FINAL REPORT

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

Prepared for the

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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.

Richard F. Spellman, President
GDS Associates, Inc.
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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**

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	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.

[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

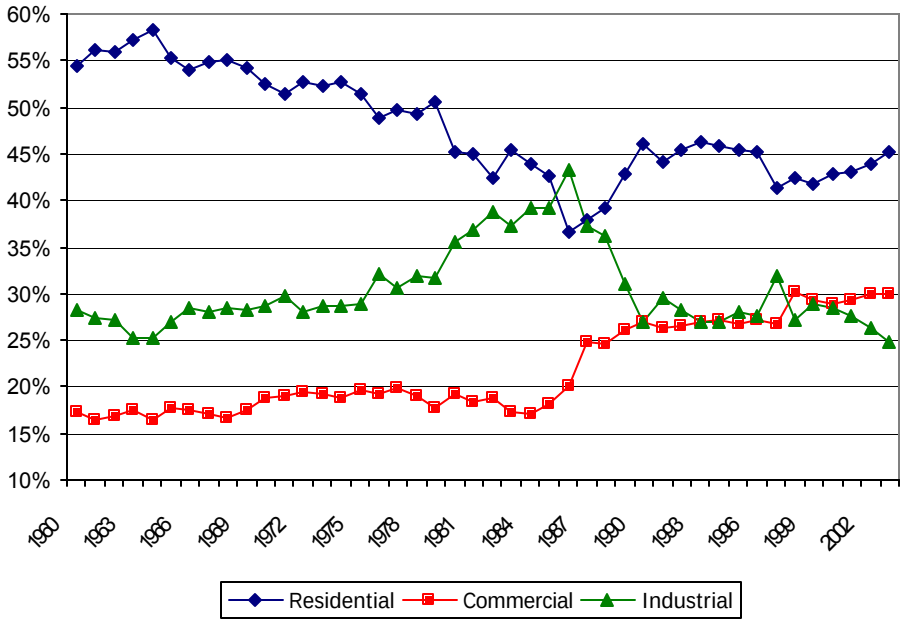
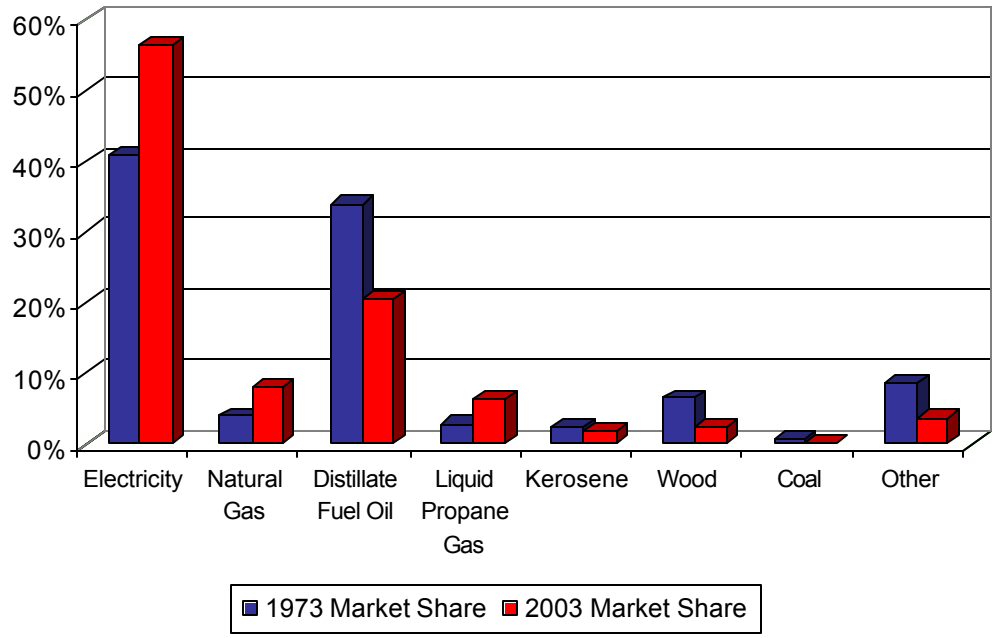


Figure 3-2 shows market share by fuel type for Vermont energy consumption as a whole in 1973 and 2003. In 2003, the top three fuels (electricity, natural gas, and fuel oil) accounted for over 85% of total energy consumption. Distillate fuel oil consumption accounted for approximately 20 percent of total 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

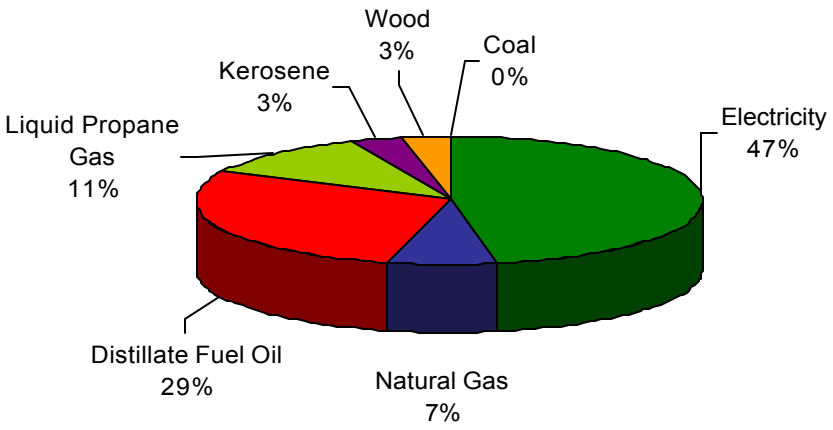


Table 3-1
Historical Residential Consumption of Key Fuels (Trillion BTU)

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

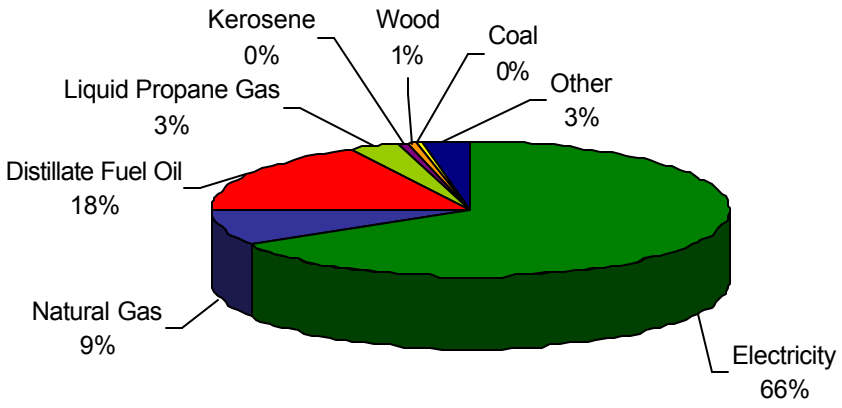


Table 3-2
Historical Commercial Consumption of Key Fuels (Trillion BTU)

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

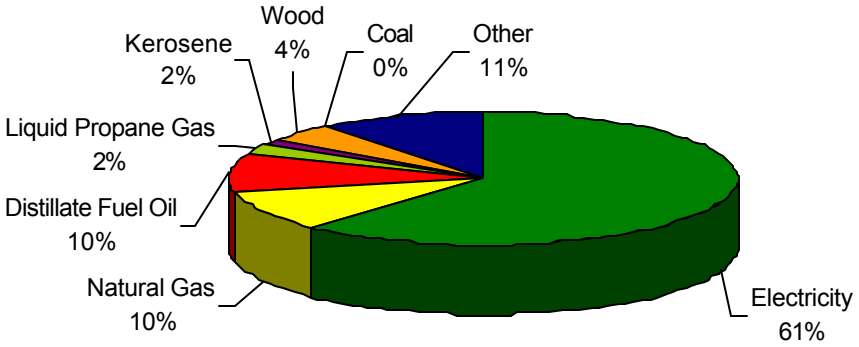


Table 3-3
Historical Industrial Consumption of Key Fuels (Trillion BTU)

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.

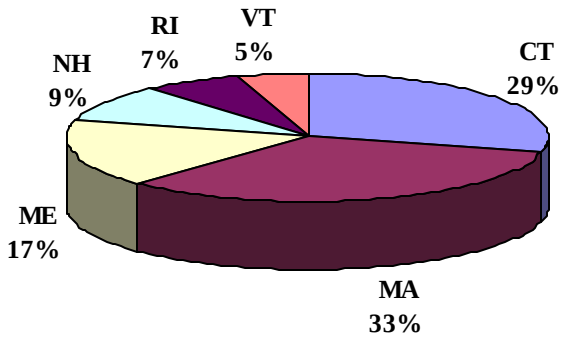
The forecast is a “top-down” approach in which projections for total fuel consumption by sector (residential, commercial, industrial) at the state level are developed and then broken down to the end-use level. Primary data sources utilized in the development of the forecasts include the Energy Information 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.

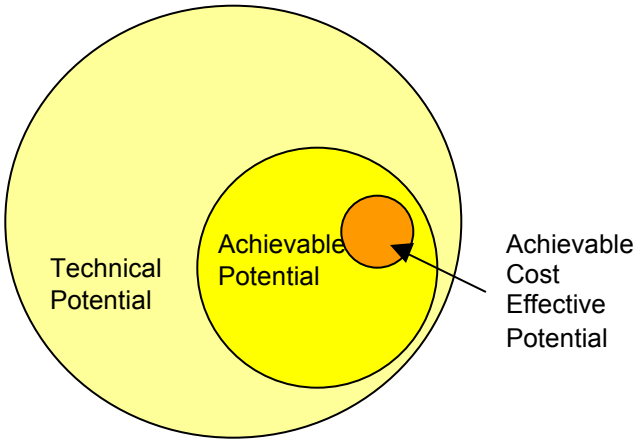
- **Technical potential** is defined as the complete and immediate penetration of all measures analyzed in applications where they are deemed to be technically feasible from an engineering perspective. The total technical potential for energy efficiency savings for each sector was developed from estimates 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.

[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]

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[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.

[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.

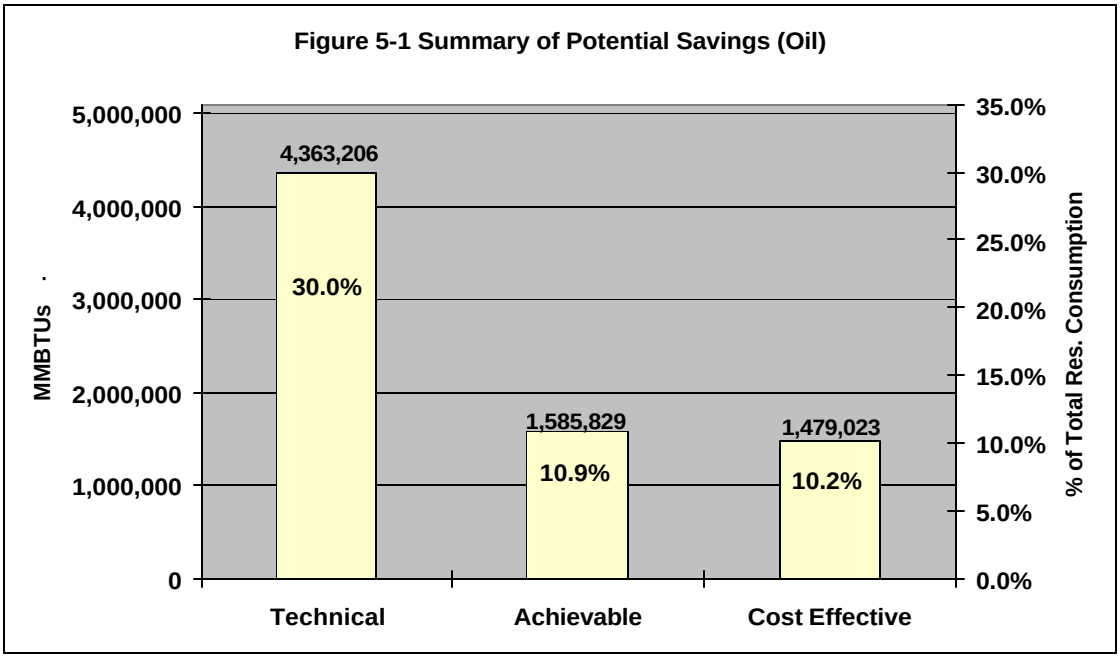


Table 5-3: Summary of Residential **Fuel Oil** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Fuel Oil Consumption
Technical Potential	4,363,206	30.0%
Achievable Potential	1,585,829	10.9%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

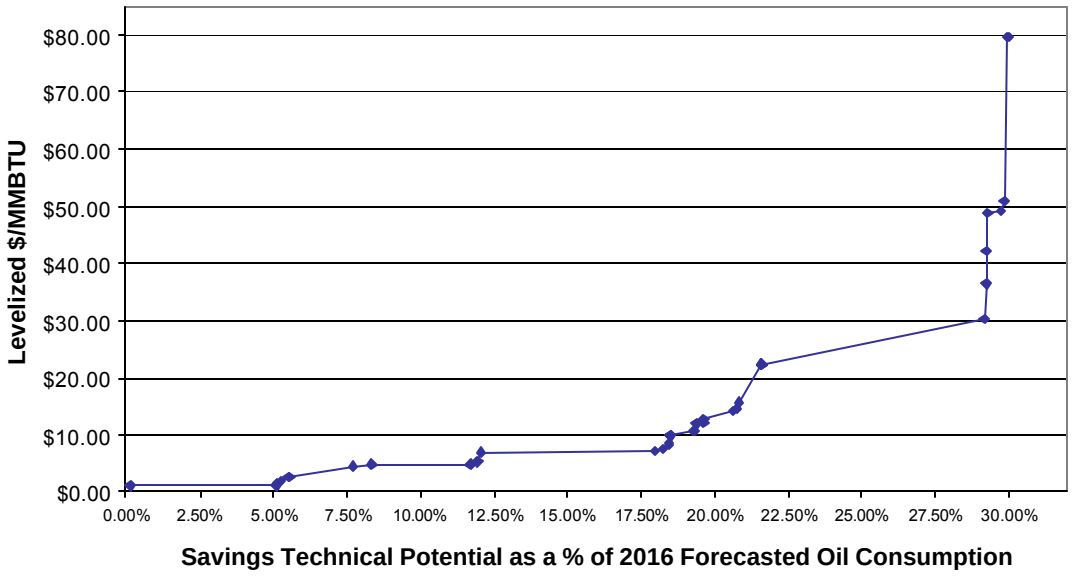
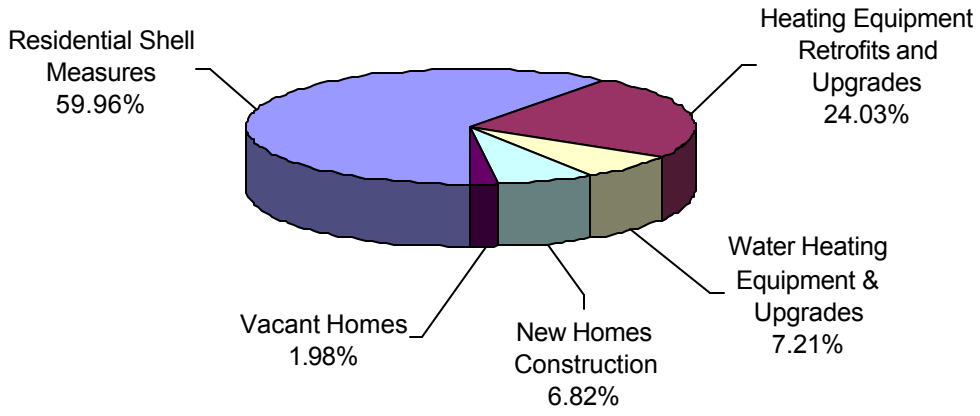


Figure 5-3: Residential Sector Cost Effective Fuel Oil MMBTU Savings by Measure Type



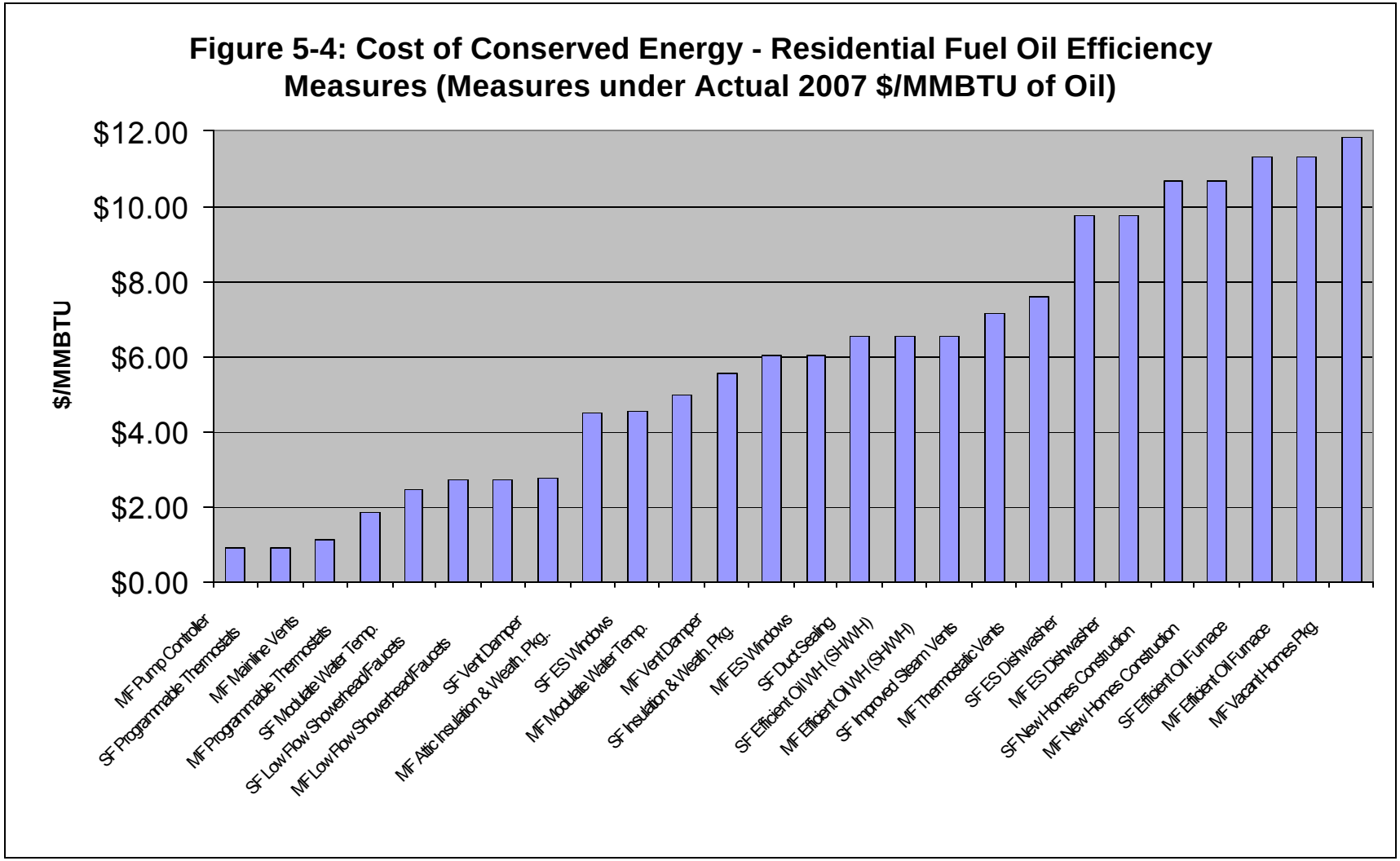


Figure 5-4: Cost of Conserved Energy - Residential Fuel Oil Efficiency Measures (Measures under Actual 2007 $/MMBTU of Oil)
$/MMBTU
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
MF Pump Controller
SF Programmable Thermostats
MF Mainline Vents
MF Programmable Thermostats
SF Modulate Water Temp.
SF Low Flow Showerhead/Faucets
MF Low Flow Showerhead/Faucets
SF Vent Damper
MF Attic Insulation & Weath. Pkg.
SF ES Windows
MF Modulate Water Temp.
MF Vent Damper
SF Insulation & Weath. Pkg.
MF ES Windows
SF Duct Sealing
SF Efficient Oil WH (SHWH)
MF Efficient Oil WH (SHWH)
SF Improved Steam Vents
MF Thermostatic Vents
SF ES Dishwasher
MF ES Dishwasher
SF New Homes Construction
MF New Homes Construction
SF Efficient Oil Furnace
MF Efficient Oil Furnace
MF Vacant Homes Pkg.

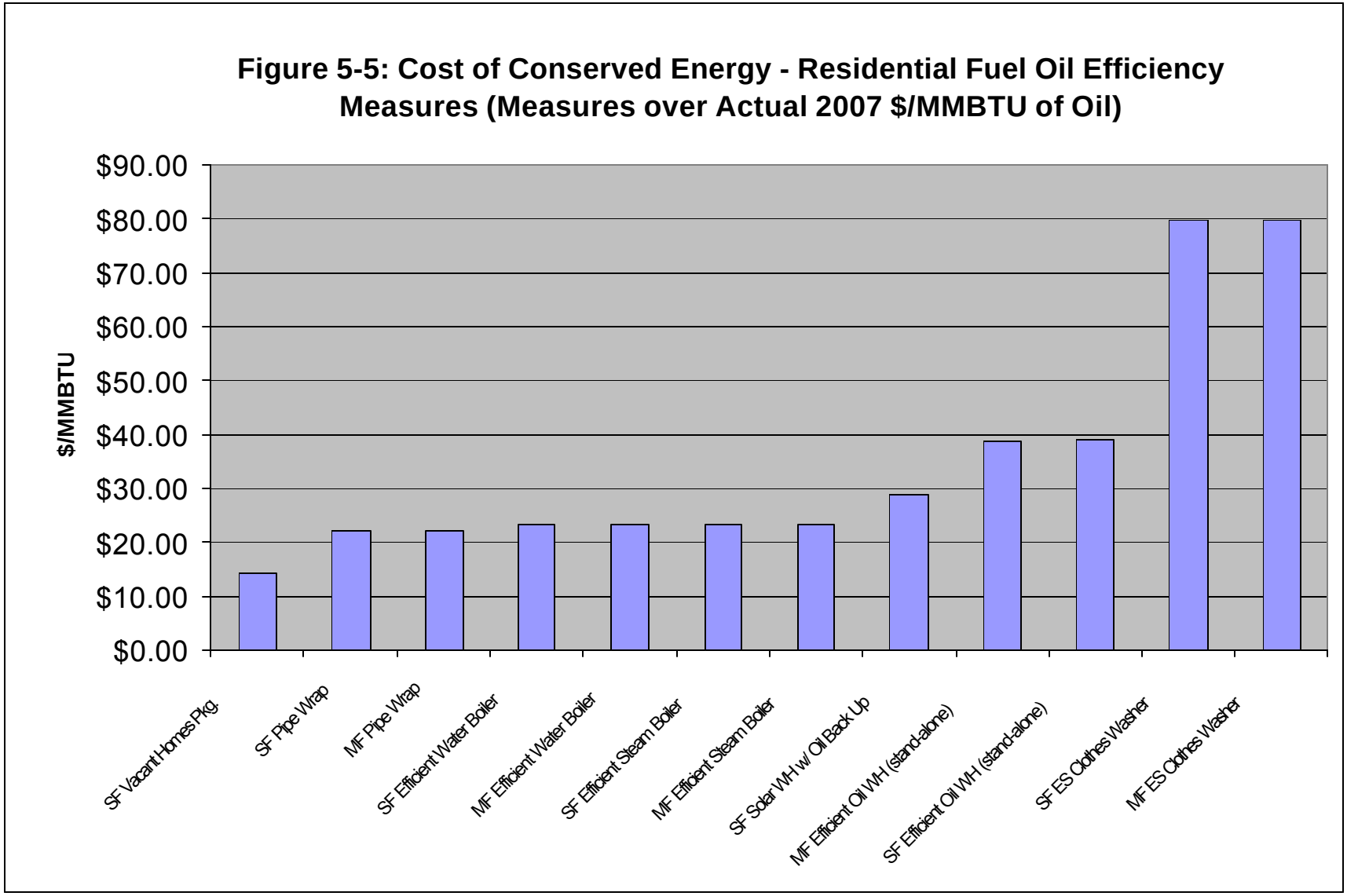


Figure 5-5: Cost of Conserved Energy - Residential Fuel Oil Efficiency Measures (Measures over Actual 2007 $/MMBTU of Oil)
$/MMBTU
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
SF Vacant Homes Pkg.
SF Pipe Wrap
MF Pipe Wrap
SF Efficient Water Boiler
MF Efficient Water Boiler
SF 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)

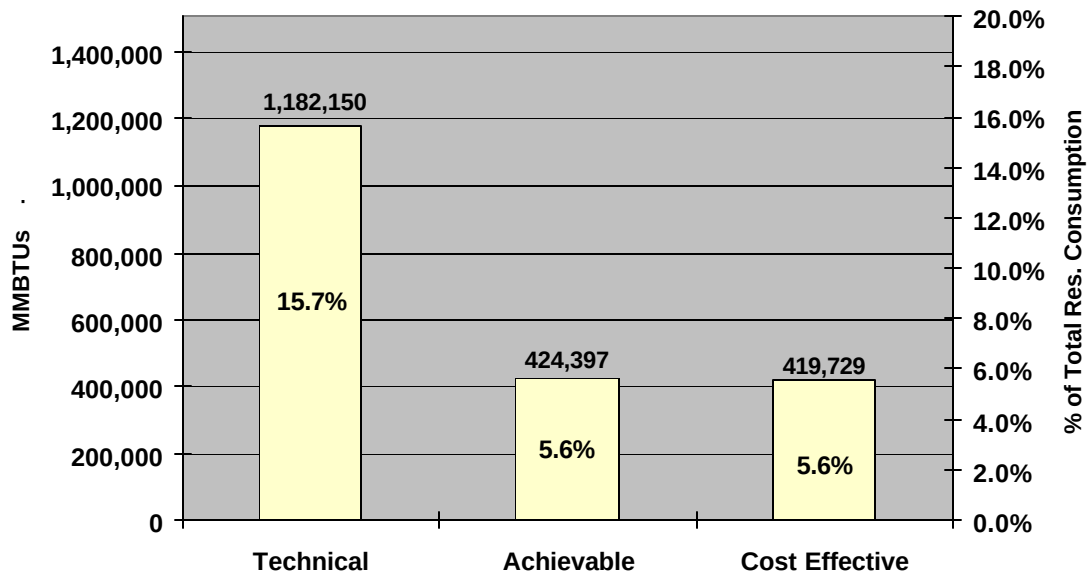


Table 5-7: Summary of Residential **Propane** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Propane Consumption
Technical Potential	1,182,150	15.7%
Achievable Potential	424,397	5.6%
Achievable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

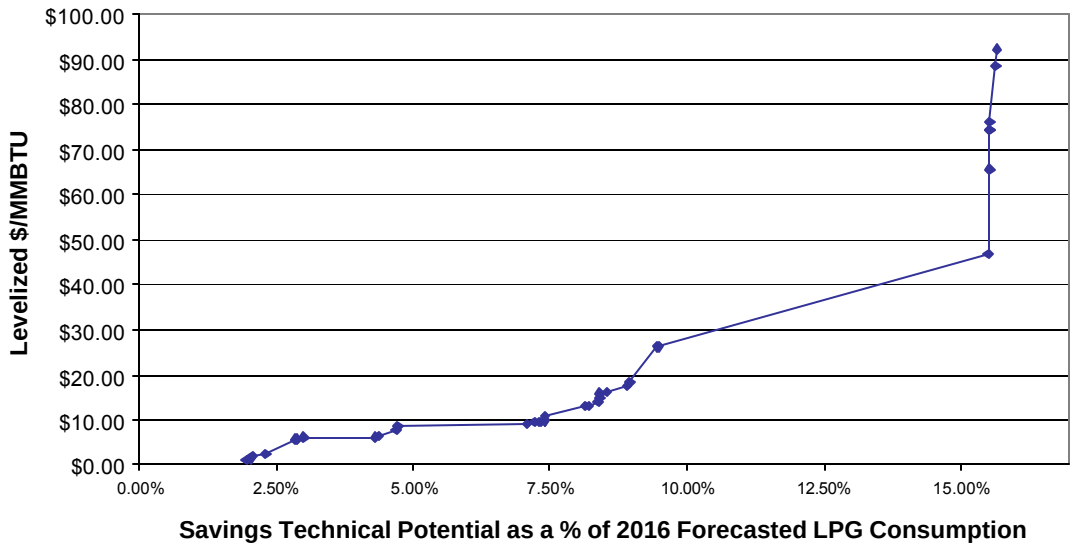


Figure 5-8: Residential Sector Cost Effective Propane MMBTU Savings by Measure Type

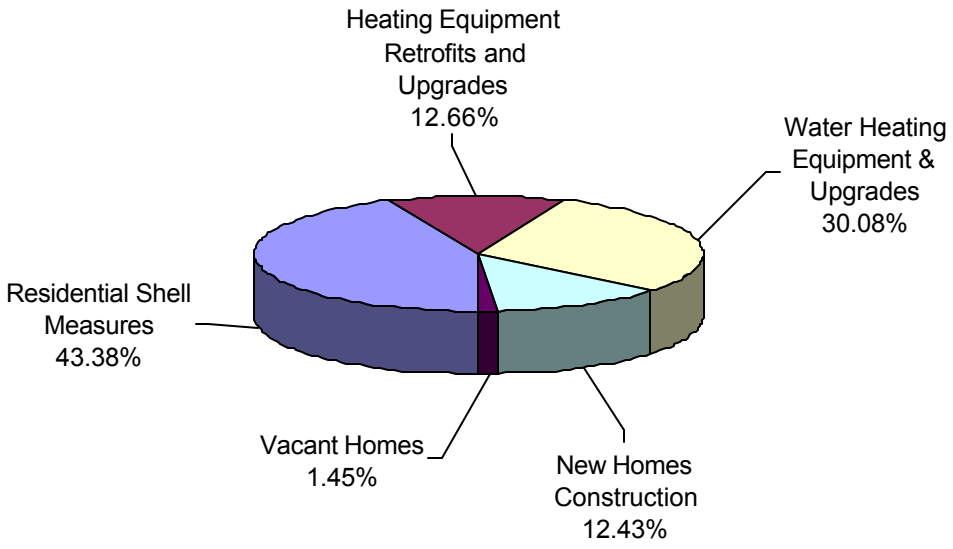


Figure 5-9: Cost of Conserved Energy - Residential Propane Efficiency Measures (Measures under Actual 2007 $/MMBTU of Propane)

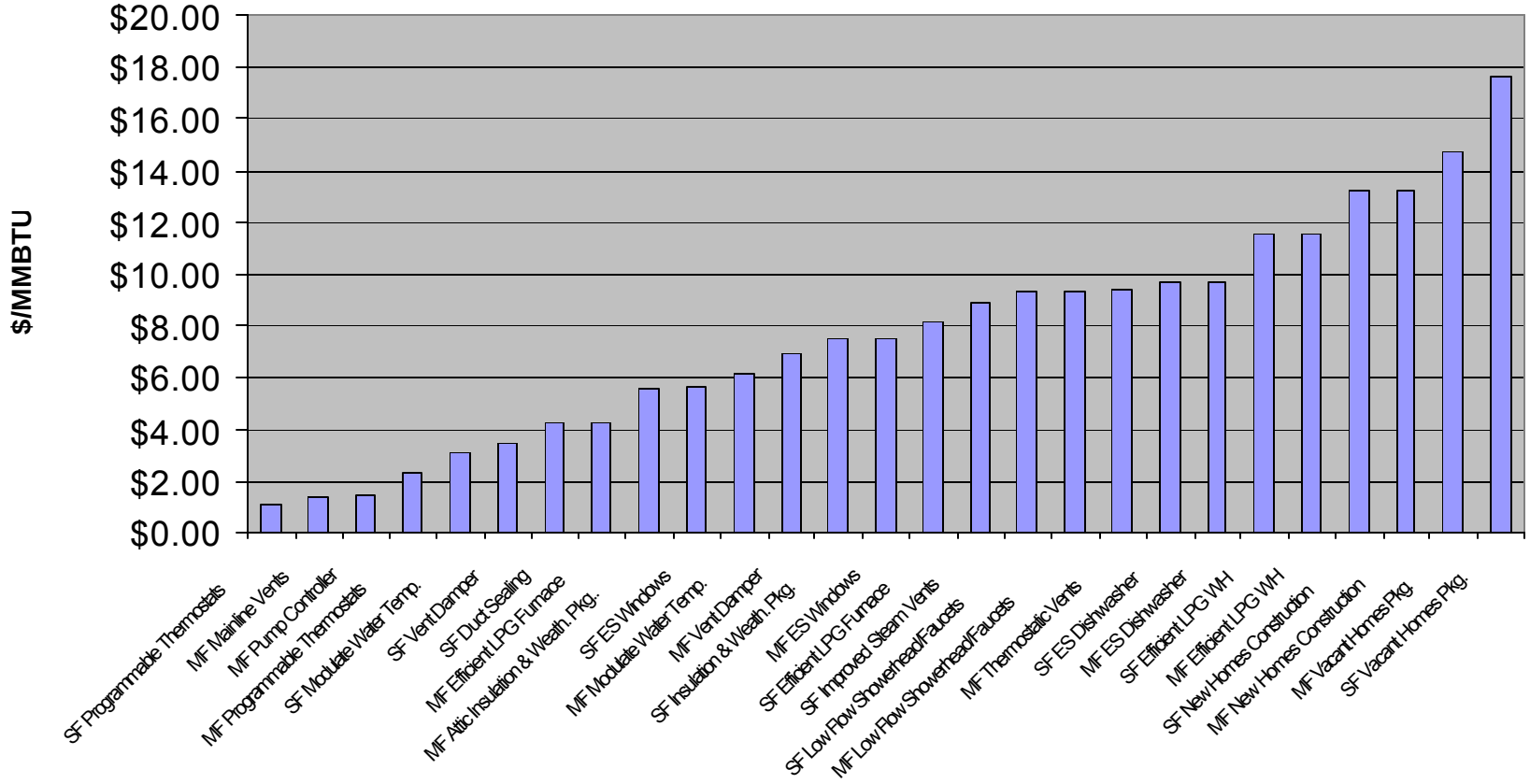
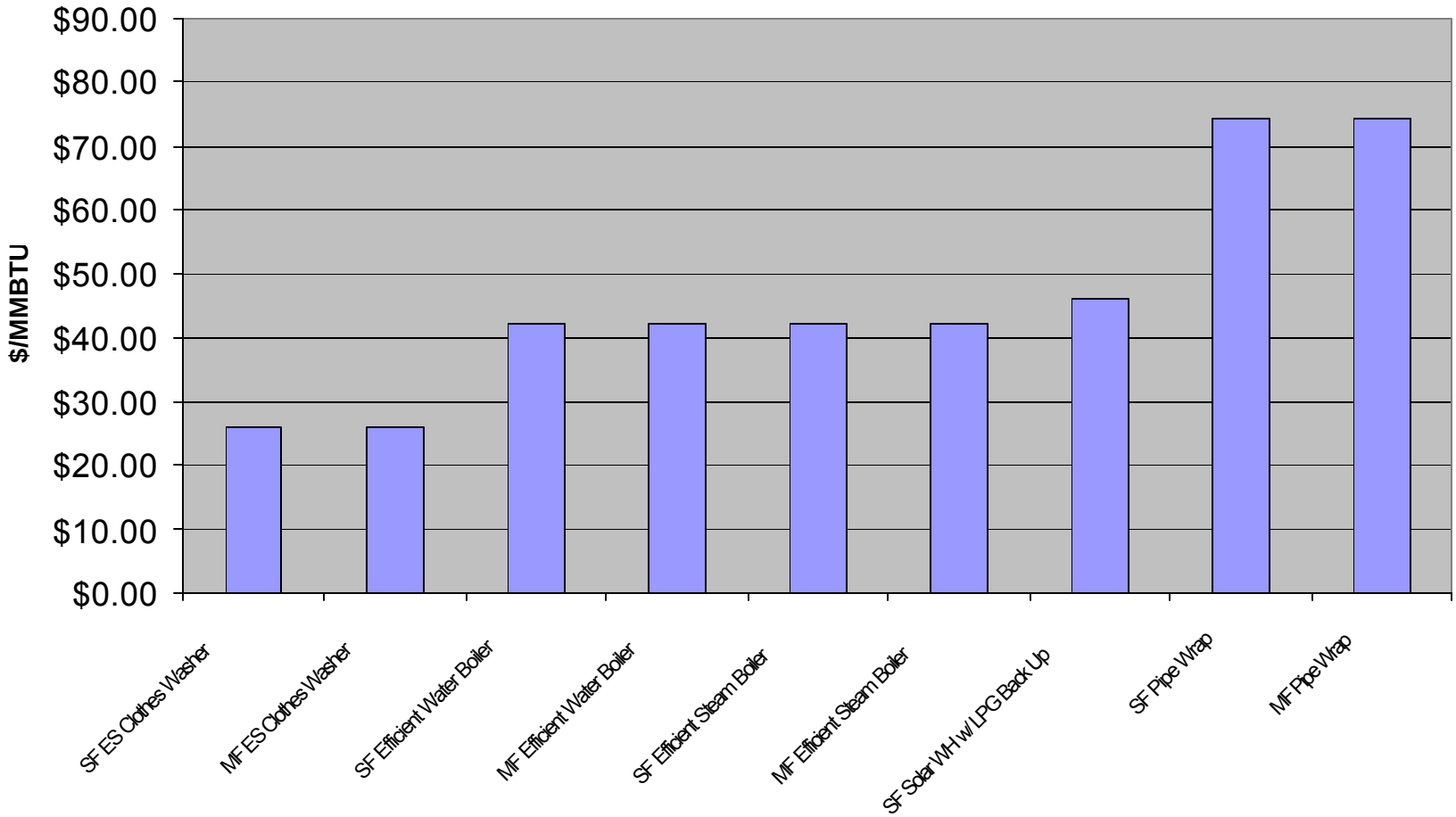


Figure 5-10: Cost of Conserved Energy - Residential Propane Efficiency Measures (Measures over Actual 2007 $/MMBTU of Propane)



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)

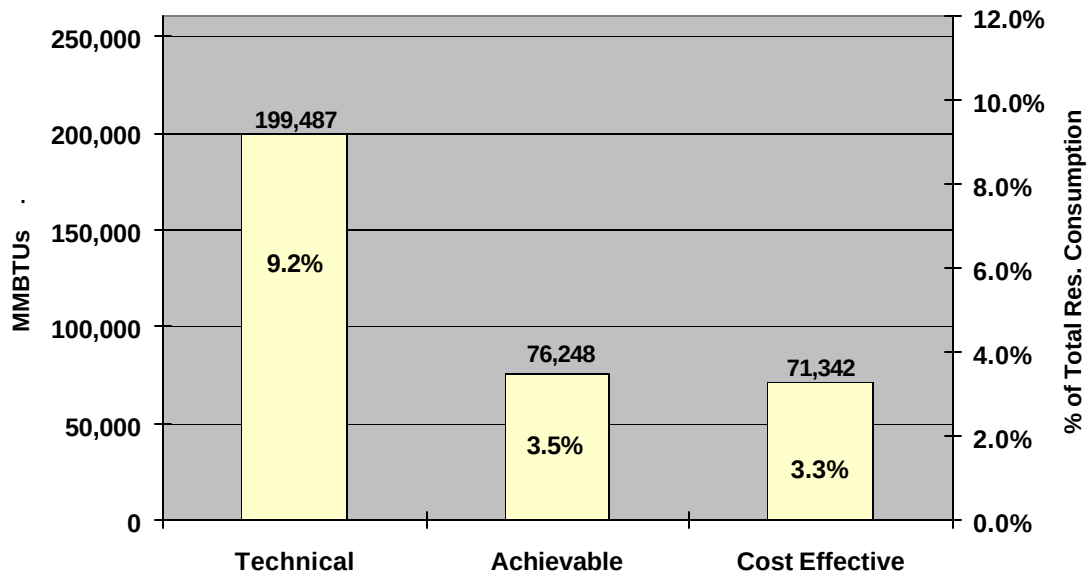


Table 5-11: Summary of Residential **Kerosene** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Kerosene Consumption
Technical Potential	199,487	9.2%
Achievable Potential	76,248	3.5%
Achievable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

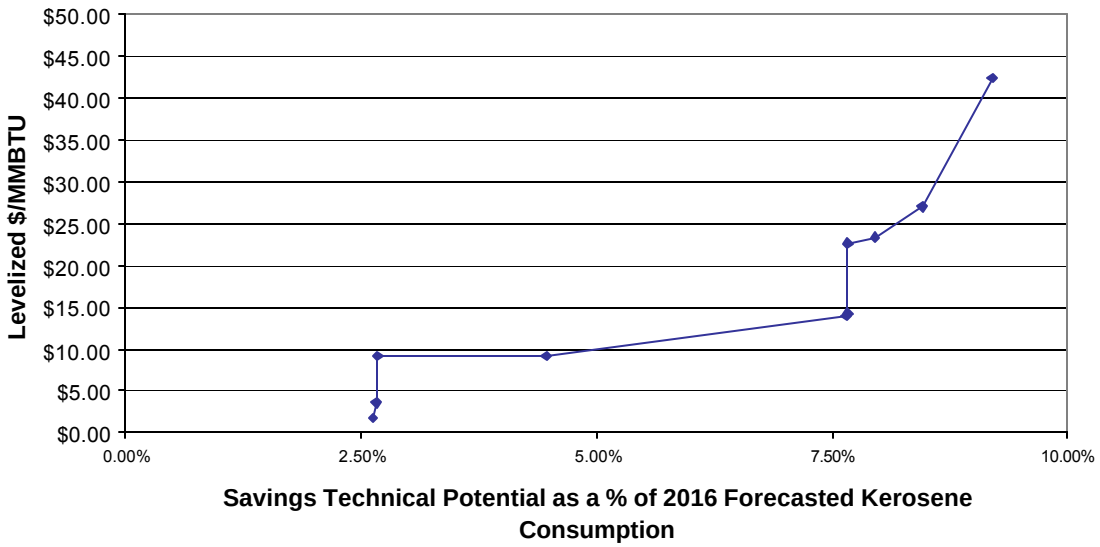
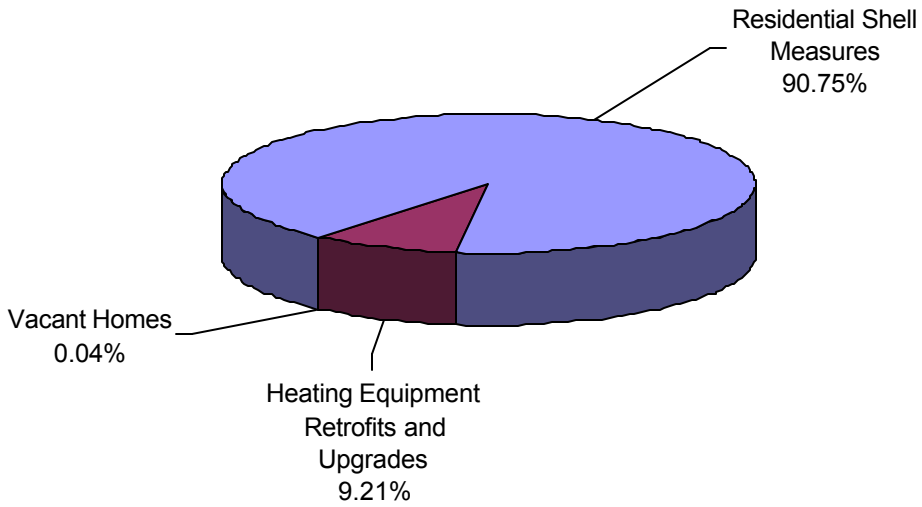


Figure 5-13: Residential Sector Cost Effective Kerosene MMBTU Savings by Measure Type



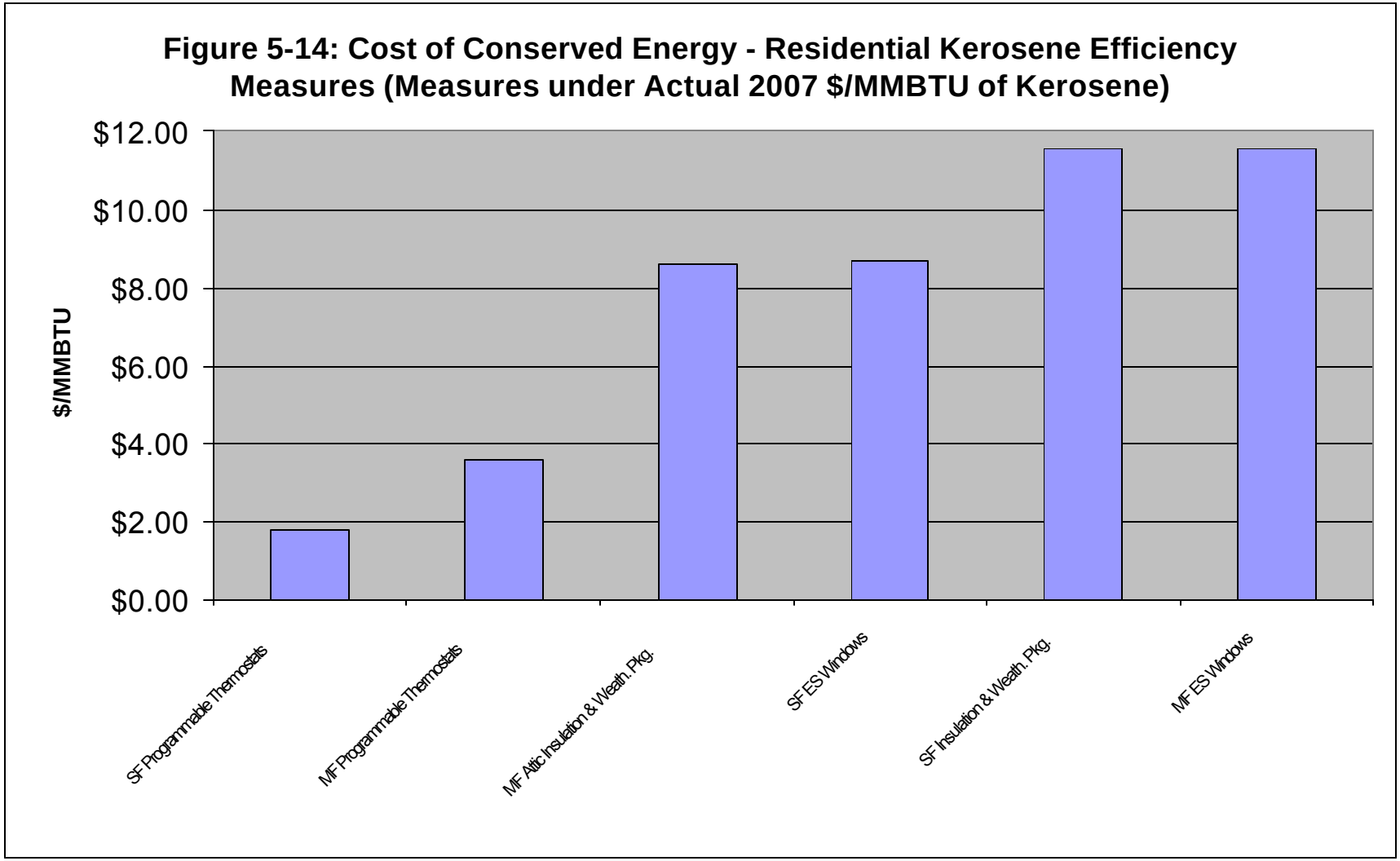


Figure 5-14: Cost of Conserved Energy - Residential Kerosene Efficiency Measures (Measures under Actual 2007 $/MMBTU of Kerosene)
$/MMBTU
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
SF Programmable Thermostats
MF Programmable Thermostats
MF Attic Insulation & Weath. Pkg.
SF ES Windows
SF Insulation & Weath. Pkg.
MF ES Windows

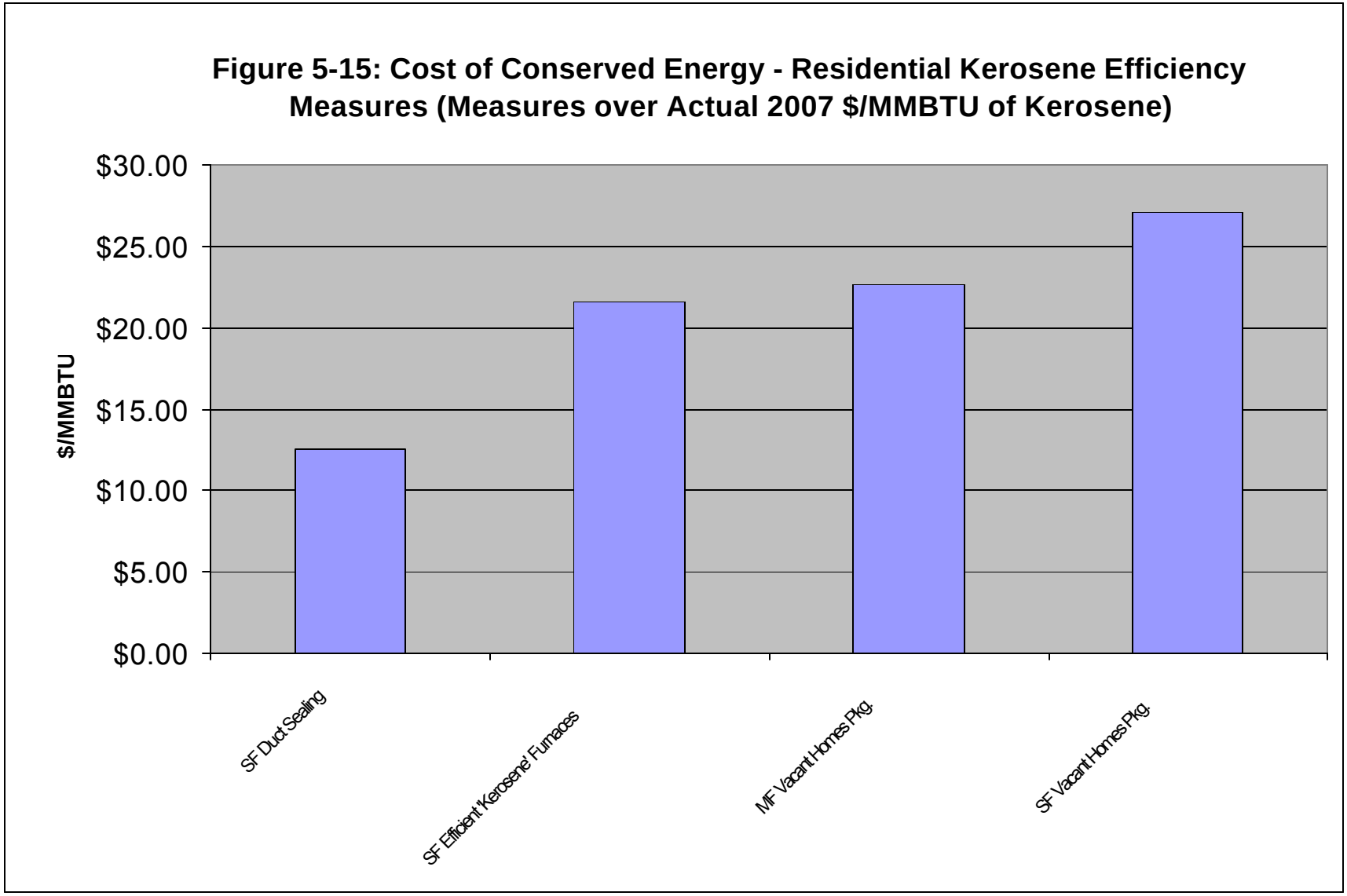


Figure 5-15: Cost of Conserved Energy - Residential Kerosene Efficiency Measures (Measures over Actual 2007 $/MMBTU of Kerosene)
$/MMBTU
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
SF Duct Sealing
SF Efficient 'Kerosene' Furnaces
MF Vacant Homes Pkg.
SF Vacant Homes Pkg.

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)

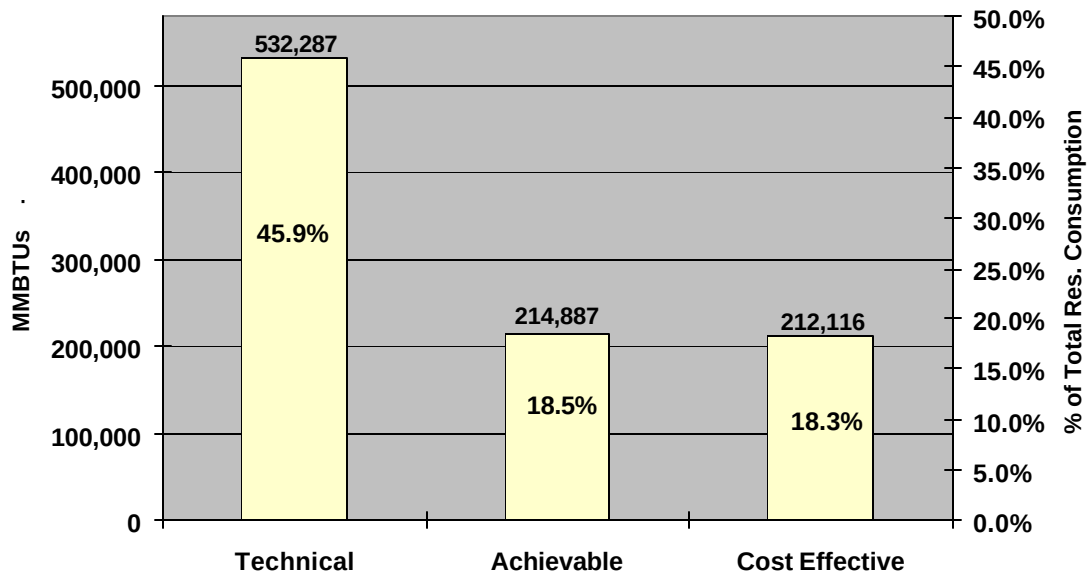


Table 5-15: Summary of Residential **Wood** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Residential Sector Wood Consumption
Technical Potential	532,287	45.9%
Achievable Potential	214,887	18.5%
Achievable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

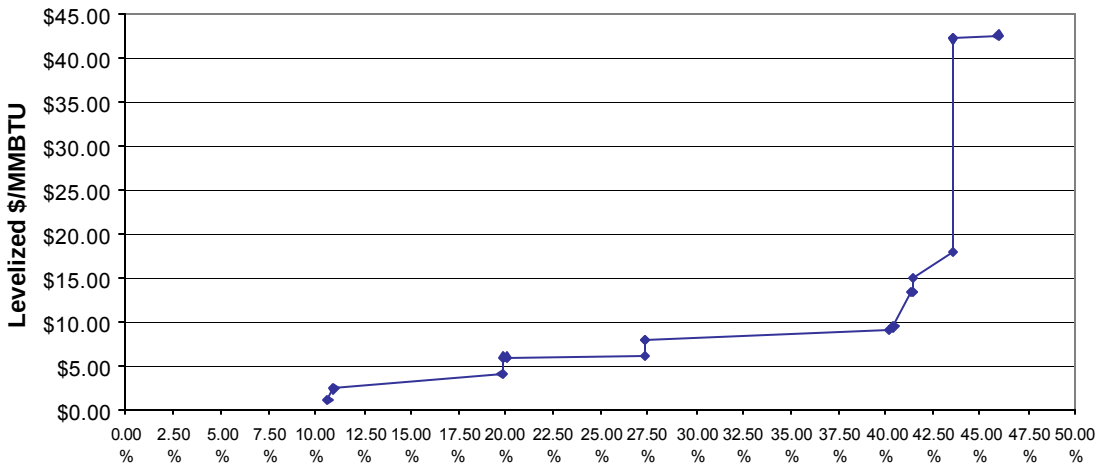
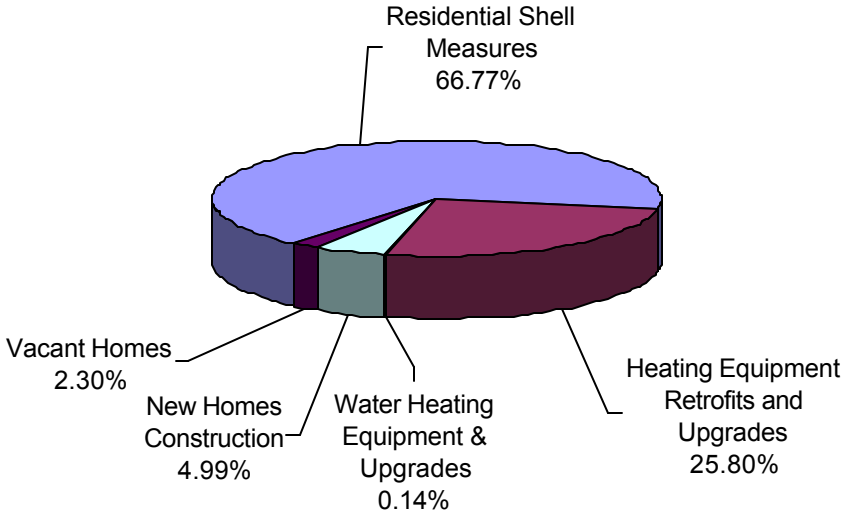


Figure 5-18: Residential Sector Cost Effective Wood MMBTU Savings by Measure Type



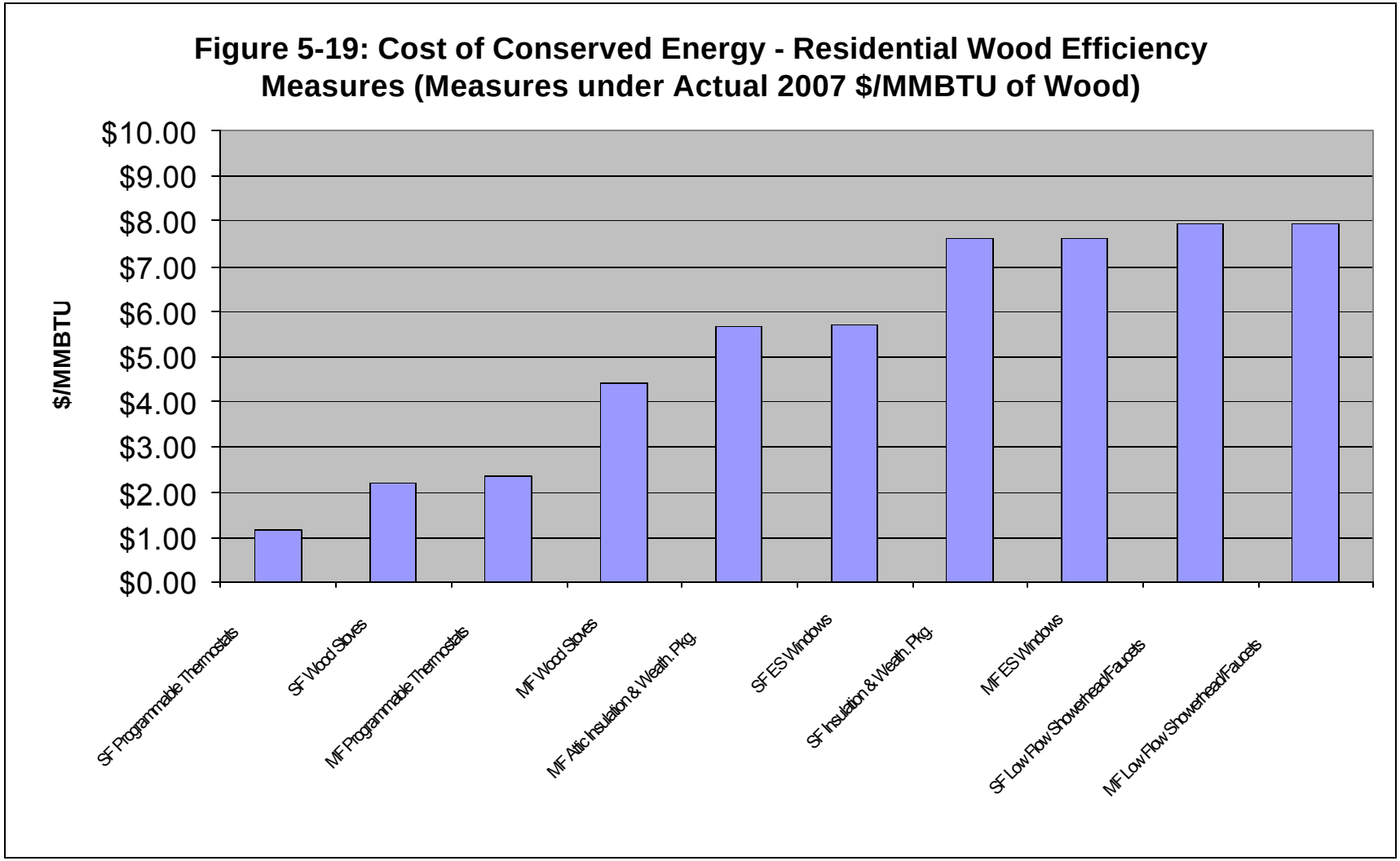


Figure 5-19: Cost of Conserved Energy - Residential Wood Efficiency Measures (Measures under Actual 2007 $/MMBTU of Wood)
$/MMBTU
$10.00
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
SF Programmable Thermostats
SF Wood Stoves
MF Programmable Thermostats
MF Wood Stoves
MF Attic Insulation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

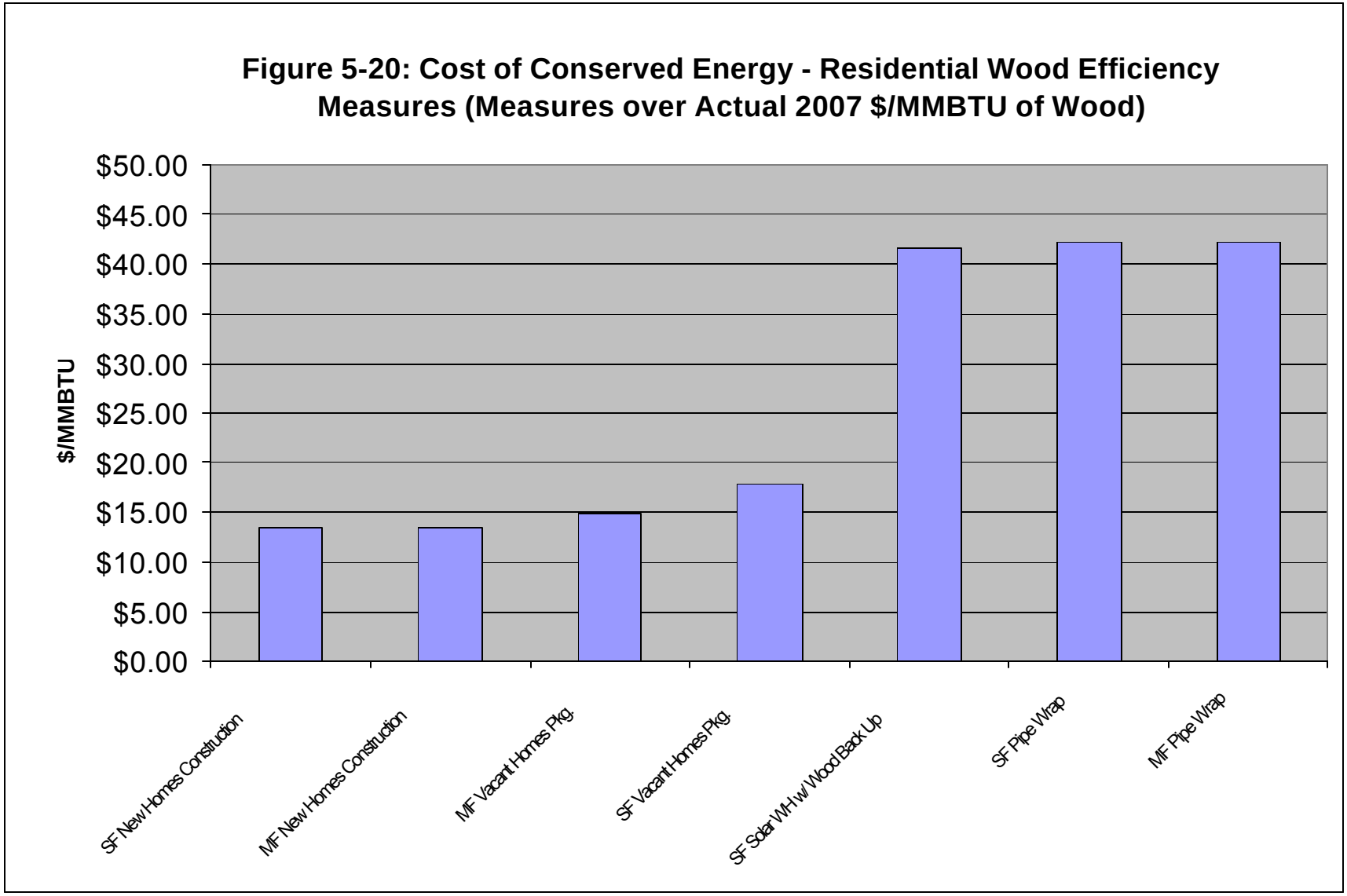


Figure 5-20: Cost of Conserved Energy - Residential Wood Efficiency Measures (Measures over Actual 2007 $/MMBTU of Wood)
$/MMBTU
$50.00
$45.00
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
SF New Homes Construction
MF New Homes Construction
MF Vacant Homes Pkg.
SF Vacant Homes Pkg.
SF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

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	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)**

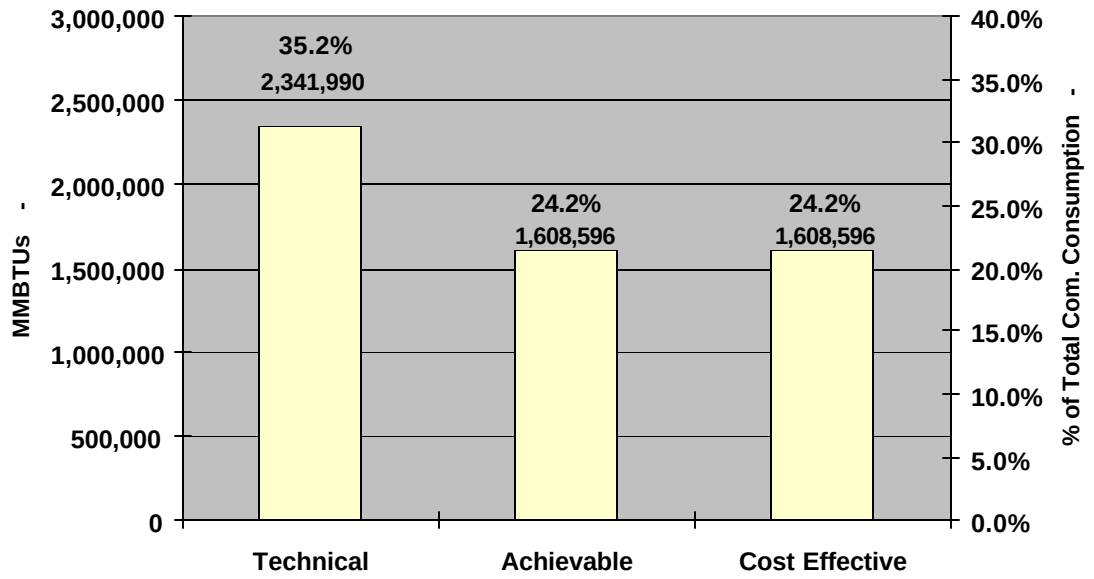


Table 6-3: Summary of Commercial **Fuel Oil** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Fuel Oil Consumption
Technical Potential	2,341,990	35.2%
Achievable Potential	1,608,596	24.2%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

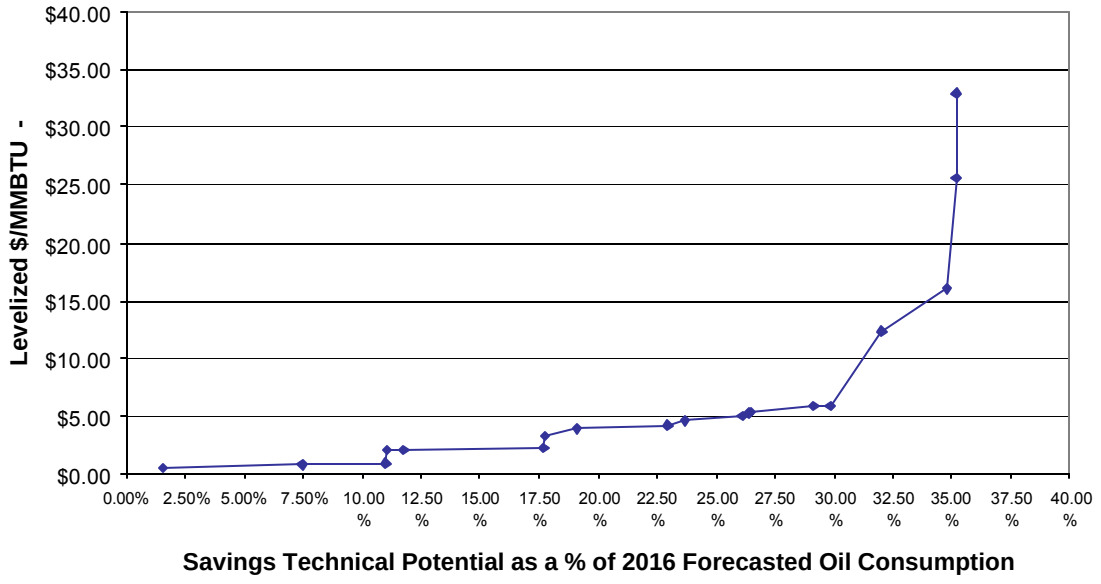
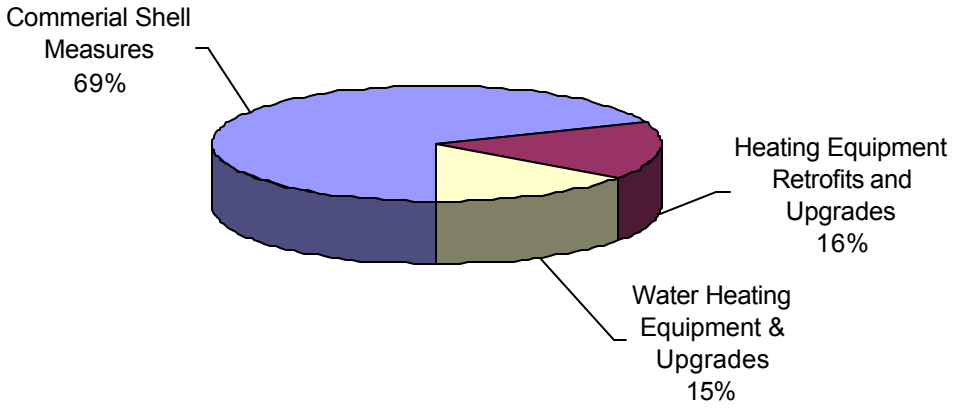


Figure 6-3: Commercial Sector Cost Effective **Fuel Oil** MMBTU Savings by Measure Type



