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CHAPTER 4
ENERGY OPTIONS FOR VERMONT: POLICY ANALYSES

This chapter presents policy options that are intended to help meet Vermont's energy goals of safety, reliably, adequacy, security, sustainability, affordability, environmental soundness, and efficiency, while ensuring Vermont's economic vitality. These goals were described in detail in Chapter 2. For a summarized version of these policies with Department of Public Service (DPS) recommendations, see Volume 1, Chapter 4.

> **Note: In Volume 1, some similar policies have been combined and summarized. A few policies in this volume have complex issues needing further exploration before recommendations can be made. Information on these policies appears in this volume only.**

The policies in this chapter are important because our current energy acquisition and use do not fully meet Vermont's energy goals. For example, it is difficult to ensure the security of Vermont's energy when the state is heavily dependent on oil and when the supply of oil is vulnerable to unpredictable foreign events and interruptions. Also, fossil fuel use, of which oil use is one example, is not sustainable unless we limit the definition of sustainability to time frames of a couple generations. Energy also can be used more efficiently. The United States could save $300 billion per year if our electric energy use was as efficient as Japan's (Lovins, "Four Revolutions in Electric Efficiency," 1990, 125). Affordability is an area in which Vermont can make important improvements. A recent study found that Vermont's energy costs for the poorest citizens were the second highest in the nation (National Consumer Law Center, 1995, 17). Significant improvements can also be made in the areas of environmental soundness and the safer use of energy.

Current energy use does not meet Vermont's energy goals because both market and governmental mechanisms are imperfect. In an ideal world, the market would allocate resources, costs, and benefits in a just and efficient manner. There are many real world examples, however, where this is not the case. For instance, labor markets do not have mechanisms to prevent exploitation of child labor or discrimination which must be accomplished by non-market mechanisms. Resources held in common, such as our air and water, can be polluted by businesses or individuals, while only people downwind or downstream suffer the consequences. Furthermore, the market has no means of addressing the issue of sustainability. Decisions and choices made in the marketplace are not driven by concern for what resources will be left for future generations, but by short term return on capital invested (typically a few years or, at most, 5 to 10 years). Moreover, the value of future resources is discounted in the marketplace by the cost of capital by 8%-12% per year for government and utilities, and 20% or more for many private businesses and individuals, further weakening the value of those future resources. The necessities of life, however, such as clean air, water, food, shelter, and opportunities for productive work to meet other needs are of no less value to future Vermonters than they are to us today.

Because market forces alone do not meet Vermont's energy goals and do not normally capture and reflect the external costs of energy use, environmental degradation, and dependence on non-renewable resources, government action is often necessary to correct market distortions and encourage a more efficient allocation of resources. This too is not a perfect process. Regulations can be slow to react to changing market conditions. And politicians, businesspersons, and regulators can be wrong in their analyses of problems or predictions about the effects of regulations.

The fact that government action and intervention in the market are not perfect, however, does not mean that we should abandon rules and regulations any more than the fact that markets are imperfect means that we should abandon market economics. Ideally, policies should try to take advantage of what each sector, public and private, does best. The market, for example, ensures efficient production and allocates resources quite well, but has difficulties assigning the proper costs and prices to resources (reflecting the full societal costs or the costs to future generations). Government functions best, not when it micromanages details of lives or businesses, but when citizens come together to *set limits to acceptable behavior or performance* while

protecting as many personal rights and freedoms as possible. Laws regarding drunk driving, violence, pollution, and unfair business practices are examples of this. Government action is also valuable in that it *allows citizens to interact in an orderly way*. It allows us to organize in ways that are beneficial. For example, conventions such as driving on the same side of the street and yielding to pedestrians in crosswalks allow society to function more smoothly. Government also *provides or secures many services for society* that are in society's interests but that the market does not provide: military protection, police, fire, health and safety protection, a legal system, transportation infrastructure, education, and others. Energy planning, regulation, and taxation are particularly relevant examples of services and measures that are beneficial to society but that the market does not provide. The market incentives for movement toward Vermont's energy goals are not as great as the market incentives to use resources unsustainably, in manners that damage air and water quality, that are unsafe, or that leave the United States vulnerable to embargoes or shortages.

The best energy policies that try to take advantage of what the market and government each do best fall into three parallel categories. The first category contains those policies that set limits to actions. The federal appliance and automobile efficiency and safety standards are good examples. For instance, CAFE standards set a lower limit on the average efficiency of automobiles without specifically telling automobile manufacturers how those automobiles should be made. The second category contains policies that organize society in ways that encourage smooth and efficient operation. Daylight-savings time is a good example of this. By shifting our clocks (and daily schedules) to more closely reflect the sun's schedule, we use solar energy more efficiently and eliminate the need for another hour of lighting in the evening, at no cost to society. The third category contains policies that provide services to society that the market does not provide. In addition to the direct benefits of services such as energy planning and regulation, energy goals can be supported through government services that are unrelated to energy. Such is the case when policies combine the government's need to finance important services through taxes with the market's ability to make good choices when the prices are right. With respect to Vermont's energy goals, this involves using taxes to internalize the external costs of energy use. Using taxes to reflect the true costs of energy gives signals that enable the market to better allocate resources, reducing the need for more direct government intervention. (See the Energy Taxation subsection in the Energy Sources and Supply section of this chapter for further discussion of these issues.)

This Plan contains a mix of policies meeting the above criteria. Most are policies that Vermont can implement itself. However, Vermont is too small to implement some of the recommended polices. These require national or regional action. Some policies presented in this Plan are less ambitious versions of policies that could be more fully implemented on a regional or national level. Others seek to fill the gaps or exert leadership until there is stronger political will or more public support for definitive solutions. There are also several policies designed to meet Vermont's character as a rural state with unique natural resources and history.

The chapter is composed of five major sections: Energy Sources and Supply, Transportation, Buildings and Equipment, Affordability, and Government Energy Use and Energy Policy. In each section there are several strategies that represent the general direction Vermont should move toward or the general approach Vermont should use to attain its energy goals. The policies that fall under a particular strategy are specific actions Vermont can take to help achieve our energy goals. The order of the strategies and policies is by topic and does not reflect a priority ranking.

For the sake of clarity, policies are considered individually within each section of this chapter. In Chapter 5, however, a selected set of policy options is presented as a suggested set of actions to move the state toward the goals laid out in Chapter 2.

This Plan strives to provide the reader with a consistent format and analysis for each policy, including presentation of results and assessment of both the advantages and disadvantages to all policy options, in order to be used as a reference document for concerned citizens, planners, and policy makers.

In this chapter, policies are presented in a consistent format that includes a brief description of the policy, the rationale for the policy, an analysis of the impacts of each policy, and (in some cases) steps needed to implement the policy.

Thirty-one of the 72 policies described in this chapter were analyzed using an interactive computer forecasting model, customized to represent Vermont. The same computer model generated the base case forecast or scenario presented in Chapter 3. When the model is run to simulate the implementation of a policy through 2020, data is generated that reflects the policy's impacts on about 60 variables or indicators related to energy use, sustainability, energy efficiency, environmental quality and Vermont's economy. The impact sections summarize the predominant changes brought about by each modeled policy and compare what happens in the policy forecast scenario to the base case or "business as usual" forecast scenario. The key impacts of each modeled policy in the year 2005, a midpoint in the forecast period, are shown in a bar chart with comparisons to the base case for 2005 and the 1990 level. In addition, the policy's impacts on energy use and other important indicators are shown in accompanying tables. Appendix 5 contains more detailed information about each of the policies modeled in this Plan.

Following is an inventory of energy strategies and specific policies assessed in this Plan. Policies that were modeled are starred in the list below. **Policies that are listed below in bold type are the set of modeled policies selected as the composite policy case.** This group of policies was modeled together, as though they were all implemented at once, and their combined impacts are discussed in Chapter 5.

I. ENERGY SOURCES AND SUPPLY

This section presents a range of policy options affecting the supply and provision of both traditional and renewable sources of energy. The policies presented reflect the primary goals of this Plan: to maintain a safe, adequate, and secure supply of energy for Vermont's needs as the 21st century begins and to transform that supply into one that is sustainable beyond the 21st century, while minimizing the impact of energy consumption on the environment, assuring affordability, and increasing overall efficiency.

Traditionally, energy plans have focused on projected growth in demand and have asked "What fuel should meet this demand, and where should we buy it?" The result is a shopping list of new generators and energy vendors. This Plan takes a different approach. It starts with the same projected growth and asks "What policies can help us meet the anticipated need and at the same time lessen the adverse impact of energy use on future generations and our environment, while maintaining affordability and providing for our needs in a more reliable manner?"

To answer that question, this chapter begins with several strategies that recommend increased use and promotion of renewable energy sources. Greater use of energy from wood, wind, solar, some types of hydro, and landfill and farm methane would increase the sustainability of energy use, reduce the environmental impacts of energy use, and increase the security of Vermont's energy supply. These energy sources could replace non-renewable fossil fuels which are currently being used at nonsustainable rates. In addition to preserving resources for future generations, renewable fuels can reduce the impact of current energy use on future generations and the environment by reducing air emissions. Wind, solar, and hydro energy have no air emissions. Burning methane derived from waste reduces the global warming potential of emissions more than twenty fold, and burning wood has no net carbon dioxide emissions when the resource is harvested sustainably. Finally, diversifying the energy supply to include more renewable fuels decreases our reliance

II. TRANSPORTATION (continued)

Strategy D. Reduce Transportation Related Emissions

*Policy 1. Implement a Vehicle Emissions Check Program

***Policy 2. Continue Phased-In Implementation of Vapor Recovery at Gas Stations**

***Policy 3. Adopt Low Emissions Vehicle Standards**

Policy 4. Promote Incentives for Alternative Transportation Fuels, Including Electric Vehicles

Strategy E. Internalize Costs of Transportation More Fully through Transportation Energy Taxation

***Policy 1. Review and Revise State Tax Policy to More Fully Internalize the Cost of Transportation**

Shift Roadway Const/Maint Funding from Property Tax to Motor Fuels Tax

Shift Police/Fire Transportation Funding from Property Tax to Motor Fuels Tax

Remove Sales Tax Exemptions on Motor Fuels

Remove Parking Subsidies (not modeled)

***Policy 2. Support Phase-Out of Federal Policies Giving Advantages to Traditional Fuels and Projects: Equalize Market Opportunities for New Technologies and Alternative Transportation Fuels**

***Policy 3. Shift Registration and License Fees to Motor Fuels Taxes**

Policy 4. Support Commuter Buses with a Motor Fuels Tax

Policy 5. Consider Establishing a Vermont Feebates Program

III. BUILDINGS AND EQUIPMENT

*Strategy A. Improve Efficiency and Indoor Air Quality in New Homes

Policy 1. Implement Residential Building Energy Standards for New Construction

Policy 2. Statewide Residential New Construction DSM Programs for Premium Homes

Policy 3. Increase Efficiency of New Manufactured Housing

Policy 4. Expand the Vermont Home Energy Rating System

Impacts of Residential New Construction Policies

Strategy B. Improve the Efficiency of Vermont's Existing Housing Stock

Policy 1. Time-of-Sale Energy Efficiency Requirement

Policy 2. DSM Program Support for a Time-of-Sale Standard

Policy 3. Discount Mortgage Rates for Energy Efficient Homes

Policy 4. Promote Energy Efficient Products Through a Statewide Trade Ally Program

Policy 5. Diversify the Vermont Weatherization Program

*Strategy C. Increase Efficiency in Commercial and Industrial New Construction

Policy 1. Adopt a Commercial New Construction Energy Efficiency Code

Policy 2. Statewide Commercial and Industrial DSM Programs

Policy 3. Establish Energy Efficiency Partnership & Information Clearinghouse

Impacts of Commercial New Construction and Retrofit Policies

Strategy D. Improve Efficiency in Commercial & Industrial Facilities by Targeting Retrofits & Lost Opportunities

Policy 1. Adopt a Statewide Energy Code For C&I Remodeling, Renovations, and Additions

Policy 2. Statewide DSM Programs for C&I Equipment Replacement, Remodeling, and Renovation

Policy 3. DSM Retrofit Programs in T&D Constrained Areas

Policy 4. Financing Mechanisms for Cost–Effective Energy Efficiency and Renewable Energy: Performance Contracting and ESCOs

IV. AFFORDABILITY

Strategy A. Promote Efficiency for Low Income Housing and Affordability in an Increasingly Competitive Marketplace

Policy 1. Energy Efficiency Standards for Multi-Family Rental Housing

Policy 2. Energy Efficiency Services Integrated with the Fuel Assistance Program

Policy 3. Reinvent Weatherization Services Delivery to Low Income, Multi-Family Housing

Policy 4. Encourage Development of a Consumers' Cooperative or Consumerco

Policy 5. Establish a Statewide Affordability Program to Take Effect When Vermont Initiates Retail Competition

V. GOVERNMENT ENERGY USE AND ENERGY POLICY

Strategy A. Improve Government's Energy Use, Programs, and Policy

Policy 1. Government Energy Use in Buildings, Equipment, and Vehicles

Policy 2. Government Energy Planning

Policy 3. Public Education and Information

on oil and other fossil fuels, thereby increasing the security of our energy supply. The first four strategies recommend the expanded use of wood, wind, solar, hydro, and methane energy.

The fifth strategy recommends reduced reliance on petroleum, coal, and nuclear energy use, and the expansion of natural gas use when it replaces other fossil fuels. Two of these fuels, oil and coal, face unique problems related to air emissions, environmental impacts, and sustainability issues. Nuclear power also faces problems

with continued use, especially with respect to sustainability and human health and environmental risks. Continuing use of natural gas has the potential to improve the environmental impacts of our energy use if it replaces other fossil fuels, but will worsen air emissions considerably if it replaces fuels such as hydro or nuclear power. The policies falling under this strategy thus seek to protect the reliability, safety, security, sustainability, and environmental soundness of our energy supply. Factors that play a part in the formulation of these policies include increasing competition in the electricity marketplace, decreasing worldwide reserves of fossil fuels, and increasing environmental impacts from fossil fuel use.

The sixth strategy employed to meet our energy needs while lessening the negative impacts of energy use, is to increase the efficiency of the production, distribution, and use of that energy. Increasing the efficiency of specific end uses such as vehicles, heating systems, and energy using appliances is discussed later in Chapter 4, in the Transportation section and Buildings and Equipment section. In this section, the growing number of energy supply and generation options available are considered, including smaller, more distributed electric generation, cogeneration, district heating, and integrated utility and communication services.

The seventh strategy deals with Vermont's electric energy supply. The process of opening the electric industry to retail competition, if it continues to move forward in Vermont, provides an opportunity to make further progress towards statewide energy goals. Retail competition is expected to lead to lower costs, but it is also an opportunity to ensure that further progress is made in other areas, such as increased renewable energy use, energy efficiency programs, and environmental protections.

Changes in the electric industry and the greater competition among fuels and providers is changing the traditional distinctions between regulated and non-regulated fuels. New tools that can be applied fairly to all fuels are needed to preserve environmental quality. In the past, regulated utilities have been held to one standard while non-regulated fuels have been addressed in a piecemeal manner, with pollution and efficiency standards applying to particular end uses. The eighth strategy involves using energy taxes to internalize the external costs of energy use (such as the damage from air pollution) in a manner that is comprehensive and fair to both regulated and non-regulated fuels. By setting the prices of energy use nearer to the full costs of that use, individuals and businesses acting in the marketplace can determine the most efficient options to reduce the costs to themselves and society. In addition, energy taxes can be used to shift our tax burden away from activities that are in society's interest to encourage, such as owning homes and working (in the case of property, income, and payroll taxes), toward activities that are in society's interest to discourage, such as inefficient energy use and polluting.

A. Strategy: Promote Sustainable Use of Wood Energy

Vermont's forests represent a significant renewable energy resource. Wood is by far the most widely used local, renewable energy source in Vermont, accounting for an estimated 7.7 TBTU in nonelectric energy use and 4.35 TBTU or 302 GWh of electric energy use in 1994 (Vt. DPS estimate). Instate hydroelectric power provides the next largest portion of local, renewable energy, with 585.9 GWh of electric energy. Greater use of wood resources can reduce greenhouse gas emissions and benefit local economies. Furthermore, precautions can be taken to ensure that extraction of the resource is environmentally sound and sustainable.

There are significant environmental advantages to expanding the use of wood biomass fuels in Vermont. When wood is used on a sustainable basis, as part of a thoughtful forest management policy, there is no net contribution of carbon dioxide to the atmosphere. The carbon component of the carbon dioxide that is released into the atmosphere when wood is burned was originally captured from the carbon dioxide in the atmosphere while the tree was alive.[i] Sustainable harvesting, in which new tree growth replaces harvested trees, will ensure that a similar amount of carbon will again be captured from the carbon dioxide in the atmosphere. Moreover, to the extent that wood use replaces the use of non-renewable fossil fuels, there can be significant reductions in Vermont's production of carbon dioxide.

Wood energy also contributes less to acid rain than fossil fuels. The sulfur dioxide and nitrogen oxide emissions from wood combustion are much lower than those from oil and coal. Use newer technology to burn wood, emissions of particulates, carbon monoxide, methane, and volatile organic compounds tend to be comparable or only slightly greater than fossil fuels.

In addition to the reduction in greenhouse gases and acid rain precursors, the use of wood fuel strengthens state and local economies because it is a local resource. It is estimated that 80% of the dollars spent on wood stays in Vermont, while only 20% of the dollars spent on non-renewable energy sources remains in the state's economy (Vt. DPS, *Vermont Comprehensive Energy Plan*, 1991, 66). A study done for the Conference of New England Governors estimated that the wood energy industry is responsible for 1,870 jobs and $85 million dollars in income in Vermont (High, 1994, 6-7).

Wood fuels also help to stabilize energy costs in Vermont. Local wood fuel prices have been historically more stable than oil and other energy prices because they are not directly linked to national or global energy markets and are not susceptible to foreign or cartel control. Because of the abundant supply and local control, wood fuels are expected to increase in price more slowly than competing fuels.

Furthermore, potential future energy taxes, such as a carbon tax or a non-renewable BTU tax, are less likely to impact the price of wood fuels than of fossil fuels. As awareness of the external costs of fossil fuel use grows, pressure to internalize those costs will also grow. Carbon and energy taxes are highly attractive means to internalize these costs because they rely on market mechanisms to lower the use of more damaging fuels instead of relying on more bureaucratic regulatory controls. Wood fuels, therefore, protect Vermonters from potential future energy price increases related to energy taxes as well as volatile world oil prices.

Vermont's wood resources are quite large. Forest covers approximately 77% of Vermont's total land area. The percentage of forested land has grown from only 20% about 90 years ago. The estimated annual growth of Vermont forest biomass is now approximately 12 million green tons per year (2.5 tons is the equivalent of one cord of wood). The total forest inventory represents approximately 475.5 million tons of living trees, and there is estimated to be an additional 80 million tons of cull and salvable dead wood in the forest.

In order to use the forest resources in a way that will achieve no net greenhouse gas emissions, these resources must be used sustainably. At the most simple level, this means that the yearly harvest must be less than the net annual growth, or less than 12 million tons a year (about four times the current harvest). Sustainable forest harvesting also requires that the harvesting practices do not damage the ability of the forest or of specific species to recover and regenerate. It is, therefore, essential that harvesting not lead to erosion of topsoil and significant loss of soil nutrients or irrecoverable damage to any species.

Vermont has no comprehensive forest management regulation to ensure sustainable forest practices, but it has made a substantial commitment through education, research, and tax policy to improve the use of its forest resource. This commitment extends beyond sustainability considerations and includes protecting the health of the forest for its scenic, wildlife, recreational, and environmental value. State and county foresters, a growing network of private foresters, and the Use Value Appraisal tax program have all helped improve the management of Vermont's forest land (32 V.S.A. §§3751-3775). Furthermore, it is possible to hold large-scale wood chip harvesting operations to very high standards. In Vermont, for example, electric generating facilities burning wood chips are required to buy only from harvesters who follow exacting forest management standards.

For a variety of environmental and economic reasons, substantial parts of the forest will not be available for harvest of any sort, which will reduce the available supply of wood resources. Wilderness areas, protected areas, inaccessible areas, high elevations, private landowners who will not allow harvesting, municipal or other governmental restrictions, and in some cases, public resistance to some forms of harvesting will always limit

the total human use of the forest resources. Other factors, such as new technologies, changes in price, and changes in forest composition, will alter the definition of what is available for use and may have the effect of increasing the available supply.

Table 4.I.1 Forest Inventory and Timber Growth in Vermont, 1994

	Million Green Tons	Million Cords
Living Trees	475.5	190.2
Cull and Salvable Dead Wood	80.0	32.0
Total Forest Inventory	**555.5**	**222.2**
Net Annual Growth	**12.0**	**4.8**
Net Growth Available (50% of Annual Growth)	6.0	2.4
1994 Timber Harvest	(3.9)	(1.5)
Potential Increased Yield	**2.2**	**0.9**

Source: Vt. DPS

A reasonable estimate of the percentage which might be available for human use is approximately 50% of the net annual growth, or 6 million tons per year. This is significantly greater than the current harvest. In 1994, a typical recent year, the total harvest of timber from Vermont's forest was approximately 3.85 million green tons of wood (including approximately 1.040 million tons of pulpwood, 1.509 million tons of sawlogs, 750,000 tons of firewood, 256,000 tons of whole tree chips, and 294,000 tons of residual waste from sawmills). The 3.85 million tons harvested is less than 1% of the standing inventory and only 32% of the annual growth. Currently the equivalent of 1% of the harvestable land base is harvested (generally through some form of selective cutting) each year.

There are two major uses for wood as an energy source. The first is the combustion of wood for the generation of electricity. The second is the combustion of wood for direct heat purposes. These can also occur simultaneously in wood cogeneration facilities. The goal of the policies described below is to increase the use of each and make those uses more sustainable and environmentally sound.

1. Policy: Promote Clean, Efficient Wood Burning with New Stoves

Promote clean, efficient wood-burning stoves by encouraging those who burn wood to trade in their pre-EPA certified appliances.

The Vermont Department of Public Service (DPS) and Agency of Natural Resources Air Pollution Control Division (APCD) already have up-to-date outreach materials concerning the advantages of newer EPA certified

stoves. DPS and APCD should create and implement a concerted public education/outreach plan using various Vermont media, including newspaper and magazine articles, radio, television, Internet, and brochures. This outreach effort could be done in conjunction with the Conference of New England Governors (CONEG), which has run a trade-up wood stove program during the past two heating seasons.

Rationale

The environmental advantages of wood energy are achieved by offsetting carbon dioxide emissions from fossil fuel use and lowering acid rain precursor emissions as discussed above. Since there is a limited amount of sustainably harvestable wood resources, using Vermont's wood resources more efficiently means that more fossil fuel use can be displaced. So, achieving the environmental benefits of wood energy requires using the most efficient technology available.

More importantly, there is a risk that global climate change and acid rain benefits from wood use could be in part offset if higher levels of other pollutants are emitted from older, more polluting, and less efficient stoves. Of particular concern is their higher levels of particulate and VOC emissions. The effects of these emissions can be made worse where the terrain, climate, weather patterns, and concentration of wood heaters promote accumulation of these pollutants.

Because heating homes with wood has in the past significantly contributed to air pollution and associated health problems, the federal government has taken action to reduce emissions. In February 1988, the Environmental Protection Agency (EPA) implemented regulatory standards limiting the emissions of new wood stoves and fireplace inserts.[ii] All new stoves and inserts must now be federally tested and certified to ensure that they meet emissions requirements for particulate matter. As a result, new wood stoves and fireplace inserts are not like their inefficient and polluting predecessors. The EPA estimates that certified wood-burning appliances burn 25%-33% less wood for the same heat output and have 75% less particulate emissions (Vt. DPS, *Buying a Wood-Burning Appliance*, 1991).

While the standards focus on particulate emissions, these stoves also reduce non-particulate air pollution and its associated health problems. The certified wood burning stoves have lower emissions of polycyclic organic materials (POM is a carcinogenic product of incomplete combustion) and carbon monoxide since they burn fuel more completely. Moreover, the more efficient certified stoves also produce 90% less creosote than conventional, noncertified stoves, reducing the risk of chimney fire and the costs of chimney cleaning. (Creosote is an oily residue that collects in the chimney over time from burning wood.)

EPA emissions standards significantly reduce air pollution, save energy and forest resources, and make new stoves and inserts safer and less costly to maintain. In addition, the new standards for emissions cut health and welfare costs, including mortality, health care, and damage from household soiling associated with particulate matter emissions. Finally, the money savings due to lower fuel wood consumption, less chimney cleaning, and fewer chimney fires are greater than the average cost increase of wood-burning appliances due to the standard (about $100-$250), resulting in a net savings to consumers.

Figure 4.I.1 Impacts of Promoting Clean, Efficient Wood-burning with New Stoves
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.35	35.98	35.95	38.27	38.26	885.25	884.75
Commercial	11.99	17.82	17.82	19.34	19.34	22.21	22.21	486.65	486.65
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.87	446.39	446.39
Transportation	42.10	60.54	60.54	64.68	64.68	70.98	70.99	1594.14	1594.15
Total	98.04	130.54	130.51	138.40	138.38	151.34	151.33	3412.43	3411.94

Table 4.I.2 Indicators of Promoting Clean, Efficient Wood-burning with New Stoves

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2899.1	0	146.1	183.8	183.8	188.1	188.1	16.0%	15.6%	15.5%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3411.9	0.5	0.01%	121.3%	173.8	217.6	217.6	222.6	222.5

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2108.3	61.79%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.68%	65.69%	63.27%	63.28%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
0	2	0.00%	$0	$0

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($2.75)	$26	$50,780	$56,452	$56,453	$58,679	$58,680	26.91%	26.62%	26.62%	27.62%	27.62%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,523,000	11,773,000	11,773,000	1,000	0.00%	165.35%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,258,000	11,407,000	11,407,000	2,000	0.00%	164.39%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	0	0.00%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	700	0.76%	56.86%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,800	31,800	0	0.00%	125.69%
Volatile Organic Compounds	21,600	20,000	19,900	19,400	19,300	2,700	0.56%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,700	93,500	93,500	2,200	0.09%	79.98%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	N/A	N/A	N/A	N/A

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] Residential sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

Impacts

This policy was modeled by accelerating the replacement of older, more polluting wood stoves with newer, more efficient EPA-approved models. This policy increases the rate at which they are replaced by 10% for five years between 1997 and 2002, after which time the rate returns to what it would have been without this policy. Because of the increase in retrofits in earlier years, most of the policy impacts also occur in those years.

Residential energy use (excluding transportation) falls modestly with this policy, by a total of 0.06% or 0.5 TBTU cumulatively through 2020 compared to the base case due to the increased efficiency of the EPA stoves. The primary impact of this policy is in the area of air emissions; the cost of air emissions decreases by 0.13% or $26 million (1995$) by 2020. This is due to a significant reduction of particulate and VOC emissions, which fall cumulatively by 0.76% and 0.56% through 2020 in spite of the modest scale of the policy. While the impacts of this policy are modest, the gain in air emissions and efficiency is achieved at a cost savings to society through reduced air emissions costs.

2. Policy: Promote Commercial and Industrial Use of Wood Energy

Encourage Vermont commercial and industrial businesses to generate more space and water heat, process heat, and/or electricity on site from wood processing residues and existing and emerging technologies.

Rationale

The benefits of expanding the use of locally produced wood residues for industrial and commercial fuel are described in the above sections. In addition, this policy would result in the expansion and diversification of markets for wood processing residues.

Managing the by-products of wood processing, known as the wood residue stream, is a critical part of sawmill and wood product manufacturing. It is no longer acceptable or feasible to dump residues on an unused portion of the facility property. It is no longer possible to burn these residues as a means of disposal either. Shipping these materials to a landfill is prohibitively expensive. Thus, the capacity of a business to dispose of wood residues at no major cost to the business plays a part in determining the competitiveness of that business.

Vermont is host to 100 commercial sawmills and 100 small sawmills as well as nearly 600 wood product manufacturing companies. All these firms have a demand for thermal and electrical energy as well as a substantial volume of wood residues. At present, many sawmills use their residues for generating process steam which is used to dry lumber. Many more mills sell residues to the pulp industry in surrounding states. A few wood product manufacturing firms use their residues to generate space heat and process steam. The remaining firms sell or pass along some residues to other manufacturers or to employees as kindling and firewood.

Consumption of residues by the business of origin is especially advantageous if the system for consuming the residuals is designed to generate electricity and/or heat. The opportunity for savings is greatly enhanced given that all the residue generated at a sawmill or manufacturing plant is paid for when the firm buys its raw materials.

Vermont has seen the successful development of clean, efficient wood chip fired space heat for 21 schools, most of which had been electrically heated. In addition, a public housing complex was converted from

electric heat to a wood chip heating system, obtaining significant savings for residents. With the development of these wood energy installations, a native wood chip manufacturing company has been established. The wood chip fuel market has begun to develop more fully along with the development of small- to mid-size scale wood chip consumption. (See Chapter 3 for the text box on Wood Chip Heating in Vermont.)

Opportunities for using energy from wood residue to produce heat and/or electricity on-site are not restricted to wood processing facilities. Institutional, commercial, and industrial facilities are using this type of wood energy system, and these opportunities could be expanded with greater use of district heat systems. A grant is presently in place to fund a feasibility study for delivering heat from the McNeil Station to the hilltop community in Burlington. This community includes the University of Vermont and the hospital complex. Expansion of the Montpelier capitol complex wood fired system is also being studied, with the possibility of serving parts of the downtown, and wood fired district heating is an option for a public housing project in Rutland.

Further development of institutional, commercial, and industrial wood fired systems will focus on the most efficient and clean combusting systems available. While currently available systems meet or exceed air quality standards, highly efficient clean burning biomass technologies are in development and will soon be available on the market. This next generation of combustion systems is expected to offer cost-competitive and reliable alternatives to direct combustion systems. These next generation systems can also be effectively and profitably coupled to established and emerging cogeneration systems which use wood gas or hot air to drive turbines.

Industrial, institutional, and commercial application developments are being supported by a growing network of partners, including the Department of Public Service, Agency of Natural Resources, Department of Economic Development, Coalition of Northeast Governors, Vermont Wood Manufacturers Association, and local and regional groups.

3. Policy: Replace Vermont Yankee Power with Two-Thirds Wood Gasification

Replace two-thirds of Vermont Yankee's power supplied to Vermont with wood gasification generation when Vermont Yankee closes.

> **Note: In Volume 1, the three policies addressing replacement of nuclear power with wood and wind generation are summarized together in the Policy: Develop Wood and Wind Power for Replacing Nuclear Power.**

When Vermont Yankee closes due to license expiration in 2012, Vermont should replace two-thirds of the state's Vermont Yankee power with new wood gasification generation technologies. This would require about 154 MW of capacity of wood gasification power, and about 590,000 cords of wood per year (approximately two-thirds of Vermont's unharvested sustainable capacity).

Rationale

When Vermont Yankee and other New England nuclear plants' licenses expire early in the next century (or if economic, safety, or market factors lead to earlier closure), the plants need to be replaced with renewable

fuel sources in order for greenhouse gas emissions not to grow. Approximately 25%-32% of Vermont's electric power has been provided by Vermont Yankee in recent years, and an average of 30% of New England's electricity has come from nuclear plants over the past decade. Thus, when these plants retire, Vermont and New England have the opportunity to either significantly increase their emissions levels or increase their levels of renewable fuel use.

The base case forecast in this Plan illustrates the likely effects on greenhouse gas emissions of replacing Vermont Yankee's power with fossil fuel generation. Under a business-as-usual scenario, Vermont's greenhouse gas emissions in 2015 are projected to be 3.5 million tons or 37% greater than in 1997. Slightly less than one-third of the growth (about 1 million tons) is due to the replacement of electricity from nuclear power with power from natural gas combined cycle plants.

Because nuclear power provides such a large portion of our electricity, the fuel sources that replace power from Vermont Yankee and other nuclear plants will determine, to a large extent, whether Vermont and New England make progress towards sustainable and environmentally sound energy use in the future. One of the most obvious and sound choices for replacement of nuclear power in Vermont is wood.

Wood has many advantages, as outlined in above discussions. Wood gasification power plants are some of the most efficient large-scale generation technologies currently under development. Gasification plants operate by turning wood (or other biomass sources) into a gaseous fuel for use in combustion turbines or combined cycle technologies. Vermont has been a leader in the testing of wood gasification technologies. A project currently underway at Burlington's McNeil Station will site a prototype wood gasification combustion turbine system at the plant, capable of powering a 20 MW electric generator. When complete, this system will be one of the first of its kind in the world, and will provide important information as a model. (See Chapter 3 for more on the McNeil project.) Because Vermont will have valuable experience with wood gasification, the state has a good opportunity to continue its leadership role in developing new technology in the future. Replacing nuclear power with wood gasification would further promote development of this new and important technology.

Impacts

This policy was modeled by assuming that two-thirds of the energy supplied by Vermont Yankee to Vermont will be replaced with instate wood gasification power. The base case, by contrast, assumes that Vermont's power from Vermont Yankee will be replaced with natural gas combined cycle generation from out-of-state sources.

The wood gasification replacement is modeled by phasing in the new capacity over five years as new generation is needed. Beginning in 2009, about 30 MW of wood gasification capacity comes on-line in Vermont each year until 2013, when 154.4 MW of capacity is available. (See Table 4.I.3.) As outlined above, about 590,000 cords of wood, or two-thirds of Vermont's unharvested sustainable wood capacity, is required. Thus, the fuel for the wood gasification power modeled here could be harvested sustainably within the state. The capital cost of the wood gasification plants is estimated to be $1,200/kW (1996$), with variable costs of 6.6 mills/kWh (1975$) in 2012 scaled with inflation. (A mill is 1/1000 of a dollar or $.001.) The plants are assumed to have a 90% availability factor and a heat rate of 9,750 BTU/kWh.

The result of building and using wood energy facilities instate is a significant boost to Vermont's economy compared to the base case (in which natural gas power is purchased from out-of-state). This is due to the $314 million investment (nominal $) in instate wood plants between 2009 and 2013, and the increase in jobs in the forestry and related sectors. The economy (GSP) grows significantly as a result of these factors and is approximately 0.2% larger in 2015 than the base case projections.
Comparison of the energy and energy cost results of this policy to other policies is difficult because the

increase in Vermont's economy entails increased energy use (0.47% cumulatively through 2020) compared with the base case. Energy costs, however, only increase by 0.24%, much less than the increase in energy use. The cost of capital, operation, and maintenance of energy-using devices also increases due to the increased economic activity.

Table 4.I.3 Modeled Wood Gasification Construction for Vermont Yankee/Wood Policy

Year	Added capacity (MW)	GWh Used	Investment in Vermont (millions of nominal $)
2009	30.0	236.45	$ 56.19
2010	30.0	472.90	$ 58.46
2011	30.0	709.34	$ 60.83
2012	34.4	980.47	$ 72.59
2013	30.0	1216.92	$ 65.87
Total	154.4		$313.94

Source: Vt. DPS

Table 4.I.4 Impacts of Replacing Vermont Yankee with Two-Thirds Wood Gasification
Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.22	38.30	884.91	886.08
Commercial	11.99	17.82	17.82	19.34	19.34	22.12	22.21	486.01	487.30
Industrial	12.42	16.79	16.79	18.41	18.41	19.90	20.01	446.66	457.79
Transportation	42.10	60.54	60.54	64.68	64.68	70.73	70.88	1591.96	1594.24
Total	98.04	130.54	130.54	138.40	138.40	150.96	151.40	3409.55	3425.41

Table 4.I.5 Indicators of Replacing Vermont Yankee with Two-Thirds Wood Gasification

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2754.6	142.7	146.1	183.8	183.8	187.9	164.8	16.0%	15.5%	15.5%	15.5%	25.9%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3425.4	15.9	0.47%	154.4%	173.8	217.6	217.6	222.3	222.3

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2114.0	61.72%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.68%	63.21%	63.10%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
14,600	565	0.11%	($2)	($0)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
N/A	$42	$50,780	$56,448	$56,448	$58,621	$58,575	26.91%	26.62%	26.62%	27.56%	27.46%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,523,000	11,749,000	11,279,000	3,747,000	1.50%	158.41%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,258,000	11,383,000	10,931,000	3,624,000	1.50%	157.53%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	14,100	3,600	0.97%	82.46%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	4,200	(7,800)	(9.21%)	69.57%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,700	31,000	5,400	0.77%	122.53%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,400	(1,000)	(0.21%)	89.81%
Carbon Monoxide (CO)	116,900	101,800	101,800	93,300	95,400	(23,100)	(0.96%)	81.61%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.00	N/A	N/A	($4)	$120

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

The important policy impacts of wood gasification plants include a cumulative increase through 2020 compared to the base case in employment (0.15% or 15,000 job-years) and the gross state product (0.11%), and the very significant decrease in greenhouse gas emissions (about 4% per year or 1.5% cumulatively).[iii] These impacts are quite large considering the policy affects only 11 years of the study period. The 4% per year reduction in greenhouse gases is a more apt indicator than the 1.5% cumulative figure, because the life expectancy of the facilities is quite long and extends well beyond the period of the study. The other major benefit of this policy is the 30% cumulative increase in renewable energy use. In 2015, for example, the percent of energy from renewables with this policy is 25.86%, compared to only 15.47% with the base case. The negative impacts associated with this policy are an increase in cumulative particulate emissions (9.2%) compared to the base case (due to the fact that wood gasification technologies emit more particulates than natural gas combined cycle generation), and much smaller rises in carbon monoxide, methane, and VOC emissions (less than 1%). Although these emissions increase compared to the base case, they actually decrease significantly relative to 1990 levels.

These increases, moreover, are more than outweighed by reductions in greenhouse gases. The total cost of air emissions, for example, declines by $42 million (1995$). In summary, this policy results in a significant decrease in greenhouse gas emissions and significant growth in Vermont's economy and renewable energy use.

4. Policy: Replace Vermont Yankee Power with Wood Gasification and Wind Power

Replace two-thirds of the power supplied by Vermont Yankee nuclear plant to Vermont with wood gasification generation and one-third with wind power when Vermont Yankee closes due to license expiration in 2012.

Note: In Volume 1, Policies I.A.3., I.A.4., and I.B.1. are summarized together in the Policy: Develop Wood and Wind Power for Replacing Nuclear Power.

Rationale

This policy is a combination of two other policies modeled separately in the Plan: 1) the policy above to replace two-thirds of Vermont Yankee power to Vermont with wood gasification; and 2) a policy described below to replace one-third of Vermont Yankee power with wind power. The advantages of this policy are outlined in the "Rationale" sections of the individual policies.

Impacts

This policy assumes that two-thirds of the energy generated by Vermont Yankee for Vermont will be replaced by instate wood gasification, and one-third will be replaced by instate wind power when Vermont Yankee's license expires. As such, this policy combines the two policies modeled in the Plan that treat wood and wind replacement of Vermont Yankee separately. The modeling assumptions for this policy are the same as the assumptions for the individual policies. (See Chapter 4, Section I.A., Policy 3. Replace Vermont Yankee Power with Two-Thirds Wood Gasification, and Section I.B., Policy 1. Replace Vermont Yankee Power with One-Third Wind Power.)

The major impacts of this policy reflect a combination of the individual policy impacts. The policy produces economic growth in increased instate energy use (growth that would have occurred out-of-state in the base case scenario). Both employment and the Gross State Product increase cumulatively through 2020 with this policy

compared to the base case, by 17,000 job-years and $600 million respectively (0.17% and 0.12%). The increase in economic activity also leads to an increased cumulative energy use of 0.59%. However, the accompanying increase in energy costs of 0.37% is less than the growth in energy use. Renewable energy use experiences a dramatic rise with this policy. In 2015, renewable energy use is at 43.6 TBTU, nearly double the amount of renewable use under the base case scenario (23.4 TBTU).

The policy also produces significant air emission cost reductions compared to the base case, amounting to $184 million (1995$) cumulatively. Greenhouse gas emissions fall cumulatively by 2.4% compared to the base case, or about 6.3% each year after the new generation is installed. Acid rain precursors and ground-level ozone precursors fall as well, by about 6.2% and 3.1% per year after the policy takes effect.

The only tradeoff in air emissions that occurs in using wood and wind instead of natural gas to replace Vermont Yankee is an increase compared to the base case in particulate emissions (8.4% cumulatively), and small increases in carbon monoxide, methane, and VOCs (all increase by less than 1%). These emissions increase compared to the base case but actually decrease significantly compared to 1990 levels. These increases, moreover, are more than outweighed by the benefits from greenhouse gas reductions.

