Consumption	6,652,380
As a percent of forecasted commercial fuel oil consumption in 2016	24.2%

Note: Achievable potential MMBTU savings were obtained from Appendix B2 (Table B2-3) of this report

Table 6-6: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Fuel Oil** Efficiency In Vermont By 2016

Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total Cumulative Annual MMBTU Savings by 2016**
10	Duct Sealing	313,822
9	Heat Recovery Vent	315,029
6	Roof Insulation	142,813
11	Wall Insulation	204,309
7	Energy Star Windows	52,728
12	Retrocommisioning	80,631
8	Efficient Unit Heaters	42,909
5	Boiler Water Temp Reset Control	42,705
4	Boiler Tune-up	8,638
3	Efficient Boiler (SH)	7,878
2	Setback Controls	81,527
1	Efficient Furnace	74,737
14	Commercial Clothes Washer	151,489
15	Low Flow Pre-Rinse Nozzle	1,560
18	Pipe Insulation	1,533
13	Efficient Storage Water Heater	43,452
19	Efficient Instantaneous Water Heater	2,184
16	Pump Controller	40,169
17	Efficient Boiler (WH)	484

Achievable Cost Effective MMBTU Savings	1,608,596
Forecast 2016 Vermont Commercial Fuel Oil Consumption	6,652,380
Savings as a percent of forecasted commercial fuel oil consumption in 2016	24.2%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 6-4 are from Table B2-4 (Appendix B2). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

Figure 6-2: **Commercial Fuel Oil** Efficiency Supply Curve for VT

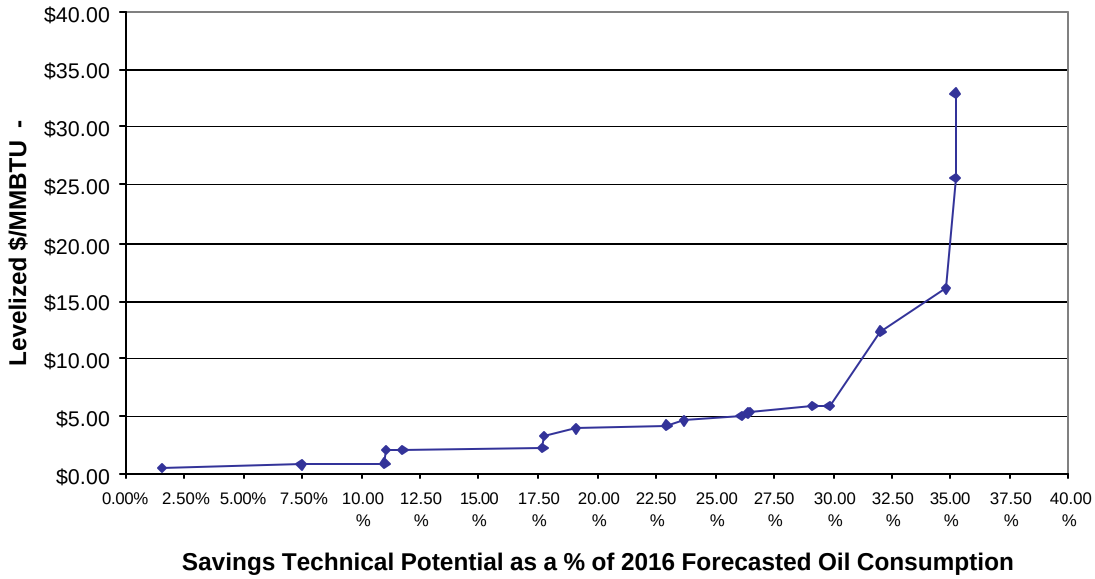
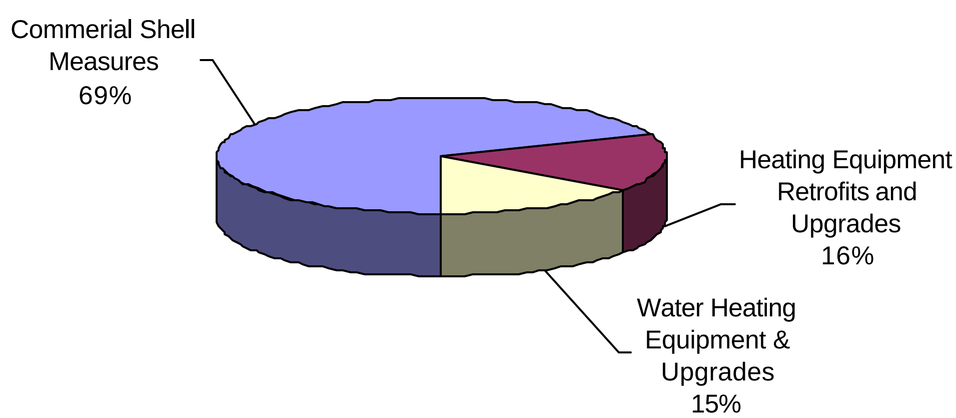


Figure 6-3: Commercial Sector Cost Effective **Fuel Oil** MMBTU Savings by Measure Type



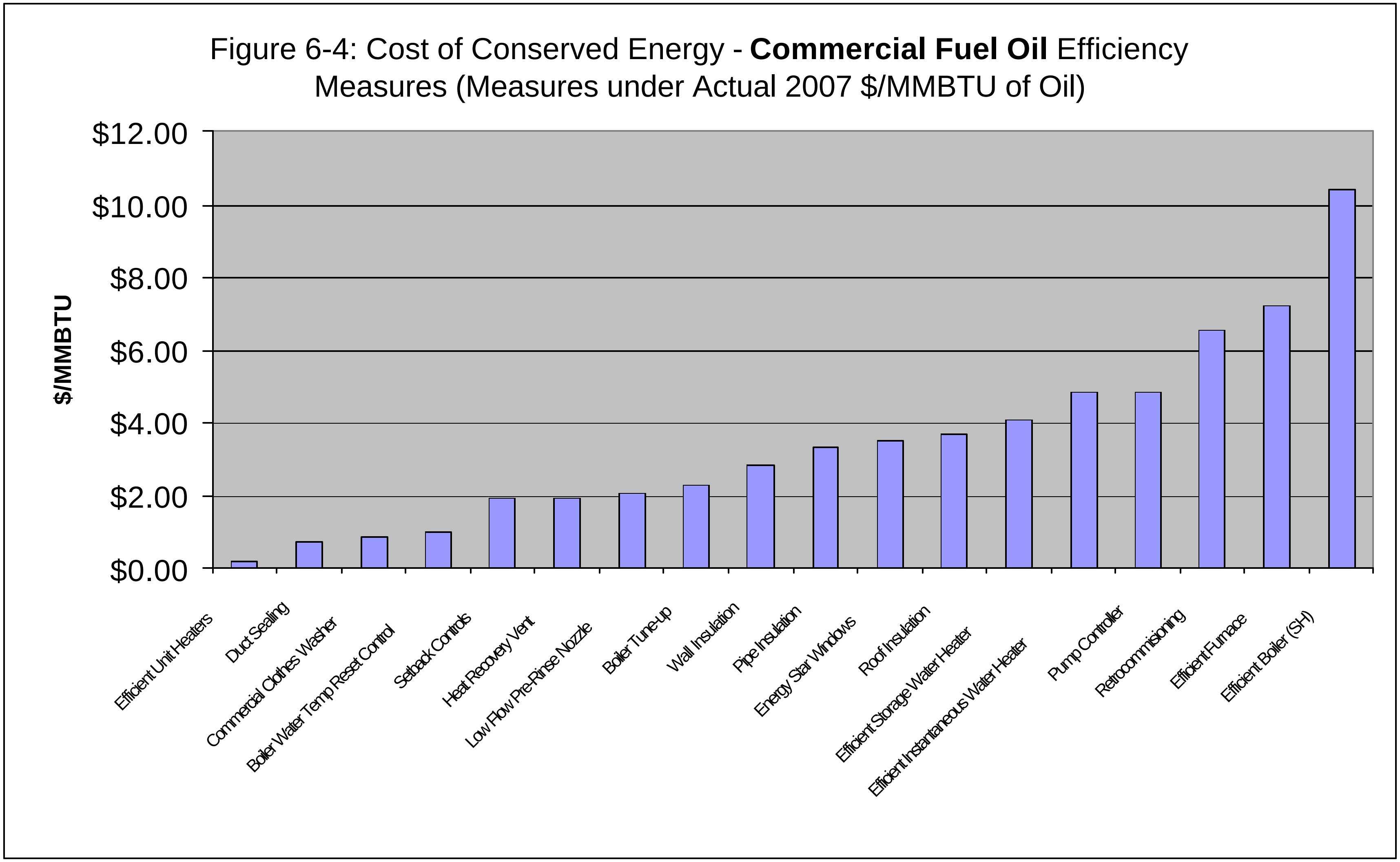
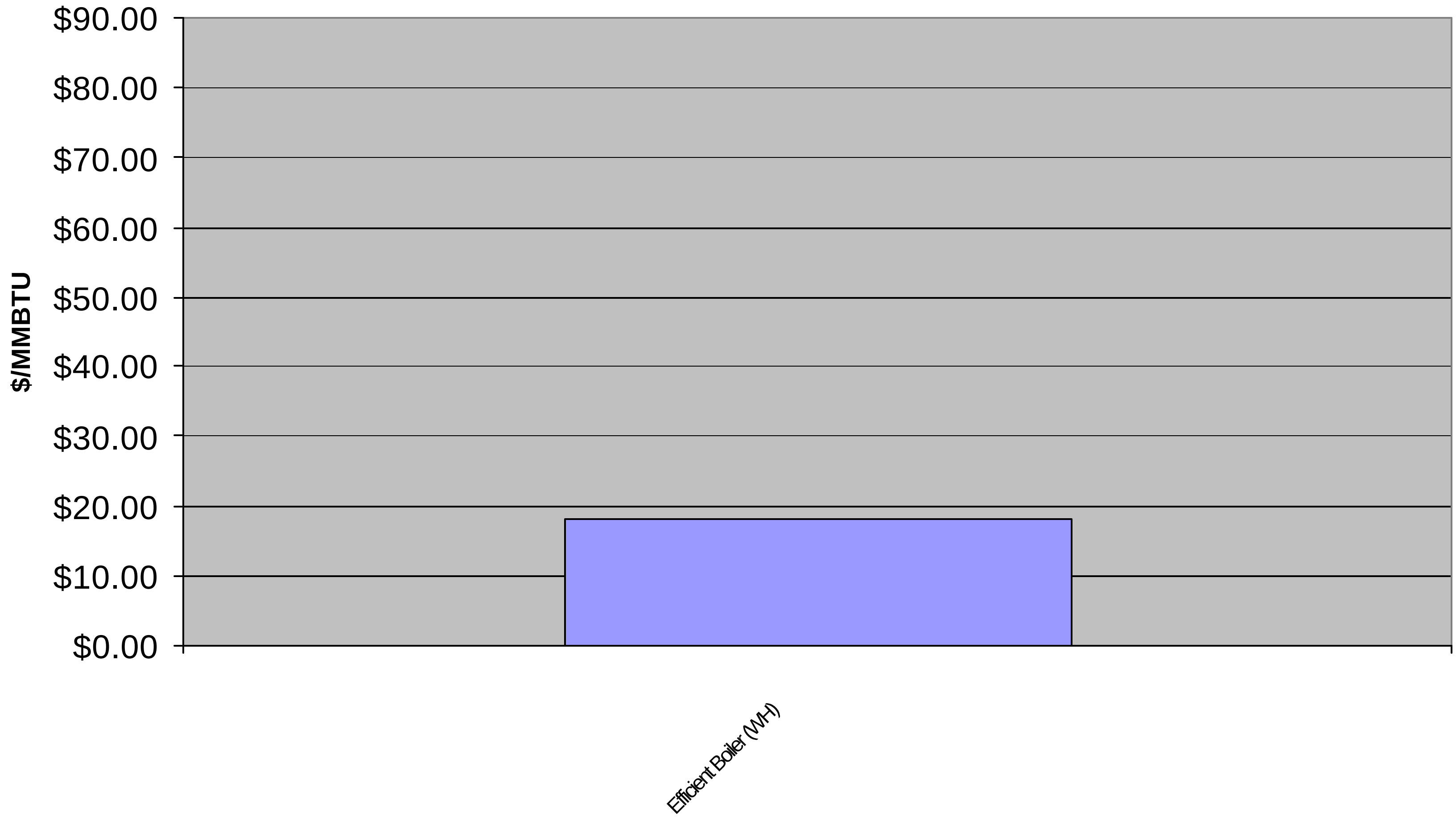


Figure 6-4: Cost of Conserved Energy - **Commercial Fuel Oil** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Oil)
$/MMBTU
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
Efficient Unit Heaters
Duct Sealing
Commercial Clothes Washer
Boiler Water Temp Reset Control
Setback Controls
Heat Recovery Vent
Low Flow Pre-Rinse Nozzle
Boiler Tune-up
Wall Insulation
Pipe Insulation
Energy Star Windows
Roof Insulation
Efficient Storage Water Heater
Efficient Instantaneous Water Heater
Pump Controller
Retrocommisioning
Efficient Furnace
Efficient Boiler (SH)

Figure 6-5: Cost of Conserved Energy - **Commercial Fuel Oil Efficiency** Measures (Measures over Actual 2007 $/MMBTU of Oil)



6.2.2 Propane

Figure 6-6 and Table 6-7 below summarizes the technical, achievable, and achievable cost effective savings potential for propane in the commercial sector by the year 2016. The achievable cost effective potential for propane is 0.302 TBTU or 21.7% of the Vermont commercial sector propane consumption forecast in 2016.

