Integrated Energy Resources

Economic Impacts of Energy Efficiency Investments in Vermont – Final Report

Prepared for

The Vermont Department of Public Service

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INTRODUCTION

OVERVIEW OF THE STUDY

The goal of this study is to quantify the economic impacts of Energy Efficiency Utility investments in Vermont. The results are based on the 2012 budgets for energy efficiency spending proposed by the Department of Public Service (DPS), including:

- $40.1 million for electric energy efficiency to be performed by Efficiency Vermont (EVT) and Burlington Electric Department (BED), funded by the energy efficiency charge on ratepayers' electric bills, and
- $5.4 million for Heat and Process Fuels (HPF) efficiency to be performed by EVT, funded by revenues from the Regional Greenhouse Gas Initiative (RGGI) and the Forward Capacity Market (FCM).[1]

This study estimates the impact of this single year of additional energy efficiency spending on the State's economy in comparison to having no spending for energy efficiency programs in that year. Actual adopted budgets may differ somewhat from these values but not to a degree that would substantially change the study's findings regarding the economic effects per dollar of spending.

The main spending categories associated with the efficiency programs include:

- the total outlays for installed efficient equipment and practices (relative to the baseline of standard-efficiency equipment and practices), comprised of two parts:
  - the "out-of-pocket" portion of those costs paid by participants , plus
  - the portion of those costs paid by the efficiency programs including any rebates or other incentives paid to program participants or vendors to promote the efficiency measures, and
- other program spending for administration, marketing, technical assistance, and related expenses.

The installation of efficient equipment and practices due to Vermont's efficiency programs results in savings in electricity, heating and process fuels (mostly oil and propane), water, and operation and maintenance costs. These savings and their economic benefits continue for as long as the efficiency measures are operational, which can be up to 20 years or more for the most durable measures. In addition, electric rates are affected by reduced demand for electricity, reduced transmission and distribution expenditures by the State's utilities, and by reduced costs for Pooled Transmission Facilities[2] and related services provided by the New England Independent System Operator.

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[1] The energy efficiency activities of Vermont Gas Systems (VGS) were outside the scope of this project.

[2] Pooled Transmission Facilities are generally transmission facilities that operate at 69 kV or higher and which fall under the authority of the New England Independent System Operator (ISO-NE).

The results of this study represent the *net new economic activity* generated by the efficiency investment: the difference between the amount of economic activity increase associated with stimulating related commercial services and industries in Vermont and the amount of economic activity reduction associated with the costs of the efficiency programs. The costs, savings and economic benefits resulting from the efficiency programs were evaluated by sector (residential, commercial, industrial) and modeled over the 20-year study period (2012-2031) using the REMI PI+ economic model, as further described below.

OVERVIEW OF ECONOMIC IMPACTS

The economic impacts of any new activity depend on the extent to which that new activity affects supporting industries in the region. Economic impacts emanate from:

1. direct economic effects (e.g. spending on goods and services at a construction site or the purchase of a piece of new equipment), and
2. multiplier effects which include
   a. spending on supporting goods and services by the firms providing that direct activity ("indirect" impacts), and
   b. re-spending by workers of their wages or disposable income from savings or costs to households ("induced" impacts).

In general, energy efficiency investments create net positive economic impacts in a given region[3]. In other words, usually more jobs are created through these projects than are lost by the activities they displace, such as electric generation or the sale of fuel oil, or spending on other goods and services rather than paying more for efficient equipment. This net positive impact is due to the fact that participants save money on their energy bills, and usually more of the dollars spent on energy efficiency remain in the local economy than dollars spent on "traditional" electric generation or fossil fuel purchases. Energy efficiency is also a more labor-intensive activity than typical generation or fuel sales, so for any given amount of efficiency spending, more local jobs are created than lost by reducing spending on electric generation. The size of that net impact depends on how the region is defined, the amount of energy savings, and how much of the spending by each affected industry remains within that given region.

The range of economic impact results from a new economic activity depends on the metric used to express that impact. This report provides estimates of two economic multipliers for the energy efficiency program evaluated. One is the ratio of change in Gross State Product (GSP) to the program spending. The other is the ratio of change in wage income to the program spending. Arguably, the most useful measure is *net job-years created per million dollars in program spending*. This measure represents the change in employment in the region due to the program's

[3] *Economic Impacts and Potential Air Emission Reductions from Renewable Generation & Efficiency Programs in New England*, prepared for the Regulatory Assistance Project by Synapse Energy Economics, April 2005.

total spending.[4] For studies that only capture the direct jobs associated with energy efficiency, the results show between three and ten *job-years per million dollars in program spending* (depending on program type and the specific region).[5] When including total economic impacts (direct, indirect and induced activity) the impacts are much higher, as with this study which shows an estimated impact of 43 job-years per million dollars.

The findings of this report are consistent with other recent studies on the economic impacts of efficiency investments. A report for Environment Northeast showed impacts between 36 and 60 job-years per million dollars spent (depending on the state) due to energy efficiency.[6] One study in Wisconsin showed between 75 and 250 job-years per million dollars over 25 years (depending on the program type).[7]

REPORT STRUCTURE

The following section of the report provides a summary of the results of the economic modeling, after which we provide a detailed explanation of the study methodology. Appendix A provides a summary of the data sources and assumptions used in the study. Appendix B then provides a description of the industries (goods and services categories) used in the economic model. Unless otherwise stated, all tables and figures are the product of Optimal Energy and/or Synapse Energy Economics.

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4 Unlike other indicators discussed below, this number is not a typical economic multiplier since the denominator (program spending) does not include participants' out-of-pocket spending on energy efficiency.

5 *Energy Efficiency Services Sector: Workforce Size and Expectations for Growth*, Ernest Orlando Lawrence Berkeley National Laboratory, September 2010. (http://eetd.lbl.gov/ea/emp/reports/lbnl-3987e.pdf)

6 *Energy Efficiency: Engine of Economic Growth*, Environment Northeast, and EDR Group, October 2009.

7 *Focus on Energy Evaluation*, State of Wisconsin Public Service Commission, March 2010, PA Consulting and EDR Group.

SUMMARY OF RESULTS

Energy efficiency generates economic activity throughout Vermont in the form of purchase and installation of energy efficiency goods and services, administration of the program itself, and net energy savings to ratepayers and participants. Households that participate in the program save on energy costs and, therefore, can spend additional money in the local economy, spurring job growth. Businesses have lower energy costs that improve their bottom-line, which enables them to be more competitive and to expand production and related employment. The investment in efficiency in itself also generates economic activity to the extent that the equipment is produced, sold, installed or maintained by Vermont businesses.

These efficiency investments also cost participants money for their part of the efficient equipment and installation costs. Further, all ratepayers participate in funding the program. These costs are taken into account in our analysis in that participants are negatively affected through their additional spending on the energy efficiency goods and services (constricting their ability to spend elsewhere), and all ratepayers are negatively impacted by the inclusion of energy efficiency program costs on their energy bills. These negative impacts offset part of the positive impacts from savings and investment.