This policy is a very important one in this Plan, because it is not possible to maintain current carbon dioxide emissions levels (or to cap such emissions from the electric sector at 1990 levels) without ensuring that Vermont Yankee power is replaced with generation that results in no net increase in carbon dioxide emissions. Wood gasification and wind energy are the two renewable sources that will be most feasible for Vermont to use in an increased manner over the next 20 years.

Table 4.I.6 Impacts of Replacing Vermont Yankee with Wood Gasification and Wind Power
Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.22	38.30	884.91	886.16
Commercial	11.99	17.82	17.82	19.34	19.34	22.12	22.21	486.01	487.40
Industrial	12.42	16.79	16.79	18.41	18.41	19.90	19.98	446.66	461.60
Transportation	42.10	60.54	60.54	64.68	64.68	70.73	70.88	1591.96	1594.60
Total	98.04	130.54	130.54	138.40	138.40	150.96	151.36	3409.55	3429.77

Table 4.I.7 Indicators of Replacing Vermont Yankee with Wood Gasification and Wind Power

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2719.6	177.8	146.1	183.8	183.8	187.9	158.2	16.0%	15.5%	15.5%	15.5%	28.8%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3429.8	20.2	0.59%	154.4%	173.8	217.6	217.6	222.3	222.3

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2116.2	61.70%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.68%	63.21%	63.05%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
16,800	603	0.12%	($7)	($2)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
N/A	$184	$50,780	$56,448	$56,448	$58,621	$58,579	26.91%	26.62%	26.62%	27.56%	27.47%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,523,000	11,749,000	11,012,000	5,991,000	2.40%	154.66%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,258,000	11,383,000	10,678,000	5,752,000	2.37%	153.88%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	13,800	4,700	1.26%	80.70%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	4,100	(7,200)	(8.43%)	68.23%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,700	30,000	14,400	2.06%	118.58%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,400	(1,000)	(0.21%)	89.81%
Carbon Monoxide (CO)	116,900	101,800	101,800	93,300	95,200	(21,500)	(0.89%)	81.44%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	0.98	N/A	N/A	$1	$94

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

5. Policy: Renewable Portfolio Standard with Wood Gasification

Adopt a strong renewable energy portfolio standard that will promote electric generation in the near term use of wood gasification plants in a more competitive electricity market.

Note: In Volume 1, this policy and the following one are summarized together in the Policy: Promote Renewable Resources and New Technologies with a Renewable Portfolio Standard.

As part of the move to retail competition in the electricity industry, Vermont and New England should adopt a portfolio standard for electricity generation from renewable resources/technologies that need further commercialization. The portfolio standard should be required of all suppliers selling electricity at wholesale or retail in Vermont. The Department of Public Service's position paper in the retail competition docket currently before the Public Service Board endorses a renewable portfolio standard of 4% of total generation after 10 years to come from biomass gasification, wind, photovoltaic, and fuel cell technologies (Vt. DPS, *Position Paper*, 1996). This standard, based on a study by the Union of Concerned Scientists, encourages renewable technologies that need commercialization assistance to mobilize them beyond the research, development, and demonstration stages. (The standard also includes fuel cells, even though they don't use renewable fuels, because they are modular, relatively clean, and are a bridge to biofuel technology development.) Other renewables such as hydro and traditional wood fired plants are not included in the standard because they generally do not require commercialization assistance.

Rationale

As outlined in the coal and oil policies in this section, increased competition in the electricity market is likely to encourage greater use of older, more polluting coal- and oil-fired plants. Without measures to mitigate this usage pattern, renewable fuels using new technologies such as wood gasification could be significantly disadvantaged. On the other hand, if the electric industry changes in a way that is friendly to renewables, wood gasification plants could gain market share.

A renewable portfolio standard as outlined above has several advantages. It would help overcome barriers blocking commercialization and use of new renewable technologies and address imperfections of the market that send incorrect price signals to consumers. In addition, it would provide near term and long term resource diversity and give Vermont and New England a competitive advantage as renewable technologies begin to take in the future. In the face of continuing environmental degradation, a renewable portfolio standard would allow the region to respond more easily to more stringent regulations in the future. The standard also guarantees a predictable market for renewables and allows flexibility in the types of generation appropriate for each region or utility. Finally, a renewable portfolio standard is neutral with respect to competitors in the market. It eliminates the need for further market intervention because contracts will develop in situations where there are willing buyers and sellers. This policy focuses on a renewable portfolio standard for new renewable sources, but a portfolio standard for all renewable sources would be advisable for Vermont as well. Vermont currently gets a sizable portion of its energy from renewables (primarily hydro and wood sources). If these sources were not used in a more competitive electricity environment, but instead, a 4% portfolio standard for new renewables was instituted, the result would be a drastic decrease in the percentage of electricity from renewables used in Vermont.

The policy earlier in this chapter, Replace Vermont Yankee Power with Two-Thirds Wood Gasification, outlines some of the advantages of wood gasification for Vermont. Both policies encourage the development of wood gasification; however, this policy focuses on near term opportunities for renewable power, while the

other policy focuses on an opportunity resulting from the loss of a major Vermont generation source within the next 20 years. Vermont will require additional energy sources before Vermont Yankee's 2012 license expiration, and that power could be provided from renewable fuels. Thus, rather than conflicting with each other, these two policies are natural complements.

Impacts

This policy models the renewable portfolio standard of 4% by 2005 using instate wood gasification generation. The policy is modeled with the same cost assumptions as the Vermont Yankee/wood gasification policy, but with capacity added as shown in Table 4.I.8 to meet the 4% goal.

Table 4.I.8 Modeled Wood Gasification Construction for Renewable Portfolio/Wood Policy

Year	Added capacity (MW)	GWh Used
1999	31	244.33
2003	2	260.09
2005	3	283.74
2010	1	291.62
2013	2	307.38
Total	39	

Source: Vt. DPS

Sustainability and environmental soundness indicators suggest that this policy's impacts are about one-half that of the Vermont Yankee/wood gasification policy impacts (a 2.4% vs. 4.6% increase in renewable resources, and a 0.8% vs. 1.5% decrease in greenhouse gases cumulatively through 2020 compared to the base case). This is somewhat deceptive, however, because this policy begins much earlier. In 2015, for example, this policy reduces carbon dioxide emissions by 1%, while the other policy reduces them by 4%. Another way of comparing the two policies shows that the Vermont Yankee/wood gasification policy has twice the environmental benefits in one-half the time.

The economic benefits are also smaller with this policy (fewer jobs created, but still 4,000 job-years more cumulatively than the base case scenario). Also, energy use increases slightly with this policy as a result of the energy sources and economic growth being shifted from out-of-state to instate. The cost of energy, however, does not increase as much as energy use itself: a 0.11% cumulative increase for energy use, but a 0.08% one for energy costs.

These results suggest that this policy is important to capture savings in the early years from 1999-2009, but that the policy alone does not capture all the benefits that are available. Replacing Vermont Yankee with an instate renewable fuel generator such as wood gasification would also be advisable.

Figure 4.I.2 Impacts of Renewable Portfolio Standard with Wood Gasification
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.41	35.43	36.02	36.02	38.23	38.24	885.41	885.60
Commercial	11.99	17.84	17.85	19.38	19.38	22.13	22.14	486.47	486.61
Industrial	12.42	16.81	16.92	18.43	18.66	19.91	19.95	447.06	450.14
Transportation	42.10	60.55	60.57	64.69	64.71	70.73	70.75	1592.14	1592.57
Total	98.04	130.61	130.76	138.52	138.77	151.01	151.07	3411.07	3414.91

Table 4.I.9 Indicators of Renewable Portfolio Standard with Wood Gasification
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2821.7	77.1	146.1	184.0	178.6	188.0	182.2	16.0%	15.5%	18.1%	15.5%	18.1%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3414.9	3.8	0.11%	154.1%	173.8	217.8	218.2	222.4	222.5

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2107.8	61.72%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.63%	65.60%	63.19%	63.18%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
3,700	91	0.02%	($12)	($7)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
N/A	$29	$50,780	$56,482	$56,466	$58,620	$58,634	26.91%	26.52%	26.53%	27.57%	27.56%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,536,000	9,463,000	11,755,000	11,638,000	1,952,000	0.78%	163.46%
Carbon Dioxide (CO_2)	6,939,000	9,270,000	9,199,000	11,388,000	11,276,000	1,892,000	0.78%	162.50%
Sulfur Dioxide (SO_2)	17,100	15,800	15,400	15,000	14,700	6,300	1.69%	85.96%
Suspended Particulates (PM-10)	6,000	3,400	3,600	3,400	3,600	(3,700)	(4.37%)	60.20%
Nitrogen Oxides (NO_X)	25,300	26,700	26,600	31,700	31,600	1,900	0.27%	124.90%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,300	(300)	(0.06)%	89.35%
Carbon Monoxide (CO)	116,900	101,800	102,300	93,300	93,800	(11,000)	(0.46%)	80.24%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.04	($2,822)	$337	$19	$45

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[b] All sectors

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[e] Household costs include energy costs, and the change in capital, operation,

[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices and maintenance costs of energy using devices that result from the policy

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

6. Policy: Renewable Portfolio Standard with Wood Gasification and Wind Power

Adopt a strong renewable energy portfolio standard that will encourage the near term use of both wood gasification and wind energy technologies.

> **Note: In Volume 1, Policies I.A.5., I.A.6., and I.B.2 are summarized together in the Policy: Promote Renewable Resources and New Technologies with a Renewable Portfolio Standard.**

Rationale

This policy is a combination of two policies modeled separately in the Plan: 1) the renewable portfolio standard that uses wood gasification, described above, and 2) the policy described in the next section that uses wind energy to fulfill a renewable portfolio standard. For a fuller description, see the two individual policies.

Impacts

This policy meets the 4% renewable portfolio standard by 2005 with equal amounts of wood gasification and wind energy (each contributes 2%). The assumptions are the same as those in the individual wood and wind portfolio policies, but with wood and wind power each supplying one-half as much capacity and GWh used. (See the Renewable Portfolio Standard with Wood Gasification, and the Renewable Portfolio Standard with Wind Power policies.)

In the combined scenario, cumulative energy use compared to the base case increases due to an increase in the cumulative Gross State Product (0.03%) and jobs (4,000 job-years). Increased energy costs are slightly greater than increased energy use, but are more than offset by the reduced cost of air emissions. While greenhouse gas emissions are reduced by more than 2 million tons in this policy, that figure is only one-third the total reduction for the Vermont Yankee/wood and wind policy (described earlier in this section). Moreover, the yearly reduction, as seen by the 2015 figures, indicates that 737,000 tons of greenhouse gases per year would be reduced by replacing Vermont Yankee with wood and wind, while 122,000 tons per year would be reduced by this policy. Both policies have a beneficial effect on the Vermont economy, but the Vermont Yankee/wood and wind policy would have roughly a six times greater environmental benefit.

These results suggest that, in any competitive energy market, Vermont should take strong steps to ensure that renewable and sustainable generation takes place inside Vermont. While the 4% renewable portfolio standard benefits Vermont in the earlier years, the replacement of Vermont Yankee with renewable instate power is essential to gaining strong benefits for the economy and environment in later years. The 4% renewable portfolio standard alone is not enough to ensure that the economic and environmental benefits of instate renewable generation are captured in a complete manner.

Figure 4.I.3 Impacts of Renewable Portfolio Standard with Wood Gasification and Wind Power

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.41	35.43	36.02	36.02	38.23	38.23	885.41	885.44
Commercial	11.99	17.84	17.85	19.38	19.38	22.13	22.13	486.47	486.52
Industrial	12.42	16.81	16.89	18.43	18.57	19.91	19.92	447.06	449.38
Transportation	42.10	60.55	60.57	64.69	64.71	70.73	70.75	1592.14	1592.68
Total	98.04	130.61	130.74	138.52	138.67	151.01	151.03	3411.07	3414.03

Table 4.I.10 Indicators of Renewable Portfolio Standard with Wood Gasification and Wind Power

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2842.6	56.3	146.1	184.0	180.0	188.0	183.7	16.0%	15.5%	17.5%	15.5%	17.4%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3414.0	3.0	0.09%	154.0%	173.8	217.8	218.0	222.4	222.4

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2107.5	61.73%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.63%	65.61%	63.19%	63.19%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
3,500	142	0.03%	($9)	($7)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
N/A	$84	$50,780	$56,482	$56,471	$58,620	$58,632	26.91%	26.52%	26.54%	27.57%	27.58%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,536,000	9,457,000	11,755,000	11,633,000	2,043,000	0.82%	163.38%
Carbon Dioxide (CO_2)	6,939,000	9,270,000	9,194,000	11,388,000	11,272,000	1,960,000	0.81%	162.44%
Sulfur Dioxide (SO_2)	17,100	15,800	15,400	15,000	14,700	7,100	1.91%	85.96%
Suspended Particulates (PM-10)	6,000	3,400	3,500	3,400	3,500	(1,400)	(1.60%)	58.19%
Nitrogen Oxides (NO_X)	25,300	26,700	26,500	31,700	31,400	4,600	0.66%	124.11%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,300	(200)	(0.04%)	89.35%
Carbon Monoxide (CO)	116,900	101,800	102,000	93,300	93,500	(5,000)	(0.21%)	79.98%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.04	($2,679)	$257	$33	$61

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

B. Strategy: Promote Wind Generated Electric Energy

The use of wind for electricity generation around the world has grown phenomenally in recent years. Installed wind power capacity worldwide grew to more than 5,000 MW during the first quarter of 1996, with about 1,300 MW of capacity installed in 1995 alone. Total installed capacity is expected to reach more than 18,500 MW by 2005, representing a market of more than $18 billion (American Wind Energy Association, 1996).

Not all countries' markets have grown equally in recent years, however. United States markets have slowed, while others are flourishing. Germany and India, for example, accounted for almost two-thirds of all new wind installations in 1995, while the United States accounted for only about 3%. Formerly, the vast majority of worldwide wind power was located in the United States, but in the last 10 years the United States share of world capacity has dropped from about 90% to about 30%. The currently slower markets in the U.S. can be attributed in part to the pending restructuring of the electric utility industry, which has made investments in new capacity risky (American Wind Energy Association, 1996).

Currently, the U.S. wind energy industry generates about three billion kilowatt-hours annually, enough power to satisfy the electricity needs of one million Americans. More than 90% of this power is generated at the three largest wind power installations in the United States, located in California. The 16,000 turbines installed at these three sites represent more than 1,700 MW of generating capacity.

There are many advantages to wind energy use, including no air emissions, few environmental impacts compared with traditional fuels, availability of efficient new technologies, modularity of wind projects, generation costs that are nearly competitive with traditional fuels, generation costs that remain relatively fixed over time (due to no energy price fluctuations), absence of external costs, and positive contributions to local economies. Disadvantages include the continuing investment needed for wind energy development, need for back-up generation sources because of the wind's intermittent nature, potentially negative visual impacts, potential impacts on wilderness recreation, potential impacts on wilderness habitat and wildlife (especially birds), and potential noise impacts for humans or wildlife living close to the turbines. Many of these potential disadvantages can be mitigated by careful design, siting, and construction.

One of wind power's most significant advantages is its lack of air emissions, since this is a serious problem with conventional fuel sources. Most of the costs of emissions from conventional fossil fuel plants are not included in energy prices, but are borne by society as a whole or by specific groups. With wind energy, not only are emissions costs not borne by society, but any risk of future operational constraints as a result of efforts to control air emissions is also eliminated. In addition, wind power does not have the environmental impacts associated with mining, drilling, transporting, leakage, etc. that fossil fuels have.

Wind technology has improved rapidly in the past several years. Advances in all aspects of wind turbine design, from blades to electronic components, have resulted in larger, more efficient, reliable and controllable technologies. The average capacity of individual wind turbines has grown from about 100 kW in the late 1980s to 350-500 kW, an optimal size for wind development in many locations.

Wind power's operational characteristics are especially attractive because of the modularity of wind project construction. Most other generation capacity additions are necessarily large, and cannot be exactly matched to future anticipated demands. By contrast, wind turbines can be erected in smaller increments and as need arises. If projected need fails to materialize or if costs are different from original projections, the wind project can be adjusted accordingly. This strategy is not possible with larger, non-modular power production technologies.

Declining costs for wind generation have made it nearly cost competitive with conventional generation sources. Wind generated electricity costs have fallen from about $0.20 per kWh in the early 1980s, to about $0.07 for wind projects installed in the early 1990s, to $0.05 for a few current wind projects using new technologies (in 1993 dollars) (Flavin, *Power Surge*, 1994, 121). The National Renewable Energy Laboratory predicts that costs will continue to decrease, and by 2000, wind-generated electricity will be produced for $0.04 or less per kWh (including up-front capital costs) in modest, 13 mph wind regimes.

The addition of wind energy to the resource portfolio of a utility diversifies the fuel mix, stabilizing costs and reducing risk. Since there is no "fuel" for a wind turbine, its costs are essentially fixed at the time of construction. As prices for other generation fuels fluctuate, the cost for wind power remains essentially constant (except for possible refinancings of the original investment and variations in projected operations and maintenance costs). Further, since there are almost no external costs associated with wind generated electricity, the risk of future environmentally based restrictions on operation (which could be imposed on fossil plants) are all but eliminated.

Wind energy also has the potential to contribute positively to state economies. Many U.S. firms (including several in Vermont) are actively producing and selling wind energy components. Expansion of wind power use in Vermont, the United States, and elsewhere ultimately will bring jobs to the state. In addition, wind power construction and operations generally create more jobs than conventional energy development, especially in the skilled manufacturing and construction sectors. (For more information, see Vt. DPS, *Wind Generated Electricity*, 1994).

Economic development already has been a force behind wind energy development in some states. For instance, farmers in southern Minnesota have lobbied their state legislature to accept a proposed wind project, arguing that their community will be strengthened by the jobs and economic activity that will result. Policy makers in Iowa have chosen to develop their state's wind resources in order to keep more energy expenditures in the state and to benefit farmers and ranchers, who can designate small parcels of grazing and cropland for wind turbine installations and generate additional income.

One of the few disadvantages to wind power is its requirement of back-up generation sources, due to the intermittent nature of wind. As a result, there is a limit to the proportion of our electricity that could be obtained from the wind. While there is no exact rule, exceeding 10-20% could result in the need for excessive back-up sources. If energy storage capabilities improved significantly in the future, we could rely more heavily on wind power.

Wind power projects also have the potential to create negative aesthetic impacts (although some people find wind turbines in operation aesthetically pleasing). Because of the characteristics of wind flow patterns, turbines must be sited on or close to visually prominent ridge tops. Modern wind turbines are usually 110 to 140 feet high, with rotors extending an additional 30-35 feet. These make a strong visual impact. However, careful planning and design can mitigate some of these impacts. For example, tubular towers, rather than latticework towers, are less visually intrusive. A well-ordered array of turbines is more pleasing than a scattered mass of machines. Following natural land contours can improve the visual impression of a wind project as well. In addition, public information and education efforts about the benefits of wind power can build community support for a project.

Potential impacts of wind projects on wilderness recreation are related to visual impacts. If wind projects are sited in locations that are used for wilderness recreation purposes, and are otherwise undisturbed by development, wilderness experiences are likely to be compromised. In a country where the number of undisturbed wilderness areas is dwindling, this is an important concern. In siting wind power projects, important wilderness lands should be avoided.

Wind power also has the potential to threaten wilderness habitat and wildlife. Human intrusion during

construction of wind projects and the alteration of these habitats could threaten wildlife in the area, though to date these impacts have not been severe. Careful research and project design can work around many potential ecosystem impacts. Potential impacts on birds have drawn attention recently, due to concerns that some large birds had been killed by wind turbines in California. While this problem remains to be solved, ongoing research is making progress toward solutions. Green Mountain Power is looking into the effects of its turbines on the migration of birds in the Searsburg area. In addition, mitigating steps are available to developers, such as avoiding migration routes for susceptible bird species.

Noise is another potential impact from wind turbines. This is likely to be a problem only to humans or wildlife living within a few hundred feet of the turbines. Since modern wind turbines were initially installed in the 1980s, significant progress has been made by designers to reduce noise levels. In summary, these impacts have the potential to be serious, but most can be partly or entirely mitigated through research, design, and consultation with affected communities.

Vermont's involvement with wind energy goes back to 1941, when the state was chosen as the test site for a first-of-its-kind wind turbine to be connected to a utility system. Vermont was chosen for the project because of our available wind resource, and this resource remains largely untapped today.

Compared to most other states, Vermont has significant wind resources. Wind resources are ranked in classes consisting of different speeds, as illustrated in Table 4.I.11. The mountains of Vermont have average annual wind speeds in Class 4 or higher ratings. (See Figure 4.I.4.) Class 3 or greater wind site ratings are considered developable for wind power, although Class 3 ratings are seen by some as marginal areas for development at this time. As shown in Tables 4.I.12 and 4.I.13, if all the potentially available land area of Class 4 wind speeds or greater were developed with wind power (which constitutes 1.7% of the state's total land area), the potential energy production would exceed Vermont's 1992 electricity consumption. While no one expects that this level of wind power development would actually occur due to the issues discussed above, the state could, in theory, meet a significant portion of its electricity needs with wind power.

While there is some potential for small-scale, non-grid connected systems in Vermont, the most significant use of wind energy is likely to be in the form of utility-scale installations of several MegaWatts in size. Vermont's prime wind resource is located along ridgelines, which are not generally close to customers. Thus, any project taking advantage of the prime wind sites will need transmission lines to get the energy to the grid or to customers.

Green Mountain Power recently was awarded a $3.5 million grant to assist in the construction of a 6 MW wind power project, with 11 wind turbines. The project, located near Searsburg, Vermont, is expected to produce power for $0.07 per kWh after grant funds are taken into account.

1. Policy: Replace Vermont Yankee Power with One-Third Wind Power

Replace one-third of the power supplied to Vermont by Vermont Yankee nuclear station with wind power when Vermont Yankee closes.

> **Note: In Volume 1, this policy is summarized with others in the Policy: Develop Wood and Wind Power for Replacing Nuclear Power.**

Figure 4.I.4 New Hampshire and Vermont Annual Average Wind Power

Table 4.I.11 Wind Speed Classes

Wind Class	Wind Speed at 33 ft.	Wind Speed at 164 ft.
3	11.5 - 12.5 MPH	14.3 - 15.7 MPH
4	12.5 - 13.4 MPH	15.7 - 16.8 MPH
5	13.4 - 14.3 MPH	16.8 - 17.9 MPH
6	14.3 - 15.7 MPH	17.9 - 19.7 MPH
7	15.7 - 21.1 MPH	19.7 - 26.6 MPH

Table 4.I.12 Vermont Land Area Available for Wind Energy
(Total Area of Vermont is 24,017 km^2)

	Class 3 or Greater Wind Speeds		Class 4 or Greater Wind Speeds	
Vermont land area	1,170 km2	4.9%	946 km^2	3.9%
Land excluded from wind development (Urban: 100%, Environmentally sensitive: 100%, Forest: 50%, Agriculture: 30%, Rangeland: 10%)	659 km^2	2.8%	535 km^2	2.2%
Potentially available Vt. land	511 km^2	2.1%	411 km^2	1.7%

Table 4.I.13 Vermont Wind Electricity Potential
(from potentially available Vt. land, as shown in Table 4.I.12)

	Class 3 or Greater Wind Speeds	Class 4 or Greater Wind Speeds
Average power potential (MW)	705	601
Annual energy potential (GWh)	6,000	5,000
Percentage of Vt. total 1992 electric consumption (4,900 GWh)	125%	107%

Source: Pacific Northwest Laboratory, for the U.S. Department of Energy, 1993. For further information, see Pacific Northwest Laboratory, *An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States*, PNL-7789.

When Vermont Yankee nuclear station closes due to license expiration in 2012, Vermont should replace one-third of the state's power from Vermont Yankee with wind generation. This would require about 300 MW of capacity of wind power, equal to one-fifth the amount currently used in California.

Rationale

This policy is similar to the policy earlier in this chapter that replaces the state's Vermont Yankee power with two-thirds wood gasification power. As outlined in that policy, when nuclear power plants close, their power needs to be replaced with renewable fuel sources in order to keep overall emissions from increasing. (See the Replace Vermont Yankee Power with Two-Thirds Wood Gasification policy.) This wind policy is also modeled in conjunction with the wood gasification policy, so that Vermont Yankee is entirely replaced with renewable power sources. (See the Replace Vermont Yankee Power with Wood Gasification and Wind Power policy earlier in this chapter.)

In addition to wood power, wind is one of the best choices for Vermont's future renewable energy use. As described above, wind resources are larger in Vermont than in many other states, and one state utility is already gaining experience with wind power by building a small wind generation facility. In addition, new wind technologies are reliable and prices are falling quickly and will be cost competitive for Vermont before any other new renewable energy source. Vermont thus has an excellent opportunity to help lead the development of this important new renewable energy source.

Impacts

This policy was modeled by replacing approximately one-third of the energy currently generated by Vermont Yankee for Vermont with instate wind generation when Vermont Yankee's license expires. The wind power modeled in this policy is used as replacement power instead of the out-of-state natural gas combined cycle power used as a replacement in the base case scenario.

As with the Vermont Yankee/wood gasification policy, wind plants are phased-in over five years as new generation is needed. Approximately 47 MW per year of wind capacity would be built between 2009 and 2013, resulting in a total of 238.3 MW. (See Table 4.I.14.) The capital costs are based on $1,000/kW (1996$), with 30-year financing. Although the physical capacity built is greater than the capacity built with the wood gasification policy, the energy generated by the wind is one-half that of the energy generated by the new wood plants. The additional capacity is scaled to account for periods of low wind. The increased capital costs that result from building more capacity with wind are offset by the elimination of fuel costs.

As with the wood gasification policy, comparison of energy costs in this policy with other policies is difficult because of the increased economic activity and investment. Energy use grows cumulatively through 2020 by 0.14% compared to the base case, and energy costs rise by 0.22% with this policy, reflecting the slightly higher cost of wind energy. This is more than offset, however, by the cumulative reduction in air emissions costs of $122 million (1995$).

The greatest impacts of this policy are the increased percentage of energy from renewable sources compared to the base case (an approximate 2.5% increase per year), the decrease in all air emissions (including an approximate 2.1% per year reduction in greenhouse gases), a 3.2% per year reduction in acid rain precursors, and a 1.6% per year reduction in ground level ozone precursors.

Table 4.I.14 Modeled Wind Generation Construction for Vermont Yankee/Wind Policy

Year	Added capacity (MW)	Annual GWh Produced
2009	47.4	116.28
2010	47.4	232.57
2011	47.4	348.86
2012	48.7	468.24
2013	47.4	584.52
Total	238.3	

Source: Vt. DPS

Table 4.I.15 Impacts of Replacing Vermont Yankee with One-Third Wind Power
Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.21	38.19	884.88	884.84
Commercial	11.99	17.82	17.82	19.34	19.34	22.12	22.09	485.98	485.93
Industrial	12.42	16.79	16.79	18.41	18.41	19.89	19.86	446.64	451.25
Transportation	42.10	60.54	60.54	64.68	64.68	70.73	70.72	1591.95	1592.31
Total	98.04	130.54	130.54	138.40	138.40	150.95	150.85	3409.45	3414.33

Table 4.I.16 Indicators of Replacing Vermont Yankee with One-Third Wind Power
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2868.0	29.2	146.1	183.8	183.8	187.9	182.2	16.0%	15.5%	15.5%	15.5%	18.0%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3414.3	4.9	0.14%	153.9%	173.8	217.6	217.6	222.3	222.2

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2108.7	61.76%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.68%	65.68%	63.21%	63.21%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
2,400	29	0.01%	($6)	($2)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
N/A	$122	$50,780	$56,448	$56,448	$58,621	$58,608	26.91%	26.62%	26.62%	27.57%	27.63%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,523,000	11,748,000	11,507,000	1,956,000	0.78%	161.62%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,258,000	11,382,000	11,153,000	1,862,000	0.77%	160.73%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	14,300	3,400	0.91%	83.63%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	500	0.55%	56.02%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,700	30,900	7,300	1.05%	122.13%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,300	0	0.00%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,800	93,300	93,100	500	0.02%	79.64%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.03	N/A	N/A	$6	$61

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy

and capital, operation, and maintenance cost of energy using devices [f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

2. Policy: Renewable Portfolio Standard with Wind Power

Adopt a strong renewable energy portfolio standard that will encourage the near term use of wind energy in a more competitive electricity market.

Note: In Volume 1, this policy is summarized with others in the Policy: Promote Renewable Resources and New Technologies with a Renewable Portfolio Standard.

Rationale

This policy is similar to the Renewable Portfolio Standard with Wood Gasification described earlier in this chapter. With this policy, however, wind instead of wood is modeled as the energy source that would fulfill such a portfolio standard. As described in the wood policy, a strong renewable portfolio standard required of all electricity providers selling power in the state is essential in a competitive electricity environment to ensure that renewable sources are not disadvantaged. A renewable portfolio standard is especially important for future wind use, since wind is a fairly new fuel source for New England and requires continuing commercialization assistance. The renewable portfolio standard was also modeled by filling the standard with one-half wind energy and one-half wood gasification. See the Renewable Portfolio Standard with Wood Gasification and Wind Power policy earlier in this chapter.

Impacts

As in the case of the renewable standard/wood gasification policy, capacity is added when additional generation is needed to meet and maintain a 4% renewable portfolio standard by 2005. The same cost assumptions were used as in the Vermont Yankee/wind power policy. To meet the 4% goal, wind generation was added as shown in Table 4.I.17.

Table 4.I.17 Modeled Wind Power Construction for Renewable Portfolio/Wind Policy

Year	Added Capacity (MW)	Annual GWh Produced
1999	101.12	248.07
2003	6.32	263.58
2005	9.48	286.84
2010	3.16	294.59
2013	6.32	310.09
Total	126.4	

Source: Vt. DPS

Figure 4.I.5 Impacts of Renewable Portfolio Standard with Wind Power
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990			2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.41	35.42	36.02	36.01	38.23	38.22	885.41	885.24
Commercial	11.99	17.84	17.85	19.38	19.37	22.13	22.12	486.47	486.39
Industrial	12.42	16.81	16.85	18.43	18.57	19.91	19.89	447.06	448.57
Transportation	42.10	60.55	60.58	64.69	64.72	70.73	70.76	1592.14	1592.77
Total	98.04	130.61	130.70	138.52	138.67	151.01	150.98	3411.07	3412.97

Table 4.I.18 Indicators of Renewable Portfolio Standard with Wind Power
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2862.8	36.1	146.1	184.0	181.2	188.0	185.2	16.0%	15.5%	16.9%	15.5%	16.7%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3413.0	1.9	0.06%	154.0%	173.8	217.8	218.0	222.4	222.4

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2107.2	61.74%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.63%	65.62%	63.19%	63.21%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
3,300	185	0.04%	($6)	($7)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
N/A	$136	$50,780	$56,482	$56,458	$58,620	$58,630	26.91%	26.52%	26.56%	27.57%	27.59%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,536,000	9,456,000	11,755,000	11,630,000	2,118,000	0.85%	163.34%
Carbon Dioxide (CO_2)	6,939,000	9,270,000	9,194,000	11,388,000	11,270,000	2,013,000	0.83%	162.42%
Sulfur Dioxide (SO_2)	17,100	15,800	15,400	15,000	14,600	7,900	2.12%	85.38%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	900	1.00%	56.35%
Nitrogen Oxides (NO_X)	25,300	26,700	26,400	31,700	31,300	7,100	1.02%	123.72%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,300	0	0.00%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,800	93,300	93,200	600	0.02%	79.73%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.04	($2,528)	$391	$44	$77

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
(1995 $)
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security

The cumulative impacts of this policy are quite similar to those of the Vermont Yankee/wind power policy, although most of the impacts are slightly lower and more of the savings occurs in earlier years. The greatest advantage of this policy is the total elimination of air emissions associated with this power, which translates into a cumulative cost reduction of about $136 million compared to the base case. Compared to the renewable standard/wood gasification policy, this policy is more expensive, but the greater energy costs are more than offset by the reduced cost of air emissions.

C. Strategy: Promote Use of Solar Energy

Solar energy is a clean, abundant, and renewable fuel source. It can provide natural lighting, space heat, hot water, and electricity. Unfortunately, it is underutilized due to a number of factors: the cost of solar installations; the unfamiliarity and inexperience of builders, energy companies, and consumers with solar energy; and tax breaks, funding, and emphasis given to and placed on non-renewable fuels. Many of the policies in this section and in the Energy Taxation strategy are intended to address these concerns.

Solar energy is often thought of as a future technology. It is, however, the ultimate source of nearly all the energy we currently use (excluding energy from nuclear power, geothermal, and lunar tides). Burning biomass or fossil fuels, for example, releases energy originally captured from the sun by trees and plants through photosynthesis. The sun is also responsible for causing winds and non-lunar tides, which can be harnessed for energy.

Each time solar energy is converted, from electromagnetic radiation to biomass by photosynthesis, from biomass to heat by combustion, from biomass to fossil fuels by decomposition and other processes over geologic time, and from fossil fuels to heat by combustion, a significant portion of the original solar energy is lost. Photosynthesis, for example, converts only about 0.5% of the incoming solar energy into biomass, and new EPA approved wood stoves convert only about 60%-70% of the stored energy. The conversion of solar energy to fossil fuels is many times more inefficient. In addition, there are significant air emissions from the combustion process, including carbon dioxide, carbon monoxide, particulates, and VOCs.

While energy originally captured from the sun and stored in fossil fuels and biomass is limited, direct solar radiation provides more sustainable energy than we can use. For practical purposes, oil is only being discovered, not created. As a comparison, Vermont forests produce about 48.5 TBTU of sustainable energy each year (Vt. DPS, *Fuelwood Assessment*, 1995). This value represents the energy content of the sustainable yield of Vermont's forests, including wood used in the paper and building trades, wood consumed for energy, and wood that is not harvested. Of that, there is 17.4 TBTU that could be harvested but currently is not. The average yearly solar energy that falls on those same forests is 85,000 TBTU.[iv] Thus, while Vermont receives less solar energy than many other U.S. states, there is still great untapped potential for solar energy use here.

Clearly, for a future of abundant clean energy, we must tap more directly into solar energy and rely less on energy stored in fossil fuels and even biomass. A simple step in this direction is to better use the light and heat of the sun by adjusting our schedules to better coincide with the sun, as described in the first policy. The second policy recommends better use of sunlight for passive and active lighting and heating in building designs. Both of these steps have minimal costs but significant returns. Other alternatives, described in the third and fourth policies, include increased use of solar energy for water heating and generation of electricity from the sun.

1. Policy: Shift Clocks Toward the Solar Day

***Shift clock time one hour ahead to take fuller advantage of existing sunlight*.**

Note: This policy has complex issues needing further exploration before recommendations can be made. A summary of this policy does not appear in Volume 1, Chapter 4.

Rationale

In order to use passive solar power for residential and commercial lighting, the sun must be shining during times when we require lighting. A resident of Rutland, Vermont, who sleeps from 11 PM to 7 AM, is asleep during 282 hours of sunlight and awake (and needing lighting) for 1,635 hours of darkness each year. Because the solar day is centered around 12 noon and our waking day is centered around 3 PM, shifting our waking day toward the solar day can provide us with extra hours of sunlight.

There are a number of options that would shift our waking day toward the solar day. One option is for individuals to make conscious efforts to adjust their schedules to the sun's schedule. A second, more effective option is to uniformly change clock times to better match the sun's schedule, as is done with Daylight Savings Time in the summer. Shifting the entire nation one time zone east (so that Eastern Time would become what is now Atlantic Time, Central Time would become what is now Eastern time, etc.) would result in significant energy savings at no cost.

The precedent for such an action already exists. The current time zones are determined by an Act of Congress, the Uniform Time Act of 1966, which sets the boundaries of time zones and provides for Daylight Savings Time. This Act was amended to save energy by placing almost the entire nation on year-round Daylight Savings Time in 1974, but Congress failed to renew that legislation when it expired in 1975.

In addition to the energy saving advantages of capturing useful daylight, additional hours of sunlight would make daylighting measures more cost-effective, by offering more hours of light to recapture investment costs (see the policy below for more about daylighting). Another energy advantage includes the ability to reduce electric use during the evening "peak usage time," due to reduced lighting demand. This reduction could have a significant financial impact because "peak time" power is the most expensive. (See the section Vermont's Daily and Yearly Electricity Demand in Chapter 3 for a further description.) Non-energy related advantages include reduced traffic accidents and related costs, and possibly reduced crime due to later sunsets.

Estimates of savings for this policy were made assuming that 80% of Vermont homes each get one hour more of daylight during waking time for six months a year, reducing energy use for lighting by 0.3 kWh per home per day, or the equivalent of four 75 watt bulbs for one hour per day.

The impact of shifting clock times ahead one hour is a savings of approximately 11.7 GWh or $1.3 million each year for the residential sector, a 0.5% reduction of residential energy use.

Estimating lighting reductions in the commercial and industrial sectors is more difficult, because businesses in these sectors often have lights on most of the time. However, lighting represents a much higher percentage of total energy requirements for commercial and industrial users than for residential users (41.5% of commercial electricity use goes for lighting, as opposed to 5% for residential). If commercial and

industrial users could take greater advantage of daylighting, then very significant gains in energy reduction can be made.

Implementation

Legislative action by the U.S. Congress is needed to amend the Uniform Time Act of 1966.

2. Policy: Increase Solar Lighting and Heating Applications

Increase the use of passive and active solar applications for lighting and space heating purposes.

The sun's energy is captured in buildings by either "passive" or "active" solar systems. Passive solar systems use architectural design and special building materials to capture and passively distribute sunlight for lighting and heating purposes. Active solar systems use mechanical devices such as pumps and fans to move heat throughout the building.

Rationale

In general, passive solar building orientation and design are the most cost-effective means of using solar energy in Vermont. Passive lighting and space heating are very efficient uses, because the energy is used directly with no conversion losses. Lighting or "daylighting" simply uses the sun for indoor lighting. This technique can garner savings when applied to homes, but it has significant potential when applied to the commercial sector, because lighting is the second largest end use for electricity in the commercial sector. Daylighting is achieved by orienting the building and windows appropriately, installing outdoor materials or devices that reflect light into windows, using light-colored indoor wall and floor coverings that reflect light, using special techniques that reduce the glare of direct sunlight, and installing special roof skylights that filter sun and distribute it throughout the building. Architects capture solar energy for heating by combining solar designs with energy efficiency measures. These measures include orienting the building and placing windows appropriately; incorporating good insulation, tightfitting multiple-paned windows, roof overhangs, and wall and floor coverings that store heat and slowly release it later; and designing a sunspace to collect the sun's energy and distribute warm air to the rest of the building. In addition to providing heat in the winter, many of these same measures promote cooling in the summer. (See Chapter 3 for more about solar energy.)

Passive solar designs can save significant portions of a building's heating requirement. For instance, a 1,500 square foot, single story house with 100 square feet of south facing, double-paned windows can save 15% of the home's space heat usage. Further designs that maximize south facing windows and provide solar heat retention and storage can provide a 20%-30% savings. Other available solar technologies can reduce space heat demands by as much as 50% (Passive Solar Industries Council, 6, 29, 31).

In many cases, passive solar buildings can be constructed at little or no extra cost compared with conventional building practices. If construction costs are higher, the benefits from reduced fuel and electricity costs, as well as savings from downsizing heating and cooling equipment often offset the construction costs.

When solar building design and siting are incorporated during construction, they require a one-time investment that provides free heat and light for as long as the building lasts. As such, passive solar design is one of the simplest and cheapest ways to use renewable energy and reduce fossil fuel use, emissions, and

reliance. There is substantial solar potential to be garnered in Vermont simply by incorporating cost-effective passive solar heating and lighting measures into our buildings.

There are three avenues available to increase the use of passive solar building designs.

- increase the information and education available to builders and homeowners;
- provide incentives for solar design; and
- use regulatory mechanisms such as Act 250 and building codes.

A combination of these techniques is likely to have the greatest impact.

3. Policy: Increase Solar Water Heating Installations

Encourage increased use of solar water heating installations where cost-effective.

Vermont should create a set of incentives to reduce the typical cost of an active solar water heating system through a combination of demand side management measures, and tax credits, rebates, and low- or no-interest loans funded by a tax on non-renewable energy sources.

Rationale

Solar water heating is one of the more cost-effective active solar applications in Vermont. In general, solar applications have the potential to offset an average of 65% of the fuel used in heating domestic water year-round in Vermont (Vt. DPS, *Vermont Solar Energy Guide*, 1993, 11). A solar water heater cannot generally supply all the hot water needed year-round because of Vermont's cloudy winter climate; thus, backup systems are required.

Water heating is the second largest energy cost in a typical household (not including transportation costs). Solar water heaters are most cost-effective when they displace electric water heaters. While solar water heaters cost more to install than other types of heaters, the total yearly fuel costs of a solar heater and backup heater are much lower. (See Chapter 3 for more about solar water heaters.)