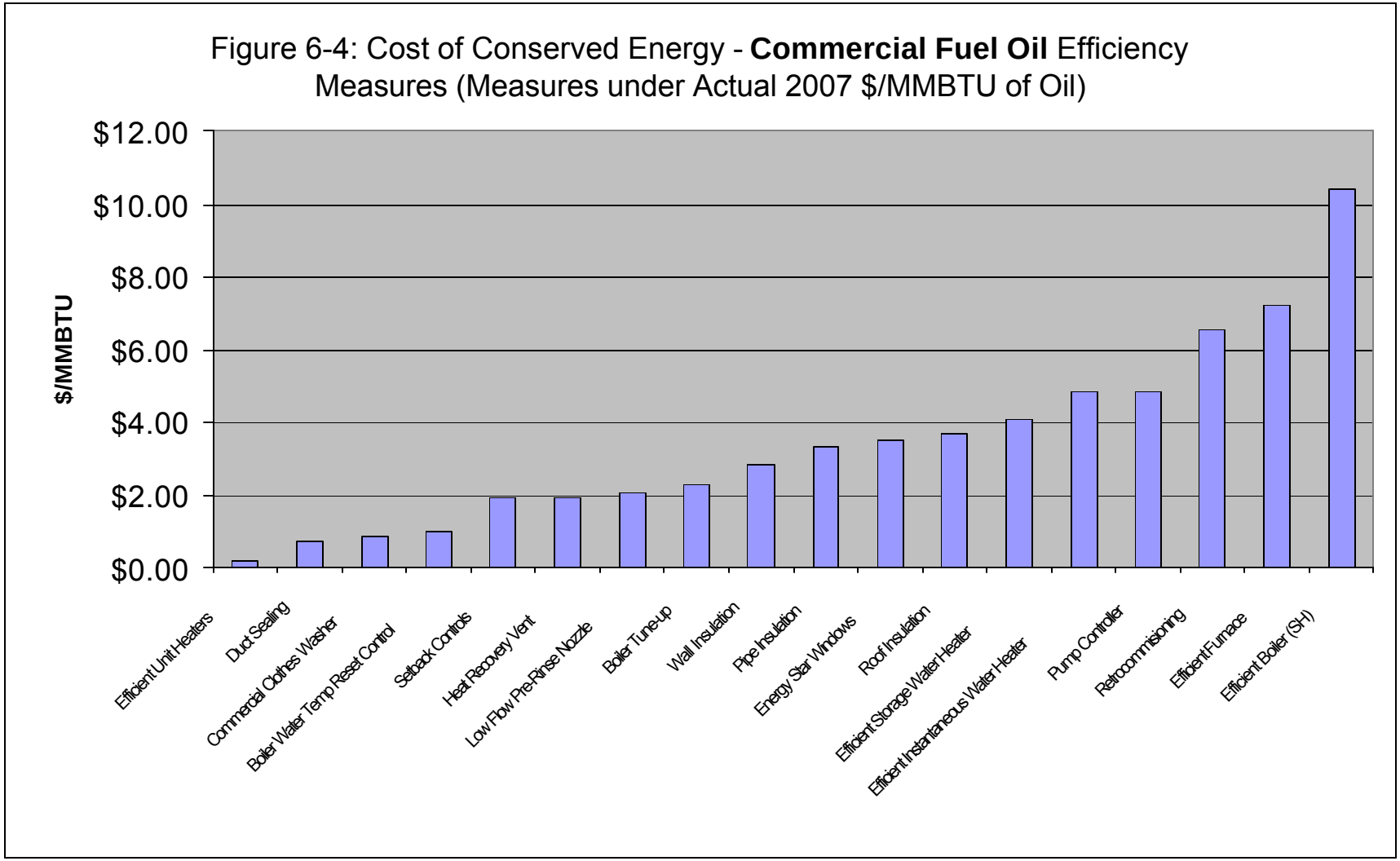


Figure 6-4: Cost of Conserved Energy - **Commercial Fuel Oil** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Oil)
$/MMBTU
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
Efficient Unit Heaters
Duct Sealing
Commercial Clothes Washer
Boiler Water Temp Reset Control
Setback Controls
Heat Recovery 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
Retrocommissioning
Efficient Furnace
Efficient Boiler (SH)

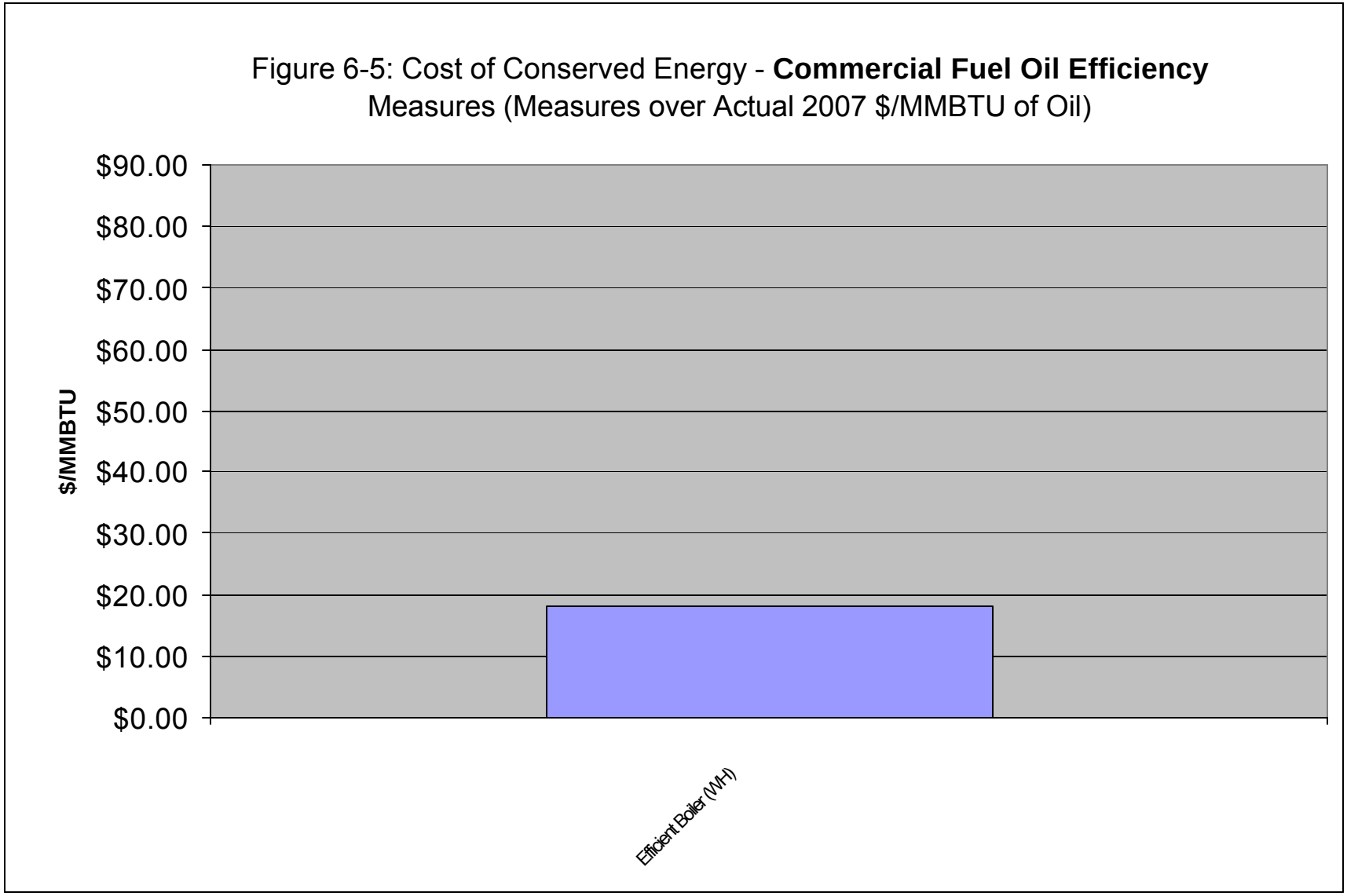


Figure 6-5: Cost of Conserved Energy - **Commercial Fuel Oil Efficiency** Measures (Measures over Actual 2007 $/MMBTU of Oil)
$/MMBTU
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$0.00
Efficient Boiler (W/H)

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)**

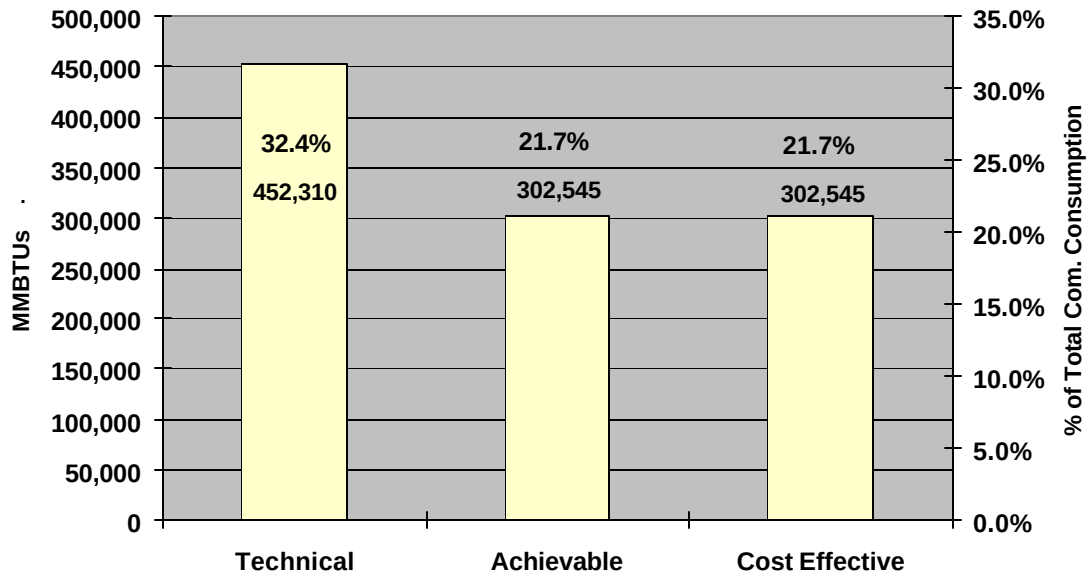


Table 6-7: Summary of **Commercial Propane** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Propane Consumption
Technical Potential	452,310	32.4%
Achievable Potential	302,545	21.7%
Achievable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

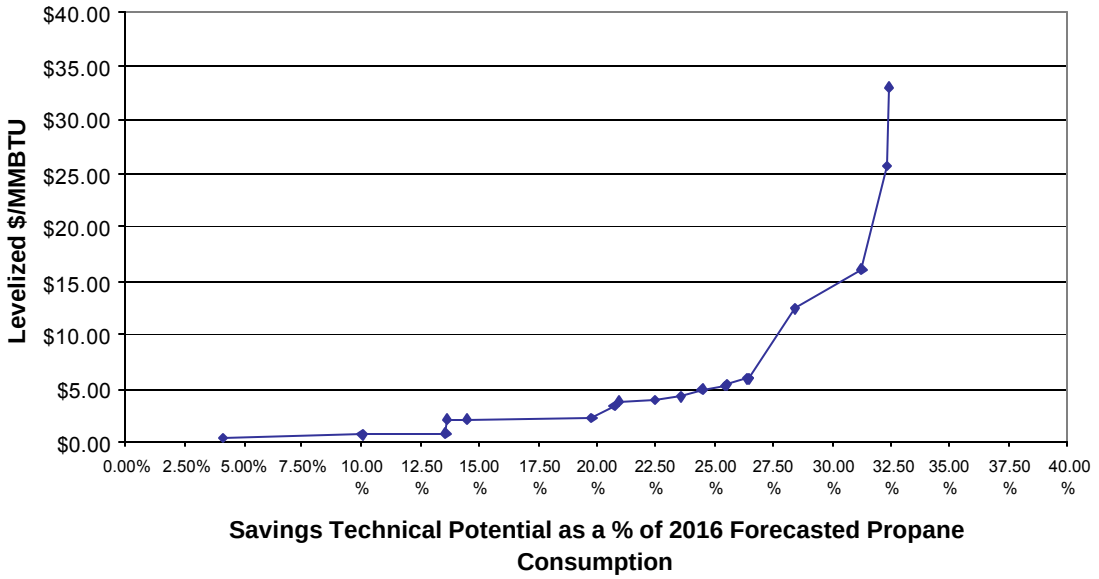


Figure 6-8: Commercial Sector Cost Effective **Propane** MMBTU Savings by Measure Type

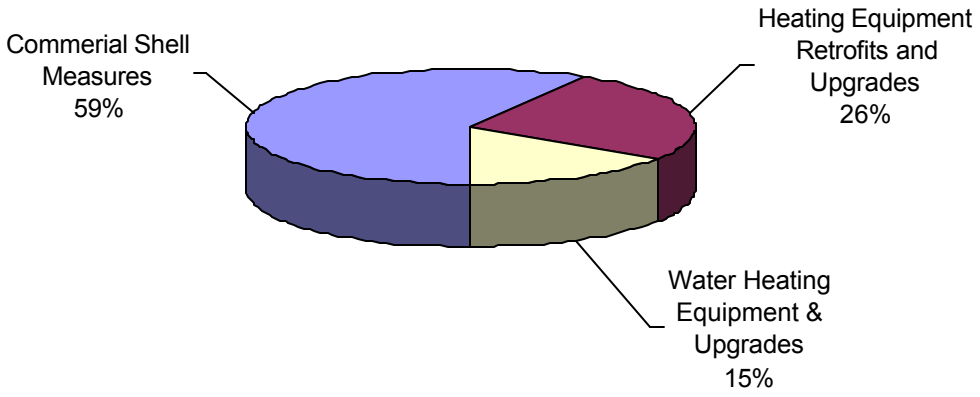
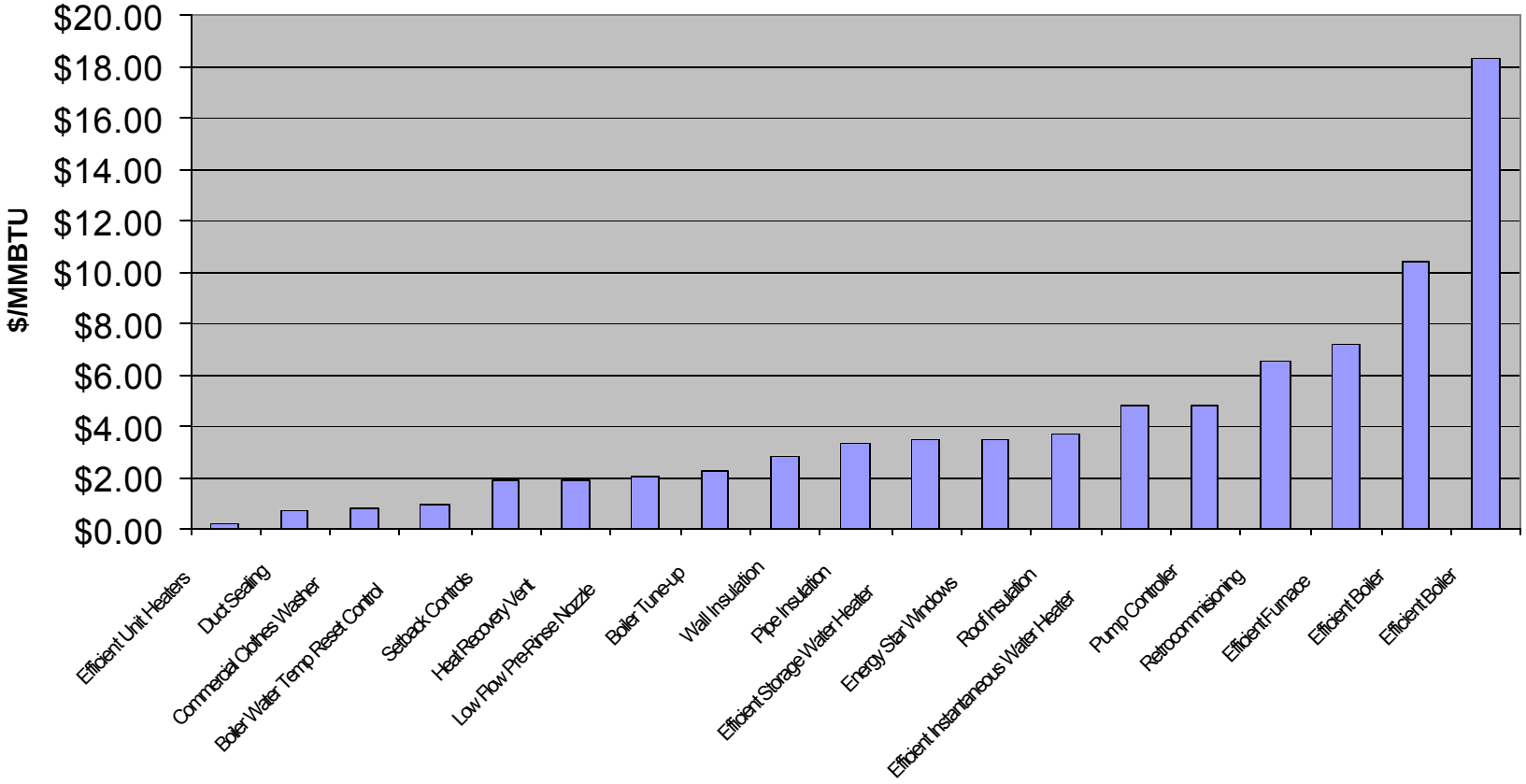


Figure 6-9: Cost of Conserved Energy - **Commercial Propane** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Propane)



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)**

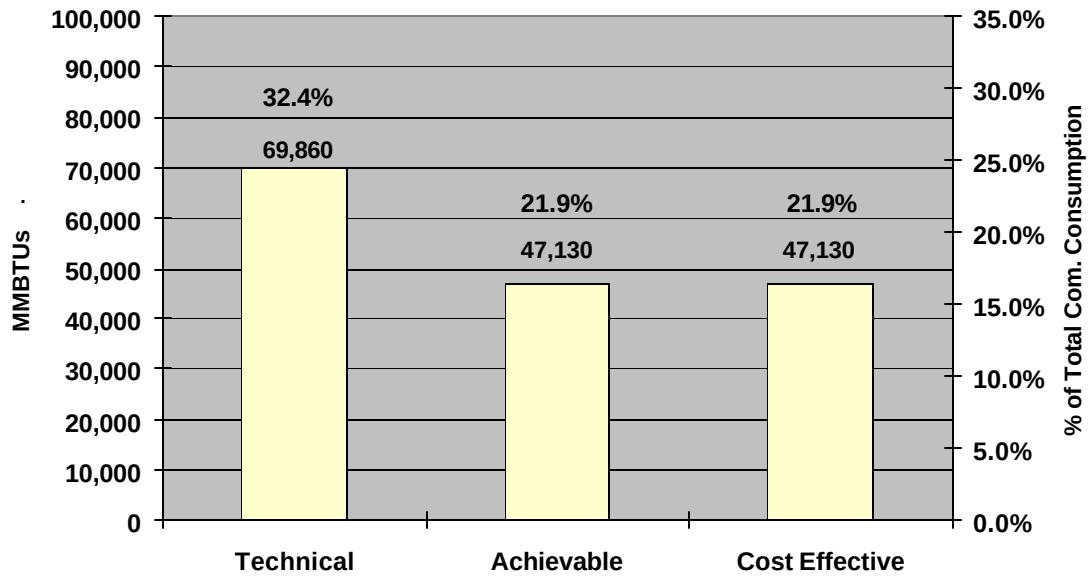


Table 6-11: Summary of **Commercial Kerosene** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Kerosene Consumption
Technical Potential	69,860	32.4%
Achievable Potential	47,130	21.9%
Achievable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

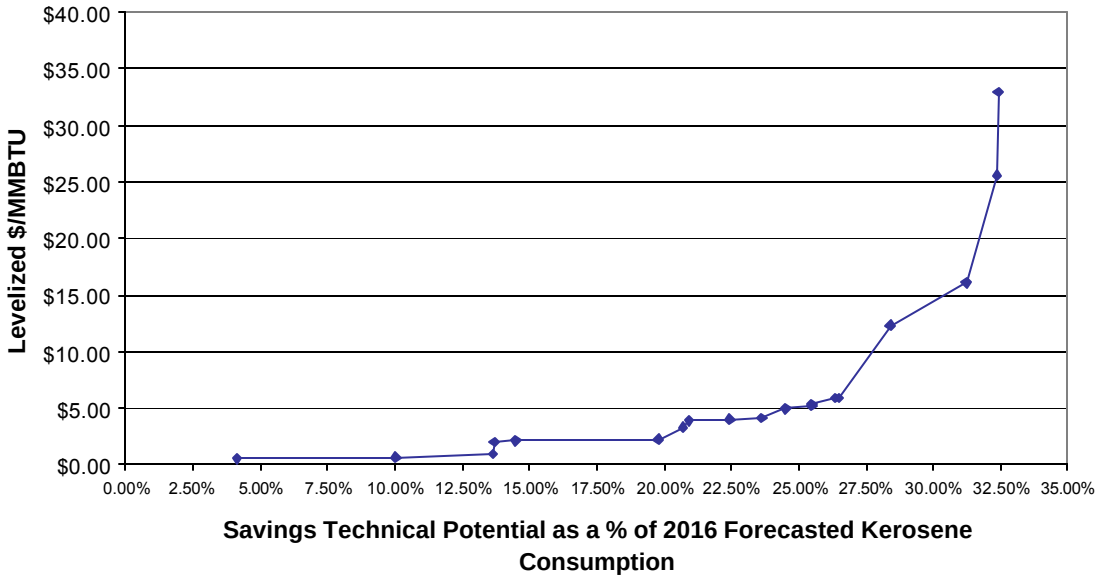


Figure 6-12: Commercial Sector Cost Effective **Kerosene** MMBTU Savings by Measure Type

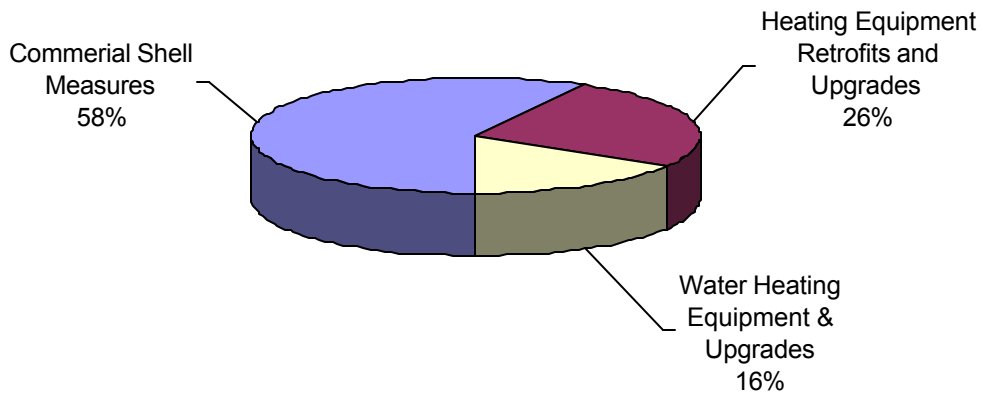


Figure 6-13: Cost of Conserved Energy - **Commercial Kerosene** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Kerosene)

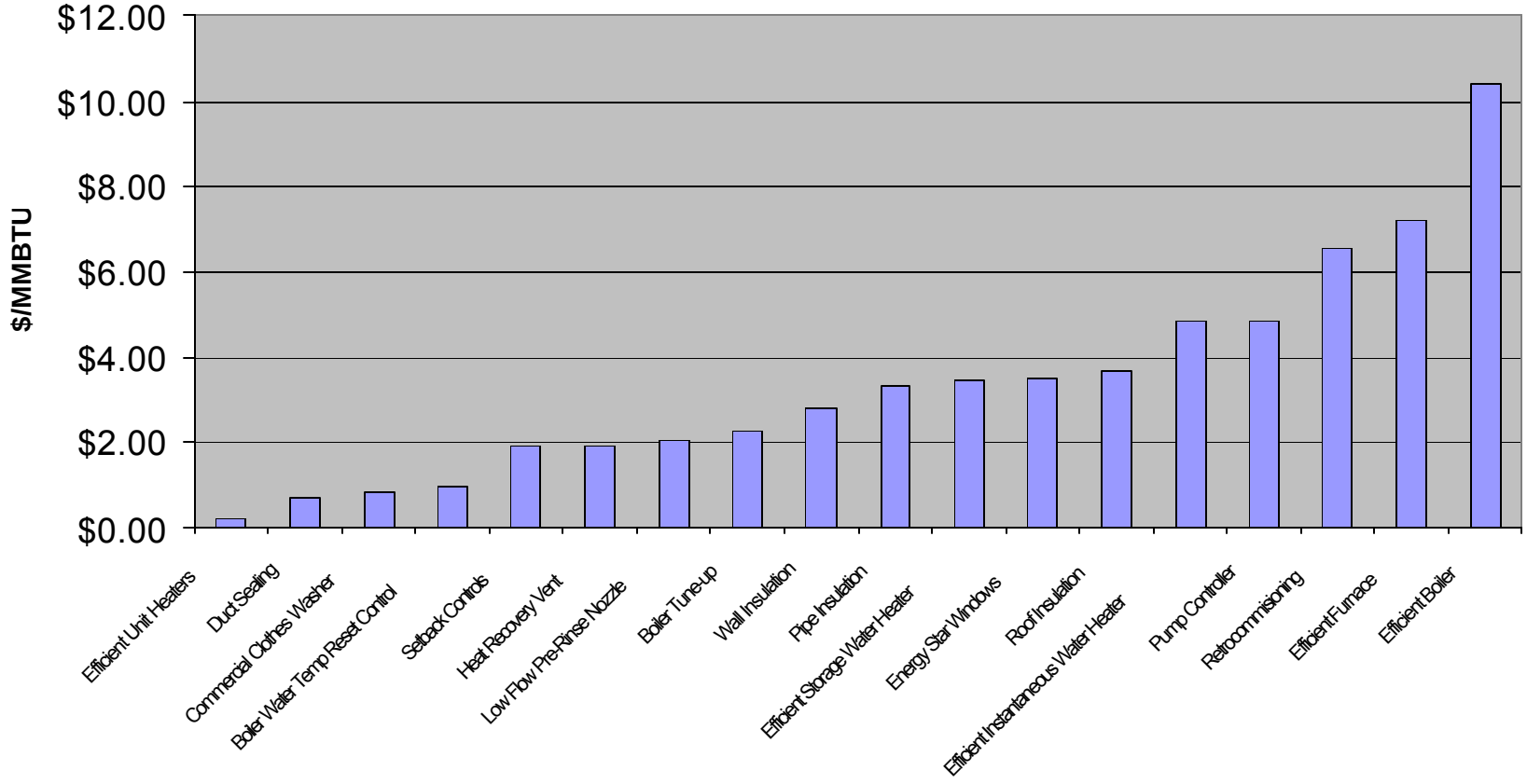
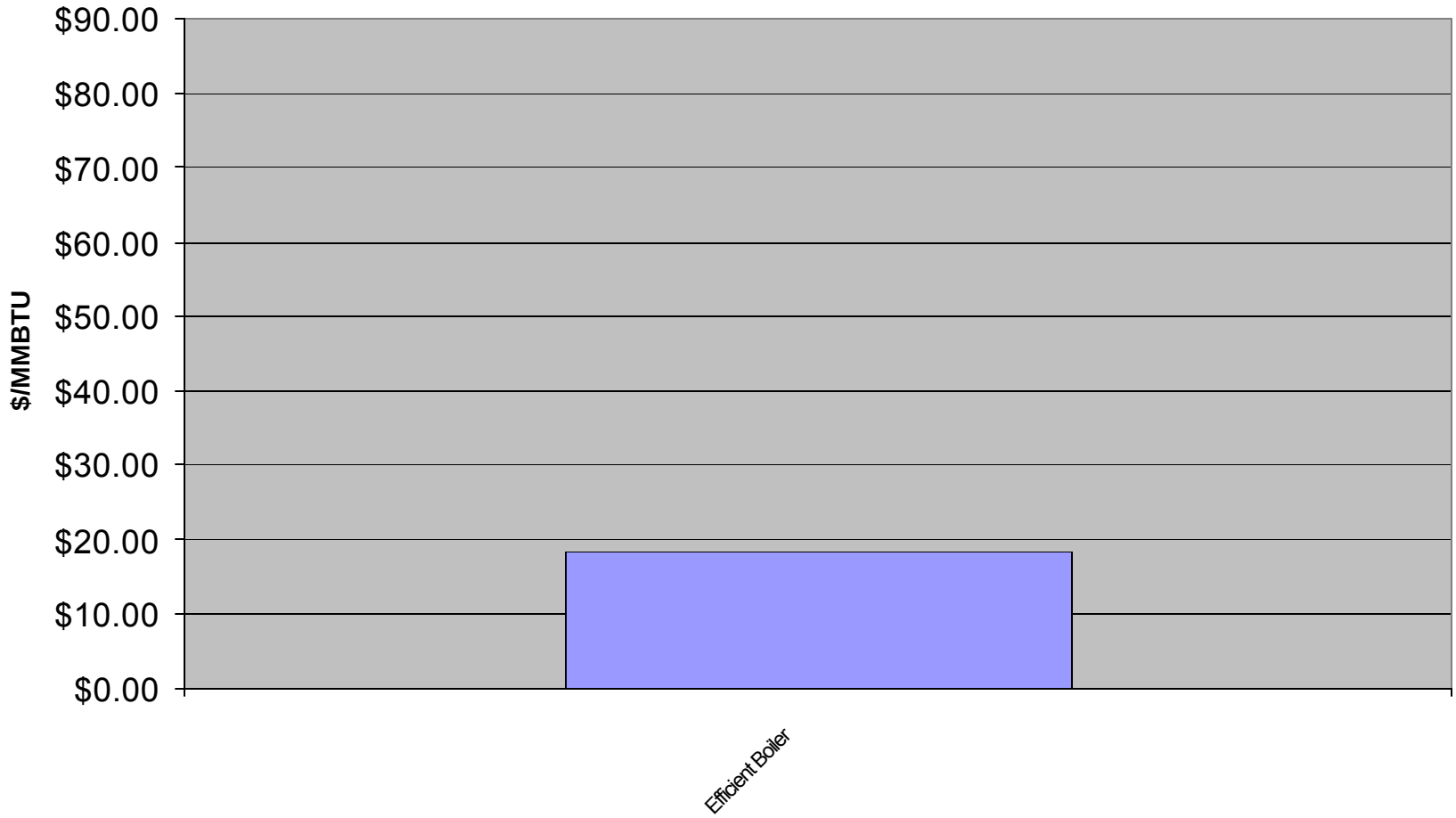


Figure 6-14: Cost of Conserved Energy - **Commercial Kerosene** Efficiency Measures (Measures over Actual 2007 $/MMBTU of Kerosene)



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)**

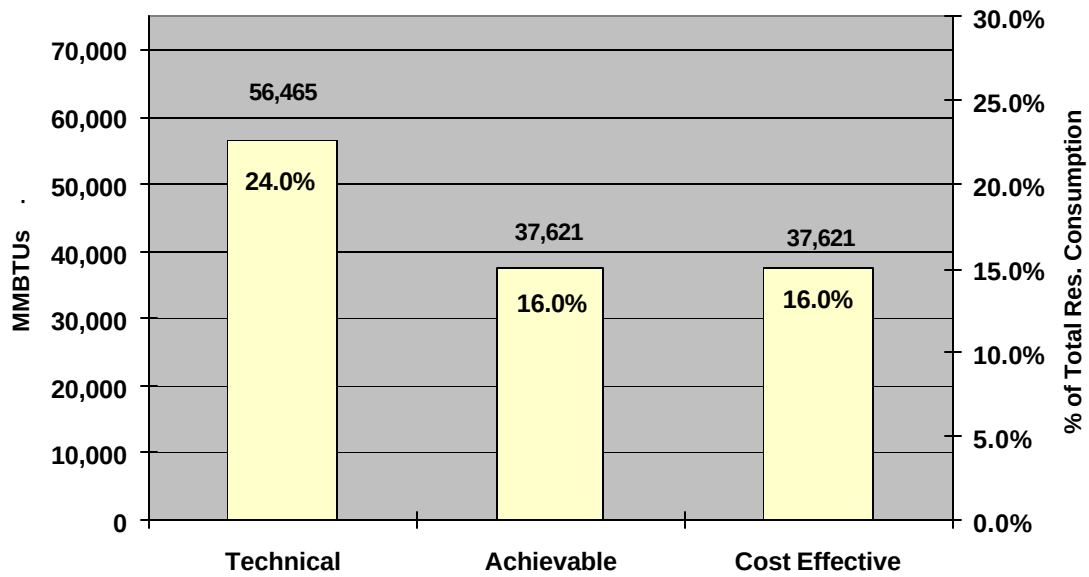


Table 6-15: Summary of **Commercial Wood** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Commercial Sector Wood Consumption
Technical Potential	56,465	24.0%
Achievable Potential	37,621	16.0%
Achievable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

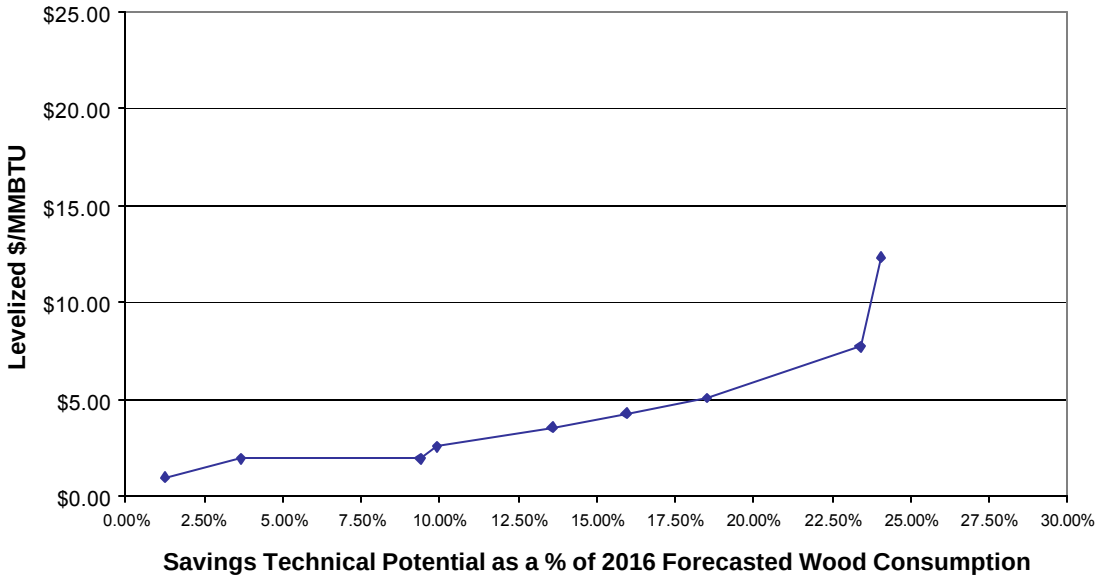


Figure 6-17: Commercial Sector Cost Effective **Wood** MMBTU Savings by Measure Type

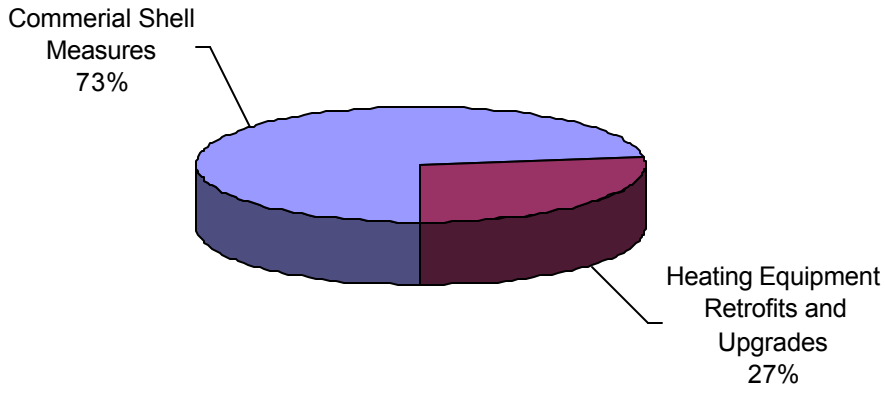


Figure 6-18: Cost of Conserved Energy - **Commercial Wood** Efficiency Measures (Measures under Actual 2007 $/MMBTU of Wood)

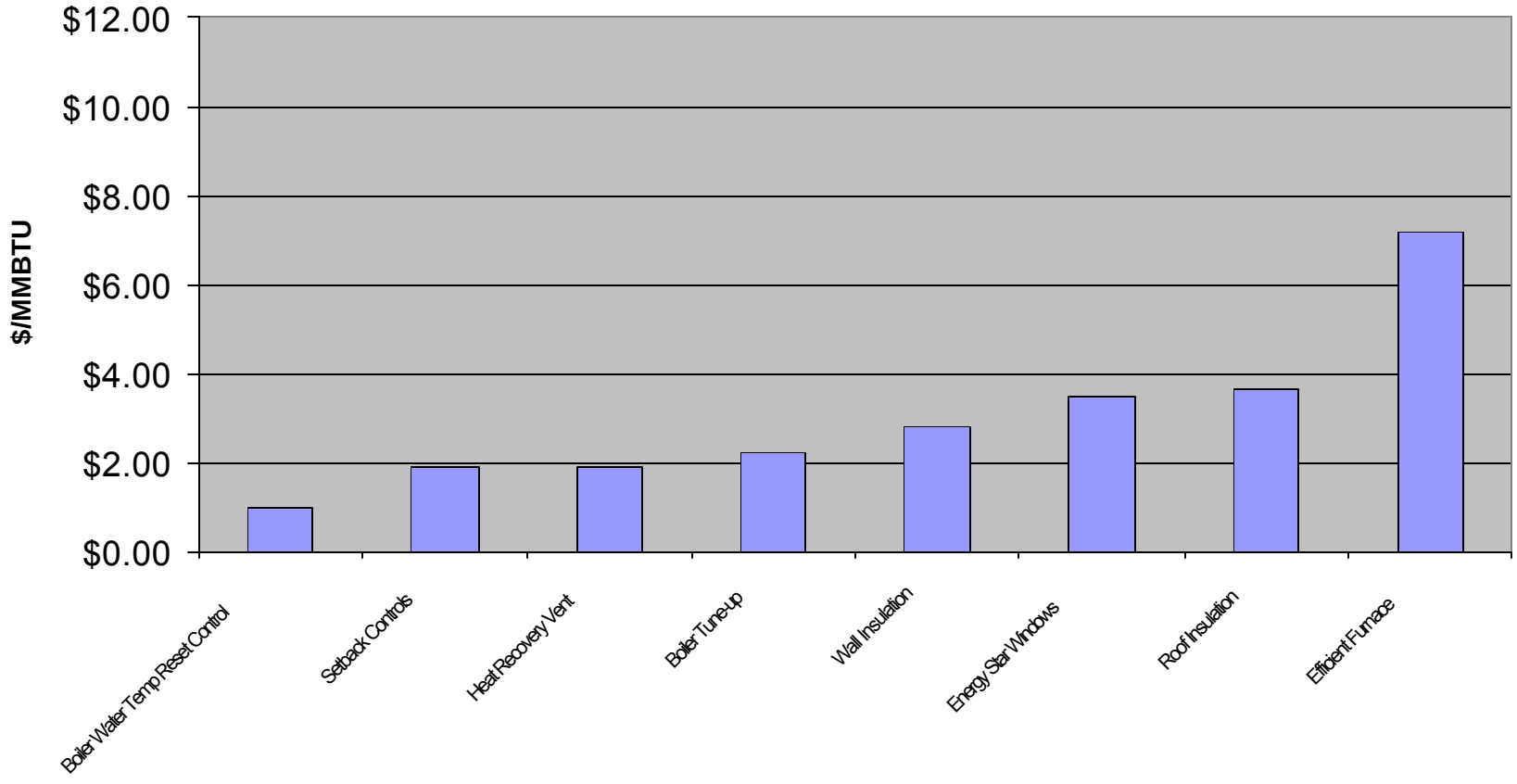
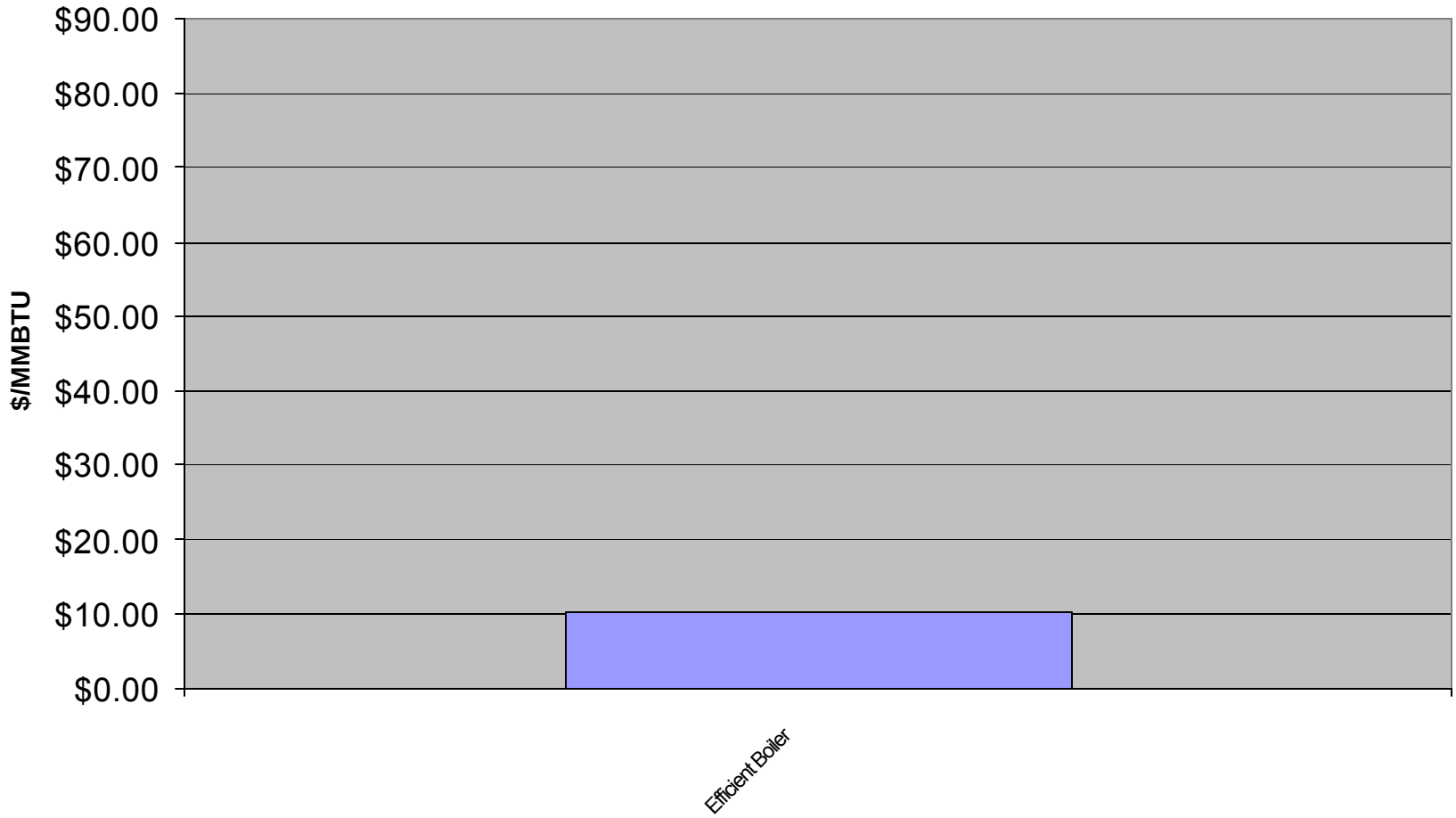


Figure 6-19: Cost of Conserved Energy - **Commercial Wood** Efficiency Measures (Measures over Actual 2007 $/MMBTU of Wood)



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**

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	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

			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	$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

			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	$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

			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	$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

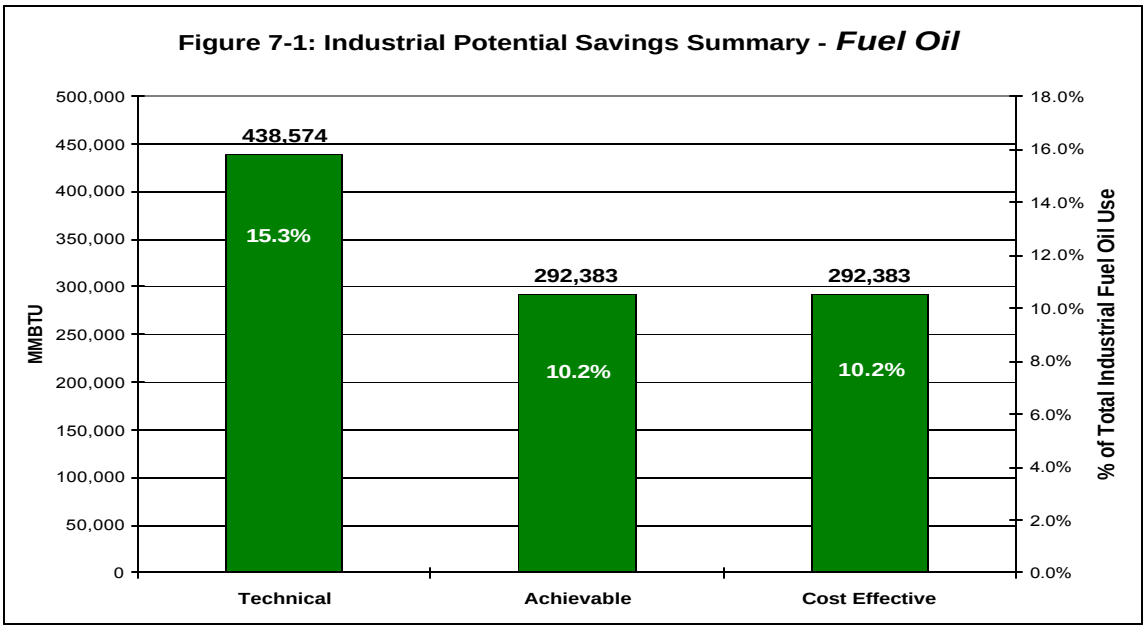
Industrial End Use	Estimated Savings
Indirect Use – Boilers	19%
Direct Use – Process	10%
Space Heating	10%

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.



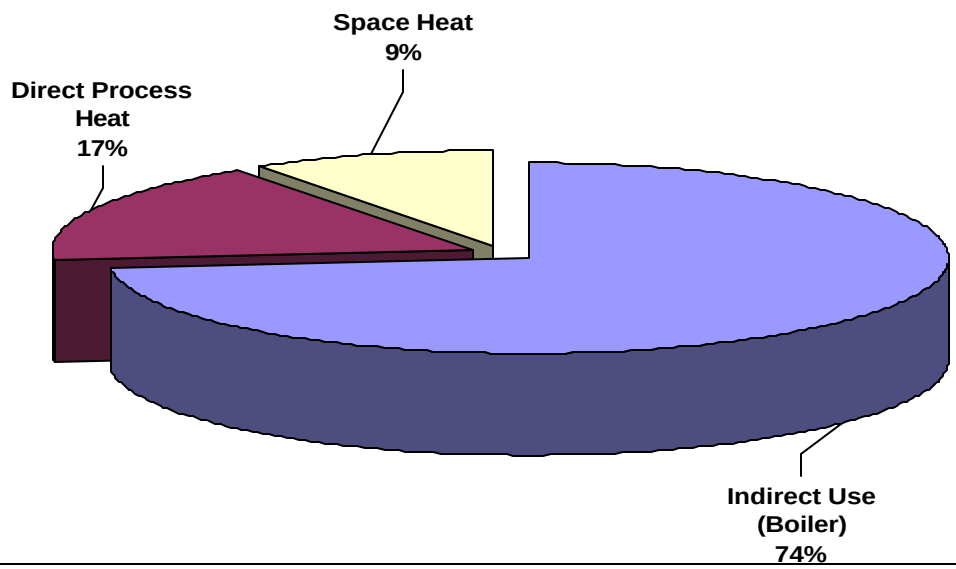
[32] Elliot, Shipley, and Nadel, Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies, ACEEE, Report Number E032, 2003.

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.

Figure 7-3: Industrial Potential Savings Summary - *Propane*

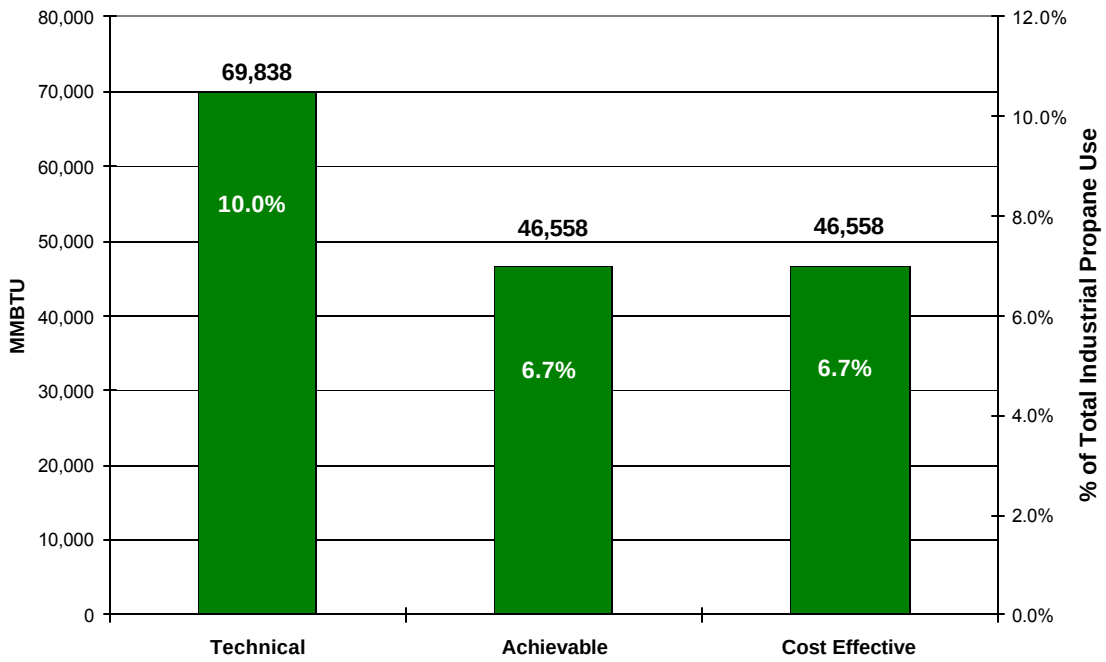
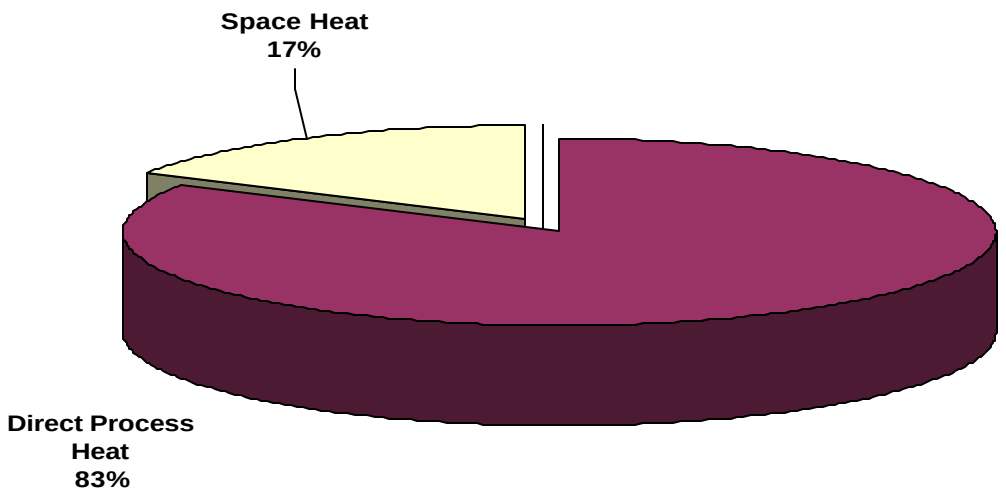


Table 7-10: Summary of Industrial **Propane** Energy Efficiency Savings Potential in Vermont

	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*

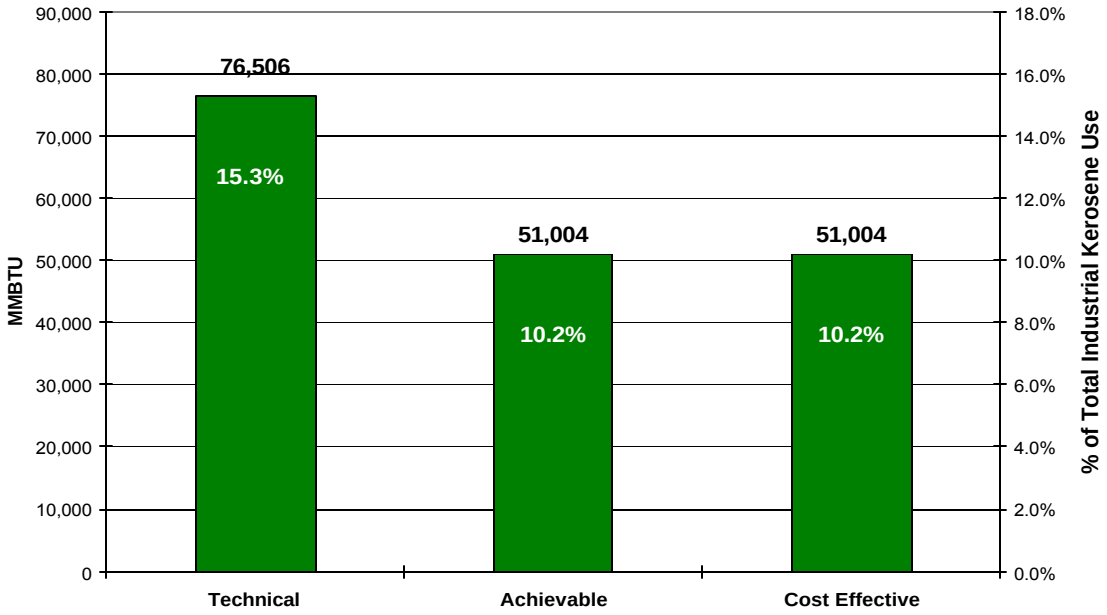
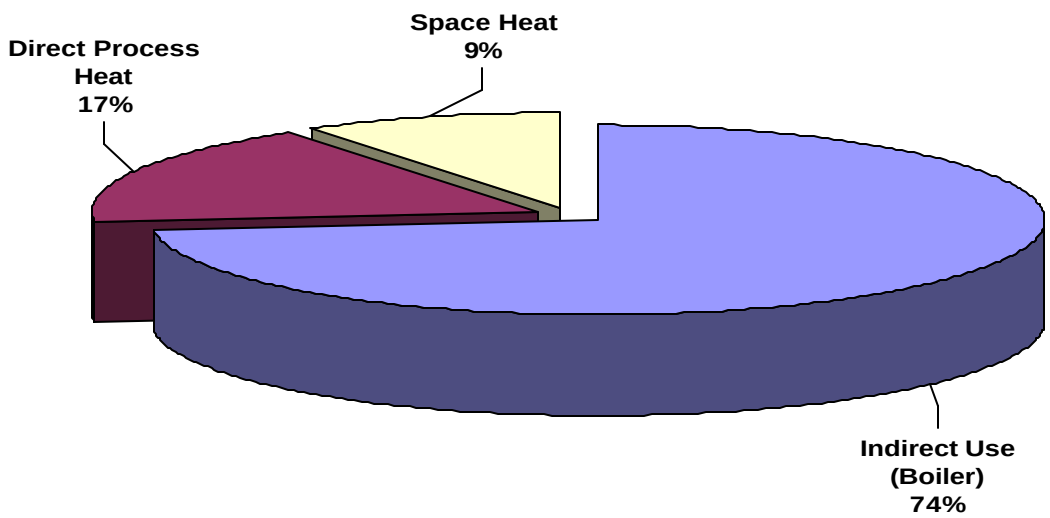


Table 7-11: Summary of Industrial **Kerosene** Energy Efficiency Savings Potential in Vermont		
	Estimated Cumulative Annual Savings by 2016 (MMBTU)	Savings in 2016 as a Percent of Total 2016 Industrial Sector Fuel Oil Consumption
Technical Potential	76,506	15.3%
Achievable Potential	51,004	10.2%
Achievable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

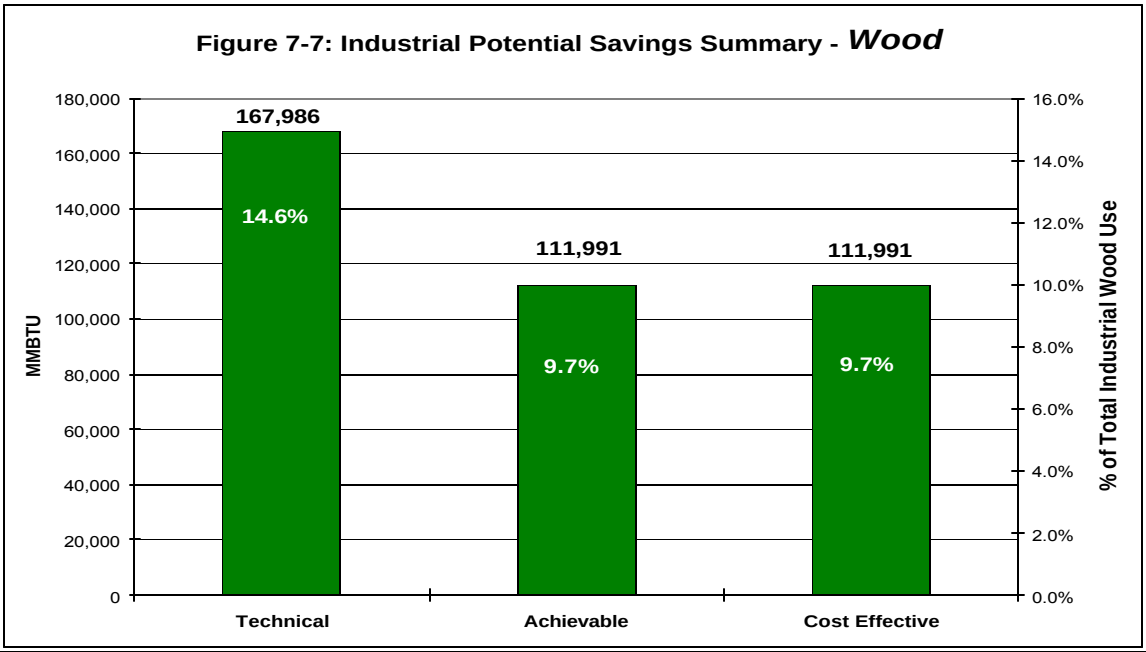
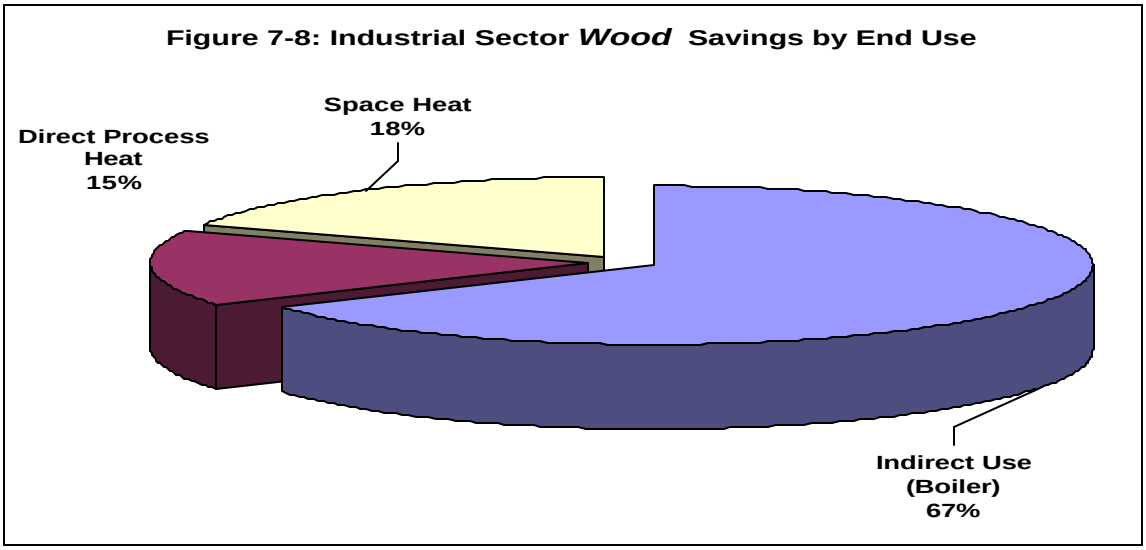


Table 7-12: Summary of Industrial **Wood** Energy Efficiency Savings Potential in Vermont

	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%.



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

APPENDICES

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APPENDIX A:

RESIDENTIAL SECTOR

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APPENDIX A1:

ALL FUELS –
RESIDENTIAL MEASURE DESCRIPTIONS, ASSUMPTIONS, AND SOURCES

Descriptions of Residential Energy Efficiency Measures

This technical appendix describes a broad range of residential sector energy efficiency measures and programs where GDS has assessed the technical and achievable potential for oil, propane, kerosene and wood energy savings in Vermont. The purpose of this technical appendix is to briefly describe these efficiency measures and to provide data on their costs, energy savings and useful lives. The calculations of the potential savings are provided in a separate Excel file that is a separate appendix to this study.

1. FUEL OIL

The following sections describe the energy efficiency measures that were included in this analysis for all homes utilizing fuel oil for either space heating and/or water heating.

1.1 Space Heating

1.1.1 All Oil Space Heated Homes

Four residential space heating energy efficiency measures are covered in this section: Insulation and Weatherization (SF)[1], Attic Insulation (MF)[2], Programmable Thermostats, and Energy Star Windows. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-1: Assumptions for All Oil Space Heated Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Insulation & Weath. Pkg.	SF	106.6	35.2%	37.52	30	$2,558	54.44%	75.00%
Attic Insul. & Weath. Pkg.	MF	53.3	12.7%	6.77	30	$344	45.56%	75.00%
Programmable Thermostats	SF	106.6	7.0%	7.46	15	$60	54.44%	14.00%
	MF	53.3	7.0%	3.73	15	$60	45.56%	12.22%
ES Windows	SF	106.6	11.0%	5.86	30	$400	54.44%	60.00%
	MF	53.3	11.0%	5.863	30	$400	45.50%	60.00%

(1) Insulation and Weatherization (SF)[3]*:* Weatherization measures address the reduction of thermal transfer through the "shell" between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures are typical components in an insulation and weatherization program: attic insulation, wall insulation, basement wall insulation, and air sealing.

[1] SF: Single Family Only
[2] MF: Multi-Family Only
[3] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 392 & 395.

(2) Attic Insulation (MF): This measure package is the same as the insulation and weatherization package described above, except multi-family homes only receive attic insulation and air sealing.

(3) Programmable Thermostats[4]*:* Programmable thermostats automatically adjust the home's temperature setting on a set schedule, allowing for daily energy conservation during periods when normal heating is unnecessary (i.e. when the house is unoccupied, or when occupants are sleeping at night). However, programmable thermostats have to be set and used properly to deliver the advertised energy savings. Routine deviation from the programmed default settings and schedules can significantly lower actual energy savings.

(4) Energy Star Windows[5]*:* In older homes, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool homes. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity coating.

1.1.2 Homes with Oil Furnaces

Two residential space heating energy efficiency measures are covered in this section: Efficient Oil Furnaces and Duct Sealing (SF). Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-2: Assumptions for All Homes with Oil Furnaces

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Oil Furnace	SF	106.6	5.9%	6.29	20	$700	17.75%	6.52%
	MF	53.3	5.9%	3.14	20	$350	11.11%	4.88%
Duct Sealing	SF	106.6	5.0%	5.33	15	$300	17.75%	60.00%

(1) Efficient Oil Furnace[6]*:* A furnace heats air that is blown through air ducts and delivered to rooms through registers or grills. This type of heating system is called a ducted warm-air or forced warm-air distribution system. In this analysis, for a replace on burn-out installation, a high efficiency warm-air oil furnace is installed instead of a standard efficiency replacement model. The baseline replacement model AFUE[7]=80%. The high efficiency model AFUE=85%.

[4] Energy Star website (www.energystar.gov)
[5] "Energy Efficiency in Remodeling: Windows" Tool Base Services website. (www.toolbase.org)
[6] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401.
[7] AFUE is an abbreviation for Annual Fuel Utilization Efficiency.

(2) Duct Sealing (SF)[8]*:* Leaky and unsealed residential air ducts for forced hot air furnaces are properly repaired and sealed. Mastic (a special paste) is the preferred method for duct sealing. Properly sealing leaky ducts can save significant amounts of energy needed to heat a home.

1.1.3 Homes with Oil Water Boilers

Two residential space heating energy efficiency measures are covered in this section: Efficient Oil Water Boilers and Modulating Water Temperature. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-3: Assumptions for All Homes with Oil Water Boilers

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Water Boiler	SF	106.6	2.4%	2.56	25	$642	28.72%	6.52%
	MF	53.3	2.4%	1.28	25	$321	26.67%	4.88%
Modulate Water Temp.	SF	106.6	11.0%	11.73	15	$250	28.72%	15.00%
	MF	53.3	11.0%	5.86	15	$250	26.67%	75.00%

(1) Efficient Water Boiler[9]*:* A hot water boiler heats water that circulates through pipes to radiators or baseboards to provide space heating for a home. Hot water systems, sometimes called hydronic systems are more common today than steam systems. In this analysis, a high efficiency water boiler is installed in lieu of a standard efficiency replacement model. The baseline replace model AFUE=83%. The high efficiency model AFUE=85%.

(2) Modulate Water Temp.[10]*:* Modulating the water temperature of hot water boiler systems is an energy-saving automatic control that measures the outside air temperature and uses this information to estimate demand or heating load as the outdoor temperature varies. The supply hot water temperature is modulated up and down in an inverse linear ratio to outside air temperature. The typical range for conventional boilers is to vary the supply water temperature from 140 to 180 degrees Fahrenheit as the outside air temperature varies from 65 to 0 degrees Fahrenheit.

1.1.4 Homes with Oil Steam Boilers

Five residential space heating energy efficiency measures are covered in this section: Efficient Oil Steam Boilers, Vent Dampers, Improved Steam Vents (SF), Thermostatic Vents (MF), and Mainline Air Vents (MF). Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

[8] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 388.
[9] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401.
[10] HVAC Systems: Boilers. Alliant Energy website (www.alliantenergy.com)

Table A1-4: Assumptions for All Homes with Oil Steam Boilers								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Steam Boiler	SF	106.6	2.4%	2.56	25	$642	7.18%	6.52%
	MF	53.3	2.4%	1.28	25	$321	6.67%	4.88%
Vent Damper	SF	106.6	9.0%	9.59	20	$263	7.18%	50.00%
	MF	53.3	9.0%	4.8	20	$263	6.67%	50.00%
Improved Steam Vents	SF	106.6	6.0%	6.4	20	$450	7.18%	50.00%
Thermostatic Vents	MF	53.3	6.0%	3.2	20	$239	6.67%	60.00%
Mainline Air Vents	MF	53.3	10.0%	5.33	30	$69	6.67%	25.00%

(1) Efficient Steam Boiler[11]*:* Steam boilers are similar to hot water boilers, except they utilize steam circulated through pipes to steam radiators rather than hot water. Steam boilers operate at a higher temperature than hot water boilers and steam systems are less common today than their hot water counterparts. In this analysis, a high efficiency steam boiler is installed in lieu of a standard efficiency replacement model. The baseline replace model AFUE=83%. The high efficiency model AFUE=85%.

(2) Vent Damper[12]*:* A vent damper prevents chimney losses by closing off a boiler's vent when the boiler isn't firing. Steam boilers benefit from vent dampers more than hot-water boilers and bigger boilers benefit more than smaller ones. Vent dampers are likely not cost effective with proper sized, newer heating systems.

(3) Improved Steam Vents (SF)[13]*:* This measure involves repairing or replacing non-functioning or poorly functioning steam vents in residential homes. In addition, an average of two thermostatic vents are installed per home in rooms that exhibit a tendency to overheat.

(4) Thermostatic Vents (MF)[14]*:* Between different areas of a steam distribution system, there may be some areas that are not meeting current heat load in a home while other areas are over-heating. Thermostatic vents restrict flow to some areas and open flow to other areas helping to balance the distribution of steam heat throughout a building.

(5) Mainline Air Vents (MF)[15]*:* As steam tries to move through a line, air sometimes impedes the flow; acting somewhat as a pressure barrier preventing the steam from reaching its destinations further down the line. Meanwhile, the

[11] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401.
[12] "Consumer's Guide to Energy Efficiency and Renewable Energy" DOE website. (www.eere.energy.gov)
[13] Personal communication with Steve Nadel (ACEEE), November 2006.
[14] Personal communication with Bruce Bennett (GDS Associates) and Dave Buck (The Granite Group), November 2006.
[15] Personal communication with Bruce Bennett (GDS Associates) and Dave Buck (The Granite Group), November 2006.

boiler is still responding to calls for heat. Mainline air vents, acting like bleeder valves, are installed at the end of the lines so that the pockets of air can be vented out of the lines allowing the steam to flow unimpeded through the system.

1.2 Water Heating

1.2.1 All Oil Water Heated Homes

Eight residential water heating energy efficiency measures are covered in this section: Efficient Oil Water Heaters(SH/WH Combo), Efficient Oil Water Heaters(stand-alone), Pipe Wrap, Low Flow Showerheads/ Faucets, Energy Star Clothes Washers, Energy Star Dishwashers, Pump Controllers, and Solar Water Heater with Oil Water Heating Back Up. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-5: Assumptions for All Oil Water Heated Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Oil Water Heater (SH/WH)	SF	30.5	35.0%	10.68	25	$750	19.31%	55.00%
	MF	30.5	35.0%	10.68	25	$750	15.97%	45.00%
Efficient Oil Water Heater (stand-alone)	SF	30.5	14.1%	4.29	10	$1,125	8.90%	55.00%
	MF	30.5	14.1%	4.3	10	$1,125	7.36%	45.00%
Pipe Wrap	SF	30.5	0.3%	0.1	10	$15	28.21%	45.00%
	MF	30.5	0.3%	0.1	10	$15	23.33%	35.00%
Low Flow Showerhead/Faucets	SF	30.5	4.1%	1.24	9	$21	28.21%	49.31%
	MF	30.5	4.1%	1.24	9	$21	23.33%	38.89%
ES Clothes Washer	SF	30.5	1.3%	0.41	14	$270	27.32%	14.00%
	MF	30.5	1.3%	0.41	14	$270	14.52%	14.00%
ES Dishwasher	SF	30.5	1.1%	0.35	13	$27	17.08%	21.00%
	MF	30.5	1.1%	0.35	13	$27	8.56%	21.00%
Pump Controller	MF	30.5	16.0%	4.88	15	$39	23.33%	40.00%
Solar WH w/ Oil Back Up	SF	30.5	65.0%	19.83	20	$5,626	28.21%	0.00%

(1) Efficient Oil Water Heater (SH/WH Combo)[16]*:* In this measure, baseline replacement oil water heaters are replaced with high efficiency water heater/space heater combination systems, such as indirect fired hot water heaters. In indirect hot water and heat systems, water is heated as a separate zone off of the furnace or boiler. There is no burner on the water heater, and the system reuses waste heat from the furnace/boiler to heat water for tap use. The hot water is stored in an insulated storage tank and is always ready for use - keeping the boiler from having to turn on frequently. This measure is applied to homes operating heating systems other than oil furnaces and oil water heaters.

