Economic Modeling Analysis of Total Energy Study Policies

Vermont Public Service Department

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Contents

Executive Summary

The FACETS modeling done by Dunsky Energy Consulting (DEC) provided the Public Service Department (PSD or Department) with an informative view of the direct monetary costs associated with the pursuit of Vermont's energy and greenhouse gas goals through various policy pathways. Three different policy sets were modeled by DEC, each with a unique (though similar) trajectory of energy related costs: (1) Carbon Tax Shift, (2) Total Renewable Energy and Efficiency Standard (TREES), and (3) TREES with an additional local requirement.[1]

In the real world changes in the costs of meeting the energy needs of an economy also imply changes to a variety of spending flows that provide revenue to businesses and wage income to workers. The purpose of PSD's economic analysis of the Total Energy Study policy sets was to estimate the net impact that results from an increase in energy costs that must be met with an equal change in the amount of spending in the economy. To perform this analysis, PSD relied on the PI+ software developed by Regional Economic Models Inc. (referred to as "REMI"). Each of the REMI simulations constructed by PSD capture the interplay of four broad economic processes that characterize Vermont's energy transition under each policy scenario:

1. The rerouting of household and business fuel spending away from fossil fuel producing industries and toward renewable energy producing and energy efficiency industries.
2. A shift by households and businesses toward greater spending on equipment and efficiency improvements, and less spending on operation and maintenance costs.
3. The price response by consumers and businesses to increases in the cost of living and doing business due to rising energy prices.
4. The use of policy instrument revenue (either carbon tax revenue or TREES certificate revenue) to offset negative effects of this price response.

PSD's REMI simulations are intended to provide answers to two central questions about the economic implications of the FACETS results. Firstly, what is the magnitude and direction of the economic impact of the three examined policies, supposing that policy instruments perform as intended? Secondly, what can be learned from the variability in economic outcomes within and across policies?

Through the modeling effort described in this document, PSD found that each of the TES policy sets could be implemented so that the economy experiences beneficial increases in output, employment and income.[2] An economically successful Carbon Tax Shift policy results in an average yearly increase in Gross State Product (GSP), compared with the baseline or business as usual (BAU) case, of between $139 and $363 million (in 2014 dollars), depending on the price and availability of biofuels. An economically successful TREES Basic policy results in an average yearly increase in GSP of between $123

[1] See DEC report, "Energy Policy Options for Vermont: Technologies and Policies to Achieve Vermont's Greenhouse Gas and Renewable Energy Goals" for details of their analysis and descriptions of each Total Energy Study (TES) policy set.

[2] PSD also modeled versions of the TES policy sets in which the policy instruments were assumed to be less effective. What follows are results from "effective implementation" versions of the policy scenarios. See Section 2 and 4 for an explanation of how policy instrument efficacy was treated in the Department's simulations.

and $238 million. An economically successful TREES Local policy results in an average yearly increase in GSP of between $140 and $246 million. Though positive, these changes are small relative to total GSP, representing between 0.23% and 0.69% increase over baseline levels. For employment, percentage changes above baseline are more salient, ranging from 0.44% and 1.26%.

These generally positive results require that policy instrument revenues—either carbon tax revenue or income from sales of TREES certificates—be used in such a way as to provide enough counter-stimulus to offset the effects of increasing unit costs of energy in each policy scenario. As described in section 4.1, policy effectiveness is especially important when the unavailability of low-priced biofuels constrains the suite of renewable energy options.

For a Carbon Tax Shift policy, the difference between effective and ineffective policy implementation policy could mean between $239 and $1,125 million in GSP a year (on average), depending on the price of biofuels. For TREES Basic, the analogous range is $341 to $1,383 million, while for TREES Local the range is $665 to $1,425 million. It is clearly important to strive for effective implementation.

The economic success of each of the policies is greater if other states pursue a similarly aggressive energy transition alongside Vermont, leaving relative energy costs between states unchanged. The economic benefit to Vermont of "going it together" is greatest when low-cost biofuels are not available. For the Carbon Tax Shift policy, "going it alone" would mean forgoing an average of $216 million in GSP per year. For TREES Basic, "going it alone" would mean forgoing $311 million per year. And for TREES Local, it would mean forgoing $375 million per year.

In each policy case, the expansion of employment and output in industries related to the supply of electricity and biomass is significant, growing by as many as 820 jobs per year (on average) in a "go it together" scenario when biofuel prices are low, and up to 2,500 jobs per year in a "go it together" scenario when biofuel prices are high. While ineffective policy implementation runs the risk of shrinking output and employment in a handful of large Vermont industries that do a large portion of overall business fuel spending, the majority of Vermont industries do not see significant net effects from any TES policy that is effectively implemented.

Exhibit 1. Percentage Change in GSP Relative to BAU Levels

	Gross State Product			
Scenario	**2015-2025**	**2025-2035**	**2035-2050**	**2015-2050**
Carbon Tax Shift: High Bio	+0.17%	+0.87%	+0.83%	+0.69%
Carbon Tax Shift: Low Bio	+0.08%	+0.15%	+0.32%	+0.23%
TREES Basic: High Bio	+0.03%	+0.70%	+0.53%	+0.45%
TREES Basic: Low Bio	+0.11%	+0.11%	+0.34%	+0.23%
TREES Local: High Bio	+0.09%	+0.58%	+0.58%	+0.47%
TREES Local: Low Bio	+0.11%	+0.13%	+0.40%	+0.27%

Exhibit 2. Percentage Change in Employment Relative to BAU Levels

	Employment			
Scenario	**2015-2025**	**2025-2035**	**2035-2050**	**2015-2050**
Carbon Tax Shift: High Bio	+0.33%	+1.65%	+1.61%	+1.26%
Carbon Tax Shift: Low Bio	+0.15%	+0.32%	+0.67%	+0.44%
TREES Basic: High Bio	+0.18%	+1.10%	+1.23%	+0.90%
TREES Basic: Low Bio	+0.22%	+0.25%	+0.70%	+0.45%
TREES Local: High Bio	+0.23%	+1.01%	+1.14%	+0.85%
TREES Local: Low Bio	+0.20%	+0.24%	+0.84%	+0.51%

Exhibits 1 and 2 display the percentage change in average GSP and employment (compared to BAU levels) for each of the TES policies under both high and low biofuel price scenarios. These results reflect simulations in which, 1) other jurisdictions take equally strong action to reduce greenhouse gas emissions and adopt renewable energy, and, 2) policy instruments are assumed to be most effective in countering consumer and business price response to higher energy costs. See Section 5 for a discussion of differences between “go it alone” and “go it together” scenarios. See Section 4.1 for a discussion of differences between “effective” and “ineffective” scenarios.

1 Economic Modeling Approach

The first step in the Department's economic impact analysis was to translate the monetary costs of meeting legislative targets, as determined by DEC's energy system modeling effort, into specific energy related spending streams created by household and business purchases in four categories:

1) spending on fuel
2) spending on equipment
3) spending on operation and maintenance
4) spending on efficiency improvements

To perform its analysis, PSD utilized PI+, a regional economic impact simulation software developed and licensed by Regional Economic Modeling Incorporated, commonly referred to as "REMI."[3] In the model mechanics of REMI, each of the above spending streams provides a demand stimulus to the economy that contends with the negative effects of increased unit costs of energy. In PSD's simulations, the net economic impact from each policy reflects the interplay of four broad economic processes expected to occur over the course of Vermont's energy transition.