Figure 6-6 Summary of Potential Savings **(Propane)**

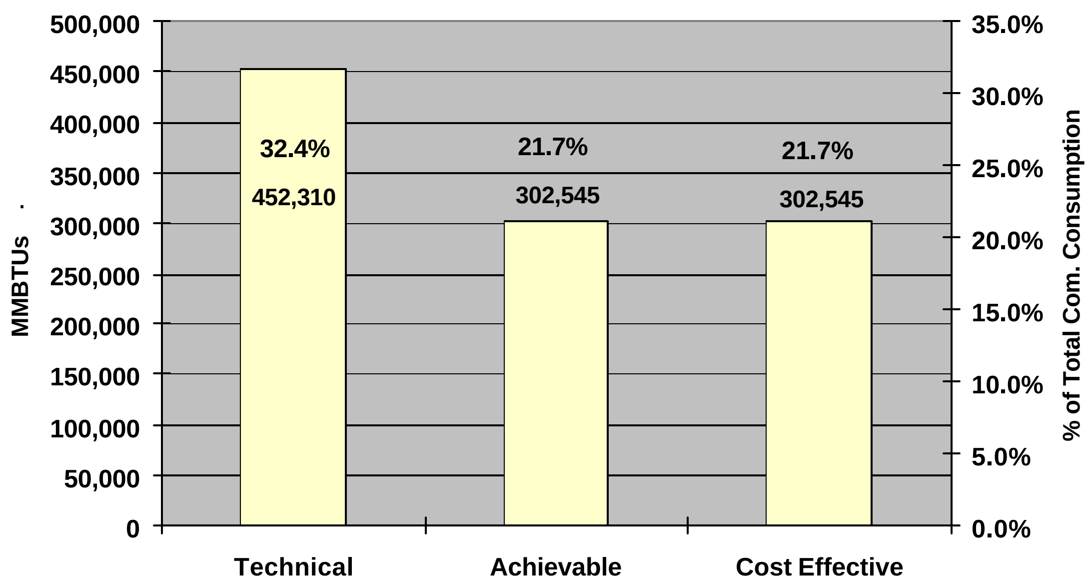


Table 6-7: Summary of **Commercial Propane** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Propane Consumption
Technical Potential	452,310	32.4%
Achievable Potential	302,545	21.7%
Achievable Cost Effective Potential	302,545	21.7%

Tables 6-8 through 6-10 list the results of the commercial sector technical, achievable, and achievable cost effective potential analyses for propane. Only measures with a Societal Test benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

The supply curve for commercial propane efficiency technical potential savings is shown in Figure 6-7, found after Tables 6-8 through 6-10. Figures 6-8 provides information on the achievable cost effective propane savings by 2016 in the commercial sector. About 59% of the achievable cost effective savings is from commercial "shell" efficiency measures, followed by heating equipment retrofits and upgrades, and water heating retrofits and upgrades. Figure 6-9 presents the cost of conserved energy (CCE) for commercial propane energy efficiency measures included in the study. Note that the CCE figures only include propane savings and do not include electric or water savings. The figure simply provides a picture of the relative cost of conserved propane for the propane efficiency measures examined in this study.

Table 6-8: Total Cumulative Annual Technical Potential MMBTU Savings for **Propane** Efficiency In Vermont By 2016

Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total**
1	Efficient Furnace	82,275
2	Setback Controls	74,333
3	Efficient Boiler	12,481
4	Boiler Tune-up	16,069
5	Boiler Water Temp Reset Control	12,442
6	Roof Insulation	27,179
7	Energy Star Windows	57,710
8	Efficient Unit Heaters	11,196
9	Heat Recovery Vent	13,588
10	Duct Sealing	15,490
11	Wall Insulation	21,374
12	Retrocommisioning	39,188
13	Pipe Insulation	50,042
14	Efficient Boiler	736
15	Pump Controller	12,658
16	Efficient Storage Water Heater	2,929
17	Efficient Instantaneous Water Heater	362
18	Low Flow Pre-Rinse Nozzle	1,053
19	Commercial Clothes Washer	1,205

Total Technical Potential MMBTU Savings	452,310
Forecast 2016 Vermont Commercial Propane Consumption	1,395,257
As a percent of Forecasted Commercial Propane Consumption in 2016	32.4%

Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 6-9: Total Cumulative Annual Achievable Potential MMBTU Savings for **Propane** Efficiency In Vermont By 2016

Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total**
1	Efficient Furnace	65,820
2	Setback Controls	66,074
3	Efficient Boiler	9,984
4	Boiler Tune-up	14,284
5	Boiler Water Temp Reset Control	3,686
6	Roof Insulation	16,911
7	Energy Star Windows	26,999
8	Efficient Unit Heaters	8,957
9	Heat Recovery Vent	5,435
10	Duct Sealing	4,957
11	Wall Insulation	17,099
12	Retrocommisioning	15,675
13	Pipe Insulation	31,773
14	Efficient Boiler	327
15	Pump Controller	11,251
16	Efficient Storage Water Heater	2,003
17	Efficient Instantaneous Water Heater	145
18	Low Flow Pre-Rinse Nozzle	843
19	Commercial Clothes Washer	321

Achievable MMBTU Savings by 2016	302,545
Forecast 2016 Vermont Commercial Propane Consumption	1,395,257
As a percent of forecasted commercial propane consumption in 2016	21.7%

Note: Achievable potential MMBTU savings were obtained from Appendix B3 (Table B3-3) of this report

Table 6-10: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Propane** Efficiency In Vermont By 2016 **Commercial Sector - Replace on Burnout and Retrofit Savings**		
1	**2**	**3**
Measure #	**Measure Description**	**Total Cumulative Annual MMBTU Savings by 2016**
1	Efficient Furnace	65,820
2	Setback Controls	66,074
3	Efficient Boiler	9,984
4	Boiler Tune-up	14,284
5	Boiler Water Temp Reset Control	3,686
6	Roof Insulation	16,911
7	Energy Star Windows	26,999
8	Efficient Unit Heaters	8,957
9	Heat Recovery Vent	5,435
10	Duct Sealing	4,957
11	Wall Insulation	17,099
12	Retrocommisioning	15,675
13	Pipe Insulation	31,773
14	Efficient Boiler	327
15	Pump Controller	11,251
16	Efficient Storage Water Heater	2,003
17	Efficient Instantaneous Water Heater	145
18	Low Flow Pre-Rinse Nozzle	843
19	Commercial Clothes Washer	321

Achievable Cost Effective MMBTU Savings	302,545
Forecast 2016 Vermont Commercial Propane Consumption	1,395,257
Savings as a percent of forecasted commercial propane consumption in 2016	21.7%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 6-4 are from Table B3-4 (Appendix B3). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

Figure 6-7: **Commercial Propane** Efficiency Supply Curve for VT

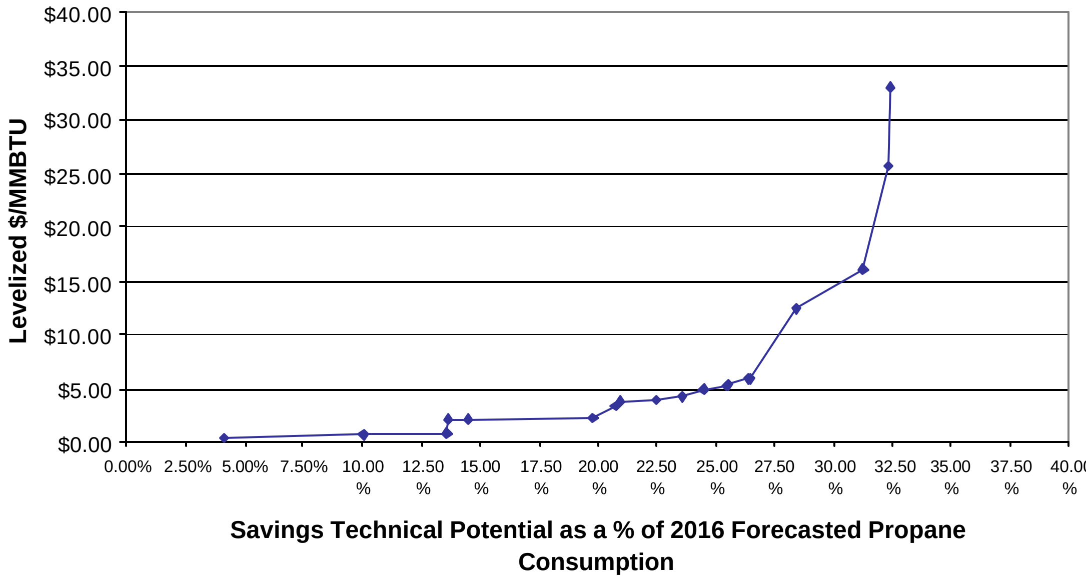
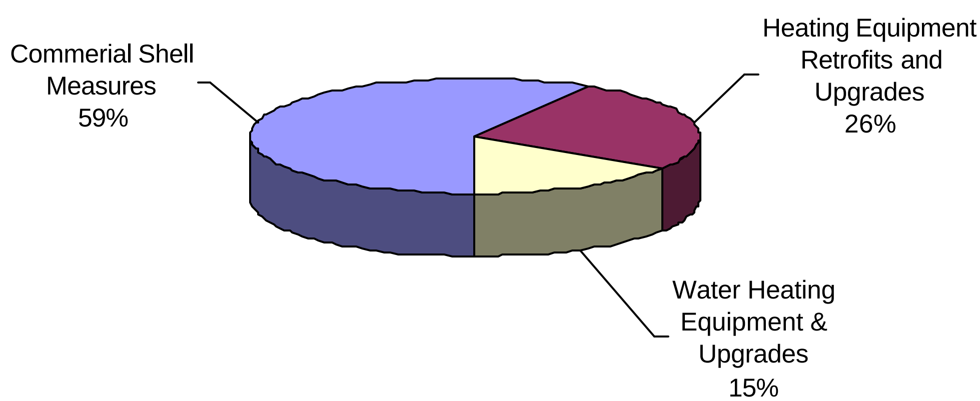


Figure 6-8: Commercial Sector Cost Effective **Propane** MMBTU Savings by Measure Type



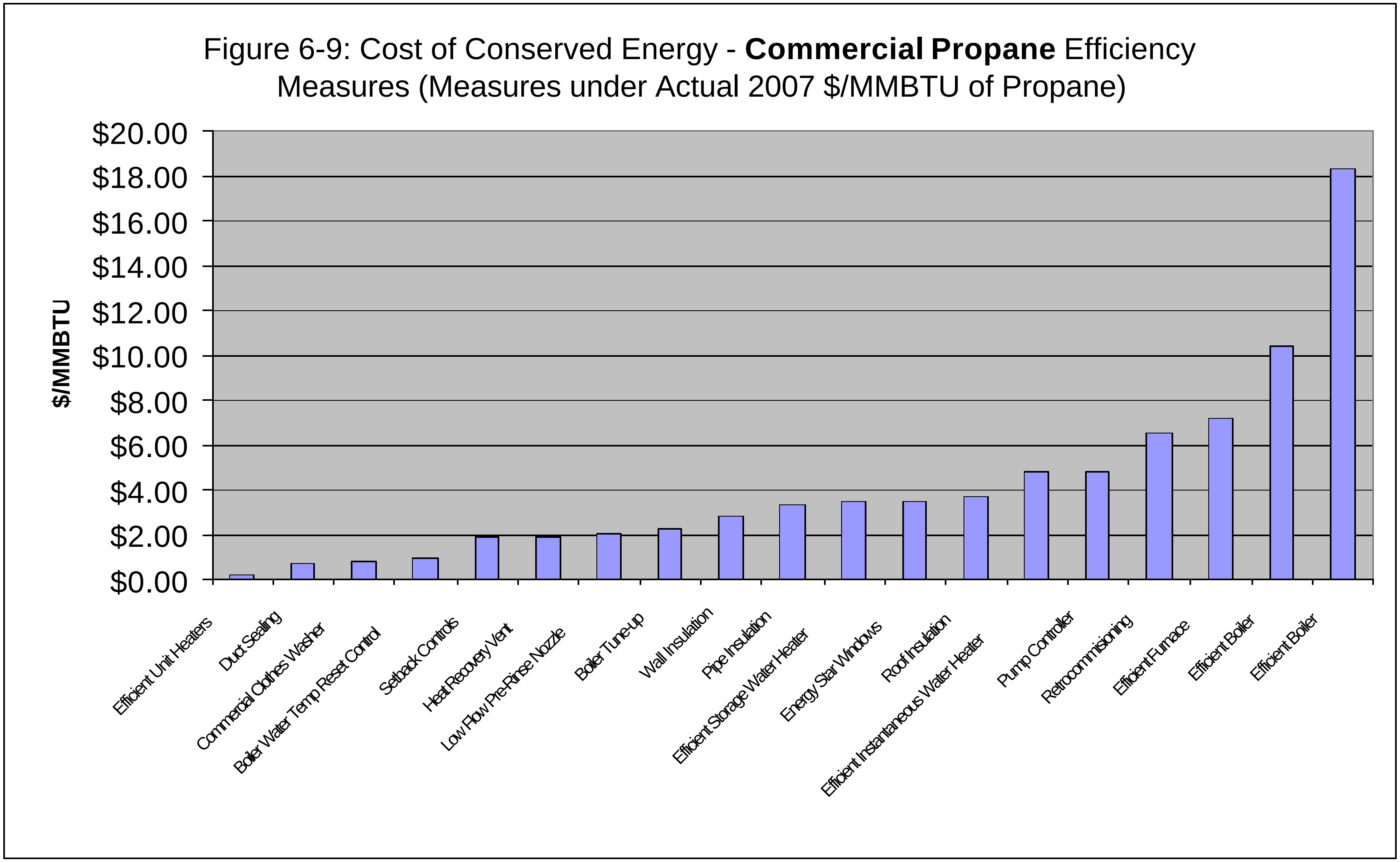


Figure 6-9: Cost of Conserved Energy - **Commercial Propane** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Propane)
$/MMBTU
$20.00
$18.00
$16.00
$14.00
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
Efficient Unit Heaters
Duct Sealing
Commercial Clothes Washer
Boiler Water Temp Reset Control
Setback Controls
Heat Recovery Vent
Low Flow Pre-Rinse Nozzle
Boiler Tune-up
Wall Insulation
Pipe Insulation
Efficient Storage Water Heater
Energy Star Windows
Roof Insulation
Efficient Instantaneous Water Heater
Pump Controller
Retrocommissioning
Efficient Furnace
Efficient Boiler
Efficient Boiler

6.2.3 Kerosene

Figure 6-10 and Table 6-11 below summarizes the technical, achievable, and achievable cost effective savings potential for kerosene in the commercial sector by the year 2016. The achievable cost effective potential for kerosene is 0.047 TBTU or 21.9% of the Vermont commercial sector kerosene consumption forecast in 2016.

Figure 6-10 Summary of Potential Savings **(Kerosene)**

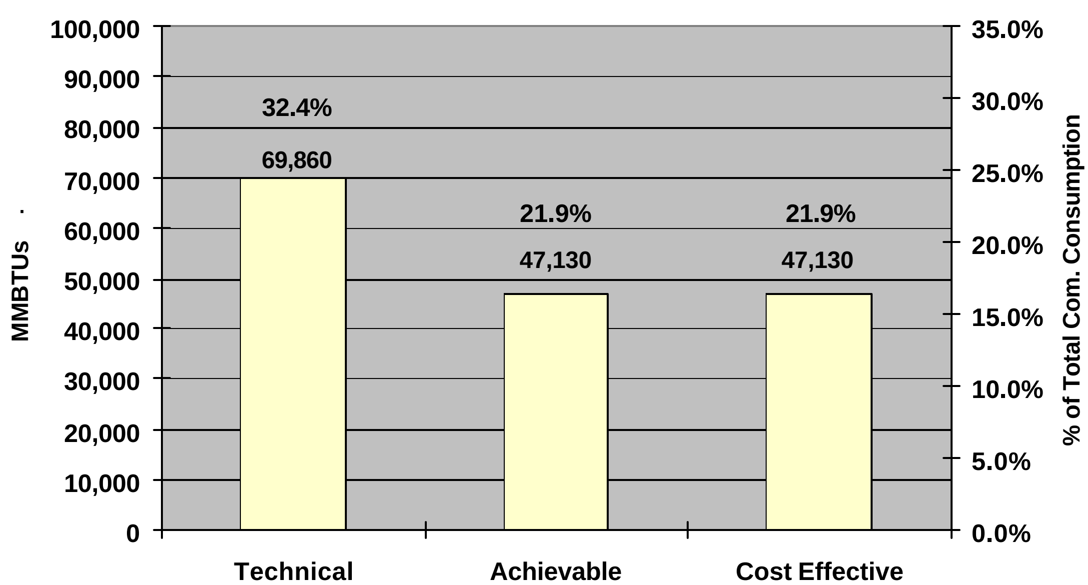


Table 6-11: Summary of **Commercial Kerosene** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Kerosene Consumption
Technical Potential	69,860	32.4%
Achievable Potential	47,130	21.9%
Achievable Cost Effective Potential	47,130	21.9%

Tables 6-12 through 6-14 list the results of the commercial sector technical, achievable, and achievable cost effective potential analyses for kerosene. Only measures with a Societal Test benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

The supply curve for commercial kerosene efficiency technical potential savings is shown in Figure 6-11, found after Tables 6-12 through 6-14. Figure 6-12 provides information on the achievable cost effective potential kerosene savings by 2016 in the commercial sector. About 58% of the achievable cost effective savings is from commercial "shell" efficiency measures, followed by heating equipment retrofits and upgrades, and water heating retrofits. Figures 6-13 and 6-14 present the cost of conserved energy (CCE) for commercial kerosene energy efficiency measures included in the study. Note that the CCE figures only include kerosene savings and do not include electric or water savings. These figures simply provide a picture of the relative cost of conserved kerosene for the kerosene efficiency measures examined in this study. Figure 6-13 displays all measures with a CCE below the 2007 $/MMBTU for kerosene. Figure 6-14 displays all measures with a CCE above the 2007 $/MMBTU for kerosene.