Table 1 shows the resulting net economic impacts in terms of job-years of employment (the equivalent of one full-time job for one year), personal income, Gross State Product (GSP),[8] and output (i.e., business sales). Program operations for the year 2012 are estimated to generate a net increase of nearly 1,900 job-years and $220 million in GSP in Vermont over 20 years. The largest impact year is 2012 itself, since this is when new equipment and installation are purchased. Some participants pay for these investments in one lump sum while others that seek financing begin paying them off over time. In the following years, positive net benefits continue due to energy cost savings to participants and price effects that occur for all ratepayers.

If the analysis considers the separate impacts from electricity efficiency and heating process fuels (HPF) programs, the latter is responsible for around one-sixth of the total first year employment impacts or 65 job-years. The "All Years" employment impact for HPF is slightly higher (85 job-years). Therefore, most of the employment impacts from heating fuel programs are felt in the first year due to the purchase and installation of new heating efficiency equipment. In reviewing the HPF results, it should be noted that the HPF program is in its early stages and currently has limited funding. The limited funding leads to a limited amount of savings associated with lower heating bills over the life of efficiency measures, and thus the investment has modest impact over the long term. Also, since use of heating fuel will decrease, the positive impacts from savings are partially counteracted by the loss in activity from heating fuel distribution and delivery services. Limited funding also leads to a higher percentage of the budget allocated to administrative costs than what is likely to be allocated over larger budgets (economies of scale reduce administrative costs). In addition, because the program is in its early stages, it is likely that ramp up costs – including initial program design and development – limit

[8] The Gross State Product (GSP) captures the additional value-added activity produced in Vermont. It generally refers to the additional wage income, plus the additional profits of production and services in Vermont.

the amount of fuel savings. Thus, a continued and/or increased investment in thermal efficiency is likely to increase the economic benefit ratio for this sector.

Table 1: Total Economic Impacts of Vermont Energy Efficiency Programs (2011$)

Impact Type	2012			All Years		
	Elec.	HPF	Total	Elec.	HPF	Total
Jobs (job-years)	305	65	370	1,808	85	1,894
Personal Income (million)	$11.3	$2.5	$14	$96	$1.9	$98
Gross State Product (million)	$11.5	$2.2	$14	$215	$4.7	$220
Output (million)	$17	$5	$22	$344	$7	$351

Another perspective for measuring the efficacy of the programs is to present the impacts as value produced per dollar of program spending, as shown below in Table 2 for the planned 2012 energy efficiency program budget of $45.5 million ($44.4 million in 2011 dollars).[9] Dividing the economic impacts above by that amount shows that this one-year investment creates a net gain of 43 job-years per million dollars of program spending and a net increase of nearly five dollars of cumulative Gross State Product (GSP) for every dollar spent. This impact is largely due to the electricity program which creates 46 job-years per million dollars of program spending and a ratio of over five for GSP impacts compared to the budget ($39.1 million). Heating and process fuels (HPF) program exhibits much lower impacts per dollar since fewer of the associated equipment is produced in-state and its energy savings are small compared to the electricity program. Another important metric is personal income. For every dollar of program spending, an additional two dollars is generated in Vermonters' income over 20 years. In terms of gross energy savings, the programs create over six dollars for every dollar spent on the program. These impacts take on more significance when we consider that Vermont's energy efficiency programs will continue to operate for multiple years, compounding these net benefits.

[9] Values in the report have not been discounted for the future value of money unless otherwise stated. Impacts were modeled using 2011 constant dollars (2011$). Therefore, 2012 dollars are adjusted downwards assuming a 2.6% long-term inflation rate to calculate "job-years per million dollars" and the two multipliers. The program spending refers to dollars funded from the efficiency charge to ratepayers and from RGGI and FCM revenues.

Table 2: Leverage of Program Spending

Program Spending Metric	Electric	HPF	All
Total Budget (million, 2011$)	$39.1	$5.3	$44.4
Job-years per million	46	16	43
$GSP/$Budget	5.5	0.9	5.0
$Personal Income/$Budget	2.5	0.4	2.2
$Energy Savings/$Budget[10]	6.6	2.7	6.1

10 If the energy savings and program budget were discounted at a real rate of 5.6%, these ratios would be 4.6 for electricity, 1.6 for HPF, and 4.2 collectively.

METHODOLOGY

THE REMI PI+ MODEL

We used the PI+ model developed by REMI (Regional Economic Models Inc.) to estimate the economic impacts of Vermont's energy efficiency programs. This model is used throughout the US, including by many state and federal government agencies. The model is dynamic and sophisticated, capturing structural changes in the regional economy that result from a direct stimulus.

REMI has built-in baseline forecasts of economic activity that are calibrated to each study region (in this case the State of Vermont). Changes to economic activity represent "policy changes" that affect the trajectory of the state economy—in this study this includes changes to consumer spending, businesses' energy costs, and additional commercial activity and industry demand related to energy efficiency investments. The model results show the difference in these alternative forecasts from the original baseline, representing what is expected to occur in the future over and above what would have occurred in the State's economy absent any changes in policy.

CASH FLOWS CAPTURED IN THE ECONOMIC MODEL

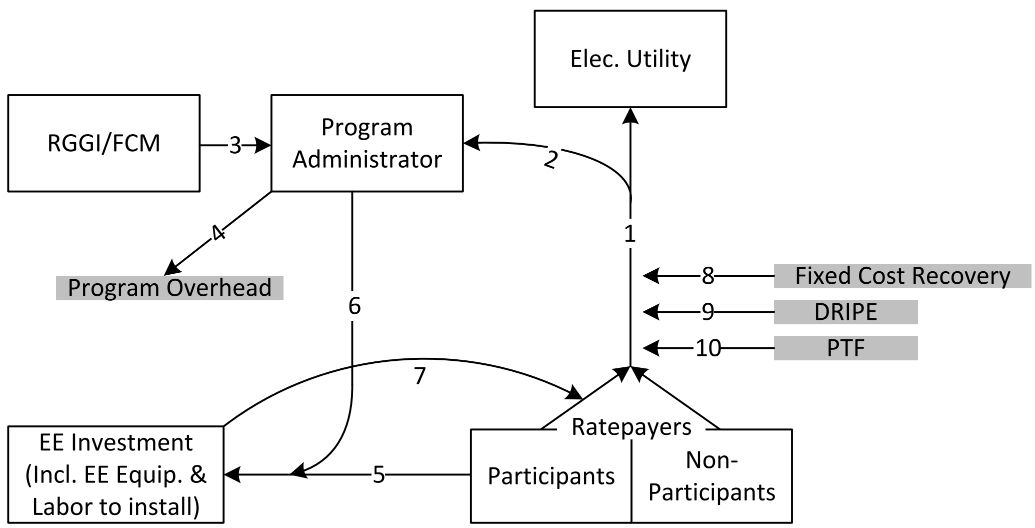
The economic modeling through REMI takes into consideration all of the changes in cash flow due to the funding and activities of the efficiency programs. Inputs to the REMI model fall into three broad categories:

- **Program and Participant Spending –** Efficiency investments have an economic impact from equipment that is produced within the region and to the extent that local contractors are installing the equipment. These investments are comprised of both participant costs and incentives contributed by the program administrators. The program also requires spending on administration and overhead to operate.
- **Participant net energy savings.** While users have to invest in upgrades or equipment at the outset, savings start to accrue after these costs have been offset (usually several years after installation) and continue throughout the efficiency measure's useful life. Households take these savings and spend a portion on other goods further stimulating the local economy. Businesses have lower costs, freeing up capital for investment and improving competitiveness. Types of savings include energy (electricity, natural gas, heat and process fuels), water, operations and maintenance, and savings due to the deferred replacement of old equipment.
- **Ratepayer Effects.** All ratepayers are affected by the adoption of energy efficiency programs. The program is funded by all customers, who pay a Systems Benefits Charge (SBC) as a percentage of their electric bill. Counteracting this additional expense is the downward pressure on energy prices due to decreased demand for energy in Vermont. Specifically, impacts

due to Demand Reduction Induced Price Effect (DRIPE), utility avoided costs, and avoided contributions to Pooled Transmission Facilities (PTFs) managed by the New England Independent System Operator (ISO-NE).