[16] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.

(2) Efficient Oil Water Heater (stand-alone)[17,18]*:* In this measure, baseline replacement stand alone oil water heaters are replaced with high efficiency stand alone storage tank water heaters. Storage water heaters work by heating up water in an insulated tank. However, because heat is lost through the walls of the storage tank, energy is consumed even when no hot water is being used. New high-efficiency storage water heaters contain higher levels of insulation around the tank, reducing standby losses. In this analysis a baseline replacement model (EF=.55) is replaced with a high efficiency model (EF=.64). This measure applies to homes operating oil furnace heating systems and oil water heaters.

(2) Pipe Wrap[19]*:* Insulating hot water pipes will reduce losses as the hot water is flowing to the faucet and, more importantly, it will reduce standby losses when the tap is turned off and then back on within an hour or so. Pipe wrap will conserve energy and water that would normally be lost waiting for the hot water to reach the tap. Energy loss still occurs after pipe wrap has been installed, though to a smaller degree than the losses observed in non-insulated pipes.

(3) Low Flow Showerheads/Faucets[20]*:* An existing showerhead/faucet is replaced with a new unit that has a low-flow rate. Significant savings in hot water use can be achieved by installing low-flow showerheads and faucets. The single best action is to replace old showerheads as showers use 37% of the hot water in typical U.S. homes.

(4) ES Clothes Washer[21]*:* Clothes washers exceeding minimum qualifying efficiency standards established under Energy Star Program with a Modified Energy Factor (MEF) >= 1.8 and a Water Factor (WF) <=7.5. The MEF measures the energy used during the washing process, including machine energy, water heating energy, and dryer energy. The higher the MEF, the more efficient the clothes washer is. Energy Star qualified washers extract more water from clothes during the spin cycle. This reduces the drying time and saves energy and wear and tear on your clothes. In addition, substantial savings on water and sewer bills contribute to the economic benefits of high-efficiency washers. A high efficiency clothes washer can save approximately 4,300 gallons of water a year. For purposes of this study, this measure is limited to homes having oil water heating systems *and* clothes washers.

(5) ES Dishwasher[22]*:* Dishwashers exceeding minimum qualifying efficiency standards established under Energy Star Program with an Energy Factor (EF) >= .58. Energy Star labeled dishwashers save energy by using both improved technology for the primary wash cycle, and by using less hot water to clean.

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[17] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003. Table 6.6.
[18] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 376.
[19] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[20] Global Green USA website (www.globalgreen.org/pha-energytoolbox/tech_dhw.htm)
[21] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 237
[22] Energy Star website (www.energystar.gov) Energy Star has determined new energy efficiency standards for dishwashers (EF >= .65). This future criterion is effective January 1, 2007.

Construction includes more effective washing action, energy efficient motors and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes. In addition, a high efficiency dishwasher can save approximately 135 gallons of water a year. This measure is limited to homes having oil water heating *and* dishwashers.

(6) Pump Controller (MF)[23]*:* Pump controllers are electronic controls that save energy by memorizing building hot water demand patterns. The controller, based on usage patterns, automatically reduces hot water loop temperatures during periods of low hot water demand. This reduces the amount of wasted energy expended to heat water during periods of low usage.

(7) Solar WH w/ Oil Back-up (SF)[24]*:* Solar water heaters are designed to serve as pre-heaters for conventional storage or demand water heaters. As the solar system preheats the water, the extra temperature boost required by the storage or demand water heater is relatively low, and high flow rate can be achieved. Solar water heaters can be particularly effective if they are designed for three-season use, with a home's heating system providing hot water during the winter months. Although less common than they were two to three decades ago, solar water heating units are considerably less expensive and more reliable.

1.3 New Homes Construction

1.3.1 All Oil Heated New Homes

One residential space heating energy efficiency measures is covered in this section: Energy Efficient New Homes Construction. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-6: Assumptions for Oil Heated New Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
New Homes Construction	SF	83.1	20.0%	16.62	30	$2,000	45.00%	33.00%
	MF	41.55	20.0%	8.31	30	$1,000	45.00%	33.00%

(1) Energy Efficient New Homes Construction[25]*:* Energy efficient new homes are new residential construction projects that have been independently verified to be at least 20% more energy efficient than homes built to 2004 International Energy Conservation Code (IECC). A new home constructed to exactly to IECC code (reference home) is assigned a score of 100 and a zero energy house assigned a score of 0. Each 1 percent reduction in energy usage (compared to

[23] Personal communication with Steve Nadel (ACEEE), November 2006.
[24] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[25] "September 2005 Update: EPA Releases Final New Guidelines for ENERGY STAR Qualified Homes." (www.energystar.gov)

the reference house) results in a one point decrease in the HERS score. In Vermont, an Energy Efficient New Home is required to be approximately 20 percent more energy efficient than 2004 IECC standards and receive a rating of 80. Savings are based on heating, cooling, and typically achieved through a combination of: high performance windows, controlled air infiltration, upgraded heating and conditioning systems, tight duct systems, and high efficiency building envelope standards. These features contribute to improved home quality and homeowner comfort, and to lower energy demand and reduced air pollution.

1.4 Vacant Homes

1.4.1 All Oil Heated Vacant Homes

One residential space heating energy efficiency measures is covered in this section: Energy Efficient Vacant Homes Package. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-7: Assumptions for All Oil Heated Vacant Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Vacant Homes Package	SF	43.4	46.4%	20.12	30	$3,218	54.44%	75.00%
	MF	21.7	27.7%	6.02	30	$804	45.56%	75.00%

(1) Energy Efficient Vacant Homes Package[26]*:* There were 60,234 vacant homes in Vermont according to the latest census estimates. A housing unit is considered 'vacant' if no individual was living in the home at the time of the survey. This excludes any homes whose usual occupants were only temporarily absent. However, this includes homes whose sole occupants were persons who usually live elsewhere. Most vacant homes are intended only for seasonal use, particularly in the Northeast. As a result, annual heating consumption demands for these homes are typically lower than those found in typical existing homes. For this analysis, GDS assumed a suite of thermal shell efficiency measures (Insulation & Weatherization, Energy Star Windows, and Programmable Thermostats) would be installed in vacant homes.

[26] "Vacant Homes Statistical Brief. US Bureau of the Census website. (www.census.gov)

Table A1-8: Oil Measure Assumptions

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)
All Homes with Oil Space Heat												
1	Insulation & Weatherization Pkg.	SF	106.60	35.2%	37.52	30	$2,558	Homes w/ Oil SH	54.44%	75.00%		
2	Programmable Thermostats	SF	106.60	7.0%	7.46	15	$60	Homes w/ Oil SH	54.44%	14.00%		
3	ES Windows	SF	106.60	11.0%	11.73	30	$600	Homes w/ Oil SH	54.44%	60.00%		
4	Attic Insulation & Weatherization Pkg.	MF	53.30	12.7%	6.77	30	$344	Homes w/ Oil SH	45.56%	75.00%		
5	Programmable Thermostats	MF	53.30	7.0%	3.73	15	$60	Homes w/ Oil SH	45.56%	12.22%		
6	ES Windows	MF	53.30	11.0%	5.86	30	$400	Homes w/ Oil SH	45.56%	60.00%		
All Homes with Oil Furnaces												
7	Efficient Oil Furnace	SF	106.60	5.9%	6.29	20	$700	Homes w/ Oil Furnaces	17.75%	6.52%	462	
8	Duct Sealing	SF	106.60	5.0%	5.33	15	$300	Homes w/ Oil Furnaces	17.75%	60.00%		
9	Efficient Oil Furnace	MF	53.30	5.9%	3.14	20	$350	Homes w/ Oil Furnaces	11.11%	4.88%	231	
Homes with Oil Water Boilers												
10	Efficient Water Boiler	SF	106.60	2.4%	2.56	25	$642	Homes w/ Oil Water Boilers	28.72%	6.52%		
11	Modulate Water Temp.	SF	106.60	11.0%	11.73	15	$250	Homes w/ Oil Water Boilers	28.72%	15.00%		
12	Efficient Water Boiler	MF	53.30	2.4%	1.28	25	$321	Homes w/ OilWater Boilers	26.67%	4.88%		
13	Modulate Water Temp.	MF	53.30	11.0%	5.86	15	$250	Homes w/ Oil Water Boilers	26.67%	75.00%		
Homes with Oil Steam Boilers												
14	Efficient Steam Boiler	SF	106.60	2.4%	2.56	25	$642	Homes with Oil Steam Boilers	7.18%	6.52%		
15	Improved Steam Vents	SF	106.60	6.0%	6.40	20	$450	Homes with Oil Steam Boilers	7.18%	50.00%		
16	Vent Damper	SF	106.60	9.0%	9.59	20	$263	Homes with Oil Steam Boilers	7.18%	50.00%		
17	Efficient Steam Boiler	MF	53.30	2.4%	1.28	25	$321	Homes with Oil Steam Boilers	6.67%	4.88%		
18	Thermostatic Vents	MF	53.30	6.0%	3.20	20	$239	Homes with Oil Steam Boilers	6.67%	60.00%		
19	Mainline Vents	MF	53.30	10.0%	5.33	30	$69	Homes with Oil Steam Boilers	6.67%	25.00%		
20	Vent Damper	MF	53.30	9.0%	4.80	20	$263	Homes with Oil Steam Boilers	6.67%	50.00%		
Oil Water Heating												
21	Pipe Wrap	SF	30.50	0.3%	0.10	10	$15	Homes with Oil WH	28.21%	45.00%		
22	Low Flow Showerhead/Faucets	SF	30.50	4.1%	1.24	9	$21	Homes with Oil WH	28.21%	49.31%		4937
23	Efficient Oil Water Heater (SH/WH)	SF	30.50	35.0%	10.68	25	$750	Homes w/ Oil WH & Non-Furn.	19.31%	55.00%		
24	Efficient Oil Water Heater (stand-alone)	SF	30.50	14.1%	4.29	10	$1,125	Homes with Oil WH & Furn.	8.90%	55.00%		
25	ES Clothes Washer	SF	30.50	1.3%	0.41	14	$270	Homes with Oil WH & CW	27.32%	14.00%	223	4338.4
26	ES Dishwasher	SF	30.50	1.1%	0.35	13	$27	Homes with Oil WH & DW	17.08%	21.00%	34	134.64
27	Solar WH w/ Oil Back Up	SF	30.50	65.0%	19.83	20	$5,626	Homes with Oil WH	28.21%	0.00%		
28	Pipe Wrap	MF	30.50	0.3%	0.10	10	$15	Homes with Oil WH	23.33%	35.00%		
29	Low Flow Showerhead/Faucets	MF	30.50	4.1%	1.24	9	$21	Homes with Oil WH	23.33%	38.89%		4937

Table A1-8: Oil Measure Assumptions

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)
30	Efficient Oil Water Heater (SH/WH)	MF	30.50	35.0%	10.68	25	$750	Homes w/ Oil WH & Non-Furn.	15.97%	45.00%		
31	Efficient Oil Water Heater (stand-alone)	MF	30.50	14.1%	4.30	10	$1,125	Homes with Oil WH & Furn.	7.36%	45.00%		
32	ES Clothes Washer	MF	30.50	1.3%	0.41	14	$270	Homes with Oil WH & CW	14.52%	14.00%	223	4338.4
33	ES Dishwasher	MF	30.50	1.1%	0.35	13	$27	Homes with Oil WH & DW	8.56%	21.00%	34	134.64
34	Pump Controller	MF	30.50	16.0%	4.88	15	$39	Homes with Oil WH	23.33%	40.00%		
All Oil-Heated New Homes												
35	New Homes Construction	SF	83.10	20.0%	16.62	30	$2,000	All Oil Heated New Homes	45.00%	33.00%		
36	New Homes Construction	MF	41.55	20.0%	8.31	30	$1,000	All Oil Heated New Homes	45.00%	33.00%		
All Oil-Heated Vacant Homes												
37	Vacant Homes Package	SF	43.40	46.4%	20.12	30	$3,218	All Oil Heated Vacant Homes	54.44%	75.00%		
38	Vacant Homes Package	MF	21.70	27.7%	6.02	30	$804	All Oil Heated Vacant Homes	45.56%	75.00%		

Note: All potential oil/kerosene heated new homes were assumed to install oil measures.

Note: Vacant Homes estimated to use 40.71 % of Existing Homes Base Consumption

Note: New Homes estimated to use 78% of Existing Homes Base Consumption

Table A1-9: Oil Measure Sources

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings	Useful Life	Measure Cost	Base Saturation	EE Saturation	Notes
All Homes with Oil Space Heat										
1	Insulation & Weatherization Pkg.	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	GDS/VT	
2	Programmable Thermostats	SF	RECS CE2	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	
3	ES Windows	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	KEMA 3-33	
4	Attic Insulation & Weatherization Pkg.	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	GDS/VT	(Base Fuel Use)- Approximately 50% of SF Base Use. Same % found in ACEEE report
5	Programmable Thermostats	MF	RECS CE2	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	(Base Fuel Use) - Approx. 50% of SF Base Use.
6	ES Windows	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	KEMA 3-33	(Base Fuel Use) - Approx. 50% of SF Base Use.
All Homes with Oil Furnaces										
7	Efficient Oil Furnace	SF	REC CE2	EVT 403		EVT 400	EVT 401	KEMA	KEMA	
8	Duct Sealing	SF	REC CE2	EVT 389		EVT 389	EVT 389	KEMA	ACEEE 41	
9	Efficient Oil Furnace	MF	REC CE2	EVT 403		EVT 400	EVT 400	KEMA	KEMA	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use.
Homes with Oil Water Boilers										
10	Efficient Water Boiler	SF	RECS CE2	EVT 403		EVT 400	EVT 401	GDS/KEMA	KEMA	(Base Saturation)-Assumes 80% of boilers are water boilers
11	Modulate Water Temp.	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	GDS/KEMA	ACEEE 41	(Base Saturation)-Assumes 80% of boilers are water boilers
12	Efficient Water Boiler	MF	RECS CE2	EVT 403		EVT 400	EVT 400	GDS/KEMA	KEMA	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 80% of boilers are water boilers
13	Modulate Water Temp.	MF	RECS CE2	ACEEE 42		ACEEE 42	GDS/ACEEE	GDS/KEMA	ACEEE 42	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 80% of boilers are water boilers
Homes with Oil Steam Boilers										
14	Efficient Steam Boiler	SF	RECS CE2	EVT 403		EVT 400	EVT 401	GDS/KEMA	KEMA	(Base Saturation)-Assumes 20% of boilers are steam boilers
15	Improved Steam Vents	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	GDS/KEMA	ACEEE 41	(Base Saturation)-Assumes 20% of boilers are steam boilers
16	Vent Damper	SF	RECS CE2	ACEEE2 70		GDS/ACEEE2	ACEEE2 70	GDS/KEMA	GDS/ACEEE2	(Base Saturation)-Assumes 20% of boilers are steam boilers
17	Efficient Steam Boiler	MF	RECS CE2	EVT 403		EVT 400	EVT 400	GDS/KEMA	KEMA	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
18	Thermostatic Vents	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	GDS/KEMA	ACEEE 42	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
19	Mainline Vents	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	GDS/KEMA	ACEEE 42	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
20	Vent Damper	MF	RECS CE2	ACEEE2 70		GDS/ACEEE2	ACEEE2 70	GDS/KEMA	GDS/ACEEE2	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
Oil Water Heating										
21	Pipe Wrap	SF	RECS CE4		ECT 368	EVT 368	EVT 368	KEMA	GDS/KEMA	
22	Low Flow Showerhead/Faucets	SF	RECS CE4		EVT 372	EVT 372	EVT 372	KEMA	KEMA	Also EVT 374
23	Efficient Oil Water Heater (SH/WH)	SF	RECS CE4	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	ACEEE 42	(Base Saturation) - % of homes with oil water heaters * % of oil heated homes with non-furnaces
	Efficient Oil Water Heater (stand-alone)	SF	RECS CE4	ACEEE T6.6 & EVT 376		EVT 376	ACEEE T6.6 & EVT 376	KEMA	ACEEE 42	(Base Saturation) - % of homes with oil water heaters * % of oil heated homes with furnaces
25	ES Clothes Washer	SF	RECS CE4		EVT 239	EVT 238	EVT 238	KEMA	D&R	
26	ES Dishwasher	SF	RECS CE4		EVT 246	EVT 245	EVT 245	KEMA	D&R	

Table A1-9: Oil Measure Sources

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings	Useful Life	Measure Cost	Base Saturation	EE Saturation	Notes
27	Solar WH w/ Oil Back Up	SF	RECS CE4	RERC		ACEEE T6.6	RERC	KEMA	KEMA	GDS calculation based on information from RERC (VEIC)
28	Pipe Wrap	MF	RECS CE4		ECT 368	EVT 368	EVT 368	KEMA	GDS/KEMA	
29	Low Flow Showerhead/Faucets	MF	RECS CE4		EVT 372	EVT 372	EVT 372	KEMA	KEMA	Also EVT 374
30	Efficient Oil Water Heater (SH/WH)	MF	RECS CE4	ACEEE 42		ACEEE 42	GDS/ACEEE	KEMA	ACEEE 42	(Base Saturation) - % of homes with oil water heaters * % of oil heated homes with non-furnaces
31	Efficient Oil Water Heater (stand-alone)	MF	RECS CE4	ACEEE T6.6 & EVT 376		EVT 376	ACEEE T6.6 & EVT 376	KEMA	ACEEE 42	(Base Saturation) - % of homes with oil water heaters * % of oil heated homes with furnaces
32	ES Clothes Washer	MF	RECS CE4		EVT 239	EVT 238	EVT 238	KEMA	D&R	
33	ES Dishwasher	MF	RECS CE4		EVT246	EVT 245	EVT 245	KEMA	D&R	
34	Pump Controller	MF	RECS CE4	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	ACEEE 42	
All Oil-Heated New Homes										
38	New Homes Construction	SF	GDS	GDS/Fasey		GDS/Fasey	GDS/Fasey	KEMA2	GDS/Fasey	
39	New Homes Construction	MF	GDS	GDS/Fasey		GDS/Fasey	GDS/Fasey	KEMA2	GDS/Fasey	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use.
All Oil-Heated Vacant Homes										
40	Vacant Homes Package	SF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	
41	Vacant Homes Package	MF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	(Base Fuel Use) - Approx. 50% of SF Base Use.

Note: Any additional electric and water savings per measure are attributed to the measure's '% savings/annual fuel savings' source.

Source Code Index:

ACEEE: N. Elliott et al. 'Reducing Oil Use Through Energy Efficiency: Opportuniities Beyond Cars and Light Trucks.' Report E061. ACEEE. Washington D.C. January 2006.

ACEEE2: 'Consumer Guide to Home Energy Savings' 8th ed. ACEEE. 2003. Table 6.6

ACEEE T6.6: 'Consumer Guide to Home Energy Savings' 8th ed. ACEEE. 2003. Table 6.6

D&R: Personal Communication, Bill McNary, February 22, 2006.

ES Calc-PT: Energy Star Calculator (www.energystar.gov) Energy Star Calculator - Programmable Thermostats (.xls)

EVT: Efficiency Vermont. Technical Reference User Manual (TRM) No. 2006-41.

GDS: Calculation based on data compiled for "Incremental Cost of Energy Star Homes in Massachusetts & New Hampshire" GDS Associates. February 2003 and REMrate model. Base consumption in new homes was estimated to be 78% of existing homes.

GDS2: Vacant Homes Package is a combination of shell measures (insulation & weatherization, programmable thermostats, and windows) for savings, useful life, and cost. Base consumption was estimated by GDS using REMrate. A vacant home is estimated to use ~40.71% of a normal existing home.

GDS/ACEEE: GDS estimate based on information provided in the ACEEE 2006 Oil Report (see above citation)

GDS/ACEEE2: GDS estimate based on information provided in the ACEEE Consumer Guide to Home Energy Savings and similar efficiency measures.

GDS/Fasey: GDS Associates, personal communication with Richard Fasey, EVT New Homes Program in December 2006.

GDS/KEMA: GDS Estimate based on available data in the KEMA Residential Appliance Survey (Dec. 2005) / 80/20 split between water & steam boilers is an estimate provided to Bruce Bennett from Dave Buck (The Granite Group) on 11/22/2006.

GDS/VT: GDS Estimate based on meeting with Efficiency Vermont and Vermont Department of Public Service

KEMA: 'Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs' KEMA Dec. 2005. (No page number means GDS calculation based on KEMA data.)

KEMA2: 'Final Report: Phase 1 Evaluation of the Efficiency Vermont Residential Programs' KEMA Oct. 2003. Page 4-16.

RECS CE2: Residential Energy Consumption Survey, 2001. Energy Information Administration. Table CE2-9c: Space-Heating Energy Consumption in US Households by Northeast Census Region, 2001.

RECS CE4: Residential Energy Consumption Survey, 2001. Energy Information Administration. Table CE4-9c: Water-Heating Energy Consumption in US Households by Northeast Census Region, 2001.

RERC: 'Investing in a Solar Hot Water System' Renewable Energy Resource Center: A Project of the Vermont Energy Investment Corporation. (www.rerc-vt.org/shw_investing.htm)

2. PROPANE

The following sections describe the energy efficiency measures that were included in this analysis for all homes utilizing propane for either space heating and/or water heating.

2.1 Space Heating

2.1.1 All Propane Space Heated Homes

Four residential space heating energy efficiency measures are covered in this section: Insulation and Weatherization (SF)[27], Attic Insulation (MF)[28], Programmable Thermostats, and Energy Star Windows. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-10: Assumptions for All Propane Space Heated Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Insulation & Weath. Pkg.	SF	85.6	35.2%	37.52	30	$2,558	13.81%	75.00%
Attic Insul. & Weath. Pkg.	MF	42.8	12.7%	6.77	30	$344	18.89%	75.00%
Programmable Thermostats	SF	85.6	7.0%	7.46	15	$60	13.81%	14.00%
	MF	42.8	7.0%	3.73	15	$60	18.89%	12.22%
ES Windows	SF	85.6	11.0%	5.86	30	$400	13.81%	60.00%
	MF	42.8	11.0%	5.863	30	$400	18.89%	60.00%

(1) Insulation and Weatherization (SF)[29]: Weatherization measures address the reduction of thermal transfer through the "shell" between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures are typical components in an insulation and weatherization program: attic insulation, wall insulation, basement wall insulation, and air sealing.

(2) Attic Insulation (MF): This measure package is the same as the insulation and weatherization package described above, except multi-family homes only receive attic insulation and air sealing.

(3) Programmable Thermostats[30]: Programmable thermostats automatically adjust the home's temperature setting on a set schedule, allowing for daily energy conservation during periods when normal heating is unnecessary (i.e. when the house is unoccupied, or when occupants are sleeping at night). However, programmable thermostats have to be set and used properly to deliver the advertised energy savings. Routine deviation from the programmed default settings and schedules can significantly lower actual energy savings.

[27] SF: Single Family Only
[28] MF: Multi-Family Only
[29] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 392 & 395.
[30] Energy Star website (www.energystar.gov)

(4) Energy Star Windows[31]*:* In older homes, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool homes. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity coating.

2.1.2 Homes with Propane Furnaces

Two residential space heating energy efficiency measures are covered in this section: Efficient Propane Furnaces and Duct Sealing (SF). Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-11: Assumptions for All Homes with Propane Furnaces

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Propane Furnace	SF	85.6	5.6%	4.79	20	$200	5.13%	6.52%
	MF	42.8	5.6%	2.4	20	$100	4.44%	4.88%
Duct Sealing	SF	85.6	5.0%	4.28	15	$300	5.13%	60.00%

(1) Efficient Propane Furnace[32]*:* A furnace heats air that is blown through air ducts and delivered to rooms through registers or grills. This type of heating system is called a ducted warm-air or forced warm-air distribution system. In this analysis, for a replace on burn-out installation, a high efficiency warm-air propane furnace is installed instead of a standard efficiency replacement model. The baseline replacement model AFUE[33]=85%. The high efficiency model AFUE=90%.

(2) Duct Sealing (SF)[34]*:* Leaky and unsealed residential air ducts for forced hot air furnaces are properly repaired and sealed. Mastic (a special paste) is the preferred method for duct sealing. Properly sealing leaky ducts can save significant amounts of energy needed to heat a home.

2.1.3 Homes with Propane Water Boilers

Two residential space heating energy efficiency measures are covered in this section: Efficient Propane Water Boilers and Modulating Water Temperature. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

[31] "Energy Efficiency in Remodeling: Windows." Tool Base Services website. (www.toolbase.org)
[32] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401.
[33] AFUE is an abbreviation for Annual Fuel Utilization Efficiency.
[34] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 388.

Table A1-12: Assumptions for All Homes with Propane Water Boilers								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Water Boiler	SF	85.6	2.3%	1.97	25	$890	4.58%	6.52%
	MF	42.8	2.3%	0.98	25	$445	6.22%	4.88%
Modulate Water Temp.	SF	85.6	11.0%	9.42	15	$250	4.58%	15.00%
	MF	42.8	11.0%	4.71	15	$250	6.22%	75.00%

(1) Efficient Water Boiler[35]*:* A hot water boiler heats water that circulates through pipes to radiators or baseboards to provide space heating for a home. Hot water systems, sometimes called hydronic systems are more common today than steam systems. In this analysis, a high efficiency water boiler is installed in lieu of a standard efficiency replacement model. The baseline replace model AFUE=84%. The high efficiency model AFUE=86%.

(2) Modulate Water Temp.[36]*:* Modulating the water temperature of hot water boiler systems is an energy-saving automatic control that measures the outside air temperature and uses this information to estimate demand or heating load as the outdoor temperature varies. The supply hot water temperature is modulated up and down in an inverse linear ratio to outside air temperature. The typical range for conventional boilers is to vary the supply water temperature from 140 to 180 degrees Fahrenheit as the outside air temperature varies from 65 to 0 degrees Fahrenheit.

2.1.4 Homes with Propane Steam Boilers

Five residential space heating energy efficiency measures are covered in this section: Efficient Propane Vent Dampers, Steam Boilers, Improved Steam Vents (SF), Thermostatic Vents (MF), and Mainline Air Vents (MF). Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-13: Assumptions for All Homes with Propane Steam Boilers								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Steam Boiler	SF	85.6	2.3%	1.97	25	$890	1.14%	6.52%
	MF	42.8	2.3%	0.98	25	$445	1.56%	4.88%
Vent Damper	SF	85.6	9.0%	7.7	20	$263	1.14%	50.00%
	MF	42.8	9.0%	3.85	20	$263	1.56%	50.00%
Improved Steam Vents	SF	85.6	6.0%	5.14	20	$450	1.14%	50.00%
Thermostatic Vents	MF	42.8	6.0%	2.57	20	$239	1.56%	60.00%
Mainline Air Vents	MF	42.8	10.0%	4.28	30	$69	1.56%	25.00%

(1) Efficient Steam Boiler[37]*:* Steam boilers are similar to hot water boilers, except they utilize steam circulated through pipes to steam radiators rather than hot water. Steam boilers operate at a higher temperature than hot water boilers and

[35] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401.
[36] HVAC Systems: Boilers. Alliant Energy website (www.alliantenergy.com)
[37] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401.

steam systems are less common today than their hot water counterparts. In this analysis, a high efficiency steam boiler is installed in lieu of a standard efficiency replacement model. The baseline replace model AFUE=84%. The high efficiency model AFUE=86%.

(2) Vent Damper[38]*:* A vent damper prevents chimney losses by closing off a boiler's vent when the boiler isn't firing. Steam boilers benefit from vent dampers more than hot-water boilers and bigger boilers benefit more than smaller ones. Vent dampers are likely not cost effective with proper sized, newer heating systems.

(3) Improved Steam Vents (SF)[39]*:* This measure involves repairing or replacing non-functioning or poorly functioning steam vents in residential homes. In addition, an average of two thermostatic vents are installed per home in rooms that exhibit a tendency to overheat.

(4) Thermostatic Vents (MF)[40]*:* Between different areas of a steam distribution system, there may be some areas that are not meeting current heat load in a home while other areas are over-heating. Thermostatic vents restrict flow to some areas and open flow to other areas helping to balance the distribution of steam heat throughout a building.

(5) Mainline Air Vents (MF)[41]*:* As steam tries to move through a line, air sometimes impedes the flow; acting somewhat as a pressure barrier preventing the steam from reaching its destinations further down the line. Meanwhile, the boiler is still responding to calls for heat. Mainline air vents, acting like bleeder valves, are installed at the end of the lines so that the pockets of air can be vented out of the lines allowing the steam to flow unimpeded through the system.

2.2 Water Heating

2.2.1 All Propane Water Heated Homes

Seven residential water heating energy efficiency measures are covered in this section: Efficient Propane Water Heaters, Pipe Wrap, Low Flow Showerheads/ Faucets, Energy Star Clothes Washers, Energy Star Dishwashers, Pump Controllers, and Solar Water Heater with Propane Water Heating Back Up. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

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[38] "Consumer's Guide to Energy Efficiency and Renewable Energy" DOE website. (www.eere.energy.gov)
[39] Personal communication with Steve Nadel (ACEEE), November 2006.
[40] Personal communication with Bruce Bennett (GDS Associates) and Dave Buck (The Granite Group), November 2006.
[41] Personal communication with Bruce Bennett (GDS Associates) and Dave Buck (The Granite Group), November 2006.

Table A1-14: Assumptions for All Propane Water Heated Homes								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Propane Water Heater	SF	19.1	23.8%	4.54	15	$450	18.15%	3.96%
	MF	19.1	23.8%	4.54	15	$450	10.00%	3.96%
Pipe Wrap	SF	19.1	20.0%	0.03	10	$15	18.15%	45.00%
	MF	19.1	20.0%	0.03	10	$15	10.00%	35.00%
Low Flow Showerhead/Faucets	SF	19.1	1.9%	0.36	9	$21	18.15%	49.31%
	MF	19.1	1.9%	0.36	9	$21	10.00%	38.89%
ES Clothes Washer	SF	19.1	6.5%	1.25	14	$270	17.58%	14.00%
	MF	19.1	6.5%	1.25	14	$270	6.22%	14.00%
ES Dishwasher	SF	19.1	1.8%	0.35	13	$27	10.99%	21.00%
	MF	19.1	1.8%	0.35	13	$27	3.67%	21.00%
Pump Controller	MF	19.1	16.0%	306	15	$39	10.00%	40.00%
Solar WH w/ Propane Back Up	SF	19.1	65.0%	12.42	20	$5,626	18.15%	0.00%

(1) Efficient Propane Water Heater[42]*:* In this analysis, baseline replacement propane water heaters are replaced with high efficiency tank-less/instantaneous propane water heaters. Instantaneous water heaters heat water directly without the use of a storage tank. Therefore, they avoid the standby heat losses associated with storage water heaters. For this analysis, the baseline replacement propane water heater is a stand alone water heater with an EF=.61. A high efficiency instantaneous propane water heater has an EF=.80.

(2) Pipe Wrap[43]*:* Insulating hot water pipes will reduce losses as the hot water is flowing to the faucet and, more importantly, it will reduce standby losses when the tap is turned off and then back on within an hour or so. Pipe wrap will conserve energy and water that would normally be lost waiting for the hot water to reach the tap. Energy loss still occurs after pipe wrap has been installed, though to a smaller degree than the losses observed in non-insulated pipes.

(3) Low Flow Showerheads/Faucets[44]*:* An existing showerhead/faucet is replaced with a new unit that has a low-flow rate. Significant savings in hot water use can be achieved by installing low-flow showerheads and faucets. The single best action is to replace old showerheads as showers use 37% of the hot water in typical U.S. homes.

(4) ES Clothes Washer[45]*:* Clothes washers exceeding minimum qualifying efficiency standards established under Energy Star Program with a Modified Energy Factor (MEF) >= 1.8 and a Water Factor (WF) <=7.5. The MEF measures the energy used during the washing process, including machine energy, water heating energy, and dryer energy. The higher the MEF, the more efficient the clothes washer is. Energy Star qualified washers extract more water from clothes during the spin cycle. This reduces the drying time and saves

[42] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 376.
[43] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[44] Global Green USA website (www.globalgreen.org/pha-energytoolbox/tech_dhw.htm)
[45] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 237

energy and wear and tear on your clothes. In addition, substantial savings on water and sewer bills contribute to the economic benefits of high-efficiency washers. A high efficiency clothes washer can save approximately 4,300 gallons of water a year. For purposes of this study, this measure is limited to homes having propane water heating systems *and* clothes washers.

(5) ES Dishwasher[46]*:* Dishwashers exceeding minimum qualifying efficiency standards established under Energy Star Program with an Energy Factor (EF) >= .58. Energy Star labeled dishwashers save energy by using both improved technology for the primary wash cycle, and by using less hot water to clean. Construction includes more effective washing action, energy efficient motors and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes. In addition, a high efficiency dishwasher can save approximately 135 gallons of water a year. This measure is limited to homes having propane water heating *and* dishwashers.

(6) Pump Controller (MF)[47]*:* Pump controllers are electronic controls that save energy by memorizing building hot water demand patterns. The controller, based on usage patterns, automatically reduces hot water loop temperatures during periods of low hot water demand. This reduces the amount of wasted energy expended to heat water during periods of low usage.

(7) Solar WH w/ Propane Back-up (SF)[48]*:* Solar water heaters are designed to serve as pre-heaters for conventional storage or demand water heaters. As the solar system preheats the water, the extra temperature boost required by the storage or demand water heater is relatively low, and high flow rate can be achieved. Solar water heaters can be particularly effective if they are designed for three-season use, with a home's heating system providing hot water during the winter months. Although less common than they were two to three decades ago, solar water heating units are considerably less expensive and more reliable.

2.3 New Homes Construction

2.3.1 All Propane Heated New Homes

One residential space heating energy efficiency measures are covered in this section: Energy Efficient New Homes Construction. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

[46] Energy Star website (www.energystar.gov) Energy Star has determined new energy efficiency standards for dishwashers (EF >= .65). This future criterion is effective January 1, 2007.
[47] Personal communication with Steve Nadel (ACEEE), November 2006.
[48] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.

Table A1-15: Assumptions for Propane Heated New Homes								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
New Homes Construction	SF	66.77	20.0%	13.35	30	$2,000	29.00%	33.00%
	MF	33.38	20.0%	6.68	30	$1,000	29.00%	33.00%

(1) Energy Efficient New Homes Construction[49]*:* Energy efficient new homes are new residential construction projects that have been independently verified to be at least 20% more energy efficient than homes built to 2004 International Energy Conservation Code (IECC). A new home constructed to exactly to IECC code (reference home) is assigned a score of 100 and a zero energy house assigned a score of 0. Each 1 percent reduction in energy usage (compared to the reference house) results in a one point decrease in the HERS score. In Vermont, an Energy Efficient New Home is required to be approximately 20 percent more energy efficient than 2004 IECC standards and receive a rating of 80. Savings are based on heating, cooling, and typically achieved through a combination of: high performance windows, controlled air infiltration, upgraded heating and conditioning systems, tight duct systems, and high efficiency building envelope standards. These features contribute to improved home quality and homeowner comfort, and to lower energy demand and reduced air pollution.

2.4 Vacant Homes

2.4.1 All Propane Heated Vacant Homes

One residential space heating energy efficiency measures is covered in this section: Energy Efficient Vacant Homes Package. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-16: Assumptions for All Propane Heated Vacant Homes								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Vacant Homes Package	SF	34.85	46.4%	16.16	30	$3,218	13.81%	75.00%
	MF	17.42	27.7%	4.83	30	$804	18.89%	75.00%

(1) Energy Efficient Vacant Homes Package[50]*:* There were 60,234 vacant homes in Vermont according to the latest census estimates. A housing unit is considered 'vacant' if no individual was living in the home at the time of the survey. This excludes any homes whose usual occupants were only temporarily absent. However, this includes homes whose sole occupants were persons who usually live elsewhere. Most vacant homes are intended only for seasonal use, particularly in the Northeast. As a result, annual heating consumption demands for these homes are typically lower than those found in typical existing homes. For this analysis, GDS assumed a

[49] "September 2005 Update: EPA Releases Final New Guidelines for ENERGY STAR Qualified Homes." (www.energystar.gov)
[50] "Vacant Homes Statistical Brief. US Bureau of the Census website. (www.census.gov)

suite of thermal shell efficiency measures (Insulation & Weatherization, Energy Star Windows, and Programmable Thermostats) would be installed in vacant homes.

Table A1-17: Propane Measure Assumptions

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)
All Homes with Propane Space Heat												
1	Insulation & Weatherization Pkg.	SF	85.60	35.2%	30.13	30	$2,558	Homes w/ LPG SH	13.81%	75.00%		
2	Programmable Thermostats	SF	85.60	7.0%	5.99	15	$60	Homes w/ LPG SH	13.81%	14.00%		
3	ES Windows	SF	85.60	11.0%	9.42	30	$600	Homes w/ LPG SH	13.81%	60.00%		
4	Attic Insulation & Weatherization Pkg.	MF	42.80	12.7%	5.44	30	$344	Homes w/ LPG SH	18.89%	75.00%		
5	Programmable Thermostats	MF	42.80	7.0%	3.00	15	$60	Homes w/ LPG SH	18.89%	12.22%		
6	ES Windows	MF	42.80	11.0%	4.71	30	$400	Homes w/ LPG SH	18.89%	60.00%		
All Homes with Propane Furnaces												
7	Efficient Propane Furnace	SF	85.60	5.6%	4.79	20	$200	Homes w/ LPG Furnaces	5.13%	6.52%	462	
8	Duct Sealing	SF	85.60	5.0%	4.28	15	$300	Homes w/ LPG Furnaces	5.13%	60.00%		
9	Efficient Propane Furnace	MF	42.80	5.6%	2.40	20	$100	Homes w/ LPG Furnaces	4.44%	4.88%	231	
Homes with Propane Water Boilers												
10	Efficient Water Boiler	SF	85.60	2.3%	1.97	25	$890	Homes w/ LPG Water Boilers	4.58%	6.52%		
11	Modulate Water Temp.	SF	85.60	11.0%	9.42	15	$250	Homes w/ LPG Water Boilers	4.58%	15.00%		
12	Efficient Water Boiler	MF	42.80	2.3%	0.98	25	$445	Homes w/ LPG Water Boilers	6.22%	4.88%		
13	Modulate Water Temp.	MF	42.80	11.0%	4.71	15	$250	Homes w/ LPG Water Boilers	6.22%	75.00%		
Homes with Propane Steam Boilers												
14	Efficient Steam Boiler	SF	85.60	2.3%	1.97	25	$890	Homes with LPG Steam Boilers	1.14%	6.52%		
15	Improved Steam Vents	SF	85.60	6.0%	5.14	20	$450	Homes with LPG Steam Boilers	1.14%	50.00%		
16	Vent Damper	SF	85.60	9.0%	7.70	20	$263	Homes with LPG Steam Boilers	1.14%	50.00%		
17	Efficient Steam Boiler	MF	42.80	2.3%	0.98	25	$445	Homes with LPG Steam Boilers	1.56%	4.88%		
18	Thermostatic Vents	MF	42.80	6.0%	2.57	20	$239	Homes with LPG Steam Boilers	1.56%	60.00%		
19	Mainline Vents	MF	42.80	10.0%	4.28	30	$69	Homes with LPG Steam Boilers	1.56%	25.00%		
20	Vent Damper	MF	42.80	9.0%	3.85	20	$263	Homes with LPG Steam Boilers	1.56%	50.00%		
Propane Water Heating												
21	Pipe Wrap	SF	19.10	0.2%	0.03	10	$15	Homes with LPG WH	18.15%	45.00%		
22	Low Flow Showerhead/Faucets	SF	19.10	1.9%	0.36	9	$21	Homes with LPG WH	18.15%	49.31%		4937
23	Efficient Propane Water Heater	SF	19.10	23.8%	4.54	15	$450	Homes with LPG WH	18.15%	3.96%		
24	ES Clothes Washer	SF	19.10	6.5%	1.25	14	$270	Homes with LPG WH & CW	17.58%	14.00%	26	4338.4
25	ES Dishwasher	SF	19.10	1.8%	0.35	13	$27	Homes with LPG WH & DW	10.99%	21.00%	34	134.64
26	Solar WH w/ Propane Back Up	SF	19.10	65.0%	12.42	20	$5,626	Homes with LPG WH	18.15%	0.00%		
27	Pipe Wrap	MF	19.10	0.2%	0.03	10	$15	Homes with LPG WH	10.00%	35.00%		
28	Low Flow Showerhead/Faucets	MF	19.10	1.9%	0.36	9	$21	Homes with LPG WH	10.00%	38.89%		4937
29	Efficient Propane Water Heater	MF	19.10	23.8%	4.54	15	$450	Homes with LPG WH	10.00%	3.96%		
30	ES Clothes Washer	MF	19.10	6.5%	1.25	14	$270	Homes with LPG WH & CW	6.22%	14.00%	26	4338.4
31	ES Dishwasher	MF	19.10	1.8%	0.35	13	$27	Homes with LPG WH & DW	3.67%	21.00%	34	134.64

Table A1-17: Propane Measure Assumptions

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)
32	Pump Controller	MF	19.10	16.0%	3.06	15	$39	Homes with LPG WH	10.00%	40.00%		
All Propane-Heated New Homes												
33	New Homes Construction	SF	66.77	20.0%	13.35	30	$2,000	All LPG Heated New Homes	29.00%	33.00%		
34	New Homes Construction	MF	33.38	20.0%	6.68	30	$1,000	All LPG Heated New Homes	29.00%	33.00%		
All Propane-Heated Vacant Homes												
35	Vacant Homes Package	SF	34.85	46.4%	16.16	30	$3,218	All LPG Heated Vacant Homes	13.81%	75.00%		
36	Vacant Homes Package	MF	17.42	27.7%	4.83	30	$804	All LPG Heated Vacant Homes	18.89%	75.00%		

Note: For ES Clothes Washers, 0.41 MMBTU savings come from the washer, 0.84 savings come from propane dryer savings (decreased drying time due to lessened saturation of clothing from washer spin cycle.

Note: EVT TRM claims no increased efficiency for LPG Space Heaters in a replace-on-burnout scenario

Note: Vacant Homes estimated to use 40.71 % of Existing Homes Base Consumption

Note: New Homes estimated to use 78% of Existing Homes Base Consumption

Table A1-18: Propane Measure Sources

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings	Useful Life	Measure Cost	Base Saturation	EE Saturation	Notes
All Homes with Propane Space Heat										
1	Insulation & Weatherization Pkg.	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	GDS/VT	
2	Programmable Thermostats	SF	RECS CE2	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	
3	ES Windows	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	KEMA 3-33	
4	Attic Insulation & Weatherization	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	GDS/VT	(Base Fuel Use)- Approximately 50% of SF Base Use. Same % found in ACEEE report
5	Programmable Thermostats	MF	RECS CE2	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	(Base Fuel Use) - Approx. 50% of SF Base Use.
6	ES Windows	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	KEMA 3-33	(Base Fuel Use) - Approx. 50% of SF Base Use.
All Homes with Propane Furnaces										
7	Efficient Propane Furnace	SF	REC CE2	EVT 403		EVT 400	EVT 401	KEMA	GDS/KEMA	
8	Duct Sealing	SF	REC CE2	EVT 389		EVT 389	EVT 389	KEMA	ACEEE 41	
9	Efficient Propane Furnace	MF	REC CE2	EVT 403		EVT 400	EVT 400	KEMA	GDS/KEMA	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use.
Homes with Propane Water Boilers										
10	Efficient Water Boiler	SF	RECS CE2	EVT 403		EVT 400	EVT 401	GDS/KEMA	GDS/KEMA	(Base Saturation)-Assumes 80% of boilers are water boilers
11	Modulate Water Temp.	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	GDS/KEMA	ACEEE 41	(Base Saturation)-Assumes 80% of boilers are water boilers
12	Efficient Water Boiler	MF	RECS CE2	EVT 403		EVT 400	EVT 400	GDS/KEMA	GDS/KEMA	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 80% of boilers are water boilers
13	Modulate Water Temp.	MF	RECS CE2	ACEEE 42		ACEEE 42	GDS/ACEEE	GDS/KEMA	ACEEE 42	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 80% of boilers are water boilers
Homes with Propane Steam Boilers										
14	Efficient Steam Boiler	SF	RECS CE2	EVT 403		EVT 400	EVT 401	GDS/KEMA	GDS/KEMA	(Base Saturation)-Assumes 20% of boilers are steam boilers
15	Improved Steam Vents	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	GDS/KEMA	ACEEE 41	(Base Saturation)-Assumes 20% of boilers are steam boilers
16	Vent Damper	SF	RECS CE2	ACEEE2 70		GDS/ACEEE2	ACEEE2 70	GDS/KEMA	GDS/ACEEE2	(Base Saturation)-Assumes 20% of boilers are steam boilers
17	Efficient Steam Boiler	MF	RECS CE2	EVT 403		EVT 400	EVT 400	GDS/KEMA	GDS/KEMA	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
18	Thermostatic Vents	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	GDS/KEMA	ACEEE 42	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
19	Mainline Vents	MF	RECS CE2	ACEEE 42		ACEEE 42	ACEEE 42	GDS/KEMA	ACEEE 42	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
20	Vent Damper	MF	RECS CE2	ACEEE2 70		GDS/ACEEE2	ACEEE2 70	GDS/KEMA	GDS/ACEEE2	(Base Fuel Use) - Approx. 50% of SF Base Use. (Base Saturation)-Assumes 20% of boilers are steam boilers
Propane Water Heating										
21	Pipe Wrap	SF	RECS CE4		ECT 368	EVT 368	EVT 368	KEMA	GDS/KEMA	
22	Low Flow Showerhead/Faucets	SF	RECS CE4		EVT 372	EVT 372	EVT 372	KEMA	KEMA	Also EVT 374
23	Efficient Propane Water Heater	SF	RECS CE4	EVT 376		EVT 377	EVT 378	KEMA	KEMA	
24	ES Clothes Washer	SF	RECS CE4		EVT 239	EVT 238	EVT 238	KEMA	D&R	
25	ES Dishwasher	SF	RECS CE4		EVT 246	EVT 245	EVT 245	KEMA	D&R	

Table A1-18: Propane Measure Sources

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings	Useful Life	Measure Cost	Base Saturation	EE Saturation	Notes
26	Solar WH w/ Propane Back Up	SF	RECS CE4	RERC		ACEEE T6.6	RERC	KEMA	KEMA	GDS calculation based on information from RERC (VEIC)
27	Pipe Wrap	MF	RECS CE4		ECT 368	EVT 368	EVT 368	KEMA	GDS/KEMA	
28	Low Flow Showerhead/Faucets	MF	RECS CE4		EVT 372	EVT 372	EVT 372	KEMA	KEMA	Also EVT 374
29	Efficient Propane Water Heater	MF	RECS CE4	EVT 376		EVT 377	EVT 378	KEMA	KEMA	
30	ES Clothes Washer	MF	RECS CE4		EVT 239	EVT 238	EVT 238	KEMA	D&R	
31	ES Dishwasher	MF	RECS CE4		EVT246	EVT 245	EVT 245	KEMA	D&R	
32	Pump Controller	MF	RECS CE4	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	ACEEE 42	
All Propane-Heated New Homes										
33	New Homes Construction	SF	GDS	GDS/Fasey		GDS/Fasey	GDS/Fasey	KEMA2	GDS/Fasey	
34	New Homes Construction	MF	GDS	GDS/Fasey		GDS/Fasey	GDS/Fasey	KEMA2	GDS/Fasey	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use.
All Propane-Heated Vacant Homes										
35	Vacant Homes Package	SF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	
36	Vacant Homes Package	MF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	(Base Fuel Use) - Approx. 50% of SF Base Use.

Note: Any additional electric and water savings per measure are attributed to the measure's '% savings/annual fuel savings' source

Source Code Index:

ACEEE: N. Elliott et al. 'Reducing Oil Use Through Energy Efficiency: Opportuniities Beyond Cars and Light Trucks.' Report E061. ACEEE. Washington D.C. January 2006.
ACEEE2: 'Consumer Guide to Home Energy Savings' 8th ed. ACEEE. 2003. Table 6.6
ACEEE T6.6: 'Consumer Guide to Home Energy Savings' 8th ed. ACEEE. 2003. Table 6.6
D&R: Personal Communication, Bill McNary, February 22, 2006.
ES Calc-PT: Energy Star Calculator (www.energystar.gov) Energy Star Calculator - Programmable Thermostats (.xls)
EVT: Efficiency Vermont. Technical Reference User Manual (TRM) No. 2006-41.
GDS: Calculation based on data compiled for "Incremental Cost of Energy Star Homes in Massachusetts & New Hampshire" GDS Associates. February 2003 and REMrate model. Base consumption in new homes was estimated to be 78% of existing homes.
GDS2: Vacant Homes Package is a combination of shell measures (insulation & weatherization, programmable thermostats, and windows) for savings, useful life, and cost. Base consumption was estimated by GDS using REMrate. A vacant home is estimated to use ~40.71% of a normal existing home.
GDS/ACEEE: GDS estimate based on information provided in the ACEEE 2006 Oil Report (see above citation)
GDS/ACEEE2: GDS estimate based on information provided in the ACEEE Consumer Guide to Home Energy Savings and similar efficiency measures.
GDS/Fasey: GDS Associates, personal communication with Richard Fasey, EVT New Homes Program in December 2006.
GDS/KEMA: GDS Estimate based on available data in the KEMA Residential Appliance Survey (Dec. 2005) / 80/20 split between water & steam boilers is an estimate provided to Bruce Bennett from Dave Buck (The Granite Group) on 11/22/2006.
GDS/VT: GDS Estimate based on meeting with Efficiency Vermont and Vermont Department of Public Service
KEMA: 'Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs' KEMA Dec. 2005. (No page number means GDS calculation based on KEMA data.)
KEMA2: 'Final Report: Phase 1 Evaluation of the Efficiency Vermont Residential Programs' KEMA Oct. 2003. Page 4-16.
RECS CE2: Residential Energy Consumption Survey, 2001. Energy Information Administration. Table CE2-9c: Space-Heating Energy Consumption in US Households by Northeast Census Region, 2001.
RECS CE4: Residential Energy Consumption Survey, 2001. Energy Information Administration. Table CE4-9c: Water-Heating Energy Consumption in US Households by Northeast Census Region, 2001.
RERC: 'Investing in a Solar Hot Water System' Renewable Energy Resource Center: A Project of the Vermont Energy Investment Corporation. (www.rerc-vt.org/shw_investing.htm)

3. KEROSENE

The following sections describe the energy efficiency measures that were included in this analysis for all homes utilizing propane for either space heating and/or water heating.

3.1 Space Heating

3.1.1 All Kerosene Space Heated Homes

Four residential space heating energy efficiency measures are covered in this section: Insulation and Weatherization (SF)[51], Attic Insulation (MF)[52], Programmable Thermostats, and Energy Star Windows. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-19: Assumptions for All Kerosene Space Heated Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Insulation & Weath. Pkg.	SF	55.8	35.20%	19.64	30	$2,558	8.28%	75.00%
Attic Insul. & Weath. Pkg.	MF	27.9	12.70%	3.54	30	$344	1.11%	75.00%
Programmable Thermostats	SF	55.8	7.00%	3.91	15	$60	8.28%	14.00%
	MF	27.9	7.00%	1.95	15	$60	1.11%	12.22%
ES Windows	SF	55.8	11.00%	6.14	30	$600	8.28%	60.00%
	MF	27.9	11.00%	3.07	30	$400	1.11%	60.00%

(1) Insulation and Weatherization (SF)[53]: Weatherization measures address the reduction of thermal transfer through the "shell" between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures are typical components in an insulation and weatherization program: attic insulation, wall insulation, basement wall insulation, and air sealing.

(2) Attic Insulation (MF): This measure package is the same as the insulation and weatherization package described above, except multi-family homes only receive attic insulation and air sealing.

(3) Programmable Thermostats[54]: Programmable thermostats automatically adjust the home's temperature setting on a set schedule, allowing for daily energy conservation during periods when normal heating is unnecessary (i.e. when the house is unoccupied, or when occupants are sleeping at night). However, programmable thermostats have to be set and used properly to deliver

[51] SF: Single Family Only
[52] MF: Multi-Family Only
[53] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 392 & 395.
[54] Energy Star website (www.energystar.gov)

the advertised energy savings. Routine deviation from the programmed default settings and schedules can significantly lower actual energy savings.

(4) Energy Star Windows[55]*:* In older homes, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool homes. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity coating.

1.1.2 Homes with 'Kerosene' Furnaces

Two residential space heating energy efficiency measures are covered in this section: Efficient Oil Furnaces and Duct Sealing (SF). Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-20: Assumptions for All Homes with Kerosene Furnaces

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient 'Kerosene' Furnace	SF	55.8	5.90%	3.29	20	$700	4.93%	6.52%
Duct Sealing	SF	55.8	50.00%	2.79	15	$300	4.93%	60.00%

(1) Efficient Oil Furnace[56]*:* A furnace heats air that is blown through air ducts and delivered to rooms through registers or grills. This type of heating system is called a ducted warm-air or forced warm-air distribution system. In this analysis, for a replace on burn-out installation, a high efficiency warm-air oil furnace is installed instead of a standard efficiency replacement model. The baseline replacement model AFUE[57]=80%. The high efficiency model AFUE=85%.

(2) Duct Sealing (SF)[58]*:* Leaky and unsealed residential air ducts for forced hot air furnaces are properly repaired and sealed. Mastic (a special paste) is the preferred method for duct sealing. Properly sealing leaky ducts can save significant amounts of energy needed to heat a home.

Note: Homes with Kerosene Furnaces were assumed to have Fuel Oil heating equipment, but choose to run this equipment utilizing Kerosene as a fuel source, rather than fuel oil. As a result, heating equipment efficiency mirrors that found for fuel oil.

[55] "Energy Efficiency in Remodeling: Windows" Tool Base Services website. (www.toolbase.org)
[56] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401.
[57] AFUE is an abbreviation for Annual Fuel Utilization Efficiency.
[58] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 388.

1.2 Vacant Homes

1.2.1 All Kerosene Heated Vacant Homes

One residential space heating energy efficiency measures is covered in this section: Energy Efficient Vacant Homes Package. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-21: Assumptions for All Kerosene Heated Vacant Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Vacant Homes Package	SF	22.72	46.40%	10.53	30	$3,218	8.28%	75.00%
	MF	11.36	27.70%	3.15	30	$804	1.11%	75.00%

(1) Energy Efficient Vacant Homes Package[59]*:* There were 60,234 vacant homes in Vermont according to the latest census estimates. A housing unit is considered 'vacant' if no individual was living in the home at the time of the survey. This excludes any homes whose usual occupants were only temporarily absent. However, this includes homes whose sole occupants were persons who usually live elsewhere. Most vacant homes are intended only for seasonal use, particularly in the Northeast. As a result, annual heating consumption demands for these homes are typically lower than those found in typical existing homes. For this analysis, GDS assumed a suite of thermal shell efficiency measures (Insulation & Weatherization, Energy Star Windows, and Programmable Thermostats) would be installed in vacant homes.

[59] "Vacant Homes Statistical Brief. US Bureau of the Census website. (www.census.gov)

Table A1-22: Kerosene Measure Assumptions

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)
All Homes with Kerosene Space Heat												
1	Insulation & Weatherization Pkg.	SF	55.80	35.2%	19.64	30	$2,558	Homes w/ Kerosene SH	8.28%	75.00%		
2	Programmable Thermostats	SF	55.80	7.0%	3.91	15	$60	Homes w/ Kerosene SH	8.28%	14.00%		
3	ES Windows	SF	55.80	11.0%	6.14	30	$600	Homes w/ Kerosene SH	8.28%	60.00%		
4	Attic Insulation & Weatherization Pkg.	MF	27.90	12.7%	3.54	30	$344	Homes w/ Kerosene SH	1.11%	75.00%		
5	Programmable Thermostats	MF	27.90	7.0%	1.95	15	$60	Homes w/ Kerosene SH	1.11%	12.22%		
6	ES Windows	MF	27.90	11.0%	3.07	30	$400	Homes w/ Kerosene SH	1.11%	60.00%		
Homes with 'Kerosene' Furnaces												
7	Efficient 'Kerosene' Furnace	SF	55.80	5.9%	3.29	20	$700	Homes w/ Oil Furnaces	4.93%	6.52%	462	
8	Duct Sealing	SF	55.80	5.0%	2.79	15	$300	Homes w/ Oil Furnaces	4.93%	60.00%		
All Kerosene-Heated Vacant Homes												
9	Vacant Homes Package	SF	22.72	46.4%	10.53	30	$3,218	All Kerosene Heated Vacant Homes	8.28%	75.00%		
10	Vacant Homes Package	MF	11.36	27.7%	3.15	30	$804	All Kerosene Heated Vacant Homes	1.11%	75.00%		

Note: EVT TRM does not report any savings between a standard efficiency and high efficiency replacement kerosene space heater

Note: Homes with 'Kerosene' Furnaces were assumed to have fuel oil furnace equipment and choose to use kerosene as their heating fue

Note: Under 1% of homes in Vermont have Kerosene Water Heating. Ommitted from analysis.

Note: All potential oil/kerosene heated new homes were assumed to install oil measures.

Note: Vacant Homes estimated to use 40.71 % of Existing Homes Base Consumption

Table A1-23: Kerosene Measure Sources

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings	Useful Life	Measure Cost	Base Saturation	EE Saturation	Notes
All Homes with Kerosene Space Heat										
1	Insulation & Weatherization Pkg.	SF	RECS CE2	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	GDS/VT	
2	Programmable Thermostats	SF	RECS CE3	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	
3	ES Windows	SF	RECS CE4	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	KEMA 3-33	
4	Attic Insulation & Weatherization Pkg.	MF	RECS CE5	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	GDS/VT	(Base Fuel Use)- Approximately 50% of SF Base Use. Same % found in ACEEE report
5	Programmable Thermostats	MF	RECS CE6	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	(Base Fuel Use) - Approx. 50% of SF Base Use.
6	ES Windows	MF	RECS CE7	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	KEMA 3-33	(Base Fuel Use) - Approx. 50% of SF Base Use.
Homes with 'Kerosene' Furnaces										
7	Efficient Oil Furnace	SF	REC CE2	EVT 403		EVT 400	EVT 401	KEMA	KEMA	
8	Duct Sealing	SF	REC CE2	EVT 389		EVT 389	EVT 389	KEMA	ACEEE 41	
All Kerosene-Heated Vacant Homes										
9	Vacant Homes Package	SF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	
10	Vacant Homes Package	MF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	(Base Fuel Use) - Approx. 50% of SF Base Use.

Note: Any additional electric and water savings per measure are attributed to the measure's '% savings/annual fuel savings' source.

Source Code Index:

ACEEE: N. Elliott et al. 'Reducing Oil Use Through Energy Efficiency: Opportuniities Beyond Cars and Light Trucks.' Report E061. ACEEE. Washington D.C. January 2006.

ES Calc-PT: Energy Star Calculator (www.energystar.gov) Energy Star Calculator - Programmable Thermostats (.xls)

GDS2: Vacant Homes Package is a combination of shell measures (insulation & weatherization, programmable thermostats, and windows) for savings, useful life, and cost. Base consumption was estimated by GDS using REMrate. A vacant home is estimated to use ~40.71% of a normal existing home.

GDS/VT: GDS Estimate based on meeting with Efficiency Vermont and Vermont Department of Public Service

KEMA: 'Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs' KEMA Dec. 2005. (No page number means GDS calculation based on KEMA data.)

KEMA2: 'Final Report: Phase 1 Evaluation of the Efficiency Vermont Residential Programs' KEMA Oct. 2003. Page 4-16.

RECS CE2: Residential Energy Consumption Survey, 2001. Energy Information Administration. Table CE2-9c: Space-Heating Energy Consumption in US Households by Northeast Census Region, 2001.

4. WOOD

The following sections describe the energy efficiency measures that were included in this analysis for all homes utilizing propane for either space heating and/or water heating.

4.1 Space Heating

4.1.1 All Wood Space Heated Homes

Four residential space heating energy efficiency measures are covered in this section: Insulation and Weatherization (SF)[60], Attic Insulation (MF)[61], Programmable Thermostats, and Energy Star Windows. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-24: Assumptions for All Wood Space Heated Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Insulation & Weath. Pkg.	SF	84.48	35.20%	19.64	30	$2,558	11.83%	75.00%
Attic Insul. & Weath. Pkg.	MF	42.24	12.70%	3.54	30	$344	3.33%	75.00%
Programmable Thermostats	SF	84.48	7.00%	3.91	15	$60	11.83%	14.00%
	MF	42.24	7.00%	1.95	15	$60	3.33%	12.22%
ES Windows	SF	84.48	11.00%	6.14	30	$600	11.83%	60.00%
	MF	42.24	11.00%	3.07	30	$400	3.33%	60.00%

(1) Insulation and Weatherization (SF)[62]: Weatherization measures address the reduction of thermal transfer through the "shell" between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures are typical components in an insulation and weatherization program: attic insulation, wall insulation, basement wall insulation, and air sealing.

(2) Attic Insulation (MF): This measure package is the same as the insulation and weatherization package described above, except multi-family homes only receive attic insulation and air sealing.

(3) Programmable Thermostats[63]: Programmable thermostats automatically adjust the home's temperature setting on a set schedule, allowing for daily energy conservation during periods when normal heating is unnecessary (i.e. when the house is unoccupied, or when occupants are sleeping at night). However, programmable thermostats have to be set and used properly to deliver the advertised energy savings. Routine deviation from the programmed default settings and schedules can significantly lower actual energy savings.

[60] SF: Single Family Only
[61] MF: Multi-Family Only
[62] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 392 & 395.
[63] Energy Star website (www.energystar.gov)

(4) Energy Star Windows[64]*:* In older homes, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool homes. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity coating.

4.1.2 Homes with Wood Stoves

One residential space heating energy efficiency measures is covered in this section: Efficient Wood Stoves. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-25: Assumptions for All Homes with Wood Stoves

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Efficient Wood Stove	SF	84.48	12.50%	10.56	15	$200	9.47%	10.00%
	MF	42.24	12.50%	5.28	15	$200	1.11%	10.00%

(1) Efficient Wood Stove[65,66]*:* A wood stove functions like a space heater. Wood stoves are typically located centrally in the main floor living area of a house and flue pipe running straight up into the chimney. Today's woodstove models feature improved safety and efficiency. They produce almost no smoke, minimal ash, and require less firewood. Wood stoves can be sized to heat a family room, a small cottage, or a full-sized home. The internal design of wood stoves has changed drastically in the past 15 years, as a result of the U.S. Environmental Protection Agency regulation established in the late 1980s. The EPA's mandatory smoke emission limit for wood stoves is 7.5 grams of smoke per hour. Today, all wood stoves sold in the U.S. must meet this limit. As a result, all new wood replacement wood stoves have a minimum standard efficiency with an EF=.63. More advanced technology can result in higher efficiency levels and an EF=.72.

4.2 Water Heating

4.2.1 All Wood Water Heated Homes

Three residential water heating energy efficiency measures are covered in this section: Pipe Wrap, Low Flow Showerheads/ Faucets, and Solar Water Heater with Wood Water Heating Back Up. Listed below are the basic assumptions used

[64] "Energy Efficiency in Remodeling: Windows" Tool Base Services website. (www.toolbase.org)
[65] "All About Wood Stoves." Wood Heat Organization website. (www.woodheat.org)
[66] "List of EPA Certified Wood Stoves" Environmental Protection Agency. September 2006. (www.epa.gov)

in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-26: Assumptions for All Wood Water Heated Homes								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Pipe Wrap	SF	21.12	0.30%	0.05	10	$15	0.99%	45.00%
	MF	21.12	0.30%	0.05	10	$15	1.11%	45.00%
Low Flow Showerhead/Faucets	SF	21.12	2.00%	0.42	9	$21	0.99%	49.31%
	MF	21.12	2.00%	0.42	9	$21	1.11%	49.31%
Solar WH w/ Wood Back Up	SF	21.12	65.00%	13.73	20	$5,626	0.99%	0.00%

(1) Pipe Wrap[67]*:* Insulating hot water pipes will reduce losses as the hot water is flowing to the faucet and, more importantly, it will reduce standby losses when the tap is turned off and then back on within an hour or so. Pipe wrap will conserve energy and water that would normally be lost waiting for the hot water to reach the tap. Energy loss still occurs after pipe wrap has been installed, though to a smaller degree than the losses observed in non-insulated pipes.

(2) Low Flow Showerheads/Faucets[68]*:* An existing showerhead/faucet is replaced with a new unit that has a low-flow rate. Significant savings in hot water use can be achieved by installing low-flow showerheads and faucets. The single best action is to replace old showerheads as showers use 37% of the hot water in typical U.S. homes.

(3) Solar WH w/ Wood Back-up (SF)[69]*:* Solar water heaters are designed to serve as pre-heaters for conventional storage or demand water heaters. As the solar system preheats the water, the extra temperature boost required by the storage or demand water heater is relatively low, and high flow rate can be achieved. Solar water heaters can be particularly effective if they are designed for three-season use, with a home's heating system providing hot water during the winter months. Although less common than they were two to three decades ago, solar water heating units are considerably less expensive and more reliable.

4.3 New Homes Construction

4.3.1 All Wood Heated New Homes

One residential space heating energy efficiency measures are covered in this section: Energy Efficient New Homes Construction. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-27: Assumptions for Wood Heated New Homes								
Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
New Homes Construction	SF	65.89	20.00%	13.18	30	$2,000	6.00%	33.00%
	MF	32.95	20.00%	6.59	30	$1,000	6.00%	33.00%

[67] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[68] Global Green USA website (www.globalgreen.org/pha-energytoolbox/tech_dhw.htm)
[69] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.

(1) Energy Efficient New Homes Construction[70]*:* Energy efficient new homes are new residential construction projects that have been independently verified to be at least 20% more energy efficient than homes built to 2004 International Energy Conservation Code (IECC). A new home constructed to exactly to IECC code (reference home) is assigned a score of 100 and a zero energy house assigned a score of 0. Each 1 percent reduction in energy usage (compared to the reference house) results in a one point decrease in the HERS score. In Vermont, an Energy Efficient New Home is required to be approximately 20 percent more energy efficient than 2004 IECC standards and receive a rating of 80. Savings are based on heating, cooling, and typically achieved through a combination of: high performance windows, controlled air infiltration, upgraded heating and conditioning systems, tight duct systems, and high efficiency building envelope standards. These features contribute to improved home quality and homeowner comfort, and to lower energy demand and reduced air pollution.

1.4 Vacant Homes

1.4.1 All Wood Heated Vacant Homes

One residential space heating energy efficiency measures is covered in this section: Energy Efficient Vacant Homes Package. Listed below are the basic assumptions used in this study for these technologies. Complete sources for the data can be found at the end of this section.

Table A1-28: Assumptions for All Wood Heated Vacant Homes

Measure Name	Home Type	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life (Years)	Measure Cost	Base Saturation	EE Saturation
Vacant Homes Package	SF	34.39	46.40%	15.94	30	$3,218	11.83%	75.00%
	MF	17.2	27.70%	4.77	30	$804	3.33%	75.00%

(1) Energy Efficient Vacant Homes Package[71]*:* There were 60,234 vacant homes in Vermont according to the latest census estimates. A housing unit is considered 'vacant' if no individual was living in the home at the time of the survey. This excludes any homes whose usual occupants were only temporarily absent. However, this includes homes whose sole occupants were persons who usually live elsewhere. Most vacant homes are intended only for seasonal use, particularly in the Northeast. As a result, annual heating consumption demands for these homes are typically lower than those found in typical existing homes. For this analysis, GDS assumed a suite of thermal shell efficiency measures (Insulation & Weatherization, Energy Star Windows, and Programmable Thermostats) would be installed in vacant homes.