Table 6-12: Total Cumulative Annual Technical Potential MMBTU Savings for **Kerosene** Efficiency In Vermont By 2016

Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total**
10	Duct Sealing	12,708
9	Heat Recovery Vent	11,481
6	Roof Insulation	1,928
11	Wall Insulation	2,482
7	Energy Star Windows	1,922
12	Retrocommisioning	4,198
8	Efficient Unit Heaters	8,913
5	Boiler Water Temp Reset Control	1,729
4	Boiler Tune-up	2,099
3	Efficient Boiler	2,392
2	Setback Controls	3,301
1	Efficient Furnace	6,053
19	Commercial Clothes Washer	7,729
18	Low Flow Pre-Rinse Nozzle	114
13	Pipe Insulation	1,955
16	Efficient Storage Water Heater	452
17	Efficient Instantaneous Water Heater	56
15	Pump Controller	163
14	Efficient Boiler	186

Total Technical Potential MMBTU Savings	69,860
Forecast 2016 Vermont Commercial Kerosene Consumption	215,501
As a percent of Forecasted Commercial Kerosene Consumption 2016	32.4%

Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 6-13: Total Cumulative Annual Achievable Potential MMBTU Savings for **Kerosene** Efficiency In Vermont By 2016

Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total**
10	Duct Sealing	10,166
9	Heat Recovery Vent	10,205
6	Roof Insulation	1,542
11	Wall Insulation	2,206
7	Energy Star Windows	569
12	Retrocommisioning	2,612
8	Efficient Unit Heaters	4,170
5	Boiler Water Temp Reset Control	1,383
4	Boiler Tune-up	839
3	Efficient Boiler	766
2	Setback Controls	2,641
1	Efficient Furnace	2,421
19	Commercial Clothes Washer	5,285
18	Low Flow Pre-Rinse Nozzle	101
13	Pipe Insulation	1,738
16	Efficient Storage Water Heater	161
17	Efficient Instantaneous Water Heater	45
15	Pump Controller	130
14	Efficient Boiler	149

Achievable MMBTU Savings by 2016	47,130
Forecast 2016 Vermont Commercial Kerosene Consumption	215,501
As a percent of Forecasted Commercial Kerosene Consumption in 2016	21.9%

Note: Achievable potential MMBTU savings were obtained from Appendix B4 (Table B4-3) of this report

Table 6-14: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Kerosene** Efficiency In Vermont By 2016 **Commercial Sector - Replace on Burnout and Retrofit Savings**		
1	**2**	**3**
Measure #	**Measure Description**	**Total Cumulative Annual MMBTU Savings by 2016**
10	Duct Sealing	10,166
9	Heat Recovery Vent	10,205
6	Roof Insulation	1,542
11	Wall Insulation	2,206
7	Energy Star Windows	569
12	Retrocommisioning	2,612
8	Efficient Unit Heaters	4,170
5	Boiler Water Temp Reset Control	1,383
4	Boiler Tune-up	839
3	Efficient Boiler	766
2	Setback Controls	2,641
1	Efficient Furnace	2,421
19	Commercial Clothes Washer	5,285
18	Low Flow Pre-Rinse Nozzle	101
13	Pipe Insulation	1,738
16	Efficient Storage Water Heater	161
17	Efficient Instantaneous Water Heater	45
15	Pump Controller	130
14	Efficient Boiler	149

Achievable Cost Effective MMBTU Savings	47,130
Forecast 2016 Vermont Commercial Fuel Oil Consumption	215,501
Savings as a percent of forecasted commercial fuel oil consumption in 2016	21.87%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 6-4 are from Table B4-4 (Appendix B4). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

Figure 6-11: **Commercial Kerosene** Efficiency Supply Curve for VT

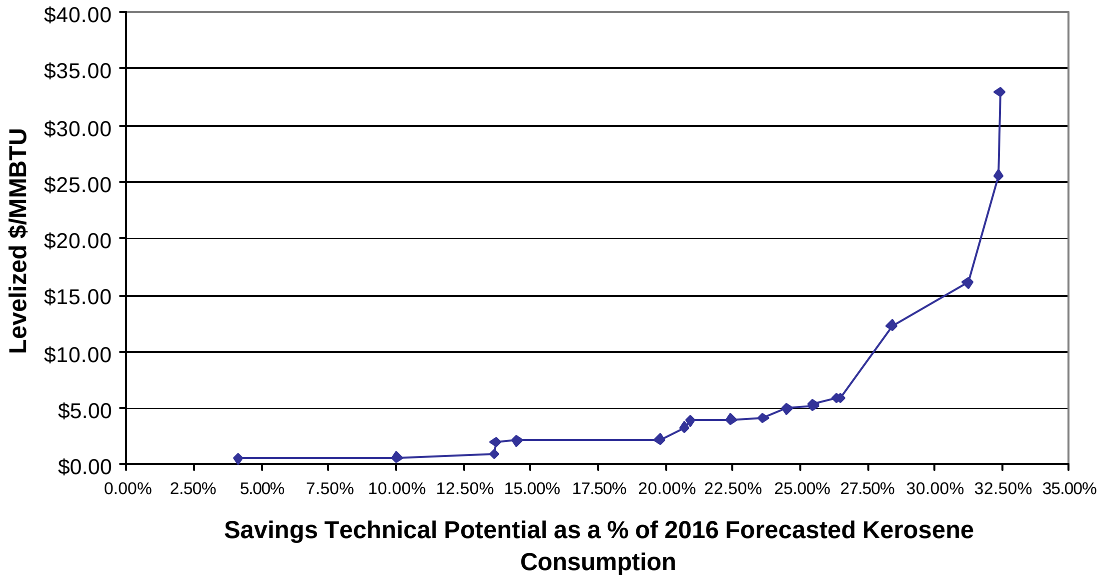


Figure 6-12: Commercial Sector Cost Effective **Kerosene** MMBTU Savings by Measure Type

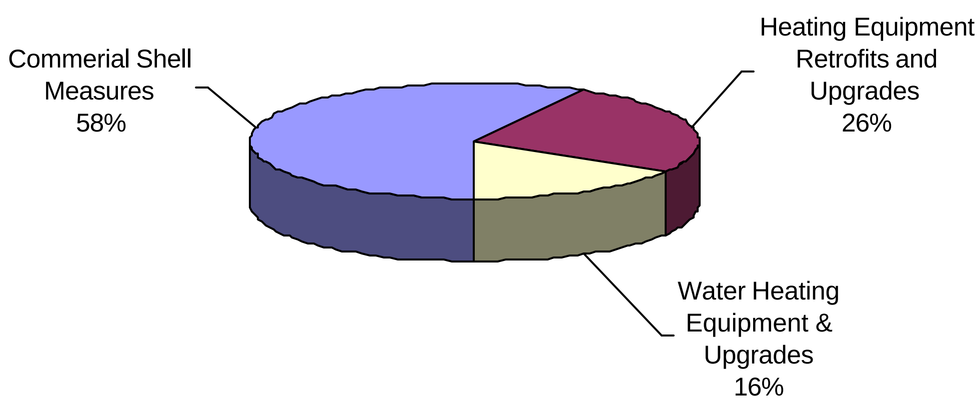


Figure 6-13: Cost of Conserved Energy - **Commercial Kerosene** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Kerosene)

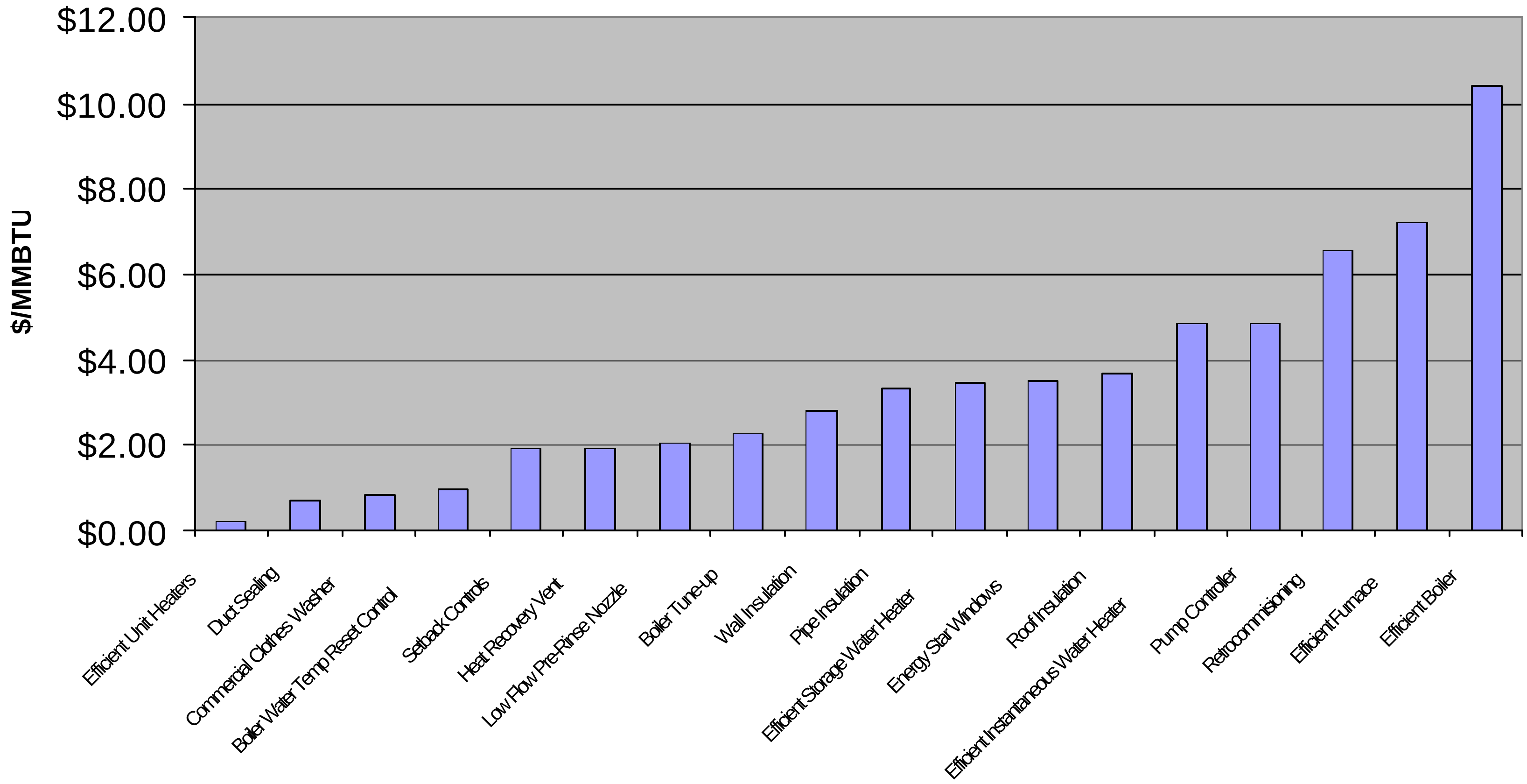
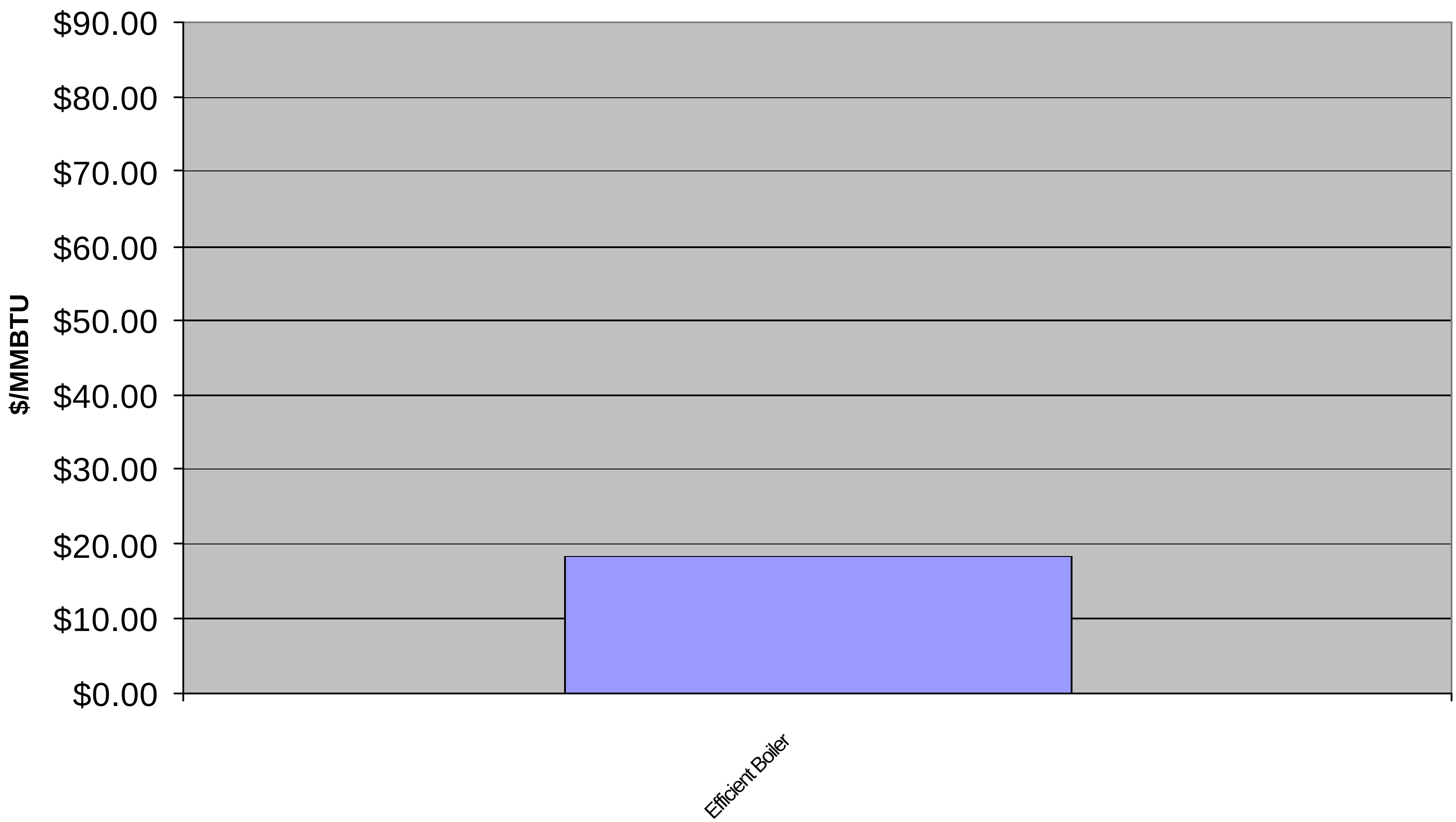


Figure 6-14: Cost of Conserved Energy - **Commercial Kerosene** Efficiency Measures (Measures over Actual 2007 $/MMBTU of Kerosene)



6.2.4 Wood

Figure 6-15 and Table 6-15 below summarizes the technical, achievable, and achievable cost effective savings potential for wood in the commercial sector by the year 2016. The achievable cost effective potential for wood is 0.038 TBTU or 16.0% of the Vermont commercial sector wood consumption forecast in 2016.