Two potential options could help reduce the cost of solar water heater systems. The first is for the Department of Public Service to ensure that, in situations where it is cost-effective, all utility DSM programs include solar water heaters as measures offered to customers, with adequate financing and incentives provided to ensure wide customer acceptance.

The second option is to use some combination of a limited tax credit program, low- or no-interest loan program, and a rebate program to reduce the cost of solar water heater systems. The oversight and implementation of this program must assure that subsidies are given only in situations where the measure is cost-effective, and guarantee that the program is coordinated with utility efforts. In the past, tax credits were used to encourage investment in selected renewable technologies. From the mid-1970s to the mid-1980s, both federal and Vermont tax credits were offered to encourage energy conservation and development of renewable energy sources. During these years, investment in renewable energy increased substantially.

There were also criticisms of solar investment tax credits; these criticisms helped contribute to their phase-out. One objection was that investments were credited, not on the basis of the energy saved or cost-effectiveness of the system, but on the total cost of the technology installed. This would often lead to the installation of systems that were not cost-effective. A new tax credit, therefore, should include a mechanism to ensure that installations are cost-effective. An additional criticism of tax credits was that they tended to be available to

the affluent. For this reason, a rebate program or a low- or no-interest loan program might make solar systems more widely available. A final criticism was that tax credits and rebate programs are "tax expenditures" and are difficult to predict in exact amounts in the budget process. A special fund created from energy taxes on non-renewable fuels would isolate the general fund from these concerns. (See the Energy Taxation section that follows in this chapter for more details.)

4. Policy: Promote Development of Photovoltaics and Encourage Their Use

Promote development of new photovoltaics systems and encourage their use when cost-effective.

Vermont should encourage and support the use of photovoltaics (PVs) in applications where they are currently cost-effective. Such uses may include some niche applications and some homes located in remote areas in Vermont.

Rationale

Photovoltaic cells convert solar energy into electricity and have a wide range of sizes and applications, from collections of large cells that form a utility-sized plant to small cells built into roofing shingles or mounted on small appliances.

PVs also can power homes, and are especially attractive for those living in remote areas where transmission line extensions are costly to install. An estimated 300 Vermont homes use PV power for electricity and are disconnected from the utility power grid (Solar Works, personal communication, July 1995). Because Vermont's climate is cloudy in the winter, most large PV systems also include an oil or propane generator that can be used as back-up when solar energy isn't available.

Photovoltaic systems also offer opportunities for residential customers who are connected to the electric distribution system. Retail electric customers who have photovoltaic cells that generate up to 10 kiloWatts of electricity can become "customer-generators" and have "net metered" service. Net metering means that the meter registers the flow of electricity from the electric distribution system to the customer and the reverse flow when the customer-generator has electricity to feed back into the distribution system. A customer-producer whose net metered service for any billing period is less than zero would be paid by the distribution company for electricity fed back to the system.

Utility-sized PV plants are not likely to be a cost competitive, near term option for Vermont due to their higher cost and New England's cloudy winter weather. However, the cost of PVs will continue to decrease as the technology advances, while costs of many other methods of electricity generation will continue to increase as fuel costs and environmental impacts rise. The average wholesale price of PVs fell to $0.25-0.40 per kWh by 1993, but projections suggest the price could fall to $0.10 per kWh by 2000 and $0.04 by 2020 (Flavin, *Power Surge*, 1994, 156, 173). With these projected rates, PVs are likely to be feasible for the sunniest United States regions in the next two decades. And, if the electricity market is opened up to increased competition and a renewable portfolio standard is required for New England, the development of PVs could be hastened in this region.

In addition to PV power plants and PV-powered homes, there are niche applications for PVs which are currently cost competitive in some cases, including street and parking lot lights, gate controls, environmental monitoring systems, vehicle battery chargers, remote rest area lights and fans, remote stock watering pumps, and irrigation controls.

D. Strategy: Support Appropriate Uses of Hydroelectric Power and Methane Sources

In addition to wood, wind, and solar energy, two other renewable fuel sources could play important parts in Vermont's energy future. Water power has been a traditional energy source in New England since the time of the early settlers, and currently has a significant role in Vermont's electricity supply. Using energy from methane sources (such as landfills and farm manure) is a newer concept, but it has been successfully applied for at least two decades in the United States.

Small-scale, instate hydroelectric and methane energy are similar in that they are both local, renewable fuels and the technology for both is well developed. Consequently, unlike wind and solar energy, they do not require extensive commercialization assistance. However, both sources suffer because economic considerations often work against them when they are compared to other traditional fuel supply sources (this is more true of small scale hydro projects than large ones). This is largely due to the fact that the external costs of energy use are not included in energy prices. In fact, Vermont's hydropower production is being reduced somewhat in order to bring it into compliance with environmental laws. If environmental costs were included in the prices of fossil fuels, hydroelectric and methane generation sources would become much more cost competitive due to their lower environmental costs. Small-scale, instate hydropower currently is Vermont's largest renewable, non-emitting source of electricity. If this hydropower were replaced in the future with more conventional fossil fuel sources because of economic considerations, the state's emissions would rise dramatically. Taking measures to place hydropower on more equal footing with conventional sources will make it easier for the state to avoid a large increase in emissions levels.

Methane energy, like hydro, wood, wind, and solar, is an instate fuel source that has the potential to be used in a small scale, decentralized fashion. While energy from methane currently is not widely used in Vermont, technologies for its use are quite mature. Thus, it too would benefit from a policy that required new electric generation to be renewable.

The first policy below outlines hydropower issues, while the second and third discuss methane energy from landfills and farms.

1. Policy: Support Appropriate Use of Hydroelectric Energy

Vermont should support appropriate expansions and efficiency improvements in hydroelectric resources in the state, in a manner that fairly balances energy supply considerations, environmental protection, and economic concerns.

In order to encourage expansions and efficiency improvements at existing statewide hydropower facilities, the full costs of non-renewable energy use should be internalized by setting externality adders, emissions caps, and energy taxation strategies. In this way, repowering or installing more efficient turbines at non-producing or underproducing existing dams will be more cost competitive with other energy alternatives.

Rationale

Hydroelectric power use has many advantages: it is renewable, has no emissions, uses fully developed technologies, and has available new technologies that can improve efficient operation. It has received encouragement in recent years by the passage of PURPA and the establishment of Qualifying Facilities. (See the text box in Chapter 3 on Independent Power Producers and Qualifying Facilities.) Disadvantages associated with hydropower use include its seasonality and variability in stream flow, limited undeveloped

potential in Vermont and New England, negative environmental impacts on river habitats, and an economic disadvantage compared to fossil fuels because the full costs of air emissions are not included in prices.

The greatest disadvantage with hydropower is the potential environmental impacts, which can be severely damaging if projects are not carefully constructed. Although many hydropower projects built in the past have not focused on minimizing environmental impacts, hydropower has the potential to be used without creating serious environmental degradation. When used in this way, hydropower can be a better energy choice in comparison to other traditional fuels. (See Chapter 3, Section II, Electric Fuel Sources for more about the environmental problems of hydroelectric energy.)

In recent years, Vermont has derived 41%-49% of its electric energy from hydro sources (Vt. DPS, compilation of 1993-95 VELCO data). (See Chapter 3.) Of this amount, the vast majority has come from Hydro-Québec, a much smaller amount from a large number of relatively small instate sources, and the remainder from relatively few out-of-state sources.

The potential for importing additional hydropower from out-of-state is limited in Vermont primarily to additional purchases from Hydro-Québec. However, in order to maintain a diverse power supply, it is unlikely that the state would want to increase its purchases of Hydro-Québec power in the near future. If increased competition becomes part of the electricity industry, however, diversity of fuel sources among individual companies selling electricity may not be as regulated as is the current case.

The potential for expanding Vermont's instate hydropower generating capacity is very limited because nearly all the environmentally sound and economically feasible sites have already been developed. Given the environmental and economic constraints on the development of new hydro projects, the greatest potential for additional hydropower lies either in repowering (upgrading the generation potential by installing new, more efficient turbines and making other changes) or in installing turbines at non-producing or underproducing existing dams. Depending on the age of existing active hydro facilities, investment in repowering can produce significant increases in generation potential. However, the cost of both options is high compared to the price of competing non-renewable fuels. When the costs of air emission of fossil fuels are considered, hydropower costs may be lower in some cases. Significant increases in electric production from hydropower are unlikely unless the greater environmental and social costs of competing fuels are considered. A carbon tax that internalizes some of the costs of fossil fuels, for example, could make hydropower more cost competitive.

Many existing hydro power plants are coming up for relicensing (FERC licenses generally are for 40 years), and sites that have been unlicensed are now undergoing the licensing process. This process may require increased river flow conditions or changes in the timing of power production to address water quality concerns. Relicensing may also provide an opportunity to evaluate the feasibility of repowering and the installation of new turbines with improved efficiency.

The key to supporting small-scale instate hydro and other renewable resources is eliminating the economic disadvantage they incur compared to traditional fuel supply sources because environmental and external costs are not included in energy prices. Eliminating or internalizing the full cost of energy will make planning and decision making about investments in renewable resources, for instance repowering or installing more efficient turbines at non-producing or under-producing existing dams, more cost competitive with other energy alternatives. (See Strategy H: Use Energy Taxation to Meet Vermont's Energy Goals and Section II, Strategy E: Internalize Costs of Transportation More Fully Through Transportation Energy Taxation.)

2. Policy: Increase Appropriate Use of Landfill Methane Energy

ANR, DPS, and solid waste planners should seek cost effective opportunities for capturing and using landfill methane from solid waste sites for electricity generation or for direct heating.

Rationale

Emissions of gases from landfills are of growing concern to both environmentalists and those concerned with energy efficiency. Landfills, as a result of the decay of buried organic materials, emit a mixture of methane (40%-60%) and carbon dioxide (30%-50%), with trace amounts of volatile organic compounds (VOCs) and toxic gases. The methane in these gases can be used for electricity generation or heating needs. In fact, from an energy efficiency perspective, the failure to capture the methane generated by decaying garbage wastes a valuable source of readily available energy.

Landfills currently are the largest human-caused source of methane emissions in the United States. This is significant because methane is an extremely potent greenhouse gas, with 24.5 times the warming impact of carbon dioxide per unit of emissions.[v] Nationally, methane is second only to carbon dioxide in its overall impact on climate change. The concentration of methane in the atmosphere doubled between 1992 and 1994 (U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994*, 1995, ES-9).

Energy from landfill methane has several advantages: it is a "free" fuel source that is otherwise wasted; when it displaces other energy sources there are no additional environmental costs; it has fewer emissions compared to a do-nothing approach; some landfills already have an infrastructure to collect emissions (which is necessary for landfill gas energy use); and there are well developed technologies for power generation using landfill methane. In addition, some federal incentives and EPA regulations encourage landfill methane generation, and there is high generation potential nationwide as many landfills reach their capacity in the 1990s. Landfill methane is a statewide, localized energy source that can be used for electricity generation or for direct heating. Disadvantages include the facts that emissions of landfill methane do not continue indefinitely, but stop 10-15 years after a landfill closes, and building the infrastructure needed for methane collection is not cost-effective for many smaller Vermont landfills. (See Chapter 3, Electricity from Landfill Gas, for more information.)

Newer, larger landfills are required to collect and dispose of methane emissions. Disposal is often accomplished by "flaring" the gas, a process which converts the methane to carbon dioxide and water, converting VOCs and other gases to less harmful substances. However, another disposal option is to use methane to produce energy. This option has about the same effect on emissions as flaring does, but often reduces toxic emissions even more. Thus, flaring methane or collecting it for energy use results in less net greenhouse gas emissions because methane is converted to carbon dioxide, a less harmful greenhouse gas. (Obviously, the carbon dioxide emissions still contribute to global warming, but reducing these emissions can only be accomplished by reducing garbage quantities.) Collecting methane for energy use also offsets the combustion of other fuels, and in this sense it results in even fewer emissions than flaring.

In order to collect landfill methane for flaring, a collection infrastructure is put in place throughout the landfill. This infrastructure is also necessary to collect the landfill methane for energy use. Many smaller, older Vermont landfills are not required to collect landfill methane, and they do not produce enough gas to make electric generation feasible. However, the landfills that are larger and already have or are required to put a collection system in place are good candidates for landfill methane energy use.

Technologies for converting landfill methane to electricity have been available for at least two decades. Because landfill methane emissions fluctuate over time, generation facilities are structured to be modular units that can be added to increase capacity and removed as emissions decrease.
Vermont currently has two landfills that generate electricity: the Windham County Landfill in Brattleboro (which generated 5.85 GWh in 1992) and the Burlington Intervale Landfill (which expects to generate 4.13

GWh in 1996). In addition, there are several smaller landfills that use landfill gas for space heating purposes.

The potential of landfill methane to be used further in Vermont depends largely on the quantity of gas emitted, the presence or requirement of a gas collection system, and in some cases the proximity of the landfill to activities requiring energy. The majority of Vermont's landfills do not produce enough methane to make electric power production cost-effective for sale through a utility. However, direct use of landfill methane as a fuel or for electricity generation by a nearby facility is feasible for the Vermont landfills that are located near facilities that have a continuous need for fuel or power (Vt. ANR, memo from Doug Elliott, 1995). In addition, there are an estimated five landfills that are large enough to potentially be used for electricity generation (see below).

Impacts

To model the potential generation capacity from landfills, it was assumed that five additional existing landfills in Vermont could be used to generate electricity.[vi] These five sites are all large enough to generate reasonable amounts of electricity, and are or will be required to capture and control their emissions. Combined, these landfills will emit between 230-310 million cubic feet of methane per year over the next 10 years. If 90% of that methane could be used to generate electricity (with a heat rate of 11,000 BTU/kWh), the landfills could generate between 18.6-25.1 GWh of electricity per year for Vermont.

This policy, however, was modeled using more conservative estimates, and assumed the landfills would generate 15 GWh of power per year beginning in 1997. The generators were modeled as Qualifying Facilities. The cost of electricity was assumed to be 4.287 cents/kWh (real levelized cost in 1997$). This too is a conservative figure, because there are no fuel costs. The facilities are or will be required to trap and flare the gases, so the fuel is essentially free. The only major costs are the capital costs associated with portable generators and the connection to the electric grid.

Both the scope and impacts of this policy are quite moderate. The cumulative impacts on energy use, efficiency, cost, and the economy are negligible (within 1/100th of a percent of the base case). There are, however, proportionately much larger impacts on the sustainability, affordability, and environmental indicators. The percent of energy from renewables climbs 0.19%, and the cost of air emissions declines 0.16% or $30 million between now and 2020 compared to the base case. Greenhouse gases show the greatest decline of approximately one million tons (CO_2 equivalent) cumulatively through 2020 (a 0.42% decline). Overall, the policy results in a modest but important decline in air emissions with no additional economic cost to Vermont.

Figure 4.I.6 Impacts of Increasing Appropriate Use of Landfill Methane Energy
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.22	38.22	884.91	884.90
Commercial	11.99	17.82	17.82	19.34	19.34	22.12	22.12	486.01	486.00
Industrial	12.42	16.79	16.79	18.41	18.41	19.90	19.90	446.66	446.65
Transportation	42.10	60.54	60.54	64.68	64.68	70.73	70.73	1591.96	1591.96
Total	98.04	130.54	130.54	138.40	138.40	150.96	150.96	3409.55	3409.51

Table 4.I.19 Indicators of Increasing Appropriate Use of Landfill Methane Energy
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2896.3	1.0	146.1	183.8	183.7	187.9	187.9	16.0%	15.5%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3409.5	0	0.00%	154.0%	173.8	217.6	217.6	222.3	222.3

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2105.7	61.76%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.68%	65.68%	63.21%	63.21%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
0	0	0.00%	$0	$0

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
$25.84	$30	$50,780	$56,448	$56,448	$58,621	$58,621	26.91%	26.62%	26.62%	27.56%	27.56%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,480,000	11,749,000	11,705,000	1,044,000	0.42%	164.40%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,253,000	11,383,000	11,377,000	126,000	0.05%	163.96%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	500	0.13%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	100	0.06%	57.02%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,700	31,700	400	0.06%	125.30%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,300	0	0.00%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,800	93,300	93,300	100	0.00%	79.81%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.04	$3	$2	$0	$1

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] All sectors
operation,
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital,

and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

3. Policy: Increase Appropriate Use of Farm Methane Energy

DPS should work with ANR and the Department of Agriculture to encourage the recovery of methane from farm manure for electricity generation or for direct heating.

Rationale

As described in the previous policy, methane is emitted from the decomposition of garbage in landfills. In addition, methane is produced from the decomposition of any organic matter, including animal waste, human waste, and organic by-products of manufacturing processes. Capturing this methane for electricity generation or direct heating moves toward two important goals: it efficiently utilizes an energy source that is otherwise wasted (and thereby displaces other energy use), and it reduces emissions of methane, a potent greenhouse gas. (For more about methane emissions and the advantages and disadvantages of methane energy use, see the policy above: Increase Appropriate Use of Energy Landfill Methane.)

Farms offer an opportunity to capture methane emissions from animal wastes through the use of a methane digester. Capturing methane is a fairly simple process, involving storing manure in a pit and capping it for methane collection. The same process can be used at sewage treatment facilities or manufacturing plants that produce organic waste.

In addition to the energy benefits of capturing methane for energy, there are side benefits for farmers, including the fact that once methane is burned the remaining solid waste is odorless and has more readily available soil nutrients. This results in a higher quality manure product which can be sold in commercial or retail markets.

Currently, there is only one active farm methane digester in Vermont. The Foster Brothers Farm, a 500 cow dairy farm in Middlebury, produces electricity from their methane digester mostly for their farm's electrical needs. This by-product of their process is a high quality soil additive that they spread on their fields and sell both as a commercial potting soil additive and as bagged cow manure for retail markets.

DPS in cooperation with the Vt. Department of Agriculture, Food & Markets and Vt. Agency of Natural Resources have made a proposal to U.S. DOE to develop a demonstration project that would enable the state's larger farms to jointly manage their agricultural waste product storage. This proposed project would demonstrate to the farm community both the physical and economic feasibility of capturing and utilizing methane from agricultural waste projects for combined heat and power on the farm.

In local, regional, and statewide permitting processes, producing energy from methane should be promoted as a desirable practice. In addition, research and development into the capture and use of methane should be encouraged and promoted. For example, development of small-scale equipment could increase the feasibility of small farms using this technology. Including community wastes, food processing wastes, and other agricultural wastes with animal wastes for methane digestion could also expand the potential of small farms to use this technology.

Impacts

Modeling the potential generation from existing dairy farms in the state was based on an extrapolation of experience from the only farm in the state currently generating electricity from the manure methane. A total of approximately 0.34 GWh of electricity is generated at the Foster Brothers Farm in Middlebury and is sold to an electric utility or used on site.

Figure 4.I.7 Impacts of Increasing Appropriate Use of Farm Methane Energy
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.22	38.22	884.91	884.91
Commercial	11.99	17.82	17.82	19.34	19.34	22.12	22.12	486.01	486.01
Industrial	12.42	16.79	16.79	18.41	18.41	19.90	19.90	446.66	446.66
Transportation	42.10	60.54	60.54	64.68	64.68	70.73	70.73	1591.96	1591.96
Total	98.04	130.54	130.54	138.40	138.40	150.96	150.96	3409.55	3409.54

Table 4.I.20 Indicators of Increasing Appropriate Use of Farm Methane Energy
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2897.2	0.2	146.1	183.8	183.8	187.9	187.9	16.0%	15.5%	15.5%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3409.5	0	0.00%	154.0%	173.8	217.6	217.6	222.3	222.3

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2105.7	61.76%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.68%	65.68%	63.21%	63.21%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
0	(1)	(0.00%)	($0)	$0

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
$39.78	$4	$50,780	$56,448	$56,448	$58,621	$58,621	26.91%	26.62%	26.62%	27.56%	27.56%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,517,000	11,749,000	11,742,000	153,000	0.06%	164.92%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,257,000	11,383,000	11,382,000	19,000	0.01%	164.03%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	100	0.03%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	0	0.01%	57.02%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,700	31,700	100	0.01%	125.30%
Volatile Organic Compounds	21,600	20,000	20,000	19,300	19,300	0	0.00%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,800	93,300	93,300	0	0.00%	79.81%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	$4	$2	$2	$1

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
d Calculated using Vt. DPS externality adders, see Appendix 5

[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

The Foster Brothers Farm is larger than the typical Vermont dairy farm, with approximately 500 head of cattle, 300-350 of which are milk cows. Only a few farms in the state have more than 500 cattle, and these farms were assumed to realize sufficient economies in their size to have generation potential comparable to the Foster Brothers Farm. There were roughly 2,950 milk cows on these larger dairy farms as of 1987, and the generation potential of a dairy farm ranges from 2-3 kWh per day per milk cow. Applying a conservative estimate of 2 kWh per day to the 2,950 milk cows yields an approximate generation potential of 2.2 GWh per year.

There are, however, at least several reasons for viewing this figure as a low estimate of the potential. While there are only a few Vermont farms with dairy herds of more than 500 cattle, there are roughly 99 farms with herds of more than 200-500 milkers as of 1995. It is not clear at which point scale economies permit economic generation from cow manure. Additional economies and potential generation from manure might be realized through collective or cooperative arrangements among groups of farms. Scaling the performance of the Foster Brothers Farm to all farms with more than 200 cattle (and estimating the percentage of milk cows) would suggest a potential generation of 20-30 GWh per year.

The modeling of the farm methane policy was identical to that of the landfill methane policy, except that a total of 2.2 GWh of electricity was assumed to be generated per year. As in the case of the landfill methane policy, the only detectable effects occurred in the indicators related to sustainability (0.03% increase in renewable fuel use through 2020 compared to the base case), affordability (0.02% cumulative decrease in cost of air emissions), and environmental soundness (0.06% cumulative decrease in greenhouse gases). Both the landfill methane and farm methane generation policies result in a moderate decrease in greenhouse gases at no additional cost to Vermont, either in terms of jobs, income, or energy costs.

E. Strategy: Reduce, Monitor, and Support Selected Uses of Traditional Fuels

The conventional fuels that are already widely used have several advantages over newer fuels: in general, they have a good deal of infrastructure already in place, they are familiar to consumers, and in most cases they are widely available and inexpensive. However, three of the conventional fuels most used in the United States -- oil, coal, and nuclear energy -- have major problems associated with their continued use. These problems are related to emissions, other environmental impacts, security, sustainability, supply, and economic issues, and issues related to possible consequences from increased competition in the electricity marketplace. Policies for mitigating these problems include emissions standards, the internalization of the full costs of energy use in energy prices, the reduction of the use of these fuels, the efficient use of these fuels, the redirection of research funding toward renewable fuels and sustainable uses, and public education efforts (especially necessary if increased competition becomes part of the electricity marketplace). Natural gas, while suffering from some of the same problems as the other conventional fuels, has fewer problems associated with its use. Thus, its use can be a useful mitigation strategy for some problems if it replaces other fossil fuels.

The policies below outline specific actions for improving our use of and mitigating problems associated with petroleum, coal, nuclear power, and natural gas.

1. Policy: Reduce Use of Petroleum Energy and Establish Emissions Standards

Encourage the reduction of petroleum energy use by implementing policies in the Transportation section of this chapter, incorporating more of the costs of oil use in oil prices and setting strong emissions standards for electric generation.

The basic features of this policy are:

- Vermont should implement policies that decrease transportation energy use, as outlined in the Transportation section of this chapter.

- Vermont should seek to include more of the total costs of oil use in oil prices through taxes, as suggested in the Energy Taxation strategies and the Transportation Taxation and Transportation Energy Taxation strategies in this chapter.

- Vermont should encourage the federal government to fund the Strategic Petroleum Reserve through a charge on oil suppliers.

- Vermont should set strong sulfur dioxide and nitrogen oxides emissions standards for generation companies selling electricity in the state and should encourage similar standards for New England.

- Vermont should advocate for a strong carbon dioxide emissions cap for companies selling electricity in Vermont and New England and a "cap and trade" system to facilitate compliance with the cap.

Rationale

Petroleum products, including gasoline, diesel fuel, heating oil, propane, kerosene, and others, are the most used fuels in Vermont and the United States, accounting for 71% of the state's 1993 delivered energy use. For this reason, our use of petroleum products deserves special attention.

Advantages of petroleum use include the relatively low cost of extracting and transporting fuel (resulting in relatively low oil prices in the United States), a delivery infrastructure that is already extensive and in place, the availability of new, more efficient technologies for burning fuel oil and LPG (propane), and LPG's relatively lower emissions compared to many other fossil fuels. Disadvantages include a fairly small domestic oil supply and falling U.S. oil production; United States dependence on oil from the politically unstable Persian Gulf area, which poses threats to our national, economic, and energy security; the finite nature of the oil resource, which makes it non-renewable and very difficult to use sustainably; growing oil demand in both developed and developing countries; and high levels of emissions from oil, with human health, environmental, and climate change consequences. (For more information about oil use, see Chapter 3.)

There are many policies that can address these disadvantages. Because much of our oil use is a result of our transportation habits, policies that focus on transportation energy use are extremely important. Transportation energy use accounted for 43% of Vermont's 1993 delivered energy use, virtually all of which was delivered through oil products. The Transportation section of this chapter describes many policies that would reduce oil use, including policies about collecting the costs of driving through user fees (instead of through property taxes, etc.), transferring some of the fixed costs of driving to marginal costs, reducing vehicle miles traveled, making cars more efficient, and encouraging the use of alternative fueled vehicles. These policies are some of the most important in this Plan for reducing oil dependence and overall energy use.

Although the prices of energy generally do not reflect the full costs of their use, this is particularly true of the prices of petroleum products. (See the Chapter 3 text box on the External Costs of Oil Use.) Petroleum use has military costs, security costs, transportation infrastructure costs, and subsidies that other fuels do not have, and that are not paid for directly by petroleum users. If more of these costs were included in oil prices, the prices and/or marginal costs of using gasoline, diesel fuel, and heating oil would increase, sending more accurate signals to consumers. This in turn would cause people to use less oil, to use oil more efficiently, and to consider switching to other fuels. For a full description of these issues, see the Energy Taxation strategy that follows in this section of Chapter 4.

One of the most serious costs and risks associated with oil use is security. Our reliance on foreign oil imports

threatens our national, economic, and energy security. The political instability of the Middle East (which contains 54%-66% of worldwide oil reserves, according to two separate estimates), leads to a greater risk of an oil supply or price disruption, with accompanying shortages of oil and an unstable economy (U.S. DOE/EIA, *International Energy Outlook*, 1995, 99-100). Reliance on foreign oil also increases the costs of the United States military, which patrols the Persian Gulf area, and the pressure to use the military in case of oil supply disruptions. Finally, foreign oil reliance adds significantly to the United States trade deficit.

To address these security problems, the U.S. Government created the Strategic Petroleum Reserve (SPR) in 1975. The SPR was intended to stabilize the economy and ensure the continued supply of oil during times of disruptions in the oil supply. In the event of an interruption of imported oil or other emergency, the President can authorize the release of oil from the SPR, selling oil to the highest bidder. (For more information about the SPR, see the Petroleum Products section in Chapter 3.)

Creating, maintaining, and purchasing the oil for the SPR is necessary for national and energy security because of our dependence on oil. Although the SPR currently is funded by general tax revenues, it is more appropriate that those who are dependent on oil directly pay for the costs of the SPR. Since these costs are not included in the price paid by oil consumers, the market doesn't send consumers the signals they need to make efficient fuel choices in the marketplace. An additional benefit of including SPR costs in oil prices is that oil use and dependence will decrease. A national charge of approximately one cent per gallon would recover past costs for the SPR within 10 years, while continuing to meet ongoing maintenance costs (Vt. DPS estimate).

Electricity generation from oil has accounted for only about 4%-5% of Vermont's total electricity generation in recent years. The vast majority of this power has come from out-of-state oil plants. However, if and customer choice for electricity generation takes hold in Vermont, oil power generated in other states likely will be marketed directly to Vermont consumers. (See Chapter 3 and Strategy G. that follows, Policy 1. Move Toward Greater Retail Competition While Maintaining Societal Benefits.) New England currently has many older oil fired plants; with increased competition, electric power from these older, more polluting plants will be priced lower than that from newer, cleaner plants because the older plants will have lower capital costs, risks, and environmental standards. These lower prices could translate into increased use of oil for electric generation.

This problem can be mitigated by pursuing policies that ensure that the oil generated electricity used by Vermonters meets certain emissions standards. Vermont should set emissions standards and encourage similar standards for New England, requiring individual generators or generation companies' portfolios to adhere to emissions standards that do not differentiate between old and new plants. Sulfur dioxide and nitrogen oxides emissions standards could be modeled after those proposed by the Massachusetts Division of Energy Resources for oil and coal fired generation; these standards are more stringent than the current *New Source Performance Standards* required of all new or repowered plants. To address carbon dioxide emissions, Vermont should advocate for a strong carbon dioxide cap for all power plants in New England and a "cap and trade" system to facilitate compliance with the cap. Such emissions standards will be extremely important in ensuring that increased competition in New England does not bring about more polluting uses of electric energy from oil and coal fired plants. (See the *Position Paper of the Vermont Department of Public Service* in Docket 5854, March 1996; this paper, however, does not include a proposal for total electric sector carbon dioxide emissions.)

2. Policy: Reduce Use of Coal Energy

Encourage reduction of coal energy use from plants using older technologies, set strong emissions requirements for users of coal, and educate consumers about the negative environmental consequences of coal use.

The basic features of this policy are:

- Vermont should set strong sulfur dioxide and nitrogen oxides emissions standards for companies selling coal generated electricity in the state, and similar standards should be encouraged for all of New England.

- Vermont should advocate for a strong carbon dioxide cap for power plants in New England and a "cap and trade" system to facilitate compliance with the cap.

- Vermont should require a strong public education campaign during and after the transition to greater competition that teaches consumers about the negative environmental impacts of coal use in comparison with other fuel sources.

Rationale

Coal energy use has several strong advantages and disadvantages. Advantages include the following: coal is the most abundant fossil fuel resource in the world; much of the resource is located in the United States (about 23% of worldwide proven reserves); it is one of the cheapest fuels for electricity; substantial investment exists in coal fired generation plants; and newer, more efficient technologies have been promoted and funded for some time with research dollars by the U.S. Department of Energy. However, the disadvantages are also significant. Combustion of coal produces the greatest amounts of most emissions compared to all other fossil fuels, with powerful impacts on human health, the environment, and future climate change; it is not renewable and is difficult to use sustainably; and coal is and will be increasingly used in developing countries which do not have strong environmental controls on emissions. The economics of existing coal fired generation plants may change in the near future as new requirements of the Clean Air Act Amendments take effect and as other emissions controls are instituted. (For more information about coal use, see Chapter 3.)

The advantages of coal use, especially its domestic supply and the current investment in coal plants, have led many to champion its continued use, including the Department of Energy, which funds a "clean coal" program. However, coal may not be the fuel of choice for the difficult energy and environmental future we face. The extensive negative impacts clearly call for substantial efforts to reduce these environmental impacts. In addition, the probable use of coal by developing countries should counsel the United States to decrease its own contributions to additional emissions from coal.

Air emissions are the most detrimental impact from coal use. Existing coal fired electric plants emit significantly more carbon dioxide, sulfur oxides, and particulates (those under 10 microns) per unit of energy used than any other fossil fuel used to generate electricity. (See Table 3.II.3.) Other emissions from coal use are similar to those of other fossil fuels. There are also concerns that toxic chemicals from coal ash, if landfilled improperly, could leach into groundwater.

Technologies are being developed currently that would reduce some emissions from coal combustion. The Department of Energy's "clean coal" program promotes coal gasification combined cycle plants that are more efficient and clean than conventional plants. A coal gasification combined cycle plant, in comparison with a conventional steam cycle coal plant with scrubbers, can achieve significantly lower nitrogen oxide and sulfur dioxide emissions, but only 14% less carbon dioxide emissions. Moreover, a natural gas combined cycle plant can achieve 54% less carbon dioxide emissions than a coal gasification combined cycle plant, with about the same amount of nitrogen oxide emissions and no sulfur dioxide emissions (Flavin, *Powering the Future*, 1994, 23). There is no feasible way to meaningfully reduce carbon dioxide emissions from coal use, aside from reducing coal use itself. Thus, significant carbon dioxide emissions reductions are nearly impossible with continued promotion of coal use. For each additional BTU of coal used, 2 BTU of natural gas, or 1.3 BTU of oil must be eliminated just to prevent an increase in carbon dioxide emissions.

For these reasons, substantial investment exclusively in future coal technologies is misplaced, in spite of coal's advantages. If equivalent amounts of investment and research were focused on renewable and cleaner fuel sources, these sources could more easily compete with coal's current low prices, gaining some of coal's market share and moving the United States toward a more environmentally benign future.

In Vermont, coal has supplied 8%-10% of our electricity needs in recent years. This coal generated power has been supplied by the Merrimack 2 power station in New Hampshire, under a contract that ends in 1998. Merrimack 2's compliance with the Clean Air Act Amendments will be costly in the next several years, and there is a possibility for early plant retirement.

However, if retail competition for electricity sales occurs, coal generated electricity from other states may be marketed directly to Vermont consumers. (See Chapter 3 and the policy on Greater Retail Competition in this chapter.) Because of its low fuel price, electricity from coal has the potential to be an attractive choice to many consumers. In addition (as outlined with respect to oil generation), electric power from older, more polluting plants may be priced lower than that from newer, cleaner plants due to lower capital costs, risks, and environmental standards. It is possible that increased competition could result in older, more polluting coal plants operating more frequently than at present. In crafting its position on increased competition, both regional and national, Vermont must be aware of this potential and act accordingly.

Vermont can mitigate this problem by ensuring that generation from coal and other fossil fuels used by Vermonters meets strong emissions standards. As outlined in the oil policy, the state should set strong emissions standards and encourage similar standards to be set for New England. Sulfur dioxide and nitrogen oxides emissions standards could be modeled after those proposed by the Massachusetts Division of Energy Resources for coal and oil fired generation, which are more stringent than the current *New Source Performance Standards* required of all new or repowered plants. Vermont also should advocate for a strong carbon dioxide cap for all power plants in New England and a "cap and trade" system to facilitate compliance with the cap. (See the *Position Paper of the Vermont Department of Public Service* in Docket 5854, March 1996; this paper, however, does not include a proposal for total electric sector carbon dioxide emissions.)

In addition, the Department of Public Service should mount or require a strong public education campaign during and after the transition to greater competition that teaches consumers about the negative environmental impacts of coal use in comparison with other fuel sources.

3. Policy: Support Appropriate Use of Natural Gas Energy

Encourage the expanded use of natural gas where it is cost-effective and can replace other fossil fuels as an energy option in the transition to the use of cleaner and renewable resources.

Vermont should encourage the increased use of natural gas vehicles, efficient natural gas technologies for electric generation, and continuing research and development with natural gas.

Rationale

Natural gas accounts for a relatively small portion of Vermont's total energy use, due to the limited availability of natural gas in Vermont, our dispersed population and commercial centers, and our small industrial base. In recent years, natural gas has accounted for about 6% of the state's total delivered energy use. Major applications for natural gas in Vermont include residential and commercial space heating, water heating, and cooking, various industrial processes, and a small amount of electrical generation (supplied from an out-of-state plant). The state has a single natural gas distribution company, Vermont Gas Systems, serving about 27,000 customers. (For more information about natural gas, see Chapter 3.)

Advantages of natural gas use include lower levels of almost all emissions compared to other fossil fuels, the availability of new, efficient technologies for natural gas, and the ability of natural gas to be used as a vehicle fuel. Disadvantages include the need for additional infrastructure in Vermont to bring natural gas to new customers, the fact that natural gas is not renewable and is difficult to use sustainably, potential price volatility, and the fact that natural gas has greater emissions than renewable fuels (except wood, for some pollutants).

While natural gas is not without environmental impacts, those impacts are less harmful than the impacts of other fossil fuels. For nonelectric uses, natural gas (as currently used in Vermont) emits the lowest amount of almost all pollutants per unit of energy used compared to other fossil fuels. (See Table 3.II.1.) Natural gas emissions are very low for sulfur oxides and low for particulates under 10 microns, carbon monoxide, and volatile organic compounds. Carbon dioxide emissions per unit of energy used are quite high, and are therefore problematic due to their contribution to global warming; however, they are emitted at the lowest level of any fossil fuel source. Natural gas emissions of nitrogen oxides per unit of energy used are at a similar level as emissions from LPG and a higher level than emissions from distillate fuel or wood use. Natural gas electric generation (as currently used by Vermont) emits similar amounts of nitrogen oxides per unit of energy used as oil fired plants; natural gas and oil emit the highest amounts of nitrogen oxides of any fossil fuel. (See Table 3.II.3.) Natural gas emissions of carbon monoxide from electric generation are also similar to those of oil fired plants.

Additional environmental impacts from natural gas include pipeline construction impacts, natural gas leakage from distribution systems (usually small amounts), and exploratory drilling impacts. Pipeline construction impacts can include disruption of wetlands, streams and rivers, water supplies, fields, woodlands, and endangered species habitats. Methane leakage from natural gas distribution systems is serious because methane contributes strongly to global warming. However, the leakage rate of methane from natural gas is estimated to be very small in most U.S. cities. Finally, there are growing concerns about an uncontrolled "gas rush" disrupting pristine sections of the Canadian Rockies and other regions with exploratory drilling efforts, and about future price increases as consumers shift to natural gas.

Despite the important environmental impacts from natural gas use, the overall impact on the environment from energy use can be improved by moving toward more natural gas use if it replaces coal or oil use. While making the transition to more renewable fuels, natural gas is a cleaner fuel with lower impacts.

There is good potential for replacing other fossil fuel use with natural gas use in Vermont. Expanding the existing pipeline's capacity is one option. (A phased expansion by Vermont Gas Systems is underway.) A new pipeline through Vermont is another option, although two recent proposals for new pipelines in Vermont have not been approved. Electric generation from natural gas also has the potential to increase in New England, especially if emissions standards are set for other fossil fuel generation. Generation from natural gas is especially attractive if cogeneration, combustion turbines, or combined cycle plants are used, which improve efficiency and emissions. (See Chapter 3 for a description of these technologies.) A power

generator built in Vermont south of Chittenden County using natural gas could act as an "anchor tenant" drawing gas into currently unserved areas. This idea has been discussed since the mid 1980s.

Another opportunity is increased use of natural gas as a vehicle fuel. If sufficient storage capacity existed, natural gas could be stored during times of low usage and later used to run vehicles. (See Chapter 3 for more about natural gas powered vehicles.) Continuing to allow natural gas distributors to recover expenses associated with research, testing, and market development, as is currently done in Vermont, also can encourage further natural gas use. Vermont Gas Systems' activities in the past have included gas application research and development, construction and operation of natural gas power vehicles and a filling station, market development associated with industrial customers and electric generation, and educational and technical assistance to smaller customers.

If the electric industry moves to a more competitive market, measures should be taken to ensure that natural gas use can compete fairly with and gain market share from oil and coal fired plants. As outlined earlier, a competitive market has the potential to increase the use of older, more polluting oil and coal fired plants. If nitrogen oxides standards are put in place for oil and coal fired plants, natural gas will be a more attractive option in the competitive market.

If our nuclear energy use is replaced with natural gas use when nuclear plant licenses expire (as is predicted in the base case forecast of this Plan), all emission impacts (other than nuclear specific impacts) will worsen considerably and carbon dioxide emissions will worsen dramatically. In the base case forecast, nearly one-third of the state's projected difference in carbon dioxide emissions between 1997 and 2015 results from replacing Vermont Yankee with natural gas powered combined cycle plants.[vii] This is a significant increase in emissions that would not be allowed to occur if a carbon dioxide cap system was in place.

If a more competitive market takes hold in New England, DPS should ensure that customers have timely and relevant information about the environmental impacts of natural gas generated electricity use in comparison with generation from other fossil fuels and renewable fuels. Although replacing oil and coal use with natural gas use will improve the environmental impacts of our current energy use situation, replacing fossil fuels with renewables will improve impacts even more.

4. Policy: Monitor the Use of Nuclear Energy

Maintain vigilance to ensure that economic pressures do not degrade safe operation at nuclear energy facilities. Continue to work to secure a solution to radioactive waste disposal, to ensure that safety at nuclear facilities is maintained, and to strictly scrutinize proposals for further nuclear energy development.

The major features of this policy are:

- The DPS should closely monitor nuclear safety issues as competition increases in the electric utility industry progresses to determine whether new or increased oversight is warranted, including working with federal regulators to assure safety standards are retained and met.