Energy efficiency investments are modeled in REMI as transfers of money from one party to another (from ratepayers to various industries in and out of state), whereas savings due to investments are modeled as increased discretionary spending for residents and lower energy costs for businesses that participate. Both are considered cash flows. To conceptualize the interactive effects of these cash flows (in the way that REMI does), it is useful to look at an illustration. Figure 1 represents the various cash flows and how they relate, with explanations provided below the figure.

Figure 1. Cash Flow Diagram of Vermont's Energy Efficiency Investment



1. Payments by electric ratepayers via their electric bills.
2. The surcharge on electric bills collected to fund electric energy efficiency programs (EVT and BED).
3. Allowance auction revenues provided to the Heat and Process Fuels (HPF) program administrator (Efficiency Vermont) from the Regional Greenhouse Gas Initiative (RGGI), and revenue provided to EVT for demand resources from the Forward Capacity Market (FCM).
4. Payments to EVT and BED for program administration, core supporting services, and other non-incentive costs used to deliver the energy efficiency programs.
5. The incremental cost of energy efficient equipment, above the cost of baseline equipment, paid by those installing the efficient equipment due to the efficiency programs.

6. The incentive contributed toward efficient equipment and technical assistance to contractors. This activity reduces market barriers to energy efficiency investments such as first cost and lack of awareness.
7. The energy efficient equipment reduces the energy consumption of the end-user, resulting in lower utility bills.
8. Items 8, 9 and 10 all impact customer electric rates due to reduced electric consumption. Item 8 shows impacts in customer electric rates due to fixed cost recovery, since they are not supplying as much electricity.
9. Reductions in customer electric rates due to Demand Reduction Induced Price Effects (DRIPE).
10. Reductions in customer electric rates due to Vermont's reduced contributions to Pooled Transmission Facilities (PTF) and ancillary services provided by the New England Independent System Operator.

DEVELOPEMENT OF INPUTS TO THE REMI MODEL

The basis for the development of economic impacts due to the electric portion of efficiency investments was the Demand Resource Planning Project (DRP) conducted by Vermont Energy Investment Corporation (VEIC) and Optimal Energy for the DPS in the spring of 2011. The DRP was a detailed measure-level analysis whose savings and spending targets were close to those recommended by the DPS and used for this study. Measure incentive and market penetration levels were thus adjusted in the DRP study to match the desired yields ($/MWh) for this analysis. Additional adjustments were made for the inclusion of BED (the VEIC DRP only included EVT), as well as for the effects of geotargeting (which lowered savings per dollar invested). The strength of this approach lies in the fact that once the necessary changes to spending and savings were made, the energy impacts and associated costs were readily available by sector, program, and measure over the 20-year study period.

The basis for the economic impacts due to the non-electric portion of efficiency investments was an efficiency potential analysis of the Heating and Process Fuel (HPF) as part of the 2011 DRP project developed by VEIC. Developed in response to the Vermont Energy Efficiency and Affordability Act (2008), which established new, aggressive goals for increasing building thermal efficiency, the plan provides high-level strategies and anticipated savings for efficiency services beginning in 2012. The energy impacts are based on the anticipated savings while key assumptions such as average measure life and incremental cost were developed from a review of the individual program designs.

Once the energy savings were estimated by sector and year, they were multiplied by average retail rates[11] to determine the net benefits to end users. They were also used to determine the total reduced supply requirements for the utilities.

[11] See Appendix A for further detail on the source and development of retail rates for electricity, natural gas, and heat and process fuels

PROGRAM AND PARTICIPANT SPENDING

The energy efficiency program requires significant resources to operate but these expenditures also induce economic activity for industries and services that operate in Vermont. Firstly, the program calls upon technicians, administrators, and other professionals to operate. Secondly, participants in the program must purchase efficient equipment and install them in their home or business. These purchases include more efficient appliances, light bulbs, furnaces, etc., some of which must be installed by professional contractors.

Table 3 below shows the one year spending of $67.1 million on program administration, equipment, and installation. The program overhead and delivery cost (including technical assistance, marketing, and administrative costs) is $23.3 million.[12] The investments in equipment and installation total $43.8 million, of which some is covered by financial incentives ($21 million) to purchase efficient equipment; participants then pay the remainder of the costs of investment "out-of pocket" ($22.7 million).

Table 3: Program and Participant Costs (2011$)

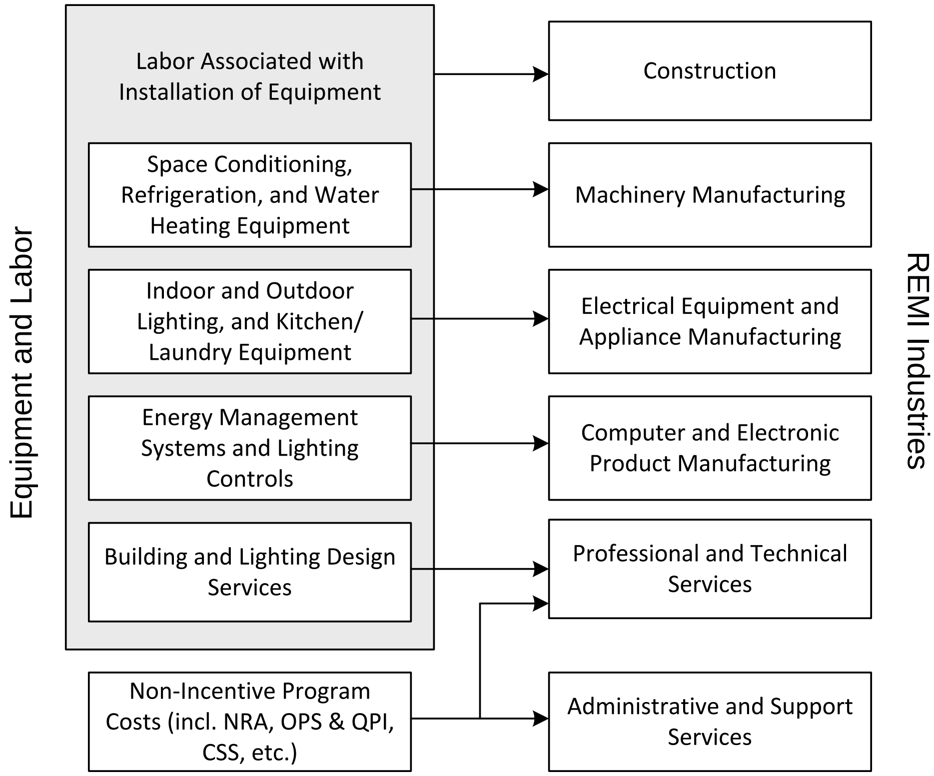
Spending Category	$Million
Total Equipment and Installation	$43.8
Participant out-of-pocket costs	*$22.7*
Incentives	*$21.0*
Program Delivery/Administration	$23.3
Total Program and Participant Spending	**$67.1**