Figure 6-15 Summary of Potential Savings **(Wood)**

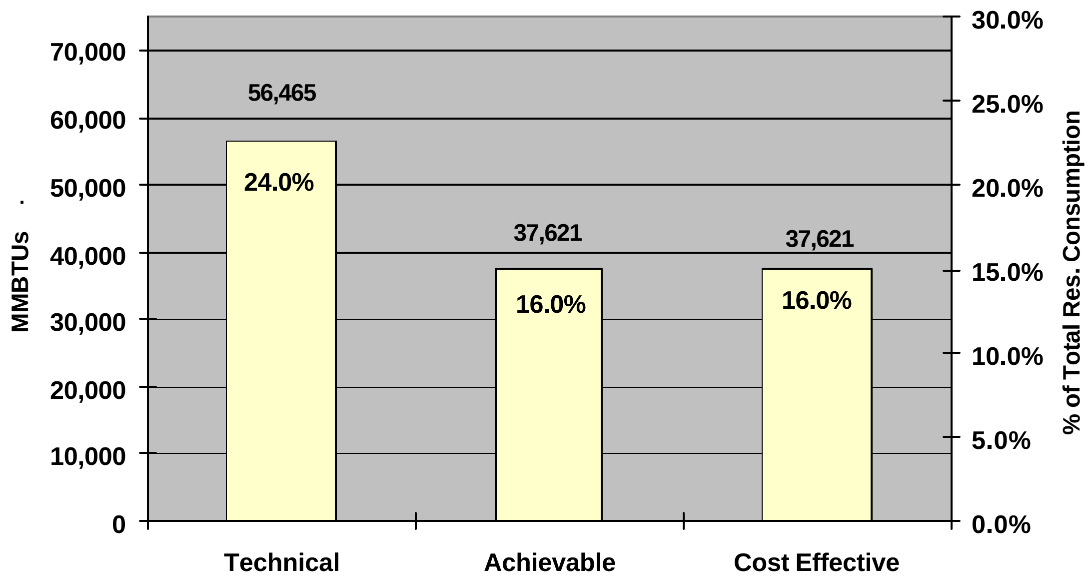


Table 6-15: Summary of **Commercial Wood** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Wood Consumption
Technical Potential	56,465	24.0%
Achievable Potential	37,621	16.0%
Achievable Cost Effective Potential	37,621	16.0%

Tables 6-16 through 6-18 list the results of the commercial sector technical, achievable, and achievable cost effective potential analyses for wood energy. Only measures with a Societal Test benefit/cost ratio greater than or equal to 1.0 were included in the analyses.

The supply curve for commercial wood efficiency technical potential savings is shown in Figure 6-16, found after Tables 6-16 through 6-18. Figure 6-17 provides information on the achievable cost effective potential wood savings by 2016 in the commercial sector. About 73% of the achievable cost effective savings is from commercial "shell" efficiency measures, followed by heating equipment retrofits and upgrades. Figures 6-18 and 6-19 present the cost of conserved energy (CCE) for commercial wood energy efficiency measures included in the study. Note that the CCE figures only include wood savings and do not include electric or water savings. These figures simply provide a picture of the relative cost of conserved wood for the wood efficiency measures examined in this study. Figure 6-18 displays all measures with a CCE below the 2007 $/MMBTU for wood. Figure 6-19 displays all measures with a CCE above the 2007 $/MMBTU for wood.

Table 6-16: Total Cumulative Annual Technical Potential MMBTU Savings for **Wood** Efficiency In Vermont By 2016

Commercial Sector - Replace on Burnout and Retrofit Savings

1	2	3
Measure #	**Measure Description**	**Total**
8	Heat Recovery Vent	13,426
6	Roof Insulation	5,478
9	Wall Insulation	8,707
7	Energy Star Windows	6,067
5	Boiler Water Temp Reset Control	2,954
4	Boiler Tune-up	1,195
3	Efficient Boiler	1,514
2	Setback Controls	5,639
1	Efficient Furnace	11,487

Total Technical Potential MMBTU Savings	56,465
Forecast 2016 Vermont Commercial Wood Consumption	234,903
As a percent of Forecasted Commercial Wood Consumption 2016	24.0%

Note: See Section 3 for a detailed description of fuel forecasting methodology.

Table 6-17: Total Cumulative Annual Achievable Potential MMBTU Savings for **Wood** Efficiency In Vermont By 2016 **Commercial Sector - Replace on Burnout and Retrofit Savings**		
1	**2**	**3**
Measure #	**Measure Description**	**Total**
8	Heat Recovery Vent	10,740
6	Roof Insulation	4,869
9	Wall Insulation	6,966
7	Energy Star Windows	1,798
5	Boiler Water Temp Reset Control	2,625
4	Boiler Tune-up	531
3	Efficient Boiler	484
2	Setback Controls	5,012
1	Efficient Furnace	4,595

Achievable MMBTU Savings by 2016	37,621
Forecast 2016 Vermont Commercial Wood Consumption	234,903
As a percent of Forecasted Commercial Wood Consumption in 2016	16.0%

Note: Achievable potential MMBTU savings were obtained from Appendix B2 (Table B2-3) of this report

Table 6-18: Total Annual Achievable Cost-Effective Potential MMBTU Savings for **Wood** Efficiency In Vermont By 2016 **Commercial Sector - Replace on Burnout and Retrofit Savings**		
1	**2**	**3**
Measure #	**Measure Description**	**Total Cumulative Annual MMBTU Savings by 2016**
8	Heat Recovery Vent	10,740
6	Roof Insulation	4,869
9	Wall Insulation	6,966
7	Energy Star Windows	1,798
5	Boiler Water Temp Reset Control	2,625
4	Boiler Tune-up	531
3	Efficient Boiler	484
2	Setback Controls	5,012
1	Efficient Furnace	4,595

Achievable Cost Effective MMBTU Savings	37,621
Forecast 2016 Vermont Commercial Wood Consumption	234,903
Savings as a Percent of Forecasted Commercial Wood Consumption in 2016	16.02%

Note: The VT Societal Test Benefit/Cost Ratios were obtained from the GDS Benefit/Cost Screening Model, from the Program Cost Effectiveness Results Worksheet. The MMBTU savings shown above in Table 6-4 are from Table B5-4 (Appendix B5). MMBTU savings are counted only for those measures that have a Societal Test benefit/cost ratio greater than or equal to 1.0.

Figure 6-16: **Commercial Wood** Efficiency Supply Curve for VT

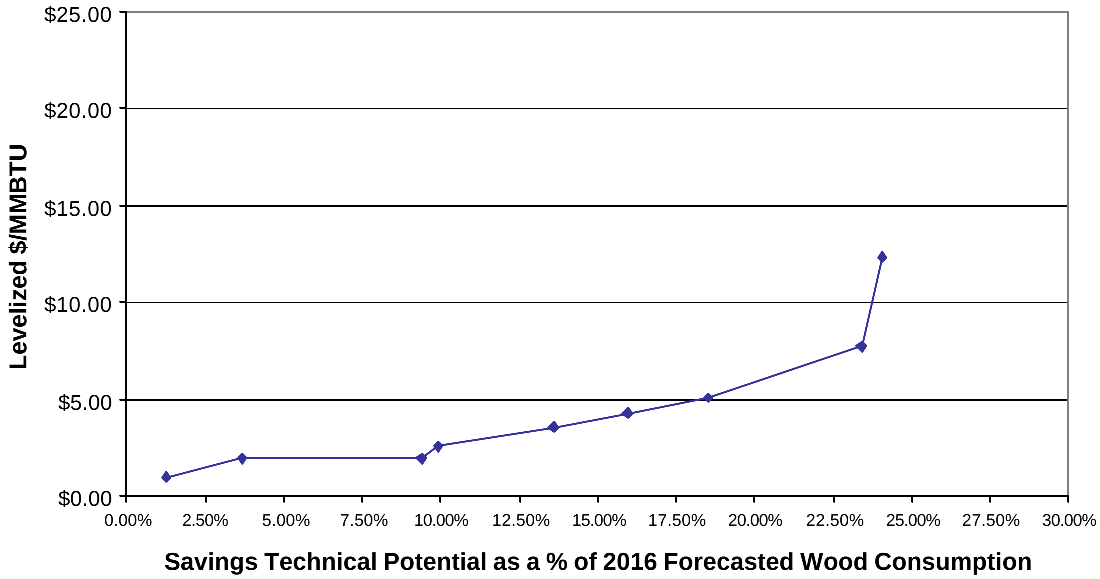
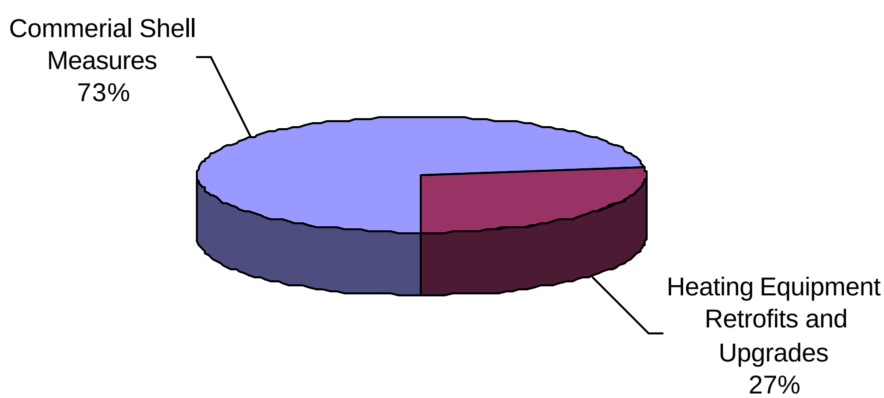


Figure 6-17: Commercial Sector Cost Effective **Wood** MMBTU Savings by Measure Type