- The federal government should be held responsible for removal of high-level radioactive waste from reactor sites beginning in 1998. The federal government should continue its work to develop a repository for final disposal of high-level waste.

- Vermont should consider methods for withholding Vermont Yankee payments into the Nuclear Waste Fund if Congress fails to appropriate sufficient funds from the Nuclear Waste Fund for development of interim storage and final disposal of high-level radioactive waste.

- Vermont Yankee should prepare and file its plan on how to resolve the issue of on-site spent fuel storage as called for in the 1994 *Vermont Electric Plan*. If the federal government fails to meet its 1998 obligation for removal of high-level waste, the DPS should participate in and oversee a safe solution to the storage of additional high-level radioactive waste. According to Vermont Yankee's current fuel management plan, additional used nuclear fuel storage space must be provided before startup from the spring 2001 refueling outage. (Vermont Yankee would no longer be able to unload all the nuclear fuel in the reactor following the 2001 outage without additional storage space. If this space for full-core off-load is used, Vermont Yankee can operate through the spring of 2004.)

  Full-core off-load capacity refers to space set aside in the spent fuel pool to allow unloading the nuclear fuel which is in the reactor vessel. Without the ability to unload fuel from the reactor vessel, it would be difficult to inspect and repair possible flaws associated with reactor vessel internal components under the core plate or with the reactor vessel itself.

- The DPS should continue to monitor activities related to disposal of low-level radioactive waste in Texas.

- The market should bear the full risk of forward looking resource commitments related to nuclear power. The DPS should support legislation to require a certificate of public good for any renewal of nuclear operating licenses in order to assure that the risks and obligations a nuclear plant places upon the state and locality are fully considered. It is not expected that new nuclear generation, for which approval by the legislature is required, will be pursued in the foreseeable future.

- Vermont should urge the federal government to redirect nuclear research dollars that are not related to existing nuclear plant issues to cost-effective renewable and sustainable fuel sources and technologies.

Rationale

Although nuclear power has some advantages, it continues to present society with concerns. Advantages of nuclear energy include a strong domestic uranium supply, no on-site combustion related emissions, and substantial infrastructure that is already in place (except for one critical component: waste storage facilities). Disadvantages include high construction and other fixed costs, risks related to creation of radioactive waste and the possibility of accidents, environmental impacts from the front end of the nuclear fuel cycle (including those associated with uranium mining, milling, enrichment, fabrication, and transportation), uncertainty about ultimate disposal of radioactive waste, long term consequences for future generations related to radioactive waste, increases in operation and maintenance costs, the financial risk of early shutdown, and rising decommissioning cost estimates. (For more information about these issues, see Chapter 3.) In addition, many segments of the public have a negative perception of nuclear power.

Increased competition in the electricity industry (if it occurs) is likely to have consequences for nuclear power, most of which are still uncertain. In a more competitive market, it is likely customers will choose electric service from a variety of generation companies and sources within and possibly outside New England. Under this system, generation companies will no longer be guaranteed a reliable and consistent customer base. Competition may be expected to place economic pressures on generators. It will be incumbent on the regulatory structure to ensure that cost cutting at nuclear facilities does not result in unsafe operation or practices. The DPS, through its existing inspections protocol with the Nuclear Regulatory Commission (NRC), must urge and maintain increased vigilance over key indicators of unacceptable economic pressure, such as increased maintenance backlogs, and deferral of engineering projects related to safety.

As indicated, high-level radioactive waste is a most pressing and disturbing issue associated with nuclear power. The federal government has collected more than $11 billion from the customers of nuclear power plants for high-level radioactive waste disposal, and has spent approximately $5 billion investigating the proposed Yucca Mountain, Nevada disposal site, with little tangible progress. The disposal facility originally was expected to be available by 1998, but Congress recently has been unwilling to appropriate additional amounts from the remaining funds for continued development of the site. The U.S. Department of Energy recently has claimed that it is not required to meet the 1998 deadline, and 27 states (including Vermont) are suing DOE to meet this date. The Department of Energy currently projects completion of the disposal site by 2015; however, lack of progress in the past leaves doubt about whether a disposal facility will ever be completed. Nevertheless, in July 1996, the U.S. Court of Appeals, D.C. Circuit, ruled that the Department of Energy is obligated to begin removing fuel from reactor sites in 1998. Several possibilities are open for meeting this obligation, including establishing interim storage at Yucca Mountain and using existing federal spent fuel disposal sites in South Carolina and Idaho. It remains unclear what action the Department of Energy will take.

Currently, high-level radioactive waste is stored in water-filled pools at nuclear plant sites. Because the federal disposal facility will not be ready as expected, some nuclear plants are requesting and gaining NRC approval to move high-level waste into dry storage in concrete and metal casks at the plant sites. As this occurs at more sites, the concern arises that these dry casks may become the final storage/disposal solution. This possibility of having high-level waste permanently stored at sites throughout the country carries more risk than disposal at a single site. For this reason, the federal government should remain responsible for developing an interim storage site, and should also move forward with development of a final repository.

Vermont Yankee also stores its high-level radioactive waste in storage pools, but if present practices continue, the existing storage capacity will run out in 2001. The DPS should participate in and advocate for a safe solution to the storage of additional high-level radioactive waste from Vermont Yankee after the current storage space is filled. A recommended action in the 1994 *Vermont Electric Plan* calls for Vermont Yankee to file a plan with the DPS by January 1, 1996, on how it will resolve the issue of on-site spent fuel storage (Vt. DPS, 1994, 4-23 and 8-1). This plan has not yet been filed.

Disposal of low-level radioactive waste is another unsolved problem with nuclear energy. While the Low-level Radioactive Waste Policy Amendments Act of 1985 established a policy for states to form low-level radioactive waste compacts, none of the 10 compacts which formed has been successful in developing a disposal facility. Congressional approval of the last compact, in which Texas would accept waste from Vermont and Maine, has been stalled since 1995. As of this writing, that legislation has passed both the House and Senate and is awaiting conference action. Meanwhile, new opportunities for disposal are opening at the existing facility in Barnwell, South Carolina, and at the Envirocare facility in Utah. The DPS should continue to monitor issues and developments surrounding low-level radioactive waste to achieve the best disposal solution.

With the advent of retail competition, the market is expected to play a role in determining the future of nuclear power. Because of high capital costs, negative public perception, and a variety of other concerns, it is not expected that market forces will support the development of new nuclear resources for the foreseeable future, despite their potential to reduce greenhouse gas emissions. As existing nuclear generation comes under market scrutiny, unexpected costly events, such as aging equipment failures or regulatory forced outages, may terminate operation at some plants. It is possible that some units could operate beyond their present licensing term. However, a solution to radioactive waste disposal will be an essential requirement for any decision for license renewal. In addition, the full costs of both the front end and back end of the nuclear fuel cycle must be considered (including the costs associated with uranium mining, milling, enrichment, fabrication, and transportation). Least cost planning practices with externalities included should be applied to compare replacing nuclear power with alternatives.

The resolution of a five-year discourse between the states and the NRC over states' rights concerning nuclear license renewal has resulted in a clear statement in the pending NRC license renewal rule which indicates that states have the right to determine the need for power within their boundaries. Vermont does not have a mandated review of nuclear license renewal. A process for conducting this type of review could be the certificate of public good process established in 30 V.S.A. §248. In order to exercise the rights NRC has stated in its rule, nuclear license renewal could be specifically included in Section 248. In the new era of electric competition, a nuclear plant may in many ways compete freely. However, a nuclear plant's location in Vermont establishes distinct state interests. On the one hand, a home nuclear plant establishes a range of economic benefits for the state. On the other hand, while a home nuclear plant's electricity may go where it will, its nuclear waste remains instate and becomes an environmental obligation for the state. The certificate of public good determination would consider environmental and cost issues. The determination would not include consideration of the safety of license renewal, which we believe is within federal jurisdiction. Therefore, the DPS should pursue legislation which will establish a certificate of public good requirement for nuclear license renewal.

When Vermont Yankee and other New England nuclear plants' licenses expire in the early 2000s (or when economic, safety, or market factors lead to their earlier closure), they will need to be replaced with renewable fuel sources to avoid growth in carbon dioxide emissions. Because a large percentage of our region's electricity generation comes from nuclear plants (an average of 30% over the past decade), New England has an important opportunity to increase its share of renewable fuels in the future. However, a strong carbon dioxide cap is essential for achieving gains. If such a cap is not set for New England, a good deal of nuclear plant generation could be replaced with fossil fuel power. The fuel generation sources that replace power from Vermont Yankee and other nuclear plants will determine, to a large extent, whether Vermont and New England make progress towards sustainable and environmentally sound energy use. Thus the New England carbon dioxide cap and a "cap and trade" system proposed earlier is relevant for nuclear power as well. (See Chapter 4, Section I, Strategies A and B.)

F. Strategy: Encourage Efficient Production and Distribution Technologies/Infrastructure

This strategy seeks to increase the efficiency of the production, distribution, and use of energy by encouraging wider use of efficient production and distribution technologies and infrastructure. Policies supporting this strategy address new energy supply and generation options that have can have significant impacts since they generally affect many customers or large customers. Options considered here include encouraging cogeneration, encouraging district heating, encouraging distributed electric generation, and promoting integrated utility and communication services. (Comparable policies such as increasing the efficiency of vehicles, heating systems, and energy-using appliances are discussed later in Chapter 4, in the Transportation section and Buildings and Equipment section.)

1. Policy: Encourage Cogeneration

Encourage utilities, business owners, and others to consider cogeneration technologies when examining energy supply options.

Cogeneration involves the simultaneous production of electricity and useable heat from the same process. In most cases, the heat is a by-product of the electrical generation, although in some cases, the waste heat from an industrial process (or from electrical generation) can be collected and used to make electricity. By capturing and making use of this waste heat, the efficiency of the combined process greatly exceeds the efficiency of two

separate processes supplying heat and electricity. There may be significant savings in capital costs as well.

Rationale

Central station generating plants operate at overall efficiencies on the order of 30%. This means that 70% of the energy contained in the fuel input is not converted into electricity, but is wasted. Much of this energy is lost out the boiler stack or through the engine exhaust system and some is lost in the conversion from steam to mechanical power. The rest is consumed in condensing the low pressure steam as it returns to the boiler. Much of the wasted energy is in the form of low grade heat, *i.e.*, either stack gases or low pressure steam. If this energy could be recaptured and used, efficiency would be increased and alternate fuel use would be reduced.

In order to utilize the waste energy from generation of electricity, the load and the generation source must be well matched. For example, a paper mill which needs steam around the clock is well matched to a base load generating plant. On the other hand, while space heating loads can be served through cogeneration systems, matching the heat load to the generation is a more difficult balance due to the variable load for heating. If a cogeneration system can be a complete substitute for all or part of a heating system, savings can accrue in capital expenditures as well. A promising development for residential and small commercial applications is a cogeneration system that operates off the thermostat. When the house calls for heat, a generator runs until it provides enough waste heat to satisfy the demand and shuts off. The electricity is a byproduct of space heating.

The most recent Vermont installation of a cogeneration system of significant size is at the Vermont Marble OMYA plant in Florence, Vermont. In this installation, waste heat in the form of hot air from two 4 MW turbines is used to dry material used in the manufacturing process. Existing cogeneration plants in the state tend to be clustered in two market segments, the wood products industry and educational/institutional facilities.

Utility owned cogeneration plants have been rare in Vermont, in part due to the nature of the industrial base here. There are limited opportunities for either base load generation or year-round heat needs. Industrial and large commercial establishments have been reluctant to install cogeneration systems because of the need for back-up power when the plant is down and for matching heating loads. A more competitive electric market could mean a big boost for cogeneration. In a more flexible marketplace and with innovative ownership and operator options, more companies will search for cogeneration opportunities in Vermont and industrial steam hosts will be more likely to operate a new, on-site energy producing facility. (For more information on cogeneration, see Energy Technologies for the Present and Future in Chapter 3.)

2. Policy: Encourage District Heating and Cooling

Encourage communities, developers, and homeowners to consider district heating or cooling systems in new and existing developments and investigate cost-effective opportunities for modernizing the Montpelier and Waterbury district heating systems, making them models of efficient, clean-burning biomass district energy.

District heating and cooling (DHC) employs a central system and the use of a central plant to serve the heating and cooling needs of a group of buildings by distributing hot water or steam in a limited area. It is most commonly used by large institutions such as colleges or universities that have many buildings spread over a defined area. In most cases, there is one owner for all the facilities who pays the energy bills for the entire site. However, technology is available to meter the "heat" delivered to each building so common ownership is not essential.

Efficiency, both thermal and economic, is increased since a larger boiler can be operated more efficiently and

duplicative heating equipment is not needed at each structure. Opportunities for biomass fueled systems are increased due to the larger size of the system.

Rationale

The primary energy benefit from DHC systems comes from the increased efficiencies of a central heating plant. DHC technologies can also be combined with a cogeneration system for a truly integrated energy production system.

Vermont's potential district heating systems are found in three general settings:

- existing steam power plants;
- retrofits to heat only systems; and
- development of new DHC systems.

Currently a number of district heating systems operate in Vermont. Two of the largest systems service the state office complexes in Montpelier and Waterbury. Both of these systems are dual-fuel steam systems using wood chips. A number of the state's colleges and universities also operate district heating systems to serve a variety of facilities on their campuses. A number of these systems could be expanded to serve a larger population of buildings in their communities and/or modernized to provide an integrated heating and cooling system based on modern cogeneration technology.

McNeil Station in Burlington is an example of a power plant located close to a demand center that is being considered for a district heating project; the CORE Project. District heating was part of the original design concept of McNeil Station. Planning discussions are in progress with the University of Vermont and Fletcher Allen Health Care regarding links to their heating plants from McNeil. These links may be constructed in the near future. There are also potential retrofit opportunities in many town and village centers. There may be some potential in new construction. Some condominium developments pool propane supply systems. The next logical step in that trend would be to install a DHC system for a set of buildings. The Green Acres housing project in Barre is an example of a multi-building development that has been retrofit to use a wood fired district heating system.

3. Policy: Encourage Distributed Utility Services

Encourage utilities to examine distributed utility options when looking for least cost solutions to resource needs, especially in areas with impending need for reinforcement of the transmission or distribution system or to resolve congestion .

Distributed utility (DU) services are the strategic integration of small generation, energy storage, and demand side management into the electrical system to cost-effectively obtain both location-specific and system-wide benefits. In general, distributed utility technologies are relatively small (less than 10 MW in size) and modular. DU generation technologies include wind, photovoltaics, combustion turbines, fuel cells, and internal combustion engines. Demand side management strategies include intensive, targeted retrofit programs (such as fuel switching), load control, and real-time pricing programs. The benefits of distributed utility services can include avoiding or deferring investments in transmission and distribution infrastructure, reducing the risk of generation over-capacity, high energy efficiencies associated with cogeneration technologies, and greater reliability of electric service.

Rationale

Historically, economies of scale have favored electrical energy production from central station generating plants, requiring energy to be delivered over an elaborate system of circuits using long transmission lines. Costs for providing transmission and distribution of electricity to ultimate customers can account for one-third to one-half of the costs of that service. Often these poles and wires are underutilized assets, running at or near capacity for only a fraction of the year. Further, costs to upgrade or reinforce a constrained area can be significant. By selectively incorporating generation, storage, or targeted DSM into a least cost resource acquisition plan, not only can central station generation be augmented, but transmission and distribution (T&D) asset utilization can also be greatly improved and new problematic investments can be avoided, or deferred.

The efficiency of new small-scale generation technologies and targeted DSM opportunities have changed greatly relative to the economics of central station generation. In areas requiring T&D investment, distributed technologies can result in a least cost solution.

Targeted DSM has appeal because programs can be focused on a stressed area and cost-effectiveness ratios can be adjusted to reflect the additional T&D benefits. More traditional methods of load control have applications as do real-time pricing programs.

Under current regulation, utilities are responsible for providing electric service at the lowest cost consistent with reliability and quality standards. To the extent that distributed utility technologies represent a least cost solution they should be pursued. However, as with any new procedure, there are issues which must be resolved between the utility and the regulator. In order for the concept of a distributed utility to move forward at a pace which could show results, utilities and regulators must work together to develop a vision for such a utility. Analytical protocols need to be developed and there needs to be some room for demonstration of techniques and technologies. Given the current situation surrounding competition in the electric industry, further analysis of how a utility can cost-justify investments in nontraditional distributed utility investments will be needed. (See Chapter 3 for more on distributed generation.)

4. Policy: Be Prepared to Act on Proposed Projects to Expand Gas Pipelines and Storage to Unserved Areas

When initiatives are proposed for bringing new pipelines into Vermont or adding new storage facilities in areas that are unserved, Vermont should be ready to act if the proposed project meets statutory siting requirements.

Natural gas represents 6.5% of end use energy consumption in Vermont and less than 1% of Vermont's electric generation fuel sources. There is a great potential for expanding the use of natural gas to fuel more of Vermont's energy needs and to replace more environmentally damaging sources either in direct use or in electric generation. From an environmental perspective, substitution of natural gas for other fossil fuels offers substantial benefits because natural gas produces significantly smaller amounts of CO_2, CO, and VOCs per unit of energy than other fossil fuels. Substituting natural gas for traditional transportation fuels and for other fossil fuel in electric generation suits many of the goals of this plan, particularly environmental soundness.

Since the state's pipeline and storage facilities are limited and at capacity, Vermont should give serious consideration to projects that propose building new pipelines to connect Vermont with outlying natural gas fields or building local distribution systems and storage facilities for liquified natural gas (LNG) and propane (LPG) that is brought in by truck. Project proposals targeting under served areas should be investigated, so long as the projects meet statutory siting requirements. Some of the issues related to siting a new pipeline can be effectively addressed using geographic information system (GIS) technology.

The Champlain Pipeline, initially proposed in 1989, was to bring natural gas through Vermont from Highgate to Rockingham, via Rutland, on route to the Boston area. Recently the Portland Natural Gas Transmission System (PNGTS) Project proposed passing through the Northeast Kingdom, New Hampshire and Maine on its route to the Boston area. Natural gas pipeline capacity in New England has increased 80% in the last decade, according to the New England Gas Association, and projects proposing to bring natural gas from New York to Bennington or Rutland are being developed. Given the importance of its role in the transition from fossil fuels to renewables, the supply of natural gas is of critical importance.

5. Policy: Investigate Feasibility of Rehabilitating and Reactivating Old City Gas Distribution Systems.

Six manufactured gas distribution systems operated in Vermont prior the 1980s. These systems should be mapped and assessed to determine the feasibility of rehabilitating and reactivating one or more of them, using propane-air or natural gas.

In the early 1980s there were six manufactured gas distribution systems operating in Vermont. These systems were located in Montpelier, Springfield, Barre, St. Johnsbury, Rutland, and Bennington. They provided service to residential, commercial, and industrial consumers. Economic and maintenance problems led to the closing of all of these facilities. Recently, there has been interest in rehabilitating and reactivating these distribution systems by inserting polyethylene pipe into the old pipes so they can carry gas. This method of upgrading the pipes greatly reduces both the amount of construction needed to build a distribution system and the cost of delivering gas. With relatively high-pressure polyethylene pipe, greater volumes of gas can be delivered than was possible with the manufactured gas systems that operated at low pressure. Polyethylene piping also eliminates corrosion problems experienced with cast or wrought iron piping that was used in the older distribution systems.

Rehabilitation and reactivation of some of these systems could coincide with the installation of a gas transmission line, expediting the availability of natural gas in areas where is has not previously been an option. A rehabilitated system could also utilize propane air or LPG until a gas transmission line was built.

6. Policy: Promote Integrated Electrical Utility Broadband Communication Networks

Encourage the development of projects and joint ventures to provide integrated electrical control and communication services.

> **Note: This policy has complex issues needing further exploration before recommendations can be made. A summary of this policy with recommendations does not appear in Volume 1, Chapter 4.**

Vermont electric utilities should explore the potential of offering advanced broadband two-way communication services to customers through partnerships with telephone and cable companies. Pilot projects targeted at constrained electrical distribution areas of the state, which are adjacent to fiber optic lines but not currently served by cable television networks, should also be encouraged.

Rationale

A number of electric utilities in the United States and around the world are rapidly expanding into the telecommunications business through links with local telephone companies, cable television companies, and other communication companies. Electric utilities have developed fiber optic communication networks to serve their internal communication and electrical system control and data acquisition (SCADA) needs. Pilot

projects and joint ventures between electrical utilities and telecommunications companies are developing rapidly in order to establish broadband two-way communication networks. In addition to supplying electrical service to homes and businesses in the service area, these ventures provide two-way data communication services over existing fiber optic and coaxial cable networks. Although the ultimate goal of these ventures may be to provide a third wire to their customers' premises to compete for long distance telephone, cable TV, and two-way data communication services in the future, more immediate benefits to consumers may be from the integrated network's energy management capabilities and other value-added services.

Modern two-way broadband communication systems that link utilities with their customers' homes and businesses can result in significant cost efficiencies for both the utility and its customers. Utility load management and monitoring abilities, as well as power quality monitoring and load profiling capabilities, are greatly enhanced through the integrated systems. Equipment and appliance operating schedules can be programmed by customers or controlled by the utility to reduce the system's peak demand and schedule electrical loads to coincide with the utility's lower cost off-peak periods and individual customer usage requirements. Remote meter reading, real-time pricing, environmental monitoring, security, and alarm capabilities are added values to be gained from the integrated broadband systems.

Near term prospects for the integrated broadband systems include automated dispatching and monitoring of small-scale, distributed electrical generation equipment located at the utility or customer premises. Advanced distributed utility technologies, including efficient standby generators and cogeneration plants, fuel cells, solar photovoltaics, wind, methane, and biomass gasification generating plants, can be dispatched on command to meet local and regional loading conditions, reduce losses, and mitigate congestion on transmission and distribution lines and feeders.

Technical advances and lower costs for data communication, as well as monitoring and control equipment, will enable electric utilities to better manage, dispatch, and optimize demand side efficiency, load management resources, and distributed generation sources to match system loads while avoiding or deferring significant transmission and distribution costs. Similar technological advances in electrical transmission and distribution equipment, including advanced electronic controls, capacitors, transformers, and switching devices will enable utility operators to better direct and control electrical flows and reduce line losses on the system, thereby enhancing the ability to transmit more electricity over Vermont's electrical power grid.

Real-time pricing of electrical consumption on both the wholesale and retail level promises to develop rapidly due to the enhanced communication and metering capabilities of interactive monitoring equipment, controls, and meters. As the electric industry is opened to greater competition, these technological and market forces are transforming the electrical power industry and making it more dispersed, diverse, competitive, and efficient.

G. Strategy: Increase Competition in the Electric Utility Industry

For the past decade, the electric industry in the U.S. has been moving at an accelerating rate toward new organizing principles. It is now technologically and economically possible to bring competitive market forces to what has historically been perceived as a natural monopoly. An important impetus for competition is new technology that can readily be installed at customer locations, and essential telecommunications and computing capabilities are now available to support these new technologies. Many observers of the electricity business believe the change to a more market-driven environment is inevitable.

The electric industry of the past, with cost-based rates and rates of return paid by captive customers, is evolving into a system with more open and competitive markets, in segments and niches of what was fully integrated service, allowing customer choice and preserving or improving public benefits that have been achieved. Sixteen states — including all the New England states except Vermont — have passed legislation providing for retail competition in their respective states, with effective dates ranging from 1998 to 2004.

Congress is working on a comprehensive electric competition plan to modify or repeal outdated federal law, address regional electric markets, ensure reliability on the interstate electricity grid, and protect public benefits for all consumers. The Clinton Administration has proposed that all U.S. electric consumers should be able to choose their electric supplier by 2003.

Milestones in the movement toward more competition in the electric industry include:

- The 1978 federal Public Utility Regulatory Policies Act (PURPA), designed to encourage increased reliance on competition and market mechanisms in the electric utility industry. PURPA increased non-utility generation by creating a new class of independent power producers, providing them access to the transmission grid, and requiring electric utilities to purchase power from a certain group of these producers. Also, PURPA opened the door to some of these new technologies by creating an acceptable way for non-utilities to get into the generation business.

- EPACT, the federal Energy Policy Act, passed in 1992, opened transmission lines to independent power producers, enabling them to sell their power to utilities, and reaffirming that the states have authority over retail competition. In general, EPACT's provisions were designed to encourage the electric power industry to rely increasingly on market forces instead of cost-based regulation, with expectations that as the process gained momentum, efficiency and public benefits would result.

- FERC, the Federal Energy Regulatory Commission, was already playing a critical role in promoting the competitive transformation of wholesale power generation before the passage of EPACT, and in Order No. 888, effective 7/96, opened the door to wholesale competition.[viii] This rule requires all public utilities that own, control, or operate facilities used for transmitting electricity in interstate commerce to provide open access, as well as nondiscriminatory transmission rates and terms of service. Open access must be provided to any electric utility, federal power marketing agency, person generating electric energy for sale or resale, entity engaged in wholesale electricity purchases or sales, and eligible retail customers that request such access. (See Order 888 pp. 152-159.) As a result, utility transmission systems are being reorganized to serve as common carriers, removing impediments to competition in the wholesale bulk power marketplace and, one hopes, bringing more efficient, lower cost power to consumers. FERC's action made it easier to buy and sell power, as nontraditional generators of cheaper power gain access to the transmission grid. These rulings, along with required unbundling or separation of a utility's generation and transmission, are expected to ensure that transmission owners do not have an unfair advantage in emerging competitive markets. Turning transmission over to an independent system operator (ISO) that is completely independent of generation owners is one way to comply with FERC's nondiscriminatory transmission tariff requirements. FERC is pursuing establishment of regional ISOs around the country. Taken together, FERC expects these provisions to maintain system reliability while starting a chain of events to remove impediments to competition in wholesale trade and bring more efficient, lower cost power to the nation's electricity customers.

In response to these federal initiatives, there has been a surge of activities at state utility commissions and in state legislatures to assess the adequacy and compatibility of their regulatory framework to meet challenges likely to confront the electric utility industry in the future. Many states are investigating a range of activities to promote competition at the retail level and accommodate wholesale competition initiated by FERC. California Public Utility Commission and states with high electric rates took the lead in promoting competition, in hope of achieving lower rates. New York, Michigan, Massachusetts, and Wisconsin soon followed. Except for Alabama, Arkansas, Florida, South Dakota, and Tennessee, all states and the District of Columbia are considering or addressing restructuring activities through regulatory proceedings or legislative actions.

Key issues being addressed by the states are:

- industry structure, including the relative merits of functional unbundling and divestiture of generation assets;
- creation of independent system operators and working wholesale markets for power and ancillary services;
- estimation and recovery of uneconomic costs which could be stranded by eliminating the monopoly franchise;
- evaluation of current "obligation to serve" requirement in a deregulated environment;
- techniques to preserve public benefits previously provided by regulated electric service, such as environmental protections, efficiency and demand side management programs;
- consumer protection, assistance to low income households, role of renewable resources, and others;
- standards for information in customer service proposals;
- time tables for implementation and educating the public.
- to allow competition for electricity only, or to broaden it to include, for example, metering and billing; and
- how to regulate remaining monopoly tasks such as distribution system.

In the northeast, Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island have passed restructuring legislation. Vermont had an early start in considering a move toward retail competition. In 1994, a Roundtable Group formed by DPS and the PSB with representatives from utilities, industrial customers, environmental groups, low income advocates, and government agencies established a set of principles to govern a restructured Vermont marketplace for electric energy.

In September 1995, the Board opened an investigation into restructuring the electric utility industry in Vermont (Docket 5854). In this docket, the Board directed utilities to present plans consistent with the agreed-on principles to restructure their service territories. Those plans were filed in June 1996. The Board issued its report and order in Docket 5854, *The Power to Choose: A Plan to Provide Customer Choice of Electricity Suppliers* at the end of 1996, with comprehensive recommendations designed to enable retail competition to being in 1998. The Vermont Senate passed a bill (S.62) in 1997 that laid out a process and plan for reforming the state's electric utility industry, but no action followed in the House. During the 1998 legislative session, several House bills were drafted but none made it out of committee and House leaders were hesitant to act on complex issues associated with introducing retail competition. DPS will work with the legislature and interested parties and seek passage of legislation in 1999, enabling Vermont consumers to choose their electricity suppliers in a reformed marketplace.

Meanwhile back in Washington, Congress is considering several legislative proposals for comprehensive restructuring and deregulation that deal with a wide range of electric industry issues, including retail competition, stranded cost recovery, mergers, market power, divestiture of utility assets, and repeal or reform of PURPA and other federal legislation considered by some to be irrelevant given the current move to competition. These House and Senate bills are aimed at providing a national focus for the electric industry's competitive evolution, taking over piecemeal efforts of the states. Opponents in Congress and in the states favor a slower pace and an approach that deals with each issue as it arises. A feature that appears in some of the congressional restructuring proposals is recognition and "grand fathering" of restructuring legislation and regulatory decisions already passed by the states.

1. Policy: Move Toward Greater Retail Competition While Maintaining Societal Benefits

The Department of Public Service and the Public Service Board should continue their support for opening Vermont's electric industry to retail competition with safeguards to ensure that consumer protection efforts and public benefit programs policy efforts are enhanced rather than diminished in a more market driven environment.

The Workgroup has agreed on two overarching principles that should guide any development of a more competitive electric industry in Vermont and the region. They are efficiency and fairness. A restructured industry should provide opportunities to capture improved efficiencies in the production, delivery, and use of electricity, and seek to maximize customer value at the least cost to society. (By the phrase "maximized customer value at the least cost to society" we mean to include both customer value and costs that would result from efficient markets and those other costs that are external to market transactions.) In addition, the system should treat all producers and consumers equitably, according to the costs they impose and benefits they derive, both during and after the transition to a more competitive industry. Realizing such efficiency gains should improve the well being of society and promote the economic vitality of Vermont.

The Department of Public Service staunchly supports legislative and regulatory change so Vermont's electric industry will operate as a competitive market, while preserving public benefits such as consumer and environmental protections and regulatory control over distribution utilities. Key issues related to serving and protecting the public interest and preserving societal benefits are discussed below.

Concentration of market power is a concern in a restructured environment. To ensure a fully competitive market for electricity, it is important that no company dominates all or any part of the market, abuses market power through price fixing, charges predatory prices, sets up barriers to market entry, or stifles competition in any way. Safeguards are also needed to ensure that Vermont consumers are not subjected to excess market power through mergers and acquisitions in Vermont or in the broader wholesale power and transmission markets.

Protecting environmental quality, improving energy efficiency programs for consumers throughout the state, and increasing renewable resources and new technologies are vital public benefits that must be preserved and enhanced as Vermont moves toward retail competition. To preserve and enhance air quality in Vermont, air emissions standards should be set for all retail providers selling electricity in the state and all generation located in the state. Energy efficiency programs, which provide energy and cost savings to customers, should continue in a restructured environment, funded through a charge to all customers that purchases competitively selected energy efficiency services. Finally, renewable resources and sustainable, innovative technologies are important for improved environmental soundness and sustainability (two of Vermont's statutory energy goals), as well as for fuel diversity and reduced emissions. Vermont should have standards so that an appropriate percentage of the electricity sold at retail in the state comes from renewable resources and emerging, sustainable technologies. This basic information should be communicated in an easy to read label.

Strong customer protections and benefits that accrue equitably to all utility customers are also essential in Vermont's restructured environment. With increased competition, no customer group should be disadvantaged, especially residential, low income, small commercial, and farm customers. DPS and the PSB should set policies that ensure that competition benefits all customers equitably. Specifically, an Electric Consumer Bill of Rights should be formulated that guarantees service standards for customers in the new marketplace. This Consumer Bill of Rights should cover minimum standards for quality of service and customer service. It should assure fairness for all customers, including:

7. A restructured industry must preserve key public benefits of the current system, including cost-effective end-use efficiency, research and development, and the development, commercialization and use of renewable resources.

Vermont plans for restructuring must include precise and realistic mechanisms to secure attainment of this principle.

8. Existing commitments of utilities arising from past decisions made pursuant to historic regulatory and legal principles must be honored. Utilities are entitled to recover legitimate, verifiable, and otherwise recoverable and prudently incurred costs pursuant to those principles. Utilities have an obligation to take all reasonable measures to mitigate the costs of their existing commitments.

Vermont plans for restructuring must include precise and realistic mechanisms to secure attainment of this principle.

9. Electric service is a basic necessity. Any restructuring of the electric utility industry must address the needs of consumers in general and in particular low-income consumers. Reform proposals must specifically empower all consumers with the necessary resources to assume responsibility and accountability for their electrical services.

Vermont plans for restructuring must include precise and realistic mechanisms to secure attainment of this principle.

10. The benefits of restructuring must extend equitably to all classes of consumers. (Equity, here, is also intended to reflect a temporal component. The benefits of restructuring must extend to all customer classes contemporaneously.) The benefits of restructuring must not be achieved through shifting of costs among customer classes.

11. There must be a clear system of public accountability and public participation in any restructured system. The implications of a new utility structure must be thoroughly understood before being implemented.

12. Vermont's policy must enhance the ongoing competitiveness of its businesses and economy.

13. Universal access to safe, efficient and reliable electric distribution service must be assured in a restructured industry. Electric distribution service must be available to all customers. Restructuring of any other aspect of the electric industry must not harm or reduce customer access, customer service or customer protections in regard to electric distribution service.

Universal access to reliable, reasonably priced electric service must be assured in a restructured industry. Electric service must be available to all consumers, and no consumer should be denied continuing or new service because they are deemed to be undesirable in a competitive environment. Achieving this end may require designation of a provider of last resort (which may be the local distribution company or some other entity), or it may be achieved through requirements placed on some or all retail electric service providers.

14. Restructuring must maintain and improve upon customer service safeguards and protections, including line extensions, service connections, deposits, bill payment options, budget billing, disconnection notices and limitations, reconnection, metering, due process and appeal, and liability. Additional customer service requirements and customer protections may need to be developed in response to restructuring.

- access to electricity service at a reasonable price;
- reasonable payment terms;
- fair treatment by all providers;
- opportunities to join with other consumers for mutual benefit;
- impartial resolution of disputes;
- reasonable consideration for service failure; and
- nondiscrimination in price, terms, conditions, or offers on any basis other than credit history.

In addition to this Consumer Bill of Rights, special protections are needed for low income customers. While competition should produce generally lower prices, volatility will likely increase. Low income consumers are most vulnerable to this. A low income program should be developed and funded through a charge on all electricity consumption. (See Affordability Section below.)

Finally, restructuring should in no way lower the standards for safe nuclear power station operation and decommissioning. The focus that competition puts on cost reduction is at odds with the need to prepare for decommissioning activities, long term storage of radioactive waste, and the necessity of minimizing the risk of low probability accidents with catastrophic consequences. DPS and the PSB should closely monitor nuclear

safety issues as restructuring progresses to determine whether new or increased oversight is warranted.

For further discussion of these issues, see the Competition and Restructuring section in Volume 2, Chapter 3; the *Position Paper of the Vermont Department of Public Service* in Docket 5854 (March 1996); the summary of that paper; *Restructuring the Electric Utility Industry: Competition, the Consumer, and the Environment* (May 1996); the PSB Report and Order in Docket 5854 - *The Power to Choose: A Plan to Provide Customer Choice of Electricity Supplier* (Dec. 1996); and Docket 5980 - *Vt. DPS Statewide Energy Efficiency Plan* (May 1997)

H. Strategy: Use Energy Taxation to Meet Vermont's Energy Goals

This strategy would be to develop an energy taxation system which begins to internalize the social and environmental costs associated with fossil fuel use and supports the development of renewable energy technologies and energy efficiency investments.

Early in our nation's history, Benjamin Franklin observed that nothing is certain but death and taxes. This observation continues to express the negative perspective many people have of taxes. Popular attitudes have changed significantly in the last 200 plus years, but the negative associations with taxes have not. "No taxation without representation" has given way to representatives of the public calling for "no new taxes."

It might seem that a strategy that involves increasing energy taxes deserves no more consideration than any other form of taxation. There are reasons to take a second look at energy taxation, however.

- Energy taxes offer unique opportunities to lower other taxes (such as property and income taxes) while achieving many of Vermont's energy goals at no additional cost to average taxpayers and without additional regulations for energy users.

- Energy taxes can be used to leverage additional cost and energy savings by reinvesting the revenue in more efficient homes and vehicles, thereby increasing Vermont's economic vitality.

- Eliminating some tax credits, tax breaks, and government spending for non-renewable resources could help meet Vermont's energy goals and regain revenue that could be better spent or returned to taxpayers.

This strategy begins with a brief discussion of current energy taxes in Vermont, followed by a discussion of important general concerns about taxes and some issues specific to Vermont. Criticisms and concerns about taxes are discussed because energy taxes can address these concerns. Then, five specific forms of energy taxation are considered (including carbon, BTU, motor vehicle fuels, sales, and gross receipts tax), and two potential uses of tax revenue (to offset non-energy taxes and to leverage additional energy and cost savings) are considered. Next, the value of a well constructed energy tax policy is contrasted with past energy policies that have encouraged the use of non-renewable sources with hazardous waste streams. Finally, specific policy recommendations are offered.

1. Review Current Energy Goals and Energy Taxes and Assess their Consistency

Meeting Vermont's energy goals means moving toward a future that reflects a long term, sustainable integration of the economy and the environment. Carefully designed energy taxes can promote progress toward our goals. Vermont should investigate a range of energy tax options and focus energy tax policy on achieving long range energy goals that are closely linked with vitality of the economy, the environment, and Vermont's distinct identity.

Current Energy Taxes in Vermont

Vermont energy taxes can, in general, be divided into two categories: motor vehicle fuel taxes and non-motor vehicle fuel taxes. The taxes on non-motor vehicle fuels used in homes and businesses vary between fuels and uses. The 5% sales tax (32 V.S.A. §§9771, 9772, 9773, 9741) revenue that goes into the General Fund applies to most products sold in Vermont, but it does not apply to energy used in the residential sector, such as electricity, natural gas, propane, or wood. A 5% sales tax on fuels not intended for motor vehicles applies to electricity, natural gas, propane, and wood sold to commercial establishments. Prior to July 1996, industrial customers paid 2% sales tax on energy used for manufacturing, but after July 1, 1996, industrial customers were exempt from sales taxes on energy. The sales tax does not apply to motor vehicle fuels. (Motor vehicle energy taxes are described below.)

There is a Utilities Gross Receipts Tax (30 V.S.A. §22) of 0.5% on electric and 0.3% on gas utilities' gross operating revenue that supports the Public Service Board and the Department of Public Service. The Board receives 40% of those funds and the Department 60%. At the local level, the City of Burlington charges all Burlington Electric Department customers a 3.5% franchise fee for use of the city's rights-of-way. There is a 0.5% Fuel Gross Receipts Tax (33 V.S.A. §2503) on non-motor vehicle fuels (except wood) that funds the Low Income Home Weatherization Program. Both of these taxes ultimately fall on residential, commercial, and industrial users. There is also an Electric Energy Tax (32 V.S.A. §8661) which is 3.5% of the net book value (less an adjustment for local property taxes) of electric generating plants with a name plate generating capacity of more than 200,000 kW. Currently, the only instate generating plant that falls into this category is Vermont Yankee Nuclear Plant. Since Vermont receives roughly half the energy generated at Vermont Yankee, some of this tax ultimately falls on energy users outside Vermont. See Table 4.I.21 for an overview of Vermont's tax receipts from non-motor vehicle energy taxes.

Motor fuels taxes, as non-motor fuels taxes, vary depending on the fuel and use. Gasoline is taxed at $0.15 per gallon at the distributor (23 V.S.A. §3106), with an additional $0.01 per gallon fee for the Leaky Underground Storage Tank Program (LUST) that is set to expire in 2002. Diesel fuel is taxed at $0.16 per gallon (23 V.S.A. §3003) with an additional $0.01 fee for the LUST Program. Diesel fuel vehicles greater than 10,000 pounds gross vehicle weight must pay $0.25 per gallon.[ix] Operators of these vehicles must report their mileage and fuel use to the state and pay the additional $0.09 per gallon quarterly. (The Agency of Transportation's (AOT) long range plan recommends a $0.05 per gallon increase in the gasoline tax. The Agency of Natural Resources (ANR) expects that in 2001 the LUST fund will be about $9 million short of what is needed to clean up the storage tanks in Vermont, and ANR may seek an increase in the fee assessed for this program.) With the exception of the leaky tank cleanup fee, all motor fuel taxes collected go into the transportation fund and make up approximately 34% (gasoline) and 8% (diesel) of the transportation fund revenues (Vt. Legislative Joint Fiscal Office, *1995 Fiscal Facts*, 18).