1. The rerouting of household and business fuel spending away from fossil fuel producing industries and toward renewable energy producing and energy efficiency industries.
2. A shift by households and businesses toward greater spending on equipment and efficiency improvements, and less spending on operation and maintenance costs.
3. The response of consumers and businesses to an increase in the cost of living and doing business resulting from the integration of renewables into the energy supply and the expense added to energy purchases by the policy instrument (either carbon taxes or TREES certificates).[4]
4. The use of policy instrument revenue to counter these price response effects. In Carbon Tax Shift scenarios, this is accomplished by fiscal policy. In TREES scenarios this is accomplished when income from certificates sales enables renewable energy producers to lower retail prices.

[3] The REMI model is structured around an econometrically-derived baseline projection of input-output flows between industries. Exogenous changes to the size of those I-O spending flows are resolved through gradual endogenous quantity adjustments (by both firms and consumers) back toward baseline levels. Technical information about the REMI model architecture can be found at http://www.remi.com/resources/documentation.

[4] For households, PSD modeled the policy-induced increase in energy costs as a proportional decrease in consumer purchasing power. Consumers respond to this loss of purchasing power by substituting toward cheaper goods and services, and, when cheaper imports are unavailable, reducing overall spending. For businesses, the increase in energy cost is modeled as a proportional increase in production costs. Businesses respond to this increase in costs by increasing use of cheaper production inputs, and, when unavailable, decreasing investment spending.

Exhibit 3. Cumulative Changes in Energy Related Spending (in millions of 2014 dollars) Relative to BAU levels (2015-2050)

	Carbon Tax Shift		TREES Basic		TREES Local	
	High Bio ($1,250)	Low Bio ($450)	High Bio	Lo Bio	High Bio	Lo Bio
Electricity	+17,624	+3,663	+13,510	+4,288	+12,479	+3,582
NG & LPG	-7,288	-3,103	-7,024	-3,043	-7,008	-3,264
Distillates & Residual	-1,944	-4,680	-1,845	-2,348	-1,853	-2,515
Gasoline & Diesel	-23,774	-31,280	-19,491	-29,259	-19,578	-28,485
Biomass	+1,716	+410	+1,236	+591	+1,355	+527
Biofuels	+9,309	+36,621	+15,142	+29,516	+14,694	+26,897
Total Fuel	-4,356	+1,630	+1,528	-255	+90	-3,258
Conservation	+2,186	+239	+1,569	+323	+1,629	+457
Equipment & Maintenance	+5,579	+73	+1,968	+1,429	+5,115	+1,818
Operation & Maintenance	-1,102	-308	-1,746	-393	-1,051	-340
Total Spending	+2,308	+1,634	+3,320	+1,103	+5,783	-1,323

Exhibit 3 displays the cumulative change in energy related spending (relative to baseline levels) taking place in each policy scenario over the entire projection period (in millions of 2014 dollars from 2015-2050). Each TES policy induces a shift toward higher levels of spending on capital and efficiency improvements, but lower levels of spending on operation and maintenance costs. When low cost biofuels are unavailable (i.e. in high biofuel price scenarios), these shifts are more pronounced.

Policy-induced changes in the level of total spending on fuel—whether greater or less than business as usual levels—do not respond uniformly to the price of biofuels. When biofuels prices are only available at high prices, it is the TREES policies that see more spending on fuel. But when biofuel prices are lower, it is the Carbon Tax Shift policy that sees more spending on fuel. These outcomes are explained by the larger quantities of renewable energy brought online in the TREES scenarios. In order to achieve a 90% renewable energy supply, biofuels become a necessary component of the energy supply regardless of price. Not being constrained by the 90% renewable goal, the Carbon Tax Shift policy achieves emissions reductions targets with less use of biofuels.

2 Policy Scenario Variations

For each of the three TES policy scenarios, PSD performed two different sets of simulations, each including separate high and low biofuel price versions. As depicted in Exhibit 4, the first set of simulations is defined by the assumption that Vermont pursues the policy independently of other states. In these "go it alone" simulations, other states do not take on the costs of building a renewable energy supply alongside Vermont. As a consequence, the competitive position of Vermont declines; businesses lose market share and consumer dollars leak increasingly out of state to cheaper sources of supply.

Left unchecked, this process (endogenous to the REMI model) would culminate in lower investment spending by business, lower employment levels, reduced income, and an overall decline in Vermont output. As discussed in section 4, PSD found there are several ways in which the TES policy instruments could successfully work to counter such a retrenchment in spending. This finding followed from the simulation of a range of policy scenario versions in which the policy instruments are assumed to be more or less effective at offsetting increases in energy unit costs. These "policy effectiveness" simulations are a subset of the "go it alone" simulations, represented for simplicity in Exhibit 4 as either "well implemented" or "poorly implemented" versions of each policy.

The second set of simulations performed by PSD is defined by the assumption that other states pursue comparably aggressive energy policy alongside Vermont. In "going it together," relative energy prices between states do not change, and thus there is no significant loss of competitive position by Vermont firms or leakage of consumer spending to other states[5]. As discussed in Section 5, REMI simulations show "going it together" to be the more economically beneficial course to take for all policies. Because there are no changes in relative energy costs in a "goes it together" scenario, no tests of policy effectiveness assumptions are possible in this set of simulations. The findings from the "go it alone" set of simulations regarding policy effectiveness are nonetheless applicable to a "go it together" context.

[5] A real-world implementation of "go it together" energy policy is unlikely to leave relative cost structures between states completely unaltered. For modeling purposes however, this assumption yields useful information about the potential economic benefits of a cooperative approach.