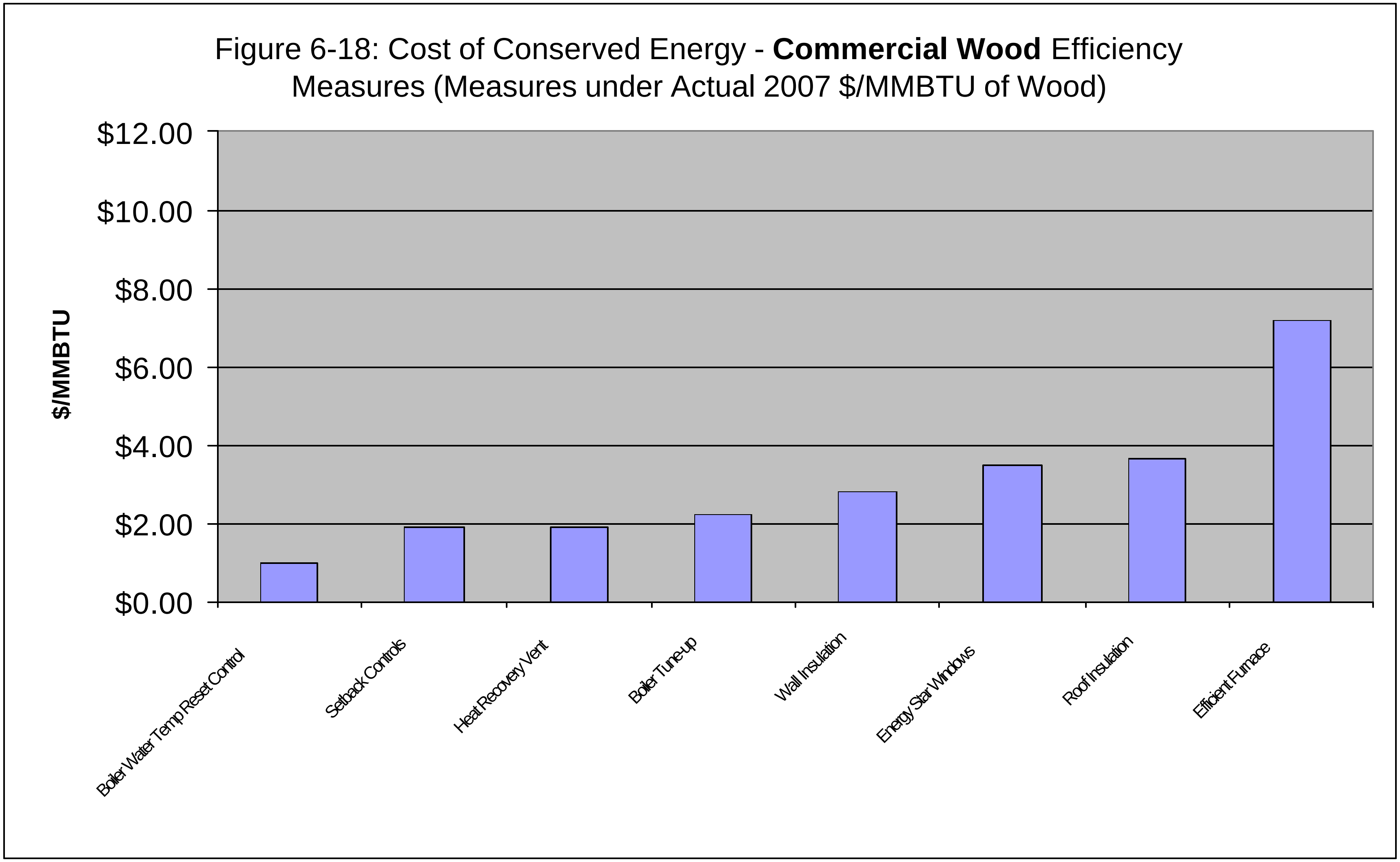
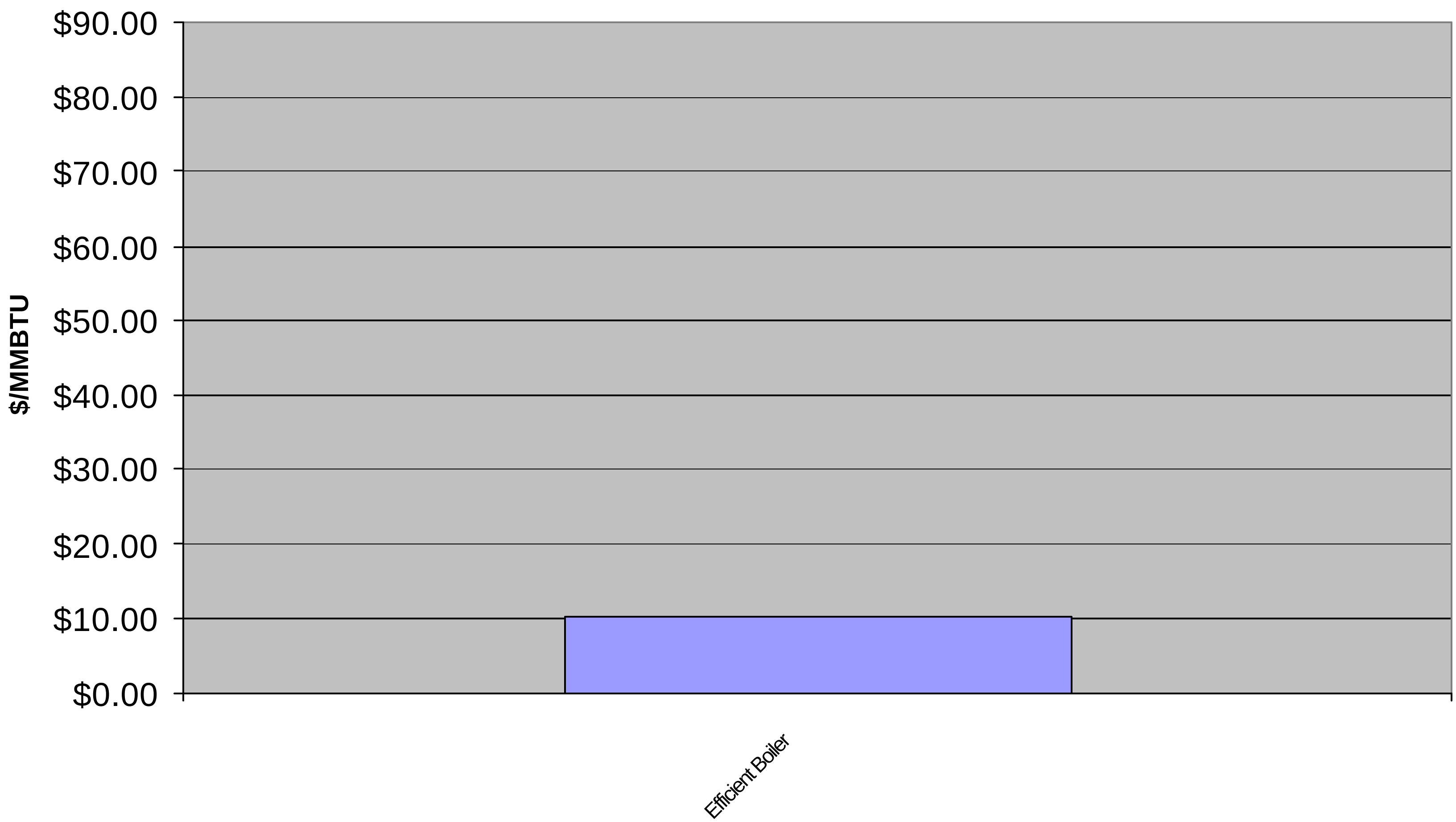


Figure 6-18: Cost of Conserved Energy - **Commercial Wood** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Wood)
$/MMBTU
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
Boiler Water Temp Reset Control
Setback Controls
Heat Recovery Vent
Boiler Tune-up
Wall Insulation
Energy Star Windows
Roof Insulation
Efficient Furnace

Figure 6-19: Cost of Conserved Energy - **Commercial Wood** Efficiency Measures (Measures over Actual 2007 $/MMBTU of Wood)



6.3 Benefit/Cost Screening Results and Emissions Savings

The cumulative annual emissions savings for CO_2, methane (CH_4) and NO_2 in the commercial sector are shown in Table 6-19 for the period 2007 to 2016. These savings represent the combined emission reductions from all four fuel types. The Societal Test Benefit/Cost screening results for the commercial sector analyses are shown below in Tables 6-20 to 6-24. The Participant Test Benefit/Cost screening results for the commercial sector analyses are shown below in Tables 6-25 to 6-29. These cost effectiveness screening calculations were obtained from the GDS Benefit/Cost Screening Model, from the program cost effectiveness results worksheet.

Table 6-19: Summary of Cumulative **Annual Emissions Savings** for the Achievable Cost Effective Potential Scenario for Vermont - **Commercial**

	Cumulative Annual Emissions Savings Derived from Energy Savings (Tons)			
Year	Total Cumulative Annual mmbtu savings	CO2 Emissions Reduction (tons)	Methane (CH4) Emissions Reduction (tons)	NO2 Emissions Reduction (tons)
2007	199,642	15,312	3.4	0.1
2008	399,284	30,623	6.7	0.3
2009	598,927	45,935	10.1	0.4
2010	798,569	61,246	13.4	0.6
2011	998,211	76,558	16.8	0.7
2012	1,197,747	91,870	20.1	0.9
2013	1,397,283	107,181	23.5	1.0
2014	1,596,819	122,493	26.8	1.2
2015	1,796,355	137,805	30.1	1.3
2016	1,995,891	153,116	33.4	1.5
Total	10,978,730	842,139	184.4	8.0

Table 6-20: Vermont **Societal Test** Benefits and Costs for **Oil** Energy Efficiency Measures for the Commercial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Efficient Furnace	COMM	$8,944,150	$738,102	$1,919,470	$1,535,576	$4,193,148	$4,751,002	2.17
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$6,911,912	$203,200	$528,431	$422,745	$1,154,377	$5,757,536	6.08
#3	Insulation	COMM	$54,653,281	$1,923,153	$5,001,256	$4,001,005	$10,925,413	$43,727,868	5.08
#4	HVAC Energy Efficient Upgrades	COMM	$80,165,646	$1,269,396	$3,301,129	$2,640,904	$7,211,429	$72,954,217	11.28
#5	Retrocommisioning	COMM	$6,522,677	$549,132	$1,428,046	$1,142,437	$3,119,615	$3,403,062	2.12
#6	Efficient Boiler and Efficient Controls (WH)	COMM	$4,082,250	$53,289	$138,581	$110,865	$302,735	$3,779,515	13.69
#7	Pipe Insulation	COMM	$153,278	$10,154	$26,407	$21,126	$57,687	$95,590	2.70
#8	Efficient Instantaneous Water Heater	COMM	$261,384	$62,987	$163,802	$131,041	$357,830	-$96,446	0.73
#9	Efficient Storage Water Heater	COMM	$3,249,667	$251,893	$655,060	$524,048	$1,431,002	$1,818,665	2.31
#10	Efficient Clothes and Dish Washing Equipment	COMM	$14,590,083	$614,169	$1,597,176	$1,277,741	$3,489,086	$11,100,997	4.24
	Commercial Sector Total		**$179,534,327**	**$5,675,475**	**$14,759,359**	**$11,807,488**	**$32,242,322**	**$147,292,005**	**5.57**

Table 6-21: Vermont **Societal Test** Benefits and Costs for **Propane** Energy Efficiency Measures for the Commercial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Efficient Furnace	COMM	$2,667,145	$154,808	$402,586	$322,069	$879,462	$1,787,683	3.08
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$3,120,573	$103,195	$268,365	$214,692	$586,252	$2,534,320	5.40
#3	Insulation	COMM	$7,603,120	$192,808	$501,408	$401,126	$1,095,343	$6,507,778	7.05
#4	HVAC Energy Efficient Upgrades	COMM	$26,841,253	$271,865	$706,999	$565,599	$1,544,462	$25,296,790	17.64
#5	Retrocommisioning	COMM	$1,913,831	$115,174	$299,515	$239,612	$654,302	$1,259,529	2.92
#6	Efficient Boiler and Efficient Controls (WH)	COMM	$185,918	$14,149	$36,795	$29,436	$80,379	$105,539	2.35
#7	Pipe Insulation	COMM	$1,596,160	$44,725	$116,310	$93,048	$254,083	$1,342,077	6.38
#8	Efficient Instantaneous Water Heater	COMM	$24,614	$958	$2,492	$1,994	$5,445	$19,169	4.52
#9	Efficient Storage Water Heater	COMM	$256,832	$7,697	$20,016	$16,012	$43,725	$213,108	5.96
#10	Efficient Clothes and Dish Washing Equipment	COMM	$4,335,089	$32,692	$85,017	$68,014	$185,722	$4,149,367	23.69
	Commercial Sector Total		**$48,544,535**	**$938,071**	**$2,439,502**	**$1,951,602**	**$5,329,175**	**$43,215,360**	**9.11**

Table 6-22: Vermont **Societal Test** Benefits and Costs for **Kerosene** Energy Efficiency Measures for the Commercial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Efficient Furnace	COMM	$335,442	$23,910	$62,180	$49,744	$135,835	$199,607	2.51
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$394,307	$15,939	$41,450	$33,160	$90,548	$303,758	4.42
#3	Insulation	COMM	$682,810	$20,767	$54,005	$43,204	$117,975	$564,835	5.88
#4	HVAC Energy Efficient Upgrades	COMM	$3,381,936	$41,990	$109,198	$87,358	$238,546	$3,143,390	14.39
#5	Retrocommisioning	COMM	$244,950	$17,789	$46,261	$37,009	$101,059	$143,892	4.59
#6	Efficient Boiler and Efficient Controls (WH)	COMM	$43,037	$5,524	$14,366	$11,493	$31,383	$11,654	1.39
#7	Pipe Insulation	COMM	$201,385	$6,908	$17,964	$14,371	$39,244	$162,141	5.21
#8	Efficient Instantaneous Water Heater	COMM	$6,191	$296	$770	$616	$1,682	$4,509	4.59
#9	Efficient Storage Water Heater	COMM	$16,901	$618	$1,608	$1,286	$3,512	$13,389	4.89
#10	Efficient Clothes and Dish Washing Equipment	COMM	$589,558	$5,429	$14,118	$11,295	$30,842	$558,717	19.40
	Commercial Sector Total		**$5,896,517**	**$139,170**	**$361,920**	**$289,536**	**$790,625**	**$5,105,892**	**7.46**

*Other resource benefits include electric and water benefits for certain measures

Table 6-23: Vermont **Societal Test** Benefits and Costs for **Wood** Energy Efficiency Measures for the Commercial Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Efficient Furnace	COMM	$655,118	$45,378	$118,007	$94,406	$257,791	$397,327	2.58
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$501,799	$12,493	$32,488	$25,990	$70,970	$430,829	7.18
#3	Insulation	COMM	$2,246,637	$65,567	$170,510	$136,408	$372,486	$1,874,151	6.12
#4	HVAC Energy Efficient Upgrades	COMM	$2,327,518	$37,499	$97,517	$78,014	$213,029	$2,114,489	11.09
	Commercial Sector Total	**COMM**	**$5,731,073**	**$160,936**	**$418,522**	**$334,818**	**$914,276**	**$4,816,796**	**6.27**

Table 6-24: Vermont **Societal Test** Benefits and Costs for **Oil, Propane, Kerosene and Wood** Energy Efficiency Measures for the Commercial Sector in Vermont									
			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Oil	COMM	$179,534,327	$5,675,475	$14,759,359	$11,807,488	$32,242,322	$147,292,005	5.57
#2	Propane	COMM	$48,544,535	$938,071	$2,439,502	$1,951,602	$5,329,175	$43,215,360	9.11
#3	Kerosene	COMM	$5,896,517	$139,170	$361,920	$289,536	$790,625	$5,105,892	7.46
#4	Wood	COMM	$5,731,073	$160,936	$418,522	$334,818	$914,276	$4,816,796	6.27
	Commercial Sector Total		**$239,706,452**	**$6,913,653**	**$17,979,303**	**$14,383,443**	**$39,276,399**	**$200,430,053**	**6.10**

*Other resource benefits include electric and water benefits for certain measures

Table 6-25: **Participant Test** Benefits and Costs for **Oil** Energy Efficiency Measures for the Commercial Sector in Vermont

Program #	Measure Name	Sector	NPV of BENEFITS: Fuel & Other Resource Benefits* Program Total	NPV of COSTS: Participant Costs	Rebates	Customer	Program Total	NPV Savings ($2007)	B/C Ratio: Participant Test
#1	Efficient Furnace	COMM	$7,596,035	$1,919,470	$0	$0	$1,919,470	$5,676,565	3.96
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$5,870,359	$528,431	$0	$0	$528,431	$5,341,928	0.01
#3	Insulation	COMM	$46,453,679	$5,001,256	$0	$0	$5,001,256	$41,452,424	9.29
#4	HVAC Energy Efficient Upgrades	COMM	$68,037,863	$3,301,129	$0	$0	$3,301,129	$64,736,734	20.61
#5	Retrocommisioning	COMM	$5,530,001	$1,428,046	$0	$0	$1,428,046	$4,101,955	3.87
#6	Efficient Boiler and Efficient Controls (WH)	COMM	$3,467,608	$120,268	$0	$0	$120,268	$3,347,340	28.83
#7	Pipe Insulation	COMM	$130,018	$26,407	$0	$0	$26,407	$103,611	4.92
#8	Efficient Instantaneous Water Heater	COMM	$221,986	$163,802	$0	$0	$163,802	$58,185	1.36
#9	Efficient Storage Water Heater	COMM	$2,753,581	$655,060	$0	$0	$655,060	$2,098,520	4.20
#10	Efficient Clothes and Dish Washing Equipment	COMM	$12,372,757	$1,597,176	$0	$0	$1,597,176	$10,775,581	7.75
	Commercial Sector Total		$152,433,887	$14,741,046	$0	$0	$14,741,046	$137,692,841	10.34

Table 6-26: **Participant Test** Benefits and Costs for **Propane** Energy Efficiency Measures for the Commercial Sector in Vermont