[70] "September 2005 Update: EPA Releases Final New Guidelines for ENERGY STAR Qualified Homes." (www.energystar.gov)
[71] "Vacant Homes Statistical Brief. US Bureau of the Census website. (www.census.gov)

Table A1-29: Wood Measure Assumptions

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)
All Homes with Wood Space Heat												
1	Insulation & Weatherization Pkg.	SF	84.48	35.2%	29.73	30	$2,558	Homes w/ Wood SH	11.83%	75.00%		
2	Programmable Thermostats	SF	84.48	7.0%	5.91	15	$60	Homes w/ Wood SH	11.83%	14.00%		
3	ES Windows	SF	84.48	11.0%	9.29	30	$600	Homes w/ Wood SH	11.83%	60.00%		
4	Attic Insulation & Weatherization Pkg.	MF	42.24	12.7%	5.37	30	$344	Homes w/ Wood SH	3.33%	75.00%		
5	Programmable Thermostats	MF	42.24	7.0%	2.96	15	$60	Homes w/ Wood SH	3.33%	12.22%		
6	ES Windows	MF	42.24	11.0%	4.65	30	$400	Homes w/ Wood SH	3.33%	60.00%		
All Homes with Wood Stoves												
7	Efficient Wood Stoves	SF	84.48	12.5%	10.56	15	$200	Homes w/ Wood Stoves	9.47%	10.00%		
8	Efficient Wood Stoves	MF	42.24	12.5%	5.28	15	$200	Homes w/ Wood Stoves	1.11%	10.00%		
Wood Water Heating												
9	Pipe Wrap	SF	21.12	0.3%	0.05	10	$15	Homes with Wood WH	0.99%	45.00%		
10	Low Flow Showerhead/Faucets	SF	21.12	2.0%	0.42	9	$21	Homes with Wood WH	0.99%	49.31%		4937
11	Solar WH w/ Wood Back Up	SF	21.12	65.0%	13.73	20	$5,626	Homes with Wood WH	0.99%	0.00%		
12	Pipe Wrap	MF	21.12	0.3%	0.05	10	$15	Homes with Wood WH	1.11%	45.00%		
13	Low Flow Showerhead/Faucets	MF	21.12	2.0%	0.42	9	$21	Homes with Wood WH	1.11%	49.31%		4937
All Wood-Heated New Homes												
14	New Homes Construction	SF	65.89	20.0%	13.18	30	$2,000	All Wood Heated New Homes	6.00%	33.00%		
15	New Homes Construction	MF	32.95	20.0%	6.59	30	$1,000	All Wood Heated New Homes	6.00%	33.00%		
All Wood-Heated Vacant Homes												
16	Vacant Homes Package	SF	34.39	46.4%	15.94	30	$3,218	All Wood Heated Vacant Homes	11.83%	75.00%		
17	Vacant Homes Package	MF	17.20	27.7%	4.77	30	$804	All Wood Heated Vacant Homes	3.33%	75.00%		

Note: Vacant Homes estimated to use 40.71 % of Existing Homes Base Consumption

Note: New Homes estimated to use 78% of Existing Homes Base Consumption

Table A1-30: Wood Measure Sources

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings	Useful Life	Measure Cost	Base Saturation	EE Saturation	Notes
All Homes with Oil Space Heat										
1	Insulation & Weatherization Pkg.	SF	VDPS 13	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	GDS/VT	
2	Programmable Thermostats	SF	VDPS 14	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	
3	ES Windows	SF	VDPS 15	ACEEE 41		ACEEE 41	ACEEE 41	KEMA	KEMA 3-33	
4	Attic Insulation & Weatherization Pkg.	MF	VDPS 16	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	GDS/VT	(Base Fuel Use)- Approximately 50% of SF Base Use. Same % found in ACEEE report
5	Programmable Thermostats	MF	VDPS 17	ACEEE 41		ES Calc -PT	ES Calc -PT	KEMA	KEMA	(Base Fuel Use) - Approx. 50% of SF Base Use.
6	ES Windows	MF	VDPS 18	ACEEE 42		ACEEE 42	ACEEE 42	KEMA	KEMA 3-33	(Base Fuel Use) - Approx. 50% of SF Base Use.
All Homes with Wood Stoves										
7	Efficient Wood Stoves	SF	VDPS 13	EPA		VC	WoodHeat	KEMA	VC	
8	Efficient Wood Stoves	MF	VDPS 16	EPA		VC	WoodHeat	KEMA	VC	(Base Fuel Use) - Approx. 50% of SF Base Use.
Wood Water Heating										
9	Pipe Wrap	SF	VDPS 13	GDS/EVT		EVT 368	EVT 368	KEMA	GDS/KEMA	
10	Low Flow Showerhead/Faucets	SF	VDPS 13	GDS/EVT		EVT 372	EVT 372	KEMA	KEMA	Also EVT 374
11	Solar WH w/ Wood Back Up	SF	VDPS 13	RERC		ACEEE T6.6	RERC	KEMA	KEMA	GDS calculation based on information from RERC (VEIC)
12	Pipe Wrap	MF	VDPS 13	GDS/EVT		EVT 368	EVT 368	KEMA	GDS/KEMA	
13	Low Flow Showerhead/Faucets	MF	VDPS 13	GDS/EVT		EVT 372	EVT 372	KEMA	KEMA	
All Wood-Heated New Homes										
14	New Homes Construction	SF	GDS	GDS/Fasey		GDS/Fasey	GDS/Fasey	KEMA2	GDS/Fasey	
15	New Homes Construction	MF	GDS	GDS/Fasey		GDS/Fasey	GDS/Fasey	KEMA2	GDS/Fasey	(Cost) - GDS assumed cost to be 50% of SF install cost. (Base Fuel Use) - Approx. 50% of SF Base Use.
All Wood-Heated Vacant Homes										
16	Vacant Homes Package	SF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	
17	Vacant Homes Package	MF	GDS2	GDS2		GDS2	GDS2	KEMA2	GDS/VT	(Base Fuel Use) - Approx. 50% of SF Base Use.

Note: Any additional electric and water savings per measure are attributed to the measure's '% savings/annual fuel savings' source

Source Code Index:

ACEEE: N. Elliott et al. 'Reducing Oil Use Through Energy Efficiency: Opportuniities Beyond Cars and Light Trucks.' Report E061. ACEEE. Washington D.C. January 2006.

ACEEE T6.6: 'Consumer Guide to Home Energy Savings' 8th ed. ACEEE. 2003. Table 6.6

EPA:"List of EPA Certified Wood Stoves" Environmental Protection Agency. September 2006. (www.epa.gov)

ES Calc-PT: Energy Star Calculator (www.energystar.gov) Energy Star Calculator - Programmable Thermostats (.xls)

EVT: Efficiency Vermont. Technical Reference User Manual (TRM) No. 2006-41.

GDS: Calculation based on data compiled for "Incremental Cost of Energy Star Homes in Massachusetts & New Hampshire" GDS Associates. February 2003. Applied percentage calculated for oil heated homes (o heating consumption found in non-Energy Start rated new homes compared to oil heating consumption found in existing homes) to additional fuel sources.

GDS2: Vacant Homes Package is a combination of shell measures (insulation & weatherization, programmable thermostats, and windows) for savings, useful life, and cost. Base consumption was estimated by GDS using REMrate. A vacant home is estimated to use ~40.71% of a normal existing home.

GDS/KEMA: GDS Estimate based on available data in the KEMA Residential Appliance Survey (Dec. 2005)

GDS/EVT: GDS Estimate, Averages known savings from EVT Technical Resource Manual (pgs. 368,372, & 374) for oil and propane.

GDS/Fasey: GDS Associates, personal communication with Richard Fasey, EVT New Homes Program in December 2006.
GDS/VT: GDS Estimate based on meeting with Efficiency Vermont and Vermont Department of Public Service
KEMA: 'Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs' KEMA Dec. 2005. (No page number means GDS calculation based on KEMA data.)
KEMA2: 'Final Report: Phase 1 Evaluation of the Efficiency Vermont Residential Programs' KEMA Oct. 2003. Page 4-16.
RERC: 'Investing in a Solar Hot Water System' Renewable Energy Resource Center: A Project of the Vermont Energy Investment Corporation. (www.rerc-vt.org/shw_investing.htm)
VC: Personal Communication with Marc Champion (Vermont Castings), November 2006. Phone: (802)234-2381
VDPS: Vermont Residential Fuel Wood Assessment. 1997-1998. Vermont Department of Public Service. December 2000. Table 3. Page 13. (GDS converted cords of wood to mmtbu. 1 cord = 22,000,000 btu.)
WoodHeat: "Wood Stoves" Wood Heat Organization website. (www.woodheat.org)

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APPENDIX A2:

FUEL OIL

Oil Measure Assumptions (Initial Assumptions & Levelized Costs)

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)	Annual Amortized Cost Per Unit	Levelized Cost
All Homes with Oil Space Heat													7.975%	
1	Programmable Thermostats	SF	106.60	7.0%	7.46	15	$60	Homes w/ Oil SH	54.44%	14.00%			$7.00	$0.938
2	ES Windows	SF	106.60	11.0%	11.73	30	$600	Homes w/ Oil SH	54.44%	60.00%			$53.17	$4.534
3	Insulation & Weatherization Package	SF	106.60	35.2%	37.52	30	$2,558	Homes w/ Oil SH	54.44%	75.00%			$226.68	$6.042
4	Programmable Thermostats	MF	53.30	7.0%	3.73	15	$60	Homes w/ Oil SH	45.56%	12.22%			$7.00	$1.876
5	Attic Insulation & Weatherization Pack.	MF	53.30	12.7%	6.77	30	$344	Homes w/ Oil SH	45.56%	75.00%			$30.48	$4.503
6	ES Windows	MF	53.30	11.0%	5.86	30	$400	Homes w/ Oil SH	45.56%	60.00%			$35.45	$6.046
All Homes with Oil Furnaces														
7	Duct Sealing	SF	106.60	5.0%	5.33	15	$300	Homes w/ Oil Furnaces	17.75%	60.00%			$35.00	$6.566
8	Efficient Oil Furnace	SF	106.60	5.9%	6.29	20	$700	Homes w/ Oil Furnaces	17.75%	6.52%	462.0		$71.16	$11.315
9	Efficient Oil Furnace	MF	53.30	5.9%	3.14	20	$350	Homes w/ Oil Furnaces	11.11%	4.88%	231.0		$35.58	$11.315
Homes with Oil Water Boilers														
10	Modulate Water Temp.	SF	106.60	11.0%	11.73	15	$250	Homes w/ Water Boilers	28.72%	15.00%			$29.16	$2.487
11	Efficient Water Boiler	SF	106.60	2.4%	2.56	25	$642	Homes w/ Water Boilers	28.72%	6.52%			$60.01	$23.457
12	Modulate Water Temp.	MF	53.30	11.0%	5.86	15	$250	Homes w/ Water Boilers	26.67%	75.00%			$29.16	$4.974
13	Efficient Water Boiler	MF	53.30	2.4%	1.28	25	$321	Homes w/ Water Boilers	26.67%	4.88%			$30.01	$23.457
Homes with Oil Steam Boilers														
14	Vent Damper	SF	106.60	9.0%	9.59	20	$263	Homes with Steam Boilers	7.18%	50.00%			$26.74	$2.787
15	Improved Steam Vents	SF	106.60	6.0%	6.40	20	$450	Homes with Steam Boilers	7.18%	50.00%			$45.75	$7.153
16	Efficient Steam Boiler	SF	106.60	2.4%	2.56	25	$642	Homes with Steam Boilers	7.18%	6.52%			$60.01	$23.457
17	Mainline Vents	MF	53.30	10.0%	5.33	30	$69	Homes with Steam Boilers	6.67%	25.00%			$6.11	$1.147
18	Vent Damper	MF	53.30	9.0%	4.80	20	$263	Homes with Steam Boilers	6.67%	50.00%			$26.74	$5.574
19	Thermostatic Vents	MF	53.30	6.0%	3.20	20	$239	Homes with Steam Boilers	6.67%	60.00%			$24.30	$7.598
20	Efficient Steam Boiler	MF	53.30	2.4%	1.28	25	$321	Homes with Steam Boilers	6.67%	4.88%			$30.01	$23.457
Oil Water Heating														
21	Low Flow Showerhead/Faucets	SF	30.50	4.1%	1.24	9	$21	Homes with Oil WH	28.21%	49.31%		4937.0	$3.36	$2.708
22	Pipe Wrap	SF	30.50	0.3%	0.10	10	$15	Homes with Oil WH	28.21%	45.00%			$2.23	$22.329
23	Efficient Oil Water Heater (SH/WH)	SF	30.50	35.0%	10.68	25	$750	Homes w/ Oil WH & Non-Furn.	19.31%	55.00%			$70.11	$6.568
24	Efficient Oil Water Heater (stand-alone)	SF	30.50	14.1%	4.29	10	$1,125	Homes with Oil WH & Furn.	8.90%	55.00%			$167.47	$39.046
25	Solar WH w/ Oil Back Up	SF	30.50	65.0%	19.83	20	$5,626	Homes with Oil WH	28.21%	0.00%			$571.95	$28.850
26	ES Dishwasher	SF	30.50	1.1%	0.35	13	$27	Homes with Oil WH & DW	17.08%	21.00%	34.0	134.6	$3.41	$9.747
27	ES Clothes Washer	SF	30.50	1.3%	0.41	14	$270	Homes with Oil WH & CW	27.32%	14.00%	223.0	4338.4	$32.70	$79.762
28	Pump Controller	MF	30.50	16.0%	4.88	15	$39	Homes with Oil WH	23.33%	40.00%			$4.55	$0.932
29	Low Flow Showerhead/Faucets	MF	30.50	4.1%	1.24	9	$21	Homes with Oil WH	23.33%	38.89%		4937.0	$3.36	$2.708
30	Pipe Wrap	MF	30.50	0.3%	0.10	10	$15	Homes with Oil WH	23.33%	35.00%			$2.23	$22.329
31	Efficient Oil Water Heater (SH/WH)	MF	30.50	35.0%	10.68	25	$750	Homes w/ Oil WH & Non-Furn.	15.97%	45.00%			$70.11	$6.568
32	Efficient Oil Water Heater (stand-alone)	MF	30.50	14.1%	4.30	10	$1,125	Homes with Oil WH & Furn.	7.36%	45.00%			$167.47	$38.942
33	ES Dishwasher	MF	30.50	1.1%	0.35	13	$27	Homes with Oil WH & DW	8.56%	21.00%	34.0	134.6	$3.41	$9.747

Table A2-1

Oil Measure Assumptions (Initial Assumptions & Levelized Costs)

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)	Annual Amortized Cost Per Unit	Levelized Cost
34	ES Clothes Washer	MF	30.50	1.3%	0.41	14	$270	Homes with Oil WH & CW	14.52%	14.00%	223.0	4338.4	$32.70	$79.762
All Oil-Heated New Homes														
35	New Homes Construction	SF	83.10	20.0%	16.62	30	$2,000	All Oil Heated New Homes	45.00%	33.00%			$177.24	$10.664
36	New Homes Construction	MF	41.55	20.0%	8.31	30	$1,000	All Oil Heated New Homes	45.00%	33.00%			$88.62	$10.664
All Oil-Heated Vacant Homes														
37	Vacant Homes Package	SF	43.40	46.4%	20.12	30	$3,218	All Oil Heated Vacant Homes	54.44%	75.00%			$285.17	$14.174
38	Vacant Homes Package	MF	21.70	27.7%	6.02	30	$804	All Oil Heated Vacant Homes	45.56%	75.00%			$71.25	$11.837

Table A2-1

Oil Measure Annual Penetrations, Total # of Remaining Homes based on Technical Potential (100% Penetration) & Annual # of Maximum Achievable Homes (80% Penetration)*

Measure	Measure Name	Home Type	Base Case Saturation (% of all homes that contain the end use or the measure)	High Efficiency Saturation (% of homes fitting Base Case Description that are already energy efficient)	Remaining Factor (In how many homes can this be installed	Single-/Multi-Family Fraction	Number of applicable homes in 2005 (before applying remaining factor)	Total Homes Remaining without measure (after applying remaining factor)	Maximum Achievable Program Participants per year (80% penetration limit)*									
									2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Programmable Thermostats	SF	54.44%	14.00%	86.0%	84.5%	111,708	96,068	7,373	7,373	7,373	7,373	7,373	7,373	7,373	7,373	7,373	7,373
2	ES Windows	SF	54.44%	60.00%	40.0%	84.5%	111,708	44,683	745	745	745	745	745	745	745	745	745	745
3	Insulation & Weatherization Package	SF	54.44%	75.00%	25.0%	84.5%	111,708	27,927	559	559	559	559	559	559	559	559	559	559
4	Programmable Thermostats	MF	45.56%	75.00%	25.0%	15.5%	17,148	4,287	86	86	86	86	86	86	86	86	86	86
5	Attic Insulation & Weatherization Pack.	MF	45.56%	12.22%	87.8%	15.5%	17,148	15,053	1,162	1,162	1,162	1,162	1,162	1,162	1,162	1,162	1,162	1,162
6	ES Windows	MF	45.56%	60.00%	40.0%	15.5%	17,148	6,859	114	114	114	114	114	114	114	114	114	114
7	Duct Sealing	SF	17.75%	60.00%	40.0%	84.5%	36,422	14,569	728	728	728	728	728	728	728	728	728	728
8	Efficient Oil Furnace	SF	17.75%	6.52%	93.5%	84.5%	36,422	34,047	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338
9	Efficient Oil Furnace	MF	11.11%	4.88%	95.1%	15.5%	4,182	3,978	157	157	157	157	157	157	157	157	157	157
10	Modulate Water Temp.	SF	28.72%	15.00%	85.0%	84.5%	58,932	50,092	3,831	3,831	3,831	3,831	3,831	3,831	3,831	3,831	3,831	3,831
11	Efficient Water Boiler	SF	28.72%	6.52%	93.5%	84.5%	58,932	55,089	1,732	1,732	1,732	1,732	1,732	1,732	1,732	1,732	1,732	1,732
12	Modulate Water Temp.	MF	26.67%	75.00%	25.0%	15.5%	10,038	2,510	50	50	50	50	50	50	50	50	50	50
13	Efficient Water Boiler	MF	26.67%	4.88%	95.1%	15.5%	10,038	9,548	302	302	302	302	302	302	302	302	302	302
14	Vent Damper	SF	7.18%	50.00%	50.0%	84.5%	14,733	7,366	442	442	442	442	442	442	442	442	442	442
15	Improved Steam Vents	SF	7.18%	50.00%	50.0%	84.5%	14,733	7,366	442	442	442	442	442	442	442	442	442	442
16	Efficient Steam Boiler	SF	7.18%	6.52%	93.5%	84.5%	14,733	13,772	433	433	433	433	433	433	433	433	433	433
17	Mainline Vents	MF	6.67%	25.00%	75.0%	15.5%	2,511	1,883	138	138	138	138	138	138	138	138	138	138
18	Vent Damper	MF	6.67%	50.00%	50.0%	15.5%	2,511	1,255	75	75	75	75	75	75	75	75	75	75
19	Thermostatic Vents	MF	6.67%	60.00%	40.0%	15.5%	2,511	1,004	50	50	50	50	50	50	50	50	50	50
20	Efficient Steam Boiler	MF	6.67%	4.88%	95.1%	15.5%	2,511	2,388	75	75	75	75	75	75	75	75	75	75
21	Low Flow Showerhead/Faucets	SF	28.21%	49.31%	50.7%	84.5%	57,885	29,342	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776	1,776
22	Pipe Wrap	SF	28.21%	45.00%	55.0%	84.5%	57,885	31,837	2,026	2,026	2,026	2,026	2,026	2,026	2,026	2,026	2,026	2,026
23	Efficient Oil Water Heater (SH/WH)	SF	19.31%	55.00%	45.0%	84.5%	39,623	17,830	396	396	396	396	396	396	396	396	396	396
24	Efficient Oil Water Heater (stand-alone)	SF	8.90%	55.00%	45.0%	84.5%	18,262	8,218	457	457	457	457	457	457	457	457	457	457
25	Solar WH w/ Oil Back Up	SF	28.21%	0.00%	100.0%	84.5%	57,891	57,891	579	579	579	579	579	579	579	579	579	579
26	ES Dishwasher	SF	17.08%	21.00%	79.0%	84.5%	35,047	27,687	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591	1,591
27	ES Clothes Washer	SF	27.32%	14.00%	86.0%	84.5%	56,059	48,211	2,643	2,643	2,643	2,643	2,643	2,643	2,643	2,643	2,643	2,643
28	Pump Controller	MF	23.33%	40.00%	60.0%	15.5%	8,781	5,269	351	351	351	351	351	351	351	351	351	351
29	Low Flow Showerhead/Faucets	MF	23.33%	38.89%	61.1%	15.5%	8,781	5,366	361	361	361	361	361	361	361	361	361	361
30	Pipe Wrap	MF	23.33%	35.00%	65.0%	15.5%	8,781	5,708	395	395	395	395	395	395	395	395	395	395
31	Efficient Oil Water Heater (SH/WH)	MF	15.97%	45.00%	55.0%	15.5%	6,011	3,306	84	84	84	84	84	84	84	84	84	84
32	Efficient Oil Water Heater (stand-alone)	MF	7.36%	45.00%	55.0%	15.5%	2,770	1,524	97	97	97	97	97	97	97	97	97	97
33	ES Dishwasher	MF	8.56%	21.00%	79.0%	15.5%	3,222	2,545	146	146	146	146	146	146	146	146	146	146
34	ES Clothes Washer	MF	14.52%	14.00%	86.0%	15.5%	5,465	4,700	258	258	258	258	258	258	258	258	258	258
35	New Homes Construction	SF	45.00%	33.00%	67.0%	100.0%	959	642	361	406	451	497	542	587	632	677	722	767
36	New Homes Construction	MF	45.00%	33.00%	67.0%	100.0%	144	97	54	61	68	75	82	88	95	102	109	116
37	Vacant Homes Package	SF	54.44%	75.00%	25.0%	84.5%	27,709	6,927	139	139	139	139	139	139	139	139	139	139
38	Vacant Homes Package	MF	45.56%	75.00%	25.0%	15.5%	4,254	1,063	21	21	21	21	21	21	21	21	21	21

*Note: Solar Water Heating w/ Oil Back-Up only assumed a 10% achievable penetration

Oil Measure Assumptions (Adjusted for Interactive Effects), Technical Potential, and Achievable Potentia

Measure	Included in Tech. Potential =1 / Duplicate Savings = 0	Included in Achievable Potential =1 / Duplicate Savings = 0	Measure Name	Replace on Burnout or Retrofit	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Total Number of Homes in remaining in VT that can still receive efficiency measure	Technical Potential Total MMBTU savings potential if 100% penetration attained 'overnight'	Achievable Program Participants per Year (80% penetration limit)	Achievable MMBTU Savings by 2016 (80% penetration limit)
1	1	1	Programmable Thermostats	Retrofit	106.60	0.07	7.46	96,068	716,863	7,373	550,173
2	1	1	ES Windows	ROB	99.14	0.11	10.91	44,683	487,276	745	81,244
3	1	1	Insulation & Weatherization Package	Retrofit	88.23	0.35	31.06	27,927	867,278	559	173,599
4	1	1	Programmable Thermostats	Retrofit	53.30	0.07	3.73	4,287	15,995	86	3,209
5	1	1	Attic Insulation & Weatherization Pack.	Retrofit	49.57	0.13	6.30	15,053	94,774	1,162	73,161
6	1	1	ES Windows	ROB	43.27	0.11	4.76	6,859	32,651	114	5,426
7	1	1	Duct Sealing	Retrofit	57.18	0.05	2.86	14,569	41,650	728	20,813
8	1	1	Efficient Oil Furnace	ROB	54.32	0.06	3.20	34,047	109,114	1,338	42,880
9	1	1	Efficient Oil Furnace	ROB	38.51	0.06	2.27	3,978	9,038	157	3,567
10	1	1	Modulate Water Temp.	Retrofit	57.18	0.11	6.29	50,092	315,055	3,831	240,952
11	1	1	Efficient Water Boiler	ROB	50.89	0.02	1.22	55,089	67,281	1,732	21,153
12	1	1	Modulate Water Temp.	Retrofit	38.51	0.11	4.24	2,510	10,632	50	2,118
13	1	1	Efficient Water Boiler	ROB	34.28	0.02	0.82	9,548	7,855	302	2,484
14	1	1	Vent Damper	Retrofit	57.18	0.09	5.15	7,366	37,908	442	22,745
15	1	1	Improved Steam Vents	Retrofit	52.03	0.06	3.12	7,366	22,997	442	13,799
16	1	1	Efficient Steam Boiler	ROB	48.91	0.02	1.17	13,772	16,166	433	5,083
17	1	1	Mainline Vents	Retrofit	38.51	0.10	3.85	1,883	7,252	138	5,315
18	1	1	Vent Damper	Retrofit	34.66	0.09	3.12	1,255	3,916	75	2,340
19	1	1	Thermostatic Vents	Retrofit	31.54	0.06	1.89	1,004	1,900	50	946
20	1	1	Efficient Steam Boiler	ROB	29.65	0.02	0.71	2,388	1,699	75	534
21	1	1	Low Flow Showerhead/Faucets	Retrofit	30.50	0.04	1.24	29,342	36,384	1,776	22,022
22	1	1	Pipe Wrap	Retrofit	29.26	0.00	0.10	31,837	3,184	2,026	2,026
23	0	0	Efficient Oil Water Heater (SH/WH)	ROB	29.16	0.35	10.21	17,830	0	396	0
24	0	0	Efficient Oil Water Heater (stand-alone)	ROB	29.16	0.14	4.10	8,218	0	457	0
25	1	1	Solar WH w/ Oil Back Up	Retrofit	29.16	0.65	18.95	57,891	1,097,273	579	109,744
26	1	1	ES Dishwasher	ROB	18.95	0.02	0.35	27,687	9,691	1,591	5,569
27	1	1	ES Clothes Washer	ROB	18.60	0.02	0.41	48,211	19,766	2,643	10,836
28	1	1	Pump Controller	Retrofit	30.50	0.16	4.88	5,269	25,711	351	17,129
29	1	1	Low Flow Showerhead/Faucets	Retrofit	25.62	0.05	1.24	5,366	6,654	361	4,476
30	1	1	Pipe Wrap	Retrofit	24.38	0.00	0.10	5,708	571	395	395

Table A2-3

Oil Measure Assumptions (Adjusted for Interactive Effects), Technical Potential, and Achievable Potential

Measure	Included in Tech. Potential =1 / Duplicate Savings = 0	Included in Achievable Potential =1 / Duplicate Savings = 0	Measure Name	Replace on Burnout or Retrofit	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Total Number of Homes in remaining in VT that can still receive efficiency measure	Technical Potential Total MMBTU savings potential if 100% penetration attained 'overnight'	Achievable Program Participants per Year (80% penetration limit)	Achievable MMBTU Savings by 2016 (80% penetration limit)
31	1	1	Efficient Oil Water Heater (SH/WH)	ROB	24.28	0.35	8.50	3,306	28,095	84	7,138
32	1	1	Efficient Oil Water Heater (stand-alone)	ROB	24.28	0.14	3.42	1,524	5,216	97	3,321
33	1	1	ES Dishwasher	ROB	15.78	0.02	0.35	2,545	891	146	511
34	1	1	ES Clothes Washer	ROB	15.43	0.03	0.41	4,700	1,927	258	1,058
35	1	1	New Homes Construction	Market Driven	83.10	0.20	16.62	642	106,733	n/a	93,770
36	1	1	New Homes Construction	Market Driven	41.55	0.20	8.31	97	8,043	n/a	7,064
37	1	1	Vacant Homes Package	Retrofit	43.40	0.46	20.12	6,927	139,366	139	27,965
38	1	1	Vacant Homes Package	Retrofit	21.70	0.28	6.02	1,063	6,401	21	1,264
									4,363,206		1,585,829

Table A2-3

Oil Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on VT Societal Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	106.60	0.07	7.46	7,373	550,173
2	ES Windows	99.14	0.11	10.91	745	81,244
3	Insulation & Weatherization Package	88.23	0.35	31.06	559	173,599
4	Programmable Thermostats	53.30	0.07	3.73	86	3,209
5	Attic Insulation & Weatherization Pack.	49.57	0.13	6.30	1,162	73,161
6	ES Windows	43.27	0.11	4.76	114	5,426
7	Duct Sealing	57.18	0.05	2.86	728	20,813
8	Efficient Oil Furnace	54.32	0.06	3.20	1,338	42,880
9	Efficient Oil Furnace	38.51	0.06	2.27	157	3,567
10	Modulate Water Temp.	57.18	0.11	6.29	3,831	240,952
11	Efficient Water Boiler	50.89	0.02	0.00	1,732	0
12	Modulate Water Temp.	38.51	0.11	4.24	50	2,118
13	Efficient Water Boiler	34.28	0.02	0.00	302	0
14	Vent Damper	57.18	0.09	5.15	442	22,745
15	Improved Steam Vents	52.03	0.06	3.12	442	13,799
16	Efficient Steam Boiler	48.91	0.02	0.00	433	0
17	Mainline Vents	38.51	0.10	3.85	138	5,315
18	Vent Damper	34.66	0.09	3.12	75	2,340
19	Thermostatic Vents	31.54	0.06	1.89	50	946
20	Efficient Steam Boiler	29.65	0.02	0.00	75	0
21	Low Flow Showerhead/Faucets	30.50	0.04	1.24	1,776	19,820
22	Pipe Wrap	29.26	0.00	0.00	2,026	0
23	Efficient Oil Water Heater (SH/WH)	29.26	0.35	10.24	396	40,554
24	Efficient Oil Water Heater (stand-alone)	29.26	0.14	0.00	457	0
25	Solar WH w/ Oil Back Up	29.26	0.65	0.00	579	0
26	ES Dishwasher	19.02	0.02	0.35	1,591	5,569
27	ES Clothes Washer	18.67	0.02	0.41	2,643	10,836
28	Pump Controller	30.50	0.16	4.88	351	17,129
29	Low Flow Showerhead/Faucets	25.62	0.05	1.24	361	4,029
30	Pipe Wrap	24.38	0.00	0.00	395	0
31	Efficient Oil Water Heater (SH/WH)	24.38	0.35	8.53	84	7,168
32	Efficient Oil Water Heater (stand-alone)	24.38	0.14	0.00	97	0
33	ES Dishwasher	15.85	0.02	0.35	146	511
34	ES Clothes Washer	15.50	0.03	0.41	258	1,058
35	New Homes Construction	83.10	0.20	16.62	n/a	93,770
36	New Homes Construction	41.55	0.20	8.31	n/a	7,064
37	Vacant Homes Package	43.40	0.46	20.12	139	27,965
38	Vacant Homes Package	21.70	0.28	6.02	21	1,264
						1,479,023

Table A2-4

Oil Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on Participant Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	106.60	0.07	7.46	7,373	550,173
2	ES Windows	99.14	0.11	10.91	745	81,244
3	Insulation & Weatherization Package	88.23	0.35	31.06	559	173,599
4	Programmable Thermostats	53.30	0.07	3.73	86	3,209
5	Attic Insulation & Weatherization Pack.	49.57	0.13	6.30	1,162	73,161
6	ES Windows	43.27	0.11	4.76	114	5,426
7	Duct Sealing	57.18	0.05	2.86	728	20,813
8	Efficient Oil Furnace	54.32	0.06	3.20	1,338	42,880
9	Efficient Oil Furnace	38.51	0.06	2.27	157	3,567
10	Modulate Water Temp.	57.18	0.11	6.29	3,831	240,952
11	Efficient Water Boiler	50.89	0.02	1.22	1,732	21,153
12	Modulate Water Temp.	38.51	0.11	4.24	50	2,118
13	Efficient Water Boiler	34.28	0.02	0.82	302	2,484
14	Vent Damper	57.18	0.09	5.15	442	22,745
15	Improved Steam Vents	52.03	0.06	3.12	442	13,799
16	Efficient Steam Boiler	48.91	0.02	1.17	433	5,083
17	Mainline Vents	38.51	0.10	3.85	138	5,315
18	Vent Damper	34.66	0.09	3.12	75	2,340
19	Thermostatic Vents	31.54	0.06	1.89	50	946
20	Efficient Steam Boiler	29.65	0.02	0.71	75	534
21	Low Flow Showerhead/Faucets	30.50	0.04	1.24	1,776	19,820
22	Pipe Wrap	29.26	0.00	0.10	2,026	2,026
23	Efficient Oil Water Heater (SH/WH)	29.16	0.35	10.21	396	40,416
24	Efficient Oil Water Heater (stand-alone)	29.16	0.14	0.00	457	0
25	Solar WH w/ Oil Back Up	29.16	0.65	0.00	579	0
26	ES Dishwasher	18.95	0.02	0.35	1,591	5,569
27	ES Clothes Washer	18.60	0.02	0.41	2,643	10,836
28	Pump Controller	30.50	0.16	4.88	351	17,129
29	Low Flow Showerhead/Faucets	25.62	0.05	1.24	361	4,029
30	Pipe Wrap	24.38	0.00	0.10	395	395
31	Efficient Oil Water Heater (SH/WH)	24.28	0.35	8.50	84	7,138
32	Efficient Oil Water Heater (stand-alone)	24.28	0.14	0.00	97	0
33	ES Dishwasher	15.78	0.02	0.35	146	511
34	ES Clothes Washer	15.43	0.03	0.41	258	1,058
35	New Homes Construction	83.10	0.20	16.62	n/a	93,770
36	New Homes Construction	41.55	0.20	8.31	n/a	7,064
37	Vacant Homes Package	43.40	0.46	20.12	139	27,965
38	Vacant Homes Package	21.70	0.28	6.02	21	1,264
						1,510,530

Table A2-5

APPENDIX A3

PROPANE

Propane Measure Assumptions (Initial Assumptions & Levelized Costs)

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)	Annual Amortized Cost Per Unit	Levelized Cost
All Homes with Propane Space Heat													7.975%	
1	Programmable Thermostats	SF	85.60	7.0%	5.99	15	$60	Homes w/ LPG SH	13.81%	14.00%			$7.00	$1.168
2	ES Windows	SF	85.60	11.0%	9.42	30	$600	Homes w/ LPG SH	13.81%	60.00%			$53.17	$5.647
3	Insulation & Weatherization Pkg.	SF	85.60	35.2%	30.13	30	$2,558	Homes w/ LPG SH	13.81%	75.00%			$226.68	$7.524
4	Programmable Thermostats	MF	42.80	7.0%	3.00	15	$60	Homes w/ LPG SH	18.89%	12.22%			$7.00	$2.336
5	Attic Insulation & Weatherization Pkg.	MF	42.80	12.7%	5.44	30	$344	Homes w/ LPG SH	18.89%	75.00%			$30.48	$5.608
6	ES Windows	MF	42.80	11.0%	4.71	30	$400	Homes w/ LPG SH	18.89%	60.00%			$35.45	$7.529
All Homes with Propane Furnaces														
7	Efficient Propane Furnace	SF	85.60	5.6%	4.79	20	$200	Homes w/ LPG Furnaces	5.13%	6.52%	462		$20.33	$4.242
8	Duct Sealing	SF	85.60	5.0%	4.28	15	$300	Homes w/ LPG Furnaces	5.13%	60.00%			$35.00	$8.176
9	Efficient Propane Furnace	MF	42.80	5.6%	2.40	20	$100	Homes w/ LPG Furnaces	4.44%	4.88%	231		$10.17	$4.242
Homes with Propane Water Boilers														
10	Modulate Water Temp.	SF	85.60	11.0%	9.42	15	$250	Homes w/ LPG Water Boilers	4.58%	15.00%			$29.16	$3.097
11	Efficient Water Boiler	SF	85.60	2.3%	1.97	25	$890	Homes w/ LPG Water Boilers	4.58%	6.52%			$83.20	$42.257
12	Modulate Water Temp.	MF	42.80	11.0%	4.71	15	$250	Homes w/ LPG Water Boilers	6.22%	75.00%			$29.16	$6.194
13	Efficient Water Boiler	MF	42.80	2.3%	0.98	25	$445	Homes w/ LPG Water Boilers	6.22%	4.88%			$41.60	$42.257
Homes with Propane Steam Boilers														
14	Vent Damper	SF	85.60	9.0%	7.70	20	$263	Homes with LPG Steam Boilers	1.14%	50.00%			$26.74	$3.471
15	Improved Steam Vents	SF	85.60	6.0%	5.14	20	$450	Homes with LPG Steam Boilers	1.14%	50.00%			$45.75	$8.907
16	Efficient Steam Boiler	SF	85.60	2.3%	1.97	25	$890	Homes with LPG Steam Boilers	1.14%	6.52%			$83.20	$42.257
17	Mainline Vents	MF	42.80	10.0%	4.28	30	$69	Homes with LPG Steam Boilers	1.56%	25.00%			$6.11	$1.429
18	Vent Damper	MF	42.80	9.0%	3.85	20	$263	Homes with LPG Steam Boilers	1.56%	50.00%			$26.74	$6.941
19	Thermostatic Vents	MF	42.80	6.0%	2.57	20	$239	Homes with LPG Steam Boilers	1.56%	60.00%			$24.30	$9.462
20	Efficient Steam Boiler	MF	42.80	2.3%	0.98	25	$445	Homes with LPG Steam Boilers	1.56%	4.88%			$41.60	$42.257
Propane Water Heating														
21	Low Flow Showerhead/Faucets	SF	19.10	1.9%	0.36	9	$21	Homes with LPG WH	18.15%	49.31%		4937	$3.36	$9.328
22	Efficient Propane Water Heater	SF	19.10	23.8%	4.54	15	$450	Homes with LPG WH	18.15%	3.96%			$52.49	$11.572
23	Solar WH w/ Propane Back Up	SF	19.10	65.0%	12.42	20	$5,626	Homes with LPG WH	18.15%	0.00%			$571.95	$46.070
24	ES Dishwasher	SF	19.10	1.8%	0.35	13	$27	Homes with LPG WH & DW	10.99%	21.00%	34	134.64	$3.41	$9.747
25	ES Clothes Washer	SF	19.10	6.5%	1.25	14	$270	Homes with LPG WH & CW	17.58%	14.00%	26	4338.4	$32.70	$26.162
26	Pipe Wrap	SF	19.10	0.2%	0.03	10	$15	Homes with LPG WH	18.15%	45.00%			$2.23	$74.431
27	Pump Controller	MF	19.10	16.0%	3.06	15	$39	Homes with LPG WH	10.00%	40.00%			$4.55	$1.489
28	Low Flow Showerhead/Faucets	MF	19.10	1.9%	0.36	9	$21	Homes with LPG WH	10.00%	38.89%		4937	$3.36	$9.328
29	Efficient Propane Water Heater	MF	19.10	23.8%	4.54	15	$450	Homes with LPG WH	10.00%	3.96%			$52.49	$11.572
30	ES Dishwasher	MF	19.10	1.8%	0.35	13	$27	Homes with LPG WH & DW	3.67%	21.00%	34	134.64	$3.41	$9.747
31	ES Clothes Washer	MF	19.10	6.5%	1.25	14	$270	Homes with LPG WH & CW	6.22%	14.00%	26	4338.4	$32.70	$26.162
32	Pipe Wrap	MF	19.10	0.2%	0.03	10	$15	Homes with LPG WH	10.00%	35.00%			$2.23	$74.431
All Propane-Heated New Homes														

Table A3-1

Propane Measure Assumptions (Initial Assumptions & Levelized Costs)

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)	Annual Amortized Cost Per Unit	Levelized Cost
33	New Homes Construction	SF	66.77	20.0%	13.35	30	$2,000	All LPG Heated New Homes	29.00%	33.00%			$177.24	$13.273
34	New Homes Construction	MF	33.38	20.0%	6.68	30	$1,000	All LPG Heated New Homes	29.00%	33.00%			$88.62	$13.273
All Propane-Heated Vacant Homes														
35	Vacant Homes Package	SF	34.85	46.4%	16.16	30	$3,218	All LPG Heated Vacant Homes	13.81%	75.00%			$285.17	$17.652
36	Vacant Homes Package	MF	17.42	27.7%	4.83	30	$804	All LPG Heated Vacant Homes	18.89%	75.00%			$71.25	$14.741

Table A3-1

Propane Measure Annual Penetrations, Total # of Remaining Homes based on Technical Potential (100% Penetration) & Annual # of Maximum Achievable Homes (80% Penetration)

Measure	Measure Name	Home Type	Base Case Saturation (% of all homes that contain the end use or the measure)	High Efficiency Saturation (% of homes fitting Base Case Description that are already energy efficient)	Remaining Factor (In how many homes can this be installed	Single-/Multi-Family Fraction	Number of applicable homes in 2005 (before applying remaining factor)	Total Homes Remaining without measure (after applying remaining factor)	Maximum Achievable Program Participants per year (80% penetration limit)*									
									2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Programmable Thermostats	SF	13.81%	14.00%	86.0%	84.5%	28,337	24,370	1,870	1,870	1,870	1,870	1,870	1,870	1,870	1,870	1,870	1,870
2	ES Windows	SF	13.81%	60.00%	40.0%	84.5%	28,337	11,335	189	189	189	189	189	189	189	189	189	189
3	Insulation & Weatherization Pkg.	SF	13.81%	75.00%	25.0%	84.5%	28,337	7,084	142	142	142	142	142	142	142	142	142	142
4	Programmable Thermostats	MF	18.89%	12.22%	87.8%	15.5%	7,110	6,241	482	482	482	482	482	482	482	482	482	482
5	Attic Insulation & Weatherization Pkg.	MF	18.89%	75.00%	25.0%	15.5%	7,110	1,778	36	36	36	36	36	36	36	36	36	36
6	ES Windows	MF	18.89%	60.00%	40.0%	15.5%	7,110	2,844	47	47	47	47	47	47	47	47	47	47
7	Efficient Propane Furnace	SF	5.13%	6.52%	93.5%	84.5%	10,526	9,840	387	387	387	387	387	387	387	387	387	387
8	Duct Sealing	SF	5.13%	60.00%	40.0%	84.5%	10,526	4,211	211	211	211	211	211	211	211	211	211	211
9	Efficient Propane Furnace	MF	4.44%	4.88%	95.1%	15.5%	1,671	1,590	63	63	63	63	63	63	63	63	63	63
10	Modulate Water Temp.	SF	4.58%	15.00%	85.0%	84.5%	9,398	7,988	611	611	611	611	611	611	611	611	611	611
11	Efficient Water Boiler	SF	4.58%	6.52%	93.5%	84.5%	9,398	8,785	276	276	276	276	276	276	276	276	276	276
12	Modulate Water Temp.	MF	6.22%	75.00%	25.0%	15.5%	2,341	585	12	12	12	12	12	12	12	12	12	12
13	Efficient Water Boiler	MF	6.22%	4.88%	95.1%	15.5%	2,341	2,227	70	70	70	70	70	70	70	70	70	70
14	Vent Damper	SF	1.14%	50.00%	50.0%	84.5%	2,339	1,170	70	70	70	70	70	70	70	70	70	70
15	Improved Steam Vents	SF	1.14%	50.00%	50.0%	84.5%	2,339	1,170	70	70	70	70	70	70	70	70	70	70
16	Efficient Steam Boiler	SF	1.14%	6.52%	93.5%	84.5%	2,339	2,187	69	69	69	69	69	69	69	69	69	69
17	Mainline Vents	MF	1.56%	25.00%	75.0%	15.5%	587	440	32	32	32	32	32	32	32	32	32	32
18	Vent Damper	MF	1.56%	50.00%	50.0%	15.5%	587	294	18	18	18	18	18	18	18	18	18	18
19	Thermostatic Vents	MF	1.56%	60.00%	40.0%	15.5%	587	235	12	12	12	12	12	12	12	12	12	12
20	Efficient Steam Boiler	MF	1.56%	4.88%	95.1%	15.5%	587	559	18	18	18	18	18	18	18	18	18	18
21	Low Flow Showerhead/Faucets	SF	18.15%	49.31%	50.7%	84.5%	37,243	18,878	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143
22	Efficient Propane Water Heater	SF	18.15%	3.96%	96.0%	84.5%	37,243	35,768	1,888	1,888	1,888	1,888	1,888	1,888	1,888	1,888	1,888	1,888
23	Solar WH w/ Propane Back Up	SF	18.15%	0.00%	100.0%	84.5%	37,243	37,243	372	372	372	372	372	372	372	372	372	372
24	ES Dishwasher	SF	10.99%	21.00%	79.0%	84.5%	22,550	17,815	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023
25	ES Clothes Washer	SF	17.58%	14.00%	86.0%	84.5%	36,066	31,017	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700
26	Pipe Wrap	SF	18.15%	45.00%	55.0%	84.5%	37,243	20,483	1,303	1,303	1,303	1,303	1,303	1,303	1,303	1,303	1,303	1,303
27	Pump Controller	MF	10.00%	40.00%	60.0%	15.0%	3,642	2,185	146	146	146	146	146	146	146	146	146	146
28	Low Flow Showerhead/Faucets	MF	10.00%	38.89%	61.1%	15.5%	3,764	2,300	155	155	155	155	155	155	155	155	155	155
29	Efficient Propane Water Heater	MF	10.00%	3.96%	96.0%	15.5%	3,764	3,615	191	191	191	191	191	191	191	191	191	191
30	ES Dishwasher	MF	3.67%	21.00%	79.0%	15.5%	1,380	1,090	63	63	63	63	63	63	63	63	63	63
31	ES Clothes Washer	MF	6.22%	14.00%	86.0%	15.5%	2,342	2,014	110	110	110	110	110	110	110	110	110	110
32	Pipe Wrap	MF	10.00%	35.00%	65.0%	15.5%	3,764	2,447	169	169	169	169	169	169	169	169	169	169
33	New Homes Construction	SF	29.00%	33.00%	67.0%	100.0%	618	414	233	262	291	320	349	378	407	436	465	494
34	New Homes Construction	MF	29.00%	33.00%	67.0%	100.0%	93	62	35	39	44	48	53	57	61	66	70	74
35	Vacant Homes Package	SF	13.81%	75.00%	25.0%	84.5%	7,029	1,757	35	35	35	35	35	35	35	35	35	35
36	Vacant Homes Package	MF	18.89%	75.00%	25.0%	15.5%	1,764	441	9	9	9	9	9	9	9	9	9	9

*Note: Solar Water Heating w/ Oil Back-Up only assumed a 10% achievable penetration

Propane Measure Assumptions (Adjusted for Interactive Effects), Technical Potential, and Achievable Potential

Measure	Included in Tech. Potential =1 / Duplicate Savings = 0	Included in Achievable Potential =1 / Duplicate Savings = 0	Measure Name	Replace on Burnout or Retrofit	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Total Number of Homes in remaining in VT that can still receive efficiency measure	Technical Potential Total MMBTU savings potential if 100% penetration attained 'overnight'	Achievable Program Participants per Year (80% penetration limit)	Achievable MMBTU Savings by 2016 (80% penetration limit)
1	1	1	Programmable Thermostats	Retrofit	85.60	0.07	5.99	24,370	146,025	1,870	112,050
2	1	1	ES Windows	ROB	79.61	0.11	8.76	11,335	99,258	189	16,551
3	1	1	Insulation & Weatherization Pkg.	Retrofit	70.85	0.35	24.94	7,084	176,665	142	35,411
4	1	1	Programmable Thermostats	Retrofit	42.80	0.07	3.00	6,241	18,699	482	14,441
5	1	1	Attic Insulation & Weatherization Pkg.	Retrofit	39.80	0.13	5.06	1,778	8,987	36	1,820
6	1	1	ES Windows	ROB	34.75	0.11	3.82	2,844	10,871	47	1,796
7	1	1	Efficient Propane Furnace	ROB	45.91	0.06	2.57	9,840	25,301	387	9,950
8	1	1	Duct Sealing	Retrofit	43.34	0.05	2.17	4,211	9,125	211	4,573
9	1	1	Efficient Propane Furnace	ROB	30.93	0.06	1.73	1,590	2,753	63	1,091
10	1	1	Modulate Water Temp.	Retrofit	45.91	0.11	5.05	7,988	40,344	611	30,859
11	1	1	Efficient Water Boiler	ROB	40.86	0.02	0.94	8,785	8,257	276	2,594
12	1	1	Modulate Water Temp.	Retrofit	30.93	0.11	3.40	585	1,991	12	408
13	1	1	Efficient Water Boiler	ROB	27.52	0.02	0.63	2,227	1,410	70	443
14	1	1	Vent Damper	Retrofit	45.91	0.09	4.13	1,170	4,833	70	2,893
15	1	1	Improved Steam Vents	Retrofit	41.78	0.06	2.51	1,170	2,932	70	1,755
16	1	1	Efficient Steam Boiler	ROB	39.27	0.02	0.90	2,187	1,975	69	623
17	1	1	Mainline Vents	Retrofit	30.93	0.10	3.09	440	1,362	32	990
18	1	1	Vent Damper	Retrofit	27.83	0.09	2.50	294	735	18	451
19	1	1	Thermostatic Vents	Retrofit	25.33	0.06	1.52	235	357	12	182
20	1	1	Efficient Steam Boiler	ROB	23.81	0.02	0.55	559	306	18	99
21	1	1	Low Flow Showerhead/Faucets	Retrofit	19.10	0.02	0.36	18,878	6,796	1,143	4,115
22	0	1	Efficient Propane Water Heater	ROB	18.74	0.24	4.45	35,768	0	1,888	84,030
23	1	0	Solar WH w/ Propane Back Up	Retrofit	18.74	0.65	12.18	37,243	453,653	372	0
24	1	1	ES Dishwasher	ROB	14.29	0.02	0.35	17,815	6,235	1,023	3,581
25	1	1	ES Clothes Washer	ROB	13.94	0.09	1.25	31,017	38,771	1,700	21,250
26	1	1	Pipe Wrap	Retrofit	13.53	0.00	0.03	20,483	615	1,303	391
27	1	1	Pump Controller	Retrofit	19.10	0.16	3.06	2,185	6,679	146	4,462
28	1	1	Low Flow Showerhead/Faucets	Retrofit	16.04	0.02	0.36	2,300	828	155	558
29	1	1	Efficient Propane Water Heater	ROB	15.68	0.24	3.72	3,615	13,465	191	7,115
30	1	1	ES Dishwasher	ROB	11.96	0.03	0.35	1,090	382	63	221

Table A3-3

Propane Measure Assumptions (Adjusted for Interactive Effects), Technical Potential, and Achievable Potential

Measure	Included in Tech. Potential =1 / Duplicate Savings = 0	Included in Achievable Potential =1 / Duplicate Savings = 0	Measure Name	Replace on Burnout or Retrofit	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Total Number of Homes in remaining in VT that can still receive efficiency measure	Technical Potential Total MMBTU savings potential if 100% penetration attained 'overnight'	Achievable Program Participants per Year (80% penetration limit)	Achievable MMBTU Savings by 2016 (80% penetration limit)
31	1	1	ES Clothes Washer	ROB	11.61	0.11	1.25	2,014	2,518	110	1,375
32	1	1	Pipe Wrap	Retrofit	11.20	0.00	0.03	2,447	73	169	51
33	1	1	New Homes Construction	Market Driven	66.77	0.20	13.35	414	55,265	n/a	48,527
34	1	1	New Homes Construction	Market Driven	33.38	0.20	6.68	62	4,164	n/a	3,654
35	1	1	Vacant Homes Package	Retrofit	34.85	0.46	16.16	1,757	28,389	35	5,654
36	1	1	Vacant Homes Package	Retrofit	17.42	0.28	4.83	441	2,131	9	435
									1,182,150		424,397

Table A3-3

Propane Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on VT Societal Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	85.60	0.07	5.99	1,870	112,050
2	ES Windows	79.61	0.11	8.76	189	16,551
3	Insulation & Weatherization Pkg.	70.85	0.35	24.94	142	35,411
4	Programmable Thermostats	42.80	0.07	3.00	482	14,441
5	Attic Insulation & Weatherization Pkg.	39.80	0.13	5.06	36	1,820
6	ES Windows	34.75	0.11	3.82	47	1,796
7	Efficient Propane Furnace	45.91	0.06	2.57	387	9,950
8	Duct Sealing	43.34	0.05	2.17	211	4,573
9	Efficient Propane Furnace	30.93	0.06	1.73	63	1,091
10	Modulate Water Temp.	45.91	0.11	5.05	611	30,859
11	Efficient Water Boiler	40.86	0.02	0.00	276	0
12	Modulate Water Temp.	30.93	0.11	3.40	12	408
13	Efficient Water Boiler	27.52	0.02	0.00	70	0
14	Vent Damper	45.91	0.09	4.13	70	2,893
15	Improved Steam Vents	41.78	0.06	2.51	70	1,755
16	Efficient Steam Boiler	39.27	0.02	0.00	69	0
17	Mainline Vents	30.93	0.10	3.09	32	990
18	Vent Damper	27.83	0.09	2.50	18	451
19	Thermostatic Vents	25.33	0.06	1.52	12	182
20	Efficient Steam Boiler	23.81	0.02	0.00	18	0
22	Low Flow Showerhead/Faucets	19.10	0.02	0.36	1,143	3,703
23	Efficient Propane Water Heater	18.74	0.24	4.45	1,888	84,030
24	Solar WH w/ Propane Back Up	18.74	0.65	0.00	372	0
25	ES Dishwasher	14.29	0.02	0.35	1,023	3,581
26	ES Clothes Washer	13.94	0.09	1.25	1,700	21,250
27	Pipe Wrap	13.53	0.00	0.00	1,303	0
28	Pump Controller	19.10	0.16	3.06	146	4,462
29	Low Flow Showerhead/Faucets	16.04	0.02	0.36	155	502
30	Efficient Propane Water Heater	15.68	0.24	3.72	191	7,115
31	ES Dishwasher	11.96	0.03	0.35	63	221
32	ES Clothes Washer	11.61	0.11	1.25	110	1,375
33	Pipe Wrap	11.20	0.00	0.00	169	0
34	New Homes Construction	66.77	0.20	13.35	n/a	48,527
35	New Homes Construction	33.38	0.20	6.68	n/a	3,654
36	Vacant Homes Package	34.85	0.46	16.16	35	5,654
37	Vacant Homes Package	17.42	0.28	4.83	9	435
						419,729

Table A3-4

Propane Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on Participant Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	85.60	0.07	5.99	1,870	112,050
2	ES Windows	79.61	0.11	8.76	189	16,551
3	Insulation & Weatherization Pkg.	70.85	0.35	24.94	142	35,411
4	Programmable Thermostats	42.80	0.07	3.00	482	14,441
5	Attic Insulation & Weatherization Pkg.	39.80	0.13	5.06	36	1,820
6	ES Windows	34.75	0.11	3.82	47	1,796
7	Efficient Propane Furnace	45.91	0.06	2.57	387	9,950
8	Duct Sealing	43.34	0.05	2.17	211	4,573
9	Efficient Propane Furnace	30.93	0.06	1.73	63	1,091
10	Modulate Water Temp.	45.91	0.11	5.05	611	30,859
11	Efficient Water Boiler	40.86	0.02	0.94	276	2,594
12	Modulate Water Temp.	30.93	0.11	3.40	12	408
13	Efficient Water Boiler	27.52	0.02	0.63	70	443
14	Vent Damper	45.91	0.09	4.13	70	2,893
15	Improved Steam Vents	41.78	0.06	2.51	70	1,755
16	Efficient Steam Boiler	39.27	0.02	0.90	69	623
17	Mainline Vents	30.93	0.10	3.09	32	990
18	Vent Damper	27.83	0.09	2.50	18	451
19	Thermostatic Vents	25.33	0.06	1.52	12	182
20	Efficient Steam Boiler	23.81	0.02	0.55	18	99
22	Low Flow Showerhead/Faucets	19.10	0.02	0.36	1,143	3,703
23	Efficient Propane Water Heater	18.74	0.24	4.45	1,888	84,030
24	Solar WH w/ Propane Back Up	18.74	0.65	0.00	372	0
25	ES Dishwasher	14.29	0.02	0.35	1,023	3,581
26	ES Clothes Washer	13.94	0.09	1.25	1,700	21,250
27	Pipe Wrap	13.53	0.00	0.00	1,303	0
28	Pump Controller	19.10	0.16	3.06	146	4,462
29	Low Flow Showerhead/Faucets	16.04	0.02	0.36	155	502
30	Efficient Propane Water Heater	15.68	0.24	3.72	191	7,115
31	ES Dishwasher	11.96	0.03	0.35	63	221
32	ES Clothes Washer	11.61	0.11	1.25	110	1,375
33	Pipe Wrap	11.20	0.00	0.00	169	0
34	New Homes Construction	66.77	0.20	13.35	n/a	48,527
35	New Homes Construction	33.38	0.20	6.68	n/a	3,654
36	Vacant Homes Package	34.85	0.46	16.16	35	5,654
37	Vacant Homes Package	17.42	0.28	4.83	9	435
						423,488

Table A3-5

APPENDIX A4

KEROSENE

Kerosene Measure Assumptions (Initial Assumptions & Levelized Costs)

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)	Annual Amortized Cost Per Unit	Levelized Cost
All Homes with Kerosene Space Heat													7.975%	
1	Programmable Thermostats	SF	55.80	7.0%	3.91	15	$60	Homes w/ Kerosene SH	8.28%	14.00%			$7.00	$1.792
2	ES Windows	SF	55.80	11.0%	6.14	30	$600	Homes w/ Kerosene SH	8.28%	60.00%			$53.17	$8.663
3	Insulation & Weatherization Pkg.	SF	55.80	35.2%	19.64	30	$2,558	Homes w/ Kerosene SH	8.28%	75.00%			$226.68	$11.542
4	Programmable Thermostats	MF	27.90	7.0%	1.95	15	$60	Homes w/ Kerosene SH	1.11%	12.22%			$7.00	$3.584
5	Attic Insulation & Weatherization Pkg.	MF	27.90	12.7%	3.54	30	$344	Homes w/ Kerosene SH	1.11%	75.00%			$30.48	$8.602
6	ES Windows	MF	27.90	11.0%	3.07	30	$400	Homes w/ Kerosene SH	1.11%	60.00%			$35.45	$11.550
Homes with 'Kerosene' Furnaces														
7	Duct Sealing	SF	55.80	5.0%	2.79	15	$300	Homes w/ Oil Furnaces	4.93%	60.00%			$35.00	$12.543
8	Efficient 'Kerosene' Furnace	SF	55.80	5.9%	3.29	20	$700	Homes w/ Oil Furnaces	4.93%	6.52%	462		$71.16	$21.616
All Kerosene-Heated Vacant Homes														
9	Vacant Homes Package	SF	22.72	46.4%	10.53	30	$3,218	All Kerosene Heated Vacant Homes	8.28%	75.00%			$285.17	$27.079
10	Vacant Homes Package	MF	11.36	27.7%	3.15	30	$804	All Kerosene Heated Vacant Homes	1.11%	75.00%			$71.25	$22.613

Table A4-1

Kerosene Measure Annual Penetrations, Total # of Remaining Homes based on Technical Potential (100% Penetration) & Annual # of Maximum Achievable Homes (80% Penetration)*

Measure	Measure Name	Home Type	Base Case Saturation (% of all homes that contain the end use or the measure)	High Efficiency Saturation (% of homes fitting Base Case Description that are already energy efficient)	Remaining Factor (In how many homes can this be installed	Single-/Multi-Family Fraction	Number of applicable homes in 2005 (before applying remaining factor)	Total Homes Remaining without measure (after applying remaining factor)	Maximum Achievable Program Participants per year (80% penetration limit)*									
									2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Programmable Thermostats	SF	8.28%	14.00%	86.0%	84.5%	16,990	14,611	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121	1,121
2	ES Windows	SF	8.28%	60.00%	40.0%	84.5%	16,990	6,796	113	113	113	113	113	113	113	113	113	113
3	Insulation & Weatherization Pkg.	SF	8.28%	75.00%	25.0%	84.5%	16,990	4,248	85	85	85	85	85	85	85	85	85	85
4	Programmable Thermostats	MF	1.11%	12.22%	87.8%	15.5%	418	367	28	28	28	28	28	28	28	28	28	28
5	Attic Insulation & Weatherization Pkg.	MF	1.11%	75.00%	25.0%	15.5%	418	104	2	2	2	2	2	2	2	2	2	2
6	ES Windows	MF	1.11%	60.00%	40.0%	15.5%	418	167	3	3	3	3	3	3	3	3	3	3
7	Duct Sealing	SF	4.93%	60.00%	40.0%	84.5%	10,116	4,046	202	202	202	202	202	202	202	202	202	202
8	Efficient 'Kerosene' Furnace	SF	4.93%	6.52%	93.5%	84.5%	10,116	9,456	372	372	372	372	372	372	372	372	372	372
16	Vacant Homes Package	SF	8.28%	75.00%	25.0%	84.5%	4,214	1,054	21	21	21	21	21	21	21	21	21	21
17	Vacant Homes Package	MF	1.11%	75.00%	25.0%	15.5%	104	26	1	1	1	1	1	1	1	1	1	1

Table A4-2

Kerosene Measure Assumptions (Adjusted for Interactive Effects), Technical Potential, and Achievable Potential

Measure	Included in Tech. Potential =1 / Duplicate Savings = 0	Included in Achievable Potential =1 / Duplicate Savings = 0	Measure Name	Replace on Burnout or Retrofit	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Total Number of Homes in remaining in VT that can still receive efficiency measure	Technical Potential Total MMBTU savings potential if 100% penetration attained 'overnight'	Achievable Program Participants per Year (80% penetration limit)	Achievable MMBTU Savings by 2016 (80% penetration limit)
1	1	1	Programmable Thermostats	Retrofit	55.80	0.07	3.91	14,611	57,072	1,121	43,786
2	1	1	ES Windows	ROB	51.89	0.11	5.71	6,796	38,794	113	6,450
3	1	1	Insulation & Weatherization Pkg.	Retrofit	46.19	0.35	16.26	4,248	69,047	85	13,818
4	1	1	Programmable Thermostats	Retrofit	27.90	0.07	1.95	367	716	28	547
5	1	1	Attic Insulation & Weatherization Pkg.	Retrofit	25.95	0.13	3.30	104	344	2	66
6	1	1	ES Windows	ROB	22.65	0.11	2.49	167	416	3	75
7	1	1	Duct Sealing	Retrofit	29.93	0.05	1.50	4,046	6,055	202	3,023
8	1	1	Efficient 'Kerosene' Furnace	ROB	28.43	0.06	1.68	9,456	15,864	372	6,241
9	1	1	Vacant Homes Package	Retrofit	22.72	0.46	10.53	1,054	11,096	21	2,212
10	1	1	Vacant Homes Package	Retrofit	11.36	0.28	3.15	26	82	1	32
									199,487		76,248

Table A4-3

Kerosene Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on VT Societal Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	55.80	0.07	3.91	1,121	43,786
2	ES Windows	51.89	0.11	5.71	113	6,450
3	Insulation & Weatherization Pkg.	46.19	0.35	16.26	85	13,818
4	Programmable Thermostats	27.90	0.07	1.95	28	547
5	Attic Insulation & Weatherization Pkg.	25.95	0.13	3.30	2	66
6	ES Windows	22.65	0.11	2.49	3	75
7	Duct Sealing	29.93	0.05	0.00	202	0
8	Efficient 'Kerosene' Furnace	29.93	0.06	1.77	372	6,569
9	Vacant Homes Package	22.72	0.46	0.00	21	0
10	Vacant Homes Package	11.36	0.28	3.15	1	32
						71,342

Table A4-4

Kerosene Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on Participant Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	55.80	0.07	3.91	1,121	43,786
2	ES Windows	51.89	0.11	5.71	113	6,450
3	Insulation & Weatherization Pkg.	46.19	0.35	16.26	85	13,818
4	Programmable Thermostats	27.90	0.07	1.95	28	547
5	Attic Insulation & Weatherization Pkg.	25.95	0.13	3.30	2	66
6	ES Windows	22.65	0.11	2.49	3	75
7	Duct Sealing	29.93	0.05	1.50	202	3,023
8	Efficient 'Kerosene' Furnace	28.43	0.06	1.68	372	6,241
9	Vacant Homes Package	22.72	0.46	10.53	21	2,212
10	Vacant Homes Package	11.36	0.28	3.15	1	32
						76,248

Table A4-5

APPENDIX A5

WOOD

Wood Measure Assumptions (Initial Assumptions & Levelized Costs)

Measure	Measure Name	Home Type	Annual Base Fuel Use (MMBTU)	% Annual Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	End Use Description	Base Saturation	EE Saturation	Annual Electrical (kWh) Savings	Annual Water Savings (gal.)	Annual Amortized Cost Per Unit	Levelized Cost
All Homes with Wood Space Heat													7.975%	
1	Programmable Thermostats	SF	84.48	7.0%	5.91	15	$60	Homes w/ Wood SH	11.83%	14.00%			$7.00	$1.184
2	ES Windows	SF	84.48	11.0%	9.29	30	$600	Homes w/ Wood SH	11.83%	60.00%			$53.17	$5.722
3	Insulation & Weatherization Pkg.	SF	84.48	35.2%	29.73	30	$2,558	Homes w/ Wood SH	11.83%	75.00%			$226.68	$7.624
4	Programmable Thermostats	MF	42.24	7.0%	2.96	15	$60	Homes w/ Wood SH	3.33%	12.22%			$7.00	$2.367
5	Attic Insulation & Weatherization Pkg.	MF	42.24	12.7%	5.37	30	$344	Homes w/ Wood SH	3.33%	75.00%			$30.48	$5.682
6	ES Windows	MF	42.24	11.0%	4.65	30	$400	Homes w/ Wood SH	3.33%	60.00%			$35.45	$7.629
All Homes with Wood Stoves														
7	Efficient Wood Stoves	SF	84.48	12.5%	10.56	15	$200	Homes w/ Wood Stoves	9.47%	10.00%			$23.33	$2.209
8	Efficient Wood Stoves	MF	42.24	12.5%	5.28	15	$200	Homes w/ Wood Stoves	1.11%	10.00%			$23.33	$4.419
Propane Water Heating														
9	Low Flow Showerhead/Faucets	SF	21.12	2.0%	0.42	9	$21	Homes with Wood WH	0.99%	49.31%		4937	$3.36	$7.950
10	Solar WH w/ Wood Back Up	SF	21.12	65.0%	13.73	20	$5,626	Homes with Wood WH	0.99%	0.00%			$571.95	$41.663
11	Pipe Wrap	SF	21.12	0.3%	0.05	10	$15	Homes with Wood WH	0.99%	45.00%			$2.23	$42.290
12	Low Flow Showerhead/Faucets	MF	21.12	2.0%	0.42	9	$21	Homes with Wood WH	1.11%	49.31%		4937	$3.36	$7.950
13	Pipe Wrap	MF	21.12	0.3%	0.05	10	$15	Homes with Wood WH	1.11%	45.00%			$2.23	$42.290
All Wood-Heated New Homes														
14	New Homes Construction	SF	65.89	20.0%	13.18	30	$2,000	All Wood Heated New Homes	6.00%	33.00%			$177.24	$13.448
15	New Homes Construction	MF	32.95	20.0%	6.59	30	$1,000	All Wood Heated New Homes	6.00%	33.00%			$88.62	$13.448
All Wood-Heated Vacant Homes														
16	Vacant Homes Package	SF	34.39	46.4%	15.94	30	$3,218	All Wood Heated Vacant Homes	11.83%	75.00%			$285.17	$17.886
17	Vacant Homes Package	MF	17.20	27.7%	4.77	30	$804	All Wood Heated Vacant Homes	3.33%	75.00%			$71.25	$14.936

Table A5-1

Wood Measure Annual Penetrations, Total # of Remaining Homes based on Technical Potential (100% Penetration) & Annual # of Maximum Achievable Homes (80% Penetration*)

Measure	Measure Name	Home Type	Base Case Saturation (% of all homes that contain the end use or the measure)	High Efficiency Saturation (% of homes fitting Base Case Description that are already energy efficient)	Remaining Factor (In how many homes can this be installed	Single-/Multi-Family Fraction	Number of applicable homes in 2005 (before applying remaining factor)	Total Homes Remaining without measure (after applying remaining factor)	Maximum Achievable Program Participants per year (80% penetration limit)*									
									2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Programmable Thermostats	SF	11.83%	14.00%	86.0%	84.5%	24,274	20,876	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602
2	ES Windows	SF	11.83%	60.00%	40.0%	84.5%	24,274	9,710	162	162	162	162	162	162	162	162	162	162
3	Insulation & Weatherization Pkg.	SF	11.83%	75.00%	25.0%	84.5%	24,274	6,069	121	121	121	121	121	121	121	121	121	121
4	Programmable Thermostats	MF	3.33%	12.22%	87.8%	15.5%	1,253	1,100	85	85	85	85	85	85	85	85	85	85
5	Attic Insulation & Weatherization Pkg.	MF	3.33%	75.00%	25.0%	15.5%	1,253	313	6	6	6	6	6	6	6	6	6	6
6	ES Windows	MF	3.33%	60.00%	40.0%	15.5%	1,253	501	8	8	8	8	8	8	8	8	8	8
7	Efficient Wood Stoves	SF	9.47%	6.52%	93.5%	84.5%	19,432	18,165	952	952	952	952	952	952	952	952	952	952
8	Efficient Wood Stoves	MF	1.11%	4.88%	95.1%	15.5%	418	397	21	21	21	21	21	21	21	21	21	21
9	Low Flow Showerhead/Faucets	SF	0.99%	49.31%	50.7%	84.5%	2,031	1,030	62	62	62	62	62	62	62	62	62	62
10	Solar WH w/ Wood Back Up	SF	0.99%	0.00%	100.0%	84.5%	2,031	2,031	20	20	20	20	20	20	20	20	20	20
11	Pipe Wrap	SF	0.99%	45.00%	55.0%	84.5%	2,031	1,117	71	71	71	71	71	71	71	71	71	71
12	Low Flow Showerhead/Faucets	MF	1.11%	38.89%	61.1%	15.5%	418	255	17	17	17	17	17	17	17	17	17	17
13	Pipe Wrap	MF	1.11%	35.00%	65.0%	15.5%	418	272	19	19	19	19	19	19	19	19	19	19
14	New Homes Construction	SF	6.00%	33.00%	67.0%	100.0%	128	86	48	54	60	62	72	78	84	90	96	102
15	New Homes Construction	MF	6.00%	33.00%	67.0%	100.0%	19	13	7	8	9	10	11	12	13	14	15	15
16	Vacant Homes Package	SF	11.83%	75.00%	25.0%	84.5%	6,021	1,505	30	30	30	30	30	30	30	30	30	30
17	Vacant Homes Package	MF	3.33%	75.00%	25.0%	15.5%	311	78	2	2	2	2	2	2	2	2	2	2

*Note: Solar Water Heating w/ Oil Back-Up only assumed a 10% achievable penetration

Wood Measure Assumptions (Adjusted for Interactive Effects), Technical Potential, and Achievable Potential

Measure	Included in Tech. Potential =1 / Duplicate Savings = 0	Included in Achievable Potential =1 / Duplicate Savings = 0	Measure Name	Replace on Burnout or Retrofit	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Total Number of Homes in remaining in VT that can still receive efficiency measure	Technical Potential Total MMBTU savings potential if 100% penetration attained 'overnight'	Achievable Program Participants per Year (80% penetration limit)	Achievable MMBTU Savings by 2016 (80% penetration limit)
1	1	1	Programmable Thermostats	Retrofit	84.48	0.07	5.91	20,876	123,452	1,602	94,736
2	1	1	ES Windows	ROB	78.57	0.11	8.64	9,710	83,915	162	14,001
3	1	1	Insulation & Weatherization Pkg.	Retrofit	69.92	0.35	24.61	6,069	149,356	121	29,780
4	1	1	Programmable Thermostats	Retrofit	42.24	0.07	2.96	1,100	3,253	85	2,513
5	1	1	Attic Insulation & Weatherization Pkg.	Retrofit	39.28	0.13	4.99	313	1,563	6	299
6	1	1	ES Windows	ROB	34.29	0.11	3.77	501	1,891	8	302
7	1	1	Efficient Wood Stoves	ROB	45.31	0.13	5.66	18,165	102,888	952	53,922
8	1	1	Efficient Wood Stoves	ROB	30.52	0.13	3.82	397	1,516	21	801
9	1	1	Low Flow Showerhead/Faucets	Retrofit	21.12	0.02	0.42	1,030	435	62	262
10	1	1	Solar WH w/ Wood Back Up	Retrofit	20.70	0.65	13.45	2,031	27,330	20	2,691
11	1	1	Pipe Wrap	Retrofit	7.24	0.01	0.05	1,117	59	71	37
12	1	1	Low Flow Showerhead/Faucets	Retrofit	21.12	0.02	0.42	255	108	17	72
13	1	1	Pipe Wrap	Retrofit	20.70	0.00	0.05	272	14	19	10
14	1	1	New Homes Construction	Market Driven	65.89	0.20	13.18	86	11,285	n/a	9,832
15	1	1	New Homes Construction	Market Driven	32.95	0.20	6.59	13	850	n/a	751
16	1	1	Vacant Homes Package	Retrofit	34.39	0.46	15.94	1,505	24,001	30	4,783
17	1	1	Vacant Homes Package	Retrofit	17.20	0.28	4.77	78	371	2	95
									532,287		214,887

Table A5-3

Wood Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on VT Societal Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	84.48	0.07	5.91	1,602	94,736
2	ES Windows	78.57	0.11	8.64	162	14,001
3	Insulation & Weatherization Pkg.	69.92	0.35	24.61	121	29,780
4	Programmable Thermostats	42.24	0.07	2.96	85	2,513
5	Attic Insulation & Weatherization Pkg.	39.28	0.13	4.99	6	299
6	ES Windows	34.29	0.11	3.77	8	302
7	Efficient Wood Stoves	45.31	0.13	5.66	952	53,922
8	Efficient Wood Stoves	30.52	0.13	3.82	21	801
9	Low Flow Showerhead/Faucets	21.12	0.02	0.42	62	236
10	Solar WH w/ Wood Back Up	20.70	0.65	0.00	20	0
11	Pipe Wrap	20.70	0.00	0.00	71	0
12	Low Flow Showerhead/Faucets	21.12	0.02	0.42	17	65
13	Pipe Wrap	20.70	0.00	0.00	19	0
14	New Homes Construction	65.89	0.20	13.18	n/a	9,832
15	New Homes Construction	32.95	0.20	6.59	n/a	751
16	Vacant Homes Package	34.39	0.46	15.94	30	4,783
17	Vacant Homes Package	17.20	0.28	4.77	2	95
						212,116

Table A5-4

Wood Measure Assumptions (Adjusted for Interactive Effects) and Cost Effective Achievable Potential, Based on Participant Test Cost-Effectiveness

Measure	Measure Name	Annual Base Fuel Use (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Achievable Program Participants per Year (80% penetration limit)	Cost-Effective Achievable MMBTU Savings by 2016 (80% penetration limit)
1	Programmable Thermostats	84.48	0.07	5.91	1,602	94,736
2	ES Windows	78.57	0.11	8.64	162	14,001
3	Insulation & Weatherization Pkg.	69.92	0.35	24.61	121	29,780
4	Programmable Thermostats	42.24	0.07	2.96	85	2,513
5	Attic Insulation & Weatherization Pkg.	39.28	0.13	4.99	6	299
6	ES Windows	34.29	0.11	3.77	8	302
7	Efficient Wood Stoves	45.31	0.13	5.66	952	53,922
8	Efficient Wood Stoves	30.52	0.13	3.82	21	801
9	Low Flow Showerhead/Faucets	21.12	0.02	0.42	62	236
10	Solar WH w/ Wood Back Up	20.70	0.65	0.00	20	0
11	Pipe Wrap	20.70	0.00	0.00	71	0
12	Low Flow Showerhead/Faucets	21.12	0.02	0.42	17	65
13	Pipe Wrap	20.70	0.00	0.00	19	0
14	New Homes Construction	65.89	0.20	13.18	n/a	9,832
15	New Homes Construction	32.95	0.20	6.59	n/a	751
16	Vacant Homes Package	34.39	0.46	15.94	30	4,783
17	Vacant Homes Package	17.20	0.28	4.77	2	95
						212,116

Table A5-5

APPENDIX B:

COMMERCIAL SECTOR

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APPENDIX B1:

FUEL OIL

Descriptions of Commercial Energy Efficiency Measures

This technical appendix describes a range of commercial sector energy efficiency measures and programs where GDS has assessed the technical, achievable, and achievable cost effective potential for oil, propane, kerosene and wood energy savings in Vermont. The purpose of this technical appendix is to briefly describe these efficiency measures and to provide data on their costs, energy savings and useful lives. The calculations of the potential savings are provided in a separate Excel file that is a separate appendix to this study.