This activity creates an initial stimulus in the local economy for the first year of the program's operation. Moreover, this stimulus is only felt by a handful of industries, namely those associated with energy efficient equipment and its installation. The magnitude of the impact felt by each industry depends on the total incremental cost associated with a given industry's corresponding equipment/services, and the amount purchased. The process of matching equipment with industries was, with a few exceptions, based on the equipment's end-use. A more granular, measure-level approach could not be taken due to the limited set of industries in the REMI model (e.g. *Electrical Equipment and Appliance Manufacturing* encompasses both indoor and outdoor lamps and ballasts, as well as household appliances such as clothes washers and dishwashers). Figure 2 below shows the general mapping of equipment and labor categories to REMI industries[13].

[12] Despite the significant positive economic impacts shown in this report, it is important to recognize that these costs, too, are significant. Efforts should continue to ensure that programs are as efficient as possible, to maximize both the efficiency savings and economic benefit associated with those savings.

[13] See Appendix B for detailed descriptions of the REMI industries.

Figure 2. Mapping Equipment and Labor Investments to REMI Industries

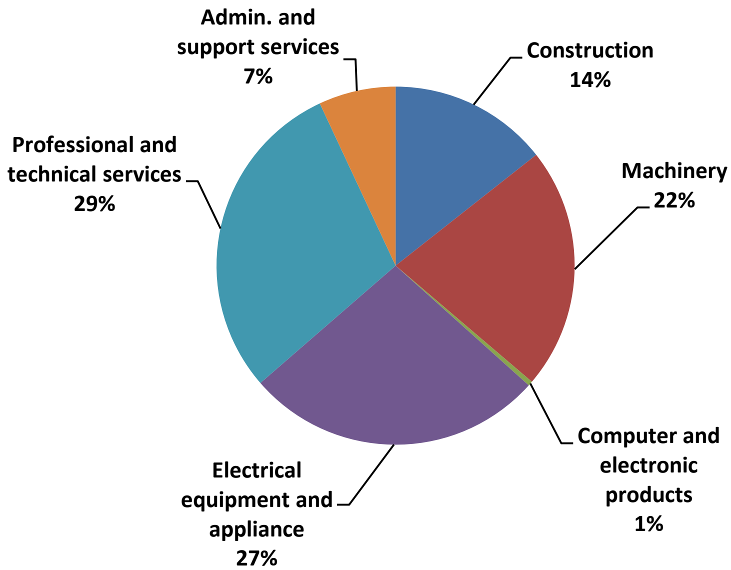


NRA = Non-Resource Acquisition. OPS & QPI = Operations and Quantifiable Performance Indicators, which comprise EVT's performance incentive. CSS = Core Supporting Services, mainly marketing and information technology services.

The mapping of equipment and labor categories to REMI industries was conducted on a program-by-program basis. This was due to the fact that the portion of the incremental cost due to labor was most easily estimated by program (e.g., labor costs were estimated to be near 0% for retail products programs, but upwards of 30% for the low-income program).

Figure 3 below shows the proportion of the total investments going to each industry. The extent of economic impacts depends on the amount of each activity provided in Vermont. Program administration (professional, technical, administration and support services) and installation of equipment (construction) were both considered largely in-state activities since the program is run in Vermont and would most likely call on local contractors for installation. However, the production of efficient equipment (machinery, computer and electronics, electronic equipment and appliances) will not all take place in-state. The economic model uses assumptions for the portion of demand that is provided locally for each of these industries to ensure that only the local production is counted in Vermont's economic impact.

Figure 3. Distribution of Program and Participant Spending by Industry



ECONOMIC BENEFITS OF ENERGY SAVINGS

Participants in the energy efficiency program save by forgoing the purchase of energy and related expenses that they would have without the program. Over the course of 20 years, residents and businesses participating in the efficiency programs save over $247 million in estimated energy-related spending. The savings directly related to the electric efficiency investments were modeled using Optimal Energy's Portfolio Screening Tool. Benefits from the Heat and Process Fuels programs are based on projected spending and savings for 2012 developed by Vermont Energy Investment Corporation (VEIC). Table 4 shows the distribution of total savings by type of energy spending. Not surprisingly, the majority of savings is attributed to spending on electricity ($207.6 million, 84%) while the rest is distributed among heating fuels, water and operations and maintenance savings.

All ratepayers are also subject to the responses of prices due the decreases in energy demand afforded by participants. In this case, ratepayers experience an initial cost due to utilities increasing rates to recover fixed costs. However, this force is counteracted by the savings from reduced transmission from Pooled Transmission Facilities (PTF), and DRIPE (Demand Reduction Induced Price Effects) which refers to a drop in prices due to the reduction of demand. This amounts to $25 million in savings due to rate effects, also shown in Table 4. See Appendix A for the data sources and assumptions for each of these components.

Table 4: Cumulative Gross Benefits from Energy Savings by Type (2012-2031, 2011$)

Energy Spending[14]	Gross Benefits (million)	Percent of participant savings
Electricity	$207.6	84%
Oil, Propane, Kerosene	$13.8	6%
O&M	$20.1	8%
Water	$5.6	2%
Participant Savings	**$247**	**100%**
Ratepayer Savings[15]	**$25**	**-**
Total Gross Savings	**$272**	**-**

Figure 4 shows the estimated gross benefits (presented above) for participants and ratepayers distributed by year. The timing of these benefits is based on assumptions of deterioration of efficiency investments (by type of equipment) over time. Likewise, the savings resulting from these investments taper off as the equipment becomes less efficient or expires. It is important to note that these effects were estimated for one year's spending in 2012. A program with continued funding year-to-year would not show this decrease over time since new efficiency would be perpetually coming on-line each year (though the program benefits would change from year to year as prices for equipment and energy change, and due to increases in the baseline efficiency of new equipment, from which program savings are measured).