Program #	Measure Name	Sector	NPV of BENEFITS: Fuel & Other Resource Benefits* Program Total	NPV of COSTS: Participant Costs	Rebates	Customer	Program Total	NPV Savings ($2007)	B/C Ratio: Participant Test
#1	Efficient Furnace	COMM	$2,452,644	$402,586	$0	$0	$402,586	$2,050,058	6.09
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$2,868,534	$268,365	$0	$0	$268,365	$2,600,169	10.69
#3	Insulation	COMM	$4,977,998	$349,651	$0	$0	$349,651	$4,628,347	14.24
#4	HVAC Energy Efficient Upgrades	COMM	$24,672,268	$706,999	$0	$0	$706,999	$23,965,270	34.90
#5	Retrocommisioning	COMM	$1,755,885	$299,515	$0	$0	$299,515	$1,456,369	5.86
#6	Efficient Boiler and Efficient Controls (WH)	COMM	$170,887	$36,795	$0	$0	$36,795	$134,092	4.64
#7	Pipe Insulation	COMM	$1,466,629	$116,310	$0	$0	$116,310	$1,350,319	12.61
#8	Efficient Instantaneous Water Heater	COMM	$22,635	$2,492	$0	$0	$2,492	$20,142	9.08
#9	Efficient Storage Water Heater	COMM	$235,873	$20,016	$0	$0	$20,016	$215,857	11.78
#10	Efficient Clothes and Dish Washing Equipment	COMM	$3,982,287	$85,017	$0	$0	$85,017	$3,897,270	46.84
	Commercial Sector Total		$42,605,639	$2,287,745	$0	$0	$2,287,745	$40,317,893	18.62

Table 6-27: **Participant Test** Benefits and Costs for **Kerosene** Energy Efficiency Measures for the Commercial Sector in Vermont

Program #	Measure Name	Sector	NPV of BENEFITS: Fuel & Other Resource Benefits* Program Total	NPV of COSTS: Participant Costs	Rebates	Customer	Program Total	NPV Savings ($2007)	B/C Ratio: Participant Test
#1	Efficient Furnace	COMM	$291,770	$62,180	$0	$0	$62,180	$229,590	4.69
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$342,992	$41,450	$0	$0	$41,450	$301,543	8.27
#3	Insulation	COMM	$594,269	$54,005	$0	$0	$54,005	$540,265	11.00
#4	HVAC Energy Efficient Upgrades	COMM	$2,940,338	$109,198	$0	$0	$109,198	$2,831,140	26.93
#5	Retrocommisioning	COMM	$212,793	$46,261	$0	$0	$46,261	$166,532	4.60
#6	Efficient Boiler and Efficient Controls (WH)	COMM	$32,235	$8,656	$0	$0	$8,656	$23,579	3.72
#7	Pipe Insulation	COMM	$175,012	$17,964	$0	$0	$17,964	$157,048	9.74
#8	Efficient Instantaneous Water Heater	COMM	$3,366	$770	$0	$0	$770	$2,596	4.37
#9	Efficient Storage Water Heater	COMM	$21,820	$1,608	$0	$0	$1,608	$20,212	13.57
#10	Efficient Clothes and Dish Washing Equipment	COMM	$494,515	$14,118	$0	$0	$14,118	$480,396	35.03
	Commercial Sector Total		$5,109,110	$356,210	$0	$0	$356,210	$4,752,900	14.34

*Other resource benefits include electric and water benefits for certain measures

Table 6-28: **Participant Test** Benefits and Costs for **Wood** Energy Efficiency Measures for the Commercial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Customer	Program Total	NPV Savings ($2007)	Participant Test
#1	Efficient Furnace	COMM	$655,118	$118,007	$0	$0	$118,007	$537,111	5.55
#2	Efficient Boiler and Efficient Controls (SH)	COMM	$501,799	$32,488	$0	$0	$32,488	$469,312	15.45
#3	Insulation	COMM	$2,246,637	$170,510	$0	$0	$170,510	$2,076,126	13.18
#4	HVAC Energy Efficient Upgrades	COMM	$1,956,212	$97,517	$0	$0	$97,517	$1,858,695	20.06
	Commercial Sector Total		$5,359,766	$418,522	$0	$0	$418,522	$4,941,244	12.81

Table 6-29: **Participant Test** Benefits and Costs for **Oil, Propane, Kerosene and Wood** Energy Efficiency Measures for the Commercial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Customer	Program Total	NPV Savings ($2007)	Participant Test
#1	Oil	COMM	$152,433,887	$14,741,046	$0	$0	$14,741,046	137,692,840.93	10.34
#2	Propane	COMM	$42,605,639	$2,287,745	$0	$0	$2,287,745	40,317,893.44	18.62
#3	Kerosene	COMM	$5,109,110	$356,210	$0	$0	$356,210	4,752,900.36	14.34
#4	Wood	COMM	$5,359,766	$418,522	$0	$0	$418,522	4,941,243.96	12.81
	Commercial Sector Total		$205,508,402	$17,803,523	$0	$0	$17,803,523	$187,704,879	11.54

*Other resource benefits include electric and water benefits for certain measures

7.0 INDUSTRIAL SECTOR ENERGY EFFICIENCY SAVINGS POTENTIAL IN VERMONT FOR OIL, PROPANE, KEROSENE, AND WOOD

This section of the report presents the estimates of the industrial sector technical, achievable and achievable cost effective energy efficiency savings potential for oil, propane, kerosene and wood fuels in Vermont. According to this analysis, there is still a large remaining potential for savings of these fuels in the industrial sector. Over the period 2007 to 2016, the net present value savings for additional energy savings of oil, propane, kerosene and wood energy efficiency in the industrial sector is $33 million.

Approximately 65% of the industrial sector savings is estimated to be associated with improvements to industrial boilers. Approximately 23% of the total savings is associated with improvements to process heating equipment. The remaining 12% is associated with improvements to space heating equipment.

Table 7-1 below summarizes the industrial sector achievable cost effective energy savings potential by fuel type by year. By the year 2016, the achievable cost effective potential for oil and kerosene energy efficiency savings is 10.2% of the forecast of consumption in that year for each respective fuel. The achievable cost effective potential for wood is 9.7% and for propane is 6.7% of the forecast of consumption for those fuels in the year 2016.

Table 7-1: Energy Efficiency Achievable Cost Effective Potential by Fuel Type by 2016 as a Percent of Total Fuel Type Energy Consumption in 2016 - Industrial Sector

Year	Oil	Propane	Kerosene	Wood
2007	1.0%	0.7%	1.0%	1.0%
2012	5.1%	3.4%	5.1%	4.9%
2016	10.2%	6.7%	10.2%	9.7%

7.1 Industrial Sector Energy Efficiency Measures

GDS examined eighteen (18) energy efficiency measures in the analysis of industrial sector energy savings potential for oil, propane, kerosene and wood fuels. Table 7-2 presents a list of these energy efficiency measures and shows the measures examined for each fuel type.

In order to develop the list of industrial sector energy efficiency measures to be examined, GDS reviewed the measures included in the July 21, 2006 Vermont Electric Energy Efficiency Potential Study, the Efficiency Vermont Technical Resource Manual, as well as other energy efficiency technical potential studies and related research papers. This measure list was then reviewed and expanded by VDPS staff. The set of energy efficiency programs or measures considered was pre-screened to only include those measures that are currently commercially available. Tables 7-3 to 7-6 list the specific industrial sector energy efficiency measures included in this potential savings analysis. These tables also summarize measure costs, energy savings and useful life data. The data shown in these four tables are presented at the "measure" level, and represent energy savings that can be achieved at a prototypical industrial facility.

It is important to note that while the set of measures shown in the following tables would be implemented in order to achieve the potential savings levels presented in this report, the overall industrial sector savings potential for Vermont was not estimated directly from these measures. Due to data limitations for the industrial market, the savings potential for this sector was estimated by applying savings factors to three major end use categories: 1) Indirect Use – Boilers; 2) Direct Use – Process; and 3) Space Heating (non-boiler). The methodology used is further described in Section 7.2.

Table 7-2 List of Industrial Sector Energy Efficiency Measures

Row	Measure	Brief Description	End-Use	Oil	Propane	Kerosene	Wood
1	Efficient Boiler	Replace a standard efficiency boiler with a high efficiency boiler.	B	X		X	X
2	Boiler pipe insulation	Insulate space heating and process hot water distribution lines	B	X		X	X
3	Boiler Tune-up	Tune up boiler to enhance the performance, safety and efficiency.	B	X		X	X
4	Stack Heat Exchanger	Capture waste heat from boilers and use for pre-heat or process heating.	B	X		X	X
5	Heat Recovery Air-to-Air	Capture heat content from heated air and use for space, water or process heat.	B / PR	X		X	X
6	Boiler Reset Controls	Boiler controls to maximize efficiency.	B	X		X	X
7	Boiler O2 Trim Controls	Optimizes oxygen percentage for most efficient burner combustion	B	X		X	X
8	Boiler Blowdown Heat Exchanger (steam)	Capture waste heat from blowdown water to preheat makeup water	B	X		X	X
9	Steam Trap Repair	Repair malfunctioning steam traps to reduce losses in steam system.	B	X		X	X
10	Insulate Steam Lines & Condensate Tank	Insulate steam lines and condensate tank as steam systems work with high delta T.	B	X		X	X
11	Retrocommisioning	Recalibrate and tune-up all heating, DHW, and process systems including EMS.	B / SH	X	X	X	X
12	Roof Insulation	Roof insulation upgrades for more efficiency.	B / SH	X	X	X	X
13	Efficient Boiler	Replace a standard efficiency boiler with a high efficiency boiler.	WH	X	X	X	X
14	Boiler Tune-up	Tune up boiler to enhance the performance, safety and efficiency.	WH	X	X	X	X
15	Pump Controller	Automatically regulates the on and off periods of pump equipment.	WH	X	X	X	X
16	Efficient Water Heater	Replace standard efficiency WH with a high efficiency WH.	WH	X	X	X	X
17	Solar Pre-Heat	Install solar DHW system to pre-heat water for space heat, water heat, or process heat.	WH	X	X	X	X
18	Pipe Insulation	Insulation is wrapped around pipes to/from water heater.	WH	X	X	X	X

B = Boilers; PR = Process Heating; SH = Space Heating; WH = Water Heating

Table 7-3 Energy Efficiency Measures for Oil Fuel

Measure	Measure Name	End Use	% Savings	Useful Life	Savings MMBTU	Measure Cost	Units	Typical Industrial Measure Size	Typical Measure Size Units	Extended Measure Cost	End Use Description
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers
4	Stack Heat Exchanger	Boiler, Space	5%	20	208.00	$21,100	$/install	n/a	n/a	$21,100	Assumes a 400 GPM plate type heat exchanger.
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	$20	lf.	$120	Facilities with steam boilers.
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.
17	Solar Pre-Heat of Hot Water	Boiler, Space	60%	15	1248.00	$8,712	$/system	n/a	n/a	$8,712	Based on PNM study
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass

Table 7-4 Energy Efficiency Measures for Propane

Measure	Measure Name	End Use	% Savings	Useful Life	Savings MMBTU	Measure Cost	Units	Typical Industrial Measure Size	Typical Measure Size Units	Extended Measure Cost	End Use Description
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers
4	Stack Heat Exchanger	Boiler, Space	5%	20	208.00	$21,100	$/install	n/a	n/a	$21,100	Assumes a 400 GPM plate type heat exchanger.
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	20	lf.	$120	Facilities with steam boilers.
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.
17	Solar Pre-Heat of Hot Water	Boiler, Space	60%	15	1248.00	$8,712	$/system	n/a	n/a	$8,712	Based on PNM study
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass

Table 7-5 Energy Efficiency Measures for Kerosene

Measure	Measure Name	End Use	% Savings	Useful Life	Savings MMBTU	Measure Cost	Units	Typical Industrial Measure Size	Typical Measure Size Units	Extended Measure Cost	End Use Description
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers
4	Stack Heat Exchanger	Boiler, Space	5%	20	208.00	$21,100	$/install	n/a	n/a	$21,100	Assumes a 400 GPM plate type heat exchanger.
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	20	lf.	$120	Facilities with steam boilers.
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.
17	Solar Pre-Heat of Hot Water	Boiler, Space	60%	15	1248.00	$8,712	$/system	n/a	n/a	$8,712	Based on PNM study
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass

Table 7-6 Energy Efficiency Measures for Biomass (Wood)

Measure	Measure Name	End Use	% Savings	Useful Life	Savings MMBTU	Measure Cost	Units	Typical Industrial Measure Size	Typical Measure Size Units	Extended Measure Cost	End Use Description
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers
4	Stack Heat Exchanger	Boiler, Space	5%	20	208.00	$21,100	$/install	n/a	n/a	$21,100	Assumes a 400 GPM plate type heat exchanger.
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	20	lf.	$120	Facilities with steam boilers.
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.
17	Solar Pre-Heat of Hot Water	Boiler, Space	60%	15	1248.00	$8,712	$/system	n/a	n/a	$8,712	Based on PNM study
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass

7.2 Overview of Energy Savings for the Industrial Sector

The Industrial Sector savings potential was estimated using market data provided by the VT DPS along with savings values from recent efficiency studies conducted by the American Council for an Energy Efficient Economy (ACEEE).

The analysis was conducted using the following steps:

1. Obtain the VT DPS estimates of use by end use and market segment (see Table 7-7);
2. Apportion VT DPS category "HEAT" into subcategories "Indirect Use – Boiler" (69.25%) and "Direct Use – Process" (30.75%), using MECS 2002 data for the Northeast Region;
3. Make assumption that VT DPS category OTHSUB (defined as end uses that could be addressed with fuel *or* electricity) can be treated as subcategory "Space Heat";
4. Use VT DPS end use breakdown for Oil as a proxy for Kerosene since there was no specific breakdown for Kerosene;
5. Apply GDS forecasted value for energy consumption by fuel type in 2016 to each of the three end uses in each market segment;
6. Apply savings percent estimate by end use (see Table 7-8) to each market segment for each fuel type;
7. Sum savings estimates for each end use category, by fuel type, and present Technical Potential results in MMBTU's saved in 2016; and,
8. Per the 2006 ACEEE study on oil energy efficiency[31], apply a factor of two thirds (66.66%) to the Technical Potential estimates as estimated in Step 7 to estimate the Achievable and Cost Effective Achievable Potential for the Industrial Sector.

For Step 1, the sizes of various end-use market segments were based on data developed by the VT DPS, which is derived from the 2002 EIA Manufacturers Energy Consumption Survey (MECS). The VT DPS used their in-house Energy 2020 demand model as well as other Vermont-specific economic factors to calibrate the MECS data to better represent Vermont industries. End use fractions for each of the industries shown in Table 7-7 were developed by the VT DPS and included in Appendix C.

[31] Elliot, Langer, and Nadel, Reducing Oil Through Energy Efficiency: Opportunities Beyond Cars and Light Trucks, ACEEE, Report Number E061, January 2006.

Table 7-7 – Industrial Sector Segmentation

Industrial Sector
Lumber
Furniture
Paper
Fabricated Metals
Computers
Electric Equipment
Other Manufacturing
Mining
Agriculture
Construction

For Step 2, GDS used the breakdown of industrial end uses by the end use categories Indirect Uses – Boiler Fuel and Direct Uses – Total Process from Table 5.5 of the 2002 MECS to split the "HEAT" category as provided by the VT DPS. For Oil, this resulted in a split of 69.25% for Boiler Fuel and 30.75% for Total Process. For Propane, this split was 100% Total Process and 0% Boiler Fuel. Per discussions with VT DPS, the Oil split was used as a proxy for Kerosene and Wood.