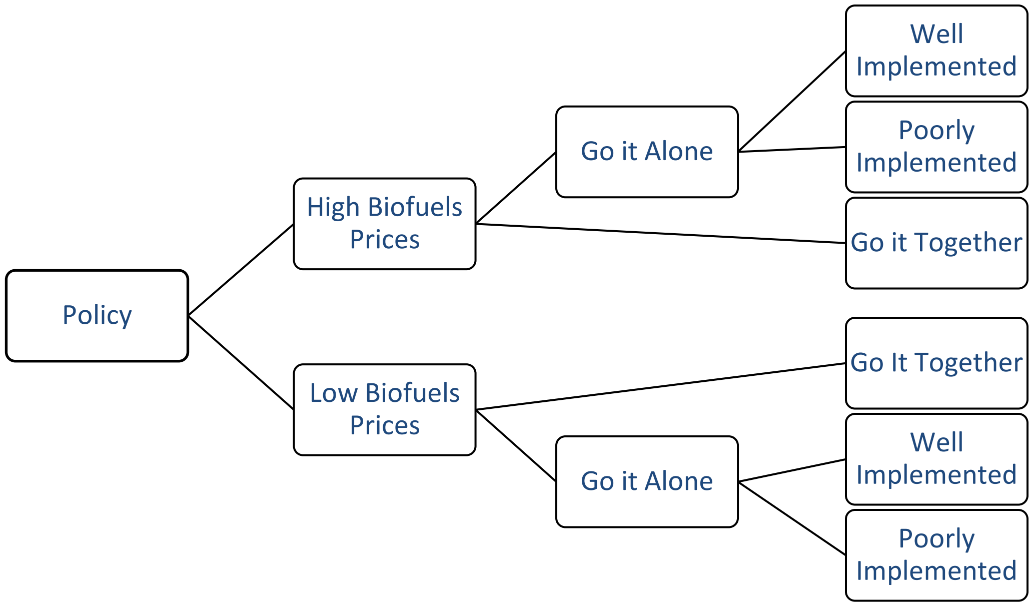

Exhibit 4. Organization of PSD's REMI Simulations. For each policy scenario, two sets of simulations were run. Each set included both high biofuel and low biofuel price scenarios. The first set is defined by the assumption that Vermont "goes it alone." In addition, a variety of second-order assumptions about the effectiveness of the policy instrument were tested. The second set of simulations is defined by the assumption that Vermont "goes it together."

3 Summary of Simulation Results

PSD's general finding from the various simulation exercises described in Section 2 above is that, with effective use of policy instrument revenues, each of the TES policies is conducive to a well-performing Vermont economy. As summarized in Exhibits 5 and 6 below, results for all simulations of well-implemented policies show Vermont experiencing a small but positive impact in the level of employment and Gross State Product.[6]

Across policies, the average yearly increase in GSP ranges from +$118 million (at the low end), to +$363 million (at the high end). These changes represent slight increases over baseline GSP levels of 0.23% and 0.69% respectively. The positive impacts on employment levels are slightly more salient, ranging from an average yearly increase of +2,200 jobs at the low end, to +6,400 jobs at the high end (representing increases over baseline employment levels of 0.44% and 1.26% respectively).

The majority of this growth in economic activity, though relatively small in aggregate, is driven by large expansions of output and employment in industries associated with the supply of renewable electricity, biomass, and to a lesser extent, efficiency services. Across policy scenarios, annual output and employment levels in the electricity-producing sector increase by 20 to 30 percent on average when

[6] Though not shown here or elsewhere in this document, results for measures of personal income follow similar trends as GDP and employment.

biofuel prices are high, and 5 to 8 percent on average when biofuel prices are low. The growth experienced by the biomass producing sector—a small player in Vermont's overall economy—is substantial enough in the high biofuels price scenarios to double baseline levels of sales and employment. When biofuel prices are low, biomass industry growth ranges between 40 and 60 percent above baseline values. Collectively, average employment over the entire 2015-2050 period in these two sectors scenarios grows by as many as 2,500 jobs a year if biofuel prices are high, and 820 jobs a year if biofuel prices are low. These results are consistent with the economy's increased dependence on electricity and solid biomass in each of the FACETS policy scenarios. In the TREES policies where liquid biofuels are heavily used, electricity and forestry related industries benefit somewhat less, while retail (which includes the distribution of liquid fuels) does somewhat better.

As discussed in section 4.2, the details of policy implementation are important in determining the economic performance of a handful of large individual industries. REMI simulation results show that the majority of Vermont industries are not likely to experience significant net effects from the TES policies. If policy is effective in balancing the increase in unit energy costs with appropriate counter-stimulus measures, the expansion of the emergent "clean industry" in Vermont need not come at the expense of established industries (very few of which are inextricably dependent on the production of fossil fuels for their existence). Fuel intensive industries, though not generally large employers in Vermont, could face difficulties for which policy instruments may struggle to compensate. Any energy transition of the scale contemplated by the TES is bound to prove disruptive to conventional business models predicated on access to inexpensive fossil fuels. However PSD's simulation results give no reason to expect that higher energy costs will necessarily undermine any major Vermont industry. More than any "creative destruction" that might take place along the way, the greatest risks and challenges of the TES policies lie in how the policy instruments can be most effectively used to distribute and offset the incremental costs of a growing renewable energy supply and increased implementation of energy efficiency.

Exhibit 5. Percentage Change in GSP Relative to BAU Levels

	Gross State Product			
Scenario	**2015-2025**	**2025-2035**	**2035-2050**	**2015-2050**
Carbon Tax Shift: High Bio	+0.17%	+0.87%	+0.83%	+0.69%
Carbon Tax Shift: Low Bio	+0.08%	+0.15%	+0.32%	+0.23%
TREES Basic: High Bio	+0.03%	+0.70%	+0.53%	+0.45%
TREES Basic: Low Bio	+0.11%	+0.11%	+0.34%	+0.23%
TREES Local: High Bio	+0.09%	+0.58%	+0.58%	+0.47%
TREES Local: Low Bio	+0.11%	+0.13%	+0.40%	+0.27%

Exhibit 6. Percentage Change in Employment Relative to BAU Levels

	Employment			
Scenario	**2015-2025**	**2025-2035**	**2035-2050**	**2015-2050**
Carbon Tax Shift: High Bio	+0.33%	+1.65%	+1.61%	+1.26%
Carbon Tax Shift: Low Bio	+0.15%	+0.32%	+0.67%	+0.44%
TREES Basic: High Bio	+0.18%	+1.10%	+1.23%	+0.90%
TREES Basic: Low Bio	+0.22%	+0.25%	+0.70%	+0.45%
TREES Local: High Bio	+0.23%	+1.01%	+1.14%	+0.85%
TREES Local: Low Bio	+0.20%	+0.24%	+0.84%	+0.51%

Exhibits 5 and 6 display the percentage change in average GSP and employment levels (compared to BAU levels) for each of the TES policies under both high and low biofuel price scenarios. These results reflect simulations in which 1) other jurisdictions take equally strong action to reduce greenhouse gas emissions and adopt renewable energy, and 2) policy instruments are effective in countering consumer and business price response to higher energy costs.

In addition to the simulations represented by the results in Exhibits 5 and 6, PSD modeled several other versions of the TES policies that entertained less optimistic assumptions about the effectiveness of each policy instrument. It is notable that even in the “ineffective policy” or “poorly implemented” scenarios (discussed further in section 4), the range of economic impact results remains small. Neither the high nor the low end of the results from these policy effectiveness tests reveal a large enough change in economic activity to significantly alter long term baseline growth rates in GSP (2015-2050). Compared to an annualized growth rate of 2.11% in the REMI control forecast (i.e. business as usual), the high end of this range (a perfectly effective policy) represents a long term growth rate of 2.13% while the low end represents a growth rate of 2.07%. It is notable that even in nonsensical scenarios, where the revenue generated by the Carbon Tax or by TREES certificates effectively disappears (i.e. fails to recirculate through the economy) the impact on the growth rate is still not drastically detrimental. Thus one of the most significant findings of the PSD's economic impact analysis is that even so large an energy transition as Vermont's goals imply does not necessarily also imply outsized impacts on the Vermont economy, in either positive or negative direction.