Taxation of other motor fuels is more complex and there are some exemptions to motor fuels and sales taxes. See Table 4.I.22 for an overview of Vermont's motor fuels energy taxes and user fees. There is no tax that goes to the transportation fund on alternative motor vehicle fuels such as natural gas, propane, and electricity. Instead, these vehicles are charged 175% of the normal registration fee at time of registration. Motor fuels used in farm vehicles are also exempt from motor fuels and sales taxes. Fuels other than gasoline used for

off-road vehicles, such as log skidders, forklifts, or boats, are exempt from sales and motor fuels taxes. Railroad fuel is taxed at $0.03 per gallon (23 V.S.A. §3003), aviation jet fuel at 5% (19 V.S.A. §11(4) and 32 V.S.A. Ch. 233), and aviation gasoline is taxed at the gasoline rate. Buses registered in Vermont are exempt from motor fuels and sales taxes (23 V.S.A. §3003), but buses registered outside Vermont pay diesel motor fuel taxes.

Table 4.I.21 Vermont Non-Motor Vehicle Energy Taxes, 1985-1995

Year	Utilities Gross Receipts Tax[a]	Fuel Gross Receipts Tax	Electric Energy Tax[b]	Est. Comm. Energy Sales Tax[c]	Est. Ind. Energy Sales Tax[c]	**Est. Total Non-Motor Vehicle Energy Taxes**
1995	2,562,671	3,481,373	3,974,270	11,400,000	5,500,000	**26,918,314**
1994	2,553,754	3,558,497	4,206,188	10,900,000	6,900,000	**28,118,439**
1993	2,481,636	3,165,788	4,406,455	10,200,000	7,300,000	**27,553,879**
1992	2,220,551	3,289,982	4,662,752	9,100,000	7,700,000	**26,973,285**
1991	2,186,135	2,643,496	2,397,873	7,400,000	5,700,000	**20,327,504**
1990	2,149,248	0	463,680	7,000,000	5,300,000	**14,912,928**
1989	1,958,019	0	1,148,957	6,900,000	5,200,000	**15,206,976**
1988	1,678,434	0	1,642,272	6,600,000	5,100,000	**15,020,706**
1987	1,397,476	0	1,915,398	6,200,000	5,200,000	**14,712,874**
1986	1,394,396	0	1,805,381	5,700,000	4,800,000	**13,699,777**
1985	1,184,772	0	1,761,206	5,200,000	4,500,000	**12,645,978**

[a]From 1989-present, the tax rate was 0.5% for electricity and 0.3% for natural gas. Prior to 1988, the tax rates were 0.45% for electricity and 0.15% for natural gas.
[b]On July 1, 1991, the tax rate increased from 1.9% of net book value to 3.5% because state taxes are adjusted for local taxes, and since local taxes had grown significantly, state revenue had dropped off during the late 1980s. Revenues are again dropping, by about $500,000 per year. 1996 revenues were $3,484,270.
[c]These number are not tracked by the Vt. Department of Taxes but were estimated using commercial and industrial energy sales estimates. The sales tax was 4% until 1991, when it became 5%. In 1993, after a very brief period of 4% sales taxes, the commercial rate returned to 5%, but the industrial rate remained at 4%. In 1995, the industrial rate decreased to 2%. On July 1, 1996, the energy sales tax to manufacturing costumers was eliminated.

Sources: Vt. Department of Taxes, Biennial Report 1995, Vt. DPS, 32 V.S.A. §9741, and Vt. Agency of Human Services.

Aside from fuel taxes, there are other taxes and fees that fall on transportation energy users. Railroads pay additional taxes into the transportation fund: railroads pay 1% of their appraised value of property (32 V.S.A §8211), and unlike vehicles on state owned roadways, they must lease state rail lines (5 V.S.A. Ch. 58). There is also a Motor Vehicle Fuel Users License fee that applies to buses (23 V.S.A. §442), and other large diesel fuel vehicles (23 V.S.A. §3007(a)) and non-diesel fuel vehicles collected at the time of registration (23 V.S.A. §415).

Sales tax exemptions for energy result in relatively few energy tax dollars entering the General Fund.[x] The estimated lost revenue due to the sales tax exemption for farm fuels, fuels for domestic use, and motor fuels is $1.5 million, $16 million, and $23.5 million per year respectively (Vt. Legislative Joint Fiscal Office, *1995 Fiscal Facts*, 6). In addition, the estimated lost revenue from the industrial sector will be about $10 million in 1997 when the exemption is fully in effect (Vt. DPS). Motor fuel taxes are user fees that support the transportation infrastructure. They do not go into the General Fund, but transportation fund monies can be and have been transferred to the General Fund.

Table 4.I.22 Vermont Motor Fuels Energy Taxes and User Fees, 1987-1995

Year	Gasoline Tax[a]	Diesel Fuel Tax[b]	LUST Fee	Aviation Jet Fuel Tax	**Total of Energy Taxes**	Motor Fuels User License[c]	Railroad Property Tax[d]	Railroad Leases[d]
1995	46,223,813	11,195,846	4,002,034	122,484	**61,544,177**	1,398,151	98,746	313,360
1994	48,078,744	10,568,697	3,927,721	85,805	**62,660,967**	697,090	101,786	348,900
1993	44,394,772	11,242,557	3,478,742	107,731	**59,223,802**	173,839	108,575	462,379
1992	45,357,552	10,330,070	3,581,656	165,843	**59,435,121**	63,778	127,324	474,484
1991	41,302,586	10,767,796	3,255,738	142,126	**55,468,246**	133,769	118,636	723,893
1990	43,711,768	9,866,203	3,305,120	146,800	**57,029,891**	101,806	121,895	194,053
1989	37,437,385	6,459,186	2,311,599	264,241	**46,472,411**	891,073	155,561	416,705
1988	36,376,297	6,059,268	0	7,654	**42,443,219**	639,474	155,561	433,823
1987	34,306,582	5,901,096	0	0	**40,207,678**	608,183	168,792	562,168

[a]Includes aviation gasoline.
[b]Includes road and railroad diesel as well as some late filing fees.
[c]Not included in total of energy taxes.

Source: ANR, Petroleum Cleanup Fund Balance Reports, 1989-1995; FY Transportation Fund Revenue Account reports, 1987-1995

2. Tax Policy and Energy Policy

In general, energy policies are designed and implemented to encourage consumer choices and behaviors that are societally beneficial in the long term. Taxes tend to discourage the activity or action that is taxed. Taxes applied to positive behaviors, such as income taxes and property taxes, send a negative signal making these beneficial actions less attractive. On the other hand, when the price of a product or energy consumption fails to fully reflect its cost, a tax is warranted. Tax policy and energy policy are effectively coordinated when a tax is used to internalize the full cost of energy use. Then the consumer gets accurate signals for making market choices.

Tax policies and energy policies overlap because tax dollars are collected on energy, tax breaks are given to certain types of energy or uses of energy, and government spending of taxes subsidizes research, development,

and use of some types of energy. The external costs of energy use also place a hidden tax on society, not in the form of support to the government, but in the form of costs and consequences placed on current or future individuals or society. For example, neither energy users nor suppliers are required to pay for the environmental and social damage resulting from acid precipitation and global warming.

The overlap between tax and energy policies and the usefulness of employing tax policies to internalize the full cost of energy in the price of energy is the focus of this strategy. Taxes are an excellent means to incorporate the unpriced costs of energy production and use, such as costs related to global warming and acid precipitation, into the price of the fuel. In cases where resources damaged by energy use, such as air and water, are not privately owned but are held in common, energy taxes are a means of compensating society for some of the damage done to the resources by the producers and users of energy. The major energy benefits of energy taxes arise because the tax substitutes for the unpriced external costs of energy use. Therefore, producers and consumers receive a price signal that more accurately reflects the cost of energy. This encourages conservation, efficiency, and fuel switching to cleaner or more efficient fuels.

In addition to the energy benefits, using energy taxes is better tax policy than using many of the current taxes. To understand why this is the case, especially since incorporating more of the full costs of energy use in taxes requires raising taxes (at least on some fuels) and is controversial, it is important to understand the major criticisms and concerns regarding taxes. The following section explores several common criticisms and problems of the current tax system, and it shows how energy taxes avoid many of these criticisms while addressing many of the concerns regarding impacts of energy use. Among the tax issues considered are the impact of taxes on the economy as well as the wise and efficient use of tax dollars, local concerns regarding the overdependence on property taxes, the problem of state revenue short falls, and the impact of taxes on the competitiveness of Vermont's businesses and products. In each case, energy taxes offer unique opportunities to correct problems with current tax policy while addressing energy concerns.

Distorting Impacts of Taxes. A frequent criticism of taxes is that they have a distorting impact on the economy. An ideal marketplace with the right prices and rational consumers, will efficiently allocate resources, labor, goods, and services. Taxes raise the costs of products or reduce the money that consumers have to make purchases. Similarly, tax incentives and tax breaks make some activities less expensive while requiring that the needed tax revenue be derived from other sources. Some income and payroll taxes may discourage the hiring of additional labor; some capital gains taxes may discourage investment; and some property taxes may discourage home owning or investment. The effect of any tax is to change the prices set by the marketplace. This diminishes the efficiency of the marketplace, which, with the right prices and rational consumers, is claimed to maximize utility by the efficient allocation of resources, labor, goods, and services.

Examining the criticism that taxes have a distorting effect on the economy provides an excellent example of how energy taxes can help solve both tax and energy problems. Taxes do have a distorting impact on the economy, but that impact does not always lead to inefficiencies. When prices do not reflect full costs, as is the case for energy prices, prices are already distorted, and the market does not allocate resources most efficiently. Taxes can correct underpricing due to external costs by substituting taxes for the unpriced externalities. When prices reflect full costs, market efficiency is restored.

The right price signals encourage environmentally sound, sustainable, and efficient use of resources at the lowest cost to society. Energy taxes provide an efficient means of working with the markets to send consumers the right price signal, one that includes full costs. Energy taxes also send an important price signal to manufacturers, providing an incentive to reduce energy use and its impacts in order to reduce the cost of their product. In addition, energy taxes can reduce distorting impacts of other taxes. Energy taxes large enough to internalize external costs would raise large amounts of revenue that could be used to reduce any distorting taxes.

Since taxes are necessary to support our society and its infrastructure, they might as well be collected in a manner that also helps achieve other important social goals, such as Vermont's energy goals, instead of being collected in ways that adversely affect the efficiency of the economy. The effect of taxes is often to discourage the activity taxed. Therefore, it makes sense to tax activities that are in Vermonters' interests to discourage, such as those activities that are polluting or inefficient. It also makes sense to use the revenue gained from such taxes to decrease the taxes on activities that are in Vermont's interest to encourage. For example, home ownership would be encouraged if energy taxes were used to reduce property taxes; working would be encouraged if energy taxes were used to reduce payroll or income taxes.

Regressive Taxes. Another criticism of taxes (which applies to energy taxes) is that some can be regressive, that is, fall disproportionately on lower income groups. The regressiveness of a tax can only be fully evaluated in the context of the full roster of all taxes. This potential creates a social constraint on how extensively energy taxes can be used and potential issues with regard to this Plan's affordability goal.

Efficient Use of Tax Revenue. Another major concern regarding taxes is that tax money be collected and used efficiently. Tax money collected or spent inefficiently may purchase less "good" than if that same amount of money remained in the marketplace.

This concern regarding taxes applies to all taxes, including energy taxes, and it is clear that to fully realize the good that comes from taxes, money must be spent as wisely as possible, avoiding wasteful and unnecessary expenses. Efforts by citizens and government agencies are and should be made to ensure that all taxes are spent wisely.

Energy taxes are one of the most efficient means of reducing energy impacts. They raise revenue and reduce energy impacts without the social costs associated with distorting taxes and without the problems of command and control emissions reduction strategies. They rely on consumers to make informed decisions rather than placing pollution limits, regulations, or other restrictions on energy users. They are also much more flexible than more regulatory approaches to controlling energy impacts: they do not dictate what is an acceptable level of emissions for each end use, but rely on the user of energy to determine when reductions are cost-effective. Producers and consumers, not regulators, codes, or standards, decide if energy efficiency, fuel switching, or emissions controls are cost-effective. Energy taxes achieve two goals at once. They generate revenue and decrease energy impacts.[xi]

In addition to using energy tax revenue to fund government operations as in the case of the sales tax, utilities gross receipts tax, and motor fuels tax, there are two important uses of energy taxes that directly address the issue of using taxes in the most efficient way:

- using energy tax revenues to reduce other distorting taxes, as mentioned above; and
- using energy tax revenues to fund cost-effective programs aimed at reducing the total societal cost of energy use.

The second use of energy taxes, recycling the revenue to projects that increase energy efficiency or reduce energy impacts, has three benefits. When the tax is collected, the energy tax helps to internalize costs, which results in decreased energy use and impacts. When the revenues are used to purchase cost-effective efficiencies or to lower emissions, energy impacts are further reduced. In addition, consumers save money that would have been spent on energy, and they are able to spend that money on other goods, services, or activities. Moreover, recycling taxes in this way greatly reduces the level of taxation needed to bring about an equal reduction in emissions compared with when taxation is used alone.

The two uses of energy tax dollars, reducing other taxes and recycling energy tax dollars into projects that

increase efficiency and reduce impacts, are not mutually exclusive. Both can be pursued (although not with the same revenue) at the same time. It may be impractical and unnecessary to invest all the money raised by an energy tax (that is large enough to significantly impact energy use) on energy efficiency. On the other hand, smaller taxes, which would have little impact on energy use, can have much greater impact if the revenue is used to leverage further efficiencies.

Property Taxes. A tax concern that is very important to many Vermonters is the heavy reliance by local communities on property taxes to fund schools, local government services, and local roadways. In 1994, state taxes including personal and corporate income taxes, sales taxes, motor fuel taxes, etc., raised $765 million (Vt. Agency of Administration, 1994, *Vermont, A Fiscal Summary of 1994*, 2). In 1994, local property taxes raised $634.3 million (Vt. Department of Taxes, *Annual Report 1995*, 19). In 1995, local property taxes raised $661 million, more than all the state's General Fund taxes. Relying on a single tax to raise nearly half the total amount of state and local taxes has caused serious problems and repeated calls for property tax reform. There is much debate about what form property tax relief should take, including the most fair distribution of education costs and property tax burdens, and the ideal relationship between local and state government.

In the property tax debate, and the 1997 legislative property tax reform package, much of the focus has been on education because it makes up the greatest portion of property taxes ($460 million in 1995). Consequently, roadway costs have been overlooked. In 1993, about $65 million of property tax revenue was spent on roadways in Vermont (U.S. DOT, *1993 Highway Statistics*, 1995, IV-9). This is about 10% of the total property taxes collected in the state. Shifting the source of this revenue to motor fuels taxes would provide immediate property tax relief and internalize more of the costs of driving in the price of fuels, which would contribute to meeting many of Vermont's energy goals. (See Motor Fuels Tax below for more details.)

As discussed above, energy taxes can be used to substitute for many types of taxes. It is particularly important, however, that energy taxes be used in the place of property taxes, because energy taxes on motor fuels are a much better means of funding roadways than property taxes. When fuel user fees fund roadways, drivers are paying for the roadways. When local property taxes fund roadways, property owners subsidize the cost of driving, which encourages more driving and increases the impacts of energy use.

Revenue Shortfalls. Tax revenue shortfalls are a serious concern for Vermonters. State tax receipts, based on sales and income, have always been susceptible to fluctuations. These fluctuating tax revenues combined with requirements for balanced budgets have led to periodic "budget crises." During tight fiscal times, there is strong pressure to cut back on services and personnel, to use dedicated funds such as the transportation fund, and to raise taxes.

One appealing alternative is to create a "rainy day fund"; a substantial reserve fund to smooth out the fluctuations in available revenue. Energy taxes could be used to establish this fund to help stabilize Vermont's volatile and difficult to predict tax revenues. Creating this reserve fund would institutionalize a practice that has already occurred: using energy taxes from the transportation and leaky underground storage tank funds as well as the utilities gross receipts tax to cover shortfalls in the General Fund. Any form of tax or General Fund revenues could be used to create a rainy day fund, but since relatively little energy tax revenue goes to the General Fund, since energy taxes can have a correcting rather than distorting effect on economic efficiency, and since energy taxes have, in some sense, already been used for this purpose, they provide a possible solution for this problem. Institutionalizing this practice with an energy tax could help stabilize Vermont's tax revenue without putting pressure on the transportation fund or other dedicated funds, while at the same time internalizing more of the full cost of energy use.

Competitiveness and the Race to the Bottom. The final tax issue for discussion has been called the "race to

the bottom." This issue involves the competitiveness of economies with high tax rates and competition among communities and states to bring in jobs or maintain local economies by giving tax breaks.

States often use tax breaks to attract or keep tourists, commercial sales, and manufacturing industries. The governor of New Hampshire, for example, proposed eliminating that state's gas tax for the summer to attract tourists. Vermont has recently taken a similar action in the area of energy used for manufacturing. To improve their competitiveness energy sales to industrial customers are now exempt from Vermont sales tax. (See the discussion of Current Energy Taxes in Vermont.)

There is a potential conflict between internalizing of external costs (using taxes or other mechanisms) and maintaining economic competitiveness with communities that do not seek to internalize such costs. If the full energy costs are internalized and significantly increase the price of comparable products made in Vermont over the price of products made elsewhere, then Vermont products will be less competitive in the marketplace.

One of the most difficult concerns for any tax policy to address is competitiveness. Energy taxes have advantages over other tax collecting mechanisms because energy taxes generally allow industries some option to limit their tax impact through conservation and efficiency. A company can seek to decrease its energy use to reduce its tax burden so that it is more competitive. That same company, however, might not want to reduce its profits to reduce its income taxes, its property to reduce its property taxes, or its employees to reduce its payroll taxes.

By shifting some corporate taxes to energy taxes, the corporate tax burden could remain roughly the same, but companies would have greater incentive to increase efficiency. Greater efficiency and productivity help make companies in countries with higher energy costs competitive in the world market. Higher energy prices in Japan and Europe, for example, result in more efficient energy use rather than a less competitive economy, and there is no reason the same could not happen in the United States with careful planning.

The impact of energy taxes could be further minimized by slowly phasing in these taxes, by refunding taxes for energy efficiency to hard hit industries, or by refunding money to some vulnerable industries or exempting them (a strategy used in Europe).

In addition, for states, including Vermont, to achieve the savings and reductions in energy impacts that are possible through internalizing of external costs, regional and federal policy changes are needed. Federal policy could be improved in two specific ways:

- policies are needed to eliminate or avoid competition between states; and
- federal policies are needed to get states to compete positively to reduce energy use and emissions; not to reduce costs, taxes, or standards.

To avoid competition between states, regional cooperation initiatives offer some hope. For example, New England states or the Northeast Ozone Transport Region could implement some policies while avoiding some competition problems. Nevertheless, one state, by not joining the others, could ruin the effort. More promising options that need further consideration involve getting states to compete positively to reduce emissions. A very large federal block grant to states that internalize external costs would be one option for encouraging states to compete in emissions reductions.

3. Types of Energy Taxes

Five energy taxes and their impacts on energy use are discussed below. They include a carbon tax, a BTU tax, a motor fuels tax, a sales tax, and a gross receipts tax. While all of them can be used to internalize the costs of energy use, each has different impacts on energy use.

Carbon Tax

A carbon tax is an energy tax assessed on the carbon content of various fuels (usually measured in dollars per ton of carbon contained in the fuel or per ton of carbon dioxide emissions). A carbon tax is one promising means of reducing carbon dioxide emissions from energy use and limiting the scale of climate change as described here. Although it would be most effective on a national or international level, Vermont could take a leadership role by implementing a small carbon tax. By taxing carbon dioxide emissions, carbon taxes employ the principle "the polluter pays."

Controlling Carbon Dioxide Emissions. Carbon dioxide is unique among pollutants. The typical approaches to reducing pollutants (technological improvements that reduce or eliminate the pollutant and legislated limits or bans on emissions) are either incomplete, inappropriate, or ineffective with carbon dioxide. There are three reasons for this. First, damage that results from carbon dioxide is unlike most emissions. For example, unlike benzene (from gasoline vapors and combustion) that is carcinogenic or carbon monoxide that is poisonous, carbon dioxide is a harmless gas (unless it has displaced the oxygen in a confined space). It makes up 5% of the air we exhale and is commonly ingested in carbonated beverages. Breathing carbon dioxide, in either its preindustrial concentrations or its currently increasing levels, has no direct impact on living beings. Its damage is indirect and delayed. When carbon dioxide is released into the atmosphere in amounts much greater than natural systems can absorb, it results in a warming of the atmosphere and related impacts discussed in Chapter 2. Since the damage caused by the emissions is indirect and distant in time, there is little or no non-regulatory incentive or pressure to reduce carbon dioxide emissions.

The second reason traditional emissions control approaches are inadequate is that there is no way to eliminate carbon dioxide from combustion emissions. Heat, carbon dioxide, and water are the primary products of combustion. There is no technological means of removing carbon dioxide from the emissions of carbon containing fuels.

Third, carbon dioxide emissions come from numerous dispersed sources, making control difficult. Nearly every automobile and truck, as well as gas or oil fueled furnaces, water heaters, clothes driers, and stoves are sources of carbon dioxide. Coal, gas, or oil boilers and electric generating plants are also sources. Emissions of one of the most important carbon dioxide sources, automobiles, are relatively small compared to those of large boilers, and typically range from four to eight tons of carbon dioxide per year. The cumulative impact of the emissions of millions of automobiles, however, is very large. In Vermont, transportation is responsible for 42% of CO_2 emissions in 1990 (Vt. DPS). As a result of the dispersed emissions, measures that have been effective for other major pollutants are less effective in controlling carbon dioxide. Utility energy planning which controls emissions by externality adders can address emissions from electric generation but cannot address emissions from dispersed non-regulated sources. A comprehensive tradable emission permit program that includes small dispersed sources is most likely unworkable, given the number of sources (although limited programs may reduce emissions in some areas).

The traditional means of controlling emissions (such as emissions limits for each device), many of which are recommended in this Plan, alone are not sufficient to reduce carbon dioxide emissions to sustainable levels. Voluntary and purely market mechanisms have been ineffective (the United States will undoubtedly not meet its goal of limiting carbon dioxide emissions in the year 2000 to 1990 levels). Banning emissions is impossible. Technological improvements cannot remove carbon dioxide. Efficiency standards do not cover all the sources of emission and at best, efficiency standards can only reduce the volume of emissions. Planning methods used in regulated utility industries to identify emissions produced by different fuels do not address emissions from diverse sources and non-regulated industries.

The options for reducing or eliminating carbon dioxide emissions are:

- using less energy through conservation or efficiency;
- switching to carbon free fuels such as wind, solar, or hydropower; (See Chapter 4. Section I., B. through D.)
- switching to fuels with no net carbon dioxide emissions such as wood or other biomass fuels used sustainably (See Chapter 4. Section I.A. policies promoting use of wood energy); and
- switching to fuels with lower carbon content (such as natural gas).

A carbon tax is one of the most effective ways to encourage conservation, efficiency, and fuel switching. It is the only emissions controlling mechanism that can comprehensively address carbon emissions from all combustion sources. This tax substitutes for the unpriced external costs of carbon dioxide emissions, internalizing costs and raising the price of polluting fuels as discussed above. Market mechanisms and price signals that more accurately reflect the full cost of energy use allow consumers to make better informed decisions about fuel choices. Consumers can choose conservation or efficiency if the higher price of the full cost of fuel is not worth the value they receive, or they can switch to a fuel that has lower full costs.

A carbon tax also avoids other problems related to command and control emissions reduction strategies. It is much more flexible than emissions limits, in that it does not dictate what is an acceptable level of emissions for specific users, but relies on energy users to determine if it is more cost-effective to reduce emissions by switching to other fuels or increasing energy efficiency.

Details of a Carbon Tax. A carbon tax can be efficiently implemented. Of the major details of a carbon tax, such as what is taxed, how it is taxed, when and where it is taxed, how much it is taxed, and who bears the tax, only the last two are controversial. The carbon content of fuels is known, and nearly all the carbon in a fuel is emitted as carbon dioxide when that fuel is burned. Therefore, assessing fuels based on their carbon content accurately reflects their carbon dioxide emissions. Table 4.I.23 shows the carbon content of selected fuels measured in pounds of carbon per million BTU. Carbon content can be taxed with an excise tax assessed on raw fossil fuels or, as in the case of imported refined fuels, as close as possible to the point at which fossil fuels enter the economy. This minimizes the number of tax collection points and ensures that the tax influences as many energy decisions as possible. Also, since the tax relative to the cost of the product is higher before any value is added, the tax will provide more emissions reductions (and less tax revenue) for a given carbon tax rate.

The greatest difficulty in defining a carbon tax is determining the appropriate tax rate. Since the tax is meant to substitute for the unpriced side effects of energy use, ideally one would want to determine those costs and allocate them to the appropriate fuels. Determining the exact external costs, however, is difficult. The total costs related to global climate change are difficult to predict, but they will likely include additional costs to food production as well as costs related to sea level rises and more frequent and severe storms.

Alternatively, carbon taxes could be used to maintain the sustainable release of carbon such that carbon emissions would be equal to carbon uptake by the environment, producing a balanced carbon budget. Other long term sustainability criteria might also be used, such as limiting global climate change to a range beyond

which irreversible damage to biological resources might increase significantly. (See Chapter 2, Sustainability, for a discussion of the value of biological resources that support life.)

Given the uncertainties as well as the potentially high costs of taking no action, interim targets such as stabilizing carbon dioxide at 1990 levels or stabilizing total greenhouse gases at or below a doubling of preindustrial atmospheric concentrations are likely substitutes for more precise external cost estimates and

Table 4.I.23 Carbon Content and Carbon Dioxide Emissions For Selected Fuels

Fuel	Carbon Coefficient[a] (lbs C/10^6 BTU)	Carbon Dioxide Emissions (lbs CO_2/10^6 BTU)
Coal (Anthracite)	62.1	225.42
Coal (Bituminous)	56.0	203.28
Coal (Sub-Bituminous)	57.9	210.18
Coal (Lignite)	58.7	213.08
Ethanol	41.8	151.73
Fuel Oil (Distillate)	44.0	159.72
Fuel Oil (Residual)	47.4	172.06
Gasoline (Aviation)	41.6	151.01
Gasoline (Motor)	42.8	155.36
Jet Fuel	43.5	157.91
Kerosene	43.5	157.91
Misc. Petroleum Prod. and Crude Oil	44.7	162.26
Natural Gas	31.9	115.80
Propane (LPG)	37.8	137.21
Wood[b]	N/A	0.00

Note: Coefficients are given as pounds of carbon and carbon dioxide emitted per million BTU of fuel consumed. When multiplied by consumption given in 10^6 BTU, they result in emissions of carbon or carbon dioxide in pounds (lbs C or CO_2). Carbon dioxide emissions from electric generation vary depending on the primary energy used to create the electricity. To ensure that a carbon tax shifts energy sources to renewable fuels, and to account for the external costs of nuclear energy, many carbon tax proposals include a tax on electricity generated by nuclear power.
[a]Content coefficients are sometimes called carbon content coefficients or carbon coefficients.
[b]The carbon content of wood is approximately 4.75% of the weight of the wood. The wood emissions coefficient is a net value when biomass resources are harvested sustainably.

Source: U.S. EPA, *States Workbook*, 1995, I-11

exact knowledge of the damage from global warming. Stabilizing emissions levels at 1990 levels is only a temporary measure, however, and will not stop the accumulation of greenhouse gases in the atmosphere, but it will achieve United States commitments to other nations and the goals of the Climate Change Action Plan.

DPS has estimated the taxation level necessary to reduce Vermont emissions to 1990 levels greatly exceeds $300 per ton of carbon (equivalent to approximately $0.81 per gallon of gasoline or about or $0.92 per gallon

of fuel oil). This is higher than estimates for what would be required to stabilize emissions nationwide at 1990 levels, which are estimated to be nearer to $100 per ton (U.S. Congress, 1991, 103). Vermont's low use of fossil fuels for electricity and the lack of short term transportation alternatives and transportation fuel alternatives (transportation is Vermont's major source of carbon dioxide emissions) are the primary reasons for this difference. There are fewer options available for Vermonters to switch to lower content carbon fuels compared to other areas of the country, particularly where a large percentage of electric generation is from coal. Much of the tax related reductions will come from conservation measures in Vermont. Also, the computer model used to estimate these impacts probably understates the effect of large taxes because it was calibrated using the impacts of smaller historical price changes. Table 4.I.24 shows the yearly emissions and revenues related to various carbon tax rates in Vermont.

Who should be taxed is also a key issue. Out of concern for economic competitiveness, manufacturing is often exempt from some of the carbon tax burden. A carbon tax has the greatest effects on high carbon content fuels, such as the coal industry and industries dependent on those fuels. To moderate the impact on specific industries, carbon taxes can be and are combined with energy taxes such as a BTU tax to achieve some of the same goals but reduce the burden on coal producers and coal producing regions.

Revenues and Impacts of Carbon Taxes. Carbon taxes large enough to impact energy use would raise large amounts of revenue and could significantly reduce other taxes. A tax of $50 per ton of carbon (equal to about $0.13 per gallon of gasoline) on fossil fuels burned in Vermont would raise over $100 million per year, beginning at $97 million in 1997. A tax of $100 per ton of carbon would generate over $200 million in revenue per year ($188 million in 1997), enough to lower some combination of federal, state, or local taxes by nearly $700 per Vermont household. (See Table 4.I.24 Vermont Revenues, Energy Use, and Emissions at Various Carbon Tax Levels.)

If Vermont (or any other small region) implemented a tax carbon rate high enough to significantly influence its carbon dioxide emissions, some energy intensive industries might experience a competitive disadvantage. One way to alleviate this is to lower other taxes, as discussed above. Other alternatives include using a lower carbon tax rate, in which case the benefits and tax revenues are also lower. For example, a $10 per ton of carbon tax in Vermont would increase gasoline prices by only $0.027 and would reduce carbon dioxide emissions by 0.54% over the next 20 years. The impact of a small carbon tax can be greatly increased, however, if the revenue is used to purchase greater energy savings. If the tax were recycled into a hypothetical commuter bus line that was subsidized so that commuters pay only $0.04 per mile and an expanded weatherization program, the resulting carbon dioxide emissions reductions would be much greater. Using a $10 per ton carbon tax to fund a commuter bus line would double the emissions reductions, to 1.01% cumulatively. (See Motor Fuels Taxation in the Transportation section of this chapter and the Affordability section for more information on recycling tax revenues.) (See Table 4.I.25 on carbon dioxide emissions reductions when carbon tax revenues are recycled, and Section 6 below for further information on the impacts of carbon taxes when they are returned to taxpayers.)

European Carbon Taxes. Many European countries including Denmark, The Netherlands, Norway, Sweden, and Finland employ carbon taxes, and the European Economic Community is considering adopting a carbon tax throughout Europe. Denmark implemented a tax on oil, coal, and natural gas of approximately 100 DKK

Table 4.I.24 Vermont Revenues, Energy Use, and Emissions at Various Carbon Tax Levels

Tax Rate ($ per Ton)	Revenue/Tax Relief (Millions of 1995$)	Energy Use (TBTU)	Energy Saved (TBTU)	Greenhouse Gas Emissions (CO_2 Equiv. Tons)	Greenhouse Gas Emissions Reduced (CO_2 Equiv. Tons)
$0	$0	130.54	0.00	10,088,000	0
$10	$21.95	129.94	0.60	10,042,000	46,000
$25	$54.50	129.08	1.46	9,974,000	114,000
$50	$107.84	127.78	2.76	9,873,000	215,000
$75	$160.22	126.62	3.92	9,783,000	305,000
$100	$211.77	125.56	4.98	9,702,000	386,000
$200	$412.35	122.25	8.29	9,447,000	641,000
$300	$606.21	119.74	10.80	9,253,000	835,000

Source: Vt. DPS

Table 4.I.25 Impacts of Recycling Carbon Tax Revenues into Energy Efficiency

Tax Rate ($ per Ton)	Recycling Revenue to Taxpayers		Revenue to Commuter Bus Line		Revenue to Weatherization Program	
	Energy Saved (TBTU)	GHGs Reduced (Tons CO_2 Equiv.)	Energy Saved (TBTU)	GHGs Reduced (Tons CO_2 Equiv.)	Energy Saved (TBTU)	GHGs Reduced (Tons CO_2 Equiv.)
$0	0.00	0	0.00	0	0.00	0
$10	0.60	46,000	1.13	88,000	0.66	51,000
$25	1.46	114,000	2.76	216,000	1.60	124,000
$50	2.76	215,000	5.32	417,000	3.05	235,000
$75	3.92	305,000	7.96	602,000	4.35	336,000
$100	4.98	386,000	NA	NA	NA	NA
$200	8.29	641,000	NA	NA	NA	NA
$300	10.80	835,000	NA	NA	NA	NA

Source: Vt. DPS

Table 4.I.26 Energy Content of Selected Fuels
BTU Values[a]

Fuel	Energy Content
Coal (Anthracite)	25,200,000 BTU/ton
Coal (Bituminous)	25,200,000 BTU/ton
Diesel Fuel	139,700 BTU/gallon
Electricity[b]	3,412 BTU/kWh
Fuel Oil #2	138,200 BTU/gallon
Fuel Oil #4	145,700 BTU/gallon
Fuel Oil #5	148,800 BTU/gallon
Fuel Oil #6	150,300 BTU/gallon
Gasoline (Motor)	126,000 BTU/gallon
Gasoline (Aviation)	123,000 BTU/gallon
Jet Fuel	139,700 BTU/gallon
Kerosene	136,600 BTU/gallon
Natural Gas	1,000 BTU/cubic foot
Propane (LPG)	91,600 BTU\gallon
Wood - Average[c]	20,200,000 BTU/cord[d]
White Ash	20,500,000 BTU/cord[d]
Beech	20,900,000 BTU/cord[d]
Yellow Birch	20,900,000 BTU/cord[d]
American Elm	17,700,000 BTU/cord[d]
Sugar Maple	21,800,000 BTU/cord[d]
Red Maple	19,100,000 BTU/cord[d]

[a]The values in this table are typical of the various fuels. Actual analyses of individual shipments and/or deliveries can differ.
[b]The 3412 BTU/kWh figure represents the energy in electricity and not the energy required to create the electricity, which, depending on the fuel, is often between 10,000 BTU/kWh and 13,000 BTU/kWh. A BTU tax would fall on the primary energy used to create the electricity.
[c]Wood would not be taxed since it is a renewable fuel. Wood values are included for comparison purposes.
[d]A cord is assumed to contain approximately 80 cubic feet of solid wood at approximately 20% moisture content.

Source: Federal Energy Administration (FEA), *Energy Interrelationships*, June 1977

Table 4.I.27 Vermont Revenues, Energy Use, and Emissions at various BTU Tax Levels

Tax Rate ($ per MMBTU)	Revenue/Tax Relief (Millions of 1995$)	Energy Use (TBTU)	Energy Saved (TBTU)	Greenhouse Gas Emissions (CO_2 Equiv. Tons)	Greenhouse Gas Emissions Reduced (CO_2 Equiv. Tons)
$0	$0	130.54	0.00	10,088,000	0
$0.25	$ 26.73	129.82	0.72	10,033,000	55,000
$0.50	$ 53.16	129.14	1.40	9,980,000	108,000
$0.75	$ 79.32	128.50	2.04	9,931,000	157,000
$1.00	$105.22	127.88	2.66	9,884,000	204,000
$1.50	$156.35	126.74	3.80	9,797,000	291,000
$2.00	$206.70	125.71	4.83	9,717,000	371,000
$4.00	$402.73	122.48	8.06	9,470,000	618,000

Source: Vt. DPS

($17.75) per ton of carbon dioxide emissions($65.09 per ton of carbon).[xii] The tax falls mostly on the residential and public sectors. The commercial and industrial sectors are eligible for tax refunds of 50% or more. The Netherlands has an energy tax (see BTU Tax below) and a carbon tax on all fossil fuels. The energy component is equal to Dfl. 0.3352 per GJ ($0.22 per MMBTU); the carbon component, Dfl. 5.16 ($3.23) per ton of carbon dioxide ($11.84 per ton of carbon). The Netherlands has used this tax to lower federal income taxes. Approximately 60% of Norway's carbon dioxide emissions are taxed at varying rates for oil, gasoline, and coal. Sweden has a carbon tax of SEK 322.8 ($46.55) per ton of carbon dioxide on heating and fuel oils, motor fuels, coal, natural gas, and LPG ($170.70 per ton of carbon). There is also a 25% value added tax on energy and the carbon tax. Electricity is exempt and the taxes are reduced on manufacturing in order to maintain international competitiveness (ICF Consulting Group, 1995, Memo).

BTU Tax

A BTU tax is quite similar to a carbon tax and is often employed with a carbon tax. Instead of being assessed based on the carbon content of the fuel, it is assessed on the energy content of the fuel (measured in British Thermal Units, BTU) and is expressed in terms of dollars per million BTU. Most often, renewable energy resources are exempt from the tax. A BTU tax can be applied at a state or national level, with the most dramatic energy and cost savings coming from a larger national tax.

A BTU tax is best suited to slow the depletion of non-renewable resources and internalize costs related to energy use. It encourages energy efficiency and fuel switching to renewable resources by raising the cost of energy intensive goods and services compared to those requiring less energy use or renewable fuels. As in the case of the carbon tax, it promotes efficiency and renewables using market mechanisms and individual choices rather than command and control regulatory mechanisms.

Details and Impacts of a BTU Tax. The typical energy content of various fuels is known and is presented in Table 4.I.26. Taxing each BTU of energy amounts to an excise tax. It is assessed on non-renewable fuels as close as possible to the point at which the fuel enters the economy. This minimizes the number of tax collection points and ensures that the tax influences as many energy decisions as possible.

As in the case with a carbon tax, determining the ideal rate for a BTU tax is both important and difficult. A tax large enough to significantly affect energy use will generate significant amounts of revenue, which can offset other taxes. States that have great concern about competitiveness can consider lower tax rates. Other factors for consideration in developing a BTU tax include whether it will be used with other energy taxes and on which sectors of the economy it will be applied. Table 4.I.27 shows Vermont revenues, energy use, and carbon dioxide emissions at various BTU tax levels.

Motor Fuels Tax

A motor fuels tax is an energy tax assessed on the volume of a fuel consumed (usually measured in dollars per gallon of gasoline or diesel fuel). Motor fuels taxes are usually collected by distributors who pass the cost along to consumers. It is commonly employed as a user fee on the state and federal levels (and in some areas, the local level) to pay some of the cost of roadways. As such, motor fuel taxes usually contribute more to increased future energy use than they do to reduce energy impacts and costs because they pay for the roadways. Raising motor fuels taxes, however, could be used to more completely cover the cost of roadways, thereby reflecting more accurately the cost of transportation in the price drivers pay and influencing their energy use. If the principle behind the carbon tax and BTU tax is "the polluter pays," the principle behind motor fuels taxes is "the user pays."

Controlling the growth of transportation energy use and its associated impacts are among the greatest energy challenges facing Vermont and the nation. While motor fuel taxes are not currently part of a comprehensive strategy to reduce transportation energy impacts, they provide an excellent means to internalize more of the full costs of driving. Currently, motor fuel taxes cover only some of the costs of roadways and some of the environmental damage. Vermont's $0.15 and $0.16 per gallon taxes on gasoline and diesel account for approximately 41% of the transportation fund revenues. The $0.01 per gallon tax on gasoline and diesel that is directed to the Leaky Underground Storage Tank Program addresses only some of the external costs of energy use (Vt. Legislative Joint Fiscal Office, 1995, *1995 Fiscal Facts*, 18). There are many other costs not included in the price of driving, including the $65 million contribution from local property taxes. (See the sections of this chapter on Full Cost of Transportation in Least Cost Transportation Planning, Pay at the Pump Insurance, and Property Taxes.) Table 4.I.28 shows the sources of revenue for Vermont's highway expenditures. User fees account for 65%-73% of roadway expenditures and none of the external costs related to air emissions.

Uses and Impacts of Motor Fuels Taxes. There are at least four potential uses for additional funds raised from a motor fuels tax. The most obvious is that these monies could go into the transportation fund, speeding up the repair and replacement of Vermont's transportation infrastructure. While it is important to protect Vermont's investment in transportation infrastructure with a sound maintenance program, this alone will not reduce energy impacts.