For Step 3, the VT DPS noted that the 2020 category OTHSUB was defined as those end uses, which could be addressed with either electricity or another fuel. This end use represents a relatively small portion of the overall use, approximately 15% depending on fuel type. GDS proposed that this category be treated, for savings purposes, as representative of non-boiler space heating in industrial facilities. This seemed reasonable as non-boiler space heating could be addressed with electricity via heat pumps and/or resistance heaters and this representation was in line with the MECS data.

As noted in Step 4, the VT DPS data did not include a specific breakout for Kerosene so GDS used the Oil values as a proxy for Kerosene.

In Step 5, GDS applied the Fuel Use Apportionment values, as shown in Appendix C, to the forecasted value for each fuel in 2016. This results in an estimate of fuel use, by end use and industrial segment, for the year 2016 which will then be used as the basis for applying savings estimates.

For Step 6, GDS applied the end use savings estimates as shown in Table 7-8 to each of the industrial segments by fuel type. These calculations are shown in detail in Appendix C.

Table 7-8 – End Use Savings Estimates

Industrial End Use	Estimated Savings
Indirect Use – Boilers	19%
Direct Use – Process	10%
Space Heating	10%

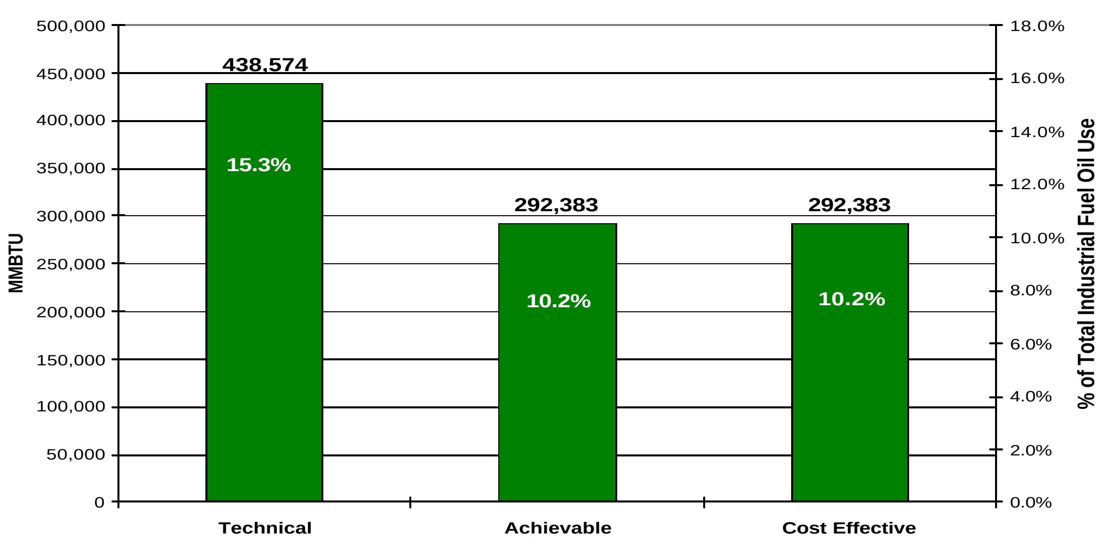
Step 7 involved the summation of all industrial segments' end use savings into a single value for each fuel type, which represents the Technical Savings potential for the Industrial Sector.

Finally, Step 8 applied a factor of two thirds (66.66%) to the values as calculated in Step 7 to represent the Achievable Potential savings for the Industrial Sector. This value is also the Achievable Cost Effective Potential savings level because all savings associated with the savings percentages shown in Table 7-8 are assumed to be cost effective per the 2006 ACEEE study. As noted previously, the achievable savings factor of two thirds is based on the same 2006 ACEEE study and is consistent with findings from a meta-analysis of potential assessments conducted by ACEEE.[32]

7.2.1 Fuel Oil Summary

Figure 7-1 and Table 7-9 summarize the technical, achievable, and achievable cost effective savings potential for fuel oil in the industrial sector by the year 2016. The achievable cost effective potential for fuel oil is 292,383 MMBTU or 10.2% of the Vermont industrial sector fuel oil consumption forecast in 2016.

Figure 7-1: Industrial Potential Savings Summary - *Fuel Oil*



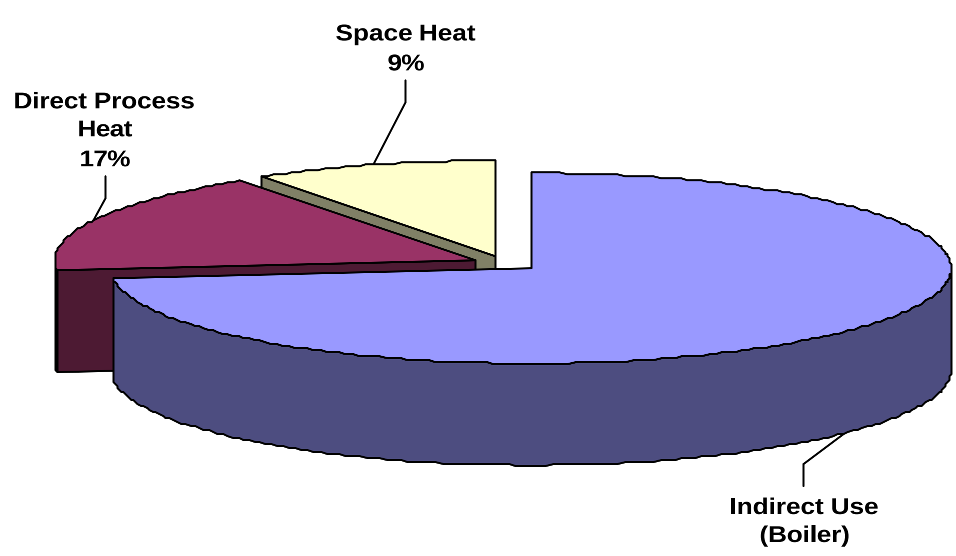
[32] Elliot, Shipley, and Nadel, Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies, ACEEE, Report Number E032, 2003.

Table 7-9: Summary of Industrial **Fuel Oil** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Industrial Sector Fuel Oil Consumption
Technical Potential	438,574	15.3%
Achievable Potential	292,383	10.2%
Achievable Cost Effective Potential	292,383	10.2%

Figure 7-2 provides information on the industrial sector achievable cost effective potential fuel oil savings by 2016 by end use. About 74% of the achievable cost effective savings is estimated to be from upgrades to industrial boilers, followed by process heating equipment retrofits and upgrades with 17%, and space heating improvements with 9% of total savings.

Boiler savings are based on values included in the 2006 ACEEE oil efficiency study[33] and assume an average industrial boiler efficiency of 65% at an average age of 50 years. To arrive at the overall savings of 19%, ACEEE assumed that 40% of the boilers could be replaced with new boilers with efficiencies of approximately 85% and the remaining boilers could achieve approximately 15% savings through a combination of new equipment, controls and improved operation and maintenance practices[34]. Specific boiler-related measures and associated economic factors are included in Section 7.1.

Figure 7-2: Industrial Sector *Fuel Oil* Savings by End Use



[33] Elliot, Langer, and Nadel, Reducing Oil Through Energy Efficiency: Opportunities Beyond Cars and Light Trucks, ACEEE, Report Number E061, January 2006.
[34] Email communication with Anna Shipley of ACEEE on December 21, 2006.

7.2.2 Propane Summary

Figure 7-3 and Table 7-10 summarize the technical, achievable, and achievable cost effective savings potential for propane in the industrial sector by the year 2016. The achievable cost effective potential for propane is 46,558 MMBTU or 6.7% of the Vermont industrial sector propane consumption forecast in 2016.

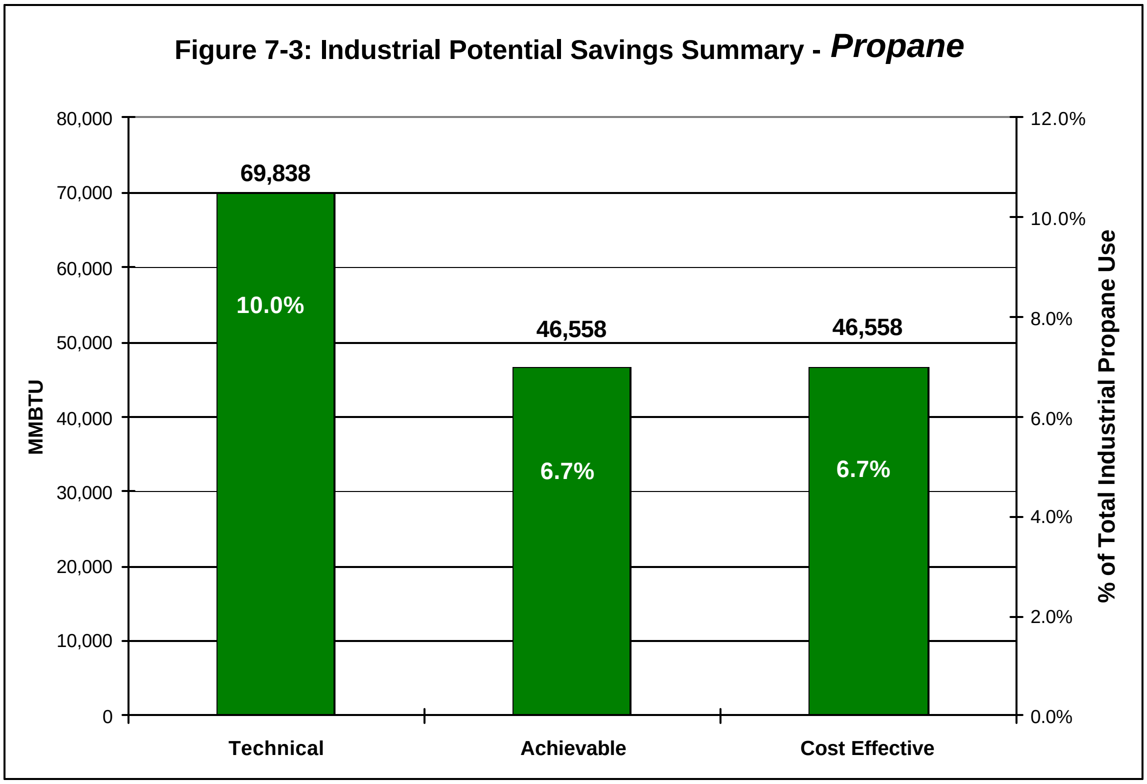
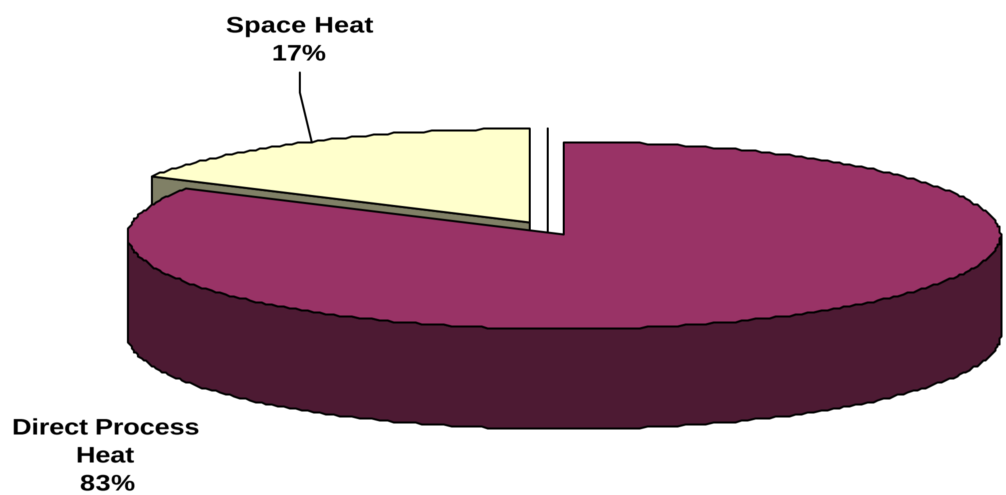


Table 7-10: Summary of Industrial **Propane** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Industrial Sector Fuel Oil Consumption
Technical Potential	69,838	10.0%
Achievable Potential	46,558	6.7%
Achievable Cost Effective Potential	46,558	6.7%

Figure 7-4 provides information on the industrial sector achievable cost effective potential propane savings by 2016 by end use. About 83% of the achievable cost effective savings is estimated to be from process heating equipment retrofits and upgrades and 17% is attributed to space heating improvements. Per the data found in Table 5.5 of the 2002 MECS for the Northeast Region, there is no propane use associated with industrial boilers and therefore no associated savings for boilers.

Figure 7-4: Industrial Sector *Propane* Savings by End Use



7.2.3 Kerosene Summary

Figure 7-5 and Table 7-11 summarize the technical, achievable, and achievable cost effective savings potential for kerosene in the industrial sector by the year 2016. The achievable cost effective potential for kerosene is 51,004 MMBTU or 10.2% of the Vermont industrial sector kerosene consumption forecast in 2016.