4 Insights from Policy Scenario Variations

4.1 Policy Instrument Efficacy

The intended effect of the policy instruments considered by the TES is to lower the relative end-use prices of renewable energy and efficiency improvements to levels at which renewable energy and efficiency become the most cost-competitive options for meeting energy demand. DEC's energy system modeling gives an informative view of how much more expensive fossil fuels would need to be in order to meet the State's goals. However, the costs that the TES policy instruments add to purchases of fossil fuels also constitute revenue streams that might cycle through the economy in any of a variety of ways not captured by an energy-sector cost-optimization model such as FACETS. PSD simulated a range of ways that policy instrument revenue could re-enter the economy after first being paid by producers and consumers of fossil fuels. Exhibits 7 and 8 below show results from these "policy effectiveness" simulations, comparing scenarios in which uses of policy instrument revenue was found to be most and least economically successful. They display the difference in economic performance between "perfectly effective" and "perfectly ineffective" versions of each policy. For all policies, there is a bigger difference in impact between "effective" and "ineffective" versions when biofuel prices are high.

Exhibit 7. Percentage Change in GSP: "Effective" Relative to "Ineffective" Policy

	Gross State Product			
Scenario	**2015-2025**	**2025-2035**	**2035-2050**	**2015-2050**
Carbon Tax Shift: High Bio*	+0.63%	+2.02%	+2.78%	+2.17%
Carbon Tax Shift: Low Bio**	+0.66%	+0.82%	+0.31%	+0.45%
TREES Basic: High Bio	+1.56%	+2.06%	+3.17%	+2.70%
TREES Basic: Low Bio	+0.36%	+0.43%	+0.79%	+0.65%
TREES Local: High Bio	+1.56%	+2.05%	+3.31%	+2.79%
TREES Local: Low Bio	+0.43%	+1.05%	+1.65%	+1.28%

Exhibit 8. Percentage Change in Employment: "Effective" Relative to "Ineffective" Policy

	Employment			
Scenario	**2015-2025**	**2025-2035**	**2035-2050**	**2015-2050**
Carbon Tax Shift: High Bio *	+0.51%	+1.71%	+2.36%	+1.73%
Carbon Tax Shift: Low Bio ***	+0.86%	+1.21%	+0.67%	+0.80
TREES Basic: High Bio	+0.84%	+1.83%	+3.21%	+2.39%
TREES Basic: Low Bio	+0.41%	+0.48%	+0.86%	+0.69%
TREES Local: High Bio	+1.78%	+2.35%	+3.66%	+2.99%
TREES Local: Low Bio	+0.60%	+1.26%	+2.02%	+1.48%

*The Tax Relief approach is more economically effective when biofuel prices are high.
**The Dividend approach is more economically effective when biofuel prices are low.

4.1.1 Uses of Carbon Tax Revenue

In a Carbon Tax Shift scenario, the policy instrument revenue flows first to state government. DEC's energy system modeling did not capture how that revenue is then used by the state. PSD simulated two possibilities for how carbon tax revenue might be recirculated back into the economy after being collected by the state. In practice, some mix of these two methods could also be implemented.

1. *Revenue neutrality achieved through tax relief*. In this scenario, carbon tax revenue is used by the state to offset existing taxes paid by businesses and households. The effectiveness of the tax relief approach depends on the response by businesses and individuals to reductions in the cost of production inputs, consumer goods and other expenses that make up the cost of living and doing business in Vermont. Currently, the state collects more than a third of its revenue from property taxes, a third from various consumption taxes, a quarter from personal income tax, and around 5 percent from corporate income taxes. The effect of replacing some of these revenue sources with a carbon tax is that there will be a broad range of price reductions for a wide variety of intermediate and final goods that no longer have to be marked up to cover a tax bill. In REMI, firms and consumers will respond to this reduction in costs by increasing investment, hiring, and consumption. The tax relief approach would be an economic success then if the reductions in the cost of living and doing business effected by tax relief are impactful enough to counter the effects of higher energy costs.

2. *Revenue neutrality achieved through transfer payments*. In this scenario, carbon tax revenue collected from all sources (businesses and individuals both) is remitted in full to the household sector as a "household dividend." The economic effectiveness of the transfer payment approach relies on the stimulus provided by increased levels of consumer spending made possible by redistributive fiscal action. It is fundamentally a demand-side approach that attempts to offset the price response effects of higher energy costs by increasing households' spending capacity. In REMI, a successful transfer payment approach requires that any reduction in business investment and hiring induced by higher energy costs is outweighed by the increase in discretionary consumer purchases. This outcome is more likely if those receiving the income are apt to use it for consumption of locally supplied goods and services. It is estimated that less than half of Vermont demand is supplied by in-state producers.

PSD's simulations showed that the effectiveness of both the tax relief approach and the transfer payment approach depends on the cost at which biofuels can be added to the energy supply. As can be seen in Exhibits 7 and 8 above, when biofuels can only be obtained only at high costs (i.e. in high biofuels price scenarios), economic performance is best if revenue neutrality is maintained through the tax relief approach. That is, in a high biofuel price environment, remitting a "citizen's dividend" back to taxpayers was found to be insufficient stimulus to offset the loss of market share and purchasing power effected by higher energy costs. However when biofuels are less expensive, the resulting increase in cost of energy is small enough that an increase in consumption out of transfer payment income can compensate for the reduction in businesses and consumer spending related to energy costs. Thus in a low biofuel price environment the transfer payment approach does provide sufficient stimulus to offset price response impacts. One challenge for the design of a Carbon Tax Shift policy, therefore, would be to select the best method for returning tax revenue in the face of uncertainty about future biofuel availability.

The revenue from a carbon tax would provide the state with sufficient fiscal resources to more than compensate for the negative economic effects of any loss of market share or purchasing power that would naturally accompany an increase in Vermont's energy unit costs. If the costs of building a renewable energy supply are steep (i.e. biofuel prices are high), effective fiscal action will need to be directed more toward lowering existing tax burdens, in order to avoid loss of competitive position and leakage of consumer dollars to other states. In a world where renewable energy is less expensive, a demand-side approach could bring as much or more in benefits than a reduction in taxes.

4.1.2 Uses of TREES Certificate Income

For the TREES policies, the payment of the price of TREES certificates by energy distributors generates a revenue stream for the renewable energy and energy efficiency industries. The intent of the TREES policy design, in addition to raising the relative price of fossil fuels, is that this certificate revenue would lower the amount of revenue that renewable energy suppliers require from sales to end users, thereby encouraging the development of scale economies that result in lower retail prices of renewable energy. The extent to which this might take place in actuality is difficult to assess.

PSD simulated a variety of possibilities ranging from a "perfectly effective" TREES policy, in which every dollar earned on certificate sales by renewable energy producers translates into a dollar reduction in the retail cost of renewable energy, to a "perfectly ineffective" TREES policy, in which no reduction in the retail cost of renewable energy takes place, no matter how large the earnings on certificate sales. A "perfectly ineffective" TREES policy does nothing to offset the policy-induced increase in energy costs (an unlikely prospect), while a "perfectly effective" TREES policy does the maximum amount possible to contain the policy-induced increase in energy costs.