Money raised with a motor fuels tax could also be used to offset Vermont's property taxes, providing property tax relief. In 1995, Vermont was 45th in the nation in terms of motor fuels tax rates. (See Table 4.I.31 Federal and State Taxes on Motor Fuels). In contrast, Vermont was sixth on the basis of property tax per capita in 1991 (Vt. Legislative Joint Fiscal Office, 1995, *1995 Fiscal Facts*, 12). Nationwide, property taxes account for about 5% of highway revenues, but in Vermont it is closer to 25% (U.S. DOT, *Highway Statistics*, 1985-1993, Table HF-1). A $0.21 (1995$) motor fuels tax increase could replace the local property tax

contribution to roadways. This could be accomplished while maintaining the advantages of local control that are important to Vermont communities and returning the revenues directly to those communities on a per capita basis or some other formula based on existing miles and types of roadways. Further study is required to determine the exact impacts of various formulas on individual communities. (Table 4.I.29 shows the property tax relief available from a range of increases in motor fuels taxes dedicated to local roadways.)

Table 4.I.28 Sources of Revenue for Vermont Highway Expenditures
Millions of Dollars

Year	Property Tax	General Fund	State Gas and Diesel Tax	State User Fees[a]	Federal User Fees	Total Funds[b]	Property Taxes as a % of Total Funds
1992	65.073	5.058	55.687	52.597	64.540	268.961	24.2
1991	55.449	3.734	52.071	55.705	38.282	212.445	26.1
1990	51.558	9.469	53.578	53.690	29.957	212.295	24.3
1989	49.969	6.656	43.896	50.729	35.533	196.553	25.4
1988	41.500	5.567	42.429	52.197	33.369	181.933	22.8
1987	38.950	6.146	40.208	52.828	27.313	175.645	22.2
1986	34.000	5.314	89.037		28.080	160.216	21.2
1985	26.784	6.456	84.888		32.230	156.792	17.1

[a]State user fees include state fees other than the gas and diesel tax, such as registration fees.
[b]There are other minor sources of funding so the total is not just the total of property taxes, general fund, state user fees, and federal user fees.

Source: Compiled from U.S. DOT, *Highway Statistics*, 1985-1993, Table HF-1; Vt. AOT Tax Reports

A third possible use for motor fuels tax revenues is using them to leverage further efficiency improvements, thereby lowering the costs and impacts of energy use. Transportation energy use is the sector with the greatest potential for improvement with respect to Vermont's energy goals. Recycling funds generated by a motor fuel tax back into the economy by purchasing energy efficiencies can have many benefits. A small investment in public transit that is cost- effective when the full costs of transportation are considered would result in much lower emissions compared to the same tax used to offset other taxes, while at the same time lowering the costs of transportation for society and individuals who use public transportation. Table 4.I.30 presents data from a hypothetical commuter bus line that is subsidized by a motor fuels tax so that commuters pay only $0.04 per mile. (See the section of this chapter on Transportation Energy Taxation for more information on the commuter bus modeling.)

Motor fuels taxes could also be put into the General Fund. Currently, no motor fuels taxes go into the General Fund, but the motor fuels tax mechanism could be implemented to raise General Fund revenue. Another option is to remove the sales tax exemption for motor fuels (see below).
Vermont's Motor Fuels Taxes Compared to Other States and Nations. Vermont has one of the lowest motor fuels tax rates in the United States and can significantly increase motor fuel taxes and still remain competitive

with other state's motor fuels taxes. Table 4.I.31 shows motor fuel taxes in various states. Table 4.I.32 show United States gasoline prices and taxes in comparison to other nations. The United States has by far the lowest gasoline price and tax of the western industrialized nations listed (the price of gas in the United States and the four nations with the highest price are in bold for comparison). American transportation energy consumption is also the most inefficient. (See Table 4.I.33 Gas Tax, Price, Use, and Yearly Bill in Selected Countries.) If the experience of these other countries is any indicator of what will happen in the United States, slowly increasing motor fuel taxes will lead to greater efficiency and reduced energy use not to economic disaster.

Table 4.I.29 Impacts of Motor Fuel Taxes used for Property Tax Relief

Tax Rate ($/gallon) (Nominal $)	Revenue (Millions of 1995$)	Energy Saved (TBTU)	Greenhouse Gas Emissions Reduced (Tons CO_2 Equiv.)
$0.00	$ 0.00	0.00	0
$0.05	$ 23.10	0.63	50,000
$0.10	$ 45.72	1.23	97,000
$0.15	$ 67.88	1.80	142,000
$0.20	$ 89.73	2.30	182,000
$0.25	$111.25	2.77	219,000

Source: Vt. DPS

Table 4.I.30 Motor Fuel Tax Revenue used to Purchase Further Efficiencies

Tax Rate ($/gallon) (Nominal $)	Commuter Miles Reduced (Millions of Miles)	Energy Saved (TBTU)	Greenhouse Gas Emissions Reduced (Tons CO_2 Equiv.)
$0.00	0	0.00	0
$0.05	185	1.20	94,000
$0.10	366	2.35	185,000
$0.15	543	3.46	271,000
$0.20	718	4.47	351,000
$0.25	890	5.43	426,000

Source: Vt. DPS

Energy Sales Tax

A sales tax on energy is assessed on the cost of various fuels as opposed to the carbon content, energy content, or volume of the above taxes. It is assessed at the time of the final sale of the product and is a percent of the sale price. Many states exclude state and federal highway motor fuels taxes from the taxable value. Sales taxes are a commonly used form of taxation that typically goes into general funds, but energy is often exempt from sales taxes. In Vermont, motor fuels and fuels used in the residential, manufacturing, and farm sector have exemptions from the 5% sales tax. Commercial energy use is subject to the sales tax.

Sales taxes are rarely employed to achieve energy goals. Rather, they are used as revenue raising mechanisms for the state. Vermont sales taxes raised $152.6 million in fiscal year 1994. Sales tax exemptions can work against many energy goals, however. Since nearly all products except food are taxed in Vermont, sales tax exemptions for energy lower the relative costs of energy, slightly distorting the efficiency of the marketplace by making energy intensive options relatively less expensive. Of the approximately $153 million of sales tax revenue raised in 1994, energy sales taxes contributed approximately $17.7 million on energy purchases of $1,300 million for an effective tax rate of 2.5% (Vt. DPS). In 1997, energy sales taxes are predicted to raise only $12.7 million for an effective sales tax rate of less than one percent.

Reasons for Vermont's energy sales tax exemptions vary. The residential energy tax exemption was introduced in the 1970s to ease the effects of energy price shocks. The manufacturing exemption was phased-in in the 1990s to increase the competitiveness of Vermont made products. Motor fuels have not been taxed. Some individuals have argued that a sales tax on the price of motor fuels, including state and federal motor fuels taxes would be a double tax, but this is not the case because the motor fuels tax is a user fee supporting roadways and transportation. Sales taxes on motor vehicle tires provide an example. The state sales tax on tires is calculated on the sale price of tires which includes a federal excise tax on tires that goes to the federal highway fund. Similarly, a sales tax on motor fuels could be calculated on the sale price of the fuel. Since use of the roadways is not taxed, and since the mechanism for purchasing and maintaining the roadways is the user fee, the logical place for the sales tax to fall is on the full sales price of highway motor fuels. Several states have taken this approach, including New York, California, and Georgia. Several other states assess their sales taxes on the price of fuel, excluding state and federal taxes. (See Table 4.I.31 Federal and State Taxes on Motor Fuels. See also Section 6 below for further information on the impacts of a sales tax on transportation energy.)

Reasons for the sales tax exemptions are often very good. For low income persons, an energy tax can be both burdensome and regressive. For companies that are barely profitable, a 5% change in energy costs can be very important to their continued existence. However, energy tax exemptions, while working toward these social goals, work against Vermont's energy goals of sustainability, environmental soundness, and efficiency.

Energy sales tax exemptions need not be used to resolve the apparent conflict between energy goals of sustainability and environmental soundness and energy goals of economic vitality and affordability (the reasons most offered for tax exemptions). It is possible to maintain energy taxes that incorporate the fuller costs of energy in the price and address concerns about the effect of the tax on the economy (and the ability of persons and corporations to pay for energy) by reducing other taxes. (This idea has been discussed extensively above.) In fact, lowering personal and corporate income taxes (or some other appropriate tax) on those hardest hit by energy taxes and vastly increasing energy efficiency are the only means currently capable of simultaneously and comprehensively addressing the goals of sustainability, environmental soundness, economic vitality, and affordability.

Table 4.I.31 Federal and State Taxes on Motor Fuels
Cents per Gallon[1]

State Rank		Motor Gasoline	Diesel Fuel	Add. Local Taxes	State Rank		Motor Gasoline	Diesel Fuel	Add. Local Taxes
	Federal	18.40	24.40		25	Iowa[2]	21.00	23.50	
	Avg. State Tax	20.87	20.61		26	Massachusetts	21.00	21.00	
					27	New Mexico	21.00	19.00	
1	Connecticut[2]	36.00	22.00		28	Louisiana	20.03	20.03	
2	Hawaii[2 3]	30.58	30.58	Yes	29	District of Columbia	20.00	20.00	
3	Rhode Island[2]	28.00	34.00		30	South Dakota	20.00	20.00	
4	California[2 4]	27.60	27.60	Yes	31	Texas	20.00	20.00	
5	New York[2 4]	27.56	29.58	Yes	32	Indiana[2]	19.80	20.80	
6	Montana	27.00	27.76	Yes	33	Utah	19.50	19.50	
7	Wisconsin	26.10	26.10		34	Maine	19.00	20.00	
8	West Virginia[2]	25.35	25.35		35	New Hampshire	18.80	18.80	
9	Illinois[2]	24.30	26.80	Yes	36	Arkansas	18.70	18.70	
10	Nebraska	24.20	24.20		37	Mississippi	18.40	18.40	Yes
11	Oregon	24.00	24.00	Yes	38	North Dakota	18.03	18.03	
12	Florida[3]	23.80	23.80	Yes	39	Kansas	18.02	20.02	
13	Nevada	23.60	27.60	Yes	40	Alabama	18.00	19.00	Yes
14	Maryland	23.50	24.25		41	Arizona	18.00	18.00	
15	Washington	23.12	23.12	Yes	42	Virginia[2]	17.72	16.22	
16	Delaware	23.00	22.00		43	Oklahoma	17.00	14.00	
17	Michigan[2]	22.88	22.88		44	South Carolina	16.75	16.75	Yes
18	Pennsylvania	22.35	22.35		45	**Vermont**	**16.00**	**17.00**	
19	Colorado	22.00	20.50		46	Kentucky	15.10	12.10	
20	Idaho	22.00	22.00		47	Missouri	15.04	15.04	Yes
21	Minnesota[2]	22.00	22.00		48	New Jersey	14.60	17.60	
22	Ohio	22.00	22.00		49	Georgia[2 4]	11.70	11.70	Yes
23	North Carolina	21.95	21.95		50	Wyoming	9.00	9.00	
24	Tennessee	21.40	18.40		51	Alaska	8.00	8.00	

[1] This table lists rates of general application (including, but not limited to, excise taxes, sales taxes, environmental taxes, special taxes, and inspection fees), exclusive of county or local taxes and gross or net receipts taxes. The state rates are effective January 1, 1995.
[2] Includes additional taxes levied as follows: California: 7.25 % sales tax; Connecticut: 5 % gross earnings tax; Georgia: 3 % sales tax; Hawaii: 4 % sales tax; Illinois: 6.25 % sales tax; Indiana: 5 % sales tax; Iowa: 1 cent per gallon environmental protection tax; Michigan: 6 % sales tax; Minnesota: cleanup fund rate of 1.5-2.0 cents per gallon based on storage size (added 2 cents in table); New York: 4 % sales tax; Rhode Island: 7% sales tax on diesel fuel; Virginia: 2 % sales tax in areas where mass transit systems exist; West Virginia: consumer and sales tax of 4.85 cents per gallon. All sales taxes calculated using $0.86/gallon pre tax price of fuel. Because reformulated gas which is more expensive is required in many areas, sales taxes in those areas may be slightly higher than estimated here.
[3] In Florida, the state assesses a State Comprehensive Enhanced Transportation System (SCETS) tax which is two-thirds of each county's rate. In addition, the state collects a "ninth cent tax" and a second local tax. These taxes add an average of 11.5 cents to the motor fuel state tax which has been added above. In Hawaii: local option taxes (LOTS) are as follows: Honolulu: 16.5 cents per gallon; Maui: 11.0 cents per gallon; Hawaii 8.8 cents per gallon; Kauai: 10.0 cents per gallon (LOTS add 11.58 cents to Hawaii's motor fuels tax and is included in the information in the table.)
[4] Tax based on sales price including state and federal highway taxes.

Sources: U.S. EIA, 1995 *Petroleum Marketing Monthly*, July 1995, 164; US EIA, 1994, *End-Use Taxes*, 86; and the tax departments of Iowa, Louisiana, Michigan, Washington DC, and West Virginia.

Table 4.I.32 Gasoline Prices and Tax Components in the Organization for Economic Cooperation and Development Countries, 1992

Country	Gasoline Prices		Tax Component (Percent of Total)
	Dollars per Liter	Dollars per Gallon	
Australia	0.499	1.89	46.2
Austria	0.970	3.67	64.8
Belgium	0.987	3.74	70.0
Canada	0.455	1.72	46.2
Denmark	0.961	3.64	67.2
Finland	1.013	3.83	68.0
France	0.992	3.75	77.2
Germany	0.981	3.71	72.4
Greece	0.820	3.10	69.1
Ireland	1.001	3.79	66.6
Italy	**1.236**	**4.68**	**75.8**
Japan	0.977	3.70	46.1
Luxembourg	0.746	2.82	62.0
Netherlands	1.141	4.32	72.4
New Zealand	0.541	2.05	46.6
Norway	**1.284**	**4.86**	**71.4**
Portugal	**1.083**	**4.10**	**75.4**
Spain	0.943	3.57	69.8
Sweden	**1.137**	**4.30**	**69.2**
Switzerland	0.759	2.87	62.5
Turkey	0.745	2.82	63.7
United Kingdom	0.882	3.34	69.5
United States	**0.298**	**1.13**	**33.9**

Note: U.S. federal gas taxes increased $0.043 per gallon in 1993, after this study was completed. One gallon equals 3.785 liters.

Source: International Energy Agency, *Energy Prices and Taxes*: Third Quarter 1993 (Paris, France), 284, 293.

Table 4.I.33 Gasoline Tax, Price, Use, and Yearly Bill for Selected Industrial Countries, 1993[1]

Country	Tax ($/Gallon)	Total Price[2] ($/Gallon[3])	Average Use (Gallons/Person[3])	Average Yearly Bill ($)
United States	0.34	1.29	422.16	544.59
Canada	0.80	1.74	296.57	516.03
Australia	0.91	2.01	246.97	496.41
Japan	1.14	2.46	96.04	236.26
Germany	1.82	2.50	131.13	327.83
Sweden	2.08	2.96	165.44	489.70
Italy	2.73	3.79	l05.54	400.00
Portugal	3.22	4.59	62.01	284.63

[1]Tax and price differences between this table and the previous table are due to different years studied and different methods of converting currency.
[2]Prices are for premium unleaded, except for Japan, where only regular unleaded is sold.
[3]Converted from domestic currencies on the basis of purchasing power parities.

Source: Brown, *State of the World* (1996); Original Source: Organization for Economic Co-operation and Development, *Energy Prices and Taxes* (Paris: various editions); United Nations, *Energy Statistics Yearbook* (New York: 1995).

Table 4.I.34 Estimates of Revenues and Energy Savings from the Elimination of Sales Tax Exemptions
(with revenues returned to Taxpayers in Lower State Taxes, 2005)

	Revenues (Millions of Nominal $)	Energy Saved in the Sector (TBTU)	Greenhouse Gases Reduced (Tons CO_2 Equiv.)
Residential	31.4	.1	3,000
Industrial	16.6	.22	13,000
Transportation	43.9	1.34	102,000
All Uses	92.1	1.48	118,000

Source: Vt. DPS

Table 4.I.35 Gross Receipts Tax Used for Weatherization

Tax Rate Increase	Additional Homes Weatherized 2000	Energy Saved 2000 (TBTU)	Greenhouse Gas Emissions Reduced 2000 (Tons CO_2 Equiv.)	Energy Saved 2005 (TBTU)	Greenhouse Gas Emissions Reduced 2005 (Tons CO_2 Equiv.)
Excluding Motor Fuels					
Base Case	0	0	0	0	0
0.25%	1,120	0.02	1,000	0.04	2,000
0.50%	2,240	0.04	2,000	0.07	5,000
1.00%	4,460	0.07	5,000	0.14	11,000
All Fuels					
Base Case	0	0	0	0	0
0.25%	1,750	0.07	5,000	0.15	11,000
0.50%	3,490	0.13	10,000	0.23	17,000
1.00%	6,550	0.26	20,000	0.45	34,000

Source: Vt. DPS

Gross Fuel Receipts Tax

A gross fuel receipts tax is very closely related to an energy sales tax. Like a sales tax, a gross receipts tax is a tax on the value of energy sold. It is a percentage of the gross receipts of energy suppliers, such as electric and gas utilities, or oil and propane dealers. As such, it is the final tax collected. In some cases, gross receipts taxes are collected from fewer entities, making administration, collection, and oversight simpler and more efficient than a sales tax. And in some cases, a gross receipts tax is a broader tax than a sales tax, because there are numerous sales tax exemptions. As long as a sales tax covers all goods and services, there is very little practical difference between a gross receipts and a sales tax.

Gross receipts taxes are typically used to fund specific programs. For example, in Vermont, a gross receipts tax is used to fund the Low Income Weatherization Trust Fund. This tax provides an excellent example of how energy tax policy can be used to address issues of affordability as well as other energy goals. A very small tax of only 0.5% on gross energy receipts on all fuels except wood funds cost-effective energy efficiency improvements for about 3,500 low income homes per year, significantly and permanently reducing the energy bills for those who are least able to afford them. At the same time, the increased efficiency lowers energy demand in Vermont and the impacts of energy use. A family whose home is weatherized benefits from a warmer, more healthy home with energy bills that are more manageable, and all Vermonters benefit from reduced air emissions and progress toward more sustainable and environmentally sound energy use.

Increasing the gross receipts tax and recycling that money into the Weatherization Trust Fund would have

significant impacts on efficiency in Vermont. Table 4.I.35 shows the results from various increases in the gross receipts tax. (See Section 6 below for further information about the impacts of a gross fuel receipts tax with revenue funding weatherization. Also, see Section IV of this chapter on Affordability for a fuller description of the proposed weatherization policy.)

4. Current Energy Tax Policies That Work Against Vermont's Energy Goals

There are significant differences between current energy tax policies and policies aimed at internalizing the external costs of energy use and leveraging further energy efficiency gains, particularly at the national level. In many ways, current energy tax policies work against Vermont's energy goals. To rectify this, it is important that a coherent energy tax policy is developed that

- supports cleaner and renewable fuels;
- incorporates external costs into the price of the energy;
- recognizes that external costs are similar to a tax break for energy producers and consumers.

One of the greatest hindrances to reaching Vermont's energy goals is that renewable fuels and cleaner fuels are forced to compete with fossil fuels and fuels with more hazardous waste streams on an unequal footing. One example is the subsidy given to fossil fuels when the economy fails to account for external costs of energy use. Neither energy users nor suppliers are required to pay for the environmental and social damage resulting from acid precipitation and global warming. This subsidy acts like a tax, not in the form of a payment to support the government, but in the form of a burden placed on the public. (External costs have been described more fully in the Full Cost of Energy section of Chapter 3, and the advantages of using taxes to internalize these external costs have been discussed above.)

Government spending on defense of oil rich areas and maintaining a strong military presence in oil rich areas and shipping lanes are other examples of costs related to energy that are shifted to the public. The 1991 war against Iraq, for example, cost about $61 billion ($52.4 billion came from contributions from other countries).

Another obvious subsidy given to non-renewable fuels comes in the form of government spending on research and development. Federal funding for development of renewable energy peaked in 1980 at $900 million (1986 dollars) (Shea, 1988, 41). Spending quickly declined during the 1980s and was about $150 million by 1989 (U.S. DOE, 1992, *National Energy Strategy*, 36). Since then it has risen to about $400 million per year, but is likely to decline again.

Government spending on non-renewable fuels has been much greater. During the 1980s, for example, government spending on research and development of nuclear and fossil fuels was more than double that of renewable fuels and energy efficiency (U.S. Congress, 1991, 105). Since the first nuclear reactor was built in 1942, the federal government has spent $30 billion on nuclear energy technology (and fusion energy research has received about $9 billion) (Vartabedian, *Minneapolis Star Tribune*, 12/30/95, 4A). The U.S. Department of Energy's Clean Coal Program is another example. The federal government is investing more than $2.3 billion on research to reduce some of the environmental impacts of the non-renewable fuel with the greatest impact on global warming (U.S. DOE, *Clean Coal Technology*, 1995, 1). This money could have been invested in renewable fuels that can more comprehensively address issues of sustainability and environmental soundness (including air quality, acid rain, and global warming).

Another example of unbalanced advantages given to non-renewable energy is that some risks and associated costs related to energy are shifted from the producers and users of energy to society. Global warming is a clear example where the risks and costs of a warmer planet are not borne by those producing or using energy, but by future generations. Other examples of risks shifted to the public include the risks associated with nuclear accidents. Those living down wind of a nuclear plant bear the health risks of an accident. The

Price-Anderson Act further shifts the risks to the public by limiting insurance premiums and the liability of each nuclear plant to $7 billion. Although the chance of an accident is quite small, the potential damage is quite great and not limited to $7 billion. Until recently, the liability was only $590 million, providing an even greater subsidy.

In addition to the risk of accidents, there are many costs related to nuclear waste that future generations may be asked to bear. Clearly, one criterion that must be met for nuclear energy to be sustainable (in this case meaning that costs are not shifted to others or future generations), is to build a waste disposal site and to adequately compensate future generations for the loss of that land, and for the continued maintenance and control of the site. Nuclear waste facilities need to be maintained in perpetuity at great potential cost. Those costs should be borne by current nuclear power users and not future generations.

In the case of oil, taxpayers assume the risks related to changes in the political conditions in other countries. The Overseas Private Investment Corporation (OPIC), funded by tax dollars, insures American companies against losses in investments due to political instability. Some of the costs associated with dependence on foreign oil and risks of another energy shortage are also borne by the public. The Strategic Petroleum Reserve, which stores crude oil in case of disruptions, is financed not by industry but by $21.1 billion ($16.7 billion to purchase and $4.4 billion to maintain and manage) collected from tax payers (Rothschild, 1995, 15).

In the past, more government tax breaks have been given to non-renewable fuels than to renewable and sustainable fuels. The greatest tax break given to oil and energy companies comes from the foreign tax credits. (See Table 4.I.36 for components of income tax for major United States oil and energy companies over a 10 year period.) The foreign tax credit allows United States companies to deduct from their U.S. tax liability taxes paid to foreign governments. The effect of such tax deductions is to provide approximately $5 billion per year incentive for American companies to invest in oil overseas. This tax break increases our energy dependence on foreign resources, increases our trade deficit, and costs taxpayers money while exporting energy jobs. Significant progress towards Vermont's energy goals could be achieved if that tax break went to local renewable sources of energy. There are also several other smaller tax breaks that benefit the oil industry, including the percentage depletion allowance, expensing of exploration and development

Table 4.I.36 Components of Annual U.S. Income Tax of Major U.S. Oil/Energy Companies
(Billions of Dollars)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Total
Taxable Income	38.3	34.7	14.8	20.1	29.0	26.6	31.8	19.8	17.9	20.4	253.4
Expected Tax @ Statutory Rate	17.6	16.0	6.8	8.1	9.9	9.0	10.8	6.7	6.1	7.1	98.1
Foreign Tax Credits	(9.1)	(10.6)	(7.0)	(5.5)	(4.8)	(5.0)	(6.0)	(5.3)	(4.6)	(4.8)	(62.7)
U.S. Income Tax Expense	7.4	6.5	1.3	4.4	5.5	4.1	5.5	1.4	0.4	1.9	38.4

Source: Rothschild, *Oil Imports, Taxpayer Subsidies and the Petroleum Industry*, 1995, 3
Original source: U.S. DOE/EIA, "Performance Profiles of Major Energy Producer"

expenditures, exemption from passive loss limitations, accelerated depreciation, investment tax credits, and exemptions from the Alternate Minimum Tax (Rothschild, 1995, 9-11).

Tax breaks for efficiency and renewable energy have been much smaller than those for non-renewable energy and most have been eliminated. During the late 1970s and early 1980s, there were federal and state income tax credits for certain energy-related costs. The federal credits were for 40% of the first $10,000 invested (with a maximum of $4,000) for solar and wind energy; 15% of the first $2,000 invested (with a maximum of $300) for insulation, caulking, weatherstripping, storm and thermal windows and doors, furnace efficiency, and energy saving thermostats. Vermont offered a tax credit that applied to renewable energy systems including solar, wind, hydro, and wood. The credit was for 25% of the first $4,000 for businesses and $12,000 for businesses. This tax credit expired in 1994.

The most significant renewable fuel tax break is given to ethanol used in gasohol. This exemption from federal motor fuels taxes amounts to about $0.06 per gallon of gasohol. Many Midwestern farm states also provide gasohol exemptions from state taxes (Gordon, 1991, 87).

Tax exemptions for energy use in Vermont include a sales tax exemption for transportation, industrial, and residential energy use. These have already been examined in detail.

As citizens become increasingly concerned about taxes and tax policy and as the impacts of energy use become more apparent, it is important that Vermont and the federal government reexamine tax policies to ensure that tax breaks and tax spending are not subsidizing unsustainable use of energy resources or subsidizing the use of more polluting fuels. Fuels with high external costs already place a burden on society and tax policy should seek to internalize those costs rather than further subsidize them. This requires a comprehensive reexamination of tax policy because current tax policies often subsidize fuels with high external costs. It makes no sense to use taxes to internalize the external costs of energy use while giving subsidies to fuels with greater external costs. Elimination of tax breaks to non-renewable fuels should be the first step towards a consistent tax policy that helps to internalize the external costs of energy use.

5. Concerns About Affordability and Other Impacts of Taxes

Using taxes to internalize external costs presents some challenges. Taxes that internalize the cost of energy increase the price of energy to consumers (but reduce the full costs felt by society). This raises problems of energy affordability, particularly for low income persons and industries that must be competitive with industries in states and nations that do not limit external costs. Also, some energy intensive industries and some energy industries (such as the coal and to a lesser extent, oil industries) will experience declining energy use and revenues.

Solutions to the problem of affordability are quite simple. The first, which has already been discussed in some detail, is to return the revenues to energy users by lowering individual and corporate taxes. A second option is to structure other taxes so as to shift the burden away from those most affected. For example, raising the personal deduction decreases tax rates on low income individuals. In addition, energy efficiency programs targeting low income persons (such as an expanded weatherization program) can lower their energy costs more than the taxes increase them. Predictions of dire consequences of high energy taxes most often result from ignoring the positive impact of recycling energy tax dollars back to energy users (Tellus Institute, 1993, 80). Because energy taxes encourage energy efficiency, higher energy taxes can result in more net disposable income. The modeling performed for this Plan also confirms this.

Some industries will remain vulnerable to high energy taxes, specifically those that are energy intensive. To mitigate the impact on these industries, some European countries have employed lower tax rates and rebates

to these industries. The cost, however, of exemptions and rebates is the decreased benefits gained by the tax, but this may be necessary to gain the positive benefits of energy taxes in other areas of the economy.

There may also be a decline in non-renewable energy producing sectors of the economy. To the extent that this is matched by an increase in renewable energy and energy efficiency suppliers, the overall impact on the economy and society will be beneficial. Localized impacts could be very great and potentially damaging, however. With a carbon tax, for example, communities with energy efficiency industries and significant renewable energy resources would experience significant growth while coal producing areas would experience decline. Local negative impacts accompany most efforts to significantly reduce energy impacts. Investments in efficiency that save money and resources for individuals and society often result in temporary unemployment in some sectors of the economy, such as those displaced by the efficiency. This is not a reason to forgo the efficiency, but it may be a strong reason for assisting those who are displaced. Therefore, some of the tax revenue can also be used to mitigate the local negative impacts of these changes and create new jobs and opportunities.

Energy taxes can help meet many of Vermont's energy goals, including decreasing the impact of energy use on the environment and future Vermonters, increasing energy efficiency, and assuring an affordable energy supply. Energy taxes address environmental and sustainability issues by raising the price of activities that damage the environment or harm future generations. By raising prices on more damaging fuels, energy taxes discourage their use as well as make energy efficiency and fuel switching to cleaner and renewable fuels more attractive. Ironically, energy taxes can also decrease the total cost of energy use, addressing issues of affordability. This is because the current price of energy does not reflect the full cost. When full costs are not paid, resources are used inefficiently in ways that would not be chosen if the full costs were assessed.

Currently, the goal of energy tax policy is not to achieve energy goals but primarily to fund the government. Energy taxes, however, offer a unique opportunity to achieve energy goals and fund the government at no additional cost to society. The two ways this can be achieved are to use the revenue raised by energy taxes to lower other taxes and to use the revenue to purchase cost-effective improvements in energy efficiency.

Specific taxes should be examined to see if they are accomplishing what they should. Transportation energy taxes and fees, for example, do not cover the cost of transportation; $65 million of property taxes are used to fund Vermont roadways. Sales, income, and property taxes have distorting impacts on the economy; energy taxes can correct distortions caused by external costs.

The two key principles behind energy taxes are "the polluter pays" and "the user pays." Energy taxes can be a fair and equitable revenue source that rectifies the distorting impacts of external costs. And, by recycling taxes, either to reduce other taxes or to purchase further efficiencies, energy taxes increase economic efficiency and vitality.

6. Impacts of Energy Taxation Policies

Many of the impacts of each tax policy have already been outlined in the text, in Section 3, Types of Energy Taxes. In general, tax policies are modeled by applying a tax to the fuels, and then using the tax revenues generated in one of two ways, either returning the revenues to taxpayers by lowering other taxes (called tax shifting) or using the revenues to purchase further efficiencies (such as financing weatherization or a commuter bus line). Specific assumptions for the tables presented above are as follows:

Carbon Tax: The carbon tax is modeled by applying a tax to the carbon content of fuels based on Table 4.I.23. The tax begins in 1997 and is modeled at several rates between $10 and $300 per ton of carbon. All values are in nominal dollars, so the impact of the tax declines in the later years of the study. Biomass fuels are exempt from the carbon tax as they produce no net emissions if used sustainably.
BTU Tax: The BTU tax is modeled by applying a tax to the energy content of fuels based on Table 4.I.26.

The tax begins in 1997 and is modeled at several rates between $0.25 and $4.00 per million BTU (nominal dollars). Biomass and solar fuels are exempt from the tax.

Motor Fuels Tax: The motor fuels tax is modeled by applying a tax of between $0.05 and $0.25 per gallon (nominal dollars) on gasoline and diesel fuels sold in Vermont for motor vehicle use. The tax begins in 1997. (Also see Motor Vehicle Fuels Taxation in the transportation section of this chapter for further modeling.)

Energy Sales Tax: The sales tax is modeled by applying a 5% tax to the sale price of fuels. The tax begins in 1997 and is applied to fuels sold to the residential, industrial, and transportation sectors (the commercial sector already pays sales tax). Biomass and solar fuels are exempt from the sales tax.

Gross Fuel Receipts Tax: The gross receipts tax is modeled by applying an increase of between 0.25% and 1.0% to the current gross receipts tax. A tax on motor fuels is also modeled, at rates between 0.25% and 1.0%. The tax begins in 1997. Biomass and solar fuels are exempt from the gross receipts tax.

If the tax revenues from an energy tax are used to reduce other taxes, the revenues collected in one year are returned to taxpayers in the next year by decreasing personal or corporate taxes. The tax shift occurs within each sector, meaning that revenues collected in the industrial sector remained within the industrial sector, and similarly for the residential and commercial sectors.

If revenues are used to purchase further energy efficiencies, one of the following assumptions applies:

- Commuter bus funding: In this case, tax revenues are used to buy down the cost of riding a commuter bus on major Vermont commuter corridors to $0.04 per mile (less than the cost of gasoline for most automobiles). The cost of a commuter bus is about $2.00 per mile (marginal costs are about $1.25). Assuming the bus is one-third full (13 passengers), approximately $0.50 per mile would come from fares and $1.50 per mile from the energy tax. Since the average occupancy of vehicles commuting to work is 1.1 persons, each mile driven by a bus with 13 passengers reduces approximately 12 automobile miles traveled.

- Low income home weatherization: In the case of the weatherization modeling, funding was used to extend the work of the current Weatherization Program. Using data from the current program, 24.5 million BTU were assumed to be saved each year per weatherized home, and 968 kWh per year for the 21.5% of weatherized homes with electric hot water. The cost per home weatherization is assumed to be $2,392 (1994$).

The results of three tax policies are outlined more completely below. They include: 1) a carbon tax of $100/ton, with revenues recycled to taxpayers; 2) a sales tax on transportation energy, with revenues returned to taxpayers; and 3) a gross fuel receipts tax, with revenue funding weatherization programs.

Impacts: Carbon Tax at $100/Ton with Revenues Returned to Taxpayers

The carbon tax was chosen for further illustration here over the BTU tax because of its advantage in reducing greenhouse gas emissions. A $100/ton of carbon is a modest carbon tax because it is likely to raise less revenue than the cost of the damage due to carbon emissions. The tax's effect on energy prices is $0.27/gallon for gasoline and $0.31/gallon for fuel oil. See Section 3, Types of Energy Taxes, for more discussion of a carbon tax.

Figure 4.I.8 Impacts of a Carbon Tax at $100/Ton with Revenues Returned to Taxpayers

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	34.89	35.98	35.34	38.27	37.62	885.25	869.97
Commercial	11.99	17.82	17.27	19.34	18.41	22.21	21.23	486.65	465.82
Industrial	12.42	16.79	16.14	18.41	17.39	19.87	18.99	446.39	425.75
Transportation	42.10	60.54	57.26	64.68	60.50	70.98	67.33	1594.14	1504.39

Total	98.04	130.54	125.56	138.40	131.65	151.34	145.17	3412.43	3265.92

Table 4.I.37 Indicators of a Carbon Tax at $100/Ton with Revenues Returned to Taxpayers

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2747.2	151.8	146.1	183.8	171.8	188.1	177.5	16.0%	15.6%	16.5%	15.5%	16.3%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3265.9	146.5	4.29%	148.1%	173.8	217.6	205.7	222.6	212.2

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
1986.1	60.81%	$0.087	$0.084	$0.089	$0.087	$0.089	65.58%	65.68%	64.64%	63.27%	62.26%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
29,600	974	0.20%	($93)	$24

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($7.26)	$850	$50,780	$56,452	$55,647	$58,679	$58,332	26.91%	26.62%	27.71%	27.62%	27.99%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	8,983,000	11,773,000	11,277,000	11,556,000	4.63%	158.38%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	8,734,000	11,407,000	10,925,000	11,222,000	4.63%	157.44%
Sulfur Dioxide (SO_2)	17,100	15,700	14,800	15,000	14,100	21,900	5.89%	82.46%
Suspended Particulates (PM-10)	6,000	3,400	3,300	3,400	3,400	1,600	1.88%	56.19%
Nitrogen Oxides (NO_X)	25,300	26,600	25,200	31,800	30,600	28,900	4.14%	120.95%
Volatile Organic Compounds	21,600	20,000	19,100	19,400	18,700	18,700	3.90%	86.57%
Carbon Monoxide (CO)	116,900	101,800	95,900	93,500	89,000	123,000	5.09%	76.13%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]

0.98	0.98	0.92	1.05	1.00	$122	($14)	($148)	($92)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

This policy results in a cumulative decrease in energy use through 2020 of 4.29% compared to the base case. The transportation sector experiences the largest cumulative decrease compared to the base case, at 5.63%, but the commercial and industrial sectors are close seconds at 4.28% and 4.62% respectively. Non-renewable energy use and oil use also decrease by substantial amounts.

Since the carbon tax is returned to taxpayers, there is no net loss to individuals' disposable income. In fact, there is a net gain because the carbon tax discourages wasteful and inefficient energy use. This results in energy and cost savings (the total of energy costs per capita falls by 3.59% cumulatively compared to the base case). The cost savings can be spent on other products and services. The overall impact is a positive boost to the economy, which includes a 0.3% cumulative rise in job-years and a 0.2% rise in the gross state product compared to the base case.

Finally, air emissions are substantially reduced through this policy. Greenhouse gas emissions, acid rain precursors, and ozone precursors all decrease cumulatively compared to the base case by between 4%-5%.

Impacts: Remove Sales Tax Exemption on Motor Fuels with Revenue Returned to Taxpayers

The most effective sales tax exemption to remove is clearly the exemption on transportation energy, because its removal results in the greatest revenue, energy savings, and greenhouse gas emissions reduction (see Table 4.I.34). See Section 3, Types of Energy Taxes, for more discussion of sales taxes.

Removing the sales tax exemption on transportation energy results in total energy savings of 0.94% cumulatively through 2020 compared to the base case. Energy use in the transportation sector, which falls cumulatively by 2.09% with this policy compared to the base case, accounts for all this decrease, with a corresponding decrease in oil use.

Impacts in employment and gross state product are small but positive with this policy. In addition, removing the sales tax exemption on transportation energy results in a shift of dollars spent on an out-of-state product (oil) to dollars that are more likely to be spent on in-state products and services. The total of energy costs per capita also decreases cumulatively compared to the base case, by 0.81%.

Most air emissions also fall substantially with this policy; greenhouse gas emissions, acid rain precursors, and ozone precursors all fall cumulatively compared to the base case (by 1.01%, 0.95%, and 1.38% respectively).

Impacts: Gross Fuel Receipts Tax with Revenue to Weatherization

The gross fuel receipts tax was chosen for further illustration here because of its ability to offset the impacts of the other taxes on low income Vermonters. This policy and the policy supporting commuter buses (Sections II.C.2 and II.E.3 of this chapter) lead to direct decreases in the energy needs of low income Vermonters and can result in reduced energy and tax bills. The impacts presented in Figure 4.I.10 and Table 4.I.39 show the results of a 1% addition onto the current 0.5% gross fuel receipts tax. See Section 3, Types of Energy Taxes, for more discussion of gross fuel receipts taxes.

The substantive impact of the gross fuel receipts tax policy accrues to low income Vermonters. By the year 2005, about an additional 36,000 homes could be weatherized through this policy, reducing the yearly energy

bills for those residents by about 20%. In addition, a weatherized home provides many non-monetary benefits such as a warmer home and a healthier family.

Figure 4.I.9 Impacts of a Sales Tax on Transportation Energy

with Revenue Returned to Taxpayers
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.37	35.38	35.96	35.98	38.26	38.29	884.84	885.42
Commercial	11.99	17.81	17.83	19.33	19.36	22.20	22.23	486.44	487.04
Industrial	12.42	16.79	16.80	18.41	18.41	19.87	19.88	446.36	446.52

Transportation	42.10	60.51	59.66	64.65	63.31	70.96	69.29	1593.51	1560.23
Total	98.04	130.48	129.67	138.35	137.06	151.29	149.69	3411.15	3379.20

Table 4.I.38 Indicators of a Sales Tax on Transportation Energy with Revenue Returned to Taxpayers

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2865.8	32.1	146.1	184.0	181.4	188.1	185.4	16.0%	15.6%	15.7%	15.5%	15.6%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3379.2	32.0	0.94%	164.6%	173.8	217.9	215.2	222.5	219.8

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2076.4	61.45%	$0.087	$0.084	$0.085	$0.087	$0.087	65.58%	65.68%	65.33%	63.27%	62.85%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
10,900	461	0.09%	($23)	$9

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($5.09)	$241	$50,780	$56,512	$56,335	$58,657	$58,596	26.91%	26.64%	26.79%	27.62%	27.77%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,519,000	9,417,000	11,770,000	11,643,000	2,533,000	1.01%	163.53%
Carbon Dioxide (CO_2)	6,939,000	9,254,000	9,154,000	11,403,000	11,278,000	2,498,000	1.03%	162.53%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	14,900	1,100	0.30%	87.13%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	300	0.31%	57.02%
Nitrogen Oxides (NO_X)	25,300	26,600	26,200	31,800	31,300	9,100	1.30%	123.72%
Volatile Organic Compounds	21,600	20,000	19,700	19,400	19,000	7,100	1.48%	87.96%
Carbon Monoxide (CO)	116,900	101,700	99,800	93,500	91,400	45,600	1.89%	78.19%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)	Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)

1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.03	$186	($104)	($117)	($64)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[b] Transportation sector

[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

Figure 4.I.10 Impacts of a Gross Fuel Receipts Tax with Revenue to Weatherization
Selected Impacts 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.35	35.98	35.91	38.27	38.18	885.25	883.48
Commercial	11.99	17.82	17.80	19.34	19.30	22.21	22.15	486.65	485.65
Industrial	12.42	16.79	16.77	18.41	18.37	19.87	19.83	446.39	445.48
Transportation	42.10	60.54	60.55	64.68	64.68	70.98	70.99	1594.14	1594.18
Total	98.04	130.54	130.47	138.40	138.26	151.34	151.14	3412.43	3408.79

Table 4.I.39 Indicators of a Gross Fuel Receipts Tax with Revenue to Weatherization
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2895.5	3.5	146.1	183.8	183.5	188.1	187.8	16.0%	15.6%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3408.8	3.6	0.11%	154.2%	173.8	217.6	217.4	222.6	222.3

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2106.1	61.78%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.68%	65.68%	63.27%	63.27%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
600	25	0.01%	$2	($1)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($53.14)	$28	$50,780	$56,452	$56,427	$58,679	$58,659	26.91%	26.62%	26.64%	27.62%	27.65%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,512,000	11,773,000	11,759,000	279,000	0.11%	165.15%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,248,000	11,407,000	11,392,000	266,000	0.11%	164.17%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	900	0.24%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	500	0.55%	56.86%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,800	31,800	200	0.03%	125.69%
Volatile Organic Compounds	21,600	20,000	19,900	19,400	19,300	1,800	0.38%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,700	93,500	93,500	1,400	0.06%	79.98%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	($1,369)	($703)	($649)	($693)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] All sectors
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

II. TRANSPORTATION

Transportation is the largest end use of energy in Vermont. As such, transportation energy use requires special attention to ensure that it meets Vermont's energy goals.