1. FUEL OIL

The following sections describe the energy efficiency measures that were included in this analysis for all commercial buildings utilizing fuel oil for either space heating and/or water heating.

1.1 Space Heating

Eleven commercial space heating energy efficiency measures are covered in this section: Efficient Furnaces, Setback Controls, Efficient Boilers, Roof Insulation, Energy Star Windows, Efficient Unit Heaters, Heat Recovery Vents, Duct Sealing, Insulation Packages, and Retro-commissioning. Listed below are the basic assumptions used in this study for these technologies. For purposes of this appendix, costs and savings figures are presented below for a typical commercial building in Vermont. Sources for this data can be found in Appendix B1: Commercial Measure Data Sources.

Table B-1: Energy Efficiency Measures for **Fuel Oil** - Space Heating

Measure Name	Annual Base Fuel Use per Building (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Levelized Cost per Lifetime MMBtu Saved
Efficient Furnace	553	14%	76	20	$5,400	$ 7.20
Setback Controls	553	7%	39	10	$500	$ 1.92
Efficient Boiler	553	6%	33	25	$3,700	$ 10.43
Boiler Tune-up	553	5%	28	5	$250	$ 2.26
Boiler Water Temp Reset Control	553	11%	61	20	$600	$ 1.00
Roof Insulation	553	8%	44	20	$1,600	$ 3.68
Energy Star Windows	553	11%	61	30	$2,400	$ 3.50
Efficient Unit Heaters	553	21%	116	19	$260	$ 0.23
Heat Recovery Vent	553	15%	83	20	$1,575	$ 1.93
Duct Sealing	553	13%	72	15	$450	$ 0.73
Wall Insulation	553	12%	69	30	$2,200	$ 2.84
Retrocommisioning	553	9.0%	50	7	$1,700	$ 6.56

(1) Efficient Oil Furnace[1]*:* A furnace heats air that is blown through air ducts and delivered to rooms through registers or grills. This type of heating system is called a ducted warm-air or forced warm-air distribution system. In this analysis, for a replace on burn-out installation, a high efficiency warm-air oil furnace is installed instead of a standard efficiency replacement model.

(2) Setback Controls[2]*:* A Thermostat Temperature Setback Control can be used in new and existing installations to provide automatic room temperature control. A given HVAC system's complexity dictates the level of controls necessary to effectively manage the system. However, for the purposes of this report, only a time-of-day setback control is analyzed. This control typically sets the temperature back 10-15 degrees in the winter for a period of 8 hours or more during periods when a building is unoccupied.

(3) Efficient Water Boiler[3]*:* A hot water boiler heats water that circulates through pipes to radiators or baseboards to provide space heating for a commercial space. Hot water systems, sometimes called hydronic systems, are more common today than steam systems. In this analysis, a high efficiency water boiler is installed in lieu of a standard efficiency replacement model.

(4) Boiler Tune-up[4]*:* A typical boiler tune-up protocol includes the following measures:

- Check and clean combustion burner and adjust combustion blower as applicable
- Check, clean, and adjust pilot (if applicable)
- Inspect and adjust all operating and safety controls
- Inspect vents
- Adjust burner and fuel input; manual or motorized draft control
- Check adequacy of combustion air intake
- Clean fire tubes or other heat-exchanger surface, if applicable

(5) Roof Insulation and Air Sealing: This measure addresses the reduction of thermal transfer through the roof of a building. This measure can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building's roof, or in the form of additional insulation to reduce the amount of heat flow between conditioned and unconditioned spaces.

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[1] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[2] http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12720, http://yosemite.epa.gov/gw/StatePolicyActions.nsf/uniqueKeyLookup/MSTY5QNHF5?OpenDocument
[3] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[4] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401., http://www.energytrust.org/bto/boiler.html

(6) Energy Star Windows[5]*:* In older commercial buildings, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool commercial buildings. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity (Low-E) coating.

(7) Efficient Unit Heaters[6]*:* The energy efficient unit heater is a power vented heater hung from ceilings or high on walls with a sealed flue. The sealed flue prevents air from escaping to the outdoors as is the case with many gravity-vented unit heaters. Increasingly, these power-vented unit heaters may contain intermittent ignition devices, which prevent the need for pilot lights and reduces fuel consumption.

(8) Heat Recovery Vents[7]*:* A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing 60 to 80 percent of the conditioned temperatures that would otherwise be lost.

(9) Duct Sealing[8]*:* Leaky and unsealed commercial air ducts for forced hot air furnaces are properly repaired and sealed. Mastic (a special paste) is the preferred method for duct sealing. Properly sealing leaky ducts can save significant amounts of energy needed to heat a building.

(10) Insulation[9]*:* Insulation measures address the reduction of thermal transfer through the “shell” between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures considers only commercial wall insulation.

(11) Retrocommissioning[10]*:* Retrocommissioning is typically a one-time event that applies a systematic investigation process for improving and optimizing building operations and maintenance (O&M). It typically focuses on energy-using

[5] “Energy Efficiency in Remodeling: Windows” Tool Base Services website. (www.toolbase.org)
[6] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[7] http://www.toolbase.org/Technology-Inventory/HVAC/energy-recovery-ventilators.
[8] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 388.
[9] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 392 & 395.
[10] http://www.aceee.org/pubs/a035full.pdf, p.5.

equipment such as mechanical systems and controls to ensure the functionality of system components as well as their combined functionality in order to reduce energy consumption and operating costs, and identify and fix existing problems within the facility. While retrocommissioning utilizes building diagnostics and O&M tune-ups in order to improve building performance, the process may also be used to identify potential capital improvements for additional performance gains.

1.2 Water Heating

Seven commercial water heating energy efficiency measures are covered in this section: Pipe Insulation, Efficient Boilers, Boiler Tune-up, Pump Controllers, Efficient Storage Water Heaters, Efficient Instantaneous Water Heaters, Low-Flow Pre-Rinse Dishwashing Nozzles, and Commercial Clothes Washers. Listed below are the basic assumptions used in this study for these technologies. For purposes of this appendix, costs and savings figures are presented below for a typical commercial water heating system in Vermont. Sources for this data can be found in Appendix B1: Commercial Measure Sources.

Table B-2: Energy Efficiency Measures for **Fuel Oil** - Water Heating

Measure Name	Annual Base Fuel Use per Building (MMBTU)	% Savings	Annual Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Levelized Cost per Lifetime MMBtu Saved
Pipe Insulation	105	10%	11	15	300	$ 3.32
Efficient Boiler	105	17%	18	30	3,700	$ 18.33
Pump Controller	105	32%	34	15	1,400	$ 4.85
Efficient Storage Water Heater	105	9%	9	10	261	$ 4.10
Efficient Instantaneous Water Heater	105	10%	11	20	500	$ 4.83
Low Flow Pre-Rinse Nozzle	105	1%	1	5	5	$ 2.04
Commercial Clothes Washer	105	40%	42	14	300	$ 0.87

(1) Pipe Insulation[11]*:* Insulating hot water pipes will reduce losses as the hot water is flowing to the faucet and, more importantly, it will reduce standby losses when the tap is turned off and then back on within an hour or so. Pipe wrap will conserve energy and water that would normally be lost waiting for the hot water to reach the tap. Energy loss still occurs after pipe wrap has been installed, though to a smaller degree than the losses observed in non-insulated pipes.

(2) Efficient Boiler[12]*:* In this analysis, a high efficiency boiler is installed in lieu of a standard efficiency replacement model. These models typically have exhaust fan that controls the flow of combustion air and combustion gases more

[11] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[12] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003, and http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12530

precisely, electric ignition rather than a pilot light, are more compact in weight to reduce cycling losses, and have a small-diameter flue pipe.

(3) Pump Controller[13]*:* Pump controllers are electronic controls that save energy by memorizing building hot water demand patterns. The controller, based on usage patterns, automatically reduces hot water loop temperatures during periods of low hot water demand. This reduces the amount of wasted energy expended to heat water during periods of low usage.

(4) Efficient Storage Water Heaters[14]*:* In this analysis, a high efficiency storage water heater is installed in lieu of a standard efficiency replacement model. An oil storage water heater means a water heater that uses oil as the energy source, has a nominal input greater than 105,000 Btu per hour, and/or has a rated storage capacity greater than 50 gallons.

(5) Efficient Instantaneous Water Heaters[15]*:* Instantaneous, or tank-less, water heaters provide hot water without using a storage tank and, therefore, don't suffer standby losses and have much higher energy factors than conventional units. Oil instantaneous water heater means a water heater that uses oil as the energy source, has an input greater than 210,000 Btu per hour, and an input rating of at least 4,000 Btu per hour per gallon of stored water.

(6) Low Flow Pre-Rinse Nozzles[16]*:* A low-flow pre-rinse spray valve uses a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. They reduce water consumption, water heating cost, and wastewater (sewer) charges. The baseline model has a flow rate of 3.0 gpm @ 60 psi.

(7) Commercial Clothes Washer[17]*:* High efficiency commercial clothes washers exceeding minimum qualifying efficiency standards established under Energy Star Program with a Modified Energy Factor (MEF) >= 1.42 can save money by using less energy and processing a greater volume of clothes in a single run, reducing the number of runs necessary and further increasing efficiency.

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[13] Personal communication with Steve Nadel (ACEEE), November 2006.
[14] http://www.nyserda.org/about/Part506.pdf
[15] http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-4_759_8408_7983-7124-6_523_943-0,00.html, and http://www.nyserda.org/about/Part506.pdf
[16] http://www.eere.energy.gov/femp/procurement/eep_low-flow_valves.cfm#features
[17] http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers_comm

Flow Pre-Rinse Dishwashing Nozzles, and Commercial Clothes Washers. Listed below are the basic assumptions used in this study for these technologies. Sources for this data can be found in Appendix B##: Commercial Measure Sources.

Table B-4: Energy Efficiency Measures for **Propane** - Water Heating

Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Levelized Cost per Lifetime MMBtu Saved
Pipe Insulation	105	10.0%	11	15	$300	$3.32
Efficient Boiler	105	17.0%	18	30	$3,700	$18.33
Pump Controller	105	32.0%	34	15	$1,400	$4.85
Efficient Storage Water Heater	105	9.0%	9	13	$261	$3.48
Efficient Instantaneous Water Heater	105	10.0%	11	20	$500	$4.83
Low Flow Pre-Rinse Nozzle	105	0.6%	1	5	$5	$2.04
Commercial Clothes Washer	105	39.53%	42	14	$300	$0.87

(1) Pipe Insulation[28]*:* Insulating hot water pipes will reduce losses as the hot water is flowing to the faucet and, more importantly, it will reduce standby losses when the tap is turned off and then back on within an hour or so. Pipe wrap will conserve energy and water that would normally be lost waiting for the hot water to reach the tap. Energy loss still occurs after pipe wrap has been installed, though to a smaller degree than the losses observed in non-insulated pipes.

(2) Efficient Boiler[29]*:* In this analysis, a high efficiency boiler is installed in lieu of a standard efficiency replacement model. These models typically have exhaust fan that controls the flow of combustion air and combustion gases more precisely, electric ignition rather than a pilot light, are more compact in weight to reduce cycling losses, and have a small-diameter flue pipe.

(3) Pump Controller[30]*:* Pump controllers are electronic controls that save energy by memorizing building hot water demand patterns. The controller, based on usage patterns, automatically reduces hot water loop temperatures during periods of low hot water demand. This reduces the amount of wasted energy expended to heat water during periods of low usage.

(4) Efficient Storage Water Heaters[31]*:* In this analysis, a high efficiency storage water heater is installed in lieu of a standard efficiency replacement model. A gas storage water heater means a water heater that uses gas as the energy source,

[28] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[29] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003. http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12530
[30] Personal communication with Steve Nadel (ACEEE), November 2006.
[31] http://www.nyserda.org/about/Part506.pdf

Vermont Energy Efficiency Potential Study - Commercial Sector Measure Database
"Commercial Energy Opportunities"

Oil Measure Assumptions 7.975%

Measure	Measure Name	Annual Base Fuel Use per Building (MMBTU)	% Savings	Annual Fuel Savings per Building (MMBTU)	Useful Life	Increm. Measure Cost	Annual Amortized Cost Per Unit	Levelized Cost per Lifetime MMBtu Saved	End Use Description
Oil Space Heating									
1	Efficient Furnace	553	14%	76	20	$5,400	$548.98	$7.20	Space Heating
2	Setback Controls	553	7%	39	10	$500	$74.43	$1.92	Space Heating
3	Efficient Boiler (SH)	553	6%	33	25	$3,700	$345.87	$10.43	Space Heating
4	Boiler Tune-up	553	5%	28	5	$250	$62.57	$2.26	Space Heating
5	Boiler Water Temp Reset Control	553	11%	61	20	$600	$61.00	$1.00	Space Heating
6	Roof Insulation	553	8%	44	20	$1,600	$162.66	$3.68	Space Heating
7	Energy Star Windows	553	11%	61	30	$2,400	$212.68	$3.50	Space Heating
8	Efficient Unit Heaters	553	21%	116	19	$260	$27.02	$0.23	Space Heating
9	Heat Recovery Vent	553	15%	83	20	$1,575	$160.12	$1.93	Space Heating
10	Duct Sealing	553	13%	72	15	$450	$52.49	$0.73	Space Heating
11	Wall Insulation	553	12%	69	30	$2,200	$194.96	$2.84	Space Heating
12	Retrocommisioning	553	9.0%	50	7	$1,700	$326.24	$6.56	Space Heating
Oil Water Heating									
13	Pipe Insulation	105	10%	11	15	$300	$35.00	$3.32	Water Heating
14	Efficient Boiler (WH)	105	17%	18	30	$3,700	$327.89	$18.33	Water Heating
15	Pump Controller	105	32%	34	15	$1,400	$163.31	$4.85	Water Heating
16	Efficient Storage Water Heater	105	9%	9	10	$261	$38.85	$4.10	Water Heating
17	Efficient Instantaneous Water Heater	105	10%	11	20	$500	$50.83	$4.83	Water Heating
18	Low Flow Pre-Rinse Nozzle	105	0.6%	1	5	$5	$1.25	$2.04	Water Heating
19	Commercial Clothes Washer	105	40%	42	14	$300	$36.34	$0.87	Water Heating

Total End Use MMBtu's by Type	Base Case Factor	Remaining Factor	Technical Convertible Factor	Savings Factor	Technical Potential of Efficient Measure	Technical Potential Factor	Achievable Convertible Factor	Acheivable Potential of Efficient Measure	Acheivable Potential Factor	Source & Notes
Oil Space Heating										
5,587,999	60.00%	90.00%	100.00%	13.80%	416,418	54.00%	80.00%	333,134	43.20%	7
5,587,999	60.00%	90.00%	90.00%	7.00%	190,104	48.60%	80.00%	168,981	43.20%	1
5,587,999	20.00%	90.00%	100.00%	6.00%	60,350	18.00%	80.00%	48,280	14.40%	7
5,587,999	20.00%	90.00%	90.00%	5.00%	45,263	16.20%	80.00%	40,234	14.40%	1
5,587,999	20.00%	90.00%	90.00%	11.00%	99,578	16.20%	80.00%	88,514	14.40%	1
5,587,999	60.00%	90.00%	90.00%	8.00%	217,261	48.60%	80.00%	193,121	43.20%	1
5,587,999	60.00%	90.00%	90.00%	11.00%	298,734	48.60%	80.00%	265,542	43.20%	1
5,587,999	20.00%	90.00%	100.00%	21.00%	211,226	18.00%	80.00%	168,981	14.40%	2, 11
5,587,999	60.00%	90.00%	100.00%	15.00%	452,628	54.00%	80.00%	362,102	43.20%	2, 11
5,587,999	60.00%	90.00%	100.00%	13.00%	392,278	54.00%	80.00%	313,822	43.20%	2, 11
5,587,999	60.00%	90.00%	100.00%	12.44%	375,379	54.00%	80.00%	300,304	43.20%	7
5,587,999	60.00%	90.00%	100.00%	9.00%	271,577	54.00%	80.00%	217,261	43.20%	3, 12, 15, 16
Oil Water Heating										
1,064,381	70.00%	90.00%	90.00%	10.00%	60,350	56.70%	80.00%	53,645	50.40%	1
1,064,381	70.00%	90.00%	90.00%	17.00%	102,596	56.70%	80.00%	91,196	50.40%	1
1,064,381	70.00%	90.00%	90.00%	32.00%	193,121	56.70%	80.00%	171,663	50.40%	1
1,064,381	20.00%	90.00%	90.00%	9.00%	15,519	16.20%	80.00%	13,794	14.40%	1
1,064,381	2.00%	90.00%	100.00%	10.00%	1,916	1.80%	80.00%	1,533	1.44%	10
1,064,381	2.00%	90.00%	100.00%	0.58%	111	1.80%	80.00%	89	1.44%	13
1,064,381	6.00%	95.00%	100.00%	39.53%	23,986	5.70%	80.00%	19,189	4.56%	14

Vermont Energy Efficiency Potential Study - Commercial Sector Measure Database

"Commercial Energy Opportunities"

Sources and Notes

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

2 "Unit Heaters Deserve Attention for Commercial Programs," Harvey M. Sachs. April 2003, page 6.

3 "Retrocommissioning: Program Strategies to Capture Energy Savings in Existing Buildings," Jennifer Thorne and Steven Nadel. ACEEE Report Number A035,

4 http://www.eere.energy.gov/

5 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html

6 http://www.energy.ca.gov/deer/

7 GDS Model developed using Energy-10, version 1.8

8 http://www.eia.doe.gov/emeu/reps/abstracts/northeast.html#Energy%20Demand

9 http://www.eere.energy.gov/femp/technologies/techdemo_publications.cfm

10 US DOE Technical Brief: "Demand (Tankless or Instantaneous) Water Heaters", January, 2004

11 http://www.aceee.org/pubs/a031full.pdf

12 http://www.cee1.org/com/com-kit/prv-guides.pdf

13 http://www.fishnick.com/saveenergy/sprayvalves/

14 per conversation with Dick Spellman, Massachussettes Gas Networks study

15 Quantum Consulting - Pilot program experience from Oakland CA per email communication from Mike Rufo on 2/3/04

16 American Council for an Energy Efficient Economy (ACEEE), Selecting Targets for Market Transformation Programs: A National Analysis, 1998.

APPENDIX B2:

PROPANE

2. PROPANE

The following sections describe the energy efficiency measures that were included in this analysis for all commercial entities utilizing propane for either space heating and/or water heating.

2.1 Space Heating

Ten commercial space heating energy efficiency measures are covered in this section: Efficient Furnaces, Setback Controls, Efficient Boilers, Roof Insulation, Energy Star Windows, Efficient Unit Heaters, Heat Recovery Vents, Duct Sealing, Insulation Packages, and Retrocommissiong. Listed below are the basic assumptions used in this study for these technologies. Sources for this data can be found in Appendix B1: Commercial Measure Sources.

Table B-3: Energy Efficiency Measures for Propane - Space Heating

Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Levelized Cost per Lifetime MMBtu Saved
Efficient Furnace	553	13.8%	76	20	$5,400	$7.20
Setback Controls	553	7.0%	39	10	$500	$1.92
Efficient Boiler	553	6.0%	33	25	$3,700	$10.43
Boiler Tune-up	553	5.0%	28	5	$250	$2.26
Boiler Water Temp Reset Control	553	11.0%	61	20	$600	$1.00
Roof Insulation	553	8.0%	44	20	$1,600	$3.68
Energy Star Windows	553	11.0%	61	30	$2,400	$3.50
Efficient Unit Heaters	553	21.0%	116	19	$260	$0.23
Heat Recovery Vent	553	15.0%	83	20	$1,575	$1.93
Duct Sealing	553	13.0%	72	15	$450	$0.73
Wall Insulation	553	12.4%	69	30	$2,200	$2.84
Retrocommisioning	553	9.0%	4973.0%	7	$1,700	$6.56

(1) Efficient Oil Furnace[18]*:* A furnace heats air that is blown through air ducts and delivered to rooms through registers or grills. This type of heating system is called a ducted warm-air or forced warm-air distribution system. In this analysis, for a replace on burn-out installation, a high efficiency warm-air oil furnace is installed instead of a standard efficiency replacement model.

(2) Setback Controls[19]*:* A Thermostat Temperature Setback Control can be used in new and existing installations to provide automatic room temperature control. A given HVAC system's complexity dictates the level of controls necessary to

[18] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[19] http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12720, and http://yosemite.epa.gov/gw/StatePolicyActions.nsf/uniqueKeyLookup/MSTY5QNHF5?OpenDocument

effectively manage the system. However, for the purposes of this report, only a time-of-day setback control is analyzed. This control typically sets the temperature back 10-15 degrees in the winter for a period of 8 hours or more during periods when a building is unoccupied.

(3) Efficient Water Boiler[20]*:* A hot water boiler heats water that circulates through pipes to radiators or baseboards to provide space heating for a commercial space. Hot water systems, sometimes called hydronic systems are more common today than steam systems. In this analysis, a high efficiency water boiler is installed in lieu of a standard efficiency replacement model.

(4) Boiler Tune-up[21]*:* A typical boiler tune-up protocol includes the following measures:

- Check and clean combustion burner, and adjust combustion blower, as applicable
- Check, clean, and adjust pilot (if applicable)
- Inspect and adjust all operating and safety controls
- Inspect vents
- Adjust burner and fuel input; manual or motorized draft control
- Check adequacy of combustion air intake
- For boilers with atmospheric burners, clean fire tubes or other heat-exchanger surface

(5) Roof Insulation: This measure addresses the reduction of thermal transfer through the roof of a building. This measure can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building's roof, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces.

(6) Energy Star Windows[22]*:* In older buildings, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool commercial buildings. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity coating.

[20] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[21] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003, and http://www.energytrust.org/bto/boiler.html
[22] "Energy Efficiency in Remodeling: Windows" Tool Base Services website. (www.toolbase.org)

(7) Efficient Unit Heaters[23]*:* The energy efficient unit heater consists of a power vented heater hung from ceilings or high on walls with a sealed flue. The sealed flue prevents air from escaping to the outdoors as is the case with many gravity-vented unit heaters. Increasingly, these power-vented unit heaters may contain intermittent ignition devices, which prevent the need for pilot lights and reduces fuel consumption.

(8) Heat Recovery Vents[24]*:* A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing 60 to 80 percent of the conditioned temperatures that would otherwise be lost.

(9) Duct Sealing[25]*:* Leaky and unsealed commercial air ducts for forced hot air furnaces are properly repaired and sealed. Mastic (a special paste) is the preferred method for duct sealing. Properly sealing leaky ducts can save significant amounts of energy needed to heat a commercial building.

(10) Insulation[26]*:* Insulation measures address the reduction of thermal transfer through the "shell" between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures considers only commercial wall insulation.

(11) Retrocommissioning[27]*:* Retrocommissioning is typically a one-time event that applies a systematic investigation process for improving and optimizing building operations and maintenance (O&M). It typically focuses on energy-using equipment such as mechanical systems and controls to ensure the functionality of system components as well as their combined functionality in order to reduce energy consumption and operating costs, and identify and fix existing problems within the facility. While retrocommissioning utilizes building diagnostics and O&M tune-ups in order to improve building performance, the process may also be used to identify potential capital improvements for additional performance gains.

1.2 Water Heating

Eight commercial water heating energy efficiency measures are covered in this section: Pipe Insulation, Efficient Boilers, Boiler Tune-up, Pump Controllers, Efficient Storage Water Heaters, Efficient Instantaneous Water Heaters, Low-

[23] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[24] http://www.toolbase.org/Technology-Inventory/HVAC/energy-recovery-ventilators.
[25] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[26] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[27] http://www.aceee.org/pubs/a035full.pdf, p.5.

has a nominal input of greater than 75,000 Btu per hour, and/or has a rated storage capacity greater than 100 gallons.

(5) Efficient Instantaneous Water Heaters[32]*:* Instantaneous, or tank-less, water heaters provide hot water without using a storage tank and, therefore, don't suffer standby losses and have much higher energy factors than conventional units. A gas instantaneous water heater means a water heater that uses gas as the energy source, is designed to deliver water at a controlled temperature of less than 180F, has an input greater than 200,000 Btu per hour, and an input rating of at least 4,000 Btu per hour per gallon of stored water,

(6) Low Flow Pre-Rinse Nozzles[33]*:* A low-flow pre-rinse spray valve uses a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. They reduce water consumption, water heating cost, and wastewater (sewer) charges. The baseline model has a flow rate of 3.0 gpm @ 60 psi.

(7) Commercial Clothes Washer[34]*:* High efficiency commercial clothes washers exceeding minimum qualifying efficiency standards established under Energy Star Program with a Modified Energy Factor (MEF) >= 1.42 can save money by using less energy and processing a greater volume of clothes in a single run, reducing the number of runs necessary and further increasing efficiency.

[32] http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-4_759_8408_7983-7124-6_523_943-0,00.html, and http://www.nyserda.org/about/Part506.pdf
[33] http://www.eere.energy.gov/femp/procurement/eep_low-flow_valves.cfm#features
[34] http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers_comm

Vermont Energy Efficiency Potential Study - Commercial Sector Measure Database
"Commercial Energy Opportunities"

Propane Measure Assumptions 7.975%

Measure	Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Annual Amortized Cost Per Unit	Levelized Cost per Lifetime MMBtu Saved	End Use Description
Propane Space Heating									
1	Efficient Furnace	553	13.8%	76	20	$5,400	$548.98	$7.20	Space Heating
2	Setback Controls	553	7.0%	39	10	$500	$74.43	$1.92	Space Heating
3	Efficient Boiler	553	6.0%	33	25	$3,700	$345.87	$10.43	Space Heating
4	Boiler Tune-up	553	5.0%	28	5	$250	$62.57	$2.26	Space Heating
5	Boiler Water Temp Reset Control	553	11.0%	61	20	$600	$61.00	$1.00	Space Heating
6	Roof Insulation	553	8.0%	44	20	$1,600	$162.66	$3.68	Space Heating
7	Energy Star Windows	553	11.0%	61	30	$2,400	$212.68	$3.50	Space Heating
8	Efficient Unit Heaters	553	21.0%	116	19	$260	$27.02	$0.23	Space Heating
9	Heat Recovery Vent	553	15.0%	83	20	$1,575	$160.12	$1.93	Space Heating
10	Duct Sealing	553	13.0%	72	15	$450	$52.49	$0.73	Space Heating
11	Wall Insulation	553	12.4%	69	30	$2,200	$194.96	$2.84	Space Heating
12	Retrocommisioning	553	9.0%	4973.0%	7	$1,700	$326.24	$6.56	Space Heating
Propane Water Heating									
13	Pipe Insulation	105	10.0%	11	15	$300	$35.00	$3.32	Water Heating
14	Efficient Boiler	105	17.0%	18	30	$3,700	$327.89	$18.33	Water Heating
15	Pump Controller	105	32.0%	34	15	$1,400	$163.31	$4.85	Water Heating
16	Efficient Storage Water Heater	105	9.0%	9	13	$261	$32.98	$3.48	Water Heating
17	Efficient Instantaneous Water Heater	105	10.0%	11	20	$500	$50.83	$4.83	Water Heating
18	Low Flow Pre-Rinse Nozzle	105	0.6%	1	5	$5	$1.25	$2.04	Water Heating
19	Commercial Clothes Washer	105	39.53%	42	14	$300	$36.34	$0.87	Water Heating

Total End Use MMBtu's by Type	Base Case Factor	Remaining Factor	Technical Convertible Factor	Savings Factor	Technical Potential of Efficient Measure	Technical Potential Factor	Achievable Convertible Factor	Acheivable Potential of Efficient Measure	Acheivable Potential Factor	Source & Notes
Propane Space Heating										
1,172,016	60.00%	90.00%	100.00%	13.80%	87,339	54.00%	80.00%	69,871	43.20%	7
1,172,016	60.00%	90.00%	90.00%	7.00%	39,872	48.60%	80.00%	35,442	43.20%	1
1,172,016	20.00%	90.00%	100.00%	6.00%	12,658	18.00%	80.00%	10,126	14.40%	7
1,172,016	20.00%	90.00%	90.00%	5.00%	9,493	16.20%	80.00%	8,439	14.40%	1
1,172,016	20.00%	90.00%	90.00%	11.00%	20,885	16.20%	80.00%	18,565	14.40%	1
1,172,016	60.00%	90.00%	90.00%	8.00%	45,568	48.60%	80.00%	40,505	43.20%	1
1,172,016	60.00%	90.00%	90.00%	11.00%	62,656	48.60%	80.00%	55,694	43.20%	1
1,172,016	20.00%	90.00%	100.00%	21.00%	44,302	18.00%	80.00%	35,442	14.40%	2, 11
1,172,016	60.00%	90.00%	100.00%	15.00%	94,933	54.00%	80.00%	75,947	43.20%	2, 11
1,172,016	60.00%	90.00%	100.00%	13.00%	82,275	54.00%	80.00%	65,820	43.20%	2, 11
1,172,016	60.00%	90.00%	100.00%	12.44%	78,731	54.00%	80.00%	62,985	43.20%	7
1,172,016	60.00%	90.00%	100.00%	9.00%	varies	54.00%	80.00%	varies	43.20%	3, 12, 15, 16
Propane Water Heating										
223,241	70.00%	90.00%	90.00%	10.00%	12,658	56.70%	80.00%	11,251	50.40%	1
223,241	70.00%	90.00%	90.00%	17.00%	21,518	56.70%	80.00%	19,127	50.40%	1
223,241	70.00%	90.00%	90.00%	32.00%	40,505	56.70%	80.00%	36,004	50.40%	1
223,241	20.00%	90.00%	90.00%	9.00%	3,255	16.20%	80.00%	2,893	14.40%	1
223,241	2.00%	90.00%	100.00%	10.00%	402	1.80%	80.00%	321	1.44%	10
223,241	2.00%	90.00%	100.00%	0.58%	23	1.80%	80.00%	19	1.44%	13
223,241	6.00%	95.00%	100.00%	39.53%	varies	5.70%	80.00%	varies	4.56%	14

Vermont Energy Efficiency Potential Study - Commercial Sector Measure Database

"Commercial Energy Opportunities"

Sources and Notes

1 "Reducing Oil Through Energy Efficiency: Opportunities Beyond Cars and Light Trucks," Elliot, Langer, and Nadel. ACEEE Report Number E061. January 20

2 "Unit Heaters Deserve Attention for Commercial Programs," Harvey M. Sachs. April 2003, page 6.

3 "Retrocommissioning: Program Strategies to Capture Energy Savings in Existing Buildings," Jennifer Thorne and Steven Nadel. ACEEE Report Number A03

4 http://www.eere.energy.gov/

5 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.htm

6 http://www.energy.ca.gov/deer/

7 GDS Model developed using Energy-10, version 1.8

8 http://www.eia.doe.gov/emeu/reps/abstracts/northeast.html#Energy%20Demand

9 http://www.eere.energy.gov/femp/technologies/techdemo_publications.cfm

10 US DOE Technical Brief: "Demand (Tankless or Instantaneous) Water Heaters", January, 2004

11 http://www.aceee.org/pubs/a031full.pdf

12 http://www.cee1.org/com/com-kit/prv-guides.pdf

13 http://www.fishnick.com/saveenergy/sprayvalves/

14 per conversation with Dick Spellman, Massachussettes Gas Networks study

15 Quantum Consulting - Pilot program experience from Oakland CA per email communication from Mike Rufo on 2/3/04

16 American Council for an Energy Efficient Economy (ACEEE), Selecting Targets for Market Transformation Programs: A National Analysis, 1998.

APPENDIX B3:

KEROSENE

3.0 KEROSENE

3.1 Space Heating

Eleven commercial space heating energy efficiency measures are covered in this section: Efficient Furnaces, Setback Controls, Efficient Boilers, Roof Insulation, Energy Star Windows, Efficient Unit Heaters, Heat Recovery Vents, Duct Sealing, Insulation Packages, and Retro-commissioning. Listed below are the basic assumptions used in this study for these technologies. For purposes of this appendix, costs and savings figures are presented below for a typical commercial building in Vermont. Sources for this data can be found in Appendix B3: Commercial Measure Data Sources.

Table B-5: Energy Efficiency Measures for **Kerosene** - Space Heating

Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Levelized Cost per Lifetime MMBtu Saved
Efficient Furnace	553	13.8%	76	20	$5,400	$ 7.20
Setback Controls	553	7.0%	39	10	$500	$ 1.92
Efficient Boiler	553	6.0%	33	25	$3,700	$ 10.43
Boiler Tune-up	553	5.0%	28	5	$250	$ 2.26
Boiler Water Temp Reset Control	553	11.0%	61	20	$600	$ 1.00
Roof Insulation	553	8.0%	44	20	$1,600	$ 3.68
Energy Star Windows	553	11.0%	61	30	$2,400	$ 3.50
Efficient Unit Heaters	553	21.0%	116	19	$260	$ 0.23
Heat Recovery Vent	553	15.0%	83	20	$1,575	$ 1.93
Duct Sealing	553	13.0%	72	15	$450	$ 0.73
Wall Insulation	553	12.4%	69	30	$2,200	$ 2.84
Retrocommisioning	553	9.0%	50	7	$1,700	$ 6.56

(1) Efficient Kerosene Furnace[35]*:* A furnace heats air that is blown through air ducts and delivered to rooms through registers or grills. This type of heating system is called a ducted warm-air or forced warm-air distribution system. In this analysis, for a replace on burn-out installation, a high efficiency warm-air Kerosene furnace is installed instead of a standard efficiency replacement model.

(2) Setback Controls[36]*:* A Thermostat Temperature Setback Control can be used in new and existing installations to provide automatic room temperature control. A given HVAC system's complexity dictates the level of controls necessary to effectively manage the system. However, for the purposes of this report, only a time-of-day setback control is analyzed. This control typically sets the

[35] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[36] http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12720, http://yosemite.epa.gov/gw/StatePolicyActions.nsf/uniqueKeyLookup/MSTY5QNHF5?OpenDocument

temperature back 10-15 degrees in the winter for a period of 8 hours or more during periods when a building is unoccupied.

(3) Efficient Water Boiler[37]*:* A hot water boiler heats water that circulates through pipes to radiators or baseboards to provide space heating for a commercial space. Hot water systems, sometimes called hydronic systems, are more common today than steam systems. In this analysis, a high efficiency water boiler is installed in lieu of a standard efficiency replacement model.

(4) Boiler Tune-up[38]*:* A typical boiler tune-up protocol includes the following measures:

- Check and clean combustion burner and adjust combustion blower as applicable
- Check, clean, and adjust pilot (if applicable)
- Inspect and adjust all operating and safety controls
- Inspect vents
- Adjust burner and fuel input; manual or motorized draft control
- Check adequacy of combustion air intake
- Clean fire tubes or other heat-exchanger surface, if applicable

(5) Roof Insulation and Air Sealing: This measure addresses the reduction of thermal transfer through the roof of a building. This measure can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building's roof, or in the form of additional insulation to reduce the amount of heat flow between conditioned and unconditioned spaces.

(6) Energy Star Windows[39]*:* In older commercial buildings, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool commercial buildings. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity (Low-E) coating.

(7) Efficient Unit Heaters[40]*:* The energy efficient unit heater is a power vented heater hung from ceilings or high on walls with a sealed flue. The sealed flue prevents air from escaping to the outdoors as is the case with many gravity-

[37] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[38] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401., http://www.energytrust.org/bto/boiler.html
[39] "Energy Efficiency in Remodeling: Windows" Tool Base Services website. (www.toolbase.org)
[40] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.

vented unit heaters. Increasingly, these power-vented unit heaters may contain intermittent ignition devices, which prevent the need for pilot lights and reduces fuel consumption.

(8) Heat Recovery Vents[41]*:* A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing 60 to 80 percent of the conditioned temperatures that would otherwise be lost.

(9) Duct Sealing[42]*:* Leaky and unsealed commercial air ducts for forced hot air furnaces are properly repaired and sealed. Mastic (a special paste) is the preferred method for duct sealing. Properly sealing leaky ducts can save significant amounts of energy needed to heat a building.

(10) Insulation[43]*:* Insulation measures address the reduction of thermal transfer through the "shell" between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures considers only commercial wall insulation.

(11) Retrocommissioning[44]*:* Retrocommissioning is typically a one-time event that applies a systematic investigation process for improving and optimizing building operations and maintenance (O&M). It typically focuses on energy-using equipment such as mechanical systems and controls to ensure the functionality of system components as well as their combined functionality in order to reduce energy consumption and operating costs, and identify and fix existing problems within the facility. While retrocommissioning utilizes building diagnostics and O&M tune-ups in order to improve building performance, the process may also be used to identify potential capital improvements for additional performance gains.

3.2 Water Heating

Seven commercial water heating energy efficiency measures are covered in this section: Pipe Insulation, Efficient Boilers, Boiler Tune-up, Pump Controllers, Efficient Storage Water Heaters, Efficient Instantaneous Water Heaters, Low-Flow Pre-Rinse Dishwashing Nozzles, and Commercial Clothes Washers. Listed below are the basic assumptions used in this study for these technologies. For purposes of this appendix, costs and savings figures are presented below for a

[41] http://www.toolbase.org/Technology-Inventory/HVAC/energy-recovery-ventilators.
[42] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 388.
[43] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 392 & 395.
[44]http://www.aceee.org/pubs/a035full.pdf, p.5.

typical commercial water heating system in Vermont. Sources for this data can be found in Appendix B1: Commercial Measure Sources.

Table B-6: Energy Efficiency Measures for Kerosene - Water Heating

Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Levelized Cost per Lifetime MMBtu Saved
Pipe Insulation	105	10.0%	11	15	$300	$ 3.32
Efficient Boiler	105	17.0%	18	30	$3,700	$ 18.33
Pump Controller	105	32.0%	34	15	$1,400	$ 4.85
Efficient Storage Water Heater	105	9.0%	9	13	$261	$ 3.48
Efficient Instantaneous Water Heater	105	10.0%	11	20	$500	$ 4.83
Low Flow Pre-Rinse Nozzle	105	0.6%	1	5	$5	$ 2.04
Commercial Clothes Washer	105	40%	42	14	$300	$ 0.87

(1) Pipe Insulation[45]*:* Insulating hot water pipes will reduce losses as the hot water is flowing to the faucet and, more importantly, it will reduce standby losses when the tap is turned off and then back on within an hour or so. Pipe wrap will conserve energy and water that would normally be lost waiting for the hot water to reach the tap. Energy loss still occurs after pipe wrap has been installed, though to a smaller degree than the losses observed in non-insulated pipes.

(2) Efficient Boiler[46]*:* In this analysis, a high efficiency boiler is installed in lieu of a standard efficiency replacement model. These models typically have exhaust fan that controls the flow of combustion air and combustion gases more precisely, electric ignition rather than a pilot light, are more compact in weight to reduce cycling losses, and have a small-diameter flue pipe.

(3) Pump Controller[47]*:* Pump controllers are electronic controls that save energy by memorizing building hot water demand patterns. The controller, based on usage patterns, automatically reduces hot water loop temperatures during periods of low hot water demand. This reduces the amount of wasted energy expended to heat water during periods of low usage.

(4) Efficient Storage Water Heaters[48]*:* In this analysis, a high efficiency storage water heater is installed in lieu of a standard efficiency replacement model. A Kerosene storage water heater means a water heater that uses Kerosene as the energy source, has a nominal input greater than 105,000 Btu per hour, and/or has a rated storage capacity greater than 50 gallons.

[45] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[46] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003, and http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12530
[47] Personal communication with Steve Nadel (ACEEE), November 2006.
[48] http://www.nyserda.org/about/Part506.pdf

(5) Efficient Instantaneous Water Heaters[49]*:* Instantaneous, or tank-less, water heaters provide hot water without using a storage tank and, therefore, don't suffer standby losses and have much higher energy factors than conventional units. Kerosene instantaneous water heater means a water heater that uses Kerosene as the energy source, has an input greater than 210,000 Btu per hour, and an input rating of at least 4,000 Btu per hour per gallon of stored water.

(6) Low Flow Pre-Rinse Nozzles[50]*:* A low-flow pre-rinse spray valve uses a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. They reduce water consumption, water heating cost, and wastewater (sewer) charges. The baseline model has a flow rate of 3.0 gpm @ 60 psi.

(7) Commercial Clothes Washer[51]*:* High efficiency commercial clothes washers exceeding minimum qualifying efficiency standards established under Energy Star Program with a Modified Energy Factor (MEF) >= 1.42 can save money by using less energy and processing a greater volume of clothes in a single run, reducing the number of runs necessary and further increasing efficiency.

[49] http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-4_759_8408_7983-7124-6_523_943-0,00.html, and http://www.nyserda.org/about/Part506.pdf
[50] http://www.eere.energy.gov/femp/procurement/eep_low-flow_valves.cfm#features
[51] http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers_comm

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Kerosene Measure Assumptions 7.975%

Measure	Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Annual Amortized Cost Per Unit	Levelized Cost per Lifetime MMBtu Saved	End Use Description
Kerosene Space Heating									
1	Efficient Furnace	553	13.8%	76	20	$5,400	$548.98	$7.20	Space Heating
2	Setback Controls	553	7.0%	39	10	$500	$74.43	$1.92	Space Heating
3	Efficient Boiler	553	6.0%	33	25	$3,700	$345.87	$10.43	Space Heating
4	Boiler Tune-up	553	5.0%	28	5	$250	$62.57	$2.26	Space Heating
5	Boiler Water Temp Reset Control	553	11.0%	61	20	$600	$61.00	$1.00	Space Heating
6	Roof Insulation	553	8.0%	44	20	$1,600	$162.66	$3.68	Space Heating
7	Energy Star Windows	553	11.0%	61	30	$2,400	$212.68	$3.50	Space Heating
8	Efficient Unit Heaters	553	21.0%	116	19	$260	$27.02	$0.23	Space Heating
9	Heat Recovery Vent	553	15.0%	83	20	$1,575	$160.12	$1.93	Space Heating
10	Duct Sealing	553	13.0%	72	15	$450	$52.49	$0.73	Space Heating
11	Wall Insulation	553	12.4%	69	30	$2,200	$194.96	$2.84	Space Heating
12	Retrocommisioning	553	9.0%	50	7	$1,700	$326.24	$6.56	Space Heating
Kerosene Water Heating									
13	Pipe Insulation	105	10.0%	11	15	$300	$35.00	$3.32	Water Heating
14	Efficient Boiler	105	17.0%	18	30	$3,700	$327.89	$18.33	Water Heating
15	Pump Controller	105	32.0%	34	15	$1,400	$163.31	$4.85	Water Heating
16	Efficient Storage Water Heater	105	9.0%	9	13	$261	$32.98	$3.48	Water Heating
17	Efficient Instantaneous Water Heater	105	10.0%	11	20	$500	$50.83	$4.83	Water Heating
18	Low Flow Pre-Rinse Nozzle	105	0.6%	1	5	$5	$1.25	$2.04	Water Heating
19	Commercial Clothes Washer	105	40%	42	14	$300	$36.34	$0.87	Water Heating

Total End Use MMBtu's by Type	Base Case Factor	Remaining Factor	Technical Convertible Factor	Savings Factor	Technical Potential of Efficient Measure	Technical Potential Factor	Achievable Convertible Factor	Acheivable Potential of Efficient Measure	Acheivable Potential Factor	Source & Notes
Kerosene Space Heating										
181,021	60.00%	90.00%	100.00%	13.80%	13,490	54.00%	80.00%	10,792	43.20%	7
181,021	60.00%	90.00%	90.00%	7.00%	6,158	48.60%	80.00%	5,474	43.20%	1
181,021	20.00%	90.00%	100.00%	6.00%	1,955	18.00%	80.00%	1,564	14.40%	7
181,021	20.00%	90.00%	90.00%	5.00%	1,466	16.20%	80.00%	1,303	14.40%	1
181,021	20.00%	90.00%	90.00%	11.00%	3,226	16.20%	80.00%	2,867	14.40%	1
181,021	60.00%	90.00%	90.00%	8.00%	7,038	48.60%	80.00%	6,256	43.20%	1
181,021	60.00%	90.00%	90.00%	11.00%	9,677	48.60%	80.00%	8,602	43.20%	1
181,021	20.00%	90.00%	100.00%	21.00%	6,843	18.00%	80.00%	5,474	14.40%	2, 11
181,021	60.00%	90.00%	100.00%	15.00%	14,663	54.00%	80.00%	11,730	43.20%	2, 11
181,021	60.00%	90.00%	100.00%	13.00%	12,708	54.00%	80.00%	10,166	43.20%	2, 11
181,021	60.00%	90.00%	100.00%	12.44%	12,160	54.00%	80.00%	9,728	43.20%	7
181,021	60.00%	90.00%	100.00%	9.00%	varies	54.00%	80.00%	varies	43.20%	3, 12, 15, 16
Kerosene Water Heating										
34,480	70.00%	90.00%	90.00%	10.00%	1,955	56.70%	80.00%	1,738	50.40%	1
34,480	70.00%	90.00%	90.00%	17.00%	3,324	56.70%	80.00%	2,954	50.40%	1
34,480	70.00%	90.00%	90.00%	32.00%	6,256	56.70%	80.00%	5,561	50.40%	1
34,480	20.00%	90.00%	90.00%	9.00%	503	16.20%	80.00%	447	14.40%	1
34,480	2.00%	90.00%	100.00%	10.00%	62	1.80%	80.00%	50	1.44%	10
34,480	2.00%	90.00%	100.00%	0.58%	4	1.80%	80.00%	3	1.44%	13
34,480	6.00%	95.00%	100.00%	39.53%	varies	5.70%	80.00%	varies	4.56%	14

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Sources and Notes

1 "Reducing Oil Through Energy Efficiency: Opportunities Beyond Cars and Light Trucks," Elliot, Langer, and Nadel. ACEEE Report Number E061. Jar
2 "Unit Heaters Deserve Attention for Commercial Programs," Harvey M. Sachs. April 2003, page 6.
3 "Retrocommissioning: Program Strategies to Capture Energy Savings in Existing Buildings," Jennifer Thorne and Steven Nadel. ACEEE Report Num
4 http://www.eere.energy.gov/
5 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.htm
6 http://www.energy.ca.gov/deer/
7 GDS Model developed using Energy-10, version 1.8
8 http://www.eia.doe.gov/emeu/reps/abstracts/northeast.html#Energy%20Demand
9 http://www.eere.energy.gov/femp/technologies/techdemo_publications.cfm
10 US DOE Technical Brief: "Demand (Tankless or Instantaneous) Water Heaters", January, 2004
11 http://www.aceee.org/pubs/a031full.pdf
12 http://www.cee1.org/com/com-kit/prv-guides.pdf
13 http://www.fishnick.com/saveenergy/sprayvalves/
14 per conversation with Dick Spellman, Massachussettes Gas Networks study
15 Quantum Consulting - Pilot program experience from Oakland CA per email communication from Mike Rufo on 2/3/04
16 American Council for an Energy Efficient Economy (ACEEE), Selecting Targets for Market Transformation Programs: A National Analysis, 1998.

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APPENDIX B4:

WOOD

4.0 WOOD

Nine commercial space heating energy efficiency measures are covered in this section: Efficient Furnaces, Setback Controls, Efficient Boilers, Roof Insulation, Energy Star Windows, Heat Recovery Vents, Insulation Packages, and Retro-commissioning. Listed below are the basic assumptions used in this study for these technologies. For purposes of this appendix, costs and savings figures are presented below for a typical commercial building in Vermont. Sources for this data can be found in Appendix B3: Commercial Measure Data Sources.

Table B-7: Energy Efficiency Measures for Wood - Space Heating

Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Levelized Cost per Lifetime MMBtu Saved
Efficient Furnace	553	13.8%	76	20	$5,400	$ 7.20
Setback Controls	553	7.0%	39	10	$500	$ 1.92
Efficient Boiler	553	6.0%	33	25	$3,700	$ 10.43
Boiler Tune-up	553	5.0%	28	5	$250	$ 2.26
Boiler Water Temp Reset Control	553	11.0%	61	20	$600	$ 1.00
Roof Insulation	553	8.0%	44	20	$1,600	$ 3.68
Energy Star Windows	553	11.0%	61	30	$2,400	$ 3.50
Heat Recovery Vent	553	15.0%	83	20	$1,575	$ 1.93
Wall Insulation	553	12.4%	69	30	$2,200	$ 2.84

(1) Efficient Wood Furnace[52]*:* A furnace heats air that is blown through air ducts and delivered to rooms through registers or grills. This type of heating system is called a ducted warm-air or forced warm-air distribution system. In this analysis, for a replace on burn-out installation, a high efficiency warm-air Kerosene furnace is installed instead of a standard efficiency replacement model.

(2) Setback Controls[53]*:* A Thermostat Temperature Setback Control can be used in new and existing installations to provide automatic room temperature control. A given HVAC system's complexity dictates the level of controls necessary to effectively manage the system. However, for the purposes of this report, only a time-of-day setback control is analyzed. This control typically sets the temperature back 10-15 degrees in the winter for a period of 8 hours or more during periods when a building is unoccupied.

[52] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[53] http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12720, http://yosemite.epa.gov/gw/StatePolicyActions.nsf/uniqueKeyLookup/MSTY5QNHF5?OpenDocument

(3) Efficient Water Boiler[54]*:* A hot water boiler heats water that circulates through pipes to radiators or baseboards to provide space heating for a commercial space. Hot water systems, sometimes called hydronic systems, are more common today than steam systems. In this analysis, a high efficiency water boiler is installed in lieu of a standard efficiency replacement model.

(4) Boiler Tune-up[55]*:* A typical boiler tune-up protocol includes the following measures:

- Check and clean combustion burner and adjust combustion blower as applicable
- Check, clean, and adjust pilot (if applicable)
- Inspect and adjust all operating and safety controls
- Inspect vents
- Adjust burner and fuel input; manual or motorized draft control
- Check adequacy of combustion air intake
- Clean fire tubes or other heat-exchanger surface, if applicable

(5) Roof Insulation and Air Sealing: This measure addresses the reduction of thermal transfer through the roof of a building. This measure can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building's roof, or in the form of additional insulation to reduce the amount of heat flow between conditioned and unconditioned spaces.

(6) Energy Star Windows[56]*:* In older commercial buildings, windows are often one of the largest sources of heat loss in winter due to their low insulating ability and high air leakage rates. Windows are also generally the major source of unwanted heat gain in the summer. As a result, windows are typically net energy losers, and can be responsible for much of the energy used to heat and cool commercial buildings. However, improved windows, combined with proper consideration of their placement and other details, can result in significant energy savings. Energy efficient windows help to reduce air leakage and heat transfer. High efficiency windows usually have double or triple glazing, have argon gas between the panes of glass, have excellent seals, and have a Low-Emissivity (Low-E) coating.

(7) Efficient Unit Heaters[57]*:* The energy efficient unit heater is a power vented heater hung from ceilings or high on walls with a sealed flue. The sealed flue prevents air from escaping to the outdoors as is the case with many gravity-vented unit heaters. Increasingly, these power-vented unit heaters may contain intermittent ignition devices, which prevent the need for pilot lights and reduces fuel consumption.

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[54] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[55] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 401., http://www.energytrust.org/bto/boiler.html
[56] "Energy Efficiency in Remodeling: Windows" Tool Base Services website. (www.toolbase.org)
[57] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.

(8) Heat Recovery Vents[58]*:* A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing 60 to 80 percent of the conditioned temperatures that would otherwise be lost.

(9) Duct Sealing[59]*:* Leaky and unsealed commercial air ducts for forced hot air furnaces are properly repaired and sealed. Mastic (a special paste) is the preferred method for duct sealing. Properly sealing leaky ducts can save significant amounts of energy needed to heat a building.

(10) Insulation[60]*:* Insulation measures address the reduction of thermal transfer through the "shell" between the interior and exterior of a heated/cooled structure. These measures can appear in the form of air-sealing to prevent air infiltration and heat loss through gaps in the building shell, or in the form of insulation to reduce the amount of heat flow between conditioned and unconditioned spaces. The following measures considers only commercial wall insulation.

(11) Retrocommissioning[61]*:* Retrocommissioning is typically a one-time event that applies a systematic investigation process for improving and optimizing building operations and maintenance (O&M). It typically focuses on energy-using equipment such as mechanical systems and controls to ensure the functionality of system components as well as their combined functionality in order to reduce energy consumption and operating costs, and identify and fix existing problems within the facility. While retrocommissioning utilizes building diagnostics and O&M tune-ups in order to improve building performance, the process may also be used to identify potential capital improvements for additional performance gains.

[58] http://www.toolbase.org/Technology-Inventory/HVAC/energy-recovery-ventilators.
[59] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 388.
[60] Efficiency Vermont Technical Reference Usual Manual (TRM). No. 2006-41. Pg. 392 & 395.
[61]http://www.aceee.org/pubs/a035full.pdf, p.5.

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Wood Measure Assumptions

7.975%

Measure	Measure Name	Base Fuel Use (MMBTU)	% Savings	Fuel Savings (MMBTU)	Useful Life	Increm. Measure Cost	Annual Amortized Cost Per Unit	Levelized Cost per Lifetime MMBtu Saved	End Use Description
Wood Space Heating									
1	Efficient Furnace	553	13.8%	76	20	$5,400	$548.98	$7.20	Space Heating
2	Setback Controls	553	7.0%	39	10	$500	$74.43	$1.92	Space Heating
3	Efficient Boiler	553	6.0%	33	25	$3,700	$345.87	$10.43	Space Heating
4	Boiler Tune-up	553	5.0%	28	5	$250	$62.57	$2.26	Space Heating
5	Boiler Water Temp Reset Control	553	11.0%	61	20	$600	$61.00	$1.00	Space Heating
6	Roof Insulation	553	8.0%	44	20	$1,600	$162.66	$3.68	Space Heating
7	Energy Star Windows	553	11.0%	61	30	$2,400	$212.68	$3.50	Space Heating
8	Heat Recovery Vent	553	15.0%	83	20	$1,575	$160.12	$1.93	Space Heating
9	Wall Insulation	553	12.4%	69	30	$2,200	$194.96	$2.84	Space Heating

Total End Use MMBtu's by Type	Base Case Factor	Remaining Factor	Technical Convertible Factor	Savings Factor	Technical Potential of Efficient Measure	Technical Potential Factor	Achievable Convertible Factor	Acheivable Potential of Efficient Measure	Acheivable Potential Factor	Source & Notes
Wood Space Heating										
165,748	60.0%	90.0%	100.0%	13.80%	12,352	54.00%	80.0%	9,881	43.20%	7
165,748	60.0%	90.0%	90.0%	7.00%	5,639	48.60%	80.0%	5,012	43.20%	1
165,748	20.0%	90.0%	100.0%	6.00%	1,790	18.00%	80.0%	1,432	14.40%	7
165,748	20.0%	90.0%	90.0%	5.00%	1,343	16.20%	80.0%	1,193	14.40%	1
165,748	20.0%	90.0%	90.0%	11.00%	2,954	16.20%	80.0%	2,625	14.40%	1
165,748	60.0%	90.0%	90.0%	8.00%	6,444	48.60%	80.0%	5,728	43.20%	1
165,748	60.0%	90.0%	90.0%	11.00%	8,861	48.60%	80.0%	7,876	43.20%	1
165,748	60.0%	90.0%	100.0%	15.00%	13,426	54.00%	80.0%	10,740	43.20%	2, 11
165,748	60.0%	90.0%	100.0%	12.44%	11,134	54.00%	80.0%	8,907	43.20%	7

Vermont Energy Efficiency Potential Study - Commercial Sector Measure Database
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Sources and Notes

1 "Reducing Oil Through Energy Efficiency: Opportunities Beyond Cars and Light Trucks," Elliot, Langer, and Nadel. ACEEE Report Number E061. J
2 "Unit Heaters Deserve Attention for Commercial Programs," Harvey M. Sachs. April 2003, page 6.
3 "Retrocommissioning: Program Strategies to Capture Energy Savings in Existing Buildings," Jennifer Thorne and Steven Nadel. ACEEE Report Nu
4 http://www.eere.energy.gov/
5 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html
6 http://www.energy.ca.gov/deer/
7 GDS Model developed using Energy-10, version 1.8
8 http://www.eia.doe.gov/emeu/reps/abstracts/northeast.html#Energy%20Demand
9 http://www.eere.energy.gov/femp/technologies/techdemo_publications.cfm
10 US DOE Technical Brief: "Demand (Tankless or Instantaneous) Water Heaters", January, 2004
11 http://www.aceee.org/pubs/a031full.pdf
12 http://www.cee1.org/com/com-kit/prv-guides.pdf
13 http://www.fishnick.com/saveenergy/sprayvalves/
14 per conversation with Dick Spellman, Massachussettes Gas Networks study
15 Quantum Consulting - Pilot program experience from Oakland CA per email communication from Mike Rufo on 2/3/04
16 American Council for an Energy Efficient Economy (ACEEE), Selecting Targets for Market Transformation Programs: A National Analysis, 1998.

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APPENDIX C:

INDUSTRIAL SECTOR

Descriptions of Industrial Energy Efficiency Measures & Analysis

This technical appendix describes a range of industrial sector energy efficiency measures and programs where GDS has assessed the technical, achievable, and achievable cost effective potential for oil, propane, kerosene and wood energy savings in Vermont. The purpose of this technical appendix is to describe these energy efficiency measures and to provide data on their costs, energy savings and useful lives.

Following the listing of measure descriptions is a table that presents the current measures assumptions for the industrial sector. The calculations of the potential savings for the industrial sector are provided in a series of tables that follows the measure-level information. Due to data limitations, the energy efficiency potential estimates for the industrial sector are based on packages of measures broken into three major end use categories: 1) Indirect Use – Boiler, 2) Direct Use – Process Heat, and 3) Space Heat (non-boiler).

1. BOILER & SPACE HEATING

The following sections describe the energy efficiency measures that were included in this analysis for space heating.

1.1 High Efficiency Boiler

Replace a standard efficiency boiler with a high efficiency boiler.

A high-efficiency or "condensing" boiler operates with lower flue-gas temperatures, lower flue-gas emissions and reduced fuel consumption by recovering heat that would otherwise be lost up the flue. High-efficiency boilers operate at efficiencies of 90% and greater, or about 10% to 15% better than traditional non-condensing boilers. They typically heat water to a temperature range of 120 degrees to 140 degrees F (49 degrees to 60 degrees C). High-efficiency boilers are called "condensing" boilers because during the process of recovering heat from the burned fuel, the temperature of the flue gas is reduced to a point where the water vapor that is produced during combustion is "condensed out."

While there are many benefits to installing a high-efficiency boiler, it can cost up to twice as much as a conventional boiler. This added cost is largely due to the higher price of stainless steel and other materials needed to resist the corrosive condensate present in high-efficiency boilers. Additionally, condensing boilers require special venting, such as an AL29-4C stainless steel vent that resists the corrosive condensate found in wet flue gases. This is not only an added cost, but also a maintenance item in the long term. By contrast, a conventional boiler can be vented in a standard tile-lined chimney or standard vent space.

1.2 Boiler Pipe Insulation

Insulate space heating and process hot water distribution lines.

Given high-intensity process and heating distribution lines in industrial facilities, insulating pipes can generate significant energy savings. A typical temperature differential between an insulated and un-insulated pipe in an industrial facility often exceeds 200 degrees Fahrenheit. Given that heat loss is a function of the linear surface area, the potential energy savings builds up rapidly with a boiler pipe insulation program in place.

1.3 Boiler Tune-up[1]

Tune up boiler to enhance the performance, safety and efficiency.

A routine boiler tune-up procedure is an excellent way to verify that the boiler is running at as close to the nameplate efficiency as possible, given constants such as age and measure life. A typical boiler tune-up will include cleaning the burner, combustion chamber and heat exchanger surfaces. In addition the flame color will be verified (blue is ideal, as other colors may indicate problems with the burner or combustion air) to ensure that the correct fuel-air ratio is being maintained. Fan belts and blowers will be adjusted as necessary, and any loose belts will be tightened to specification. Safety controls are also verified and adjusted as necessary as part of a routine boiler tune-up. Other checks include the barometric damper operation, the thermostat operation and location, and the condition of the thermocouple, chimney base and flue pipe, and pilot. Filters are also typically adjusted and replaced when necessary, and motors are lubricated. As part of boiler tune-up a combustion efficiency test is completed and vent terminals are checked for blockages. These checks and adjustments are performed as part of a regular facility maintenance schedule and are an excellent generator of energy and cost savings.

1.4 Stack Heat Exchanger[2]

Capture waste heat from boilers and use for pre-heat or process heating.

Stack heat exchangers allow waste heat from hot boiler flue gasses to be recovered in a manner that allows for combustion air to be preheated and to lighten the boiler process-steam or water heating loads. Stack heat exchangers provide an excellent way to improve boiler efficiency and energy consumption reduction.

1.5 Recover Waste Heat from Air-Compressor[3]

Capture heat content from exhaust air for use in reducing space heat load.

Heat wheels or other forms of heat exchangers can be used to cross-exchange building exhaust air with make-up air. The amount of heat energy that can be recovered is dependent on several factors including the indoor air temperature, outdoor air temperature and interior and exterior humidity levels.

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[1] Tune-up checklist adapted from a BC Hydro measure description (http://www.bchydro.com/)
[2] Measure description adapted from the Canadian Natural Resources Office of Energy Efficiency. (http://oee.nrcan.gc.ca/publications/infosource/pub/ici/eii/m92-242-2002-8e.cfm?attr=20)
[3] Industrial Assessment Center Database, AARC Code 2.2492.3

1.6 Boiler Reset Controls[4]

Boiler controls to maximize efficiency.

A boiler reset control is a devise that automatically controls the boiler water temperature according to a software program based on outdoor temperature. The water can be run a little cooler during fall and spring, and a little hotter during the coldest parts of the winter. This improves boiler efficiency and indoor comfort by providing a better match between boiler output and space heating needs.

A boiler reset control has been a standard energy management recommendation for commercial boilers for several years. Industrial applications can be applicable if the application is space heating only, or if there is a process hot water usage that would be unaffected by fluctuating water temperature. (Example: a low temperature process with a mixing valve that reduces the water temperature below the lowest boiler water temperature setting).

Savings from implementing a boiler reset control in an industrial space heating application vary depending on the size of the heat distribution system (ie: system losses are higher from larger systems full of hotter than necessary hot water).

1.7 Boiler O_2 Trim Controls[5]

Optimizes oxygen percentage for most efficient burner combustion

Boilers mix air with fuel to provide oxygen in the combustion process. For safety reasons, a small amount of additional or “excess air” is always provided to assure that all fuel is burned inside the boiler. By operating your boiler with a minimum amount of excess air, you can decrease stack heat losses and increase combustion efficiency.

1.8 Boiler Blow-down Heat Exchanger (steam)[6]

Capture waste heat from blowdown water to preheat makeup water

All steam boilers must go through blowdown cycles to reduce the amount of total dissolved solids (TDS) in the boiler water. However, along with the solids, boiler chemicals and thermal energy are lost during the blowdown cycle. Blowdown heat recovery systems cannot recover the chemicals, but they do recover up to 90% of the heat energy that would otherwise be lost down the drain. The recovered heat is used to pre-heat boiler make-up water before it enters the de-aerator, and for low pressure steam to heat water inside the de-aerator, which reduces the cost to run the de-aerator and improves overall boiler efficiency.

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[4] Adapted from the Energy Solutions Center’s article on boiler reset controls (http://www.energysolutionscenter.org/BoilerBurner/Eff_Improve/Efficiency/Boiler_Reset_Control.asp)

[5] Adapted from the Washington State University’s (WSU) Energy Efficiency Fact-sheet titled "Boiler Combustion Monitoring & Oxygen Trim Systems. Available from (http://www.energy.wsu.edu/documents/engineering/boiler_comb.pdf)

[6] Adapted from the Energy Solution’s Center article on Blowdown Heat Recovery (http://www.energysolutionscenter.org/BoilerBurner/Eff_Improve/Efficiency/Blowdown_Heat_Recovery.asp)

Blowdown heat recovery systems offer a fairly rapid payback, depending on blowdown volume. Several boilers can be connected to a single heat recovery unit, thereby reducing capital costs. Typical payback is under 12 months.

1.9 Steam Trap Repair [7]

Repair malfunctioning steam traps to reduce losses in steam system.

A steam trap holds steam in the steam coil until the steam gives up its latent heat and condenses. In a flash tank system without a steam trap (or a malfunctioning trap), the steam in the process heating coil would have a shorter residence time and not completely condense. The uncondensed high-quality steam would be then lost out of the steam discharge pipe on the flash tank. Comparing the temperature on each side of the trap can easily check steam trap operation. If the trap is working properly, there will be a large temperature difference between the two sides of the trap. A clear sign that a trap is not working is the presence of steam downstream of the trap. Nonworking steam traps allow steam to be wasted, resulting in higher steam production requirement from the boiler to meet the system needs. It is not uncommon that, over time, steam traps wear and cease to function properly.

1.10 Insulate Steam Lines & Condensate Tank[8]

Insulate steam lines and condensate tank as steam systems work with high temperature differences.

After steam is generated from the boiler(s), the steam is then distributed through pipes to wherever its final destination may be. When this energy is transferred through un-insulated pipes, it is lost to the atmosphere. Heat transfer through the pipes to undesired places means a larger load is being placed on the boiler, thus consuming more energy. This can be alleviated by simply insulating the pipes, which is rather inexpensive. In addition, by insulating the condensate tank, this will also alleviate the amount of energy required to re-heat that water into steam and in the process save energy and money.

1.11 Retrocommissioning [9]

Recalibrate and tune-up all heating, DHW, and process systems including the Energy Management System (EMS).

Existing building commissioning, also known as Retrocommissioning, is an event in the life of a facility that applies a systematic investigation process for improving and optimizing the operations and maintenance of a building. Building systems that will be analyzed will include, but are not limited to, HVAC, lighting, electrical, etc. Ultimately, the process ensures optimum system functionality. Retrocommissioning is a systematic process intended not only to optimize how equipment and systems operate, but also to optimize how the systems function

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[7] Industrial Assessment Center Database, AARC Code 2.2113 (Repair or Replace Steam Traps)

[8] Industrial Assessment Center Database, AARC Code 2.2131 (Insulate Steam & Hot Water Lines)

[9] Adapted from "A Practical Guide for Commissioning Existing Buildings", published April 1999, Portland Energy Conservation, Inc. and Oak Ridge National Laboratory for U.S. Department of Energy.

together. The ultimate goals of Retrocommissioning are to reduce energy waste, obtain energy cost savings for the owner, and to identify and fix existing (often unknown) facility problems.

1.12 Roof Insulation

Roof insulation reduces the amount of heat flow between the outdoors and the conditioned space inside the facility.

By improving the thermal barrier between the conditioned and unconditioned space, the heat load can be reduced, and significant energy savings can be realized as a result of the measure being installed.

2. WATER HEATING

The following sections describe the energy efficiency measures that were included in this analysis for commercial water heating.

2.1 Efficient Boiler

Replace a standard efficiency boiler with a high efficiency boiler.

See section 1.1 for measure description.

2.2 Boiler Tune-up

Tune up boiler to enhance boiler performance, safety and efficiency.

See section 1.3 for measure description.

2.3 Pump Controller[10]

Install a variable frequency pump controller based on past patterns of usage.

Pump controllers are electronic control units that save energy by learning building hot water demand patterns. The controller, based on usage patterns, automatically reduces hot water loop temperatures during periods of low hot-water demand. This reduces the amount of wasted energy expended to heat water during periods of low usage.

2.4 Efficient Water Heater[11]

Replace a standard efficiency water heater with a high efficiency water heater.

In this analysis, baseline oil water heaters are replaced with high efficiency water heater/space heater combination systems, such as indirect fired water heaters. In indirect hot water and heat systems, water is heated as a separate zone off of the furnace or boiler. There is no burner on the water heater, and the system reuses waste heat from the furnace/boiler to heat water for tap use. The hot water is stored in an insulated storage tank and is always ready for use - keeping the boiler from having to turn on and off frequently.

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[10] Personal communication with Steve Nadel (ACEEE), November 2006.

[11] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.

2.5 Solar Pre-Heat[12]

Solar pre-heating system to reduce energy required for water heating

Solar water heaters are designed to serve as pre-heaters for conventional storage or demand water heaters. As the solar system preheats the water, the extra temperature boost required by the storage or demand water heater is relatively low, and high flow rate can be achieved. Solar water heaters can be particularly effective if they are designed for three-season use, with a heating system providing hot water during the winter months. Although less common than they were two to three decades ago, solar water heating units are considerably less expensive and more reliable now than in years past.