The TREES policy instrument differs fundamentally from fiscal policy in the means by which it can provide counter-stimulus to the economy. That is, certificate revenue can only act on the price of energy. Fiscal policy, in contrast, would act on the price of real estate (property taxes), the price of consumer goods (sales tax), personal income levels (income tax), and business costs (corporate income tax). A TREES policy instrument, in other words, by design, directs all of its resources toward lowering the unit cost of energy.

Exhibits 7 and 8 above show the difference in economic performance under a "perfectly effective" TREES scenario compared to that of the "perfectly ineffective" version of the policy. The comparative results provide a useful illustration of the importance of policy design to economic outcomes. For example, in the high biofuel price scenario, the benefits foregone by a TREES policy that completely fails to push down retail renewable energy costs, unlikely as that may be, could amount to as much as $1.3 billion dollars in GSP per year and 14,000 jobs on average for the whole 2015-2050 period. In a scenario where biofuels are cheaper, the loss of benefits in this unrealistic case is less extreme but still significant ($340 million in annual GSP and 7,400 jobs).

As with the FACETS model runs, the price of biofuels plays a substantial role in the results of PSD's simulations. When biofuels can only be added to the energy supply at high cost, there is a more powerful price response that must be countered by equally impactful uses of policy instrument revenues. The economic performance of the TREES scenarios in the high biofuel price scenarios raises important questions about the limits that any of the TES policy instruments might encounter in providing sufficient counter-stimulus when some forms of renewable energy can only be acquired at high cost.

The difference between economic performance in high and low biofuel price scenarios suggests that a policy instrument that acts only on the price of energy, such as TREES certificates, may not provide sufficient counter-stimulus if biofuels are both necessary and available only at high cost. Other policy efforts to contain the effects of the price response may be required to ensure best economic outcomes. The broad-based tax relief approach, in targeting costs other than energy, does a better job compensating for the spending retrenchment associated with high biofuel prices. However some of the better performance of the Carbon Tax Shift policy in the high biofuel price scenario (compared to the TREES high biofuel price scenarios) is explained by the lesser amount of biofuels purchased when the 90 percent renewable energy goal is not constraining fuel choices. Thus it is difficult to say that high biofuel prices (and the prospect of high renewable energy prices generally) present more of a challenge to a TREES-like policy than they do to a tax based policy. The safer conclusion is that the effectiveness of either type of policy instrument is likely to be more limited when consumers and firms must pay very high prices for energy. PSD's results suggest there is a point at which an increase in energy cost can outstrip the ability of the TES policy instruments to sufficiently mitigate. And though PSD's high biofuel price scenarios do not exemplify such an outcome (rather only hinting at it), it stands as an important policy consideration that the effectiveness of the policy instrument does not necessarily grow in proportion to the energy bills that it must be used to offset.

Within the TREES policies simulations, PSD found that placing a premium on local renewable energy resources serves to contain some of the negative employment impacts associated with the purchase of high biofuel prices. In the TREES Basic scenario, "going it alone" without inexpensive biofuels results in an average annual loss of 1,600 jobs. But in the "go it alone" TREES Local scenario, the economy manages to add 290 jobs despite having to shoulder the high biofuel costs.

4.2 Implications for Individual Industries

The difference between the performance of the economy in "effective" and "ineffective" versions of each policy—measured in terms of GDP, employment and income—hinges to a large degree on the role played in Vermont's economy by some of the its larger industries, namely Construction, Retail and Wholesale, and Professional and Technical Services. Collectively these industries employ more than a third of Vermont workers. Simply because of their large relative size, they also account for a large relative share of overall spending on fuel by the business sector as a whole. As such, they are likely to face the greatest policy-induced increase in energy bills.

PSD's simulation results suggest that the economy performs better in aggregate when the policy instrument in question is effective in preventing this handful of industries from experiencing too large a net increase in costs. "Ineffective" policy tends to hamper the growth of these industries while "effective" policy need do little more than leave their costs unchanged on net. Other large Vermont industries, like Computer and Electronics Manufacturing, which spend less on overhead generally (and fuel specifically), are not as vulnerable to ratcheting energy costs.

However, leaving production costs unchanged (on net) for this group of larger high overhead industries proved difficult to achieve with the TES policy instruments when inexpensive biofuels were not available. Neither the tax relief in the Carbon Tax Shift scenario, nor the reduction in renewable energy prices in the TREES scenarios proved sufficient to offset a slight negative price response by these industries in a "go it alone" scenario. Small changes in the investment and hiring patterns of large industries can have outsize multiplier effects that policy design will need to take under consideration. It is possible, for example, that targeted efficiency services could save these industries enough energy expenses to leave their policy-induced production costs unchanged, even if expensive biofuels are the only way to meet policy goals. Likewise, tax relief or complementary energy policies may provide enough flexibility to accomplish this, as TREES alone acts only on energy prices.

5 Benefits of Cooperation

PSD evaluated the economic impact of joint action to reduce GHG emissions and increase renewable energy by simulating "go it alone" policy scenarios side by side with "go it together" scenarios. The comparative results shown in Exhibit 10 confirm that the Vermont economy generally performs better if policies are undertaken in cooperation with other states. For all policy scenarios, PSD simulation results show that "going it together" is an effective way of avoiding excessive retrenchment in consumer and business spending caused by a negative price response. The higher the cost of energy consumption in any policy, the more benefit there will be to going it together with other states.[7]

While economic success was not found to depend entirely on "going it together" for any policy, the results in Exhibit 10 do suggest that at least some level of cooperation with other states will be an important component of effective implementation for all policies. As an example, the benefits gained by going it together with a TREES policy could amount to as much as $311 million in GSP per year and 6,200 jobs per year (on average for the 2015-2050 period). In a scenario where biofuels are less expensive, the gain in benefits is less dramatic, but still significant ($33 million in GSP and 290 jobs). Thus "going it together" reduces the risk posed by the uncertain future price of biofuels.

[7] However it should be acknowledged that no part of PSD's economic modeling exercise was designed to capture the potential rewards, rather than just the risks, of being a first mover in the regional energy policy arena. It is not inconceivable that an aggressive energy policy that places large incentives on the standardization of efficiency services and the build out of renewable energy infrastructure could attract an influx of innovative and profitable enterprises to Vermont.

Exhibit 9. Long-Term Growth in GSP and Employment: "Go it Together" and "Go it Alone" Policy Versions

	Together		Alone	
	Δ GSP	Δ Jobs	Δ GSP	Δ Jobs
Carbon Tax Shift: High Bio	+0.69%	+1.26%	+0.28%	+0.41%
Carbon Tax Shift: Low Bio	+0.23%	+0.44%	+0.26%	+0.36%
TREES Basic: High Bio	+0.45%	+0.90%	-0.14%	-0.32%
TREES Basic: Low Bio	+0.23%	+0.45%	+0.17%	+0.39%
TREES Local: High Bio	+0.47%	+0.85%	-0.24%	+0.06%
TREES Local: Low Bio	+0.27%	+0.38%	+0.13%	+0.38%

Because the price of biofuels are the largest determinant of the overall cost of a renewable energy supply, "going it together" serves to minimize Vermont's economic exposure to the possibility that inexpensive biofuels will not be available to meet policy goals. In a "go it together" scenario, increased energy unit costs do not uniquely hamper Vermont cost-competitiveness relative to other states. In high biofuel price cases, it is the TREES policies that show the largest gains from cooperation. The greater volumes of spending attributable to purchases of expensive biofuels in the TREES scenarios actually provide a larger stimulus than under Carbon Tax Shift scenario.