Vermont's and the nation's transportation networks allow for unprecedented mobility. Our mobility is one of the defining characteristics of our culture. It helps shape where and how we live, work, and play. The role of mobility in our lives is so great that we often think of restrictions upon mobility as restrictions on our freedom. Any investigation of transportation, therefore, must be sensitive to the importance it plays in the lives of Vermonters.

One measure of its importance is the amount Vermonters invest in transportation. Transportation in general, and automobile transportation specifically, is one of the most energy-consumptive, polluting, expensive, and dangerous activities in which Vermonters engage. There is significant room for improvement in how our transportation systems address each of Vermont's energy goals.

Transportation accounts for 43% of the energy used in Vermont. Also, it accounts for 47% of the greenhouse gases released in Vermont and is the largest source for several other pollutants (see Chapter 2, Environmental Soundness and Chapter 3, Figure 3.III.29). It is the one area in which the growth in energy use has not slowed and shows no signs of slowing.

Automobile travel not only consumes large amounts of energy, it also consumes large amounts of money. New car costs typically range from $10,000 to $30,000, and cost an average of 45.7 cents per mile to maintain and operate (U.S. Bureau of the Census, 1994, 634). Interstate highways would cost between $5-$10 million per mile to build today, and a small two lane bridge can cost $300,000 to $500,000. Adding two lanes to a two lane highway costs about $1.9 million per mile, while merely resurfacing a two lane road costs $0.5 million per mile (Conservation Law Foundation, 1995, 30). The overall impact of transportation on the economy is immense. To give a sense of proportion, transportation consumes more of our GNP than health care; close to 20% (Gordon, 1991, 36). We are acutely aware of the costs of health care and the strain on our economy that results, yet we rarely hear about a transportation crisis. Occasionally there is concern about the decaying transportation infrastructure, but rarely do we question the value we receive for our transportation investment.

The burden of high costs combined with age and proficiency requirements for driving limit the viability of automobile transportation for significant numbers of Vermonters, including low income and elderly people. In Vermont, licensed drivers make up less than 75% of the population (Vermont has the second highest ratio of licensed drivers to population in the nation) (U.S. DOT, 1994, III-8). More than 135,000 Vermonters must rely on other drivers or alternate forms of transportation to meet their transportation needs. Furthermore, 8% of all Vermont households do not have access to an automobile (U.S. Bureau of the Census, 1993, 1). Neither Vermont's road system nor its transportation spending adequately reflects the needs of these people. Roads are most often designed for the relatively fast movement of two ton cars and do not adequately reflect the transportation needs of a 10-year-old on a bicycle or an elderly person with poor eyesight.

The cost of transportation is not only in dollars and inconvenience. There were 39,235 highway fatalities nationwide in 1992; 96 in Vermont. In addition, there were 1.6 million injuries related to automobile accidents nationwide and 4,649 injuries in Vermont (U.S. DOT, *Highway Statistics 1992*, 213). Automobile accidents are a greater cause of death each year than AIDS or homicide. There were 12 homicides in Vermont in 1992 (U.S. Bureau of the Census, 1994, 95, 199). Violent crime is rightly considered a significant problem. Measured in terms of needless deaths, however, transportation safety is a greater problem.

We have become accustomed to the expense, measured in money, inconvenience, and lives, as well as the high energy consumption and pollution caused by transportation. When we take a fresh look at what we receive for these costs, the result can be disappointing. If we add up all the time spent driving as well as earning money to purchase and maintain a car, insure it, and pay for fuel, and divide that by the miles traveled, the speed of automobile transportation in general (the total distance driven divided by the total time involved) is about 5 miles per hour (Hawken, 1994, 13). One of the greatest advantages of the automobile, the ability to travel great distances quickly, is offset by the large amounts of time required to earn the money to purchase and maintain automobiles and roads. The offsetting effect is so great that if that time were added to the actual travel time, the effective speed of automobile transportation would be slower than that of a bicycle.

The critical point is not that we should all switch to bicycles, but that transportation can and should be made more efficient, more affordable, safer, and cleaner, to ensure that our investment is well spent. Some will argue that since Vermont is a rural state with a cold winter climate, having a car is absolutely essential for work and for recreation. This long term Plan envisions the possibility of a different role for the car. DPS, some state agencies, and some businesses are anticipating a future for Vermont that is potentially more diversified and different than the assumption that everyone living or vacationing in the state has and prefers to use their personal automobile. For example, efforts by the Vermont Ski Areas Association in promoting ski packages with round trip rail transportation as well as year round bus tours, shows there is market potential for cost-effective, well designed, non-automotive travel packages. The popularity and success of touring by train and bus can be leveraged or stifled depending on availability of local transportation options that do not assume 100% availability of a personal car.

Key questions are: what range of transportation options are available, and is the personal automobile assumed to be 100% available and absolutely essential. Survey data gathered by the Agency of Transportation indicates that over 50% of the 1,205 Vermonters interviewed feel that they do not have acceptable access to some elements of the state's transportation system; specifically:

- bicycle lanes;
- local bus service;
- passenger train service;
- park and ride lots; and
- car and van pools (Vt. AOT, *Long Range Plan*, 13,139-40).

Long term transportation scenarios could be developed to reflect a greater reliance on more efficient modes of transportation than the personal automobile. We use the transportation modes that are available, and for a number of reasons inefficient modes have been available. New priorities can be adopted in planning for the future. This Plan proposes strategies and policies that dramatically and cost-effectively improve transportation efficiency and reduce its environmental impacts.

Since automobile and truck transportation in Vermont is by far the greatest user of energy, the greatest source of many pollutants, and the largest expenditure of transportation dollars, these means of travel have received significant attention in this update of the *Comprehensive Energy Plan*. There are several strategies that can be applied to transportation to help ensure that transportation energy use is more consistent with Vermont's energy goals.

The first strategy considered to improve Vermont's transportation energy use is to give serious consideration to implementing the principles of least cost transportation planning (LCTP). This means focusing transportation planning on meeting the needs of Vermonters for access to goods, services, and activities (after environmental, historic preservation, and safety considerations) at the lowest present value life cycle cost (including public and private costs) by combining investments and expenditures on new transportation capacity and comprehensive transportation demand management. LCTP is a tool to increase Vermonters' access to goods, services, and activities at the lowest cost to society. This strategy is the most significant step that Vermont can take toward

meeting its energy goals. LCTP considers energy impacts in the transportation planning process. This is vitally important to Vermont's energy goals because transportation consumes nearly half the energy used in the state but the costs and impacts of that energy use are not currently considered in its planning process.

The second and perhaps most immediately obvious transportation strategy involves making vehicles more efficient. Cost-effective efficiency improvements not only help reduce the cost of transportation, they reduce the fuel use and emissions, increasing sustainability and environmental soundness. Cost-effective efficiency improvements also help improve our national security by decreasing our dependence on foreign oil.

The third strategy involves measures that decrease vehicle miles traveled without decreasing access to goods, services, and activities. Past increases in efficiency have been negated by increases in vehicle miles traveled (see Figure 4.II.8 Automobile Efficiency vs. VMT, 1978-1994). Policies that fall under this strategy seek to reduce the need for travel. Telecommunications, better land use planning, and alternative forms of transportation can all contribute to reducing the need for automobile travel.

To improve the environmental soundness of transportation, the fourth strategy seeks to make transportation cleaner by reducing the level of pollutants emitted from vehicles. The remaining strategy proposes that Vermont consider exploring the use of energy taxation measures applied to transportation energy use to internalize external costs and to leverage further movement towards Vermont's energy goals. Together, these strategies illuminate important public policy changes that can significantly contribute to Vermont moving toward its energy goals.

As pointed out in the comments offered by the Vermont Transportation Policy Group, Vermont's transportation planning is vitally linked to transportation planning for the New England region. Over the long term, Vermont should encourage more regional transportation initiatives with the New England states, New York, and Canada. Furthermore, three high priority areas identified in the New England Transportation Initiative (NETI) can help advance the policies proposed in this Plan: mobility and access for persons and goods, environmental quality, and economic vitality.

There are also many points of agreement between strategies and policies in this Plan and the major NETI recommendations for future regional transportation planning efforts. These areas of potential overlap include NETI recommendations for:

- creating a New England Regional Intermodal Freight Alliance to assist the states in developing and implementing a strategic, intermodal, and regional approach to the movement of good in New England, with improvements to rail systems for passenger and freight traffic, "which offers the potential for decreasing sole reliance on trucks";

- addressing congestion in passenger transportation with regionally coordinated multimodal capacity expansion and demand management projects;

- undertaking a regional tourism transportation initiative to facilitate the movement of tourists into and throughout the region, supporting tourist trains and charter bus operations, intercity and feeder buses. "The feeder bus concept is critical to Vermont's ability to provide an interconnected transportation system to residents, visitors, and tourists alike"; and

- applying new technologies on a regional basis, such as low emissions vehicles (LEVs), alternatively fueled vehicles, and telecommuting (Vt. AOT, *Long Range Plan*, 1995, 35-38).

A. Strategy: Least Cost Transportation Planning

Least cost transportation planning (LCTP) is a transportation planning tool and method that allows planners

and citizens to assess the cost-effectiveness of transportation options in a comprehensive manner, taking into account all options and all of society's costs. LCTP is modeled after least cost integrated planning (LCIP) for electric utilities and can be an important new tool for transportation planners. Just as LCIP is used to meet the public's need for energy services at the lowest cost to society (lowest present value life cycle full cost), LCTP can be used to meet the public's transportation needs at the lowest cost to society.[xiii]

LCTP is a combination of well developed economic tools for maximizing net benefits (cost-effectiveness analysis or benefit-cost analysis) and a planning framework for making public investment decisions. Its key characteristics and corresponding advantages over the traditional demand-driven supply planning process are:

- LCTP shifts the planning focus from providing mobility to providing access;
- LCTP considers a much larger range of transportation options;
- LCTP ensures that all costs and benefits of various transportation options are considered;
- LCTP allows planners to assess the cost-effectiveness of options;
- LCTP increases public involvement and allows citizens more freedom to choose their transportation methods; and
- LCTP is extremely versatile and can be applied to any size project.

These characteristics and advantages of LCTP could have direct impacts on Vermont's energy use. Transportation is Vermont's largest single energy end use and is the fastest growing major end use. LCTP can help control the increasing energy use and costs of transportation by ensuring that planners and citizens consider all transportation options (including demand side measures and options that require less energy) and by ensuring that the full costs and impacts of transportation decision making are considered when decisions are made. As a result, LCTP will lead to significant progress toward a number of Vermont's energy goals, including sustainability, environmental soundness, affordability, and economic vitality. LCTP may be the most effective single action Vermont could take to achieve its energy goals.

Since least cost planning grew out of energy planning, the similarities and differences between energy and transportation planning are discussed first. Next, the six characteristics and advantages of LCTP already mentioned are discussed in greater detail; then, the specific methodology of LCTP is explained. Finally, after having fleshed out the most important components of LCTP, the process is compared to Vermont's current transportation planning process.

Energy, Transportation, and Least Cost Planning

Least cost planning was developed by electric energy planners seeking the most cost-effective means of meeting electric energy needs. It is useful in overcoming two obstacles that limit the ability of market mechanisms to appropriately allocate resources in the best interests of society: the natural monopolies in the electric utility industry and the fact that users do not pay the full costs of energy use. Transportation planners confront similar difficulties. The state has monopoly-like control over the roadways and many of the costs of transportation are not borne by the users. Transportation planners, like energy planners, need a tool and method that will overcome these difficulties and allocate transportation resources in society's best interest.

Both energy and transportation planning require more comprehensive and rigorous accounting methods than have traditionally been used. The current transportation planning and accounting framework, as that used in earlier energy planning, does not take into account all the costs incurred by Vermonters and Vermont businesses that result from its decisions. LCIP and LCTP strive to include all costs in their analysis. Minimizing all costs ensures that energy and transportation decisions are truly cost-effective. (The benefits of full cost and life cycle accounting are discussed below.)

Both energy and transportation planning are charged with providing a service that is not consumed for its own

sake, but is a means to achieving other ends. Energy provides heat, light, etc.; transportation provides access to work, friends, or commodities. What is most important is that people are able to engage in the end uses. In the past, however, both energy and transportation planning have been biased toward building costly new supply and capacity. They were not able to fairly compare conservation and efficiency measures with supply measures, even when the conservation and efficiency measures could provide the energy or transportation services much more cheaply. LCIP is concerned with providing energy services and not just electricity, and LCTP is concerned with providing access or transportation services and not just roadways and pavement (Nelson, 1994, 12). Least cost planning treats new capacity (*e.g.*, power plants and roads) on a par with other ways to meet energy and transportation needs.

Both energy and transportation planning involve substantial long term investments that must be made in the face of uncertainty about the future. Energy planners must, therefore, take into account the life cycle costs of investments and uncertainty about future energy costs, population and economic growth, future efficiencies, and possible changes to environmental protection laws. Partially as a result of earlier assumptions proving wrong, energy planners have developed tests for the "robustness" of options. Options are tested in a number of scenarios (for example, high and low fuel prices, strong and weak economies, fast and slow population growth) to find the options that, while perhaps not the best under every scenario, are the best given the uncertainties as to which scenario will actually occur. Transportation planners must deal with similar uncertainties, including future development and land use, population and economic changes, as well as changes in energy prices and environmental regulation.

Both energy and transportation planning commit the public to substantial costs and have large impacts on well-being. Public participation and support, therefore, are critical. LCIP and LCTP can increase public participation. (See the Increasing Public Participation and Choice section below for more details.)

The most significant difference between least cost energy and transportation planning is that the former is to a large extent concerned with publicly-regulated utilities; the latter, with publicly-owned roadways and facilities. This difference necessitates some differences between LCIP and LCTP. LCIP, for example, provides, uses, and measures its costs in terms of a very specific unit, a kWh. LCTP, on the other hand, must deal with many transportation modes and the fact that some people love their particular mode of travel. A kWh produced is the same as a kWh saved, but not all "trips" are equal. These differences make the LCTP process more complicated than the LCIP process. More modes, more benefits, and more costs must be considered (Nelson, 1994, 42-3). In addition, transportation decisions are more decentralized, with more decisions being made by individuals than in the case of electric energy planning. Therefore, LCTP must rely more heavily on pricing and market mechanisms, although LCIP is also moving in that direction.

Energy and transportation planning have more similarities than differences, and the differences do not result in significant differences between LCIP and LCTP. The goals, planning methods, and cost-effectiveness analysis are basically the same. The next sections focus on LCTP, exploring important characteristics and benefits of the planning process.

Shifting the Focus to Access

LCTP focuses on providing individuals and businesses access to people, goods, services, information, and activities. Understanding "access" is the key to understanding LCTP. "Access" is a new term to transportation planning introduced by least cost transportation planning, replacing the concept of mobility in current transportation planning (Nelson, 1994, 12). Mobility allows persons or goods to overcome the distances separating them from desired objectives or destinations by movement or travel (for example, driving to the grocery store to purchase groceries or driving across town to talk with a friend). Access is a broader term that recognizes that individuals need not travel or move to achieve some objectives (for example, talking with friends on the telephone can achieve the desired results in some instances). The term access includes the idea of mobility but adds the recognition that distance can be overcome in more ways than movement. Instead of moving the person to the destination, the destination (for example, a grocery store or workplace) can be

located nearby, cutting down on the need for mobility, or telecommunications can in some cases substitute for mobility.

Using the term access is a recognition that there is no necessary connection between growth in numbers of vehicle trips or growth in vehicle miles traveled (VMT) and economic vitality or human well-being. For LCTP, mobility, non-mobility, or reduced mobility options are considered when they can provide the same access or accomplish the same goal, such as doing the shopping or getting to work. The specific goals or end uses of transportation are what is important. What counts is access to goods, services, and activities.

Focusing on access does not mean, however, that citizens find all modes of access or transportation equal. Some modes are preferred for the advantages they offer. For example, a personal automobile often provides more flexibility and requires less time than mass transit or carpooling. LCTP recognizes and accounts for these preferences and time considerations.

There is another very great advantage to shifting the focus of transportation planning to access. Access and transportation are needs every Vermonter has. Yet, those who are elderly, young, disabled, unable to afford a car, bicyclists, or pedestrians are not well-served by transportation planning methods that concentrate on the automobile. In Vermont, more than 25% of the population does not have a driver's license. These persons, the largest group of whom are not yet of driving age, are dependent on others for automobile transportation (U.S. DOT, 1994, III-8). Furthermore, 16,854 Vermont households or about 8% have no automobile (U.S. Bureau of the Census, 1993, 1). Focusing on meeting the access needs of all Vermonters, while increasing options for everyone, increases the options for these people even more.

Access must be measured and quantified so that competing options or measures can be judged by how well they meet our access needs. This poses several challenges for LCTP. Access is more difficult to measure than mobility because it is achieved in part by reduced or non-mobility means (such as "virtual" trips made possible by telecommunications or land use planning). The typical measures of mobility such as the number of trips, number of vehicles on the road, Level of Service, vehicle miles traveled, personal miles traveled, vehicle speed in congested areas, or number of parking spaces, are fairly easy to measure, but they do not include and cannot be easily compared to the measures of virtual trips such as phone calls, electronic or computer access, and trips reduced or eliminated by land use planning.[xiv]

Because of the difficulty of determining a single measure and the complexity of transportation decisions, least cost transportation planners have concluded that no single criterion (vehicle miles traveled, personal miles traveled, or number of trips) can be used to measure access (Nelson, 1995, *Least Cost Planning*, 6). Rather, access must be measured in very site- specific ways, often employing a set of measures to quantify access, depending on the specific problems that need to be overcome.

Considering a Broader Scope of Transportation Options

Nationally and in Vermont, transportation planners have shifted their focus from meeting the increasing demand for mobility with a greater supply of roads to meeting the increasing demand for mobility with an

integrated transportation network that includes many modes of transportation. This multi-modal planning model, integrating pedestrian, bike, car, bus, truck, rail, water, and air transportation is emphasized in *Vermont's Long Range Transportation Plan*.

Substituting access for mobility further broadens the scope of transportation options considered. The bias toward roads found in traditional planning methods, and the bias toward mobility in more modern transportation planning is replaced with a bias toward creating access to those people, goods, services, information, or activities we are seeking. Demand side measures, telecommunications, and land use planning

can be used to meet our access needs and are considered viable transportation options by LCTP.

One way LCTP broadens options is that it recognizes kinds of transportation capacity and options that traditional transportation planning often omits. Where a roadway is at or near capacity, it is often crowded with vehicles containing several empty seats. On Vermont's U.S. Route 7, for example, there is an average 2.4 empty seats per vehicle.[xv] Also, roadways are rarely at capacity throughout the day, but rather only at peak periods such as rush hour. Demand side measures (such as using incentives for car/vanpooling, ride sharing, public transportation, or staggered work shifts) can take advantage of the unused capacity and may be cheaper than expanding roadways.

Other examples of options or measures considered in LCTP are given in Table 4.II.1. Measures will fall within one (or possibly more) of the categories listed. The examples within each category are meant to be demonstrative and not exhaustive.

One important energy impact of the broader scope of options is the diversification of transportation fuels. Transportation is almost 100% dependent on petroleum, a non-renewable energy source. Almost every other end use of energy has a larger share of renewable energy sources. Wood accounts for a large percentage of Vermont's heating needs. Wood and hydro account for a large percentage of Vermont's electricity needs. The overdependence of the transportation sector on only one fuel is dangerous from a national security and energy security standpoint. LCTP could help to diversify our transportation mix by adding conservation and efficiency measures to the "modes" of access/transportation. Conservation measures cannot be taken away by foreign embargoes and are not subject to disruptive price fluctuations, and therefore, they greatly increase our security.

Employing Life Cycle, Full Cost Accounting

The shift in focus to access ensures that more options are considered, but not all those options are equally cost-effective. Traditional transportation accounting methods consider only the direct public investment. Changing this approach will be a challenge, but using life cycle full cost accounting will enable the state to make decisions that move us toward a sounder future that balances sustainable development and long term growth. Each transportation decision, however, commits Vermont to future energy use and future costs related to that energy use that are much greater than the initial public investment. For example, in 1992, Vermonters spent about $124 million on road construction and reconstruction (U.S. DOT, 1994, IV-10) and about $288 million on fuel, not including federal or state fuel taxes (Vt. DPS, *Vt. Fuel Price Report*). If the fuel costs included external costs, the cost of fuel would be many times more than the capital investment. LCTP, on the other hand, seeks to include all costs, including public investment in infrastructure and public transportation, private investment in automobiles and other vehicles, fuel costs, external costs related to emissions, and non-monetized costs such as the time of travel. For LCTP, an option is cost-effective if it provides for access/transportation needs at the lowest total cost to society, not just the lowest initial public investment.

Table 4.II.1 Classification of Transportation Measures to Achieve Access

Category	Definition	Examples of measures
New Capacity/Supply	Measures that require expanding the current transportation system	New roads By-passes Wider roads Limited access roads New or larger parking lots
Repair and Maintenance	Measures that maintain the current transportation system	Resurfacing Snow plowing Street sweeping Pothole filling Crack sealing
System Management	Measures that make minor changes to the current system to increase benefits or decrease costs	Traffic re-routing One-way streets Timed signal lights Congestion pricing Parking pricing and policy
Efficiency	Measures that provide similar or increased mobility using fewer resources than currently used	Buses Commuter, light, and conventional rail Park-and-Ride lots Carpooling High occupancy vehicle lanes Bikeways CAFE standards
Conservation	Measures that reduce or eliminate the need for transportation	Integrated communities Land-use planning Telecommuting
Other Government Policies	Measures taken by national, state, or local governments that impact transportation or access	Speed limits Fuel, carbon, and energy taxes Safety standards Air quality standards Telecommunications regulations Public education Congestion, construction, and accident information
Private Sector	Measures taken by businesses and organizations that impact transportation or access	Car/vanpools Parking lots Parking policy Vehicle purchases Flexible work schedules Staggered work shifts
Consumer	Measures taken by consumers that impact transportation or access	Car/vanpools Vehicle purchases Transportation mode choices Lifestyle choices Location of residence

Source: Vt DPS

4– There are many costs of transportation that are not included in the price of transportation. Several studies have found that nationally, about $300-$590 billion per year in transportation costs are not borne directly by the user of the service (Apogee Research, 1994, 31-3). This undercollection equates to more than $1,000 per person per year, even with most of the infrastructure already in place (Brown, 1994, 88).

There are two dangers in not considering all costs and benefits. First, minimizing only public infrastructure investment costs in transportation planning results in the inefficient use of limited resources. Second, present and future generations are likely to suffer greater environmental and economic consequences than the present generation "saves" by not including full costs. It can be cheaper (and better) to prevent damage (environmental and other types) than to try to remedy damage after it has occurred. Transportation options should be evaluated at their full cost so all Vermonters later on do not have to bear even greater costs.

The most effective way to ensure that the full costs of transportation are considered by decision makers, citizens, and businesses is to ensure that the full costs of transportation are included in the price of transportation. When the price reflects the full costs, the market usually accomplishes this aspect of LCTP. Therefore, internalizing external costs in the price of fuels, removing subsidies to petroleum fuel use such as the foreign investment tax credit, and removing local property tax subsidies to transportation are important aspects of LCTP. (Also see Chapter 4, Section II. Strategy E: Internalize Costs of Transportation More Fully through Transportation Energy Taxation and associated policies.)

In addition to considering all the costs of a transportation choice, it is important to consider costs over the entire lifetime of that choice (called life cycle costs). Sometimes the most cost-effective options, ones that require greater initial investment but have lower operational and total costs, are passed over in favor of more costly options because they require less initial investment. Options that appear cheaper in short time frames are often very expensive when the entire life of the measure is considered.

Life cycle costs and benefits often extend beyond the planning time frame. For example, the Vt. Agency of Transportation uses a 20-year planning time frame but Vermonters often use roads or cross bridges that are more than 20 years-old. Given the long time between planning and completion of transportation options and the fact the costs and benefits often extend beyond the typical 20-year planning time frame, a 30-year period might be more appropriate. In either case, to adequately account for those costs and benefits that occur beyond the planning time frame, they should be properly included.

Balancing high up-front costs with benefits that are spread out many years into the future requires that both be expressed in equivalent terms, usually as a net present value. To determine the net present value, future costs and benefits must be discounted to reflect time preferences (that we would rather have a certain benefit now than later, other things being equal). The cost of capital, currently about 8.5% to large borrowers, is often used as the discount rate. While this may adequately reflect the time preferences of individual investors, major transportation investments are made by society and affect resources held in common by society. Society has longer term interests than individuals. Moreover, natural resources that help to sustain and enrich life, such as biological diversity or clean air and water are no less valuable to future generations than they are to the present generation. There is little justification for discounting biological resources given their importance and the long term effects of such damage (NARUC, 1992, 263). A real social discount rate of 2% to 3% better reflects the time preference of society, helps avoid understating the value of resources to future generations, and better protects the interests of future generations than a discount rate set at the cost of capital. In addition, strong limits on non-sustainable use of resources are needed in cases where biological resources are degraded.

The relevant costs considered by LCTP when evaluating transportation options include the cost of planning, building, maintaining, operating, and decommissioning transportation facilities (such as roadways, bike routes, parking lots, bus lines, and railways); expenses related to public education and the administration and implementation of demand side measures; public and private expenses for the purchase and maintenance of vehicles, fuel, insurance, and parking; travel time costs and preference costs (such as the value of access to a car or low-density housing); police, fire, and emergency expenses related to each transportation option; the uninsured costs of accidents, including property damage, medical costs, and lost wages; national defense costs for the protection of oil sources and the cost of the strategic petroleum reserve; external costs related to fuel

One of the greatest innovations of LCTP is that it explicitly recognizes the relationship between various land uses and transportation costs. Transportation prices, which are well below their full costs, encourage more dispersed land uses. This results in greater energy use and higher total transportation costs. LCTP seeks to address both issues, by internalizing more of the full costs of energy use in the price and by encouraging land use patterns that have lower full costs.

emissions, damage to human health, water, air, the environment, wildlife, and the depletion of non-renewable resources; the costs of "free parking" (such as land, construction and maintenance); community disruption from traffic and construction, and aesthetic damage; and costs related to the lack of accessibility for young, elderly, low income, or disabled persons. By ignoring any of these costs we risk choosing transportation options that are more costly than they need be.[xvi]

As with LCIP, it is difficult to quantify all the relevant impacts. Precise values for environmental and aesthetic impacts, lives lost in accidents, and preferences are difficult to determine. Least cost planning and benefit-cost analysis are often criticized on the grounds that it is impossible to quantify all impacts or appropriately value life. While this criticism is quite true, the alternatives are even less desirable. It is better to value these costs or benefits imperfectly than irrationally or not at all. In cases where it is difficult to achieve consensus about the appropriate values, there are two solutions:

- quantify as many costs and benefits as possible; then non-quantifiable values can be detailed and valued more subjectively by decision makers; or
- set minimum standards or criteria to protect unquantified values and minimize the costs after those standards are met.

One of the estimates for U.S. highway costs not recovered directly from users is presented in Table 4.II.2.

Table 4.II.2 Estimates of U.S. Highway Costs not Recovered Directly from Users in 1991

Component of Cost	Cost per Mile (cents)	Total cost ($ billions)	Percent of Total
Roadway Construction and Repair	6.61	143.5	39.1%
Roadway Maintenance	0.94	20.4	5.6%
Related Services (Police, etc.)	0.68	14.7	4.0%
Parking	2.44	53.1	14.5%
Pollution	3.19	69.3	18.9%
Accidents	0.66	14.4	3.9%
Fuel and Oil	0.62	13.4	3.7%
Social Overhead (Foregone Taxes)	1.75	38.1	10.3%
Total Costs	16.9	366.9	100.0%
Current User Revenues	(2.4)	(52.1)	
Cost Unrecovered Directly From Users	14.5	314.8	

Source: Lee (1994), with minor modifications by ECONorthwest (1995), *Least-Cost Planning*, B-4.

When considering a transportation project, a bypass or interchange for example, planners would quantify the benefits compared to a no action base case, including reduced travel times, traffic, noise, congestion, and accidents. The costs considered would include the cost of planning, building, and maintaining the interchange, as well as the construction travel delay costs. In addition, energy and external costs may increase or decrease with the project, and would be considered accordingly.

LCTP can also highlight the conditions under which public financial support is appropriate for transportation investments (Sheets, 1994, 14). Ideally, prices would reflect full costs and the marketplace determines the appropriate mix of transportation options. Public funding may be appropriate when, for political, economic, or technical reasons, the private costs or prices for the dominant modes of transportation do not reflect the full cost of transportation or when other barriers to market acceptance exist. In such cases, funding for alternatives that have lower full costs may encourage people to shift from the modes with higher full costs. Conversely, public funding is inappropriate when it lowers the price of options with higher full costs.

Figure 4.II.1 shows a hypothetical example of two transportation alternatives. The first bar represents the costs of an existing service (the service could be provided by a roadway corridor, parking lot, or other transportation facility). It has low private costs, making it attractive to users, but high public costs

The authors report that internalizing the $315 billion cost to society would require a $3/gal. increase in the cost of fuel to cover the full cost of transportation. A similar thorough study in Vermont would be very valuable. (See policy recommendations below.) Even without quantifying all the costs related to police and emergency services, parking, pollution, and accidents in Vermont, some general conclusions can be drawn.

- State and federal user taxes and fees cover only 67% of the highway construction and maintenance costs in Vermont. Local property taxes subsidized highway costs to the amount of $264 million between 1988 and 1992. This is 25% of highway revenue over that same period, only slightly less than state user fees. (See Table 4.II.3).

- A study by the Governor's Highway Safety Program found that accidents cost Vermont and Vermonters $239.5 million in 1993, and $184.3 million in 1994, when there was a significant drop in injuries from accidents (*1993-1994 Crash Cost*, 2). Accident related costs total $0.03 per mile of travel in Vermont. Many of these costs, including lost wages and productivity as well as emergency services are not covered by insurance.

- Air pollution costs measured using externality adders developed and advocated by state electric energy regulators and planners were estimated to be $471 million in 1995. Each of these costs, not recovered from the users of transportation, is a source of market inefficiency. Drivers react to underpricing by driving more than they would if they paid the full costs. The underpricing of transportation leads to more and inefficient energy use than otherwise would occur if drivers paid the full costs.

Table 4.II.3 1988-1992 Revenue for Vermont Highway Expenditures
Millions of Dollars

Year	Property Tax	General Fund	State Gas and Diesel Tax	State User Fees[a]	Federal User Fees	Total Funds[b]
5 Year Total	263.55	30.48	247.66	264.92	201.68	1072.19
% of Total Expenditure	25%	3%	23%	25%	19%	

[a] State user fees include state fees other than the gas and diesel tax, such as registration fees.

(such as public funding and external costs related to air emissions) that are not reflected in the price users pay. The alternative, Option 1, shown as the second bar, has higher private costs or prices, but has lower total costs.

Faced with these alternatives most drivers would choose the existing service, which has lower direct costs to them but greater costs to society. Since this is not the least costly option, LCTP would favor Option 1 represented by the second bar. To decrease total costs, ideally, LCTP would seek to remove any public funding of the existing service and internalize the external public costs in the price of the service as shown in the third and fourth bars. If this were to occur, consumers would likely choose the least costly option.

If, for some reason, removing funding and internalizing costs of the existing service is not possible, public funding for Option 1 is justified if, by lowering the private costs, it encourages or leads to the use of the least costly option. Figure 4.II.2 shows the same existing service considered in Figure 4.II.1. In this case, funding that lowers private costs for Option 1 is justified because it leads to reduced total costs. By contrast, public funding for the existing service encourages uneconomical choices due to its higher full costs, and therefore public funding is not justified. Figure 4.II.3 shows a second option to the existing service. In this example, market barriers other than cost, such as unfamiliarity, habit, or lack of availability are limiting the use of the least costly option. Public funding and support for demonstration projects, public education, etc. may again be justified if they encourage the use of the least costly option, as shown in the third bar.

In all cases, public funding is justified only if it helps to reduce the total costs by encouraging the use of the less costly option. Recognizing all public and private costs is an important first step in determining when funding is cost-effective.

[b] There are other minor sources of funding so the total is not just the total of property tax, general fund, state user fees, and federal user fees.

Source: Compiled from U.S. DOT, *Highway Statistics*, 1985-1993, Table HF-1; Vt. AOT Tax Reports

Assessing the Cost-Effectiveness of Transportation Options

The goal of LCTP is to analyze the broadest range of access/transportation options possible in a comprehensive and consistent manner, so planners and citizens can meet access needs at the lowest life cycle full cost to society.

The cost-effectiveness analysis employed by LCTP is somewhat complicated in practice but conceptually quite easy to understand. It involves setting a standard of performance that must be met and selecting the option or package of options that minimizes the net social costs of meeting that standard (or, in cases where the standard is net consumer utility, maximizing the net social benefits). Since it is probably impossible to implement all cost-effective options at once, these options should be ranked so that the most cost-effective ones could be implemented first.

Several approaches can be taken in defining the standard of performance. As in traditional benefit-cost analysis, the standard can be net social benefit. Given the complicated nature of transportation decisions and the difficulty of maximizing benefits and minimizing costs of very different transportation options, LCTP can be simplified in some cases by setting a standard for the desired level of access and minimizing the net social costs of meeting that standard. The standard can be a composite of several criteria. These could include trips, personal miles traveled, vehicle miles traveled, parking spaces, environmental and safety standards, and the level of service criteria currently employed by transportation planners.

Care should be taken when setting a standard. In some cases, a standard might not represent the least cost solution. Standards are best used in cases when there are unpriced costs (for example, perhaps environmental or safety costs) that are not adequately reflected in the benefit-cost analysis or when the smallsize of a project and limited resources require that LCTP be applied in a scaled-back manner.

LCTP can also be used to best allocate a finite amount of public funds and resources. Given today's tight financial constraints and limited transportation budgets, it is quite possible that least cost transportation planning would be used in this way. The least cost planning process could highlight options that have the greatest net benefit. The standard in this case is the most effective use of limited funds.

There are also risks in using LCTP to allocate a limited budget. One is that not all the options that have more benefits than costs will be implemented because some of those costs are likely greater than the budget. Net social benefit is not maximized in this scenario, only net social benefit given the budgetary constraints. The second risk is that there is a temptation to implement options with a high benefit-cost ratio that may not reflect the most socially beneficial mix of options.

Using performance standards, while not the ideal use of the least cost planning process, may reflect the technical, economic, and political realities that planners may face. In any of the approaches described above, the advantages of considering a broader scope of options, including energy and other costs and impacts in transportation decisions, and focusing on minimizing life cycle full costs are preserved. What may be sacrificed by simplifying the process is the rigorousness of the test for cost-effectiveness. Even in the worst case, LCTP still provides planners with more options and more information about the cost of projects than traditional planning methods.

No matter how cost-effectiveness is determined, it is important to remember that LCTP is a planning tool and not the ultimate decision maker. Not all transportation options will or should be made solely on the basis of cost-effectiveness, because transportation decisions are inherently value-laden. Transportation decisions shape and modify behavior; the results of these decisions affect the quality of life of citizens and the quality of the environment. Transportation planning involves the allocation of large amounts of public money, and in many cases, the taking of private land for public purposes. Moreover, no planning method can claim to produce the best solution in all cases, especially when precise cost evaluations are not possible. The LCTP methodology does account for more costs and options than any other planning method, and it allows comparisons that are as unbiased as possible. This is valuable whether or not the least cost option is chosen. Society may, with good reason, decide sometimes not to employ the least costly options. In such cases, LCTP has not failed as long as it has highlighted the benefits and costs of the options.

Increasing Public Participation and Choice

Transportation decisions should be made by the public or its representatives and by the choices and preferences of individuals acting in the marketplace. Good decisions, however, require good information. Good information requires knowing the possible options and the total costs of various options. LCTP is the only transportation planning tool currently available that can adequately accomplish this task. Other planning methods do not include such a broad range of options or such comprehensive consideration of costs.

In addition to giving citizens better information about the costs and impacts of transportation options, and traditional transportation planning include public hearings as well as local and regional input in the planning process. LCTP moves beyond that process in three ways.

- LCTP provides a clear framework to compare consistently and fairly very diverse access/transportation options, so participation can be more constructive and broader based. This is

particularly important when a community or decision making body becomes polarized by an issue to the point that constructive dialogue breaks down (Puget Sound Regional Council, 1995, 2 and Nelson, 1994, 4). In such cases, LCTP provides an unbiased framework to further discussion. LCTP encourages citizens to participate more fully in the transportation decision making process. Both

- LCTP results in more options being considered in the planning process from which citizens and their representatives can choose, and it also results in more access/transportation options for the public.

- With more options available to the public and with the full costs of those options more accurately reflected in the price, LCTP relies on citizens to determine how much they value each mode of access/transportation and to choose from the increased number of options the ones that will meet their needs.

Citizens are free to participate or not in programs designed to lower the full cost of transportation (such as in programs that provide incentives for carpooling). If they choose not to participate, all that is asked of them is that they pay the full cost of their choices and not expect the public or others to subsidize costs for modes of transportation with the greater life cycle full costs. (See the above section Assessing the Cost-Effectiveness of Transportation Options.)

Figure 4.II.1 Public and Private Costs of Transportation Alternatives

Figure 4.II.2 Public and Private Costs When Unable to Remove Public Funding

Figure 4.II.3 Public and Private Costs When Facing Market Barriers

Versatility in the Planning Process

One of the greatest advantages of LCTP is its versatility. It can be applied to any size problem or project, from exploring municipal parking problems to congestion in a city center to traffic along a major corridor to statewide planning. It can also be applied with varying degrees of sophistication, depending on the scale of the project and the planning resources available. In addition, demand side measures are more versatile because they can be employed incrementally or discontinued so as to respond to changing transportation conditions. New supply options such as road construction or road widening are large projects and, being inherently "lumpy," never quite match the demand, resulting in periods of congestion if the construction is done too late, or under use if the construction is done too soon (Burrington, 4).

LCTP Methodology

LCTP methodology includes the following steps. Public participation is not mentioned as a separate step but is an integral part of steps 1, 6, and 10.

Step 1: Determine the scope of the project and how LCTP will be used.

The first step is to determine the scope of the project (the area and time covered by the planning process) and then to determine how LCTP will be used. LCTP can be used:

- to maximize the net social benefit of the access/transportation system;
- to minimize the costs of meeting specific criteria or standards; or
- to most efficiently spend a limited amount of transportation funds. These are not necessarily mutually exclusive approaches.

For example there are many standards that must be met, including safety standards and design specifications that act as the floor or minimum requirements in the first approach. The difference is whether the requirements are seen as a minimum acceptable level or the goal to be achieved.

Step 2: Inventory existing facilities and forecast future demand using economic and demographic projections.

Step 3: Specify a standard of performance or criteria of access to be met by access/transportation options.

Step 4: Create a "no action" base case cost forecast to serve as a basis of comparison for various options.

This base case represents the costs of a business-as-usual approach to the transportation problem studied. Its life cycle full cost is calculated (taking into account all relevant costs mentioned above) and converted into a discounted present value, adjusted for inflation and society's time value of money. Care should be taken, however, not to discount the value of biological resources such as clean air, land, and water because future generations will find resources that sustain life no less valuable than we do today.

Step 5: Identify deficiencies in the current transportation system and the date or time frame when future deficiencies might occur. Also, identify inefficient use of resources and costs not borne by users of the current system.