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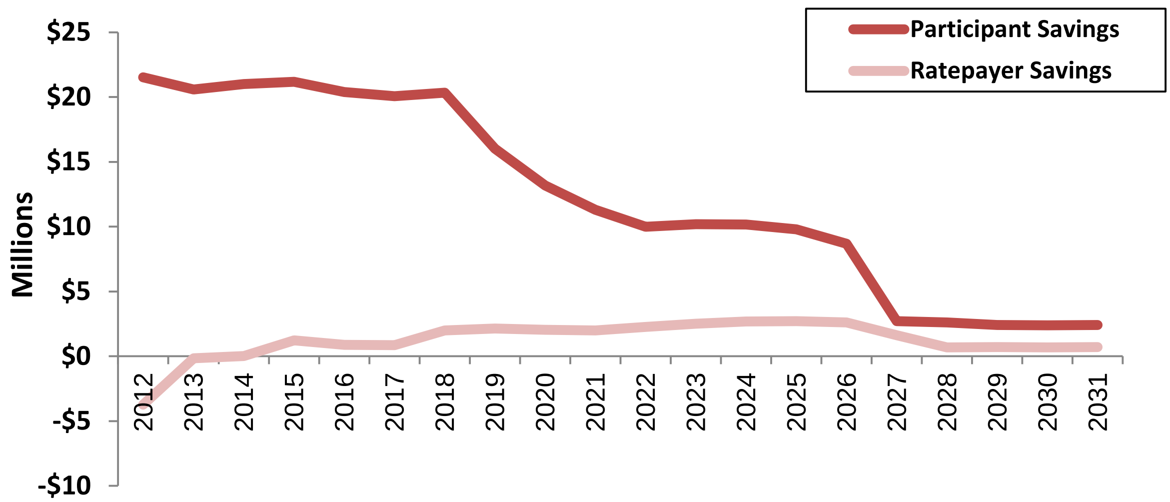
14 Natural gas savings were excluded since they were close to nothing (-$100,000 or .-04% of total savings).

15 "Ratepayers" here refers to the effects on participants and non-participants due to changes in rates. This also includes deferred replacement credits awarded to participants (nearly $6 million).

Figure 4. Participant and Ratepayer Gross Benefits on Energy Expenses by Year (2011$)

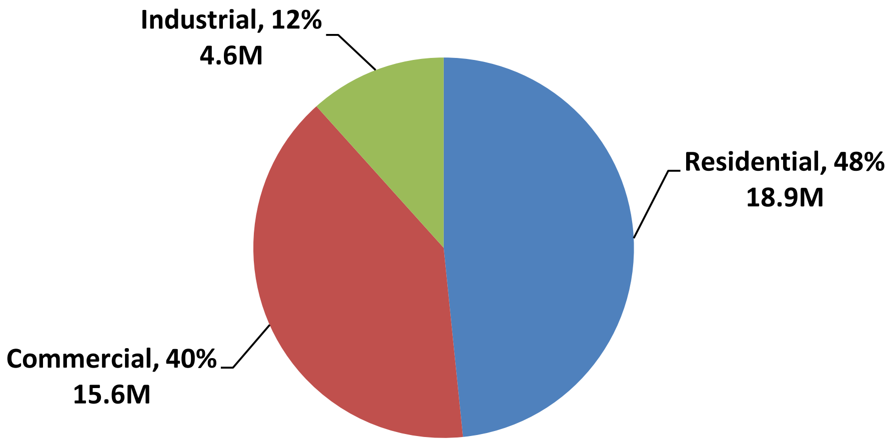


COSTS TO PARTICIPANTS AND RATEPAYERS

Of course, the gross benefits come at the expense of ratepayers and participants. All electric ratepayers are subject to an additional charge that funds the energy efficiency program. This Systems Benefit Charge (SBC) amounts to $39.1 million (2011$) which goes towards the costs to deliver and administer the program ($20.6 million) and financial incentives that participants claim when investing in efficiency ($18.5 million). The remaining funding for the HPF program comes from RGGI and FCM (Forward Capacity Market).[16] Figure 5 shows the source of the SBC by ratepayer sector.

[16] Ratepayers throughout the region pay for these costs as internalized in rates. Thus, the economic cost to the state of raising these revenues is already incorporated into the model and not considered an additional a cost for this study.

Figure 5. System Benefit Charge Collections by Sector (2011$)



Source: Vermont Department of Public Service, 2010 Collections by Rate Class

The financial incentives (funded by ratepayers) only cover a portion of the investments needed to participate. In aggregate, participants pay the majority of the total investment of $43.8 million as shown previously in Table 3. However, in reality, not all of these costs would be incurred up-front by the participants. Many will take out loans to cover the additional expense. Larger investments are more likely to require outside funding, though smaller investments often contribute to general borrowing to meet cash flow needs. This would mean that the participants amortize the cost—pay a monthly charge including interest and principal of the loan for the equipment. With this in mind, we developed estimates of how much of each type of investment would be paid up-front (with the remainder amortized over a longer period) and the average length of the amortization period.

Table 5: Assumptions for Participant Financing

Type of Program	% of expense amortized	Years to amortize
New Construction	100%	20
Residential Multi-Family programs	50%	10
Existing Homes/Retrofits	50%	5
Heating Equipment	0%	N/A
Retail Products/Low-income programs	0%	N/A

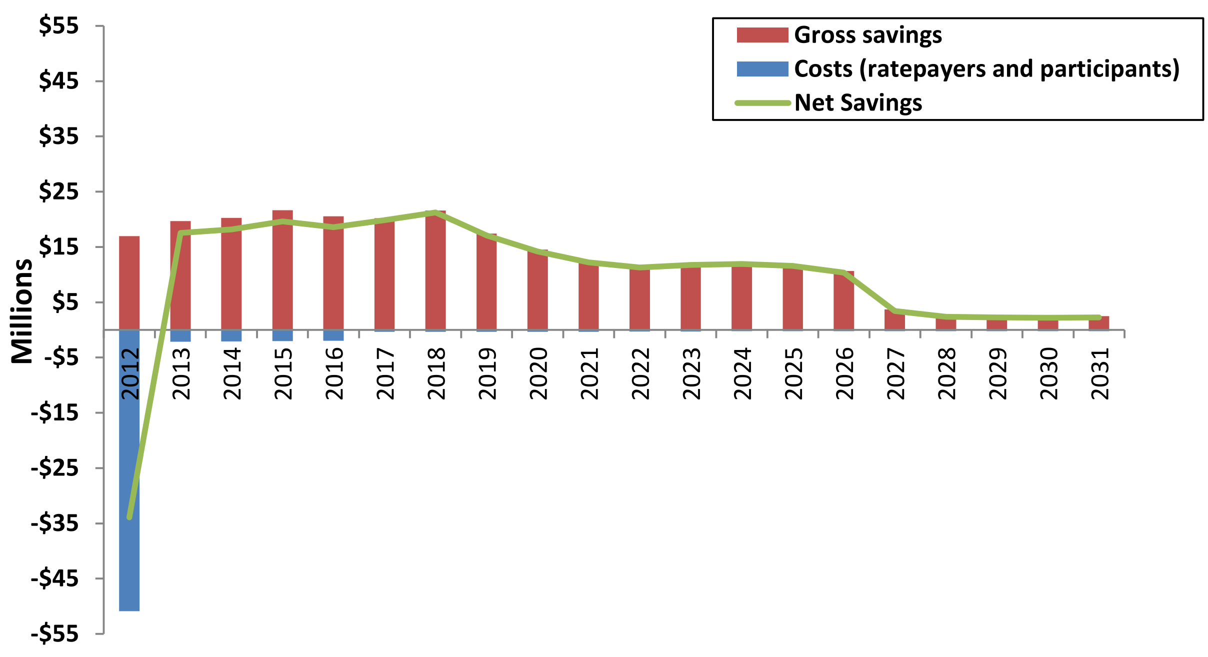
Due to the costs of borrowing, the participants pay a higher amount than if they would have paid "out-of-pocket" in the first year. Using the assumptions above, the total participant spending over 20 years is $25.1 million[17] (instead of the original $23 million). Even though the total costs are higher, distributing the costs over the years also means that participants overall expend less in the first year. In sum, this results in higher economic impacts in 2012 and slightly lower impacts in the future years.