6 Methodology

REMI PI+ is a structural model designed around the core theoretical assumption of General Equilibrium Economics that households and businesses will seek to minimize costs in order to maximize monetary gains. All changes to endogenous variable values made by users in a PI+ policy simulation are integrated into the model through a gradual quantity adjustment process by which the prices for labor, goods and services each find their own market clearing level. Within this framework, changes in levels of production and consumption are driven by changes in prices of substitutable options in markets for capital goods and consumer goods and services. For more technical information about the REMI model see http://www.remi.com/resources/documentation.

6.1 Mapping FACETS Results to REMI Input Variables

The FACETS modeling software characterizes its results as optimal strictly in terms of monetary cost. Policy requirements favoring production and consumption of renewable energy add relative costs to fossil fuel purchases and induce increased purchasing of renewable fuels that may not be cost-competitive without the policy. In an economic impact analysis, however, it is necessary to distinguish how those changes in costs translate into spending flows by households and businesses. In REMI, an exogenous increase in the costs faced by households or business—in the form of higher prices of consumer goods or factors of production—will cause an endogenous price response in which purchasing behavior substitutes away from the most expensive options. At the same time, an exogenous increase in spending or demand will flow through regional industry supply chains, providing sales revenue to businesses that causes an endogenous increase in investment and hiring spending, culminating in higher levels of output and employment.

One of the central purposes of an economic impact study is to estimate the net effect of these often countervailing processes. Thus what FACETS characterizes as costs must be represented in REMI also as spending streams that flow between different sectors and industries, providing income for business, governments and households. Some portion of those spending streams is attributable to changes in prices and should be treated as a specific monetary cost of the policy that will be met with an endogenous price response in REMI. This methodology section explains how these policy costs were differentiated from the spending flows that encompass them and entered into REMI as distinct variables.

6.2 Representing Policy Scenario Demand in REMI

The FACETS optimization results that the Department relied on to construct demand variables in REMI were organized into the following categories, originally construed by FACETS as costs, but reconceived here as spending flows:

Investment costs	→	Spending on equipment and capital
Fixed costs	→	Spending on operation and maintenance
Fuel costs	→	Spending on fuel

All data received from DEC was grouped into aggregations for Residential, Commercial, Industrial, Transportation, and Power sectors. The Department assumed that 90 percent of Transportation sector spending is done by the Residential sector and 10 percent is done by the Business sector.

Exhibits 11 through 13 below display how these native FACETS categories were mapped to specific demand variables in REMI. In Exhibit 13, Fossil Fuel spending includes spending on Natural Gas, LPG, Distillates, Motor Vehicle Fuels, Coal, and Oil Products. Biomass spending includes spending on Wood Chips, Wood Pellets and Cordwood. Biofuel Spending includes spending on Biodiesel and Ethanol.

Exhibit 10. FACETS Capital Costs Mapped to REMI Demand Variables

Investment Costs in FACETS Associated with:	Exogenous Demand variable in REMI
Electricity Consumption by Residential, Commercial and Industrial sectors	Final Demand: Electrical Equipment Investment Demand: Electrical Equipment
Fossil Fuel and Biomass Consumption by Residential, Commercial and Industrial sectors	Final Demand: Machinery Manufacturing Investment Demand: General Industrial Equipment
Efficiency Improvements made by Residential, Commercial, and Industrial Sectors	Final Demand: Repair & Maintenance Final Demand: Professional & Technical Services Final Demand: Electric Equipment Final Demand: Computer & Electronic Final Demand: Construction
Photovoltaic Electricity and Solar Thermal Energy Production by Residential and Commercial sectors	Final Demand: Computer & Electronic Final Demand: Machinery Manufacturing Final Demand: Electrical Equipment
Electricity Consumption for Transportation by Residential and Commercial sectors	Final Demand: Motor Vehicles, Bodies, Trailers, Parts Final Demand: Electrical Equipment Investment Demand: Electrical Equipment Investment Demand: Railroad Equipment
Fossil Fuel and Biofuel Consumption for Transportation by Residential and Commercial sectors	Final Demand: Motor Vehicles. Bodies, Trailers, Parts Final Demand: Electrical Equipment Investment Demand: Aircraft Investment Demand: Railroad Equipment Investment Demand: Electrical Equipment Investment Demand: Other Trucks, Buses Investment Demand: Light Trucks

Exhibit 11. FACETS Fixed Costs Mapped to REMI Demand Variables

O&M Costs in FACETS Associated with:	Exogenous Demand Variable in REMI
Residential and Commercial Transportation	Consumption: Motor Vehicle Repair & Maintenance Final Demand: Repair & Maintenance
Photovoltaic Electricity and Solar Thermal Energy Production by Residential and Commercial sectors	Final Demand: Repair & Maintenance Final Demand: Construction Final Demand: Professional & Technical Services

Exhibit 12. FACETS Fuel Costs Mapped to REMI Demand Variables

Fuel Costs in FACETS	Exogenous Demand Variable in REMI
Electricity	Industry Sales: Custom Electric Utility
Fossil Fuels	Final Demand: Oil & Gas Extraction Final Demand: Petroleum & Coal Products Manufacturing
Biomass	Final Demand: Forestry & Logging Final Demand: Agriculture & Forestry Support Final Demand: Wood Products Manufacturing

6.2.1 Treatment of Biofuel Spending in REMI

As in the FACETS optimization, the Department assumed that biofuel consumption is supplied predominately by outside-region exporters. All spending on biodiesel and ethanol was therefore represented in REMI as demand on the Retail Trade industry, a proxy for the local businesses involved with the distribution of biofuels to end users in Vermont. However, only 15 percent of the spending on biofuels reported in the FACETS results was included as demand on Vermont retailers. In effect, this assumes a 15 per cent markup by local distributors. The Department arrived at its 15 percent markup assumption based on an informal comparison with conventional fuel dealer markups. It should be noted that because of the large quantity of biofuels consumed in the FACETS optimizations—especially in the low biofuel price scenarios—REMI results are quite sensitive to assumptions about how much of this spending flows through the Vermont economy.

6.2.2 Building a Custom Electric Utility in REMI

REMI allows for the development of custom-built industries with user-specified intermediate inputs. The Department's analysis made use of this functionality in order to build an Electric Utility industry that enacts the quick transition toward a renewables-dominated power supply in each policy scenario. This was done because REMI's default Utility industry uses mostly inputs from fossil fuel industries with no large shifts in the supply chain projected.