2.6 Pipe Insulation[13]

Insulating hot water pipes will reduce losses as the hot water is flowing to its final destination and, more importantly, it will reduce standby losses when the tap is turned off and then back on at a later time. Pipe wrap will conserve energy and water that would normally be lost waiting for the hot water to reach the tap. Energy loss still occurs after pipe wrap has been installed, though to a smaller degree than the losses observed in non-insulated pipes. Pipe insulation is especially important in industrial facilities with high temperature difference process loops.

[12] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.
[13] Consumer Guide to Home Energy Savings, 8th ed. ACEEE. Washington D.C. 2003.

Industrial Measure Assumptions

Table C-1: Industrial Measure Assumptions, Distillate Fuel Oil

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	Convertible Factor	Source & Notes	BC Ratio (Participant)	BC Ratio (Societal)
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	3.85	5.29
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes	50%	2	65.13	89.60
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers	100%	5, 11	13.60	7.48
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.	25%	3, 11	1.03	1.42
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities	50%	4, 9	2.55	3.51
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.	90%	5	72.36	99.56
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.	90%	5	21.71	29.87
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.	90%	5	23.16	31.86
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.	50%	5	1.03	1.42
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	$20	lf.	$120	Facilities with steam boilers.	50%	5	36.18	49.78
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities	54%	6	0.56	0.75
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation	50%	11	0.62	0.85
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	3.85	5.29
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers	100%	5	6.80	3.74
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps	75%	10	6.31	8.70
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.	75%	1	14.47	19.91
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	50%	7	12.44	17.16
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass	50%	8	46.33	63.88

Table C-2: Industrial Measure Assumptions, 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	Convertible Factor	Source & Notes	BC Ratio (Participant)	BC Ratio (Societal)
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	6.11	7.80
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes	50%	2	103.68	132.44
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers	100%	5, 11	8.64	27.57
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.	25%	3, 11	1.64	2.09
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities	50%	4, 9	4.07	5.19
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.	90%	5	115.20	147.15
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.	90%	5	34.56	44.15
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.	90%	5	36.86	47.09
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.	50%	5	1.65	2.11
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	20	lf.	$120	Facilities with steam boilers.	50%	5	57.60	73.58
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities	54%	6	0.56	1.11
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation	50%	11	0.99	1.26
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	6.11	7.80
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers	100%	5	4.32	5.51
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps	75%	10	10.08	12.89
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.	75%	1	23.04	29.43
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	50%	7	19.89	25.43
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass	50%	8	74.05	94.68

Table C-3: Industrial Measure Assumptions, LPG (Liquid Propane Gas)

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	Convertible Factor	Source & Notes	BC Ratio (Participant)	BC Ratio (Societal)
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	6.73	8.24
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes	50%	2	114.12	139.88
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers	100%	5, 11	9.51	11.65
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.	25%	3, 11	1.80	2.21
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities	50%	4, 9	4.48	5.49
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.	90%	5	126.80	155.42
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.	90%	5	38.04	46.63
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.	90%	5	40.58	49.73
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.	50%	5	1.82	2.23
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	20	lf.	$120	Facilities with steam boilers.	50%	5	63.40	77.71
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities	54%	6	0.56	1.17
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation	50%	11	1.09	1.33
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	6.73	8.24
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers	100%	5	4.75	5.82
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps	75%	10	11.11	13.62
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.	75%	1	25.36	31.08
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	50%	7	21.91	26.87
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass	50%	8	81.56	100.03

Table C-4: Industrial Measure Assumptions, 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	Convertible Factor	Source & Notes	BC Ratio (Participant)	BC Ratio (Societal)
1	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	7.31	8.12
2	Boiler pipe insulation	Boiler, Space	3%	20	62.40	$5	$/lf	20	lf.	$100	Facilities with un-insulated boiler pipes	50%	2	122.66	136.29
3	Boiler Tune-up	Boiler, Space	2%	2	83.20	$250	$/boiler	n/a	n/a	$250	Facilities with boilers	100%	5, 11	8.89	9.88
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.	25%	3, 11	1.94	2.15
5	Heat Recovery from Air to Air	DP	16%	20	332.80	$3	$/O-A CFM	5000	CFM	$13,600	All Facilities	50%	4, 9	4.81	5.34
6	Boiler Reset Controls	Boiler, Space	10%	20	416.00	$600	$/unit	n/a	n/a	$600	Facilities with boilers.	90%	5	136.29	151.43
7	Boiler O2 Trim Controls	Boiler, Space	2%	20	41.60	$400	$/MMBTU	0.5	MMBTU	$200	Facilities with boilers.	90%	5	40.89	45.43
8	Boiler Blowdown Heat Exchanger (steam)	Boiler, Space	4%	20	83.20	$750	$/MMBTU	0.5	MMBTU	$375	Facilities with steam boilers.	90%	5	43.61	48.46
9	Steam Trap Repair	Boiler, Space	8%	5	166.40	$0	$/sq ft	100000	sq ft.	$6,000	Facilities with steam boilers.	50%	5	1.76	1.96
10	Insulate Steam Lines & Condensate Tank	Boiler, Space	2%	20	41.60	$6	$/lf	20	lf.	$120	Facilities with steam boilers.	50%	5	68.14	75.72
11	Retrocommisioning	Boiler, Space	9%	7	187.20	$0	$/sq ft	100000	sq ft.	$17,000	All Facilities	54%	6	0.56	1.05
12	Roof Insulation	Space	14%	20	291.20	$0	$/sf-roof	100000	sq ft.	$49,000	Facilities in need of roof insulation	50%	11	1.17	1.30
13	Efficient Boiler	Boiler, Space	11%	25	228.80	$14,000	$/MMBTU	0.5	MMBTU	$7,000	Facilities with Standard Efficiency Boilers	90%	1	7.31	8.12
14	Boiler Tune-up	Boiler, Space	2%	2	41.60	$100	$/boiler	n/a	n/a	$100	Facilities with boilers	100%	5	4.45	4.94
15	Pump Controller	Boiler, Space	32%	15	101.68	$1,400	$/controller	n/a	n/a	$1,400	Facilities with hot water pumps	75%	10	11.71	13.01
16	Efficient Water Heater	Boiler, Space	20%	20	416.00	$6,000	$/MMBTU	0.5	MMBTU	$3,000	Facilities with standard efficiency water heaters.	75%	1	27.26	30.29
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	50%	7	23.10	25.66
18	Pipe Insulation	Boiler, Space	2%	15	41.60	$4	$/lf	20	lf	$78	Material Assumption: Fiberglass	50%	8	85.99	95.54

Measure Assumption Sources & Notes

1 Based on a national average
2 Average price for fiberglass and calcium silicate
3 RS Means CostWorks 2005, construction cost estimating database.
4 Measure changed to better reflect VT industrial sector (formerly air-to-air heat recovery)
5 GDS Estimate based on field experience and previous studies
6 American Council for an Energy Efficient Economy (ACEEE), Selecting Targets for Market Transformation Programs: A National Analysis, 1998.
7 Public Service of New Mexico Natural Gas Technical Potential Study, 2005
8 Material Assumption: Fiberglass
9 Industrial Assessment Center, Savings TBD
10 Reducing Oil Through Energy Efficiency: Opportunities Beyond Cars and Light Trucks, Elliot, Langer, and Nadel, ACEEE, Report Number E061, p.42, January 2006
11 CALIFORNIA STATEWIDE COMMERCIAL SECTOR NATURAL GAS ENERGY EFFICIENCY POTENTIAL STUDY, Study ID #SW061, Prepared for Pacific Gas & Electric Cor

Industrial Sector Energy Efficiency Potential Analysis

The following tables illustrate the method used for estimating the energy efficiency potential available for the industrial sector in Vermont. The ten (10) industry types and associated end-use breakdowns were provided by the Vermont DPS and were based on data from the 2002 EIA Manufactures Energy Consumption Survey (MECS) as well as the DPS internal 2020 forecast analysis and other Vermont-specific economic data.

The first table illustrates the ten major industries for which the VT DPS developed end use as well as energy consumption fractions. The values shown in this Section A of this table represent the end use breakdown in each industrial segment for each fuel. The values shown in Section B were developed by VT DPS by mapping the data found in Table 1.2 of the Energy Information Agency's (EIA) 2002 Manufacturing Energy Consumption Survey (MECS) with the data in VT DPS' internal 2020 forecasting model. Section C of the table shows the resulting apportionment between the two end use categories for each fuel by industrial segment. This is calculated by multiplying the end use fractions in section A by the energy consumption fractions in section B.

Table C-5: Available Energy Efficiency Potential in the Vermont Industrial Sector

A	End Use Fractions (VT DPS Estimates)					
Industrial Sector	----------[HEAT]----------			----------[OTHSUB]----------		
	Oil	Propane	Biomass (Wood)	Oil	Propane	Biomass (Wood)
Lumber	35%	35%	35%	65%	65%	65%
Furniture	100%	100%	100%	0%	0%	0%
Paper	97%	97%	97%	3%	3%	3%
Fabricated Metals	54%	54%	54%	46%	46%	46%
Computers	83%	83%	83%	17%	17%	17%
Electric Equipment	87%	85%	87%	16%	15%	16%
Other Manufacturing	83%	83%	83%	17%	17%	17%
Mining	100%	100%	100%	0%	0%	0%
Agriculture	100%	100%	100%	0%	0%	0%
Construction	100%	100%	100%	0%	0%	0%

B	Energy Consumption (EC) Fractions (Mapping of MECS to VT DPS 2020)					
Industrial Sector	----------[HEAT]----------			----------[OTHSUB]----------		
	Oil	Propane	Biomass (Wood)	Oil	Propane	Biomass (Wood)
Lumber	10%	0%	41%	10%	0%	41%
Furniture	1%	0%	59%	1%	0%	59%
Paper	10%	0%	0%	10%	0%	0%
Fabricated Metals	4%	0%	0%	4%	0%	0%
Computers	1%	0%	0%	1%	0%	0%
Electric Equipment	1%	0%	0%	1%	0%	0%
Other Manufacturing	34%	99%	0%	34%	99%	0%
Mining	25%	0%	0%	25%	0%	0%
Agriculture	15%	0%	0%	15%	0%	0%
Construction	0%	0%	0%	0%	0%	0%

C	Fuel Use Apportionment (End Use x EC Fraction)					
Industrial Sector	----------[HEAT]----------			----------[OTHSUB]----------		
	Oil	Propane	Biomass (Wood)	Oil	Propane	Biomass (Wood)
Lumber	3%	0%	14%	6%	0%	27%
Furniture	1%	0%	59%	0%	0%	0%
Paper	9%	0%	0%	0%	0%	0%
Fabricated Metals	2%	0%	0%	2%	0%	0%
Computers	1%	0%	0%	0%	0%	0%
Electric Equipment	1%	0%	0%	0%	0%	0%
Other Manufacturing	28%	83%	0%	6%	16%	0%
Mining	25%	0%	0%	0%	0%	0%
Agriculture	15%	0%	0%	0%	0%	0%
Construction	0%	0%	0%	0%	0%	0%
Totals	86%	83%	73%	14%	17%	27%

Table C-6: Industrial Sector – Fuel Oil Efficiency Potential Analysis

Business Type	Lumber	Furniture	Paper	Fabricated Metals	Computers	Electric Equipment	Other	Mining	Agriculture	Construction	Total Oil Consumption in 2016 (Trillion BTU)
Indirect Use - Boiler (trillion BTU)	0.066	0.015	0.184	0.047	0.012	0.013	0.558	0.495	0.306	0.000	1.696
Indirect Use - Boiler Potential Savings	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	
Direct Process Heating Use (trillion BTU)	0.029	0.006	0.082	0.021	0.005	0.006	0.248	0.220	0.136	0.000	0.753
Direct Process Heating Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
Space Heating Use (OTHSUB) (trillion BTU)	0.178	0.000	0.008	0.058	0.003	0.003	0.161	0.000	0.000	0.000	0.411
Space Heating Use Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
										2016 Forecasted Consumption Value for Oil	**2.860**
Savings Summary (trillion BTU)											**SAVINGS TOTALS**
Overall Boiler Improvements	0.013	0.003	0.035	0.009	0.002	0.002	0.106	0.094	0.058	0.000	0.322
Overall Process Heating Improvements	0.003	0.001	0.008	0.002	0.001	0.001	0.025	0.022	0.014	0.000	0.075
Overall Space Heating Improvements	0.018	0.000	0.001	0.006	0.000	0.000	0.016	0.000	0.000	0.000	0.041
Totals	0.033	0.003	0.044	0.017	0.003	0.003	0.147	0.116	0.072	0.000	0.439
% Savings of Total	12.2%	16.2%	16.1%	13.4%	15.2%	15.2%	15.2%	16.2%	16.2%	#DIV/0!	15.3%

Source: Spreadsheet provided by VT DPS via email on 12/15/06 entitled Industrial Demand Data.xls.

		Energy Use Percentages		
Manufacturing Sector		**Indirect Use (Boiler)** [% of HEAT Category]	**Direct Process Heat** [% of HEAT Category]	**Space Heat** [% of OTHSUB]
Lumber		69.25%	30.75%	100.00%
Furniture		69.25%	30.75%	100.00%
Paper		69.25%	30.75%	100.00%
Fabricated Metals		69.25%	30.75%	100.00%
Computers		69.25%	30.75%	100.00%
Electric Equipment		69.25%	30.75%	100.00%
Other Manufacturing		69.25%	30.75%	100.00%
Mining		69.25%	30.75%	100.00%
Agriculture		69.25%	30.75%	100.00%
Construction		69.25%	30.75%	100.00%

Source: Based on MECS 2002 Data for the Northeast, Table 5.5.

Table C-7: Industrial Sector – LPG (Liquid Propane Gas) Efficiency Potential Analysis

Business Type	Lumber	Furniture	Paper	Fabricated Metals	Computers	Electric Equipment	Other	Mining	Agriculture	Construction	Total Propane Consumption in 2016 (Trillion BTU)
Indirect Use - Boiler (trillion BTU)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Indirect Use - Boiler Potential Savings	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	
Direct Process Heating Use (trillion BTU)	0.000	0.000	0.001	0.000	0.000	0.000	0.578	0.001	0.001	0.000	0.582
Direct Process Heating Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
Space Heating Use (OTHSUB) (trillion BTU)	0.001	0.000	0.000	0.000	0.000	0.000	0.115	0.000	0.000	0.000	0.116
Space Heating Use Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
						2016 Forecasted Consumption Value for Propane					**0.698**
Savings Summary (trillion BTU)											**SAVINGS TOTALS**
Overall Boiler Improvements	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Overall Process Heating Improvements	0.000	0.000	0.000	0.000	0.000	0.000	0.058	0.000	0.000	0.000	0.058
Overall Space Heating Improvements	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.012
Totals	0.000	0.000	0.000	0.000	0.000	0.000	0.069	0.000	0.000	0.000	0.070
% Savings of Total	10.0%	10.0%	10.0%	10.0%	#DIV/0!	10.0%	10.0%	10.0%	10.0%	#DIV/0!	10.0%

Source: Spreadsheet provided by VT DPS via email on 12/15/06 entitled Industrial Demand Data.xls.

		Energy Use Percentages		
Manufacturing Sector		**Indirect Use (Boiler)** [% of HEAT Category]	**Direct Process Heat** [% of HEAT Category]	**Space Heat** [% of OTHSUB]
Lumber		0.00%	100.00%	100.00%
Furniture		0.00%	100.00%	100.00%
Paper		0.00%	100.00%	100.00%
Fabricated Metals		0.00%	100.00%	100.00%
Computers		0.00%	100.00%	100.00%
Electric Equipment		0.00%	100.00%	100.00%
Other Manufacturing		0.00%	100.00%	100.00%
Mining		0.00%	100.00%	100.00%
Agriculture		0.00%	100.00%	100.00%
Construction		0.00%	100.00%	100.00%

Source: Based on MECS 2002 Data for the Northeast, Table 5.5.

Table C-8: Industrial Sector – Kerosene Efficiency Potential Analysis

Business Type	Lumber	Furniture	Paper	Fabricated Metals	Computers	Electric Equipment	Other	Mining	Agriculture	Construction	Total Kerosene Consumption in 2016 (Trillion BTU)
Indirect Use - Boiler (trillion BTU)	0.012	0.003	0.032	0.008	0.002	0.002	0.097	0.086	0.053	0.000	0.296
Indirect Use - Boiler Potential Savings	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	
Direct Process Heating Use (trillion BTU)	0.005	0.001	0.014	0.004	0.001	0.001	0.043	0.038	0.024	0.000	0.131
Direct Process Heating Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
Space Heating Use (OTHSUB) (trillion BTU)	0.031	0.000	0.001	0.010	0.001	0.001	0.028	0.000	0.000	0.000	0.072
Space Heating Use Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
						2016 Forecasted Consumption Value for All Fuels Combined					**0.499**
Savings Summary (trillion BTU)											**SAVINGS TOTALS**
Overall Boiler Improvements	0.002	0.000	0.006	0.002	0.000	0.000	0.018	0.016	0.010	0.000	0.056
Overall Process Heating Improvements	0.001	0.000	0.001	0.000	0.000	0.000	0.004	0.004	0.002	0.000	0.013
Overall Space Heating Improvements	0.003	0.000	0.000	0.001	0.000	0.000	0.003	0.000	0.000	0.000	0.007
Totals	0.006	0.001	0.008	0.003	0.001	0.001	0.026	0.020	0.013	0.000	0.077
% Savings of Total	12.2%	16.2%	16.1%	13.4%	15.2%	15.2%	15.2%	16.2%	16.2%	#DIV/0!	15.3%

Source: Spreadsheet provided by VT DPS via email on 12/15/06 entitled Industrial Demand Data.xls.

		Energy Use Percentages		
Manufacturing Sector		**Indirect Use (Boiler)** [% of HEAT Category]	**Direct Process Heat** [% of HEAT Category]	**Space Heat** [% of OTHSUB]
Lumber		69.25%	30.75%	100.00%
Furniture		69.25%	30.75%	100.00%
Paper		69.25%	30.75%	100.00%
Fabricated Metals		69.25%	30.75%	100.00%
Computers		69.25%	30.75%	100.00%
Electric Equipment		69.25%	30.75%	100.00%
Other Manufacturing		69.25%	30.75%	100.00%
Mining		69.25%	30.75%	100.00%
Agriculture		69.25%	30.75%	100.00%
Construction		69.25%	30.75%	100.00%

Source: Based on MECS 2002 Data for the Northeast, Table 5.5.

Table C-9: Industrial Sector – Biomass (Wood) Efficiency Potential Analysis

Business Type	Lumber	Furniture	Paper	Fabricated Metals	Computers	Electric Equipment	Other	Mining	Agriculture	Construction	Total Wood Consumption in 2016 (Trillion BTU)
Indirect Use - Boiler (trillion BTU)	0.115	0.471	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.585
Indirect Use - Boiler Potential Savings	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	
Direct Process Heating Use (trillion BTU)	0.051	0.209	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.260
Direct Process Heating Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
Space Heating Use (OTHSUB) (trillion BTU)	0.308	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.308
Space Heating Use Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
										2016 Forecasted Consumption Value for Wood	1.153
Savings Summary (trillion BTU)											**SAVINGS TOTALS**
Overall Boiler Improvements	0.022	0.089	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.111
Overall Process Heating Improvements	0.005	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026
Overall Space Heating Improvements	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031
Totals	0.058	0.110	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.168
% Savings of Total	12.2%	16.2%	#DIV/0!	-	-	-	-	-	-	-	14.6%

Source: Spreadsheet provided by VT DPS via email on 12/15/06 entitled Industrial Demand Data.xls.

		Energy Use Percentages		
Manufacturing Sector		**Indirect Use (Boiler)** [% of HEAT Category]	**Direct Process Heat** [% of HEAT Category]	**Space Heat** [% of OTHSUB]
Lumber		69.25%	30.75%	100.00%
Furniture		69.25%	30.75%	100.00%
Paper		69.25%	30.75%	100.00%
Fabricated Metals		69.25%	30.75%	100.00%
Computers		69.25%	30.75%	100.00%
Electric Equipment		69.25%	30.75%	100.00%
Other Manufacturing		69.25%	30.75%	100.00%
Mining		69.25%	30.75%	100.00%
Agriculture		69.25%	30.75%	100.00%
Construction		69.25%	30.75%	100.00%

Source: Based on MECS 2002 Data for the Northeast, Table 5.5.

Table C-10: Industrial Sector – Total Efficiency Potential Analysis

Business Type	Lumber	Furniture	Paper	Fabricated Metals	Computers	Electric Equipment	Other	Mining	Agriculture	Construction	Total Fuel Consumption in 2016 (Trillion BTU)
Indirect Use - Boiler (trillion BTU)	0.193	0.488	0.216	0.055	0.014	0.015	0.655	0.582	0.359	0.000	2.577
Indirect Use - Boiler Potential Savings	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	
Direct Process Heating Use (trillion BTU)	0.086	0.217	0.097	0.025	0.006	0.007	0.869	0.259	0.161	0.000	1.726
Direct Process Heating Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
Space Heating Use (OTHSUB) (trillion BTU)	0.517	0.000	0.009	0.069	0.004	0.004	0.304	0.000	0.000	0.000	0.907
Space Heating Use Potential Savings	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	
						2016 Forecasted Consumption Value for All Fuels Combined					**5.210**
Savings Summary (trillion BTU)											**SAVINGS TOTALS**
Overall Boiler Improvements	0.037	0.093	0.041	0.010	0.003	0.003	0.125	0.111	0.068	0.000	0.490
Overall Process Heating Improvements	0.009	0.022	0.010	0.002	0.001	0.001	0.087	0.026	0.016	0.000	0.173
Overall Space Heating Improvements	0.052	0.000	0.001	0.007	0.000	0.000	0.030	0.000	0.000	0.000	0.091
Totals	0.097	0.114	0.052	0.020	0.004	0.004	0.242	0.136	0.084	0.000	0.753
% Savings of Total	12.2%	16.2%	16.0%	13.3%	15.2%	15.2%	13.2%	16.2%	16.2%	-	14.5%

Source: Spreadsheet provided by VT DPS via email on 12/15/06 entitled Industrial Demand Data.xls.

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APPENDIX D:

CUMULATIVE ANNUAL ENERGY SAVINGS POTENTIAL BY FUEL FOR THE ACHIEVABLE COST EFFECTIVE POTENTIAL BASE CASE SCENARIO BASED UPON SOCIETAL TEST SCREENING

Appendix D - Maximum Achievable Cost Effective Potential - Cumulative Annual MMBTU Savings by Year - Based on Screeing with Vermont Societal Test
State of Vermont

	Fuel Oil Consumption Forecast (MMBTU)			Residential Fuel Oil Savings		Commercial Fuel Oil Savings		Industrial Fuel Oil Savings		Total Fuel Oil Savings (MMBTU)	
Year	Residential Sector MMBTU Consumption	Commercial Sector MMBTU Consumption	Industrial Sector MMBTU Consumption	MMBTU Savings	% of Projected Residential Consumption	MMBTU Savings	% of Projected Commercial Consumption	MMBTU Savings	% of Projected Industrial Consumption	MMBTU Savings	% of Projected Total Consumption
2007	14,013,000	6,011,687	2,959,619	144,532	1.03%	160,860	2.68%	29,238	0.99%	334,630	1.46%
2008	14,080,123	6,057,259	2,908,912	289,871	2.06%	321,719	5.31%	58,477	2.01%	670,067	2.91%
2009	14,141,035	6,124,283	2,879,218	436,016	3.08%	482,579	7.88%	87,715	3.05%	1,006,309	4.35%
2010	14,197,267	6,191,910	2,862,242	582,983	4.11%	643,438	10.39%	116,953	4.09%	1,343,374	5.78%
2011	14,255,772	6,265,059	2,853,832	730,756	5.13%	804,298	12.84%	146,191	5.12%	1,681,246	7.19%
2012	14,328,681	6,346,922	2,850,850	879,327	6.14%	965,158	15.21%	175,430	6.15%	2,019,915	8.59%
2013	14,396,959	6,423,964	2,851,085	1,028,705	7.15%	1,126,017	17.53%	204,668	7.18%	2,359,390	9.97%
2014	14,458,470	6,500,944	2,853,301	1,178,888	8.15%	1,286,877	19.80%	233,906	8.20%	2,699,671	11.34%
2015	14,514,124	6,577,937	2,856,612	1,329,877	9.16%	1,447,736	22.01%	263,145	9.21%	3,040,758	12.70%
2016	14,560,100	6,652,380	2,860,485	1,479,023	10.16%	1,608,596	24.18%	292,383	10.22%	3,380,002	14.04%

Table D-1

Appendix D - Maximum Achievable Cost Effective Potential - Cumulative Annual MMBTU Savings by Year - Based on Screeing with Vermont Societal Test
State of Vermont

	Propane Consumption Forecast (MMBTU)			Residential Propane Savings		Commercial Propane Savings		Industrial Propane Savings		Total Propane Savings (MMBTU)	
Year	Residential Sector MMBTU Consumption	Commercial Sector MMBTU Consumption	Industrial Sector MMBTU Consumption	MMBTU Savings	% of Projected Residential Consumption	MMBTU Savings	% of Projected Commercial Consumption	MMBTU Savings	% of Projected Industrial Consumption	MMBTU Savings	% of Projected Total Consumption
2007	6,201,378	1,150,561	647,366	40,146	0.65%	30,254	2.63%	4,656	0.72%	75,056	0.94%
2008	6,365,572	1,176,501	654,429	80,706	1.27%	60,509	5.14%	9,312	1.42%	150,526	1.84%
2009	6,514,570	1,205,136	660,468	121,686	1.87%	90,763	7.53%	13,968	2.11%	226,417	2.70%
2010	6,652,123	1,231,551	665,842	163,080	2.45%	121,018	9.83%	18,623	2.80%	302,721	3.54%
2011	6,795,234	1,258,599	671,440	204,895	3.02%	151,272	12.02%	23,279	3.47%	379,447	4.35%
2012	6,973,580	1,287,973	677,228	247,123	3.54%	181,527	14.09%	27,935	4.12%	456,585	5.11%
2013	7,140,596	1,315,280	682,937	289,766	4.06%	211,781	16.10%	32,591	4.77%	534,138	5.84%
2014	7,291,061	1,342,342	688,547	332,829	4.56%	242,036	18.03%	37,247	5.41%	612,112	6.57%
2015	7,427,200	1,369,280	693,941	376,306	5.07%	272,290	19.89%	41,903	6.04%	690,499	7.28%
2016	7,539,662	1,395,257	699,073	419,729	5.57%	302,545	21.68%	46,558	6.66%	768,833	7.98%

Table D-2

Appendix D - Maximum Achievable Cost Effective Potential - Cumulative Annual MMBTU Savings by Year - Based on Screeing with Vermont Societal Test
State of Vermont

	Kerosene Consumption Forecast (MMBTU)			Residential Kerosene Savings		Commercial Kerosene Savings		Industrial Kerosene Savings		Total Kerosene Savings (MMBTU)	
Year	Residential Sector MMBTU Consumption	Commercial Sector MMBTU Consumption	Industrial Sector MMBTU Consumption	MMBTU Savings	% of Projected Residential Consumption	MMBTU Savings	% of Projected Commercial Consumption	MMBTU Savings	% of Projected Industrial Consumption	MMBTU Savings	% of Projected Total Consumption
2007	1,790,199	177,373	373,441	7,134	0.40%	4,713	2.66%	5,100	1.37%	16,948	0.72%
2008	1,837,178	180,984	386,368	14,268	0.78%	9,426	5.21%	10,201	2.64%	33,895	1.41%
2009	1,879,810	185,341	400,464	21,403	1.14%	14,139	7.63%	15,301	3.82%	50,843	2.06%
2010	1,919,167	189,468	413,873	28,537	1.49%	18,852	9.95%	20,402	4.93%	67,791	2.69%
2011	1,960,114	193,746	428,134	35,671	1.82%	23,565	12.16%	25,502	5.96%	84,738	3.28%
2012	2,011,143	198,414	442,958	42,805	2.13%	28,278	14.25%	30,602	6.91%	101,686	3.83%
2013	2,058,930	202,761	457,598	49,940	2.43%	32,991	16.27%	35,703	7.80%	118,633	4.36%
2014	2,101,981	207,071	471,988	57,074	2.72%	37,704	18.21%	40,803	8.65%	135,581	4.88%
2015	2,140,934	211,362	485,827	64,208	3.00%	42,417	20.07%	45,904	9.45%	152,529	5.37%
2016	2,173,112	215,501	498,992	71,342	3.28%	47,130	21.87%	51,004	10.22%	169,476	5.87%

Appendix D - Maximum Achievable Cost Effective Potential - Cumulative Annual MMBTU Savings by Year - Based on Screeing with Vermont Societal Test
State of Vermont

	Wood Consumption Forecast (MMBTU)			Residential Wood Savings		Commercial Wood Savings		Industrial Wood Savings		Total Wood Savings (MMBTU)	
Year	Residential Sector MMBTU Consumption	Commercial Sector MMBTU Consumption	Industrial Sector MMBTU Consumption	MMBTU Savings	% of Projected Residential Consumption	MMBTU Savings	% of Projected Commercial Consumption	MMBTU Savings	% of Projected Industrial Consumption	MMBTU Savings	% of Projected Total Consumption
2007	1,572,073	234,903	1,155,153	20,835	1.33%	3,815	1.62%	11,199	0.97%	35,850	1.21%
2008	1,520,022	234,903	1,155,153	41,756	2.75%	7,630	3.25%	22,398	1.94%	71,785	2.47%
2009	1,473,225	234,903	1,155,153	62,763	4.26%	11,445	4.87%	33,597	2.91%	107,806	3.77%
2010	1,430,384	234,903	1,155,153	83,803	5.86%	15,261	6.50%	44,796	3.88%	143,859	5.10%
2011	1,386,175	234,903	1,155,153	104,981	7.57%	19,076	8.12%	55,995	4.85%	180,052	6.49%
2012	1,331,590	234,903	1,155,153	126,244	9.48%	22,785	9.70%	67,194	5.82%	216,223	7.94%
2013	1,280,976	234,903	1,155,153	147,594	11.52%	26,494	11.28%	78,393	6.79%	252,481	9.45%
2014	1,235,784	234,903	1,155,153	169,029	13.68%	30,203	12.86%	89,592	7.76%	288,824	11.00%
2015	1,195,224	234,903	1,155,153	190,549	15.94%	33,912	14.44%	100,791	8.73%	325,252	12.58%
2016	1,161,949	234,903	1,155,153	212,116	18.26%	37,621	16.02%	111,991	9.69%	361,727	14.17%

Table D-4

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APPENDIX E:

PROGRAM ADMINISTRATOR AND PARTICIPANT BUDGETS

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Fuel - Based on Screeing with Vermont Societal Test State of Vermont											
Fuel Oil											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Incentive Budget											
Residential	$3,897,627.00	$3,946,127.00	$3,994,627.00	$4,044,127.00	$4,092,627.00	$4,140,627.00	$4,189,127.00	$4,237,627.00	$4,286,127.00	$4,334,627.00	$41,163,270.00
Commercial	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$20,348,230.05
Industrial	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$636,139.48
Total	$5,996,063.95	$6,044,563.95	$6,093,063.95	$6,142,563.95	$6,191,063.95	$6,239,063.95	$6,287,563.95	$6,336,063.95	$6,384,563.95	$6,433,063.95	$62,147,639.53
Non-Incentive Budget											
Residential	$2,437,193.96	$2,523,040.33	$2,611,515.96	$2,703,364.17	$2,797,339.96	$2,893,826.64	$2,993,596.38	$3,096,390.75	$3,202,295.36	$3,311,398.13	$28,569,961.65
Commercial	$716,420.48	$732,539.94	$749,022.09	$765,875.09	$783,107.28	$800,727.19	$818,743.56	$837,165.29	$856,001.50	$875,261.54	$7,934,863.97
Industrial	$119,841.04	$122,537.47	$125,294.56	$128,113.69	$130,996.25	$133,943.66	$136,957.39	$140,038.94	$143,189.81	$146,411.58	$1,327,324.40
Total	$3,273,455.49	$3,378,117.74	$3,485,832.61	$3,597,352.95	$3,711,443.49	$3,828,497.50	$3,949,297.33	$4,073,594.97	$4,201,486.68	$4,333,071.26	$37,832,150.02
Total Budget (Incentive + Non-Incentive)											
Residential	$6,334,820.96	$6,469,167.33	$6,606,142.96	$6,747,491.17	$6,889,966.96	$7,034,453.64	$7,182,723.38	$7,334,017.75	$7,488,422.36	$7,646,025.13	$69,733,231.65
Commercial	$2,751,243.49	$2,767,362.95	$2,783,845.10	$2,800,698.09	$2,817,930.28	$2,835,550.20	$2,853,566.56	$2,871,988.29	$2,890,824.51	$2,910,084.54	$28,283,094.01
Industrial	$183,454.99	$186,151.42	$188,908.51	$191,727.64	$194,610.20	$197,557.61	$200,571.34	$203,652.88	$206,803.76	$210,025.53	$1,963,463.88
Total	$9,269,519.44	$9,422,681.70	$9,578,896.57	$9,739,916.90	$9,902,507.44	$10,067,561.45	$10,236,861.28	$10,409,658.93	$10,586,050.63	$10,766,135.21	$99,979,789.54

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Fuel - Based on Screeing with Vermont Societal Test State of Vermont											
Propane											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Incentive Budget											
Residential	$1,559,400.00	$1,590,400.00	$1,621,900.00	$1,652,900.00	$1,684,400.00	$1,715,400.00	$1,746,400.00	$1,777,900.00	$1,808,900.00	$1,839,900.00	$16,997,500.00
Commercial	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$3,363,258.94
Industrial	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$95,444.88
Total	$1,905,270.38	$1,936,270.38	$1,967,770.38	$1,998,770.38	$2,030,270.38	$2,061,270.38	$2,092,270.38	$2,123,770.38	$2,154,770.38	$2,185,770.38	$20,456,203.82
Non-Incentive Budget											
Residential	$975,095.94	$1,016,856.11	$1,060,328.72	$1,104,908.58	$1,151,299.50	$1,198,869.21	$1,247,996.71	$1,299,093.36	$1,351,484.00	$1,405,574.56	$11,811,506.70
Commercial	$118,413.62	$121,077.93	$123,802.18	$126,587.73	$129,435.95	$132,348.26	$135,326.10	$138,370.94	$141,484.28	$144,667.68	$1,311,514.67
Industrial	$17,980.67	$18,385.23	$18,798.90	$19,221.88	$19,654.37	$20,096.59	$20,548.77	$21,011.11	$21,483.86	$21,967.25	$199,148.64
Total	$1,111,490.23	$1,156,319.27	$1,202,929.80	$1,250,718.19	$1,300,389.83	$1,351,314.07	$1,403,871.58	$1,458,475.41	$1,514,452.15	$1,572,209.49	$13,322,170.01
Total Budget (Incentive + Non-Incentive)											
Residential	$2,534,495.94	$2,607,256.11	$2,682,228.72	$2,757,808.58	$2,835,699.50	$2,914,269.21	$2,994,396.71	$3,076,993.36	$3,160,384.00	$3,245,474.56	$28,809,006.70
Commercial	$454,739.52	$457,403.82	$460,128.08	$462,913.62	$465,761.85	$468,674.16	$471,651.99	$474,696.83	$477,810.18	$480,993.57	$4,674,773.61
Industrial	$27,525.16	$27,929.72	$28,343.39	$28,766.37	$29,198.86	$29,641.08	$30,093.25	$30,555.60	$31,028.35	$31,511.74	$294,593.52
Total	$3,016,760.61	$3,092,589.65	$3,170,700.19	$3,249,488.57	$3,330,660.21	$3,412,584.45	$3,496,141.96	$3,582,245.80	$3,669,222.53	$3,757,979.87	$33,778,373.83

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Fuel - Based on Screeing with Vermont Societal Test State of Vermont											
Kerosene											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Incentive Budget											
Residential	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$3,086,310.00
Commercial	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$498,966.21
Industrial	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$69,154.96
Total	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$3,654,431.18
Non-Incentive Budget											
Residential	$192,987.58	$197,329.80	$201,769.72	$206,309.54	$210,951.51	$215,697.92	$220,551.12	$225,513.52	$230,587.57	$235,775.79	$2,137,474.07
Commercial	$17,567.60	$17,962.87	$18,367.04	$18,780.30	$19,202.85	$19,634.92	$20,076.70	$20,528.43	$20,990.32	$21,462.60	$194,573.63
Industrial	$13,027.97	$13,321.09	$13,620.82	$13,927.29	$14,240.65	$14,561.07	$14,888.69	$15,223.69	$15,566.22	$15,916.46	$144,293.94
Total	$223,583.15	$228,613.77	$233,757.58	$239,017.13	$244,395.01	$249,893.90	$255,516.51	$261,265.63	$267,144.11	$273,154.85	$2,476,341.64
Total Budget (Incentive + Non-Incentive)											
Residential	$501,618.58	$505,960.80	$510,400.72	$514,940.54	$519,582.51	$524,328.92	$529,182.12	$534,144.52	$539,218.57	$544,406.79	$5,223,784.07
Commercial	$67,464.22	$67,859.49	$68,263.66	$68,676.92	$69,099.47	$69,531.54	$69,973.32	$70,425.05	$70,886.94	$71,359.22	$693,539.84
Industrial	$19,943.46	$20,236.59	$20,536.32	$20,842.78	$21,156.15	$21,476.56	$21,804.19	$22,139.18	$22,481.72	$22,831.96	$213,448.90
Total	$589,026.27	$594,056.89	$599,200.70	$604,460.24	$609,838.13	$615,337.02	$620,959.63	$626,708.75	$632,587.23	$638,597.97	$6,130,772.82

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Fuel - Based on Screeing with Vermont Societal Test State of Vermont											
Wood											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Incentive Budget											
Residential	$455,304.50	$461,804.50	$468,304.50	$470,804.50	$481,304.50	$487,804.50	$494,304.50	$500,804.50	$507,304.50	$513,304.50	$4,841,045.00
Commercial	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$577,002.63
Industrial	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$159,518.27
Total	$528,956.59	$535,456.59	$541,956.59	$544,456.59	$554,956.59	$561,456.59	$567,956.59	$574,456.59	$580,956.59	$586,956.59	$5,577,565.89
Non-Incentive Budget											
Residential	$284,702.81	$295,264.54	$306,157.41	$314,717.12	$328,975.08	$340,919.78	$353,235.45	$365,932.73	$379,022.56	$392,134.22	$3,361,061.72
Commercial	$20,315.11	$20,772.20	$21,239.57	$21,717.46	$22,206.11	$22,705.74	$23,216.62	$23,739.00	$24,273.12	$24,819.27	$225,004.21
Industrial	$30,051.33	$30,727.48	$31,418.85	$32,125.77	$32,848.60	$33,587.70	$34,343.42	$35,116.15	$35,906.26	$36,714.15	$332,839.72
Total	$335,069.25	$346,764.22	$358,815.84	$368,560.36	$384,029.79	$397,213.22	$410,795.49	$424,787.88	$439,201.95	$453,667.64	$3,918,905.65
Total Budget (Incentive + Non-Incentive)											
Residential	$740,007.31	$757,069.04	$774,461.91	$785,521.62	$810,279.58	$828,724.28	$847,539.95	$866,737.23	$886,327.06	$905,438.72	$8,202,106.72
Commercial	$78,015.37	$78,472.46	$78,939.84	$79,417.73	$79,906.37	$80,406.01	$80,916.89	$81,439.26	$81,973.39	$82,519.53	$802,006.83
Industrial	$46,003.15	$46,679.31	$47,370.68	$48,077.60	$48,800.43	$49,539.52	$50,295.25	$51,067.97	$51,858.09	$52,665.98	$492,357.98
Total	$864,025.84	$882,220.81	$900,772.43	$913,016.95	$938,986.38	$958,669.81	$978,752.08	$999,244.47	$1,020,158.54	$1,040,624.23	$9,496,471.54

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Fuel - Based on Screeing with Vermont Societal Test State of Vermont											
All Fuels Combined											
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Incentive Budget											
Residential	$6,220,962.50	$6,306,962.50	$6,393,462.50	$6,476,462.50	$6,566,962.50	$6,652,462.50	$6,738,462.50	$6,824,962.50	$6,910,962.50	$6,996,462.50	$66,088,125.00
Commercial	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$24,787,457.83
Industrial	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$960,257.59
Total	$8,795,734.04	$8,881,734.04	$8,968,234.04	$9,051,234.04	$9,141,734.04	$9,227,234.04	$9,313,234.04	$9,399,734.04	$9,485,734.04	$9,571,234.04	$91,835,840.42
Non-Incentive Budget											
Residential	$3,889,980.29	$4,032,490.78	$4,179,771.82	$4,329,299.42	$4,488,566.06	$4,649,313.55	$4,815,379.66	$4,986,930.36	$5,163,389.50	$5,344,882.70	$45,880,004.14
Commercial	$872,716.82	$892,352.94	$912,430.88	$932,960.58	$953,952.19	$975,416.12	$997,362.98	$1,019,803.65	$1,042,749.23	$1,066,211.09	$9,665,956.47
Industrial	$180,901.01	$184,971.28	$189,133.13	$193,388.63	$197,739.87	$202,189.02	$206,738.27	$211,389.88	$216,146.16	$221,009.45	$2,003,606.70
Total	$4,943,598.12	$5,109,815.00	$5,281,335.84	$5,455,648.63	$5,640,258.12	$5,826,918.69	$6,019,480.91	$6,218,123.90	$6,422,284.89	$6,632,103.23	$57,549,567.32
Total Budget (Incentive + Non-Incentive)											
Residential	$10,110,942.79	$10,339,453.28	$10,573,234.32	$10,805,761.92	$11,055,528.56	$11,301,776.05	$11,553,842.16	$11,811,892.86	$12,074,352.00	$12,341,345.20	$111,968,129.14
Commercial	$3,351,462.60	$3,371,098.73	$3,391,176.67	$3,411,706.36	$3,432,697.98	$3,454,161.90	$3,476,108.76	$3,498,549.43	$3,521,495.01	$3,544,956.87	$34,453,414.30
Industrial	$276,926.77	$280,997.04	$285,158.89	$289,414.39	$293,765.63	$298,214.78	$302,764.03	$307,415.64	$312,171.92	$317,035.20	$2,963,864.29
Total	$13,739,332.16	$13,991,549.05	$14,249,569.88	$14,506,882.67	$14,781,992.16	$15,054,152.73	$15,332,714.95	$15,617,857.94	$15,908,018.93	$16,203,337.27	$149,385,407.74

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Sector - Based on Screeing with Vermont Societal Test State of Vermont											
Residential											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Incentive Budget											
Fuel Oil	$3,897,627.00	$3,946,127.00	$3,994,627.00	$4,044,127.00	$4,092,627.00	$4,140,627.00	$4,189,127.00	$4,237,627.00	$4,286,127.00	$4,334,627.00	$41,163,270.00
Propane	$1,559,400.00	$1,590,400.00	$1,621,900.00	$1,652,900.00	$1,684,400.00	$1,715,400.00	$1,746,400.00	$1,777,900.00	$1,808,900.00	$1,839,900.00	$16,997,500.00
Kerosene	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$3,086,310.00
Wood	$455,304.50	$461,804.50	$468,304.50	$470,804.50	$481,304.50	$487,804.50	$494,304.50	$500,804.50	$507,304.50	$513,304.50	$4,841,045.00
All Fuels	$6,220,962.50	$6,306,962.50	$6,393,462.50	$6,476,462.50	$6,566,962.50	$6,652,462.50	$6,738,462.50	$6,824,962.50	$6,910,962.50	$6,996,462.50	$66,088,125.00
Non-Incentive Budget											
Fuel Oil	$2,437,193.96	$2,523,040.33	$2,611,515.96	$2,703,364.17	$2,797,339.96	$2,893,826.64	$2,993,596.38	$3,096,390.75	$3,202,295.36	$3,311,398.13	$28,569,961.65
Propane	$975,095.94	$1,016,856.11	$1,060,328.72	$1,104,908.58	$1,151,299.50	$1,198,869.21	$1,247,996.71	$1,299,093.36	$1,351,484.00	$1,405,574.56	$11,811,506.70
Kerosene	$192,987.58	$197,329.80	$201,769.72	$206,309.54	$210,951.51	$215,697.92	$220,551.12	$225,513.52	$230,587.57	$235,775.79	$2,137,474.07
Wood	$284,702.81	$295,264.54	$306,157.41	$314,717.12	$328,975.08	$340,919.78	$353,235.45	$365,932.73	$379,022.56	$392,134.22	$3,361,061.72
All Fuels	$3,889,980.29	$4,032,490.78	$4,179,771.82	$4,329,299.42	$4,488,566.06	$4,649,313.55	$4,815,379.66	$4,986,930.36	$5,163,389.50	$5,344,882.70	$45,880,004.14
Total Budget (Incentive + Non-Incentive)											
Fuel Oil	$6,334,820.96	$6,469,167.33	$6,606,142.96	$6,747,491.17	$6,889,966.96	$7,034,453.64	$7,182,723.38	$7,334,017.75	$7,488,422.36	$7,646,025.13	$69,733,231.65
Propane	$2,534,495.94	$2,607,256.11	$2,682,228.72	$2,757,808.58	$2,835,699.50	$2,914,269.21	$2,994,396.71	$3,076,993.36	$3,160,384.00	$3,245,474.56	$28,809,006.70
Kerosene	$501,618.58	$505,960.80	$510,400.72	$514,940.54	$519,582.51	$524,328.92	$529,182.12	$534,144.52	$539,218.57	$544,406.79	$5,223,784.07
Wood	$740,007.31	$757,069.04	$774,461.91	$785,521.62	$810,279.58	$828,724.28	$847,539.95	$866,737.23	$886,327.06	$905,438.72	$8,202,106.72
All Fuels	$10,110,942.79	$10,339,453.28	$10,573,234.32	$10,805,761.92	$11,055,528.56	$11,301,776.05	$11,553,842.16	$11,811,892.86	$12,074,352.00	$12,341,345.20	$111,968,129.14

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Sector - Based on Screeing with Vermont Societal Test State of Vermont											
Commercial											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Incentive Budget											
Fuel Oil	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$20,348,230.05
Propane	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$3,363,258.94
Kerosene	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$498,966.21
Wood	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$577,002.63
All Fuels	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$24,787,457.83
Non-Incentive Budget											
Fuel Oil	$716,420.48	$732,539.94	$749,022.09	$765,875.09	$783,107.28	$800,727.19	$818,743.56	$837,165.29	$856,001.50	$875,261.54	$7,934,863.97
Propane	$118,413.62	$121,077.93	$123,802.18	$126,587.73	$129,435.95	$132,348.26	$135,326.10	$138,370.94	$141,484.28	$144,667.68	$1,311,514.67
Kerosene	$17,567.60	$17,962.87	$18,367.04	$18,780.30	$19,202.85	$19,634.92	$20,076.70	$20,528.43	$20,990.32	$21,462.60	$194,573.63
Wood	$20,315.11	$20,772.20	$21,239.57	$21,717.46	$22,206.11	$22,705.74	$23,216.62	$23,739.00	$24,273.12	$24,819.27	$225,004.21
All Fuels	$872,716.82	$892,352.94	$912,430.88	$932,960.58	$953,952.19	$975,416.12	$997,362.98	$1,019,803.65	$1,042,749.23	$1,066,211.09	$9,665,956.47
Total Budget (Incentive + Non-Incentive)											
Fuel Oil	$2,751,243.49	$2,767,362.95	$2,783,845.10	$2,800,698.09	$2,817,930.28	$2,835,550.20	$2,853,566.56	$2,871,988.29	$2,890,824.51	$2,910,084.54	$28,283,094.01
Propane	$454,739.52	$457,403.82	$460,128.08	$462,913.62	$465,761.85	$468,674.16	$471,651.99	$474,696.83	$477,810.18	$480,993.57	$4,674,773.61
Kerosene	$67,464.22	$67,859.49	$68,263.66	$68,676.92	$69,099.47	$69,531.54	$69,973.32	$70,425.05	$70,886.94	$71,359.22	$693,539.84
Wood	$78,015.37	$78,472.46	$78,939.84	$79,417.73	$79,906.37	$80,406.01	$80,916.89	$81,439.26	$81,973.39	$82,519.53	$802,006.83
All Fuels	$3,351,462.60	$3,371,098.73	$3,391,176.67	$3,411,706.36	$3,432,697.98	$3,454,161.90	$3,476,108.76	$3,498,549.43	$3,521,495.01	$3,544,956.87	$34,453,414.30

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Sector - Based on Screeing with Vermont Societal Test State of Vermont											
Industrial											
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Incentive Budget											
Fuel Oil	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$636,139.48
Propane	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$95,444.88
Kerosene	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$69,154.96
Wood	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$159,518.27
All Fuels	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$960,257.59
Non-Incentive Budget											
Fuel Oil	$119,841.04	$122,537.47	$125,294.56	$128,113.69	$130,996.25	$133,943.66	$136,957.39	$140,038.94	$143,189.81	$146,411.58	$1,327,324.40
Propane	$17,980.67	$18,385.23	$18,798.90	$19,221.88	$19,654.37	$20,096.59	$20,548.77	$21,011.11	$21,483.86	$21,967.25	$199,148.64
Kerosene	$13,027.97	$13,321.09	$13,620.82	$13,927.29	$14,240.65	$14,561.07	$14,888.69	$15,223.69	$15,566.22	$15,916.46	$144,293.94
Wood	$30,051.33	$30,727.48	$31,418.85	$32,125.77	$32,848.60	$33,587.70	$34,343.42	$35,116.15	$35,906.26	$36,714.15	$332,839.72
All Fuels	$180,901.01	$184,971.28	$189,133.13	$193,388.63	$197,739.87	$202,189.02	$206,738.27	$211,389.88	$216,146.16	$221,009.45	$2,003,606.70
Total Budget (Incentive + Non-Incentive)											
Fuel Oil	$183,454.99	$186,151.42	$188,908.51	$191,727.64	$194,610.20	$197,557.61	$200,571.34	$203,652.88	$206,803.76	$210,025.53	$1,963,463.88
Propane	$27,525.16	$27,929.72	$28,343.39	$28,766.37	$29,198.86	$29,641.08	$30,093.25	$30,555.60	$31,028.35	$31,511.74	$294,593.52
Kerosene	$19,943.46	$20,236.59	$20,536.32	$20,842.78	$21,156.15	$21,476.56	$21,804.19	$22,139.18	$22,481.72	$22,831.96	$213,448.90
Wood	$46,003.15	$46,679.31	$47,370.68	$48,077.60	$48,800.43	$49,539.52	$50,295.25	$51,067.97	$51,858.09	$52,665.98	$492,357.98
All Fuels	$276,926.77	$280,997.04	$285,158.89	$289,414.39	$293,765.63	$298,214.78	$302,764.03	$307,415.64	$312,171.92	$317,035.20	$2,963,864.29

Maximum Achievable Cost Effective Potential - Annual Program Budgets by Sector - Based on Screeing with Vermont Societal Test State of Vermont											
All Sectors Combined											
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Incentive Budget											
Fuel Oil	$5,996,063.95	$6,044,563.95	$6,093,063.95	$6,142,563.95	$6,191,063.95	$6,239,063.95	$6,287,563.95	$6,336,063.95	$6,384,563.95	$6,433,063.95	$62,147,639.53
Propane	$1,905,270.38	$1,936,270.38	$1,967,770.38	$1,998,770.38	$2,030,270.38	$2,061,270.38	$2,092,270.38	$2,123,770.38	$2,154,770.38	$2,185,770.38	$20,456,203.82
Kerosene	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$3,654,431.18
Wood	$528,956.59	$535,456.59	$541,956.59	$544,456.59	$554,956.59	$561,456.59	$567,956.59	$574,456.59	$580,956.59	$586,956.59	$5,577,565.89
All Fuels	$8,795,734.04	$8,881,734.04	$8,968,234.04	$9,051,234.04	$9,141,734.04	$9,227,234.04	$9,313,234.04	$9,399,734.04	$9,485,734.04	$9,571,234.04	$91,835,840.42
Non-Incentive Budget											
Fuel Oil	$3,273,455.49	$3,378,117.74	$3,485,832.61	$3,597,352.95	$3,711,443.49	$3,828,497.50	$3,949,297.33	$4,073,594.97	$4,201,486.68	$4,333,071.26	$37,832,150.02
Propane	$1,111,490.23	$1,156,319.27	$1,202,929.80	$1,250,718.19	$1,300,389.83	$1,351,314.07	$1,403,871.58	$1,458,475.41	$1,514,452.15	$1,572,209.49	$13,322,170.01
Kerosene	$223,583.15	$228,613.77	$233,757.58	$239,017.13	$244,395.01	$249,893.90	$255,516.51	$261,265.63	$267,144.11	$273,154.85	$2,476,341.64
Wood	$335,069.25	$346,764.22	$358,815.84	$368,560.36	$384,029.79	$397,213.22	$410,795.49	$424,787.88	$439,201.95	$453,667.64	$3,918,905.65
All Fuels	$4,943,598.12	$5,109,815.00	$5,281,335.84	$5,455,648.63	$5,640,258.12	$5,826,918.69	$6,019,480.91	$6,218,123.90	$6,422,284.89	$6,632,103.23	$57,549,567.32
Total Budget (Incentive + Non-Incentive)											
Fuel Oil	$9,269,519.44	$9,422,681.70	$9,578,896.57	$9,739,916.90	$9,902,507.44	$10,067,561.45	$10,236,861.28	$10,409,658.93	$10,586,050.63	$10,766,135.21	$99,979,789.54
Propane	$3,016,760.61	$3,092,589.65	$3,170,700.19	$3,249,488.57	$3,330,660.21	$3,412,584.45	$3,496,141.96	$3,582,245.80	$3,669,222.53	$3,757,979.87	$33,778,373.83
Kerosene	$589,026.27	$594,056.89	$599,200.70	$604,460.24	$609,838.13	$615,337.02	$620,959.63	$626,708.75	$632,587.23	$638,597.97	$6,130,772.82
Wood	$864,025.84	$882,220.81	$900,772.43	$913,016.95	$938,986.38	$958,669.81	$978,752.08	$999,244.47	$1,020,158.54	$1,040,624.23	$9,496,471.54
All Fuels	$13,739,332.16	$13,991,549.05	$14,249,569.88	$14,506,882.67	$14,781,992.16	$15,054,152.73	$15,332,714.95	$15,617,857.94	$15,908,018.93	$16,203,337.27	$149,385,407.74

Maximum Achievable Cost Effective Potential - Annual Participant Budgets by Sector - Based on Screeing with Vermont Societal Test State of Vermont											
Residential											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Fuel Oil	$3,897,627.00	$3,946,127.00	$3,994,627.00	$4,044,127.00	$4,092,627.00	$4,140,627.00	$4,189,127.00	$4,237,627.00	$4,286,127.00	$4,334,627.00	$41,163,270.00
Propane	$1,559,400.00	$1,590,400.00	$1,621,900.00	$1,652,900.00	$1,684,400.00	$1,715,400.00	$1,746,400.00	$1,777,900.00	$1,808,900.00	$1,839,900.00	$16,997,500.00
Kerosene	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$308,631.00	$3,086,310.00
Wood	$455,304.50	$461,804.50	$468,304.50	$470,804.50	$481,304.50	$487,804.50	$494,304.50	$500,804.50	$507,304.50	$513,304.50	$4,841,045.00
All Fuels	$6,220,962.50	$6,306,962.50	$6,393,462.50	$6,476,462.50	$6,566,962.50	$6,652,462.50	$6,738,462.50	$6,824,962.50	$6,910,962.50	$6,996,462.50	$66,088,125.00
Commercial											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Fuel Oil	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$2,034,823.00	$20,348,230.05
Propane	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$336,325.89	$3,363,258.94
Kerosene	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$49,896.62	$498,966.21
Wood	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$57,700.26	$577,002.63
All Fuels	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$2,478,745.78	$24,787,457.83
Industrial											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Fuel Oil	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$63,613.95	$636,139.48
Propane	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$9,544.49	$95,444.88
Kerosene	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$6,915.50	$69,154.96
Wood	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$15,951.83	$159,518.27
All Fuels	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$96,025.76	$960,257.59
All Sectors Combined											
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Fuel Oil	$5,996,063.95	$6,044,563.95	$6,093,063.95	$6,142,563.95	$6,191,063.95	$6,239,063.95	$6,287,563.95	$6,336,063.95	$6,384,563.95	$6,433,063.95	$62,147,639.53
Propane	$1,905,270.38	$1,936,270.38	$1,967,770.38	$1,998,770.38	$2,030,270.38	$2,061,270.38	$2,092,270.38	$2,123,770.38	$2,154,770.38	$2,185,770.38	$20,456,203.82
Kerosene	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$365,443.12	$3,654,431.18
Wood	$528,956.59	$535,456.59	$541,956.59	$544,456.59	$554,956.59	$561,456.59	$567,956.59	$574,456.59	$580,956.59	$586,956.59	$5,577,565.89
All Fuels	$8,795,734.04	$8,881,734.04	$8,968,234.04	$9,051,234.04	$9,141,734.04	$9,227,234.04	$9,313,234.04	$9,399,734.04	$9,485,734.04	$9,571,234.04	$91,835,840.42

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APPENDIX F:

ASSUMPTIONS FOR DISCOUNT RATE, INFLATION RATE, SOCIETAL TEST ADDERS, LINE LOSS FACTORS, AND EMISSIONS REDUCTION FACTORS

Input Assumptions	
Inflation Rate:	2.25%
Discount Rate:	7.975%
Reserve Margin Assumption:	13.80%

Externality Adders for VT Societal Test	
Electric Externality Adders:	$0.0081 per kWh saved
Fossil Fuel Externality Adders:	
Fuel Oil	$1.74
Propane	$1.32
Kerosene	$1.74
Wood	$0.00

Line Loss Factors				
Energy Line Loss Factors:	Winter On-Peak	Winter Off-Peak	Summer On-Peak	Summer Off-Peak
	1.212	1.124	1.195	1.145
Demand Line Lost Factors:	Winter	Summer		
	1.152	1.152		

GREENHOUSE GAS EMISSIONS FACTORS FUELS	
CO2 Emission Factors	
Fuel Type	**LB CO2/MMBTU**
Fuel Oil	159.7
Kerosene	157.8
Propane	138.5
Wood	*N/A
Source: EPA Emissions Inventory Improvement Program Guidance Documents	
*CO2 emissions from biomass combustion are assumed to be "net zero"	
CH4 Emission Factors	
Fuel Type	**LB CH4/MMBTU**
Fuel Oil - Residential & Commercial	0.02209
Fuel Oil - Industrial	0.00441
Kerosene - Residential & Commercial	0.02209
Kerosene - Industrial	0.00441
Propane - Residential & Commercial	0.02209
Propane - Industrial	0.00441
Wood - Residential & Commercial	0.62803
Wood - Industrial	0.06281
Source: EPA Emissions Inventory Improvement Program Guidance Documents	
NO2 Emission Factors	
Fuel Type	**LB NO2/MMBTU**
Fuel Oil	0.00132
Kerosene	0.00132
Propane	0.00132
Wood	0.00838
Source: EPA Emissions Inventory Improvement Program Guidance Documents	

GREENHOUSE GAS EMISSIONS FACTORS ELECTRICITY	
Emission Factors	
Type	**LB /MWH**
*CO2	1102
**CH4	0.0766
*NOX	0.54

*2004 New England Marginal Emissions Rate Analysis

** EPA Climate Leaders GHG Inventory Protocol

Table F-1

APPENDIX G:

AVOIDED COSTS FOR ELECTRICITY, NATURAL GAS, DISTILLATE FUEL OIL, PROPANE, KEROSENE, WOOD, WATER

Appendix G - Retail Rate and Avoided Costs of Fuel Oil, Propane, Kerosene, and Wooc																
		Electric Retail Rate			Nat. Gas Retail Rate	Central New England Forecast by Sector and Fuel					Other in Nominal $ Central New England Forecast by Sector					Other
						Fuel Oil in Nominal $					Propane in Nominal $			Wood in Nominal $		
		Residential	Commercial	Industrial	All	Res. Distillate	Com. #2 Oil	Com. #4 Oil	Ind. #6 Oil	Kerosene	Residential	Commercial	Industrial	Greenwood	Seasoned	Water
	Years	(¢/kWh)	(¢/kWh)	(¢/kWh)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBTU)	($/MMBTU)	($/gallon)
1	*2005*	13.0600	11.3500	8.0800	11.9528	14.0712	12.0430	11.1127	9.5413	14.0573	20.5618	16.6042	14.6146	8.04	10.54	0.0025
2	*2006*	13.0017	11.2994	8.0439	12.6971	14.5406	12.4667	11.5155	9.9088	14.3285	21.1773	17.1306	15.0962	8.39	10.99	0.0114
3	*2007*	13.5226	11.7520	8.3662	12.5853	14.4957	12.3752	11.4026	9.7597	14.2789	21.2818	17.1440	15.0639	8.75	11.47	0.0117
4	*2008*	13.7886	11.9832	8.5308	10.8126	14.6317	12.4635	11.4689	9.7891	14.4100	21.5704	17.3395	15.2126	9.13	11.96	0.0120
5	*2009*	13.8035	11.9962	8.5400	10.0218	15.1797	12.9627	11.9458	10.2281	14.9530	22.2745	17.9485	15.7737	9.52	12.47	0.0122
6	*2010*	14.1003	12.2541	8.7236	9.4531	16.0432	13.7763	12.7365	10.9802	15.8114	23.2977	18.8743	16.6506	9.93	13.01	0.0125
7	*2011*	14.3373	12.4600	8.8702	9.7359	16.0636	13.7457	12.6825	10.8867	15.8266	23.4813	18.9584	16.6846	10.35	13.57	0.0128
8	*2012*	15.3064	13.3023	9.4698	10.1949	16.0851	13.7151	12.6280	10.7918	15.8428	23.6697	19.0450	16.7201	10.80	14.15	0.0131
9	*2013*	15.5136	13.4823	9.5980	10.6543	16.0994	13.6760	12.5645	10.6869	15.8516	23.8546	19.1259	16.7487	11.26	14.76	0.0134
10	*2014*	15.8287	13.7562	9.7930	11.5855	16.1061	13.6282	12.4916	10.5718	15.8527	24.0358	19.2007	16.7699	11.75	15.39	0.0137
11	*2015*	16.1845	14.0654	10.0131	11.3421	16.0832	13.5496	12.3874	10.4245	15.8241	24.1914	19.2475	16.7621	12.25	16.05	0.0140
12	*2016*	16.7048	14.5176	10.3350	11.6260	16.5055	13.9149	12.7266	10.7194	16.2406	24.7961	19.7410	17.1996	12.78	16.74	0.0143
13	*2017*	17.2610	15.0009	10.6791	11.8516	17.0361	14.3871	13.1721	11.1198	16.7652	25.5132	20.3443	17.7458	13.32	17.46	0.0146
14	*2018*	17.8057	15.4743	11.0161	12.3152	17.5821	14.8735	13.6312	11.5327	17.3051	26.2500	20.9648	18.3078	13.90	18.21	0.0149
15	*2019*	18.3902	15.9823	11.3777	12.8400	18.1440	15.3745	14.1042	11.9585	17.8608	27.0069	21.6028	18.8860	14.49	18.99	0.0153
16	*2020*	19.0176	16.5275	11.7659	13.3101	18.7223	15.8904	14.5915	12.3976	18.4327	27.7846	22.2588	19.4809	15.12	19.81	0.0156
17	*2021*	19.5101	16.9556	12.0706	14.0307	19.3173	16.4217	15.0936	12.8503	19.0212	28.5835	22.9334	20.0930	15.77	20.66	0.0160
18	*2022*	20.0142	17.3936	12.3824	14.4798	19.9295	16.9688	15.6108	13.3170	19.6267	29.4042	23.6270	20.7227	16.44	21.55	0.0163
19	*2023*	20.5332	17.8447	12.7035	15.3328	20.5595	17.5322	16.1436	13.7982	20.2499	30.2473	24.3402	21.3705	17.15	22.47	0.0167
20	*2024*	21.0676	18.3092	13.0342	15.8212	21.2076	18.1122	16.6924	14.2942	20.8911	31.1135	31.1135	22.0369	17.89	23.44	0.0171
21	*2025*	21.6180	18.7875	13.3747	16.9206	21.8745	18.7094	17.2576	14.8055	21.5508	32.0032	32.0032	22.7224	18.65	24.44	0.0175
22	*2026*	22.2529	19.3393	13.7675	17.3014	22.3666	19.1303	17.6459	15.1386	22.0357	32.7233	26.4083	23.2337	19.07	24.99	0.0179
23	*2027*	22.9065	19.9073	14.1719	17.6906	22.8699	19.5608	18.0430	15.4792	22.5315	33.4595	27.0025	23.7564	19.50	25.56	0.0183
24	*2028*	23.5793	20.4919	14.5881	18.0887	23.3845	20.0009	18.4489	15.8275	23.0384	34.2124	27.6101	24.2910	19.94	26.13	0.0187
25	*2029*	24.2718	21.0938	15.0166	18.4957	23.9106	20.4509	18.8640	16.1836	23.5568	34.9821	28.2313	24.8375	20.39	26.72	0.0191
26	*2030*	24.9847	21.7133	15.4576	18.9118	24.4486	20.9111	19.2885	16.5478	24.0868	35.7692	28.8665	25.3963	20.85	27.32	0.0195
27	*2031*	25.7185	22.3510	15.9116	19.3373	24.9987	21.3816	19.7225	16.9201	24.6288	36.5740	29.5160	25.9678	21.32	27.94	0.0200
28	*2032*	26.4738	23.0075	16.3789	19.7724	25.5612	21.8626	20.1662	17.3008	25.1829	37.3970	30.1801	26.5520	21.80	28.56	0.0204
29	*2033*	27.2513	23.6832	16.8599	20.2173	26.1363	22.3546	20.6200	17.6901	25.7495	38.2384	30.8592	27.1495	22.29	29.21	0.0209
30	*2034*	28.0517	24.3788	17.3551	20.6722	26.7243	22.8575	21.0839	18.0881	26.3289	39.0988	31.5535	27.7603	22.79	29.86	0.0213
31	*2035*	28.8756	25.0948	17.8648	21.1373	27.3256	23.3718	21.5583	18.4951	26.9213	39.9785	32.2634	28.3849	23.30	30.54	0.0218
32	*2036*	29.7237	25.8318	18.3895	21.6129	27.9405	23.8977	22.0434	18.9112	27.5270	40.8780	32.9894	29.0236	23.83	31.22	0.0223
33	*2037*	30.5967	26.5905	18.9296	22.0992	28.5691	24.4354	22.5394	19.3367	28.1464	41.7978	33.7316	29.6766	24.36	31.93	0.0228
34	*2038*	31.4953	27.3715	19.4856	22.5964	29.2119	24.9852	23.0465	19.7718	28.7797	42.7382	34.4906	30.3443	24.91	32.64	0.0233
35	*2039*	32.4203	28.1754	20.0579	23.1049	29.8692	25.5474	23.5650	20.2166	29.4272	43.6998	35.2666	31.0271	25.47	33.38	0.0238
36	*2040*	33.3725	29.0029	20.6470	23.6247	30.5413	26.1222	24.0952	20.6715	30.0894	44.6831	36.0601	31.7252	26.04	34.13	0.0244
37	*2041*	34.3526	29.8547	21.2534	24.1563	31.2284	26.7099	24.6374	21.1366	30.7664	45.6884	36.8715	32.4390	26.63	34.90	0.0249
38	*2042*	35.3616	30.7315	21.8776	24.6998	31.9311	27.3109	25.1917	21.6122	31.4586	46.7164	37.7011	33.1689	27.23	35.68	0.0255
39	*2043*	36.4001	31.6341	22.5201	25.2555	32.6495	27.9254	25.7585	22.0985	32.1664	47.7675	38.5494	33.9152	27.84	36.49	0.0261
40	*2044*	37.4692	32.5632	23.1816	25.8238	33.3841	28.5537	26.3381	22.5957	32.8902	48.8423	39.4167	34.6783	28.47	37.31	0.0266
41	*2045*	38.5697	33.5196	23.8624	26.4048	34.1353	29.1962	26.9307	23.1041	33.6302	49.9413	40.3036	35.4585	29.11	38.15	0.0272
42	*2046*	39.7025	34.5041	24.5632	26.9989	34.9033	29.8531	27.5367	23.6239	34.3869	51.0649	41.2104	36.2564	29.76	39.00	0.0279
43	*2047*	40.8685	35.5175	25.2847	27.6064	35.6887	30.5248	28.1562	24.1555	35.1606	52.2139	42.1377	37.0721	30.43	39.88	0.0285
44	*2048*	42.0688	36.5606	26.0273	28.2275	36.4917	31.2116	28.7898	24.6990	35.9517	53.3887	43.0858	37.9063	31.12	40.78	0.0291

Appendix G - Retail Rate and Avoided Costs of Fuel Oil, Propane, Kerosene, and Wooc															
	Electric Retail Rate			Nat. Gas Retail Rate	Central New England Forecast by Sector and Fuel					Other in Nominal $ Central New England Forecast by Sector					Other
					Fuel Oil in Nominal $					Propane in Nominal $			Wood in Nominal $		
	Residential	Commercial	Industrial	All	Res. Distillate	Com. #2 Oil	Com. #4 Oil	Ind. #6 Oil	Kerosene	Residential	Commercial	Industrial	Greenwood	Seasoned	Water
Years	(¢/kWh)	(¢/kWh)	(¢/kWh)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBTU)	($/MMBTU)	($/gallon)
45 *2049*	43.3044	37.6344	26.7917	28.8627	37.3127	31.9138	29.4375	25.2547	36.7606	54.5900	44.0552	38.7591	31.82	41.70	0.0298
46 *2050*	44.5763	38.7397	27.5786	29.5121	38.1522	32.6319	30.0999	25.8229	37.5877	55.8182	45.0464	39.6312	32.53	42.63	0.0305
47 *2051*	45.8855	39.8775	28.3886	30.1761	39.0107	33.3661	30.7771	26.4040	38.4334	57.0741	46.0600	40.5229	33.27	43.59	0.0311
48 *2052*	47.2331	41.0487	29.2223	30.8551	39.8884	34.1169	31.4696	26.9980	39.2982	58.3583	47.0963	41.4347	34.01	44.57	0.0318
49 *2053*	48.6204	42.2543	30.0806	31.5493	40.7859	34.8845	32.1777	27.6055	40.1824	59.6714	48.1560	42.3670	34.78	45.58	0.0326
50 *2054*	50.0483	43.4953	30.9641	32.2592	41.7036	35.6694	32.9017	28.2266	41.0865	61.0140	49.2395	43.3202	35.56	46.60	0.0333
51 *2055*	51.5183	44.7728	31.8735	32.9850	42.6419	36.4720	33.6419	28.8617	42.0110	62.3868	50.3474	44.2949	36.36	47.65	0.0340
52 *2056*	53.0313	46.0877	32.8096	33.7272	43.6014	37.2926	34.3989	29.5111	42.9562	63.7905	51.4802	45.2916	37.18	48.72	0.0348
53 *2057*	54.5889	47.4413	33.7732	34.4860	44.5824	38.1317	35.1729	30.1751	43.9227	65.2258	52.6385	46.3106	38.02	49.82	0.0356
54 *2058*	56.1922	48.8347	34.7651	35.2619	45.5855	38.9896	35.9643	30.8541	44.9110	66.6934	53.8229	47.3526	38.87	50.94	0.0364
55 *2059*	57.8425	50.2690	35.7862	36.0553	46.6112	39.8669	36.7735	31.5483	45.9215	68.1940	55.0339	48.4181	39.75	52.09	0.0372
56 *2060*	59.5414	51.7454	36.8372	36.8666	47.6599	40.7639	37.6009	32.2581	46.9547	69.7283	56.2722	49.5075	40.64	53.26	0.0380
57 *2061*	61.2901	53.2651	37.9191	37.6961	48.7323	41.6811	38.4469	32.9839	48.0112	71.2972	57.5383	50.6214	41.56	54.46	0.0389
58 *2062*	63.0902	54.8295	39.0328	38.5442	49.8287	42.6189	39.3119	33.7260	49.0914	72.9014	58.8329	51.7604	42.49	55.68	0.0398
59 *2063*	64.9431	56.4399	40.1792	39.4115	50.9499	43.5778	40.1964	34.4849	50.1960	74.5417	60.1566	52.9250	43.45	56.94	0.0407
60 *2064*	66.8505	58.0975	41.3593	40.2983	52.0963	44.5583	41.1009	35.2608	51.3254	76.2189	61.5102	54.1158	44.43	58.22	0.0416
61 *2065*	68.8139	59.8038	42.5740	41.2050	53.2684	45.5609	42.0256	36.0542	52.4802	77.9338	62.8941	55.3334	45.42	59.53	0.0425

*Avoided Costs for the Vermont Societal Test include an adder ($/MMBTU) that was provided by the VDPS. The adder for each fuel type can be found in Appendix F (Modeling Assumptions).