NET SAVINGS FOR PARTICIPANTS AND RATEPAYERS

In order to capture how the program affects residents and businesses, the net savings (gross savings minus the costs associated with the program) is the most important indicator. Cumulatively, the net savings is $208 million for the 20-year period. Figure 6 shows the gross savings, costs and net savings (difference between the two) by year. Initially, net savings are negative since a portion of the investments are paid for out-of-pocket in the first year and all ratepayers are paying an extra charge on their energy bills. Throughout the 20-year period, households and businesses continue to pay for the amortized portion of their initial efficiency investments but save on energy spending. All ratepayers pay the first year charge but save in future years due to downward pressure on rates. Capturing the path of these net savings from year to year is crucial for determining the economic impacts.

For households, net savings represents additional money to spend elsewhere in the Vermont economy: restaurants, retail, and entertainment to name only a few. Participating businesses in Vermont experience a reduction in fuel cost savings that increases their bottom line. This cost savings can then be invested elsewhere, translating into more production and resulting jobs.

Figure 6. Net Savings, Gross Savings and Costs by Year (2011$)



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[17] We amortized based on the term of the loan, an average interest rate of 6% (typical rate for a home equity loan) and adjusting to 2011 real dollars.

APPENDIX A: SUMMARY OF DATA SOURCES AND ASSUMPTIONS

This appendix catalogues the data sources and assumptions used for this study that are not described in the body of the report.

Summary of Key Analysis Assumptions

Factor	Value	Source
Real Discount Rate	5.6%	DPS rate used in statewide screening tool for cost-effectiveness analysis
Long-term Inflation Rate	2.6%	Long-term average inflation rate for cost-effectiveness analysis used in statewide screening tool
Average electric line loss factor	9.5%	Weighted average of VT (10%) and BED (3.05%) average line losses
EEC collections by sector	48% Res 40% Com 12% Ind	Provided by DPS for 2010 for EVT and BED
Electric sales split by sector	42% Res 39% Com 19% Ind	Calculated from Itron sales forecast, not including sales from Self-Managed Energy Efficiency Program participant sales
Heating and Process Fuels (HPF) incentive spending split by sector	75% Res 17% Com 8% Ind	HPF analysis performed by VEIC in 2011 for the DPS
Benefit for Pooled Transmission Facilities and ancillary services provided by ISO-NE ($/kWh)	$0.0216	Regional Network Service (RNS) Rate Forecast, 2012-2015 ($0.015/kWh in 2012), plus $0.0066/kWh for ancillary fixed charges (provided by Paul Chernick, Resource Insight Inc.). A flat rate was used for the forecast period, though the RNS Rate is forecast to escalate in the coming years. The benefits are assumed to occur one year after the actual savings.[18]

[18] The RNS is calculated on a $/kW-Year basis, but is converted to $/kWh for ease of use in this report.

Inclusion of Burlington Electric Department (BED) Programs - The savings from electric efficiency programs were based on a 2011potential study analysis performed for the DPS by VEIC and Optimal Energy. That analysis only modeled EVT's program activity. The analysis was therefore adapted to fit the portfolio spending and savings targets recommended by the DPS, and to include both BED and EVT. An implicit assumption in the adjusted DRP analysis is that BED and EVT have efficiency programs with similar savings and spending composition. This is reasonable because BED's impact is relatively small compared to EVT; adjusting the forecast to account for BED's unique program characteristics (e.g., greater portion of C&I savings, higher concentration of multifamily buildings) would not significantly affect the results.

Electric Avoided Costs – Based on *Avoided Energy Supply Costs in New England: 2011 Report* (Synapse Energy Economics, July, 2011).

HPF Incentive Costs – Based on a detailed budget projection for the 2011 HPF programs, provided by VEIC. The total incentive costs were calculated to be 76% of the resource acquisition budget.

HPF Participant Costs – Estimated by sector based on review of program designs and corresponding electric programs.

Average Retail Electric Rates – Based on 2010 VT utility revenues and sales by sector, adjusted to 2011$ for inflation. The 2012 average retail rates by sector were estimated to be:

$0.158/kWh	Residential
$0.136/kWh	Commercial
$0.096/kWh	Industrial.

Retail rates for the years 2013-2031 were based on the 2012 estimates, escalated in proportion to the wholesale electric rates forecasted for those years in the 2011 AESC (July 2011, Synapse Energy Economics).

Average Retail Natural Gas Rates – Based on 2010 EIA retail prices by sector for VT, adjusted up for inflation. The 2012 rates ($/MMBtu) by sector were estimated to be: $17.06 – Residential, $12.5 – Commercial, $6.97 – Industrial. Retail rates for the years 2013-2031 were based on the 2012 estimates, escalated in proportion to the wholesale gas rates forecasted for those years in *Avoided Energy Supply Costs in New England: 2011 Report* (Synapse Energy Economics, July, 2011).

Average Retail Heat and Process Fuels Rates – Based on *Avoided Energy Supply Costs in New England: 2011 Report* (Synapse Energy Economics, July, 2011), Appendix E, Petroleum Fuels. Residential rates are for Distillate Fuel Oil. Commercial and Industrial rates are a weighted average of Distillate and Residual Fuel Oil based on a 5-year average from EIA data for Vermont (commercial was 86% distillate, 14% residual, while industrial was 78% distillate and 22% residual). The 2012 average retail rates by sector were estimated to be:

$26.22/MMBtu	Residential
$16.61/MMBtu	Commercial
$9.39/MMBtu	Industrial.

Retail rates for the years 2013-2031 were based on the 2012 estimates, escalated in proportion to the wholesale HPF rates forecasted for those years in the 2011 AESC report.

DRIPE Benefits – Calculated as the sum of energy and capacity benefits for Vermont, on a per kWh saved basis, from the *Avoided Energy Supply Costs in New England: 2011 Report* (Synapse Energy Economics, July, 2011),.

Incentive Spending as % of Total Program Budgets – Based on historical program splits as captured in the DRP analysis. The percent of total program budgets going toward incentives is laid out in the following table:

Programs	Residential	C&I
New Construction	9%	65%
Retail Products	81%	81%
Retrofit	55%	69%
Efficient Equipment	n/a	75%
Low-Income	59%	n/a
Multifamily	37%	n/a
HPF	76%	76%

In-state vs. Out-of-state Economic Activity – spending on goods and services in the REMI model can be input as either "local" or "general". If it's input as local, the economic activity generated by that spending is confined to the state. If it's general, the REMI model redistributes the spending between in-state and out-of-state based on its preprogrammed understanding of VT's economy. Costs (participant and incentive) associated with equipment were input as general, whereas costs associated with installation of equipment and technical services were input as local.