Exhibit 14 below shows the percentage of all spending by the TES Custom Utility going to the purchase of each fuel type used to generate electricity, as well as the capital spending associated with the purchase and use of those fuels. When demand on the Custom Utility industry is increased in PI+, intermediate demand for industries supplying that fuel and equipment also increases (in line with the input shares shown in Exhibit 14). The percentages given in Exhibit 14 are averages for the entire projection period, 2015-2050. Note, however, that the Custom Utility industry was built with enough temporal detail to reflect the shifts in those shares that take place over the duration of the projection period. It is also important to realize that the percentages in Exhibit 14 represent the volume of spending undertaken to acquire the listed resources. These percentages are not necessarily proportional to the quantity of energy supplied by these resources. That said, a higher level of spending to acquire a resource is generally indicative of higher consumption of that resource for power production, even if the relationship is not exactly linear. The last row of Exhibit 14, labeled imports, includes electricity purchased by Vermont utilities from Hydro Quebec and nuclear generators located outside the state.

Because REMI does not supplant default Industries with user-specified Custom Industries, it was necessary to take a final step in each policy simulation to ensure that all endogenous intermediate demand for electricity was properly re-routed to the supply chain of the Custom Utility. This was done in an iterative procedure, in which a “second-to-last” simulation was run in order to determine the total quantity of intermediate demand for electricity taking place in the policy scenario. In the final simulation this “second-to-last” quantity of intermediate demand for electricity was prevented from flowing through to the suppliers of the REMI default Utility industry (using the “Nullify Intermediate Inputs Induced by Industry Sales” variable). In addition, this same quantity was entered into the final simulation as a new demand variable for the output of the Custom Utility.

Exhibit 13. Custom Utility Spending on Intermediate Inputs, Average Percentage for Projection Period

	High Biofuel Price Scenarios			Low Biofuel Price Scenarios		
	CT 1250	TREES Basic	TREES Local	CT 450	TREES Basic	TREES Local
Biomass Fuel Spending	27.85%	29.54%	29.89%	35.24%	35.66%	46.20%
Biomass O&M Spending	1.03%	1.13%	1.15%	1.41%	1.43%	1.87%
Farm Methane Equipment Spending	0.09%	0.11%	0.11%	0.13%	0.13%	0.14%
Farm Methane O&M Spending	0.14%	0.16%	0.16%	0.19%	0.20%	0.22%
Distillate Equipment Spending	0.15%	0.16%	0.17%	0.20%	0.21%	0.21%
Hydropower Equipment Spending	2.42%	2.66%	2.68%	3.25%	3.34%	3.43%
Hydropower O&M Spending	2.30%	2.53%	2.55%	3.10%	3.18%	3.27%
Landfill Gas Equipment Spending	0.66%	0.72%	0.73%	0.88%	0.91%	0.93%
Landfill Gas O&M Spending	0.27%	0.30%	0.30%	0.37%	0.38%	0.39%
Natural Gas Fuel Spending	0.26%	0.27%	0.27%	0.28%	0.29%	0.29%
Natural Gas Equipment Spending	0.53%	0.58%	0.59%	0.71%	0.73%	0.75%
Natural Gas O&M Spending	0.05%	0.11%	0.11%	0.12%	0.12%	0.12%
Solar Equipment Spending	1.12%	1.26%	1.27%	1.48%	1.56%	1.68%
Solar O&M spending	0.13%	0.15%	0.15%	0.17%	0.18%	0.20%
Wind Equipment Spending	12.32%	13.60%	13.74%	17.21%	17.45%	18.16%
Wind O&M spending	2.58%	2.83%	2.86%	3.76%	3.76%	3.78%
Import Spending	48.09%	43.91%	43.28%	31.50%	30.46%	18.34%

6.3 Representing Policy Scenario Costs in REMI

Some portion of the magnitude of the fuel spending flows described in Exhibits 11 through 13 is attributable to businesses and households paying more for the fuels they consume in each policy scenario. There are two inter-related sources of changes to the cost structures facing households and business in the Department's REMI simulation:

- Cost of purchasing renewable energy at higher relative prices
- Cost added to energy purchases by the policy instrument

Taken together these two categories comprise each sector's aggregate policy-specific increase in costs. In all scenarios, there are large efficiency gains achieved by households and businesses in reaction to high energy prices. To varying degrees (depending largely on the assumed price of biofuels), the decline in energy usage over time is large enough that the cumulative sum of spending on energy over the entire projection period is actually less than is the case for the BAU forecast. However this is not the case in all years of the projection period; the higher cost of a renewable energy supply generally causes more of a burden in the earlier stages of the projection period. In these early years the higher prices of renewable energy outweigh declining usage.

6.3.1 Costs from Policy Instrument Price

The first source of changes to the REMI economy's cost structure mentioned above is the prices of the policy instruments themselves, either the price of carbon in the Carbon Tax Shift scenarios or the price of TREES certificates in the TREES scenarios. In the case of the TREES Local scenarios, each sector's cost is determined also by the prices of the local supply credits, which are not present in the TREES Basic scenarios.

6.3.2 Cost from Higher Priced Renewable Fuels

The second source of changes to the REMI economy's cost structure is the higher relative prices of the renewable fuels that must be purchased in order to satisfy policy requirements. In effect, the presence of a carbon price or a market price for TREES certificates forces the purchase of more expensive biomass, electricity and biofuel options that are not otherwise taken up in the BAU scenario. In turn some of this increase in spending on renewable fuels is attributable to higher prices charged for biomass and electricity in the face of policy-induced increase in demand for renewable options (i.e. due to movements up the biomass and electricity supply curves).

6.3.3 Preserving FACETS fuel-switching

While REMI allows users to increase the price of a limited number of specific fuels (natural gas, electricity, and fuel oil), doing so in this context would trigger endogenous substitution responses that would distort the fuel-switching behavior implicit in the demand variable values transplanted from the FACETS output data. For this reason the cost burdens described above were entered into REMI as generalized increases in prices. For households this meant using the "Total Consumer Prices" variable, effectively reducing their purchasing power by the amount of each category of cost burden. For businesses, this meant using the production cost variable which increases the prices that each industry pays for its factors of production (labor, capital and fuel) in proportion to the industry's relative use of those inputs in the REMI control forecast.

The consequence of using these generalized cost variables is that no part of the price response by households and businesses will be determined by the cross-price elasticity coefficients programmed into REMI. That is, capital will not be substituted for labor, for example, nor will fuel oil be substituted for electricity. The endogenous effect on households will be a decrease in consumption spending, a greater portion of which will now go to suppliers outside the region offering cheaper consumer goods. For business, the effect will be a loss of sales by industries that have outside-region competitors with lower production costs. Both effects are part of a feedback sequence whereby investment, hiring, income and employment all adjust downward in response to a higher price environment.

To the extent that other states pursue similar policies that also compel the purchase of higher priced renewables by households and business, the loss of market share and consumer dollars to outside region business taking place in REMI will be overstated. This is because the price differentials between Vermont and the rest of the nation would not be so large in a reality where other states are also bearing higher energy costs. As described in Section 5, the Department performed a set of "go it together" simulations in which relative energy costs between Vermont and other states do not change.