Appendix G - Electric Avoided Costs							
		Electric Energy - Region - Vermont				Electric Capacity - Region Vermont	
		Seasonal Avoided Energy in Nominal $				Seasonal Avoided	
	Years	Winter Peak Energy (¢/kWh)	Winter Off-Peak Energy (¢/kWh)	Summer Peak Energy (¢/kWh)	Summer Off-Peak Energy (¢/kWh)	Summer Generation ($/kW)	Winter Generation ($/kW)
1	*2005*	8.5576	7.2112	8.1787	6.0479	3.6164	0.0000
2	*2006*	9.8296	8.2013	9.1375	7.0557	37.1674	0.0000
3	*2007*	10.3045	8.5883	9.6917	7.3476	43.1614	0.0000
4	*2008*	8.9473	7.2735	8.7129	6.2834	66.9585	0.0000
5	*2009*	7.6327	6.2052	7.2136	5.2887	73.1956	0.0000
6	*2010*	6.8399	5.6276	6.4466	4.8366	78.0962	0.0000
7	*2011*	7.1666	5.9376	6.7272	5.1222	83.3323	0.0000
8	*2012*	7.5095	6.2658	7.0205	5.4261	88.9259	0.0000
9	*2013*	7.7429	6.4705	7.2570	5.6020	91.1303	0.0000
10	*2014*	7.9836	6.6821	7.5016	5.7837	93.5531	0.0000
11	*2015*	8.2319	6.9006	7.7546	5.9714	96.0403	0.0000
12	*2016*	8.4879	7.1265	8.0162	6.1653	98.5936	0.0000
13	*2017*	8.9011	7.5057	8.4826	6.5389	100.1788	0.0000
14	*2018*	9.3353	7.9063	8.9776	6.9369	101.7894	0.0000
15	*2019*	9.7914	8.3294	9.5031	7.3609	103.4259	0.0000
16	*2020*	10.2706	8.7763	10.0609	7.8128	105.0888	0.0000
17	*2021*	10.6042	9.0542	10.4043	8.0848	107.9468	0.0000
18	*2022*	10.9487	9.3410	10.7597	8.3665	110.8825	0.0000
19	*2023*	11.3045	9.6370	11.1274	8.6582	113.8980	0.0000
20	*2024*	11.6720	9.9425	11.5078	8.9603	116.9956	0.0000
21	*2025*	12.0516	10.2577	11.9014	9.2731	120.1773	0.0000
22	*2026*	12.4437	10.5831	12.3086	9.5970	123.4457	0.0000
23	*2027*	12.8486	10.9190	12.7300	9.9326	126.8029	0.0000
24	*2028*	13.2669	11.2656	13.1660	10.2800	130.2514	0.0000
25	*2029*	13.6990	11.6233	13.6171	10.6399	133.7937	0.0000
26	*2030*	14.1453	11.9926	14.0839	11.0126	137.4323	0.0000
27	*2031*	14.4579	12.2315	14.4672	11.2254	130.1015	0.0000
28	*2032*	14.7774	12.4753	14.8610	11.4424	123.1616	0.0000
29	*2033*	15.1040	12.7239	15.2656	11.6635	116.5920	0.0000
30	*2034*	15.4377	12.9775	15.6812	11.8890	110.3728	0.0000
31	*2035*	15.7789	13.2361	16.1081	12.1188	104.4853	0.0000
32	*2036*	16.1276	13.5000	16.5467	12.3531	98.9119	0.0000
33	*2037*	16.4840	13.7690	16.9973	12.5919	93.6358	0.0000
34	*2038*	16.8483	14.0435	17.4602	12.8353	88.6411	0.0000
35	*2039*	17.2206	14.3235	17.9357	13.0835	83.9129	0.0000
36	*2040*	17.6080	14.6457	18.3393	13.3779	79.4368	0.0000
37	*2041*	18.0042	14.9753	18.7519	13.6789	81.2242	0.0000
38	*2042*	18.4093	15.3122	19.1738	13.9867	83.0517	0.0000
39	*2043*	18.8235	15.6567	19.6052	14.3014	84.9204	0.0000
40	*2044*	19.2471	16.0090	20.0463	14.6232	86.8311	0.0000
41	*2045*	19.6801	16.3692	20.4974	14.9522	88.7848	0.0000
42	*2046*	20.1229	16.7375	20.9586	15.2886	90.7824	0.0000
43	*2047*	20.5757	17.1141	21.4301	15.6326	92.8250	0.0000
44	*2048*	21.0386	17.4992	21.9123	15.9844	94.9136	0.0000

Table G-2

Appendix G - Electric Avoided Costs							
		Electric Energy - Region - Vermont				Electric Capacity - Region Vermont	
		Seasonal Avoided Energy in Nominal $				Seasonal Avoided	
		Winter Peak Energy	Winter Off-Peak Energy	Summer Peak Energy	Summer Off-Peak Energy	Summer Generation	Winter Generation
	Years	(¢/kWh)	(¢/kWh)	(¢/kWh)	(¢/kWh)	($/kW)	($/kW)
45	*2049*	21.5120	17.8929	22.4053	16.3440	97.0492	0.0000
46	*2050*	21.9960	18.2955	22.9095	16.7117	99.2328	0.0000
47	*2051*	22.4909	18.7072	23.4249	17.0878	101.4655	0.0000
48	*2052*	22.9970	19.1281	23.9520	17.4722	103.7485	0.0000
49	*2053*	23.5144	19.5584	24.4909	17.8654	106.0828	0.0000
50	*2054*	24.0435	19.9985	25.0420	18.2673	108.4697	0.0000
51	*2055*	24.5845	20.4485	25.6054	18.6783	110.9102	0.0000
52	*2056*	25.1376	20.9086	26.1815	19.0986	113.4057	0.0000
53	*2057*	25.7032	21.3790	26.7706	19.5283	115.9574	0.0000
54	*2058*	26.2815	21.8600	27.3729	19.9677	118.5664	0.0000
55	*2059*	26.8729	22.3519	27.9888	20.4170	121.2341	0.0000
56	*2060*	27.4775	22.8548	28.6186	20.8764	123.9619	0.0000
57	*2061*	28.0958	23.3690	29.2625	21.3461	126.7510	0.0000
58	*2062*	28.7279	23.8948	29.9209	21.8264	129.6029	0.0000
59	*2063*	29.3743	24.4325	30.5941	22.3175	132.5190	0.0000
60	*2064*	30.0352	24.9822	31.2825	22.8196	135.5007	0.0000
61	*2065*	30.7110	25.5443	31.9863	23.3330	138.5495	0.0000

Table G-2

Appendix G - Forecast of Avoided Costs								
		Natural Gas in Nominal $ - Region Vermont						
		Commerical & Industrial			Residential			
		Non-Heating	Heating	All	Heating Retrofit	New Heating	Hot Water	All
	Years	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)
1	*2005*	11.3708	11.3705	11.3707	12.4793	12.4035	12.4038	12.4290
2	*2006*	12.1158	12.0922	12.1040	13.2267	13.1484	13.1721	13.1824
3	*2007*	12.0340	11.9385	11.9863	13.0942	13.0185	13.1141	13.0754
4	*2008*	10.2037	10.1836	10.1936	11.3610	11.2879	11.3080	11.3190
5	*2009*	9.3719	9.3980	9.3849	10.6000	10.5271	10.5010	10.5429
6	*2010*	8.7558	8.8378	8.7968	10.0664	9.9924	9.9104	9.9901
7	*2011*	9.0226	9.1069	9.0647	10.3633	10.2874	10.2031	10.2850
8	*2012*	9.4646	9.5521	9.5084	10.8378	10.7592	10.6717	10.7566
9	*2013*	9.9066	9.9974	9.9520	11.3128	11.2317	11.1408	11.2289
10	*2014*	10.8182	10.9149	10.8665	12.2626	12.1769	12.0802	12.1737
11	*2015*	10.5596	10.6556	10.6076	12.0317	11.9461	11.8500	11.9431
12	*2016*	10.8257	10.9241	10.8749	12.3313	12.2436	12.1451	12.2405
13	*2017*	11.0335	11.1339	11.0837	12.5726	12.4830	12.3826	12.4799
14	*2018*	11.4779	11.5817	11.5298	13.0535	12.9612	12.8574	12.9579
15	*2019*	11.9828	12.0903	12.0365	13.5962	13.5008	13.3933	13.4973
16	*2020*	12.4329	12.5439	12.4884	14.0843	13.9861	13.8752	13.9824
17	*2021*	13.1321	13.2479	13.1900	14.8247	14.7227	14.6068	14.7186
18	*2022*	13.5604	13.6796	13.6200	15.2923	15.1875	15.0683	15.1833
19	*2023*	14.3906	14.5154	14.4530	16.1665	16.0572	15.9324	16.0527
20	*2024*	14.8572	14.9857	14.9215	16.6745	16.5622	16.4338	16.5574
21	*2025*	15.9319	16.0674	15.9997	17.7971	17.6795	17.5439	17.6741
22	*2026*	16.2904	16.4290	16.3597	18.1975	18.0772	17.9387	18.0718
23	*2027*	16.6569	16.7986	16.7278	18.6070	18.4840	18.3423	18.4784
24	*2028*	17.0317	17.1766	17.1042	19.0256	18.8999	18.7550	18.8942
25	*2029*	17.4149	17.5631	17.4890	19.4537	19.3251	19.1770	19.3193
26	*2030*	17.8068	17.9582	17.8825	19.8914	19.7599	19.6085	19.7540
27	*2031*	18.2074	18.3623	18.2849	20.3390	20.2045	20.0497	20.1985
28	*2032*	18.6171	18.7754	18.6963	20.7966	20.6591	20.5008	20.6529
29	*2033*	19.0360	19.1979	19.1169	21.2645	21.1240	20.9621	21.1176
30	*2034*	19.4643	19.6298	19.5471	21.7430	21.5993	21.4337	21.5928
31	*2035*	19.9022	20.0715	19.9869	22.2322	22.0852	21.9160	22.0786
32	*2036*	20.3500	20.5231	20.4366	22.7324	22.5822	22.4091	22.5754
33	*2037*	20.8079	20.9849	20.8964	23.2439	23.0902	22.9133	23.0833
34	*2038*	21.2761	21.4570	21.3666	23.7669	23.6098	23.4288	23.6027
35	*2039*	21.7548	21.9398	21.8473	24.3017	24.1410	23.9560	24.1338
36	*2040*	22.2443	22.4335	22.3389	24.8484	24.6842	24.4950	24.6768
37	*2041*	22.7448	22.9382	22.8415	25.4075	25.2396	25.0461	25.2320
38	*2042*	23.2565	23.4543	23.3554	25.9792	25.8075	25.6096	25.7997
39	*2043*	23.7798	23.9821	23.8809	26.5637	26.3881	26.1859	26.3802
40	*2044*	24.3149	24.5217	24.4183	27.1614	26.9819	26.7750	26.9738
41	*2045*	24.8619	25.0734	24.9677	27.7725	27.5889	27.3775	27.5807
42	*2046*	25.4213	25.6376	25.5294	28.3974	28.2097	27.9935	28.2012
43	*2047*	25.9933	26.2144	26.1039	29.0364	28.8444	28.6233	28.8358
44	*2048*	26.5782	26.8042	26.6912	29.6897	29.4934	29.2674	29.4846
45	*2049*	27.1762	27.4073	27.2917	30.3577	30.1570	29.9259	30.1480

Table G-3

Appendix G - Forecast of Avoided Costs								
		Natural Gas in Nominal $ - Region Vermont						
		Commerical & Industrial			Residential			
		Non-Heating	Heating	All	Heating Retrofit	New Heating	Hot Water	All
	Years	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)
46	*2050*	27.7876	28.0240	27.9058	31.0408	30.8356	30.5992	30.8263
47	*2051*	28.4129	28.6545	28.5337	31.7392	31.5294	31.2877	31.5199
48	*2052*	29.0521	29.2992	29.1757	32.4533	32.2388	31.9917	32.2291
49	*2053*	29.7058	29.9585	29.8321	33.1835	32.9641	32.7115	32.9542
50	*2054*	30.3742	30.6325	30.5034	33.9301	33.7058	33.4475	33.6957
51	*2055*	31.0576	31.3218	31.1897	34.6936	34.4642	34.2000	34.4539
52	*2056*	31.7564	32.0265	31.8915	35.4742	35.2397	34.9696	35.2291
53	*2057*	32.4709	32.7471	32.6090	36.2723	36.0325	35.7564	36.0217
54	*2058*	33.2015	33.4839	33.3427	37.0885	36.8433	36.5609	36.8322
55	*2059*	33.9486	34.2373	34.0929	37.9229	37.6723	37.3835	37.6609
56	*2060*	34.7124	35.0077	34.8600	38.7762	38.5199	38.2246	38.5083
57	*2061*	35.4934	35.7953	35.6444	39.6487	39.3866	39.0847	39.3748
58	*2062*	36.2920	36.6007	36.4464	40.5408	40.2728	39.9641	40.2607
59	*2063*	37.1086	37.4242	37.2664	41.4529	41.1789	40.8633	41.1666
60	*2064*	37.9436	38.2663	38.1049	42.3856	42.1054	41.7827	42.0928
61	*2065*	38.7973	39.1273	38.9623	43.3393	43.0528	42.7228	43.0399

Table G-3

Appendix G - Retail Rate and Avoided Costs of Fuel Oil, Propane, Kerosene, and Wooc															
		Electric Retail Rate			Nat. Gas Retail Rate	Central New England Forecast by Sector and Fuel					Other in Nominal $ Central New England Forecast by Sector					Other
						Fuel Oil in Nominal $					Propane in Nominal $			Wood in Nominal $		
		Residential	Commercial	Industrial	All	Res. Distillate	Com. #2 Oil	Com. #4 Oil	Ind. #6 Oil	Kerosene	Residential	Commercial	Industrial	Greenwood	Seasoned	Water
	Years	(¢/kWh)	(¢/kWh)	(¢/kWh)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBTU)	($/MMBTU)	($/gallon)
1	*2005*	13.0600	11.3500	8.0800	10.8728	12.3312	10.3030	9.3727	7.8013	12.3173	19.2418	15.2842	13.2946	8.04	10.54	0.0025
2	*2006*	13.0017	11.2994	8.0439	11.5928	12.7614	10.6876	9.7364	8.1296	12.5494	19.8276	15.7809	13.7465	8.39	10.99	0.0114
3	*2007*	13.5226	11.7520	8.3662	11.4562	12.6766	10.5560	9.5834	7.9405	12.4597	19.9017	15.7639	13.6838	8.75	11.47	0.0117
4	*2008*	13.7886	11.9832	8.5308	9.6581	12.7716	10.6033	9.6088	7.9290	12.5499	20.1593	15.9284	13.8015	9.13	11.96	0.0120
5	*2009*	13.8035	11.9962	8.5400	8.8413	13.2777	11.0607	10.0438	8.3262	13.0510	20.8316	16.5056	14.3308	9.52	12.47	0.0122
6	*2010*	14.1003	12.2541	8.7236	8.2460	14.0985	11.8316	10.7918	9.0355	13.8666	21.8223	17.3990	15.1752	9.93	13.01	0.0125
7	*2011*	14.3373	12.4600	8.8702	8.5016	14.0751	11.7572	10.6940	8.8982	13.8381	21.9728	17.4499	15.1761	10.35	13.57	0.0128
8	*2012*	15.3064	13.3023	9.4698	8.9329	14.0519	11.6818	10.5947	8.7585	13.8095	22.1272	17.5026	15.1776	10.80	14.15	0.0131
9	*2013*	15.5136	13.4823	9.5980	9.3639	14.0204	11.5970	10.4855	8.6079	13.7726	22.2775	17.5487	15.1715	11.26	14.76	0.0134
10	*2014*	15.8287	13.7562	9.7930	10.2660	13.9803	11.5024	10.3658	8.4460	13.7269	22.4231	17.5880	15.1573	11.75	15.39	0.0137
11	*2015*	16.1845	14.0654	10.0131	9.9930	13.9096	11.3760	10.2138	8.2509	13.6505	22.5424	17.5985	15.1131	12.25	16.05	0.0140
12	*2016*	16.7048	14.5176	10.3350	10.2465	14.2830	11.6924	10.5041	8.4969	14.0181	23.1101	18.0549	15.5136	12.78	16.74	0.0143
13	*2017*	17.2610	15.0009	10.6791	10.4411	14.7636	12.1146	10.8996	8.8473	14.4927	23.7892	18.6203	16.0218	13.32	17.46	0.0146
14	*2018*	17.8057	15.4743	11.0161	10.8730	15.2585	12.5499	11.3075	9.2091	14.9815	24.4872	19.2020	16.5450	13.90	18.21	0.0149
15	*2019*	18.3902	15.9823	11.3777	11.3652	15.7681	12.9986	11.7283	9.5826	15.4849	25.2045	19.8003	17.0836	14.49	18.99	0.0153
16	*2020*	19.0176	16.5275	11.7659	11.8022	16.2929	13.4610	12.1621	9.9682	16.0033	25.9416	20.4158	17.6380	15.12	19.81	0.0156
17	*2021*	19.5101	16.9556	12.0706	12.4889	16.8332	13.9377	12.6096	10.3662	16.5371	26.6990	21.0490	18.2086	15.77	20.66	0.0160
18	*2022*	20.0142	17.3936	12.3824	12.9033	17.3896	14.4289	13.0709	10.7771	17.0868	27.4773	21.7002	18.7959	16.44	21.55	0.0163
19	*2023*	20.5332	17.8447	12.7035	13.7208	17.9624	14.9351	13.5465	11.2011	17.6528	28.2771	22.3700	19.4003	17.15	22.47	0.0167
20	*2024*	21.0676	18.3092	13.0342	14.1730	18.5521	15.4567	14.0369	11.6387	18.2355	29.0989	29.0989	20.0224	17.89	23.44	0.0171
21	*2025*	21.6180	18.7875	13.3747	15.2353	19.1592	15.9941	14.5424	12.0902	18.8355	29.9433	29.9433	20.6625	18.65	24.44	0.0175
22	*2026*	22.2529	19.3393	13.7675	15.5781	19.5902	16.3540	14.8696	12.3622	19.2593	30.6170	24.3021	21.1275	19.07	24.99	0.0179
23	*2027*	22.9065	19.9073	14.1719	15.9286	20.0310	16.7219	15.2041	12.6404	19.6926	31.3059	24.8489	21.6028	19.50	25.56	0.0183
24	*2028*	23.5793	20.4919	14.5881	16.2870	20.4817	17.0982	15.5462	12.9248	20.1357	32.0103	25.4080	22.0889	19.94	26.13	0.0187
25	*2029*	24.2718	21.0938	15.0166	16.6534	20.9426	17.4829	15.8960	13.2156	20.5888	32.7305	25.9797	22.5859	20.39	26.72	0.0191
26	*2030*	24.9847	21.7133	15.4576	17.0281	21.4138	17.8762	16.2537	13.5129	21.0520	33.4670	26.5642	23.0941	20.85	27.32	0.0195
27	*2031*	25.7185	22.3510	15.9116	17.4113	21.8956	18.2785	16.6194	13.8170	21.5257	34.2200	27.1619	23.6137	21.32	27.94	0.0200
28	*2032*	26.4738	23.0075	16.3789	17.8030	22.3882	18.6897	16.9933	14.1279	22.0100	34.9899	27.7731	24.1450	21.80	28.56	0.0204
29	*2033*	27.2513	23.6832	16.8599	18.2036	22.8920	19.1102	17.3757	14.4458	22.5052	35.7772	28.3980	24.6883	22.29	29.21	0.0209
30	*2034*	28.0517	24.3788	17.3551	18.6132	23.4070	19.5402	17.7666	14.7708	23.0116	36.5822	29.0369	25.2437	22.79	29.86	0.0213
31	*2035*	28.8756	25.0948	17.8648	19.0320	23.9337	19.9799	18.1664	15.1031	23.5294	37.4053	29.6902	25.8117	23.30	30.54	0.0218
32	*2036*	29.7237	25.8318	18.3895	19.4602	24.4722	20.4294	18.5751	15.4429	24.0588	38.2469	30.3583	26.3925	23.83	31.22	0.0223
33	*2037*	30.5967	26.5905	18.9296	19.8981	25.0228	20.8891	18.9931	15.7904	24.6001	39.1075	31.0413	26.9863	24.36	31.93	0.0228
34	*2038*	31.4953	27.3715	19.4856	20.3458	25.5858	21.3591	19.4204	16.1457	25.1536	39.9874	31.7398	27.5935	24.91	32.64	0.0233
35	*2039*	32.4203	28.1754	20.0579	20.8035	26.1615	21.8397	19.8574	16.5090	25.7196	40.8871	32.4539	28.2144	25.47	33.38	0.0238
36	*2040*	33.3725	29.0029	20.6470	21.2716	26.7502	22.3311	20.3041	16.8804	26.2983	41.8070	33.1841	28.8492	26.04	34.13	0.0244
37	*2041*	34.3526	29.8547	21.2534	21.7502	27.3520	22.8335	20.7610	17.2602	26.8900	42.7477	33.9308	29.4983	26.63	34.90	0.0249
38	*2042*	35.3616	30.7315	21.8776	22.2396	27.9675	23.3473	21.2281	17.6486	27.4950	43.7095	34.6942	30.1620	27.23	35.68	0.0255
39	*2043*	36.4001	31.6341	22.5201	22.7400	28.5967	23.8726	21.7057	18.0457	28.1136	44.6930	35.4748	30.8407	27.84	36.49	0.0261
40	*2044*	37.4692	32.5632	23.1816	23.2517	29.2402	24.4097	22.1941	18.4517	28.7462	45.6986	36.2730	31.5346	28.47	37.31	0.0266
41	*2045*	38.5697	33.5196	23.8624	23.7748	29.8981	24.9589	22.6935	18.8669	29.3930	46.7268	37.0891	32.2441	29.11	38.15	0.0272
42	*2046*	39.7025	34.5041	24.5632	24.3097	30.5708	25.5205	23.2041	19.2914	30.0543	47.7782	37.9237	32.9696	29.76	39.00	0.0279
43	*2047*	40.8685	35.5175	25.2847	24.8567	31.2586	26.0947	23.7262	19.7254	30.7305	48.8532	38.7769	33.7114	30.43	39.88	0.0285
44	*2048*	42.0688	36.5606	26.0273	25.4160	31.9619	26.6819	24.2600	20.1693	31.4220	49.9524	39.6494	34.4699	31.12	40.78	0.0291

Appendix G - Retail Rate and Avoided Costs of Fuel Oil, Propane, Kerosene, and Wooc															
		Electric Retail Rate			Nat. Gas Retail Rate	Central New England Forecast by Sector and Fuel					Other in Nominal $ Central New England Forecast by Sector					Other
						Fuel Oil in Nominal $					Propane in Nominal $			Wood in Nominal $		
		Residential	Commercial	Industrial	All	Res. Distillate	Com. #2 Oil	Com. #4 Oil	Ind. #6 Oil	Kerosene	Residential	Commercial	Industrial	Greenwood	Seasoned	Water
	Years	(¢/kWh)	(¢/kWh)	(¢/kWh)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBTU)	($/MMBTU)	($/gallon)
45	*2049*	43.3044	37.6344	26.7917	25.9879	32.6811	27.2822	24.8059	20.6231	32.1290	51.0763	40.5415	35.2455	31.82	41.70	0.0298
46	*2050*	44.5763	38.7397	27.5786	26.5726	33.4164	27.8961	25.3640	21.0871	32.8519	52.2255	41.4537	36.0385	32.53	42.63	0.0305
47	*2051*	45.8855	39.8775	28.3886	27.1705	34.1683	28.5237	25.9347	21.5615	33.5910	53.4006	42.3864	36.8494	33.27	43.59	0.0311
48	*2052*	47.2331	41.0487	29.2223	27.7818	34.9370	29.1655	26.5182	22.0467	34.3468	54.6021	43.3401	37.6785	34.01	44.57	0.0318
49	*2053*	48.6204	42.2543	30.0806	28.4069	35.7231	29.8217	27.1149	22.5427	35.1196	55.8306	44.3153	38.5263	34.78	45.58	0.0326
50	*2054*	50.0483	43.4953	30.9641	29.0460	36.5269	30.4927	27.7250	23.0499	35.9098	57.0868	45.3124	39.3931	35.56	46.60	0.0333
51	*2055*	51.5183	44.7728	31.8735	29.6996	37.3488	31.1788	28.3488	23.5686	36.7178	58.3713	46.3319	40.2794	36.36	47.65	0.0340
52	*2056*	53.0313	46.0877	32.8096	30.3678	38.1891	31.8803	28.9866	24.0989	37.5439	59.6846	47.3744	41.1857	37.18	48.72	0.0348
53	*2057*	54.5889	47.4413	33.7732	31.0511	39.0484	32.5976	29.6388	24.6411	38.3887	61.0275	48.4403	42.1124	38.02	49.82	0.0356
54	*2058*	56.1922	48.8347	34.7651	31.7497	39.9269	33.3311	30.3057	25.1955	39.2524	62.4007	49.5302	43.0599	38.87	50.94	0.0364
55	*2059*	57.8425	50.2690	35.7862	32.4641	40.8253	34.0810	30.9876	25.7624	40.1356	63.8047	50.6446	44.0288	39.75	52.09	0.0372
56	*2060*	59.5414	51.7454	36.8372	33.1946	41.7439	34.8478	31.6848	26.3421	41.0387	65.2403	51.7841	45.0194	40.64	53.26	0.0380
57	*2061*	61.2901	53.2651	37.9191	33.9414	42.6831	35.6319	32.3977	26.9348	41.9620	66.7082	52.9493	46.0324	41.56	54.46	0.0389
58	*2062*	63.0902	54.8295	39.0328	34.7051	43.6435	36.4336	33.1267	27.5408	42.9062	68.2091	54.1406	47.0681	42.49	55.68	0.0398
59	*2063*	64.9431	56.4399	40.1792	35.4860	44.6255	37.2534	33.8720	28.1605	43.8716	69.7438	55.3588	48.1271	43.45	56.94	0.0407
60	*2064*	66.8505	58.0975	41.3593	36.2844	45.6295	38.0916	34.6341	28.7941	44.8587	71.3131	56.6044	49.2100	44.43	58.22	0.0416
61	*2065*	68.8139	59.8038	42.5740	37.1008	46.6562	38.9487	35.4134	29.4419	45.8680	72.9176	57.8780	50.3172	45.42	59.53	0.0425

Appendix G - Electric Avoided Costs							
		Electric Energy - Region - Vermont				Electric Capacity - Region Vermont	
		Seasonal Avoided Energy in Nominal $				Seasonal Avoided	
	Years	Winter Peak Energy (¢/kWh)	Winter Off-Peak Energy (¢/kWh)	Summer Peak Energy (¢/kWh)	Summer Off-Peak Energy (¢/kWh)	Summer Generation ($/kW)	Winter Generation ($/kW)
1	*2005*	7.7000	6.4012	7.3687	5.2379	3.6164	0.0000
2	*2006*	9.0013	7.3730	8.3093	6.2275	37.1674	0.0000
3	*2007*	9.4577	7.7415	8.8449	6.5007	43.1614	0.0000
4	*2008*	8.0814	6.4076	7.8470	5.4175	66.9585	0.0000
5	*2009*	6.7473	5.3198	6.3282	4.4033	73.1956	0.0000
6	*2010*	5.9346	4.7223	5.5413	3.9312	78.0962	0.0000
7	*2011*	6.2409	5.0119	5.8016	4.1965	83.3323	0.0000
8	*2012*	6.5630	5.3193	6.0740	4.4796	88.9259	0.0000
9	*2013*	6.7751	5.5027	6.2892	4.6342	91.1303	0.0000
10	*2014*	6.9940	5.6925	6.5120	4.7941	93.5531	0.0000
11	*2015*	7.2200	5.8888	6.7427	4.9596	96.0403	0.0000
12	*2016*	7.4533	6.0918	6.9816	5.1307	98.5936	0.0000
13	*2017*	7.8432	6.4478	7.4247	5.4810	100.1788	0.0000
14	*2018*	8.2536	6.8246	7.8959	5.8552	101.7894	0.0000
15	*2019*	8.6853	7.2233	8.3970	6.2549	103.4259	0.0000
16	*2020*	9.1397	7.6454	8.9300	6.6819	105.0888	0.0000
17	*2021*	9.4478	7.8979	9.2480	6.9285	107.9468	0.0000
18	*2022*	9.7663	8.1586	9.5773	7.1841	110.8825	0.0000
19	*2023*	10.0955	8.4280	9.9184	7.4492	113.8980	0.0000
20	*2024*	10.4358	8.7063	10.2716	7.7241	116.9956	0.0000
21	*2025*	10.7876	8.9937	10.6373	8.0091	120.1773	0.0000
22	*2026*	11.1512	9.2907	11.0162	8.3046	123.4457	0.0000
23	*2027*	11.5271	9.5974	11.4085	8.6110	126.8029	0.0000
24	*2028*	11.9157	9.9143	11.8147	8.9288	130.2514	0.0000
25	*2029*	12.3173	10.2416	12.2355	9.2582	133.7937	0.0000
26	*2030*	12.7326	10.5798	12.6712	9.5998	137.4323	0.0000
27	*2031*	13.0134	10.7870	13.0227	9.7809	130.1015	0.0000
28	*2032*	13.3004	10.9982	13.3840	9.9653	123.1616	0.0000
29	*2033*	13.5937	11.2136	13.7553	10.1532	116.5920	0.0000
30	*2034*	13.8935	11.4332	14.1369	10.3447	110.3728	0.0000
31	*2035*	14.1999	11.6571	14.5291	10.5398	104.4853	0.0000
32	*2036*	14.5130	11.8854	14.9322	10.7385	98.9119	0.0000
33	*2037*	14.8331	12.1182	15.3464	10.9410	93.6358	0.0000
34	*2038*	15.1602	12.3555	15.7722	11.1473	88.6411	0.0000
35	*2039*	15.4946	12.5975	16.2097	11.3576	83.9129	0.0000
36	*2040*	15.8363	12.8442	16.6594	11.5717	79.4368	0.0000
37	*2041*	16.1926	13.1332	17.0343	11.8321	81.2242	0.0000
38	*2042*	16.5570	13.4287	17.4175	12.0983	83.0517	0.0000
39	*2043*	16.9295	13.7308	17.8094	12.3705	84.9204	0.0000
40	*2044*	17.3104	14.0398	18.2101	12.6489	86.8311	0.0000
41	*2045*	17.6999	14.3556	18.6199	12.9335	88.7848	0.0000
42	*2046*	18.0981	14.6787	19.0388	13.2245	90.7824	0.0000
43	*2047*	18.5054	15.0089	19.4672	13.5220	92.8250	0.0000
44	*2048*	18.9217	15.3466	19.9052	13.8263	94.9136	0.0000

Table G-5

Appendix G - Electric Avoided Costs							
		Electric Energy - Region - Vermont				Electric Capacity - Region Vermont	
		Seasonal Avoided Energy in Nominal $				Seasonal Avoided	
		Winter Peak Energy	Winter Off-Peak Energy	Summer Peak Energy	Summer Off-Peak Energy	Summer Generation	Winter Generation
	Years	(¢/kWh)	(¢/kWh)	(¢/kWh)	(¢/kWh)	($/kW)	($/kW)
45	*2049*	19.3475	15.6919	20.3531	14.1373	97.0492	0.0000
46	*2050*	19.7828	16.0450	20.8110	14.4554	99.2328	0.0000
47	*2051*	20.2279	16.4060	21.2792	14.7807	101.4655	0.0000
48	*2052*	20.6830	16.7751	21.7580	15.1133	103.7485	0.0000
49	*2053*	21.1484	17.1526	22.2476	15.4533	106.0828	0.0000
50	*2054*	21.6242	17.5385	22.7482	15.8010	108.4697	0.0000
51	*2055*	22.1108	17.9331	23.2600	16.1565	110.9102	0.0000
52	*2056*	22.6083	18.3366	23.7833	16.5200	113.4057	0.0000
53	*2057*	23.1169	18.7492	24.3185	16.8917	115.9574	0.0000
54	*2058*	23.6371	19.1711	24.8656	17.2718	118.5664	0.0000
55	*2059*	24.1689	19.6024	25.4251	17.6604	121.2341	0.0000
56	*2060*	24.7127	20.0435	25.9972	18.0578	123.9619	0.0000
57	*2061*	25.2687	20.4944	26.5821	18.4641	126.7510	0.0000
58	*2062*	25.8373	20.9556	27.1802	18.8795	129.6029	0.0000
59	*2063*	26.4186	21.4271	27.7918	19.3043	132.5190	0.0000
60	*2064*	27.0131	21.9092	28.4171	19.7387	135.5007	0.0000
61	*2065*	27.6208	22.4021	29.0565	20.1828	138.5495	0.0000

Table G-5

Appendix G - Natural Gas Avoided Costs								
		Natural Gas in Nominal $ - Region Vermont						
		Commerical & Industrial			Residential			
	Years	Non-Heating ($/MMBtu)	Heating ($/MMBtu)	All ($/MMBtu)	Heating Retrofit ($/MMBtu)	New Heating ($/MMBtu)	Hot Water ($/MMBtu)	All ($/MMBtu)
1	*2005*	10.2908	10.2905	10.2907	11.3993	11.3235	11.3238	11.3490
2	*2006*	11.0115	10.9879	10.9997	12.1224	12.0441	12.0678	12.0781
3	*2007*	10.9049	10.8094	10.8571	11.9650	11.8894	11.9849	11.9463
4	*2008*	9.0491	9.0291	9.0391	10.2065	10.1334	10.1534	10.1645
5	*2009*	8.1913	8.2174	8.2044	9.4195	9.3466	9.3205	9.3624
6	*2010*	7.5487	7.6308	7.5897	8.8593	8.7853	8.7033	8.7830
7	*2011*	7.7883	7.8726	7.8305	9.1291	9.0532	8.9689	9.0508
8	*2012*	8.2026	8.2901	8.2463	9.5757	9.4972	9.4097	9.4946
9	*2013*	8.6162	8.7070	8.6616	10.0224	9.9412	9.8504	9.9385
10	*2014*	9.4987	9.5954	9.5471	10.9432	10.8575	10.7607	10.8543
11	*2015*	9.2104	9.3065	9.2585	10.6826	10.5969	10.5008	10.5939
12	*2016*	9.4462	9.5446	9.4954	10.9518	10.8641	10.7657	10.8610
13	*2017*	9.6229	9.7233	9.6731	11.1620	11.0725	10.9721	11.0694
14	*2018*	10.0356	10.1394	10.0875	11.6112	11.5189	11.4151	11.5156
15	*2019*	10.5081	10.6156	10.5618	12.1215	12.0261	11.9186	12.0226
16	*2020*	10.9250	11.0359	10.9805	12.5764	12.4782	12.3673	12.4745
17	*2021*	11.5903	11.7061	11.6482	13.2829	13.1808	13.0650	13.1768
18	*2022*	11.9839	12.1031	12.0435	13.7158	13.6110	13.4918	13.6068
19	*2023*	12.7786	12.9034	12.8410	14.5545	14.4453	14.3204	14.4407
20	*2024*	13.2090	13.3374	13.2732	15.0262	14.9139	14.7855	14.9092
21	*2025*	14.2466	14.3821	14.3143	16.1118	15.9941	15.8586	15.9888
22	*2026*	14.5671	14.7057	14.6364	16.4743	16.3540	16.2154	16.3485
23	*2027*	14.8949	15.0366	14.9657	16.8449	16.7219	16.5803	16.7164
24	*2028*	15.2300	15.3749	15.3025	17.2240	17.0982	16.9533	17.0925
25	*2029*	15.5727	15.7208	15.6468	17.6115	17.4829	17.3348	17.4771
26	*2030*	15.9231	16.0745	15.9988	18.0077	17.8763	17.7248	17.8703
27	*2031*	16.2814	16.4362	16.3588	18.4129	18.2785	18.1236	18.2724
28	*2032*	16.6477	16.8060	16.7269	18.8272	18.6897	18.5314	18.6835
29	*2033*	17.0223	17.1842	17.1032	19.2508	19.1103	18.9483	19.1039
30	*2034*	17.4053	17.5708	17.4880	19.6840	19.5402	19.3747	19.5338
31	*2035*	17.7969	17.9662	17.8815	20.1269	19.9799	19.8106	19.9733
32	*2036*	18.1973	18.3704	18.2839	20.5797	20.4294	20.2563	20.4227
33	*2037*	18.6068	18.7837	18.6952	21.0428	20.8891	20.7121	20.8822
34	*2038*	19.0254	19.2064	19.1159	21.5162	21.3591	21.1781	21.3520
35	*2039*	19.4535	19.6385	19.5460	22.0003	21.8397	21.6546	21.8324
36	*2040*	19.8912	20.0804	19.9858	22.4953	22.3311	22.1419	22.3237
37	*2041*	20.3387	20.5322	20.4355	23.0015	22.8335	22.6401	22.8260
38	*2042*	20.7964	20.9942	20.8953	23.5190	23.3473	23.1495	23.3395
39	*2043*	21.2643	21.4665	21.3654	24.0482	23.8726	23.6703	23.8647
40	*2044*	21.7427	21.9495	21.8461	24.5893	24.4097	24.2029	24.4016
41	*2045*	22.2319	22.4434	22.3377	25.1425	24.9589	24.7475	24.9507
42	*2046*	22.7322	22.9484	22.8403	25.7082	25.5205	25.3043	25.5121
43	*2047*	23.2436	23.4647	23.3542	26.2867	26.0947	25.8736	26.0861
44	*2048*	23.7666	23.9927	23.8796	26.8781	26.6819	26.4558	26.6730
45	*2049*	24.3014	24.5325	24.4169	27.4829	27.2822	27.0511	27.2732

Table G-6

Appendix G - Natural Gas Avoided Costs								
		Natural Gas in Nominal $ - Region Vermont						
		Commerical & Industrial			Residential			
		Non-Heating	Heating	All	Heating Retrofit	New Heating	Hot Water	All
	Years	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)	($/MMBtu)
46	*2050*	24.8481	25.0845	24.9663	28.1013	27.8961	27.6597	27.8868
47	*2051*	25.4072	25.6489	25.5280	28.7335	28.5237	28.2821	28.5143
48	*2052*	25.9789	26.2260	26.1024	29.3800	29.1655	28.9184	29.1558
49	*2053*	26.5634	26.8161	26.6897	30.0411	29.8217	29.5691	29.8118
50	*2054*	27.1611	27.4194	27.2903	30.7170	30.4927	30.2344	30.4826
51	*2055*	27.7722	28.0364	27.9043	31.4081	31.1788	30.9146	31.1685
52	*2056*	28.3971	28.6672	28.5321	32.1148	31.8803	31.6102	31.8697
53	*2057*	29.0360	29.3122	29.1741	32.8374	32.5976	32.3214	32.5868
54	*2058*	29.6893	29.9717	29.8305	33.5763	33.3311	33.0487	33.3200
55	*2059*	30.3573	30.6461	30.5017	34.3317	34.0810	33.7923	34.0697
56	*2060*	31.0404	31.3356	31.1880	35.1042	34.8478	34.5526	34.8363
57	*2061*	31.7388	32.0407	31.8897	35.8940	35.6319	35.3300	35.6201
58	*2062*	32.4529	32.7616	32.6072	36.7016	36.4336	36.1250	36.4216
59	*2063*	33.1831	33.4987	33.3409	37.5274	37.2534	36.9378	37.2410
60	*2064*	33.9297	34.2524	34.0911	38.3718	38.0916	37.7689	38.0790
61	*2065*	34.6931	35.0231	34.8581	39.2352	38.9487	38.6187	38.9357

Table G-6

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APPENDIX H:

ENERGY CONSUMPTION FORECASTS FOR VERMONT FOR OIL, PROPANE, KEROSENE, AND WOOD

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
PROJECTED STATE FUEL CONSUMPTION BY SECTOR
(TRILLION BTU)

	Residential				Commercial				Industrial			
Year	Distillate Fuel Oil	Kerosene	LPG	Wood	Distillate Fuel Oil	Kerosene	LPG	Wood	Distillate Fuel Oil	Kerosene	LPG	Wood
1990	13.35	1.09	4.02	1.98	3.90	0.07	0.71	0.22	3.23	0.10	0.31	1.96
1991	13.73	1.40	4.29	2.08	4.72	0.09	0.76	0.23	3.01	0.06	0.82	2.73
1992	14.84	1.19	5.16	2.18	5.52	0.08	0.91	0.24	3.44	0.04	0.82	2.53
1993	14.73	1.33	4.34	2.28	4.64	0.19	0.77	0.31	3.18	0.05	0.78	2.56
1994	14.05	1.04	4.46	2.17	4.99	0.11	0.79	0.29	2.25	0.07	0.72	2.75
1995	13.52	1.02	4.43	2.17	4.03	0.08	0.78	0.30	1.91	0.05	0.80	3.04
1996	13.79	1.15	4.98	2.25	4.63	0.08	0.88	0.31	1.90	0.13	0.71	2.82
1997	13.45	1.35	4.44	1.63	4.95	0.12	0.78	0.27	2.01	0.13	0.28	3.14
1998	11.70	1.85	5.01	1.45	5.46	0.18	0.88	0.24	2.21	0.86	0.52	2.63
1999	11.74	1.49	4.90	1.53	5.51	0.20	0.87	0.25	2.38	0.33	0.07	2.40
2000	14.27	1.85	4.74	1.64	6.06	0.13	0.84	0.27	2.22	0.54	0.80	2.90
2001	12.93	1.82	6.52	1.30	5.88	0.20	1.15	0.23	2.13	0.26	1.09	2.50
2002	12.31	1.06	6.52	1.32	5.04	0.09	1.15	0.23	1.97	0.09	0.83	1.21
2003	13.40	1.57	5.32	1.38	5.49	0.12	0.94	0.24	2.52	0.40	0.51	1.10
2004	15.70	2.30	5.60	1.66	6.00	0.20	1.00	0.23	3.40	0.30	0.50	1.16
2005	13.93	1.73	5.99	1.64	5.97	0.17	1.07	0.23	3.18	0.36	0.61	1.16
2006	13.96	1.75	6.07	1.62	5.98	0.17	1.12	0.23	3.04	0.37	0.64	1.16
2007	14.01	1.79	6.20	1.57	6.01	0.18	1.15	0.23	2.96	0.37	0.65	1.16
2008	14.08	1.84	6.37	1.52	6.06	0.18	1.18	0.23	2.91	0.39	0.65	1.16
2009	14.14	1.88	6.51	1.47	6.12	0.19	1.21	0.23	2.88	0.40	0.66	1.16
2010	14.20	1.92	6.65	1.43	6.19	0.19	1.23	0.23	2.86	0.41	0.67	1.16
2011	14.26	1.96	6.80	1.39	6.27	0.19	1.26	0.23	2.85	0.43	0.67	1.16
2012	14.33	2.01	6.97	1.33	6.35	0.20	1.29	0.23	2.85	0.44	0.68	1.16
2013	14.40	2.06	7.14	1.28	6.42	0.20	1.32	0.23	2.85	0.46	0.68	1.16
2014	14.46	2.10	7.29	1.24	6.50	0.21	1.34	0.23	2.85	0.47	0.69	1.16
2015	14.51	2.14	7.43	1.20	6.58	0.21	1.37	0.23	2.86	0.49	0.69	1.16
2016	14.56	2.17	7.54	1.16	6.65	0.22	1.40	0.23	2.86	0.50	0.70	1.16
2017	14.60	2.20	7.65	1.13	6.73	0.22	1.42	0.23	2.86	0.51	0.70	1.16
2018	14.65	2.23	7.75	1.10	6.82	0.22	1.45	0.23	2.87	0.53	0.71	1.16
2019	14.69	2.26	7.86	1.07	6.91	0.23	1.49	0.23	2.87	0.54	0.71	1.16
2020	14.73	2.29	7.96	1.04	7.01	0.24	1.52	0.23	2.88	0.55	0.72	1.16
2021	14.77	2.32	8.06	1.01	7.10	0.24	1.55	0.23	2.89	0.57	0.73	1.16
2022	14.80	2.34	8.13	0.99	7.19	0.25	1.58	0.23	2.89	0.58	0.73	1.16
2023	14.83	2.36	8.21	0.97	7.28	0.25	1.61	0.23	2.90	0.59	0.74	1.16
COMPOUND GROWTH RATES												
'94-'99	-3.5%	7.5%	1.9%	-6.8%	2.0%	13.1%	1.9%	-3.2%	1.2%	38.2%	-37.3%	-2.7%
'99-'04	6.0%	9.1%	2.7%	1.6%	1.7%	0.0%	2.9%	-1.3%	7.4%	-1.9%	48.1%	-13.6%
'04-'09	-2.07%	-3.95%	3.07%	-2.31%	0.41%	-1.51%	3.80%	0.00%	-3.27%	5.95%	5.72%	0.00%
'09-'14	0.44%	2.26%	2.28%	-3.45%	1.20%	2.24%	2.18%	0.00%	-0.18%	3.34%	0.84%	0.00%
'14-'19	0.32%	1.50%	1.51%	-2.87%	1.24%	2.12%	2.05%	0.00%	0.15%	2.70%	0.75%	0.00%
'04-'23	-0.30%	0.14%	2.03%	-2.78%	1.03%	1.19%	2.55%	0.00%	-0.84%	3.66%	2.06%	0.00%

Note: Historical data from the Energy Information Administration
Projected data based on regional forecasts developed by the Energy Information Administration

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
PROJECTED STATE FUEL CONSUMPTION BY SECTOR
MODEL SPECIFICATIONS SUMMARY

Sector	Fuel	Driver	AR-Term	First Hist. Year	R-Squared	Adjusted R-Squared	F-Statistic	Probability (F-Statistic)	t-Statistic	p-Value	MAPE
Residential	Distillate Fuel Oil	Households	No	1981	0.150	0.112	3.89	6.12%	1.973	6.25%	8.68%
Residential	Kerosene	Households	No	1990	0.355	0.305	7.14	1.92%	2.672	2.17%	17.26%
Residential	LPG	Households	No	1980	0.900	0.895	206.55	0.00%	14.372	0.00%	10.58%
Residential	Wood	Households	No	1975	0.740	0.734	130.61	0.00%	-11.428	0.00%	17.01%
Commercial	Distillate Fuel Oil	Employment	Yes	1975	0.760	0.742	41.25	0.00%	3.639	0.13%	8.69%
Commercial	Kerosene	Employment	No	1990	0.229	0.170	3.86	7.12%	1.965	7.52%	29.95%
Commercial	LPG	Employment	Yes	1980	0.892	0.881	86.42	0.00%	7.612	0.00%	9.56%
Industrial	Distillate Fuel Oil	Gross State Product	Yes	1977	0.368	0.316	7.00	0.40%	0.131	89.69%	14.31%
Industrial	Kerosene	Gross State Product	No	1981	0.183	0.146	4.94	3.69%	2.222	3.80%	107.72%
Industrial	LPG	Gross State Product	Yes	1984	0.108	0.003	1.02	38.00%	0.312	75.92%	71.62%

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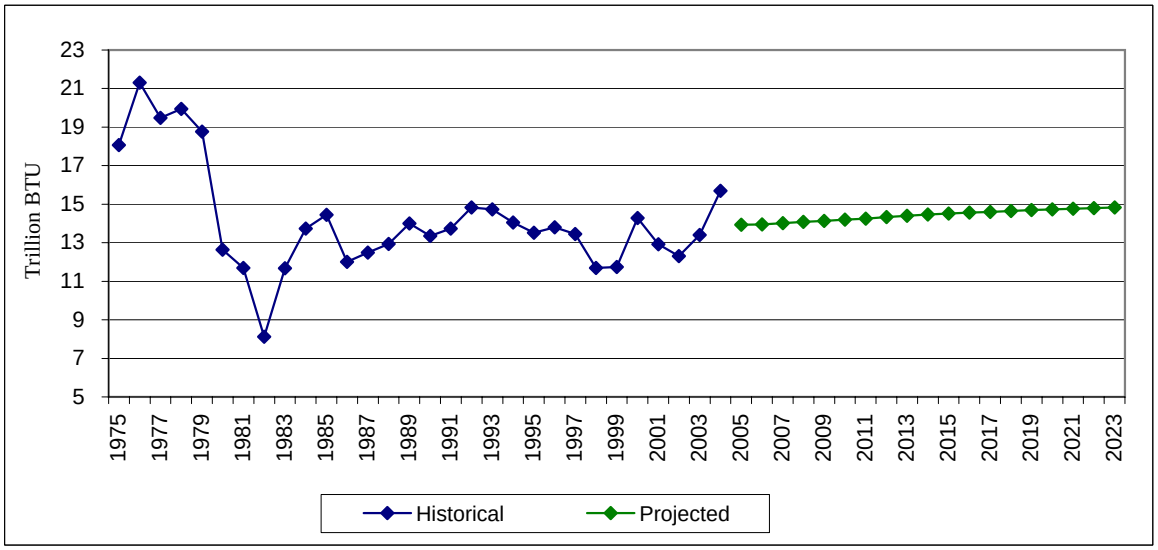
APPENDIX H1:

RESIDENTIAL FORECAST

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

RESIDENTIAL - Distillate Fuel Oil

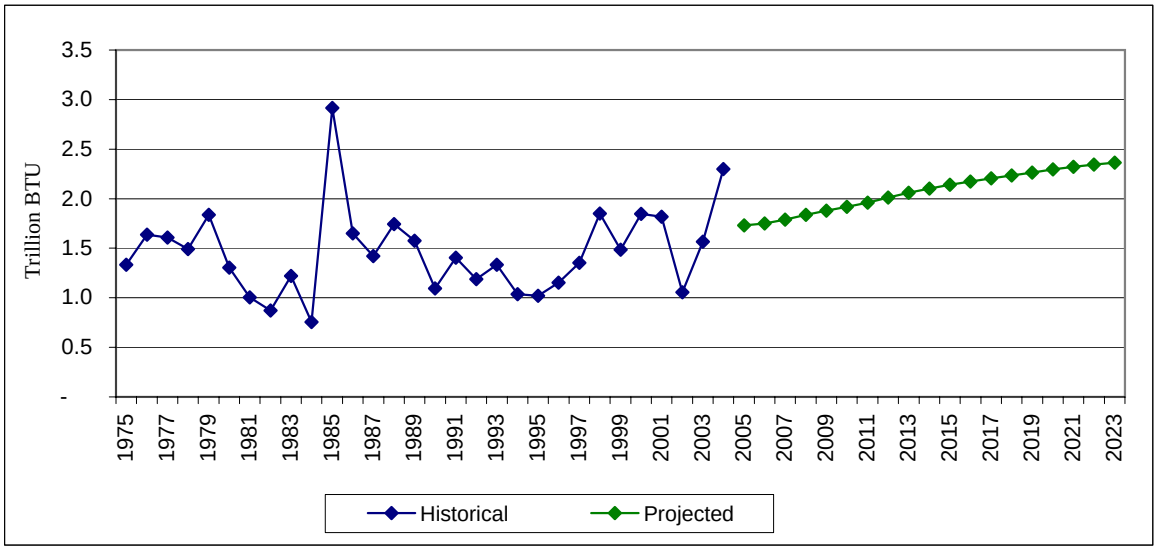


Year	Historical	Growth
1975	18.06	
1976	21.30	17.9%
1977	19.48	-8.5%
1978	19.94	2.4%
1979	18.77	-5.9%
1980	12.65	-32.6%
1981	11.70	-7.5%
1982	8.13	-30.5%
1983	11.67	43.7%
1984	13.73	17.6%
1985	14.46	5.3%
1986	12.00	-17.0%
1987	12.49	4.0%
1988	12.94	3.7%
1989	14.01	8.2%
1990	13.35	-4.7%
1991	13.73	2.8%
1992	14.84	8.1%
1993	14.73	-0.7%
1994	14.05	-4.6%
1995	13.52	-3.8%
1996	13.79	2.0%
1997	13.45	-2.5%
1998	11.70	-13.0%
1999	11.74	0.4%
2000	14.27	21.5%
2001	12.93	-9.4%
2002	12.31	-4.8%
2003	13.40	8.9%
2004	15.70	17.1%

Year	Projected	Growth
2005	13.93	-11.3%
2006	13.96	0.2%
2007	14.01	0.4%
2008	14.08	0.5%
2009	14.14	0.4%
2010	14.20	0.4%
2011	14.26	0.4%
2012	14.33	0.5%
2013	14.40	0.5%
2014	14.46	0.4%
2015	14.51	0.4%
2016	14.56	0.3%
2017	14.60	0.3%
2018	14.65	0.3%
2019	14.69	0.3%
2020	14.73	0.3%
2021	14.77	0.3%
2022	14.80	0.2%
2023	14.83	0.2%

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

RESIDENTIAL - Kerosene

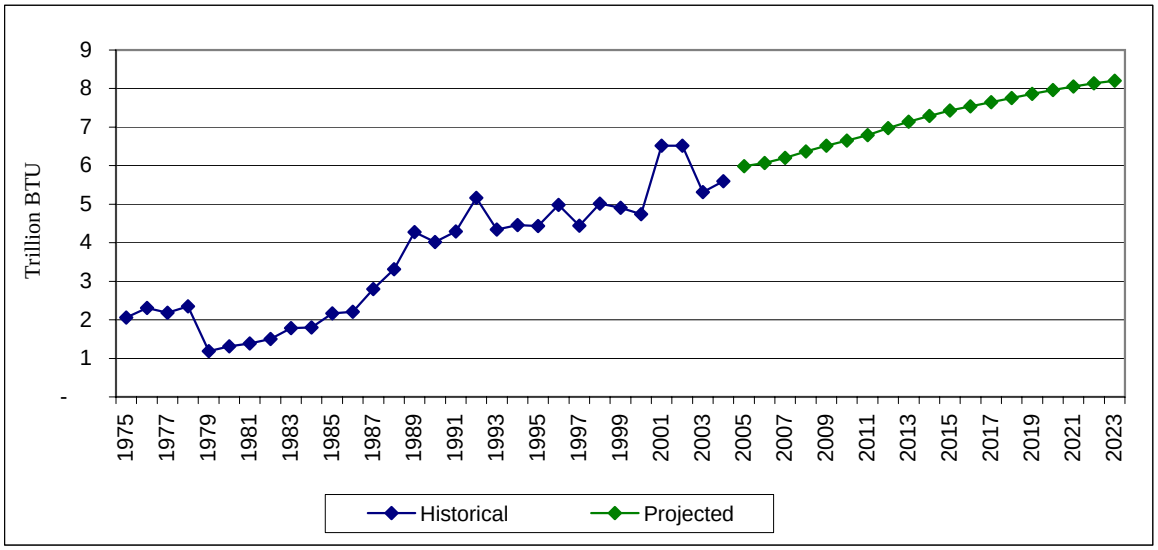


Year	Historical	Growth
1975	1.33	
1976	1.64	22.9%
1977	1.61	-1.8%
1978	1.49	-7.2%
1979	1.84	23.2%
1980	1.30	-29.0%
1981	1.00	-23.0%
1982	0.87	-13.0%
1983	1.22	39.6%
1984	0.76	-37.9%
1985	2.92	285.5%
1986	1.65	-43.5%
1987	1.42	-13.7%
1988	1.74	22.6%
1989	1.57	-9.7%
1990	1.09	-30.5%
1991	1.40	28.2%
1992	1.19	-15.3%
1993	1.33	12.1%
1994	1.04	-22.3%
1995	1.02	-1.5%
1996	1.15	12.9%
1997	1.35	17.2%
1998	1.85	36.8%
1999	1.49	-19.7%
2000	1.85	24.5%
2001	1.82	-1.7%
2002	1.06	-41.9%
2003	1.57	48.3%
2004	2.30	46.9%

Year	Projected	Growth
2005	1.73	-24.8%
2006	1.75	1.3%
2007	1.79	2.2%
2008	1.84	2.6%
2009	1.88	2.3%
2010	1.92	2.1%
2011	1.96	2.1%
2012	2.01	2.6%
2013	2.06	2.4%
2014	2.10	2.1%
2015	2.14	1.9%
2016	2.17	1.5%
2017	2.20	1.4%
2018	2.23	1.4%
2019	2.26	1.4%
2020	2.29	1.3%
2021	2.32	1.1%
2022	2.34	1.0%
2023	2.36	0.9%

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

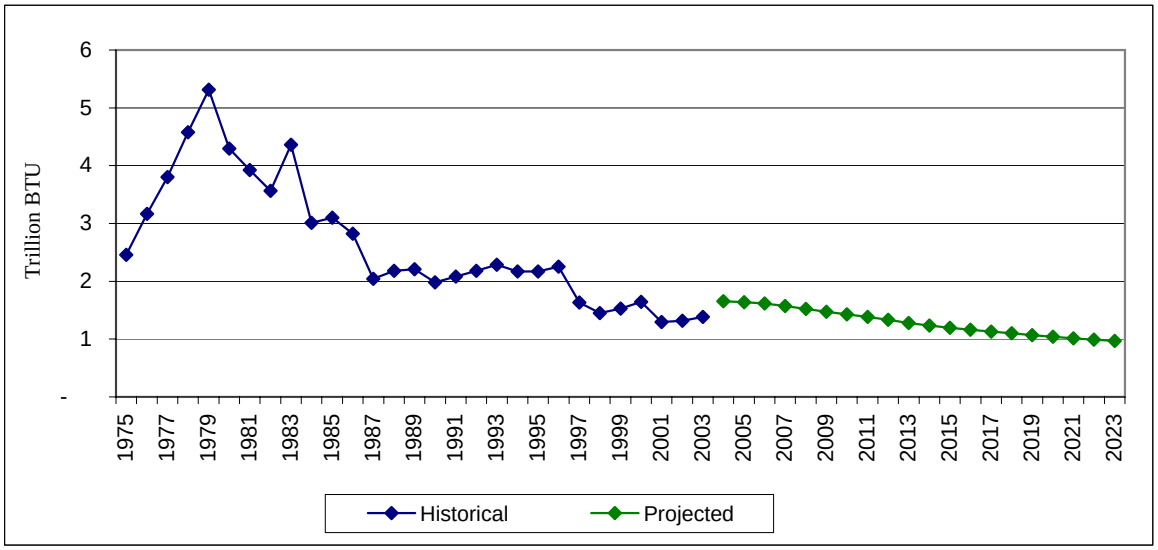
RESIDENTIAL - LPG



Year	Historical	Growth	Year	Projected	Growth
1975	2.06		2005	5.99	6.9%
1976	2.31	12.0%	2006	6.07	1.3%
1977	2.19	-5.4%	2007	6.20	2.2%
1978	2.35	7.7%	2008	6.37	2.6%
1979	1.19	-49.4%	2009	6.51	2.3%
1980	1.31	9.8%	2010	6.65	2.1%
1981	1.39	6.1%	2011	6.80	2.2%
1982	1.50	8.5%	2012	6.97	2.6%
1983	1.79	18.9%	2013	7.14	2.4%
1984	1.80	0.9%	2014	7.29	2.1%
1985	2.17	20.1%	2015	7.43	1.9%
1986	2.21	2.1%	2016	7.54	1.5%
1987	2.80	26.5%	2017	7.65	1.4%
1988	3.31	18.4%	2018	7.75	1.4%
1989	4.27	29.1%	2019	7.86	1.4%
1990	4.02	-5.9%	2020	7.96	1.3%
1991	4.29	6.7%	2021	8.06	1.1%
1992	5.16	20.2%	2022	8.13	1.0%
1993	4.34	-15.9%	2023	8.21	0.9%
1994	4.46	2.8%			
1995	4.43	-0.7%			
1996	4.98	12.4%			
1997	4.44	-10.8%			
1998	5.01	12.9%			
1999	4.90	-2.2%			
2000	4.74	-3.3%			
2001	6.52	37.5%			
2002	6.52	0.0%			
2003	5.32	-18.4%			
2004	5.60	5.3%			

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

RESIDENTIAL - Wood



Year	Historical	Growth
1975	2.46	
1976	3.16	28.7%
1977	3.80	20.1%
1978	4.58	20.4%
1979	5.31	16.2%
1980	4.30	-19.2%
1981	3.93	-8.6%
1982	3.56	-9.3%
1983	4.36	22.4%
1984	3.01	-31.0%
1985	3.10	3.0%
1986	2.82	-8.9%
1987	2.04	-27.6%
1988	2.18	6.7%
1989	2.21	1.1%
1990	1.98	-10.1%
1991	2.08	4.8%
1992	2.18	4.9%
1993	2.28	4.7%
1994	2.17	-5.1%
1995	2.17	0.0%
1996	2.25	3.8%
1997	1.63	-27.5%
1998	1.45	-11.1%
1999	1.53	5.3%
2000	1.64	7.5%
2001	1.30	-21.0%
2002	1.32	1.5%
2003	1.38	5.3%

Year	Projected	Growth
2004	1.66	19.6%
2005	1.64	-0.9%
2006	1.62	-1.5%
2007	1.57	-2.7%
2008	1.52	-3.3%
2009	1.47	-3.1%
2010	1.43	-2.9%
2011	1.39	-3.1%
2012	1.33	-3.9%
2013	1.28	-3.8%
2014	1.24	-3.5%
2015	1.20	-3.3%
2016	1.16	-2.8%
2017	1.13	-2.7%
2018	1.10	-2.8%
2019	1.07	-2.8%
2020	1.04	-2.8%
2021	1.01	-2.5%
2022	0.99	-2.2%
2023	0.97	-2.1%

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
RESIDENTIAL FUEL CONSUMPTION - RAW DATA
(TRILLION BTU)

Year	Vermont Households	Distillate Fuel Oil	Kerosene	LPG	Wood
1975	153.82	18.06	1.33	2.06	2.46
1976	158.03	21.30	1.64	2.31	3.16
1977	162.97	19.48	1.61	2.19	3.80
1978	167.81	19.94	1.49	2.35	4.58
1979	173.17	18.77	1.84	1.19	5.31
1980	178.72	12.65	1.30	1.31	4.30
1981	181.01	11.70	1.00	1.39	3.93
1982	183.51	8.13	0.87	1.50	3.56
1983	186.28	11.67	1.22	1.79	4.36
1984	188.80	13.73	0.76	1.80	3.01
1985	191.36	14.46	2.92	2.17	3.10
1986	194.19	12.00	1.65	2.21	2.82
1987	197.86	12.49	1.42	2.80	2.04
1988	202.80	12.94	1.74	3.31	2.18
1989	207.24	14.01	1.57	4.27	2.21
1990	211.41	13.35	1.09	4.02	1.98
1991	213.97	13.73	1.40	4.29	2.08
1992	216.69	14.84	1.19	5.16	2.18
1993	219.75	14.73	1.33	4.34	2.28
1994	223.27	14.05	1.04	4.46	2.17
1995	226.47	13.52	1.02	4.43	2.17
1996	229.52	13.79	1.15	4.98	2.25
1997	232.16	13.45	1.35	4.44	1.63
1998	234.68	11.70	1.85	5.01	1.45
1999	237.66	11.74	1.49	4.90	1.53
2000	241.07	14.27	1.85	4.74	1.64
2001	242.21	12.93	1.82	6.52	1.30
2002	243.58	12.31	1.06	6.52	1.32
2003	244.69	13.40	1.57	5.32	1.38
2004	245.54	15.70	2.30	5.60	-
2005	246.26				
2006	247.40				
2007	249.43				
2008	251.88				
2009	254.10				
2010	256.15				
2011	258.29				
2012	260.95				
2013	263.44				
2014	265.69				
2015	267.72				
2016	269.39				
2017	271.00				
2018	272.59				
2019	274.17				
2020	275.72				
2021	277.09				
2022	278.26				
2023	279.35				

SOURCE: Fuel Data: Energy Information Administration.
Household Data: REMI Model

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT RESIDENTIAL DISTILLATE FUEL OIL

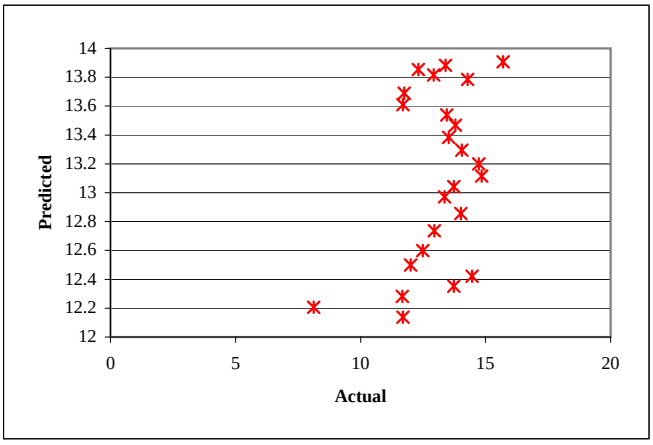
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	7.18	3.02	2.4	2.76%
Res.Hholds	Vermont Households	0.027	0.014	2.0	6.25%

Summary Model Statistics:

R-Squared	0.150
Adjusted R-Squared	0.112
Durbin-Watson Statistic	1.268
Mean Abs. % Err. (MAPE)	8.68%

Adjusted Observations	24
Deg. of Freedom for Error	22
F-Statistic	3.89
Prob (F-Statistic)	6.1%
Bayesian Information Criterian (BIC)	0.91
Model Sum of Squares	8.1
Sum of Squared Errors	45.8
Mean Squared Error	2.08
Std. Error of Regression	1.44
Mean Abs. Dev. (MAD)	1.05

Predicted vs. Actual



VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT RESIDENTIAL KEROSENE

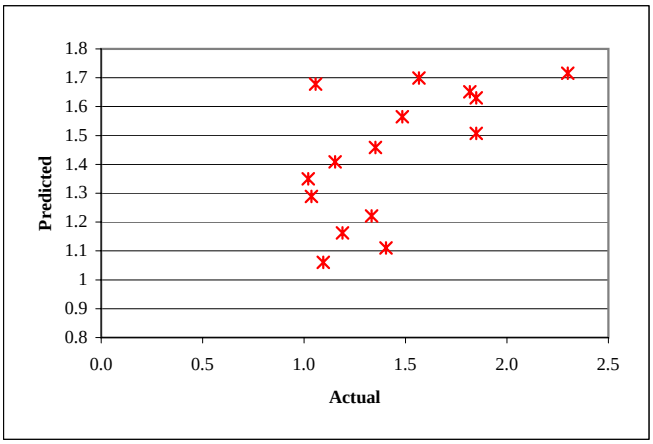
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	(2.99)	1.66	(1.80)	9.85%
Res.Hholds	Vermont Households	0.02	0.01	2.67	2.17%

Summary Model Statistics:

R-Squared	0.355
Adjusted R-Squared	0.305
Durbin-Watson Statistic	1.666
Mean Abs. % Err. (MAPE)	17.26%

Adjusted Observations	15
Deg. of Freedom for Error	13
F-Statistic	7.1
Prob (F-Statistic)	2%
Bayesian Information Criterian (BIC)	(2.09)
Model Sum of Squares	0.7
Sum of Squared Errors	1.3
Mean Squared Error	0.10
Std. Error of Regression	0.32
Mean Abs. Dev. (MAD)	0.24

Predicted vs. Actual



VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT RESIDENTIAL LPG

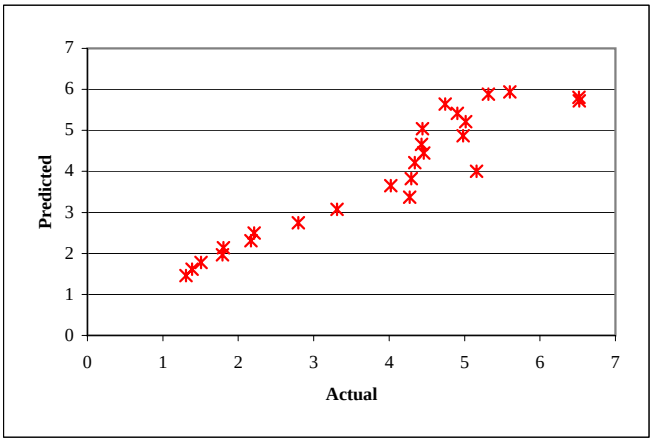
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	(10.52)	1.01	(10.4)	0.00%
Res.Hholds	Vermont Households	0.067	0.005	14.4	0.00%

Summary Model Statistics:

R-Squared	0.900
Adjusted R-Squared	0.895
Durbin-Watson Statistic	1.347
Mean Abs. % Err. (MAPE)	10.58%

Adjusted Observations	25
Deg. of Freedom for Error	23
F-Statistic	207
Prob (F-Statistic)	0.0%
Bayesian Information Criterian (BIC)	(1.16)
Model Sum of Squares	55
Sum of Squared Errors	6
Mean Squared Error	0.26
Std. Error of Regression	0.51
Mean Abs. Dev. (MAD)	0.40

Predicted vs. Actual



VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT RESIDENTIAL WOOD

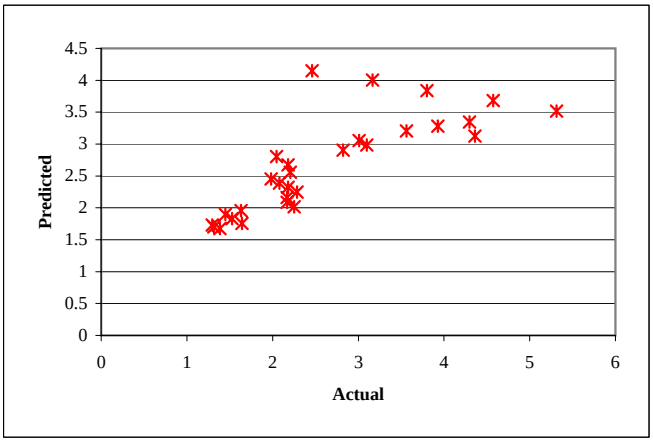
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	30.97	2.53	12.3	0.00%
Res.Hholds.exp1	Log of Households	(5.327)	0.466	(11.4)	0.00%

Summary Model Statistics:

R-Squared	0.740
Adjusted R-Squared	0.734
Durbin-Watson Statistic	0.557
Mean Abs. % Err. (MAPE)	17.01%

Adjusted Observations	48
Deg. of Freedom for Error	46
F-Statistic	131
Prob (F-Statistic)	0.0%
Bayesian Information Criterian (BIC)	(1.09)
Model Sum of Squares	39
Sum of Squared Errors	14
Mean Squared Error	0.30
Std. Error of Regression	0.55
Mean Abs. Dev. (MAD)	0.37

Predicted vs. Actual



FUEL OIL END USE ANALYSIS
RESIDENTIAL SECTOR

Item	Units	Note	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
WATER HEATING																					
Total Households in Vermont	Houses	[1]	246,255	247,400	249,431	251,880	254,103	256,155	258,289	260,950	263,441	265,686	267,716	269,394	271,000	272,590	274,171	275,724	277,087	278,264	279,347
Appliance Unit Market Share	%	[2]	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%	29.1%
Households With Primary Fuel	Houses	[3]	71,733	72,067	72,658	73,372	74,019	74,617	75,239	76,014	76,740	77,393	77,985	78,474	78,941	79,404	79,865	80,317	80,715	81,057	81,373
Energy Consumption per Household	MMBTU	[4]	30.5	30.5	30.4	30.4	30.4	30.3	30.3	30.3	30.3	30.3	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
State Total Energy Consumption for End-Use	MMBTU	[5]	2,187,868	2,195,784	2,211,412	2,230,510	2,247,843	2,263,826	2,280,721	2,302,458	2,322,889	2,341,380	2,358,299	2,372,427	2,386,259	2,400,283	2,414,249	2,427,960	2,439,994	2,450,380	2,459,903
National Projected Efficiency	EF	[6]	0.546	0.547	0.547	0.548	0.548	0.549	0.549	0.550	0.550	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551
Change in Efficiency	%			0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SPACE HEATING																					
Total Households in Vermont	Houses	[1]	246,255	247,400	249,431	251,880	254,103	256,155	258,289	260,950	263,441	265,686	267,716	269,394	271,000	272,590	274,171	275,724	277,087	278,264	279,347
Appliance Unit Market Share	%	[2]	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%	53.6%
Households With Primary Fuel	Houses	[3]	132,086	132,700	133,789	135,103	136,295	137,396	138,541	139,968	141,304	142,508	143,598	144,497	145,359	146,211	147,060	147,893	148,624	149,255	149,836
Energy Consumption per Household	MMBTU	[7]	106.6	106.2	105.8	105.5	105.3	105.2	105.0	104.8	104.7	104.6	104.5	104.5	104.4	104.3	104.3	104.3	104.3	104.2	104.2
State Total Energy Consumption for End-Use	MMBTU	[5]	14,077,201	14,086,756	14,156,740	14,259,935	14,358,099	14,448,158	14,546,518	14,673,512	14,795,891	14,907,491	15,009,381	15,093,048	15,174,802	15,256,905	15,339,827	15,422,414	15,495,615	15,555,737	15,611,564
National Projected Efficiency	AFUE	[6]	0.810	0.814	0.816	0.818	0.820	0.821	0.823	0.824	0.825	0.826	0.826	0.827	0.827	0.828	0.828	0.828	0.828	0.829	0.829
Change in Efficiency	%			0.4%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL PROJECTED USAGE (TRILLION BTU)			**13.93**	**13.96**	**14.01**	**14.08**	**14.14**	**14.20**	**14.26**	**14.33**	**14.40**	**14.46**	**14.51**	**14.56**	**14.60**	**14.65**	**14.69**	**14.73**	**14.77**	**14.80**	**14.83**
WATER HEAT			**1.87**	**1.88**	**1.89**	**1.90**	**1.91**	**1.92**	**1.93**	**1.94**	**1.95**	**1.96**	**1.97**	**1.98**	**1.98**	**1.99**	**2.00**	**2.00**	**2.01**	**2.01**	**2.02**
SPACE HEAT			**12.05**	**12.08**	**12.12**	**12.18**	**12.23**	**12.27**	**12.32**	**12.39**	**12.44**	**12.50**	**12.54**	**12.58**	**12.62**	**12.66**	**12.69**	**12.73**	**12.76**	**12.79**	**12.81**
OTHER			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WATER HEAT MARKET SHARE OF CONSUMPTION			13.5%	13.5%	13.5%	13.5%	13.5%	13.5%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%	13.6%
SPACE HEAT MARKET SHARE OF CONSUMPTION			86.5%	86.5%	86.5%	86.5%	86.5%	86.5%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%	86.4%
OTHER MARKET SHARE OF CONSUMPTION			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

NOTES

[1] From REMI Economic Forecast
[2] 2005 value from "Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs" for Vermont Department of Public Service, prepared by KEMA, Inc.
[3] = [1] x [2]
[4] From "2001 Residential Energy Consumption Survey" by the Energy Information Administration. Data is for New England region.
[5] = [3] x [4]
[6] From Annual Energy Outlook 2006 from Energy Information Administration. Data is national.
[7] From "2001 Residential Energy Consumption Survey" by the Energy Information Administration, New England region, adjusted for Vermont Weather.