APPENDIX B: INDUSTRIES USED IN THE REMI MODEL

The following "REMI industries" correspond to subsectors of the North American Industrial Classification System (NAICS) that were applied in this study. Each represents a general set of related sub-industries, and thus provides only limited precision compared to the real-world impacts of energy efficiency investments. Brief descriptions and examples of sub-subsectors are provided for each as a means of clarifying their selection as appropriate proxies in the REMI modeling.

Construction: The construction sector comprises establishments primarily engaged in the construction of buildings or engineering projects. Construction labor may be related to new work, additions, alterations, or repairs and maintenance. Relevant subsectors include:

- Residential Building Construction
- Nonresidential Building Construction
- Foundation, Structure, and Building Exterior Contractors
- Building Equipment Contractors

Machinery Manufacturing: The machinery manufacturing sector comprises establishments engaged in creating end products that apply mechanical force to perform work. This includes machinery used in a variety of commercial and industrial applications. Relevant subsectors include:

- Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing
- Air Purification Equipment Manufacturing
- Industrial and Commercial Fan and Blower Manufacturing
- Heating Equipment Manufacturing
- Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
- Pump and Compressor Manufacturing

Electrical Equipment and Appliance Manufacturing: Industries in the Electrical Equipment, Appliance, and Component Manufacturing subsector manufacture products that generate, distribute and use electrical power including electric lamp bulbs, lighting fixtures, and parts; both small and major electrical appliances and parts; electric motors, generators, transformers, and switchgear apparatus. Relevant subsectors include:

- Electric Lamp Bulb and Part Manufacturing
- Lighting Fixture Manufacturing
- Small Electrical Appliance Manufacturing

- Household Refrigerator and Home Freezer Manufacturing
- Household Laundry Equipment Manufacturing

Computer and Electronic Product Manufacturing: Industries in the Computer and Electronic Product Manufacturing subsector manufacture computers, computer peripherals, communications equipment, and similar electronic products, and establishments that manufacture components for such products. Relevant subsectors include:

- Computer and Peripheral Equipment Manufacturing

Professional and Technical Services: Industries in the Professional and Technical Services subsector engage in processes where human capital is the major input. These establishments make available the knowledge and skills of their employees, often on an assignment basis, where an individual or team is responsible for the delivery of services to the client. The distinguishing feature of this subsector is the fact that most of the industries grouped in it are almost wholly dependent on worker skills. Relevant subsectors include:

- Accounting, Tax Preparation, Bookkeeping, and Payroll Services
- Architectural Services
- Engineering Services
- Building Inspection Services
- Interior Design Services
- Industrial Design Services
- Computer Systems Design and Related Services
- Environmental Consulting Services
- Marketing Consulting Services
- Other Scientific and Technical Consulting Services

Administrative and Support Services: Industries in the Administrative and Support Services subsector group establishments engaged in activities that support the day-to-day operations of other organizations. The processes employed in this sector (e.g., general management, personnel administration, clerical activities, cleaning activities) are often integral parts of the activities of establishments found in all sectors of the economy. Relevant subsectors include:

- Office Administrative Services
- Facilities Support Services
- Business Support Services
- Other Support Services

Appendix 6—Forest Management for Bioenergy

Forest Management for Bio-Energy

Demands placed on forests include biomass used for electricity, thermal applications, and potentially for transportation (cellulosic ethanol) along with lumber, pulp, recreation, aesthetics, and environmental services. Analysis of forest-related management issues encompasses the entire resource, regardless of varying potential end uses. The analysis of demand for electric power also applies to management of forests under thermal and transportation sections. Thus, this section applies to all uses of woody biomass for energy.

Forests are renewable but limited in extent and growth rate. The extent of forest in Vermont and the region is expected to decline, a trend already in progress in neighboring states. Through judicious application of forest management options, forest growth may be increased somewhat. There is speculation about how much of an increase in forest growth might be achieved, but no agreement. Although over the past century Vermont has been increasing its forest cover, the past 20 years of forest inventory data for Vermont show a declining growth rate. This decline is recognized as a natural result of a maturing forest.

Vermont is about 78% forested (4.6 million acres). Area of forestland is a critical foundation for wood supply. The overall forest contains 324,958,303 green tons of wood in live trees, 40% of which is considered at this time to be of quality not suited to paper or lumber or wood product manufacturing. The growth of the total live tree population is approximately 5,524,000 green tons per year. The growth of the so-called low-grade fraction of the inventory is approximately 2,382,000 green tons per year. Although growth has been declining, total inventory is still increasing, though the rate of increase has been slowing. [1,2]

Wood Supply - Since at least 1977 there have been a series of wood supply studies commissioned specifically for energy interests. Some of these studies have been more quantitative than others. All have arrived at the same conclusion: there is some margin of increase in wood harvesting that can be attained on a sustained basis in Vermont and the market region. The range of projected volume that can be harvested in addition to the current volume of wood fuel harvest has been estimated to be 200,000 to 3,000,000 green tons per year. The breadth of this range reflects different assumptions about the current and projected state of the forest, how forests grow, the state of the forest products economy, and the nature of the additional demand. Wood supply projections are very sensitive to changes in growth rate and harvesting capacity. These are dynamic factors which makes reliable projection a challenge. Less dynamic but also influential are forest accessibility and general forest products demand. Assumptions that incorporate expectations of stable or increasing forest growth, a stable or growing forest products economy, and stable or increasing access to forests for harvesting lead

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[1] *Vermont's Forest Resources 2010; Morin, Randal, et al. USDA Forest Service Res. Note NRS-105 Pg. 1*

[2] *Forest Inventory and Analysis Database, Forest Inventory and Database Online (FIDO), USDA Forest Service*, http://fiatools.fs.fed.us/fido/index.htm

to projections at the upper end of the range. Assumptions in the opposite direction tend to deliver lower expectations of new harvest volume.

ANR chooses to use the moderate harvest intensity scenario as given in the Biomass Energy Resource Center (BERC) 2010 wood fuel availability assessment.[3] The volume of low-grade wood available in Vermont above and beyond current use is given at 900,000 green tons per year. Projects in progress at this time and proposed for initiation in the near future may provide additional information that better describes a potential sustained yield range. The moderate scenario figure from BERC is chosen because the assessment is the most transparent available. That transparency allows open discussion of the estimate. The assumptions used for that assessment were developed in consultation with a variety of people in the region familiar with forest inventory and modeling, with forest economics, with logging and wood energy, and with private land demographics. They are not, however, accepted by all.

Whatever the most reliable estimate of wood availability may be, the diverse and independent nature of the supply side makes any *a priori* partition of that supply to designated energy uses questionable. Under such circumstance, it can be proposed that price signal alone will determine how the resource is distributed. Financial incentives can be developed to direct wood toward preferred uses, and in the past, this has been done at both the state and federal levels – though not necessarily with a fully consistent policy in effect. Absent that application of policy, the largely unregulated forest products market will continue to aggregate tens of thousands of individual decisions that are in large part, but not totally, influenced by price.

Privately owned forestland yields an estimated 93% of the forest harvest volume each year.[4] This shows that the 14% of the forest held by government and other owners contributes a lesser volume than the share of acreage would predict. In other words, the forest products economy is close to complete dependency on the owners of private land. Policies chosen to encourage greater production of forest products must include strong consideration of the interests of these landowners.