6.3.4 Apportioning Policy-Induced Costs to Industries

For the business sector, the aggregate policy-induced change in energy costs—represented as an increase in production costs—was assigned to the various NAICS industries in proportion to each industry's individual share of the total spending on fuel by all regional industries. In order to determine these industry-specific fuel shares, it was necessary to first "regionalize" the national input-output table built into REMI so that it better reflects the specific makeup of intermediate demand by Vermont Industry.

This was an iterative process which involved running a "first-pass" simulation that included only the demand variables, as listed in Exhibits 11 through 13. From these results, the next step was to extract data on the scenario-specific output levels of each NAICS industry, which then reflected the spending patterns implicit in the FACETS optimization (but did not yet account for the changes in the REMI economy's cost structure). Next, the "first-pass" industry output levels were multiplied with the fuel shares contained in REMI's national input-output table. This gave an estimate of each regional industry's fuel spending in each scenario. The sum of those products was then used as the denominator for calculations of the specific share of the policy-induced costs borne by each industry. The greater the industry's share of total regional industry fuel spending, the greater the portion of the aggregate business sector costs borne by that industry.

6.3.5 Apportioning Carbon Tax Offsets to Households

In the Carbon Tax Shift scenarios, PSD simulated two different ways in which government might recycle carbon tax revenue back into the economy: the "transfer payment" approach, and the "tax relief" approach, both described in Section 4.1.1 above.

In the “transfer payment” approach, the entirety of the carbon tax revenue is directed to households regardless of which sector the revenue came from. This fiscal action directly increases consumer discretionary income. The extent to which this income is then spent back into the economy and thereafter re-spent by subsequent recipients is determined by REMI’s hard-coded coefficients for the household sector’s marginal propensity to consume. All else equal, in the REMI economy, a $1 million increase in transfer payments will generate more than $1 million in consumption spending.

In the “tax relief” approach, government uses of carbon tax revenue were assumed to offset existing taxes on households and business. Currently in VT, taxes paid by households comprise about three quarters of total state revenue. Using Tax Department data, PSD estimated that state revenue collected from households is divided approximately in thirds between Property, Income and Sales Tax. Tax relief to households in the REMI simulation was distributed accordingly, with each third of the Carbon Tax Revenue collected from households matched by reductions in each tax category. Even with the high price on carbon in the out years of the high biofuel price scenarios, offsets from the carbon tax revenue are never enough to reduce existing household taxes by more than 40 percent. Reductions in the sales and property tax categories are represented respectively as decreases in consumer prices and property prices. Reductions in household income tax were represented as increases in disposable income (using the Personal Income Tax variable).

REMI does not differentiate the spending behaviors of different income groups. For this reason REMI is an imperfect tool for modeling redistributions of income within the household sector. Many argue that the carbon tax is inherently regressive and should be implemented so to mitigate the disproportionate burden borne by lower income groups. PSD acknowledges that a full accounting of a carbon tax shift policy should address these distributional issues. However, PSD’s analysis looks at the household sector in aggregate and due to the limitations of REMI, does not attempt to represent the impact of any redistribution between income groups.

6.3.6 Apportioning Carbon Tax Offsets to Business Sector

Tax relief received by the Business sector was modeled as a reduction in industry production costs. Treating offsets to the business sector’s carbon tax in this way has the effect of mitigating the production cost increases attributable to the higher prices paid for both renewables and taxed fossil fuels. Currently in Vermont, taxes paid by business comprise about a quarter of total state revenue. The Department estimated that of these taxes paid by Vermont business, approximately 40 percent is Property Tax, 40 per cent is Sales Tax, and 20 percent is Corporate Income Tax. It is important to note that in both high and low biofuel price scenarios, there comes a point in the projection period when more Carbon Tax is being collected from business than would be paid if the current tax code was carried forward. This threshold is reached sooner in the high biofuel price scenarios than in the low biofuel price scenarios.

The implication of representing tax relief to business as a reduction in production costs that eventually exceeds the sector’s existing tax burden is that, beyond the thresholds mentioned above, offsets to the Carbon Tax on business would have to take the form of direct payments or subsidies to industry, such as an investment tax credit. The Department recognizes that whether tax relief or subsidies can be expected to reduce production costs and spur business expansion in the way modeled here is an open question. However REMI allows for limited options in representing corporate tax policy and standard practice is to treat corporate taxes as a cost of production. Incidentally, the Department observes that a given decrease in capital costs elicits a far weaker investment response than an equivalent decrease in production costs. All else equal, were business carbon tax offsets to be represented as a decrease in capital costs, rather than a decrease in production costs, results for GSP, employment, and income would all be lower than presented here.

6.3.7 Apportioning Carbon Tax Offsets to Specific Industries

Each individual Industry's share of the business sector's total carbon tax offsets—represented as a decrease in production costs—was determined by its share of the sum of all value-added across all regional industries. Value-added can be thought of as that portion of business revenue going to employee compensation and profits. Industries paying relatively higher amounts in salaries, wages and profits would see a relatively greater share of carbon tax revenues returned to them than industries with lower value-added. Thus in the Department's approach to modeling the carbon tax as revenue-neutral, it is those Industries that account for the highest shares of fuel spending but relatively low shares of value-added that will see the greatest increase in net cost from the policy. To the extent that a given Industry spends less on fuel than they spend on compensation and profit, their net cost will be either very low or completely absent, depending on the amount of tax collected in a given policy year. For example, in all policy scenarios the Truck Transportation industry is one of the largest spenders on fuel but ranks low in its share of value-added. On the other hand the Forestry industry does a relatively small amount of business fuel spending in each scenario but ranks higher in its share of value-added. So the net cost burden of the modeled revenue-neutral carbon tax would generally fall more on the Trucking industry than the Forestry industry.

6.3.8 Testing the Price Effect of TREES Revenue

In the TREES scenarios, there are no direct offsets to the increase in energy costs associated with the policy, as there is in the revenue-neutral carbon tax scenarios. However it can reasonably be assumed that revenue earned by originators of TREES certificates would be used in some degree to offset the supply costs of renewable energy producers and thereby mitigate the end-use energy costs facing households and business. The Department made no effort to empirically estimate what the magnitude of this price reduction might be. Instead, a variety of simulations were run testing a range of assumptions about the degree to which the revenue earned on TREES certificates would serve to mitigate the costs associated with the purchase of higher priced renewable fuels (see Section 4.1 above). For example, it can be assumed that none of the revenue generated by TREES certificates is used to reduce retail costs of renewable energy and energy efficiency services. This would mean that the effect of the TREES policy instrument is limited only to increasing the cost of non-renewable energy, an extreme and unrealistic assumption. Conversely, it can be assumed that all of the revenue generated by TREES certificates is used to reduce retail costs of renewable energy and energy efficiency services. This would mean that, in addition to having the effect of increasing the cost of non-renewable energy, the TREES policy instrument also has the effect of reducing the delivered price of renewable energy, a more plausible assumption. As shown in Exhibits 7 and 8, the results of these extreme “policy effectiveness” assumptions were treated as upper and lower bounds of the range of likely economic impacts associated with each policy.