KEROSENE END USE ANALYSIS
RESIDENTIAL SECTOR

Item	Units	Note	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
WATER HEATING																					
Total Households in Vermont	Houses	[1]	246,255	247,400	249,431	251,880	254,103	256,155	258,289	260,950	263,441	265,686	267,716	269,394	271,000	272,590	274,171	275,724	277,087	278,264	279,347
Appliance Unit Market Share	%	[2]	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Households With Primary Fuel	Houses	[3]	1,750	1,758	1,772	1,790	1,805	1,820	1,835	1,854	1,872	1,888	1,902	1,914	1,925	1,937	1,948	1,959	1,969	1,977	1,985
Energy Consumption per Household	MMBTU	[4]	17.96	17.80	17.66	17.53	17.40	17.27	17.17	17.06	16.98	16.90	16.84	16.79	16.75	16.72	16.71	16.71	16.70	16.68	16.67
State Total Energy Consumption for End-Use	MMBTU	[5]	31,421	31,296	31,303	31,369	31,412	31,437	31,500	31,638	31,778	31,909	32,035	32,139	32,255	32,390	32,548	32,726	32,882	32,984	33,075
National Projected Efficiency	EF	[6]	0.552	0.557	0.561	0.566	0.570	0.574	0.578	0.581	0.584	0.586	0.589	0.590	0.592	0.593	0.593	0.593	0.593	0.594	0.595
Change in Efficiency	%			0.9%	0.8%	0.8%	0.7%	0.7%	0.6%	0.6%	0.5%	0.4%	0.4%	0.3%	0.2%	0.2%	0.1%	0.0%	0.0%	0.1%	0.1%
SPACE HEATING																					
Total Households in Vermont	Houses	[1]	246,255	247,400	249,431	251,880	254,103	256,155	258,289	260,950	263,441	265,686	267,716	269,394	271,000	272,590	274,171	275,724	277,087	278,264	279,347
Appliance Unit Market Share	%	[2]	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%
Households With Primary Fuel	Houses	[3]	17,917	18,000	18,148	18,326	18,488	18,637	18,793	18,986	19,167	19,331	19,479	19,601	19,717	19,833	19,948	20,061	20,160	20,246	20,325
Energy Consumption per Household	MMBTU	[7]	55.8	55.4	55.0	54.6	54.3	54.0	53.8	53.5	53.3	53.2	53.0	52.9	52.7	52.7	52.6	52.5	52.4	52.4	52.3
State Total Energy Consumption for End-Use	MMBTU	[5]	999,292	996,625	997,906	1,001,087	1,003,839	1,006,686	1,010,292	1,016,221	1,022,152	1,027,467	1,032,314	1,036,107	1,040,059	1,044,242	1,048,646	1,053,113	1,057,041	1,060,325	1,063,374
National Projected Efficiency	AFUE	[6]	0.805	0.811	0.816	0.822	0.827	0.831	0.835	0.839	0.842	0.844	0.847	0.849	0.851	0.852	0.854	0.855	0.856	0.857	0.858
Change in Efficiency	%			0.7%	0.7%	0.7%	0.6%	0.5%	0.5%	0.4%	0.4%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%
TOTAL PROJECTED USAGE (TRILLION BTU)			**1.73**	**1.75**	**1.79**	**1.84**	**1.88**	**1.92**	**1.96**	**2.01**	**2.06**	**2.10**	**2.14**	**2.17**	**2.20**	**2.23**	**2.26**	**2.29**	**2.32**	**2.34**	**2.36**
WATER HEAT			**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**
SPACE HEAT			**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.01**	**1.01**	**1.02**	**1.02**	**1.03**	**1.03**	**1.04**	**1.04**	**1.04**	**1.05**	**1.05**	**1.06**	**1.06**	**1.06**
OTHER			**0.70**	**0.72**	**0.76**	**0.80**	**0.84**	**0.88**	**0.92**	**0.96**	**1.00**	**1.04**	**1.08**	**1.10**	**1.13**	**1.16**	**1.18**	**1.21**	**1.23**	**1.25**	**1.27**
WATER HEAT MARKET SHARE OF CONSUMPTION			1.8%	1.8%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
SPACE HEAT MARKET SHARE OF CONSUMPTION			57.8%	56.9%	55.7%	54.5%	53.4%	52.5%	51.5%	50.5%	49.6%	48.9%	48.2%	47.7%	47.2%	46.7%	46.3%	45.9%	45.5%	45.3%	45.0%
OTHER MARKET SHARE OF CONSUMPTION			40.4%	41.3%	42.5%	43.8%	44.9%	45.9%	46.9%	47.9%	48.8%	49.6%	50.3%	50.8%	51.3%	51.8%	52.3%	52.7%	53.0%	53.3%	53.6%

NOTES

[1] From REMI Economic Forecast
[2] 2005 value from "Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs" for Vermont Department of Public Service, prepared by KEMA, Inc.
[3] = [1] x [2]
[4] From "2001 Residential Energy Consumption Survey" by the Energy Information Administration. Data is for New England region.
[5] = [3] x [4]
[6] From Annual Energy Outlook 2006 from Energy Information Administration. Data is national.
[7] From "2001 Residential Energy Consumption Survey" by the Energy Information Administration, New England region, adjusted for Vermont Weather.

LIQUID PROPANE GAS END USE ANALYSIS
RESIDENTIAL SECTOR

Item	Units	Note	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
WATER HEATING																					
Total Households in Vermont	Houses	[1]	246,255	247,400	249,431	251,880	254,103	256,155	258,289	260,950	263,441	265,686	267,716	269,394	271,000	272,590	274,171	275,724	277,087	278,264	279,347
Appliance Unit Market Share	%	[2]	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%	17.9%
Households With Primary Fuel	Houses	[3]	44,177	44,383	44,747	45,186	45,585	45,953	46,336	46,813	47,260	47,663	48,027	48,328	48,616	48,902	49,185	49,464	49,708	49,920	50,114
Energy Consumption per Household	MMBTU	[4]	19.1	18.9	18.8	18.6	18.5	18.4	18.2	18.1	18.1	18.0	17.9	17.9	17.9	17.8	17.8	17.8	17.8	17.8	17.7
State Total Energy Consumption for End-Use	MMBTU	[5]	843,786	839,942	839,922	841,642	842,661	843,299	844,997	849,187	853,460	857,487	861,375	864,682	868,266	872,225	876,750	881,721	886,073	887,915	889,402
National Projected Efficiency	EF	[6]	0.553	0.558	0.563	0.567	0.571	0.575	0.579	0.582	0.585	0.587	0.589	0.590	0.591	0.592	0.592	0.592	0.592	0.593	0.595
Change in Efficiency	%			0.9%	0.8%	0.8%	0.8%	0.7%	0.6%	0.5%	0.4%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%	0.2%
SPACE HEATING																					
Total Households in Vermont	Houses	[1]	246,255	247,400	249,431	251,880	254,103	256,155	258,289	260,950	263,441	265,686	267,716	269,394	271,000	272,590	274,171	275,724	277,087	278,264	279,347
Appliance Unit Market Share	%	[2]	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%
Households With Primary Fuel	Houses	[3]	36,251	36,419	36,718	37,079	37,406	37,708	38,022	38,414	38,781	39,111	39,410	39,657	39,893	40,127	40,360	40,589	40,789	40,963	41,122
Energy Consumption per Household	MMBTU	[7]	85.6	84.9	84.3	83.8	83.3	82.9	82.5	82.1	81.8	81.5	81.3	81.1	80.9	80.8	80.6	80.5	80.4	80.3	80.3
State Total Energy Consumption for End-Use	MMBTU	[5]	3,101,429	3,093,153	3,097,127	3,107,001	3,115,541	3,124,377	3,135,567	3,153,970	3,172,379	3,188,874	3,203,917	3,215,690	3,227,954	3,240,936	3,254,605	3,268,469	3,280,661	3,290,851	3,300,317
National Projected Efficiency	AFUE	[6]	0.805	0.811	0.816	0.822	0.827	0.831	0.835	0.839	0.842	0.844	0.847	0.849	0.851	0.852	0.854	0.855	0.856	0.857	0.858
Change in Efficiency	%			0.7%	0.7%	0.7%	0.6%	0.5%	0.5%	0.4%	0.4%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%
TOTAL PROJECTED USAGE (TRILLION BTU)			**5.99**	**6.07**	**6.20**	**6.37**	**6.51**	**6.65**	**6.80**	**6.97**	**7.14**	**7.29**	**7.43**	**7.54**	**7.65**	**7.75**	**7.86**	**7.96**	**8.06**	**8.13**	**8.21**
WATER HEAT			**0.84**	**0.84**	**0.84**	**0.84**	**0.84**	**0.84**	**0.84**	**0.85**	**0.85**	**0.86**	**0.86**	**0.86**	**0.87**	**0.87**	**0.88**	**0.88**	**0.89**	**0.89**	**0.89**
SPACE HEAT			**3.10**	**3.09**	**3.10**	**3.11**	**3.12**	**3.12**	**3.14**	**3.15**	**3.17**	**3.19**	**3.20**	**3.22**	**3.23**	**3.24**	**3.25**	**3.27**	**3.28**	**3.29**	**3.30**
OTHER			**2.04**	**2.13**	**2.26**	**2.42**	**2.56**	**2.68**	**2.81**	**2.97**	**3.11**	**3.24**	**3.36**	**3.46**	**3.55**	**3.64**	**3.73**	**3.81**	**3.89**	**3.96**	**4.02**
WATER HEAT MARKET SHARE OF CONSUMPTION			14.1%	13.8%	13.5%	13.2%	12.9%	12.7%	12.4%	12.2%	12.0%	11.8%	11.6%	11.5%	11.4%	11.2%	11.2%	11.1%	11.0%	10.9%	10.8%
SPACE HEAT MARKET SHARE OF CONSUMPTION			51.8%	51.0%	49.9%	48.8%	47.8%	47.0%	46.1%	45.2%	44.4%	43.7%	43.1%	42.7%	42.2%	41.8%	41.4%	41.0%	40.7%	40.5%	40.2%
OTHER MARKET SHARE OF CONSUMPTION			34.1%	35.2%	36.5%	38.0%	39.2%	40.4%	41.4%	42.6%	43.6%	44.5%	45.3%	45.9%	46.4%	47.0%	47.4%	47.9%	48.3%	48.6%	48.9%

NOTES

[1] From REMI Economic Forecast
[2] 2005 value from "Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs" for Vermont Department of Public Service, prepared by KEMA, Inc.
[3] = [1] x [2]
[4] From "2001 Residential Energy Consumption Survey" by the Energy Information Administration. Data is for New England region.
[5] = [3] x [4]
[6] From Annual Energy Outlook 2006 from Energy Information Administration. Data is national.
[7] From "2001 Residential Energy Consumption Survey" by the Energy Information Administration, New England region, adjusted for Vermont Weather.

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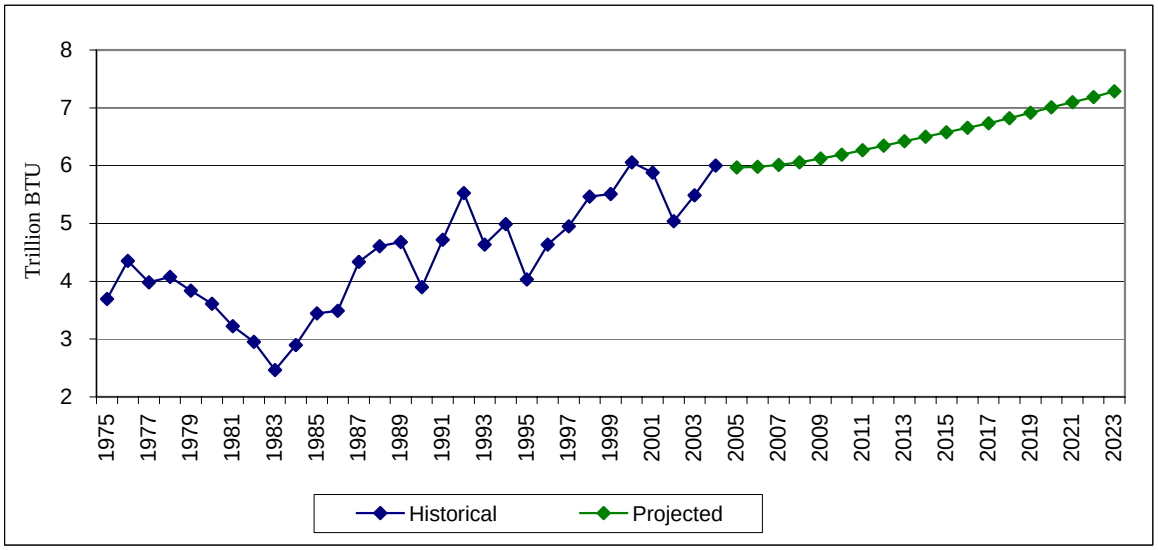
APPENDIX H2:

COMMERCIAL FORECAST

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

COMMERCIAL - Distillate Fuel Oil

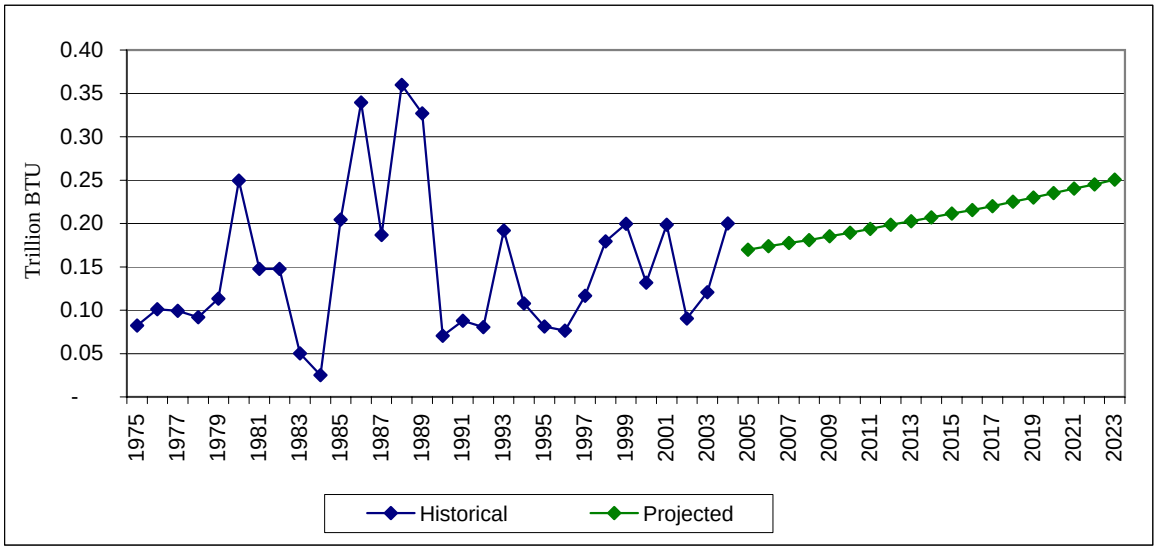


Year	Historical	Growth
1975	3.69	
1976	4.35	17.9%
1977	3.98	-8.5%
1978	4.08	2.4%
1979	3.84	-5.9%
1980	3.61	-5.9%
1981	3.23	-10.7%
1982	2.95	-8.5%
1983	2.46	-16.5%
1984	2.90	17.6%
1985	3.44	18.9%
1986	3.49	1.3%
1987	4.34	24.3%
1988	4.61	6.2%
1989	4.68	1.5%
1990	3.90	-16.7%
1991	4.72	21.1%
1992	5.52	17.1%
1993	4.64	-16.1%
1994	4.99	7.6%
1995	4.03	-19.2%
1996	4.63	15.0%
1997	4.95	6.8%
1998	5.46	10.4%
1999	5.51	0.8%
2000	6.06	10.0%
2001	5.88	-3.0%
2002	5.04	-14.3%
2003	5.49	8.9%
2004	6.00	9.3%

Year	Projected	Growth
2005	5.97	-0.6%
2006	5.98	0.2%
2007	6.01	0.5%
2008	6.06	0.8%
2009	6.12	1.1%
2010	6.19	1.1%
2011	6.27	1.2%
2012	6.35	1.3%
2013	6.42	1.2%
2014	6.50	1.2%
2015	6.58	1.2%
2016	6.65	1.1%
2017	6.73	1.2%
2018	6.82	1.3%
2019	6.91	1.3%
2020	7.01	1.4%
2021	7.10	1.3%
2022	7.19	1.3%
2023	7.28	1.3%

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

COMMERCIAL - Kerosene

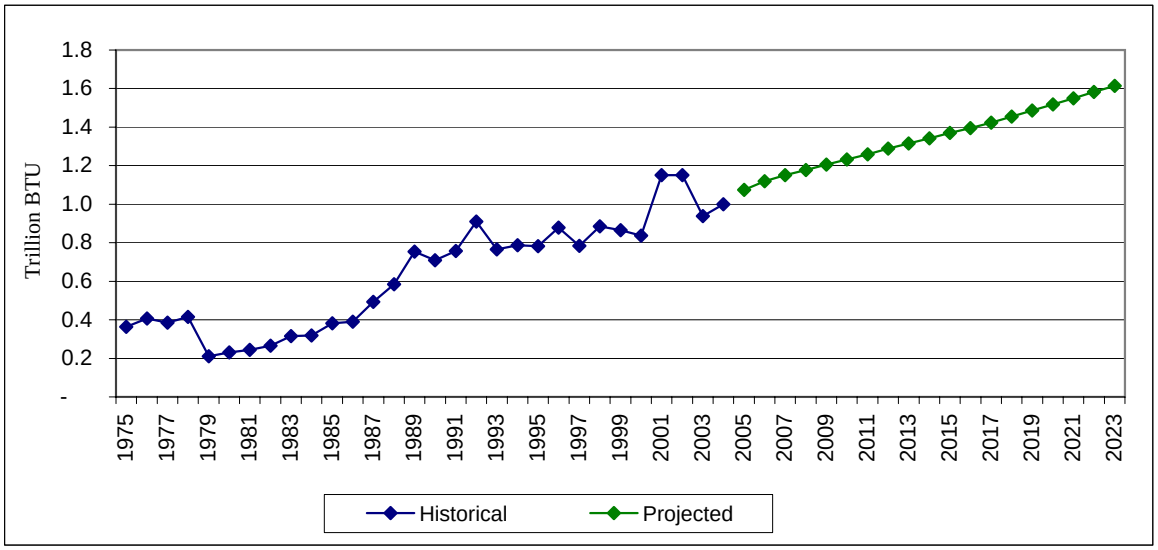


Year	Historical	Growth
1975	0.08	
1976	0.10	22.9%
1977	0.10	-1.8%
1978	0.09	-7.2%
1979	0.11	23.2%
1980	0.25	120.0%
1981	0.15	-40.9%
1982	0.15	0.0%
1983	0.05	-65.8%
1984	0.03	-50.1%
1985	0.20	714.5%
1986	0.34	66.0%
1987	0.19	-45.0%
1988	0.36	92.6%
1989	0.33	-9.1%
1990	0.07	-78.4%
1991	0.09	24.5%
1992	0.08	-8.4%
1993	0.19	138.6%
1994	0.11	-43.8%
1995	0.08	-24.9%
1996	0.08	-5.7%
1997	0.12	52.8%
1998	0.18	53.5%
1999	0.20	11.3%
2000	0.13	-34.0%
2001	0.20	50.7%
2002	0.09	-54.4%
2003	0.12	33.3%
2004	0.20	65.7%

Year	Projected	Growth
2005	0.17	-15.0%
2006	0.17	2.3%
2007	0.18	2.0%
2008	0.18	2.0%
2009	0.19	2.4%
2010	0.19	2.2%
2011	0.19	2.3%
2012	0.20	2.4%
2013	0.20	2.2%
2014	0.21	2.1%
2015	0.21	2.1%
2016	0.22	2.0%
2017	0.22	2.1%
2018	0.22	2.2%
2019	0.23	2.2%
2020	0.24	2.3%
2021	0.24	2.1%
2022	0.25	2.1%
2023	0.25	2.1%

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

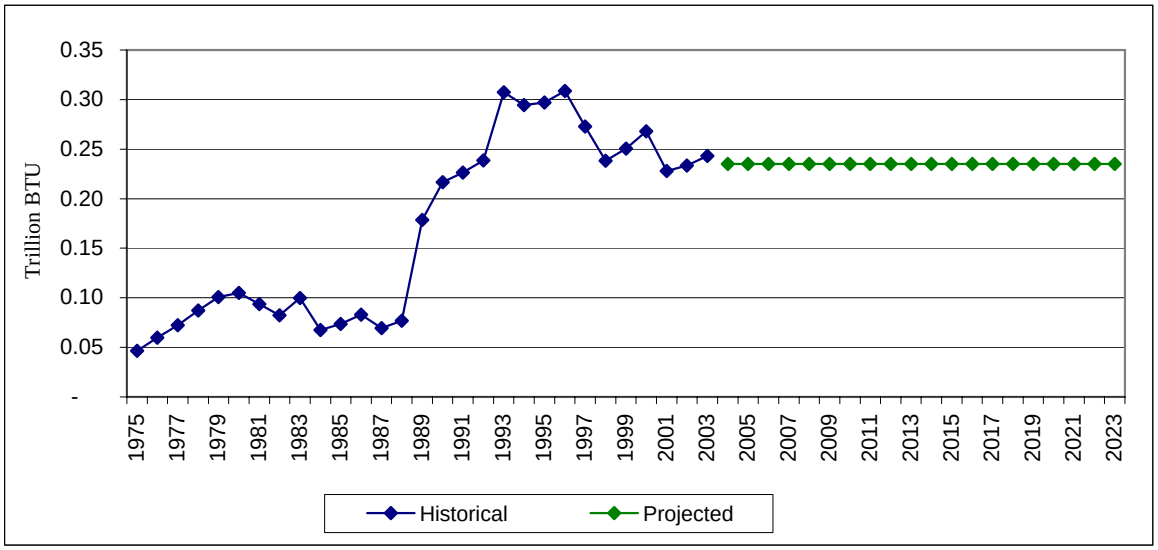
COMMERCIAL - LPG



Year	Historical	Growth	Year	Projected	Growth
1975	0.36		2005	1.07	7.4%
1976	0.41	12.0%	2006	1.12	4.2%
1977	0.39	-5.4%	2007	1.15	2.7%
1978	0.42	7.7%	2008	1.18	2.3%
1979	0.21	-49.4%	2009	1.21	2.4%
1980	0.23	9.8%	2010	1.23	2.2%
1981	0.24	6.1%	2011	1.26	2.2%
1982	0.27	8.5%	2012	1.29	2.3%
1983	0.32	18.9%	2013	1.32	2.1%
1984	0.32	0.9%	2014	1.34	2.1%
1985	0.38	20.1%	2015	1.37	2.0%
1986	0.39	2.1%	2016	1.40	1.9%
1987	0.49	26.5%	2017	1.42	2.0%
1988	0.58	18.4%	2018	1.45	2.1%
1989	0.75	29.1%	2019	1.49	2.2%
1990	0.71	-5.9%	2020	1.52	2.2%
1991	0.76	6.7%	2021	1.55	2.1%
1992	0.91	20.2%	2022	1.58	2.1%
1993	0.77	-15.9%	2023	1.61	2.1%
1994	0.79	2.8%			
1995	0.78	-0.7%			
1996	0.88	12.4%			
1997	0.78	-10.8%			
1998	0.88	12.9%			
1999	0.87	-2.2%			
2000	0.84	-3.3%			
2001	1.15	37.5%			
2002	1.15	0.0%			
2003	0.94	-18.4%			
2004	1.00	6.6%			

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

COMMERCIAL - Wood



Year	Historical	Growth	Year	Projected	Growth
1975	0.05		2004	0.23	-3.4%
1976	0.06	28.2%	2005	0.23	0.0%
1977	0.07	20.7%	2006	0.23	0.0%
1978	0.09	20.6%	2007	0.23	0.0%
1979	0.10	15.8%	2008	0.23	0.0%
1980	0.10	3.9%	2009	0.23	0.0%
1981	0.09	-10.5%	2010	0.23	0.0%
1982	0.08	-12.1%	2011	0.23	0.0%
1983	0.10	21.0%	2012	0.23	0.0%
1984	0.07	-32.4%	2013	0.23	0.0%
1985	0.07	9.1%	2014	0.23	0.0%
1986	0.08	12.5%	2015	0.23	0.0%
1987	0.07	-16.1%	2016	0.23	0.0%
1988	0.08	10.3%	2017	0.23	0.0%
1989	0.18	132.9%	2018	0.23	0.0%
1990	0.22	21.3%	2019	0.23	0.0%
1991	0.23	4.4%	2020	0.23	0.0%
1992	0.24	5.5%	2021	0.23	0.0%
1993	0.31	28.8%	2022	0.23	0.0%
1994	0.29	-4.2%	2023	0.23	0.0%
1995	0.30	0.9%			
1996	0.31	3.9%			
1997	0.27	-11.6%			
1998	0.24	-12.7%			
1999	0.25	5.2%			
2000	0.27	7.0%			
2001	0.23	-14.9%			
2002	0.23	2.4%			
2003	0.24	4.1%			

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
COMMERCIAL FUEL CONSUMPTION - RAW DATA
(TRILLION BTU)

Year	Non-Ind. Employment	Distillate Fuel Oil	Kerosene	LPG	Wood
1975	108.55	3.69	0.08	0.36	0.05
1976	113.93	4.35	0.10	0.41	0.06
1977	118.44	3.98	0.10	0.39	0.07
1978	126.95	4.08	0.09	0.42	0.09
1979	130.77	3.84	0.11	0.21	0.10
1980	132.74	3.61	0.25	0.23	0.10
1981	137.38	3.23	0.15	0.24	0.09
1982	138.14	2.95	0.15	0.27	0.08
1983	141.95	2.46	0.05	0.32	0.10
1984	149.19	2.90	0.03	0.32	0.07
1985	157.57	3.44	0.20	0.38	0.07
1986	168.45	3.49	0.34	0.39	0.08
1987	179.53	4.34	0.19	0.49	0.07
1988	188.03	4.61	0.36	0.58	0.08
1989	193.12	4.68	0.33	0.75	0.18
1990	190.08	3.90	0.07	0.71	0.22
1991	184.84	4.72	0.09	0.76	0.23
1992	188.18	5.52	0.08	0.91	0.24
1993	195.18	4.64	0.19	0.77	0.31
1994	201.61	4.99	0.11	0.79	0.29
1995	207.88	4.03	0.08	0.78	0.30
1996	211.55	4.63	0.08	0.88	0.31
1997	214.49	4.95	0.12	0.78	0.27
1998	219.37	5.46	0.18	0.88	0.24
1999	224.66	5.51	0.20	0.87	0.25
2000	230.36	6.06	0.13	0.84	0.27
2001	235.95	5.88	0.20	1.15	0.23
2002	239.57	5.04	0.09	1.15	0.23
2003	243.46	5.49	0.12	0.94	0.24
2004	248.42	6.00	0.20	1.00	-
2005	251.30				
2006	254.68				
2007	257.76				
2008	260.89				
2009	264.67				
2010	268.24				
2011	271.95				
2012	276.00				
2013	279.77				
2014	283.51				
2015	287.23				
2016	290.82				
2017	294.75				
2018	298.98				
2019	303.34				
2020	307.84				
2021	312.14				
2022	316.57				
2023	321.13				

SOURCE: Fuel Data: Energy Information Administration.
Employment Data: REMI Model

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT COMMERCIAL DISTILLATE FUEL OIL

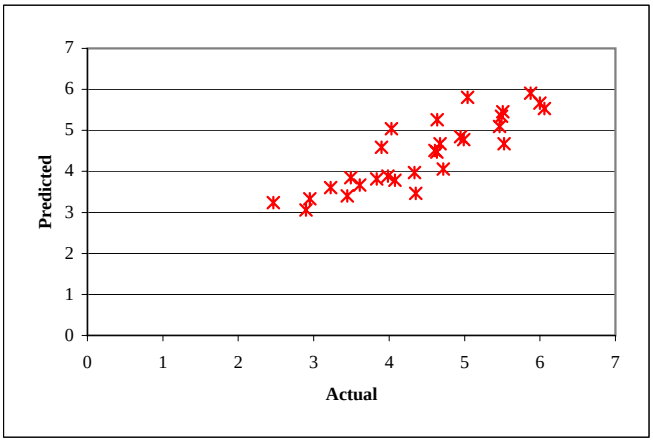
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	0.59	1.12	0.53	59.93%
Com.Emp	Employment (net Industrial)	0.02	0.01	3.64	0.13%
AR	Autoregressive Term	0.59	0.16	3.82	0.08%

Summary Model Statistics:

R-Squared	0.760
Adjusted R-Squared	0.742
Durbin-Watson Statistic	1.950
Mean Abs. % Err. (MAPE)	8.69%

Adjusted Observations	29
Deg. of Freedom for Error	26
F-Statistic	41
Prob (F-Statistic)	0%
Bayesian Information Criterian (BIC)	(1.17)
Model Sum of SquaRes	20
Sum of Squared Errors	6
Mean Squared Error	0.24
Std. Error of RegRession	0.49
Mean Abs. Dev. (MAD)	0.36

Predicted vs. Actual



VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT COMMERCIAL KEROSENE

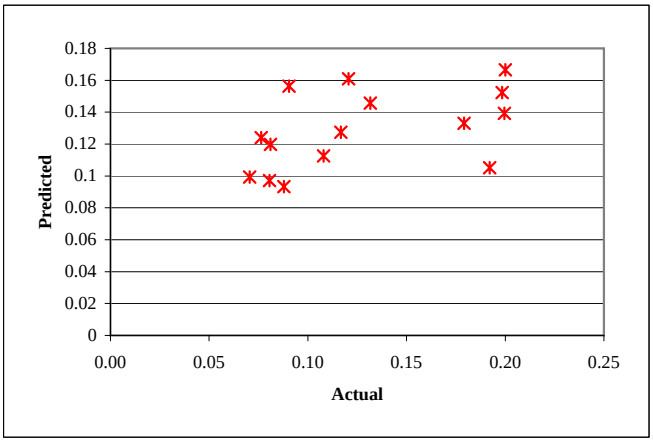
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	(0.12)	0.13	(0.9)	36.61%
Com.Emp	Employment (net Industrial)	0.001	0.001	2.0	7.52%

Summary Model Statistics:

R-Squared	0.229
Adjusted R-Squared	0.170
Durbin-Watson Statistic	1.931
Mean Abs. % Err. (MAPE)	29.95%

Adjusted Observations	15
Deg. of Freedom for Error	13
F-Statistic	4
Prob (F-Statistic)	7%
Bayesian Information Criterian (BIC)	(5.93)
Model Sum of SquaRes	0.008
Sum of Squared Errors	0.028
Mean Squared Error	0.002
Std. Error of RegRession	0.05
Mean Abs. Dev. (MAD)	0.04

Predicted vs. Actual



VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT COMMERCIAL LPG

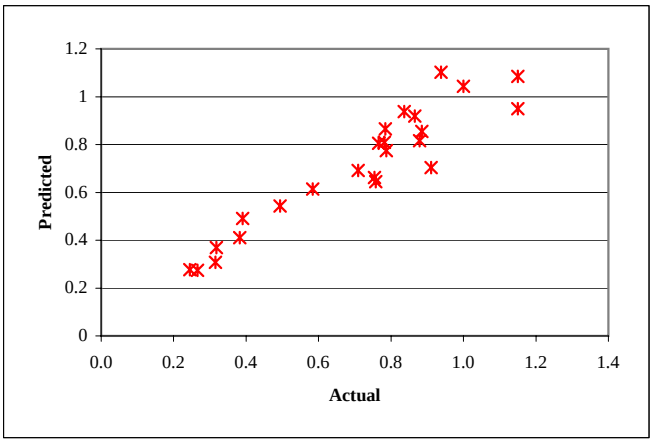
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	(0.71)	0.19	(3.71)	0.15%
Com.Emp	Employment (net Industrial)	0.01	0.00	7.61	0.00%
AR	Autoregressive Term	0.39	0.21	1.91	7.13%

Summary Model Statistics:

R-Squared	0.892
Adjusted R-Squared	0.881
Durbin-Watson Statistic	1.879
Mean Abs. % Err. (MAPE)	9.56%

Adjusted Observations	24
Deg. of Freedom for Error	21
F-Statistic	86
Prob (F-Statistic)	0%
Bayesian Information Criterian (BIC)	(4.48)
Model Sum of SquaRes	1.5
Sum of Squared Errors	0
Mean Squared Error	0.01
Std. Error of RegRession	0.09
Mean Abs. Dev. (MAD)	0.07

Predicted vs. Actual



FUEL OIL END USE ANALYSIS
COMMERCIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL DISTILLATE FUEL OIL CONSUMED	Trillion BTU	5.97	5.98	6.01	6.06	6.12	6.19	6.27	6.35	6.42	6.50	6.58	6.65	6.73	6.82	6.91	7.01	7.10	7.19	7.28
SPACE HEATING ALLOCATION	%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%
OIL CONSUMED BY SPACE HEATING	**Trillion BTU**	**5.01**	**5.02**	**5.05**	**5.09**	**5.14**	**5.20**	**5.26**	**5.33**	**5.40**	**5.46**	**5.53**	**5.59**	**5.66**	**5.73**	**5.81**	**5.89**	**5.96**	**6.04**	**6.12**
Furnace Allocation	%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%
Space Heating - Furnace Portion	Trillion BTU	3.01	3.01	3.03	3.05	3.09	3.12	3.16	3.20	3.24	3.28	3.32	3.35	3.39	3.44	3.48	3.53	3.58	3.62	3.67
Boiler Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Boiler Portion	Trillion BTU	1.00	1.00	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.22
Unit Heater Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Unit Heater Portior	Trillion BTU	1.00	1.00	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.22
WATER HEATING ALLOCATION	%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
OIL CONSUMED BY WATER HEATING	**Trillion BTU**	**0.95**	**0.96**	**0.96**	**0.97**	**0.98**	**0.99**	**1.00**	**1.02**	**1.03**	**1.04**	**1.05**	**1.06**	**1.08**	**1.09**	**1.11**	**1.12**	**1.14**	**1.15**	**1.17**
Boiler Allocation	%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%
Water Heating - Boiler Portion	Trillion BTU	0.67	0.67	0.67	0.68	0.69	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.75	0.76	0.77	0.78	0.79	0.81	0.82
Water Heater Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Water Heating - Water Heater Portion	Trillion BTU	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.23	0.23	0.23
Tankless Water Heater Allocation	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Water Heating - Tankless Water Heater Portion	Trillion BTU	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Dish Washing Allocation	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Water Heating - Dish Washing Allocation	Trillion BTU	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Clothes Washing Allocation	%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Water Heating - Clothes Washing Allocatior	Trillion BTU	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07
OTHER ALLOCATION	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
KEROSENE CONSUMED BY OTHER MEANS	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

LIQUEFIED PROPANE GAS (LPG) END USE ANALYSIS
COMMERCIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL LPG CONSUMED	Trillion BTU	1.07	1.12	1.15	1.18	1.21	1.23	1.26	1.29	1.32	1.34	1.37	1.40	1.42	1.45	1.49	1.52	1.55	1.58	1.61
SPACE HEATING ALLOCATION	%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%
LPG CONSUMED BY SPACE HEATING	**Trillion BTU**	**0.90**	**0.94**	**0.97**	**0.99**	**1.01**	**1.03**	**1.06**	**1.08**	**1.10**	**1.13**	**1.15**	**1.17**	**1.20**	**1.22**	**1.25**	**1.28**	**1.30**	**1.33**	**1.36**
Furnace Allocation	%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%
Space Heating - Furnace Portion	Trillion BTU	0.54	0.56	0.58	0.59	0.61	0.62	0.63	0.65	0.66	0.68	0.69	0.70	0.72	0.73	0.75	0.77	0.78	0.80	0.81
Boiler Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Boiler Portion	Trillion BTU	0.18	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.25	0.26	0.26	0.27	0.27
Unit Heater Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Unit Heater Portior	Trillion BTU	0.18	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.25	0.26	0.26	0.27	0.27
WATER HEATING ALLOCATION	%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
LPG CONSUMED BY WATER HEATING	**Trillion BTU**	**0.17**	**0.18**	**0.18**	**0.19**	**0.19**	**0.20**	**0.20**	**0.21**	**0.21**	**0.21**	**0.22**	**0.22**	**0.23**	**0.23**	**0.24**	**0.24**	**0.25**	**0.25**	**0.26**
Boiler Allocation	%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%
Water Heating - Boiler Portion	Trillion BTU	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18
Water Heater Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Water Heating - Water Heater Portion	Trillion BTU	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Tankless Water Heater Allocation	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Water Heating - Tankless Water Heater Portion	Trillion BTU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Dish Washing Allocation	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Water Heating - Dish Washing Allocation	Trillion BTU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Clothes Washing Allocation	%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Water Heating - Clothes Washing Allocatior	Trillion BTU	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
OTHER ALLOCATION	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
KEROSENE CONSUMED BY OTHER MEANS	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

KEROSENE END USE ANALYSIS
COMMERCIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL KEROSENE CONSUMED	Trillion BTU	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.22	0.22	0.23	0.24	0.24	0.25	0.25
SPACE HEATING ALLOCATION	%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%
KEROSENE CONSUMED BY SPACE HEATING	**Trillion BTU**	**0.14**	**0.15**	**0.15**	**0.15**	**0.16**	**0.16**	**0.16**	**0.17**	**0.17**	**0.17**	**0.18**	**0.18**	**0.18**	**0.19**	**0.19**	**0.20**	**0.20**	**0.21**	**0.21**
Furnace Allocation	%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%
Space Heating - Furnace Portion	Trillion BTU	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.13
Boiler Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Boiler Portion	Trillion BTU	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Unit Heater Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Unit Heater Portior	Trillion BTU	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
WATER HEATING ALLOCATION	%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
KEROSENE CONSUMED BY WATER HEATING	**Trillion BTU**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**
Boiler Allocation	%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%
Water Heating - Boiler Portion	Trillion BTU	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
Water Heater Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Water Heating - Water Heater Portion	Trillion BTU	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tankless Water Heater Allocation	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Water Heating - Tankless Water Heater Portion	Trillion BTU	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Dish Washing Allocation	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Water Heating - Dish Washing Allocation	Trillion BTU	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Clothes Washing Allocation	%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Water Heating - Clothes Washing Allocatior	Trillion BTU	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
OTHER ALLOCATION	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
KEROSENE CONSUMED BY OTHER MEANS	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

WOOD END USE ANALYSIS
COMMERCIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL WOOD CONSUMED	Trillion BTU	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
SPACE HEATING ALLOCATION	%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%	84.0%
WOOD CONSUMED BY SPACE HEATING	**Trillion BTU**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**
Furnace Allocation	%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%
Space Heating - Furnace Portion	Trillion BTU	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Boiler Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Boiler Portion	Trillion BTU	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Unit Heater Allocation	%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Space Heating - Unit Heater Portior	Trillion BTU	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
OTHER ALLOCATION	%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
WOOD CONSUMED BY OTHER MEANS	**Trillion BTU**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**

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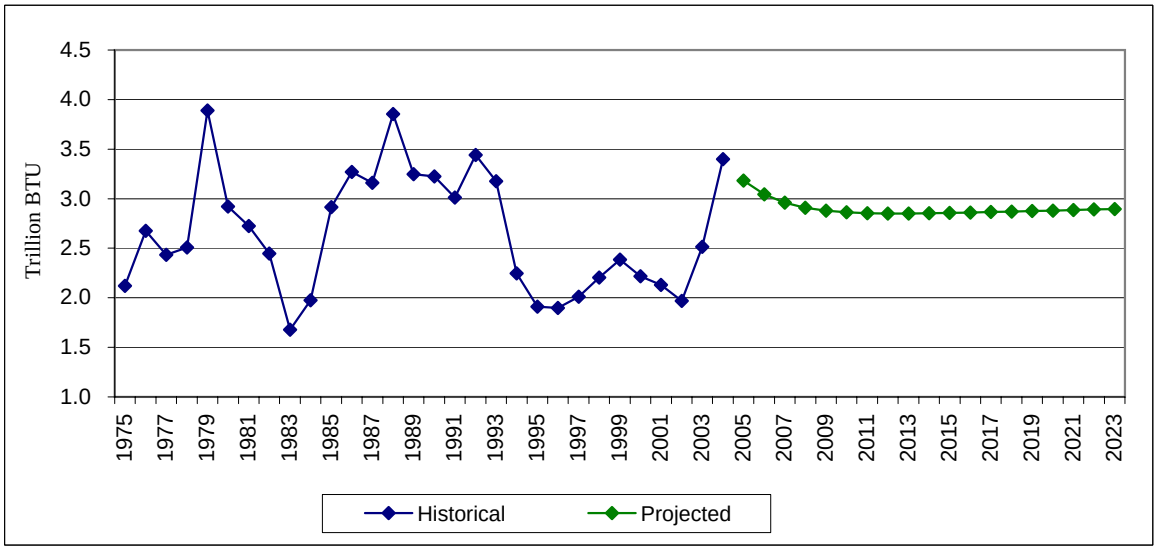
APPENDIX H3:

INDUSTRIAL FORECAST

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

INDUSTRIAL - Distillate Fuel Oil

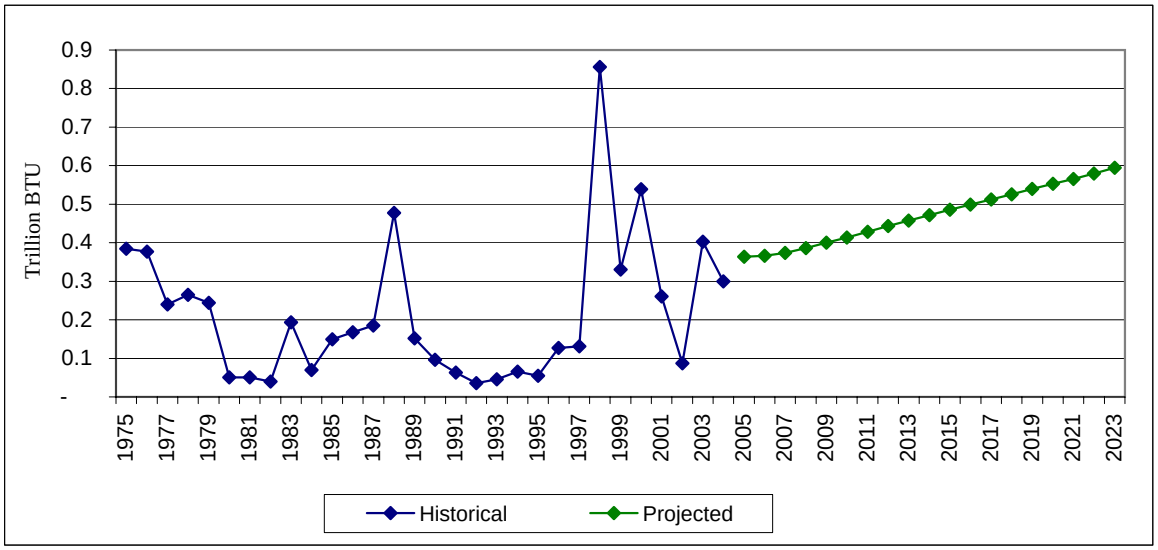


Year	Historical	Growth
1975	2.12	
1976	2.68	26.1%
1977	2.43	-9.1%
1978	2.51	3.1%
1979	3.89	55.2%
1980	2.92	-24.9%
1981	2.73	-6.7%
1982	2.45	-10.3%
1983	1.68	-31.3%
1984	1.97	17.6%
1985	2.91	47.6%
1986	3.27	12.2%
1987	3.16	-3.4%
1988	3.85	21.9%
1989	3.25	-15.7%
1990	3.23	-0.7%
1991	3.01	-6.6%
1992	3.44	14.3%
1993	3.18	-7.8%
1994	2.25	-29.2%
1995	1.91	-15.1%
1996	1.90	-0.5%
1997	2.01	5.9%
1998	2.21	9.7%
1999	2.38	8.1%
2000	2.22	-7.0%
2001	2.13	-3.9%
2002	1.97	-7.6%
2003	2.52	27.8%
2004	3.40	35.2%

Year	Projected	Growth
2005	3.18	-6.4%
2006	3.04	-4.4%
2007	2.96	-2.8%
2008	2.91	-1.7%
2009	2.88	-1.0%
2010	2.86	-0.6%
2011	2.85	-0.3%
2012	2.85	-0.1%
2013	2.85	0.0%
2014	2.85	0.1%
2015	2.86	0.1%
2016	2.86	0.1%
2017	2.86	0.2%
2018	2.87	0.2%
2019	2.87	0.2%
2020	2.88	0.2%
2021	2.89	0.2%
2022	2.89	0.2%
2023	2.90	0.2%

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

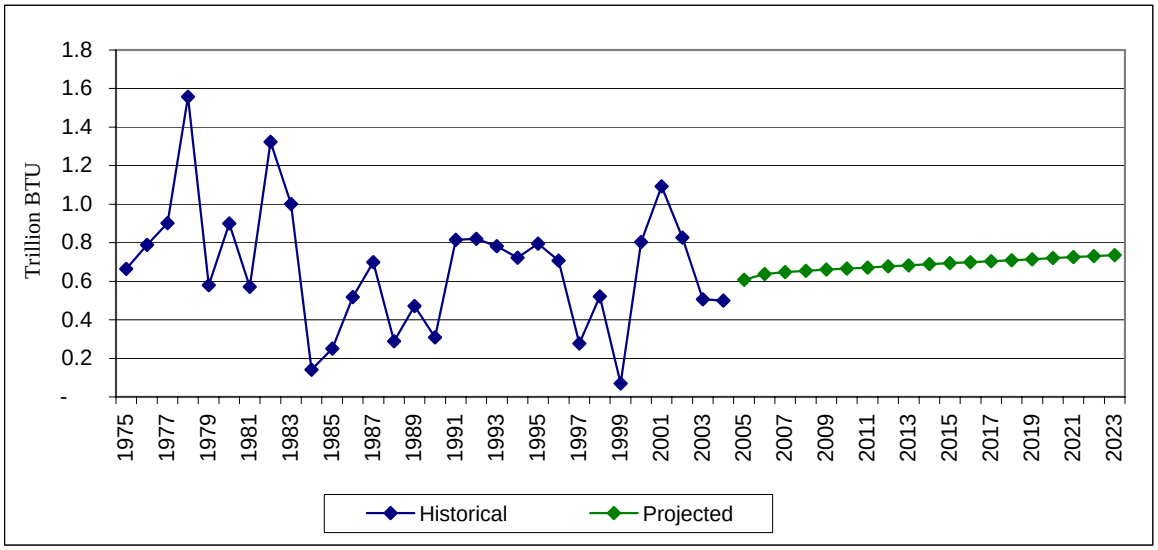
INDUSTRIAL - Kerosene



Year	Historical	Growth	Year	Projected	Growth
1975	0.38		2005	0.36	21.1%
1976	0.38	-2.0%	2006	0.37	0.7%
1977	0.24	-36.3%	2007	0.37	2.1%
1978	0.26	10.3%	2008	0.39	3.5%
1979	0.24	-8.0%	2009	0.40	3.6%
1980	0.05	-79.1%	2010	0.41	3.3%
1981	0.05	0.0%	2011	0.43	3.4%
1982	0.04	-22.2%	2012	0.44	3.5%
1983	0.19	387.4%	2013	0.46	3.3%
1984	0.07	-63.9%	2014	0.47	3.1%
1985	0.15	113.9%	2015	0.49	2.9%
1986	0.17	12.1%	2016	0.50	2.7%
1987	0.19	10.7%	2017	0.51	2.7%
1988	0.48	157.5%	2018	0.53	2.6%
1989	0.15	-68.1%	2019	0.54	2.6%
1990	0.10	-36.4%	2020	0.55	2.5%
1991	0.06	-34.8%	2021	0.57	2.4%
1992	0.04	-43.9%	2022	0.58	2.5%
1993	0.05	29.7%	2023	0.59	2.5%
1994	0.07	43.0%			
1995	0.05	-16.6%			
1996	0.13	132.5%			
1997	0.13	2.8%			
1998	0.86	554.4%			
1999	0.33	-61.4%			
2000	0.54	63.1%			
2001	0.26	-51.6%			
2002	0.09	-66.6%			
2003	0.40	361.9%			
2004	0.30	-25.5%			

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

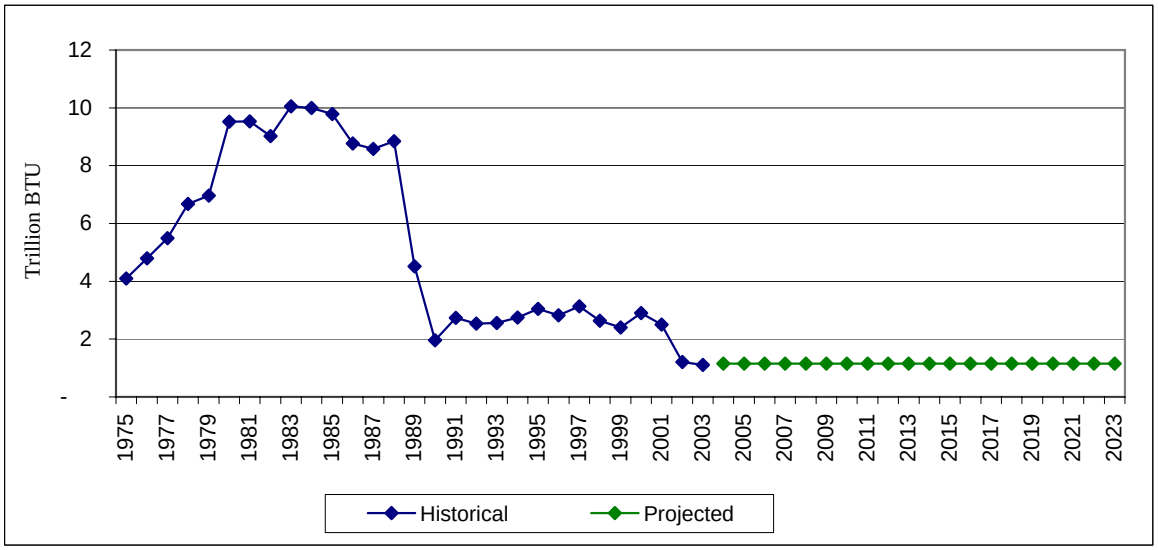
INDUSTRIAL - LPG



Year	Historical	Growth	Year	Projected	Growth
1975	0.66		2005	0.61	21.6%
1976	0.79	18.8%	2006	0.64	4.8%
1977	0.90	14.3%	2007	0.65	1.6%
1978	1.56	73.0%	2008	0.65	1.1%
1979	0.58	-62.8%	2009	0.66	0.9%
1980	0.90	55.2%	2010	0.67	0.8%
1981	0.57	-36.6%	2011	0.67	0.8%
1982	1.32	131.8%	2012	0.68	0.9%
1983	1.00	-24.3%	2013	0.68	0.8%
1984	0.14	-86.0%	2014	0.69	0.8%
1985	0.25	78.9%	2015	0.69	0.8%
1986	0.52	106.2%	2016	0.70	0.7%
1987	0.70	34.8%	2017	0.70	0.7%
1988	0.29	-58.7%	2018	0.71	0.7%
1989	0.47	63.1%	2019	0.71	0.7%
1990	0.31	-34.3%	2020	0.72	0.7%
1991	0.82	163.6%	2021	0.73	0.7%
1992	0.82	0.5%	2022	0.73	0.8%
1993	0.78	-4.6%	2023	0.74	0.8%
1994	0.72	-7.6%			
1995	0.80	10.1%			
1996	0.71	-11.1%			
1997	0.28	-60.8%			
1998	0.52	88.1%			
1999	0.07	-86.6%			
2000	0.80	1047.0%			
2001	1.09	36.0%			
2002	0.83	-24.3%			
2003	0.51	-38.8%			
2004	0.50	-1.2%			

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
STATE RESIDENTIAL FUEL CONSUMPTION
(TRILLION BTU)

INDUSTRIAL - Wood



Year	Historical	Growth
1975	4.09	
1976	4.80	17.2%
1977	5.49	14.3%
1978	6.67	21.6%
1979	6.97	4.4%
1980	9.52	36.7%
1981	9.53	0.1%
1982	9.02	-5.4%
1983	10.06	11.5%
1984	9.99	-0.7%
1985	9.79	-2.0%
1986	8.77	-10.4%
1987	8.58	-2.1%
1988	8.85	3.1%
1989	4.52	-49.0%
1990	1.96	-56.7%
1991	2.73	39.7%
1992	2.53	-7.3%
1993	2.56	1.0%
1994	2.75	7.4%
1995	3.04	10.5%
1996	2.82	-7.1%
1997	3.14	11.1%
1998	2.63	-16.1%
1999	2.40	-8.8%
2000	2.90	21.1%
2001	2.50	-13.8%
2002	1.21	-51.8%
2003	1.10	-8.7%

Year	Projected	Growth
2004	1.16	4.7%
2005	1.16	0.0%
2006	1.16	0.0%
2007	1.16	0.0%
2008	1.16	0.0%
2009	1.16	0.0%
2010	1.16	0.0%
2011	1.16	0.0%
2012	1.16	0.0%
2013	1.16	0.0%
2014	1.16	0.0%
2015	1.16	0.0%
2016	1.16	0.0%
2017	1.16	0.0%
2018	1.16	0.0%
2019	1.16	0.0%
2020	1.16	0.0%
2021	1.16	0.0%
2022	1.16	0.0%
2023	1.16	0.0%

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
INDUSTRIAL FUEL CONSUMPTION - RAW DATA
(TRILLION BTU)

Year	Gross State Product	Distillate Fuel Oil	Kerosene	LPG	Wood
1975	-	2.12	0.38	0.66	4.09
1976	-	2.68	0.38	0.79	4.80
1977	7.75	2.43	0.24	0.90	5.49
1978	8.54	2.51	0.26	1.56	6.67
1979	8.81	3.89	0.24	0.58	6.97
1980	8.94	2.92	0.05	0.90	9.52
1981	9.15	2.73	0.05	0.57	9.53
1982	9.11	2.45	0.04	1.32	9.02
1983	9.56	1.68	0.19	1.00	10.06
1984	10.16	1.97	0.07	0.14	9.99
1985	10.80	2.91	0.15	0.25	9.79
1986	11.46	3.27	0.17	0.52	8.77
1987	12.45	3.16	0.19	0.70	8.58
1988	13.52	3.85	0.48	0.29	8.85
1989	14.06	3.25	0.15	0.47	4.52
1990	14.10	3.23	0.10	0.31	1.96
1991	13.62	3.01	0.06	0.82	2.73
1992	14.30	3.44	0.04	0.82	2.53
1993	14.51	3.18	0.05	0.78	2.56
1994	14.91	2.25	0.07	0.72	2.75
1995	14.80	1.91	0.05	0.80	3.04
1996	15.29	1.90	0.13	0.71	2.82
1997	15.90	2.01	0.13	0.28	3.14
1998	16.52	2.21	0.86	0.52	2.63
1999	17.15	2.38	0.33	0.07	2.40
2000	17.78	2.22	0.54	0.80	2.90
2001	18.39	2.13	0.26	1.09	2.50
2002	18.77	1.97	0.09	0.83	1.21
2003	19.34	2.52	0.40	0.51	1.10
2004	20.10	3.40	0.30	0.50	-
2005	20.52				
2006	20.62				
2007	20.91				
2008	21.40				
2009	21.94				
2010	22.45				
2011	23.00				
2012	23.56				
2013	24.12				
2014	24.67				
2015	25.20				
2016	25.71				
2017	26.22				
2018	26.73				
2019	27.25				
2020	27.75				
2021	28.26				
2022	28.80				
2023	29.35				

SOURCE: Fuel Data: Energy Information Administration.
Gross State Product (2000$): REMI Model

VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT INDUSTRIAL DISTILLATE FUEL OIL

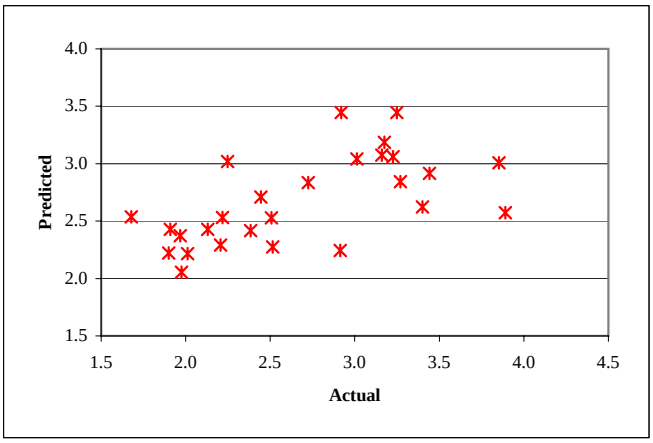
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	2.59	1.19	2.17	4.08%
Ind.GSP	Vermont Gross State Product	0.01	0.08	0.13	89.69%
AR	Autoregressive Term	0.63	0.17	3.62	0.15%

Summary Model Statistics:

R-Squared	0.368
Adjusted R-Squared	0.316
Durbin-Watson Statistic	1.678
Mean Abs. % Err. (MAPE)	14.31%

Adjusted Observations	27
Deg. of Freedom for Error	24
F-Statistic	7
Prob (F-Statistic)	0%
Bayesian Information Criterian (BIC)	(1.05)
Model Sum of Squares	4
Sum of Squared Errors	7
Mean Squared Error	0.27
Std. Error of Regression	0.52
Mean Abs. Dev. (MAD)	0.37

Predicted vs. Actual



VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT INDUSTRIAL KEROSENE

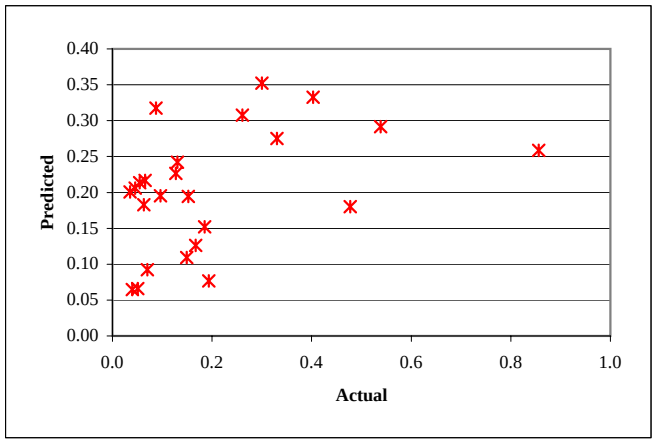
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	(0.17)	0.17	(1.00)	32.98%
Ind.GSP	Vermont Gross State Product	0.03	0.01	2.22	3.80%

Summary Model Statistics:

R-Squared	0.183
Adjusted R-Squared	0.146
Durbin-Watson Statistic	1.751
Mean Abs. % Err. (MAPE)	107.72%

Adjusted Observations	24
Deg. of Freedom for Error	22
F-Statistic	5
Prob (F-Statistic)	4%
Bayesian Information Criterian (BIC)	(3.21)
Model Sum of SquaRes	0.166
Sum of Squared Errors	0.740
Mean Squared Error	0.034
Std. Error of RegRession	0.18
Mean Abs. Dev. (MAD)	0.12

Predicted vs. Actual



VERMONT DEPARTMENT OF PUBLIC SERVICE
VERMONT ENERGY EFFICIENCY POTENTIAL STUDY
MODEL SPECIFICATIONS
VERMONT INDUSTRIAL LPG

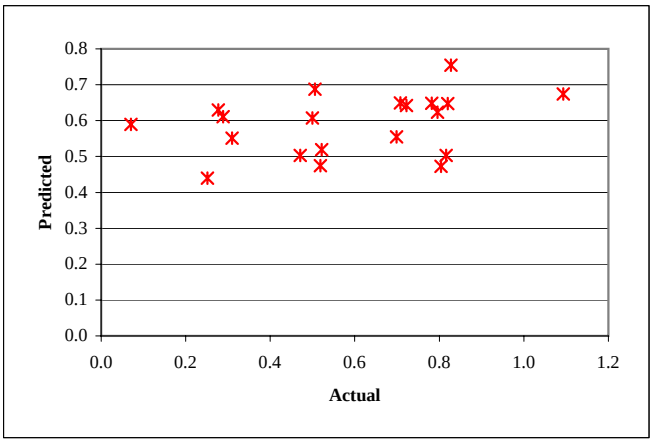
Variable	Description	Value	Standard Err.	t-Statistic	p-Value
INT	Intercept	0.44	0.52	0.85	41.07%
Ind.GSP	Vermont Gross State Product	0.01	0.03	0.31	75.92%
AR	Autoregressive Term	0.27	0.23	1.17	26.07%

Summary Model Statistics:

R-Squared	0.108
Adjusted R-Squared	0.003
Durbin-Watson Statistic	1.984
Mean Abs. % Err. (MAPE)	71.62%

Adjusted Observations	20
Deg. of Freedom for Error	17
F-Statistic	1
Prob (F-Statistic)	38%
Bayesian Information Criterian (BIC)	(2.42)
Model Sum of SquaRes	0
Sum of Squared Errors	1
Mean Squared Error	0.07
Std. Error of RegRession	0.26
Mean Abs. Dev. (MAD)	0.19

Predicted vs. Actual



FUEL OIL END USE ANALYSIS
INDUSTRIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL DISTILLATE FUEL OIL CONSUMED	Trillion BTU	3.18	3.04	2.96	2.91	2.88	2.86	2.85	2.85	2.85	2.85	2.86	2.86	2.86	2.87	2.87	2.88	2.89	2.89	2.90
ALLOCATOR: BOILERS	%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%
OIL CONSUMED BY BOILERS	**Trillion BTU**	**1.79**	**1.71**	**1.67**	**1.64**	**1.62**	**1.61**	**1.61**	**1.61**	**1.61**	**1.61**	**1.61**	**1.61**	**1.61**	**1.62**	**1.62**	**1.62**	**1.62**	**1.63**	**1.63**
ALLOCATOR: PROCESS HEATING	%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
OIL CONSUMED BY PROCESS HEATING	**Trillion BTU**	**0.80**	**0.76**	**0.74**	**0.73**	**0.72**	**0.72**	**0.71**	**0.71**	**0.71**	**0.71**	**0.71**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**
ALLOCATOR: DICRECT USE NON-PROCESS	%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%
OIL CONSUMED BY DIRECT USE NON-PROCESS	**Trillion BTU**	**0.20**	**0.19**	**0.19**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**
OIL CONSUMED BY OTHER USES	**Trillion BTU**	**0.39**	**0.38**	**0.37**	**0.36**	**0.36**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.35**	**0.36**	**0.36**	**0.36**	**0.36**	**0.36**	**0.36**	**0.36**

KEROSENE END USE ANALYSIS
INDUSTRIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL KEROSENE CONSUMED	Trillion BTU	0.36	0.37	0.37	0.39	0.40	0.41	0.43	0.44	0.46	0.47	0.49	0.50	0.51	0.53	0.54	0.55	0.57	0.58	0.59
ALLOCATOR: BOILERS	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
KEROSENE CONSUMED BY BOILERS	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALLOCATOR: PROCESS HEATING	%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
KEROSENE CONSUMED BY PROCESS HEATING	**Trillion BTU**	**0.18**	**0.18**	**0.19**	**0.19**	**0.20**	**0.21**	**0.21**	**0.22**	**0.23**	**0.24**	**0.24**	**0.25**	**0.26**	**0.26**	**0.27**	**0.28**	**0.28**	**0.29**	**0.30**
ALLOCATOR: DICRECT USE NON-PROCESS	%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
KEROSENE CONSUMED BY DIRECT USE NON-PROCESS	**Trillion BTU**	**0.18**	**0.18**	**0.19**	**0.19**	**0.20**	**0.21**	**0.21**	**0.22**	**0.23**	**0.24**	**0.24**	**0.25**	**0.26**	**0.26**	**0.27**	**0.28**	**0.28**	**0.29**	**0.30**
KEROSENE CONSUMED BY OTHER USES	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

LPG END USE ANALYSIS
INDUSTRIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL LPG CONSUMED	Trillion BTU	0.61	0.64	0.65	0.65	0.66	0.67	0.67	0.68	0.68	0.69	0.69	0.70	0.70	0.71	0.71	0.72	0.73	0.73	0.74
ALLOCATOR: BOILERS	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LPG CONSUMED BY BOILERS	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALLOCATOR: PROCESS HEATING	%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
LPG CONSUMED BY PROCESS HEATING	**Trillion BTU**	**0.30**	**0.32**	**0.32**	**0.33**	**0.33**	**0.33**	**0.34**	**0.34**	**0.34**	**0.34**	**0.35**	**0.35**	**0.35**	**0.35**	**0.36**	**0.36**	**0.36**	**0.37**	**0.37**
ALLOCATOR: DICRECT USE NON-PROCESS	%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
LPG CONSUMED BY DIRECT USE NON-PROCESS	**Trillion BTU**	**0.30**	**0.32**	**0.32**	**0.33**	**0.33**	**0.33**	**0.34**	**0.34**	**0.34**	**0.34**	**0.35**	**0.35**	**0.35**	**0.35**	**0.36**	**0.36**	**0.36**	**0.37**	**0.37**
LPG CONSUMED BY OTHER USES	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

WOOD END USE ANALYSIS
INDUSTRIAL SECTOR

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TOTAL WOOD CONSUMED	Trillion BTU	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
ALLOCATOR: BOILERS	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WOOD CONSUMED BY BOILERS	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALLOCATOR: PROCESS HEATING	%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
WOOD CONSUMED BY PROCESS HEATING	**Trillion BTU**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**
ALLOCATOR: DICRECT USE NON-PROCESS	%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
WOOD CONSUMED BY DIRECT USE NON-PROCESS	**Trillion BTU**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**
WOOD CONSUMED BY OTHER USES	**Trillion BTU**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-