Forest Products Economy - Projections of available wood for harvest in excess of current production are dependent on the forest economy. Productive capacity of the forest products sector has been declining in response to declining demand for forest products. The state of the sawlog market generally drives harvesting potential, though a few examples exist showing the possibility of adequate pulpwood price making harvest feasible.

Production of wood for fuel is a function of the forest products sector. Almost all logging in the region is organized around the fullest range of products possible from any given woodlot: sawlogs and veneer logs, pulpwood and fuelwood, including residential firewood. The principle of highest and best use has been standard for several decades by landowners, loggers, foresters

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[3] *Vermont Wood Fuel Supply Study, 2010 Update. Biomass Energy Resource Center. 2010. Pg. 29*

[4] *Morin, et al. (2010)*

and wood using businesses. Highest and best use ensures that any tree harvested will be partitioned and those parts sold into the market that pays the highest price. In other words, highest and best use is about making sure that a sawlog does not end up as firewood.

Steady decline of pulp and paper manufacturing in the region has reduced the demand for pulpwood, a lower grade of wood than sawlogs. The growing demand for wood fuel is expected to replace the market losses in pulpwood and possibly exceed historic pulpwood demand levels.

Whatever the resource base may be from which additional wood may be harvested, the productive capacity of the forest products sector plays a significant role in whether what is available may be fully obtained. Loggers and foresters as well as wood processing businesses all play a role in making a wood fuel sector viable.

Over the past 15 years the number of sawmills has declined. This matters for two reasons: First, local demand for sawlogs has declined with the loss of mills; second, wood chips from sawmills have played a dominant role in the growing wood energy market in the region, and loss of mills means loss of that fuel product. As mill chip volume has declined, growing demand for wood chips has had to be met directly from the forest. Logging businesses are faced with a substantial capital investment to acquire one or more chippers and transportation equipment including live bottom trailers.

Prices paid for forest products play a dominant role in the choice to harvest and what to harvest, how far to ship products, and how to assign wood to different markets. In times of high sawlog prices, it is possible to harvest larger volumes of low priced products, like fuelwood. In times of higher process for low-grade trees, it is possible to increase harvest in that category. In times of depressed prices for all forest products, a harvest may not be possible.

The energy market for wood also varies, and so affects the price paid for the product and the value to the landowner and logger. Wood for pellet manufacturing is frequently the same as for pulpwood in terms of quality specifications. The wood for power plant use has a specification similar to residential firewood but lower specification than for pellets. Both power plants and pellet manufacturers can use softwood, hardwood or both. Power plants can also make use of tops and limbs that cannot be used as residential firewood or for making pellets. The residential firewood market has become differentiated as more automated firewood processors come on line. These processors work best with wood that meets specifications closer to pulpwood. Wood for institutional heat, such as schools and colleges, generally uses a paper-grade chip, which as the name implies, is similar stock to pulpwood.

There is no specification established for wood to be used in making ethanol or bio-oil but current expectations are that it will fall between the power plant and firewood specifications. Forest extent and growth are limited. The forest products sector also has limits to production. The certainty of demand for wood from Vermont from users outside the state will further limit what is available for in-state use. The constraints on wood availability limit how much energy demand can be satisfied through Vermont’s resource.

Furthermore, we can expect that a hierarchy of use will continue based on price. Price for wood fuel for electric generation will be limited by the regulated price for electricity. Price for wood for ethanol and bio-oil production will be limited by the transportation sector expectations on affordability. Price for wood for combined heat and power systems will be less limited since efficiency will be higher and thermal use is not regulated. However, CHP wood will still be subject to expectations of affordability and will be somewhat limited by electricity price. Price for wood for thermal only applications, particularly space heating, is limited the least both due to its efficiency and because it competes with more expensive fossil fuels, primarily in the forms of oil and propane.

Since landowners, foresters, and especially loggers make highly independent decisions regarding each of the nearly 30,000 privately owned forest parcels[5], behavior driven by price alone is unlikely. Still, past behavior regarding allocation or forest products to various markets shows that price paid to loggers and landowners plays a major role.

Forest Sustainability – Most all acknowledge that additional forest wood use should be "sustainable"; however, there is no one single measure of forest sustainability. There is no widely agreed upon sustainability assessment approach. There are, instead, a mix of measures and comparisons commonly used.

The most common surrogate for forest sustainability is the so-called "growth to removals" ratio. This ratio compares forest growth to volume of wood harvested. Growth measures the increase in size of trees as a volume plus the volume of trees growing into a minimum diameter since a previous measurement. Removals may also include with harvest volume the land area removed from accessibility or developed.

A positive growth-to-removals ratio indicates that a forested area is growing in volume and/or extent faster than it is being harvested. The growth-to-removals ratio indicates what is known as *sustained yield* of forest products. When applied to the state, the reliability is acceptable. Growth estimates for subdivisions of the state will provide less reliability because the sample size decreases.
Latest forest inventory data show a growth to removals ratio for Vermont at 2.25 to 1; that is 2.25 times the volume of wood harvested remains in the forest as growth added to the total. This ratio has been declining since 1983 when it was about 3 to 1 and about 2.5 to 1 in 1997.[6]

The key factor for sustainability is forest health. The state's forest health monitoring program shows that the majority (>85%) of the forest area is considered healthy.[7] Forest health can serve

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[5] *Data obtained from USDA Forest Service National Woodland Owner Survey,* http://apps.fs.fed.us/fia/nwos/tablemaker.jsp

[6] *Morin, et al (2010)*

[7] *2010 Vermont Forest Health Highlights, Vt. Division of Forests, URL:*

as a more general surrogate for other factors including soil productivity, forest resilience, and human influence.

Biodiversity is a critically important factor for sustainability. Forest ecosystems are diverse. Loss of diversity is a practical concern because it can reduce forest growth. Measures of biodiversity in Vermont indicate that threats posed by climate change, invasive plants, exotic pests and diseases, land use change and wood demand can diminish biodiversity.

Given the relatively positive state of the forest and the fact that a surplus of wood is available for harvest, it is generally believed that the past use of the forest has been sustainable. With the positive condition as a starting point there is general acceptance among natural resource professionals, given the present state of knowledge, that harvesting more wood can be done sustainably, accounting for all forest values of interest.

One of the keys to harvesting more wood, especially for energy for which steady local supply is more critical than for other forest products, will be a robust and adaptive forest monitoring program. Monitoring forest condition and sustainability is already done but the extent of that work must be expanded into more categories and more depth for what is measured. This will be essential as more energy consumers both within and outside Vermont look towards the same forest resources to meet increasing demands for electric, thermal and potentially transportation power sources.

Harvesting biomass from our forests also has implications for entire ecosystems, which include wildlife. Effective future planning must consider not only the benefits of harvesting biomass, but also the existing ecosystem functions and intrinsic value of forests. A comprehensive planning approach will enable Vermont to meet its ongoing biomass harvest needs while minimizing the negative effects on things like wildlife corridors and breeding areas, vegetative buffers around lakes and streams that protect water quality, habitat for fish, and a wide variety of other species, etc.

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www.vtfpr.org/protection/documents/Final2010ConditionReport.pdf, Pg. 1