Figure 7-5: Industrial Potential Savings Summary - *Kerosene*

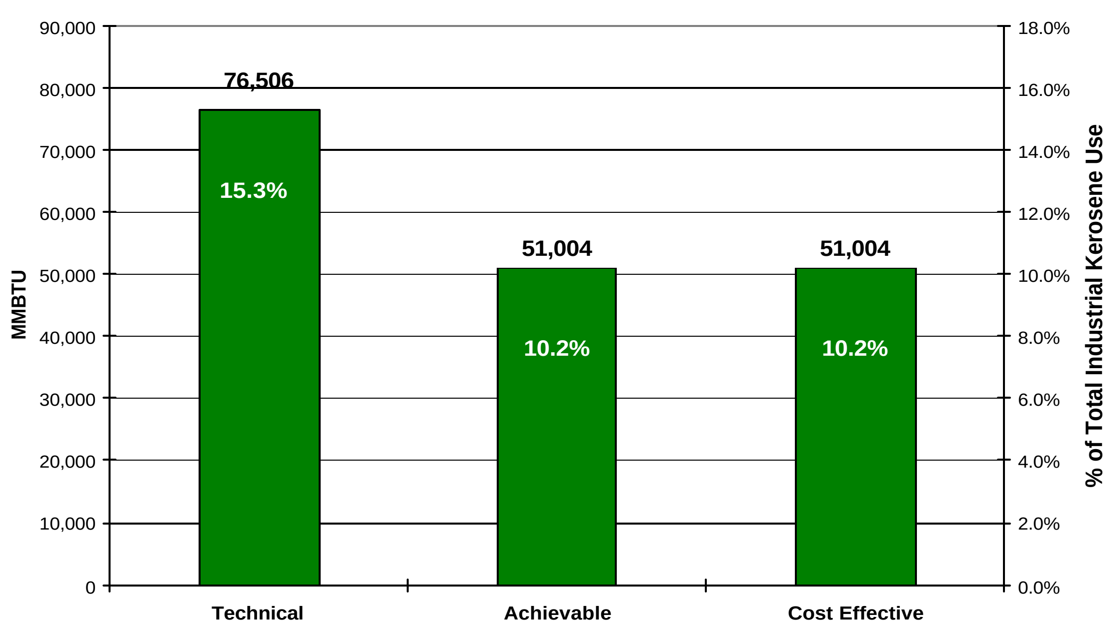
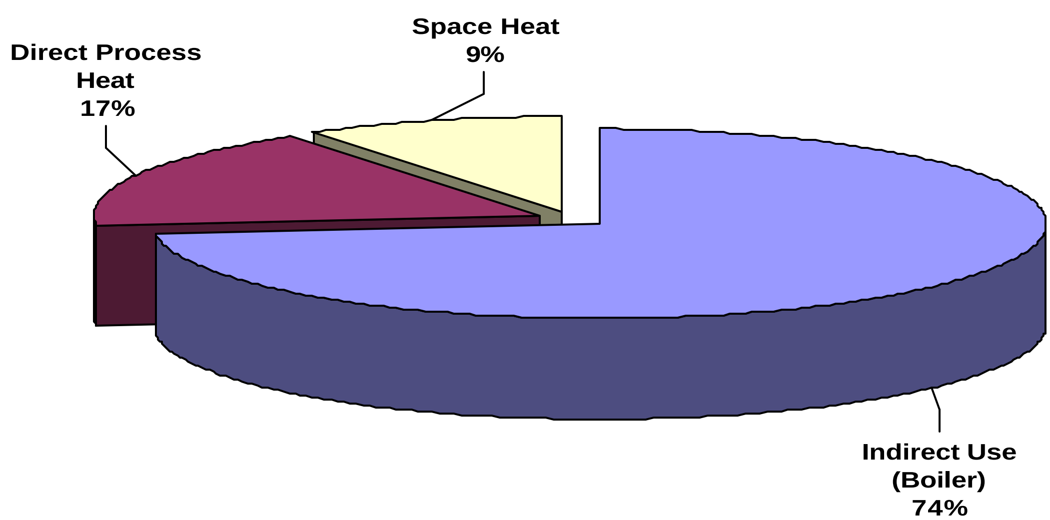


Table 7-11: Summary of Industrial **Kerosene** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Industrial Sector Fuel Oil Consumption
Technical Potential	76,506	15.3%
Achievable Potential	51,004	10.2%
Achievable Cost Effective Potential	51,004	10.2%

Figure 7-6 provides information on the industrial sector achievable cost effective potential kerosene savings by 2016 by end use. About 74% of the achievable cost effective savings is estimated to be from upgrades to industrial boilers, followed by process heating equipment retrofits and upgrades with 17%, and space heating improvements with 9% of total savings.

Figure 7-6: Industrial Sector *Kerosene* Savings by End Use



7.2.4 Wood Summary

Figure 7-7 and Table 7-12 summarize the technical, achievable, and achievable cost effective savings potential for wood in the industrial sector by the year 2016. The achievable cost effective potential for wood is 111,991 MMBTU or 9.7% of the Vermont industrial sector wood consumption forecast in 2016.

Figure 7-7: Industrial Potential Savings Summary - *Wood*

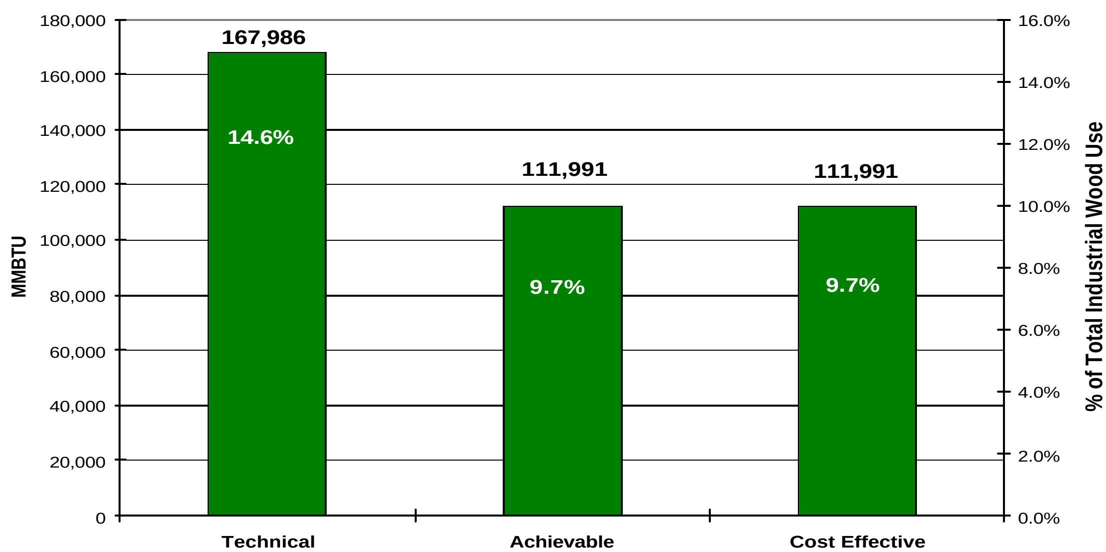
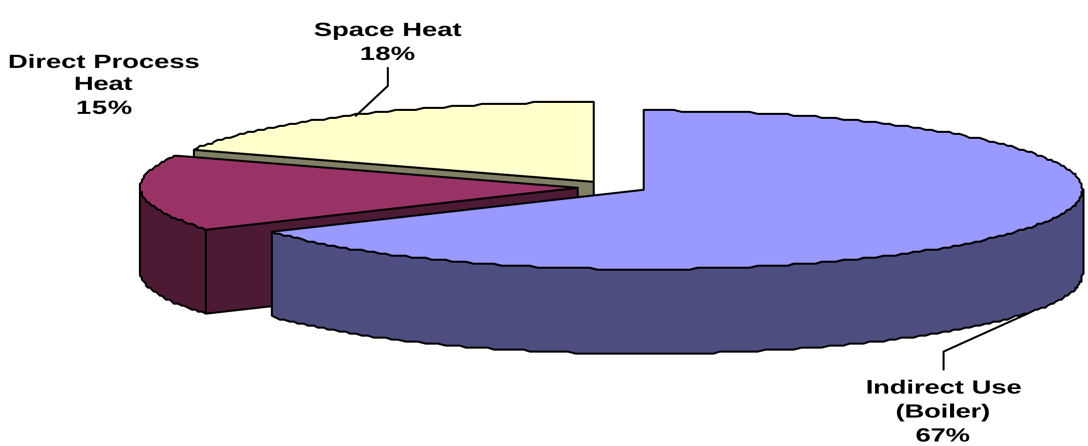


Table 7-12: Summary of Industrial **Wood** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Industrial Sector Fuel Oil Consumption
Technical Potential	167,986	14.6%
Achievable Potential	111,991	9.7%
Achievable Cost Effective Potential	111,991	9.7%

Figure 7-8 provides information on the industrial sector achievable cost effective potential wood savings by 2016 by end use. About 67% of the achievable cost effective savings is estimated to be from upgrades to industrial boilers, followed by space heating improvements with 18% of total savings and process heating equipment retrofits and upgrades with 15%.

Figure 7-8: Industrial Sector *Wood* Savings by End Use



7.3 Benefit/Cost Screening Results and Emissions Savings

The cumulative annual emissions savings for CO_2, methane (CH_4) and NO_2 in the industrial sector are shown in Table 7-13. These savings represent the combined emission reductions from all four fuel types. The Societal Test benefit/cost screening results for the industrial sector analyses are shown below in Tables 7-14 to 7-18. The Participant Test benefit/cost screening results for the industrial sector analyses are shown in Tables 7-19 to 7-23. These cost effectiveness screening calculations were obtained from the GDS Benefit/Cost Screening Model, from the program cost effectiveness results worksheet.

As discussed in Section 2 of this report, achievable market penetrations were estimated assuming that Vermont businesses would receive a financial incentive equal to 50% of the incremental cost of the measure in most programs.

Table 7-13: Summary of Cumulative **Annual Emissions Savings** for the Achievable Cost Effective Potential Scenario for Vermont - **Indutrial**

Year	Cumulative Annual Emissions Savings Derived from Energy Savings (Tons)			
	Total Cumulative Annual mmbtu savings	CO2 Emissions Reduction (tons)	Methane (CH4) Emissions Reduction (tons)	NO2 Emissions Reduction (tons)
2007	50,194	3,060	0.4	0.1
2008	100,387	6,119	0.9	0.1
2009	150,581	9,179	1.3	0.2
2010	200,774	12,238	1.8	0.3
2011	250,968	15,298	2.2	0.4
2012	301,162	18,357	2.6	0.4
2013	351,355	21,417	3.1	0.5
2014	401,549	24,476	3.5	0.6
2015	451,743	27,536	3.9	0.7
2016	501,936	30,595	4.4	0.7
Total	2,760,649	168,274	24.1	4.0

Table 7-14: Vermont Societal Test Benefits and Costs for Oil Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Indirect Use - Boilers	C/I	$12,536,324	$354,170	$172,133	$137,707	$664,010	$11,872,314	18.88
#2	Direct Use - Process	C/I	$2,929,869	$384,895	$187,066	$149,653	$721,615	$2,208,254	4.06
#3	Space Heating	C/I	$1,600,941	$210,315	$102,217	$81,774	$394,305	$1,206,636	4.06
	Industrial Sector Total		$17,067,134	$949,379	$461,417	$369,133	$1,779,929	$15,287,205	9.59

Table 7-15: Vermont Societal Test Benefits and Costs for Propane Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Indirect Use - Boilers	C/I	$0	$0	$0	$0	$0	$0	N/A
#2	Direct Use - Process	C/I	$3,557,322	$118,736	$57,708	$46,166	$222,611	$3,334,712	15.98
#3	Space Heating	C/I	$710,245	$23,707	$11,522	$9,217	$44,446	$665,799	15.98
	Industrial Sector Total		$4,267,568	$142,443	$69,230	$55,384	$267,056	$4,000,511	15.98

Table 7-16: Vermont Societal Test Benefits and Costs for Kerosene Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Indirect Use - Boilers	C/I	$3,249,413	$61,782	$30,027	$24,022	$115,832	$3,133,582	28.05
#2	Direct Use - Process	C/I	$759,422	$26,788	$13,019	$10,415	$50,222	$709,199	15.12
#3	Space Heating	C/I	$414,964	$14,637	$7,114	$5,691	$27,443	$387,521	15.12
	Industrial Sector Total		$4,423,799	$103,207	$50,161	$40,129	$193,497	$4,230,302	22.86

Table 7-17: Vermont Societal Test Benefits and Costs for Wood Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Indirect Use - Boilers	C/I	$6,284,278	$122,265	$59,423	$47,539	$229,227	$6,055,051	27.42
#2	Direct Use - Process	C/I	$1,468,701	$53,012	$25,765	$20,612	$99,388	$1,369,313	14.78
#3	Space Heating	C/I	$1,739,595	$62,789	$30,517	$24,414	$117,720	$1,621,875	14.78
	Industrial Sector Total		$9,492,573	$238,066	$115,705	$92,564	$446,335	$9,046,238	21.27

Table 7-18: Vermont Societal Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					B/C Ratio
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Administrative	Rebates	Customer	Program Total	NPV Savings ($2007)	Vermont Societal Test
#1	Oil	IND	$17,067,134	$949,379	$461,417	$369,133	$1,779,929	$15,287,205	9.59
#2	Propane	IND	$4,267,568	$142,443	$69,230	$55,384	$267,056	$4,000,511	15.98
#3	Kerosene	IND	$4,423,799	$103,207	$50,161	$40,129	$193,497	$4,230,302	22.86
#4	Wood	IND	$9,492,573	$238,066	$115,705	$92,564	$446,335	$9,046,238	21.27
	Industrial Sector Total		$35,251,074	$1,433,096	$696,512	$557,210	$2,686,817	$32,564,256	13.12

*Other resource benefits include electric and water benefits for certain measures

Table 7-19: Participant Test Benefits and Costs for Oil Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test Ratio
#1	Indirect Use - Boilers	C/I	$10,084,405	$154,920	$0	$0	$154,920	$9,929,486	65.09
#2	Direct Use - Process	C/I	$2,356,830	$168,360	$0	$0	$168,360	$2,188,471	14.00
#3	Space Heating	C/I	$1,287,821	$91,995	$0	$0	$91,995	$1,195,826	14.00
	Industrial Sector Total		$13,729,057	$415,275	$0	$0	$415,275	$13,313,782	33.06

Table 7-20: Participant Test Benefits and Costs for Propane Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test Ratio
#1	Indirect Use - Boilers	C/I	$0	$0	$0	$0	$0	$0	N/A
#2	Direct Use - Process	C/I	$3,221,190	$51,937	$0	$0	$51,937	$3,169,253	62.02
#3	Space Heating	C/I	$643,134	$10,370	$0	$0	$10,370	$632,764	62.02
	Industrial Sector Total		$3,864,324	$62,307	$0	$0	$62,307	$3,802,017	62.02

Table 7-21: Participant Test Benefits and Costs for Kerosene Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test Ratio
#1	Indirect Use - Boilers	C/I	$1,862,046	$27,025	$0	$0	$27,025	$1,835,021	N/A
#2	Direct Use - Process	C/I	$659,459	$11,717	$0	$0	$11,717	$647,742	56.28
#3	Space Heating	C/I	$360,342	$6,403	$0	$0	$6,403	$353,939	56.28
	Industrial Sector Total		$2,881,847	$45,145	$0	$0	$45,145	$2,836,702	63.84

Table 7-22: Participant Test Benefits and Costs for Wood Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					
Program #	Measure Name	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test Ratio
#1	Indirect Use - Boilers	C/I	$3,684,918	$53,481	$0	$0	$53,481	$3,631,437	N/A
#2	Direct Use - Process	C/I	$861,204	$23,188	$0	$0	$23,188	$838,015	N/A
#3	Space Heating	C/I	$1,739,595	$27,465	$0	$0	$27,465	$1,712,130	N/A
	Industrial Sector Total		$6,285,716	$104,134	$0	$0	$104,134	$6,181,582	60.36

Table 7-23: Participant Test Benefits and Costs for Oil, Propane, Kerosene and Wood Energy Efficiency Measures for the Industrial Sector in Vermont

			NPV of BENEFITS	NPV of COSTS					
Program #	Energy Efficiency Savings by Fuel Source	Sector	Fuel & Other Resource Benefits* Program Total	Participant Costs	Rebates	Incentive	Program Total	NPV Savings ($2007)	Participant Test Ratio
#1	Oil	IND	$13,729,057	$415,275	$0	$0	$415,275	$13,313,782	33.06
#2	Propane	IND	$3,864,324	$62,307	$0	$0	$62,307	$3,802,017	62.02
#3	Kerosene	IND	$2,881,847	$45,145	$0	$0	$45,145	$2,836,702	63.84
#4	Wood	IND	$6,285,716	$104,134	$0	$0	$104,134	$6,181,582	60.36
	Industrial Sector Total		$26,760,943	$626,861	$0	$0	$626,861	$26,134,082	42.69

*Other resource benefits include electric and water benefits for certain measures