Deficiencies, inefficiencies, and external costs are red flags for planners. Transportation planners have always been concerned about current or future deficiencies. To this list LCTP adds concern for inefficiencies and external costs because they may represent the inefficient use of transportation monies. Awareness of possible problem areas will help in the next step of the LCTP process.

Step 6: Assemble a list of potential measures capable of meeting the standard of performance, rectifying the

inefficiencies, or reducing the full costs.

The list of options should include not only currently available options but all options that are likely to be available during the planning time frame considered.

Step 7: Calculate the societal costs and benefits of each measure as in the no action base case.

Step 8: Test for robustness.

The cost calculations in Step 7 should be undertaken using several scenarios to account for uncertainties involving construction, operation, and maintenance costs, as well as fuel economic growth, population, fuel prices, discount rates, etc. Testing for robustness usually leads to a diversified portfolio of supply and demand side options that minimizes the risk from changes to fuel prices or supply, population, or the economy.

Step 9: Rank the measures in order of declining marginal net social benefit or increasing life cycle full costs, taking into account variations in performance due to future uncertainties.

Step 10: Choose the package of options that is most cost-effective depending on the LCTP approach chosen in Step 1. Then implement the package of options starting with the most cost-effective.

Transportation planning is more difficult than just forecasting demand and then meeting that demand with one or more of the options enumerated in Step 6. Each measure affects the transportation system in complex ways. Calculating the feedbacks and implications of each measure is very important. For instance, I-89 not only met a projected demand, it impacted land use, stimulating development along the interstate, and thereby created further demand. If such related impacts are not included in the process, the accuracy of LCTP evaluations will be affected. The LCTP process must be repeated often enough to account for changes that occur.

Vermont's Current Transportation Planning Process

Understanding Vermont's transportation planning process will show how LCTP differs from it, and how LCTP can be incorporated within Vermont's planning process.

In Vermont, transportation planning is conducted by the Vermont Agency of Transportation's (AOT) Planning Division. Their authorization derives from state statute which states:

> (a) The Agency [of Transportation] shall be the responsible agency of the state for the development of transportation policy. It shall develop a mission statement to reflect state transportation policy encompassing all modes of transportation, the need for transportation projects that will improve the state's economic infrastructure, as well as the use of resources in efficient, coordinated, cost-effective, and environmentally sound ways.
> (b) Transportation projects shall be designed to provide safe and efficient transportation and to promote economic opportunities for Vermonters and the best use of the state's natural resources, consistent with the planning goals listed in 24 V.S.A., section 4302 as amended by Act 200 of the Acts of 1988 (1987 Adjourned Session) and with appropriate consideration to local, regional and state agency plans (19 V.S.A. §10b).

AOT's mission statement nicely sums up the major criteria used in transportation planning:

> The Agency's Mission is to work cooperatively to anticipate and meet the need for the movement of people and goods in a safe, cost-effective, environmentally sensitive and timely manner (Vt. AOT, 1995, *Vermont's Long Range Transportation Plan*, vii).

The mission statement is not inconsistent with LCTP methodology. There are, however, significant differences, such as the emphasis on movement instead of access and a different definition of the term cost-effective. To understand differences between Vermont's current transportation planning process and LCTP, it is helpful to compare Vermont's planning guidelines with those of LCTP detailed above. The following statute (19 V.S.A. §10i) defines Vermont's current transportation planning process:

> **§10i. Transportation planning process**
>
> (a) **Long-Range systems plan.** The agency shall establish and implement a planning process through the adoption of a long-range multi-modal systems plan integrating all modes of transportation. The long-range multi-modal systems plan shall be based upon agency transportation policy developed under section 10b of this title, other policies approved by the legislature, agency goals, mission and objectives, and demographic and travel forecasts, design standards, performance criteria and funding availability. The long-range systems plan shall be developed with participation of the public, local and regional governmental entities, and pursuant to the planning goals and processes set forth in Act 200 of the Acts of 1988.
>
> (b) **Corridor studies.** The agency shall develop corridor studies for the highway mode identifying environmental issues, community concerns and travel projection. For each corridor, problems shall be identified and ranked according to their criticality and severity.
>
> (c) **Project identification and scope.** The agency shall identify and develop specific projects pursuant to corridor studies. For each project, a project scope shall be prepared to identify the problem to be resolved by the project, the preferred alternative, project limits, its conceptual design and estimated costs. The projects developed according to corridor studies shall be placed in one of the following four program categories:
>
> (1) System preservation: maintenance of the physical integrity of the existing state transportation system, including the upgrade of design for safety and operational reasons.
>
> (2) System management: improvements in the movement of people and goods along existing corridors through minor investment and minimal impact or right-of-way acquisition.
>
> (3) New capacity: expansion of capacity through the addition of through lanes; construction on new alignment or new interchanges or ramps.
>
> (4) Local aid: provision of projects and enhancement of local transportation networks.
>
> (d) **Project priorities.** Priorities for projects in each program category established under subsection (c) of this section shall be established based upon selection criteria adopted by the agency.
>
> (e) **Information manual.** An information manual giving a clear description of the planning process shall be prepared for town officials and the public.

There are three major differences between Vermont's transportation planning and LCTP.

1) Vermont's planning process is basically a *demand-driven supply planning* process. LCTP, on the other hand, considers supply measures equally with demand management measures. AOT, with public input and the input of local and regional planners, anticipates (projects) the need or demand for transportation and then builds infrastructure for transportation modes to meet that demand. The agency is not required to consider non-mobility and reduced mobility options (except to the extent that federal monies under ISTEA require some consideration of these). Vermont's transportation project categories in 19 V.S.A. §10i contain no category for, nor mention of, demand side measures.

2) The goal of transportation planning in Vermont is to increase mobility, not access, as would be the

case in LCTP. Recently, AOT has become increasingly aware of the value of multi-modal transportation as evidenced by the issuance of *Vermont's Long Range Transportation Plan* in the fall of 1995 and its support for the Amtrak Vermonter and Charlotte-to-Burlington commuter rail, but AOT's emphasis on "multi-modal" does not extend to non-mobility modes of meeting Vermont's access needs.

3) Vermont's transportation planning framework does not take into account as broad a range of costs when determining cost-effectiveness as LCTP. Life cycle, full costs are not taken into account as in LCTP. In most transportation planning, including Vermont's, the cost-effectiveness of a project is determined by the judgment of experienced transportation planners and not through an explicit benefit-cost analysis process. Furthermore, planning efforts usually focus on the level of service and design standards instead of whether the benefits of meeting those standards are greater than the costs. Finally, no attempt is made to quantify the full costs such as out-of-pocket expenses of users, emergency and law enforcement costs, and environmental costs.

Each of the three differences is vitally important for energy planning and Vermont's energy situation. The emphasis on new capacity means more energy efficient transportation options are not considered and future transportation energy needs will not be met in the most efficient and cost-effective manner. Similarly, the focus on mobility means that energy efficient non-mobility options that might require significantly less energy are not considered. The lack of life cycle, full cost analysis means that many energy costs are not taken into account in transportation planning. By not including the full energy costs in transportation planning, Vermont's transportation options will continue to use energy inefficiently and place the costs of that energy use on others.

Table 4.II.4 Comparison of Least Cost Transportation Planning and Traditional Planning

Significant Characteristics	LCTP	Traditional planning
Considers demand side options equally with supply side options	X	
Considers life cycle costs	X	
Considers full costs, including energy impacts	X	
Measures cost-effectiveness in terms of net societal benefit	X	
Includes public participation	X	X
Includes a focus on multi-modal solutions	X	X
Focuses on:	Increased access	Increased mobility

Problems to Avoid

Implementing LCTP is not enough to ensure that its energy and cost benefits are achieved. The method must be rigorously applied, and several potential problems avoided. These problems include:

- *Limited options*. A limited set of options may exclude the optimal solution, making an inferior

option appear as the best choice. The least cost analysis will select the best option from those presented, but it cannot invent options. Those must come from planners and citizens.

- *Inaccurate predictions*. Forecasts must be well thought out to ensure that opportunities are not missed or unnecessary projects are not undertaken.

- *Inaccurate costs*. The value of LCTP can be undermined by using inappropriate discount rates or by under or overvaluing external costs.

- *Double counting*. It is easy to double count benefits or neglect the costs of projects. For example, the jobs created by a construction project come with a cost that must be paid for from local, state, or federal funds that could have been put to some other use. To count the benefits without counting the costs or to count the benefits twice distorts the decision making process.

The approach to LCTP should be clear. First, a full range of options should be considered; second, prices should reflect the full costs; and third, incentives for demand side measures should be offered when the full costs cannot be internalized or when life cycle costs are not adequately considered in transportation decision. LCTP would often happen naturally if the prices reflected the full costs.

Summary

LCTP has a significant role to play in Vermont's transportation energy use. Transportation is Vermont's largest single end use of energy. Adopting LCTP is probably the greatest single action Vermont can take toward meeting its energy goals. LCTP increases the number of cost-effective energy saving options. It provides citizens and businesses with more accurate costs with which to make their transportation decisions. It recognizes and quantifies the direct relationship between land use, transportation costs, and energy use, so that these impacts can be taken into account when decisions affecting any one of them are made.

In addition to its energy benefits, LCTP will further enhance Vermont's transportation planning process. To the currently used transportation criteria (a coordinated and multi-modal approach emphasizing safety, efficiency, economic vitality, cost-effectiveness, and environmental soundness), LCTP adds concern for means other than transportation which can deliver the same benefits with lower costs. The concept of access expands upon the current movement in transportation planning from providing roads and highways to providing multi-modal mobility. LCTP continues the expansion of transportation planning considerations from "roads" to "modes" to "access." The effect of using access and not mobility is to increase the scope of options considered. Another innovation that LCTP brings is a broader concept of cost-effectiveness. It uses a societal test in which the cost to society, including direct and indirect public and private expenditures, is considered and minimized.

The following policies are important steps in considering the use of a comprehensive least cost transportation planning process. They involve adopting a LCTP strategy in Vermont, studying the full cost of transportation in the state, internalizing the full costs of transportation, and instituting a demand side parking/transportation voucher demonstration project.

1. Policy: Consider Adopting the Principles of Least Cost Transportation Planning

Vermont should consider adopting the principles of least cost transportation planning (LCTP), focusing the aim of transportation planning on meeting the needs of Vermonters for access to goods, services, and

activities, after environmental, historic preservation, and safety considerations, at the lowest present value life cycle cost, including public and private costs, through a strategy combining investments and

expenditures on new transportation capacity and comprehensive transportation demand management.

LCTP could play a significant role in Vermont's transportation energy use. Transportation is Vermont's largest single end use of energy. Adopting LCTP is probably the greatest single action Vermont can take toward meeting its energy goals. LCTP increases the number of cost-effective energy saving options. It provides citizens and businesses with more accurate costs with which to make their transportation decisions. It recognizes and quantifies the direct relationship between land use, environmental costs, transportation costs, and energy use, so that these impacts can be taken into account when decisions affecting any one of them are made.

In addition to its energy benefits, LCTP could enhance Vermont's transportation planning process. To the currently used transportation criteria (a coordinated and multi-modal approach emphasizing safety, efficiency, economic vitality, cost-effectiveness, and environmental soundness), LCTP adds concern for means other than transportation which can deliver the same benefits with lower costs. The concept of access expands upon the current movement in transportation planning from providing roads and highways to providing multi-modal mobility. LCTP continues the expansion of transportation planning considerations from "roads" to "modes" to "access." The effect of using access and not mobility is to increase the scope of options considered. Another innovation that LCTP brings is a broader concept of cost-effectiveness. It uses a societal test in which the cost to society, including direct and indirect public and private expenditures, is considered and minimized.

Compared to traditional demand-driven planning, LCTP:

- focuses on providing access, not mobility;
- considers a much larger range of transportation options;
- ensures that all costs and benefits of various transportation options are considered;
- allows planners to assess the cost-effectiveness of options;
- increases public involvement and the ability to choose transportation methods; and
- applies to any size project because of its versatility.

Impacts

This policy could not be evaluated using the computer model used in other policies. Further research will be needed to quantify the alternatives that can make up a LCTP. Nevertheless, certain results can be expected. A substantial lowering of energy use and impacts would result from the substitution of demand management for new construction when it is cost-effective. In addition, by incorporating the full cost of transportation in the price of transportation, drivers would respond by choosing conservation and efficiency in many instances.

Cost-effective demand management and internalizing the full cost of transportation would also result in a lowering of total transportation costs. The demand side measures are, by definition, employed when they are cost-effective. Incorporating the full costs in the price of transportation is better understood as a shift or transfer of costs to the users than an increase in costs. The economic impacts, therefore, would include a lowering of the total energy and transportation costs that result when options with lower full costs than those currently used are implemented.

The least cost planning method would likely require slightly more time and costs for Vt. AOT initially as it investigates more options. Costs likely would decrease over time as the agency gains experience with less expensive transportation alternatives.

Low income Vermonters are likely to experience an increased financial burden if they rely on the automobile for transportation because of the internalization of costs under LCTP. However, they may also gain more access to lower cost alternatives. Nevertheless, care should be taken to address the specific concerns of those most vulnerable to efforts to internalize the full costs of transportation. See 4.IV, the Affordability section of this chapter for more details.

2. Policy: Consider Studying the Full Cost of Transportation in Vermont

Vermont should consider studying the full cost of transportation in this state, using a multi-agency approach and with special attention given to costs not paid by users.

The study should consider all costs mentioned in the section Employing Life Cycle, Full Cost Accounting as well as who pays those costs. Those costs include the cost of planning, building, maintaining, operating, and decommissioning transportation facilities (such as roadways, bike routes, parking lots, bus lines, and railways); expenses related to public education and the administration and implementation of demand side measures; public and private expenses for the purchase and maintenance of vehicles, fuel, insurance, and parking; travel time costs and preference costs (such as the value of access to a car or low-density housing); police, fire, and emergency expenses related to each transportation option; the uninsured costs of accidents, including property damage, medical costs, and lost wages; national defense costs for the protection of oil sources and the cost of the strategic petroleum reserve; external costs related to fuel emissions, damage to human health, water, air, the environment, wildlife, and the depletion of non-renewable resources; the costs of "free parking" (such as land, construction, maintenance, and other costs), community disruption from traffic and construction, and aesthetic damage; and costs related to the lack of accessibility for young, elderly, low income, or disabled persons. There are several examples of studies for cities, states, and the whole United States that quantify such costs.[xvii]

Identifying and quantifying the costs related to transportation is a very complex undertaking that could be approached as a collaborative effort combining AOT's experience with transportation, ANR's expertise with emissions, Housing and Community Affairs' knowledge of local government units and land use planning, with DPS' experience with energy use, impacts, and external costs.

<u>Rationale</u>

The first step in trying to reduce or internalize the full costs of transportation is to understand what these costs are. Identifying and quantifying the costs related to transportation is a very complex undertaking that could be approached as a collaborative effort combining the Agencies of Transportation and Natural Resources and the Department of Public Service. No comprehensive study of the full costs of transportation has been conducted in Vermont. Such a study would provide a baseline from which reductions in costs can be measured, identifying costs that are not borne directly by users of the transportation system. By estimating how many police, fire, and emergency services are related to transportation and how much local communities spend on transportation related costs, legislators could begin to craft statutes that internalize these costs.

Impacts

A transportation cost study would not itself result in direct cost or energy savings, but would highlight where savings are possible, provide the information necessary to craft policies to take advantage of those potential savings, and detail where costs can be internalized. Such a study would probably cost about the same as a major corridor study, $200,000-$300,000.

Implementation

This policy could be initiated with legislation modifying 19 V.S.A. §10, the statute on transportation planning, directing AOT and other state agencies to periodically conduct such a study. AOT could also conduct such a study without legislative direction as part of its long range planning process.

3. Policy: Develop a Demonstration Project for Green Parking/Transportation Vouchers

Institute a green parking/transportation voucher demonstration project for state and city employees in Montpelier. After implementation, review, and modification if necessary, the program should be implemented in other areas with large state offices such as Waterbury or Burlington that can benefit from reduced congestion, fewer parking problems, and lower transportation costs.

Instead of receiving free parking, state and city employees would receive "green parking/ transportation vouchers" worth the cash value of the free parking benefit. In the case of Montpelier, the vouchers would be worth approximately $30 a month. These vouchers can be exchanged for parking privileges (which would also cost $30 per month) or exchanged for cash.[xviii] Employees who "cash out" their parking privileges could use the money to cover bus or car/vanpool expenses or keep the entire sum if they park in remote lots, bike, or walk to work.[xix]

Rationale

This policy demonstrates how least cost transportation planning principles can be applied to relatively small transportation projects. In this analysis, the green parking/transportation vouchers proposal is compared to only one new supply option, the building of a parking garage for state employees. A more thorough least cost analysis for broader applications would require considering a much broader range of options. The unique value of this and similar demonstration projects is to determine the costs and benefits associated with various alternative proposals. While Vermont has substantial experience with the traditional new supply options, it has limited experience with alternative options.

There are many places in Vermont that could benefit from a green voucher program, but two factors make Montpelier a promising site for a demonstration project: the significant parking problem and the recent proposals to build a large and expensive parking garage.

A recent study of Montpelier state, municipal, and on-street parking facilities found that they were insufficient during non-legislative times of the year and woefully inadequate during the legislative session.[xx] The *Montpelier Parking and Shuttle Study* found 955 state parking spaces used out of a total of 1,094. Most of those free spaces were in just one lot which is furthest from downtown and state offices. An occupancy level of 85% during peak periods is commonly accepted as a desirable level of peak occupancy because it allows for the smooth turnover of cars in lots and provides users with assurance that parking is generally available. State lots overall were 87% occupied, with most lots between 92% and 100% occupied. During

the legislative session, the situation is much worse, with an additional 400 cars needing to be accommodated. The city streets and parking lots, as the state lots, are often at or above 85% capacity (Ecosometrics, 1993, 15). The city has long recognized it has a parking problem, and most recently, joined with the state to study the problem.

To solve the parking problem, the state has proposed building a parking garage ranging in size from 100 to 700 spaces with capital cost alone between $8,000 and $15,000 per parking space. Without adding environmental costs and externalities, but including land costs, debt service, maintenance, and taxes (or lost taxes if it is tax exempt), a parking garage space costs about $1,270 per space per year.[xxi] In addition, there are private costs of commuting paid by those who park at such a facility. Given the average Vermont commute, and using only the variable costs of driving suggests private costs of at least $500 per space per year (see Table 4.II.20 for a breakdown of fixed and variable costs of driving).

There are options, however, that achieve the same goals as building a parking garage, but at a lower cost, allowing Vermonters to avoid the above costs. One of the most promising is the green voucher.

Green vouchers are particularly effective in reducing transportation costs, congestion, and energy use impacts because they allow drivers to consider more of the costs of commuting in their transportation choice. Nationwide, 95% of all commuters park their cars for free at work (Shoup, 1995, 14). Free parking is not free, however; someone must pay for that parking, including the cost of renting or purchasing the land, paving and maintaining the lot, as well as lighting and snow removal. Often parking spaces take up valuable land that could otherwise be used more productively. When employers pay the costs associated with "free parking," as is the case with state and city employees in Montpelier, they subsidize the use of automobiles (regardless of whether it is considered an employee benefit). Since driving to work accounts for about one-third of vehicle miles traveled (VMT), Vermont's businesses and governments are partially subsidizing about one-third of automobile travel in Vermont.

One way to remove the subsidy would be to charge drivers the full cost of parking. A typical commute of 30 miles round trip in an average car costs about $1.50 in gasoline. If parking costs of $1.50 per day ($30 per month) were added to the costs drivers pay, the variable cost of driving would double. Without raising the total societal cost of driving, transferring parking cost to drivers would send a market signal to drivers, encouraging them to use more efficient alternatives.

It seems inconceivable that businesses or government would subsidize gasoline for employee commuting, but they often pay an equal or greater amount for employee parking. To suggest that employees should give up a benefit that they enjoy in order to save energy, however, is a sure way to alienate commuters and give energy efficiency a bad name.

There is a another alternative, which this policy recommends. There are occasions when it is cheaper for employers who pay parking costs to give employees the cash value of their fringe benefit and allow them to choose whether the parking space is more valuable than the cash. This choice may appeal to state workers in Montpelier.

Case studies suggest that given sufficient parking problems and expenses, and when drivers pay for parking, either directly or with vouchers, parking needs are reduced by 23% (Shoup, 1995, 18).[xxii] If similar results could be achieved in Montpelier, the state could free 220 parking spots. This would greatly reduce or eliminate the need for a parking garage.

One of the greatest advantages of this proposal is the flexibility it offers. Incentives can be changed to reflect changing parking needs. For example, the $30 per month voucher figure could be raised or lowered to achieve the optimal use of existing lots.[xxiii] Extra incentives during the legislative session could be used to

meet the demand for additional parking at that time. And, in the future, if the time ever came when building a parking garage became the cheapest solution using least cost analysis, the garage could still be built.

Now, however, a parking garage is not necessary. Instead of spending the money for a garage, a fraction of the money required to build a garage can be paid to state employees who help solve the parking problem. The only change for most state and city employees (probably 50-80%) as a result of this policy is that finding a parking space will be easier. Most employees will opt to trade their green voucher in for a parking space. Some employees will join together in carpools, using one of their vouchers for parking and splitting the others worth $30 each among themselves. Other employees will walk, bike, or use remote parking lots which would not require a voucher. These people will receive $30 for their part in reducing the parking and congestion problems. The program will likely cost the state and city $40 per month per parking space gained in this program ($480 per space per year). The cost is slightly higher than the $30 per voucher "cashed out," because not every voucher that is redeemed represents a parking space gained. Some people already carpool, walk, or bike, and therefore do not free an additional parking space. Also, small administration costs such as issuing vouchers, cashing vouchers, and enforcement are necessary. The $480 cost, however, compares favorably to the 30 year life cycle costs of a parking garage of $1,270 per space per year.

Federal ISTEA transportation funds meant to encourage alternative modes of travel could potentially be used to fund 80% of the cost of this project for the first five years. However, this policy makes sense with or without federal assistance. Federal contributions, as state and city ones, come from taxpayers. The state and city should pursue this option, but achieving federal funding is not a prerequisite for success. In addition, introducing this kind of change in what is viewed as an established employee benefit for state employees will have to be reviewed through the collective bargaining process. Clearly a proposal that reduces the free parking benefit employees currently receive likely would not be supported by the collective bargaining agent. However, this policy results in employees receiving an equal or greater benefit than they currently receive.

The state and city can lead by example in the areas of congestion relief, parking and trip reduction, sound energy and environmental policy, and transportation cost reduction by implementing this green voucher program. Building a parking garage, if located in the downtown area, worsens rather than alleviates congestion. Moreover, building an expensive parking facility at the taxpayers' expense unnecessarily increases costs and continues the trend of subsidizing transportation, thereby encouraging the inefficient use of petroleum resources by employees commuting to work.

Green vouchers reduce parking problems, congestion, and energy use by making a much smaller investment, not in parking spaces, but in employees who agree to help solve the larger problems. Implementation of this policy will also increase walking, cycling, and ride sharing as means to get to work or school. In fact, as some high schools address requests for more on campus parking, this policy can act as a model for solving similar problems in the most cost-effective manner. There are other downtown areas and businesses considering expanding their parking capacity that would benefit from this experience.

B. Strategy: Increase the Efficiency of Vehicles

Improving the efficiency of energy use in the transportation sector is an important strategy for meeting the goals of security, sustainability, environmental soundness, affordability, and economic vitality. U.S. improvements in automobile efficiency since the 1973 oil embargo (attributable primarily to federal efficiency standards, the 55 MPH speed limit, and market pressures) save over 2.5 million barrels of gasoline per day or 27% of total U.S. transportation energy consumption (Center for Auto Safety, 1993, 1 and U.S. DOT, 1994, Table MF-21). In Vermont we have saved approximately 1.9 billion gallons of motor fuel during the last 22 years from gains in energy efficiency and conservation measures compared to what we

would have used if those improvements had not occurred and use had continued to grow as it had been (see

Figure 4.II.7 and Chapter 3, Page 3-13 for information on these reductions in Vermont's gasoline use). (Note: 1.9 billion gallons represents about five years of oil consumption at current Vermont levels.) In addition, 19 million tons of carbon dioxide emissions were avoided, and Vermont's transportation fuel bills were reduced by over $2.9 billion 1994 dollars.

If implemented, the effects of the policies presented here will be great efficiency savings in the transportation sector. The first policy in this section involves strengthening the federal efficiency standards for new automobiles and light trucks, which were responsible for much of the efficiency improvement since 1973 (see Figure 4.II.8). The second policy is one that Vermont can implement itself. It involves increasing the efficiency of new and existing vehicles by lowering the speed limit on interstate highways. The estimated effect of this policy on statewide energy use is dramatic, lowering Vermont's transportation energy use by almost 3% and total energy use by almost 1.5% over the forecast period. There are few actions that Vermonters can take that would lower energy use and emissions statewide as much as this policy. In addition, implementing this policy also saves money and improves safety. The third policy, as the second, seeks to increase the efficiency of automobiles by operating them at safer and more efficient speeds by reducing the speed of the vehicles traveling faster than the speed limit on Vermont highways. The fourth policy is an exploration of the potential impacts of radically redesigning the automobile for safety and efficiency. Such a redesign could likely be the next generation of the automobile and is being called the hypercar. The hypercar is a hybrid car that would use a combination of electric and combustion technologies with modern lightweight components. Prototypes of this new kind of car promise to increase vehicle efficiency and vastly reduce emissions.

1. Policy: Increase Federal CAFE Standards

Support increasing the federal automobile fuel efficiency standard (Corporate Average Fuel Efficiency standard or CAFE) to 45 MPG for passenger cars and 30 MPG for light trucks by 2005, with further increases after 2005 as cost-effective technologies become available.

CAFE refers to the average fuel efficiency of the fleet of cars or light trucks made by each manufacturer. Except for a temporary relaxation, the current standards of 27.5 for cars and 20.5 for light trucks have not changed significantly since 1985 (see Table 4.II.5 Federal CAFE Standards). Automakers must meet these levels or face fines of $5 per 0.1 MPH under the standard multiplied by the number of vehicles in the fleet. To avoid paying a fine in a particular year, automakers may carry forward or backward for up to three years any credits ($5 per 0.1 MPG over the standard multiplied by the number of vehicles) to offset fines when the standard is not met. To date only a few small specialty manufacturers have been penalized and fined. With increased sales of sport utility vehicles, the major U.S. car manufacturers may incur penalties for failure to meet the CAFE standards for trucks, although offering some alternate fuel models may enable the automakers to continue to offset the penalties. (Luke Loy, U.S. Department of Transportation, NHTSA, conversation July 1997.)

All fuel economy values discussed here are EPA *combined* city-highway driving figures: 55% city, 45% highway. The testing is done by professional drivers simulating city and highway driving on a treadmill. The tests do not accurately reflect the values consumers can expect because road conditions have changed since the tests were developed: congestion has increased, speed limits have increased, and the proportion of trips within urban areas has increased (DeCicco, 1992, *An Overview of Options*, 2). Therefore, these values must be adjusted to reflect values that consumers can expect to achieve. The *adjusted* values on the stickers of new cars are about 15% lower than the EPA figures used for the CAFE standard and used here.[xxiv]

Table 4.II.5 Federal CAFE Standards

Model Year	New Car Standard	2-Wheel Drive Light Truck Standard (under 8500 GVW)	4-Wheel Drive Light Truck Standard (under 8500 GVW)
1978	18.0		
1979	19.0	17.2	15.8
1980	20.0	N/A	N/A
1981	22.0	16.7	15.0
1982	24.0	N/A	N/A
1983	26.0	19.5	17.5
1984	27.0	N/A	N/A
1985	27.5	19.7	18.9
1986	26.0	20.5	19.5
1987	26.0	21.0	19.5
1988	26.0	21.0	19.5
1989	26.5	21.5	19.0
1990	27.5	20.5	19.0
1991	27.5	20.7	19.1
1992	27.5	20.2*	20.2*
1993	27.5	20.4*	20.4*
1994	27.5	20.5*	20.5*
1995	27.5	20.5*	20.5*

* Combined 2 and 4 wheel drive standard
Source: AAMA, *Facts and Figures 1994*, 84-5

Rationale

There are a few policies recommended in this Plan that stand out because their implementation would represent substantial progress toward meeting Vermont's energy goals. Least Cost Transportation Planning and creating a mechanism to internalize external costs are examples; raising the CAFE standards is another.
Since automobile travel represents the greatest single end use of energy in the state, and since vehicle miles traveled (VMT) have risen and are predicted to continue to rise, increases in the efficiency of automobiles must outpace the increase in automobile VMT to make progress toward Vermont's energy goals. The opposite has been the case in the past; VMT has grown faster than vehicle efficiency. Since 1978 when CAFE standards were established, Vermont VMT has risen from 3.77 billion miles to around 6 billion miles in 1994, a 59% increase (Vt. AOT memo, January 24, 1995). New car efficiency, based on EPA combined city-highway measures increased from 20 to 27.5 in that same time, a 37% increase (U.S. Congress, 1991, 153). The increase in the average efficiency of vehicles on the road was much lower. This is because light trucks have a lower standard than automobiles, the improvement in light truck efficiency was smaller than that of automobiles, and the light truck share of the market has grown since 1978. Furthermore, CAFE standards affect only the new vehicles. Before significant efficiency improvements in the entire fleet can be seen, a significant turnover of vehicles in that fleet must occur, which takes several years. Therefore, the CAFE standard increases must be significantly greater than the VMT increases to have an offsetting impact.

One reason CAFE standards are valuable is that automobiles are unusually inefficient converters of energy. Only about 17% of the energy available in gasoline is used to move the vehicle. The rest is lost in heat, internal friction, and air resistance (DeCicco, 1994, 30). This compares unfavorably to typical electric power

plants that are about 35% efficient, to more efficient modern electric power plants that can be 50%-80% efficient, and to new home water heaters and furnaces that can be more than 85% efficient.

While there is great potential for making fuel efficiency improvements in automobiles, there is little market incentive to do so because the full costs of transportation energy use are not reflected in the price of fuel and are not borne by the driver. Since the price of energy does not reflect the full costs, the cost of fuel is a relatively minor component of the cost of purchasing and operating an automobile, and it is a relatively minor factor in the purchaser's decision making process. The result is that the market does not provide an adequate incentive for the production and purchase of the most efficient vehicles.

Rigorous efficiency standards, however, can lead to significant increases in fuel economy as well as reductions in emissions, including hydrocarbons, greenhouse gases, and acid rain precursors. The current CAFE standards have been the major reason that transportation energy use has not grown more than it has, considering the growth in VMT. In 1992, the nation saved about 105 million gallons of gasoline per day due to increased corporate fuel economy since 1974 (Center for Auto Safety, 1993, 1).

Increasing the federal CAFE standards to 45 MPG for cars and 30 MPG for light trucks is both technologically and economically feasible if phased-in gradually with interim standards for new cars and light trucks. A recent study concludes,

> After screening technologies for their cost-effectiveness, we estimate that by 2005 average new-car fuel economy can be raised by 65%, from 28 to 46 miles per gallon (DeCicco, 1994, 33).

The authors found that a comparable increase in efficiency can be made for light trucks. The cost of the automobile efficiency improvements using cost-effective available technology was estimated at $800 per car or about one-third the cost of the average lifetime fuel savings of 2,100 gallons of gasoline. This savings represents a significant movement toward meeting several energy goals of efficiency, affordability, and sustainability, and environmental soundness. Few policies have such a significant impact on the environment and the pocketbook.

There are already several vehicles on the market that greatly exceed the proposed standards, including the Honda Civic HBV VX (58 MPG), the Geo Metro (53 MPG), the Suzuki Swift (53 MPG), and the Honda Civic (50 MPG). The vehicles that already meet the standard, however, are very small cars. ***The efficiency increases envisioned in this policy rely only on technological improvements and not on down-sizing cars***. Furthermore, the necessary technological improvements are already in production and use in some vehicles. Rarely are they all found on the same vehicle, however, and often they are used to increase horsepower rather than save energy. They include use of lighter, stronger materials, less engine friction, four valves per cylinder, and more aerodynamic design. Use of these cost-effective technologies in a typical mid-sized car, the Ford Taurus, would increase its fuel economy by 75% from 27 MPH to 47 MPH (DeCicco, 1993, *An Updated Assessment*, v). Another study, conducted for the Center for Auto Safety, concluded that using only cost-effective current production technology, the Ford Taurus could achieve 42 MPG (Center for Auto Safety, 1993, 1).

The issue of greater efficiency coming at the expense of vehicle size and safety has often been raised. When CAFE standards were first suggested in 1974, Ford Motor Co. asserted,

> This proposal would require a Ford product line consisting of either all sub-Pinto-sized vehicles or some mix of vehicles ranging from a sub-sub compact to perhaps a Maverick (Ford Motor Company Statement on S.1903, Hearing on Energy Conservation Wkg. Paper Before the Senate Committee on Commerce, 93rd Congress, 2nd Session, 177).

Clearly this has not come to pass. In fact, most of the energy efficiency gains have come from technological

improvements in automobiles and not from making cars smaller (Nadis, 1993, 54). Nor has safety declined as a result of increases in the CAFE standard. Automobile fatalities have been declining since 1972. Nationally, deaths have declined from a high of 56,528 (U.S. Bureau of the Census, 1989, 598) to 39,235 in 1992 (U.S. Bureau of the Census, 1994, 633). In Vermont, the decline in fatalities has been from 126 in 1972 to 77 in 1994. That decrease occurred despite a doubling of the miles traveled in the same time period (Vt. AOT, 1992, 38). Vehicles have become safer because of better design and restraint systems, many lives are being saved not because of market pressures but because automobile manufacturers were required to provide proven-technology restraint systems such as air bags.[xxv]

There are many legitimate safety concerns related to automobiles. The choice, however, is not between safety and fuel efficiency. Both efficiency and safety improvements can and should be made. Stronger crash test requirements as well as passenger and side airbags are safety features that will save additional lives and should be implemented whether or not the CAFE standards are increased.

Given that the ability to build safer and more energy efficient cars exists, delaying the inclusion of safety and efficiency improvements in new automobiles costs lives and energy. The U.S. Office of Technology Assessment, for example, presented testimony in 1989 that an average fuel economy of 33 MPG could be achieved in new cars by 1995 by intensifying the use of existing technology (Flax, 1989, 24). If this had been enacted by a 1.1 MPG increase in the CAFE standard each year, the cars purchased in Vermont between 1990 and 1995 would use 75 million gallons less fuel during their lifetimes.[xxvi] (For perspective, Vermont uses about 370 million gallons of motor fuel per year.)

Not only are the proposed 2005 standards technically and economically feasible, the automobile industry has the lead time to implement these measures. The auto industry typically needs 8-11 years of lead time to phase-in improvements as cars are redesigned. With quick legislative action, the automobile companies could achieve these fuel efficiencies without incurring additional redesign expenses beyond the actual cost of the efficiency measures themselves.

Improved fuel economy for light trucks is particularly important considering the sharp increases in use of these vehicles for commuting and other residential uses. Seventy-three percent of light truck usage is for personal transportation and the market share of light trucks has increased from 19% in 1975 to 34% in 1991 (DeCicco, 1992, *An Overview of Options*, 2). Furthermore, light trucks are much less efficient than automobiles. Possibly, the different standards for light trucks and automobiles should be eliminated. A lower standard for trucks provides a means for drivers and manufacturers to avoid the higher standard for cars by switching to light trucks.

This switch is happening right now; the overall efficiency of vehicles is actually declining because of increased use of sport utility vehicles and pickup trucks as residential vehicles. A combined car-light truck standard of 40 MPG would take into account today's mix of cars and light trucks. With such a policy it would be impossible for the total fleet average fuel efficiency to decline (by the growing market share of light trucks as is now the case) while the individual standards for cars and light trucks remain the same or even increase. Combining cars and light trucks under the gas guzzler tax is another step in this direction (see the feebate policy that follows in 4.II.E.).

In either formulation (45/30 MPG or 40 MPG standard), the point of this policy is to capture as much cost-effective savings as possible as soon as possible, since the CAFE standard defines vehicle efficiency for about a 20-year period (the industry lead time required to meet a higher standard plus the average lifetime of the car). Either the 45/30 MPG plan or a 40 MPG combination will significantly reduce future transportation energy use. Raising the CAFE standards is a measure recommended by the state energy plans of many

states, including Washington, Massachusetts, California, and Oregon. It is nationally recognized as an important and effective way to cost-effectively reduce energy use and its related impacts.

Impacts

The CAFE standard policy was modeled on research by DeCicco and Ross in their *Scientific American* article "Improving Automotive Efficiency." The impacts of stronger CAFE standards were modeled by increasing the average efficiency of new automobiles and light trucks by 55% between 1997 and 2005 at an additional cost of $800 per vehicle. A further automobile efficiency increase of 17.5% would be assumed to take place between 2005 and 2010. These efficiency gains correspond to an increase in Corporate Average Fuel Efficiency of 45 MPG in 2005 and 50 MPG in 2010 for the fleet of automobiles, and 30 MPG in 2005 for light trucks.

Because higher CAFE standards have the far-reaching ability to influence energy and emission levels of most vehicles into the future, this policy ranks as one of the best in the Plan for energy and air emissions reductions. Total energy use falls cumulatively through 2020 by 4.9% (166 TBTU) compared to the base case, while transportation energy use falls by a sizeable 10.9% (see table at bottom of Figure 4.II.6).. Because the energy reduced is non-renewable energy, the proportion of our total energy from renewable sources grows significantly compared to the base case (by 5.3% cumulatively through 2020). All air emissions also are significantly reduced: greenhouse gases by 5.2%, acid rain precursors by 4.6%, and ozone precursors by 7.9%. The two pollutants experiencing the greatest cumulative reduction are carbon monoxide (11.7%) and VOCs (9.3%) (see Table 4.II.6: Environmental Soundness).

While this policy results in cumulative costs to society of $973 million from more advanced vehicle technologies and taxes, these costs are overshadowed by other reduced costs. Energy costs decrease cumulatively compared to the base case by $1.8 billion with this policy, while air emission costs fall by $1.4 billion. The residential energy expenditure per household falls cumulatively by about $7,000 (or 9.3%), largely due to reduced energy use. This drop is particularly important for low income persons. In 2015, average residential energy expenditure as a percent of low income wage is about 23.9% with the policy, compared to 27.6% with the base case. Some of the money all consumers save by not purchasing gasoline will be spent on other energy consumptive products and activities where the money spent is more likely to remain in the local economy. The GSP increases $1.7 billion or 0.35% cumulatively with this policy compared to the base case, while about 45,000 additional job-years are created compared to the base case. Strong CAFE standards are very effective at reducing energy demand, while creating jobs, boosting the state economy, and improving energy affordability. (See Table 4.II.6 and Policy Run Output Report for detailed modeling information on Increasing CAFE Standards, described in Appendix 5.)

This policy ranks as one of the best overall policies in the Plan. It reduces transportation energy use and all air emissions by huge amounts, produces significant savings in lower energy and air emission costs, makes energy more affordable for both low income and high income individuals (through lower energy use), and has other beneficial effects on the economy. In addition, if the policy was enacted at the national level, similar benefits would accrue to every state. This policy option deserves Vermont's strong efforts to support its implementation.

Figure 4.II.4 Impacts of Increasing Federal CAFE Standards

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.47	35.98	36.20	38.27	38.58	885.25	890.62
Commercial	11.99	17.82	17.87	19.34	19.44	22.21	22.33	486.65	488.91
Industrial	12.42	16.79	16.80	18.41	18.41	19.87	19.89	446.39	446.62
Transportation	42.10	60.54	58.21	64.68	58.48	70.98	60.34	1594.14	1420.30
Total	98.04	130.54	128.35	138.40	132.53	151.34	141.15	3412.43	3246.45

Table 4.II.6 Indicators of Increasing Federal CAFE Standards
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2732.1	167.0	146.1	183.8	173.6	188.1	171.8	16.0%	15.6%	16.3%	15.5%	16.6%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3246.4	166.0	4.86%	143.3%	173.8	217.6	207.4	222.6	206.1

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
1947.4	59.98%	$0.087	$0.084	$0.081	$0.087	$0.081	65.58%	65.68%	63.97%	63.27%	60.38%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
44,800	1,744	0.35%	($57)	$27

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($4.93)	$1,348	$50,780	$56,452	$56,636	$58,679	$59,102	26.91%	26.62%	24.52%	27.62%	23.93%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,063,000	11,773,000	10,978,000	12,957,000	5.19%	154.19%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	8,806,000	11,407,000	10,625,000	12,718,000	5.25%	153.12%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	600	0.16%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,300	1,500	1.81%	55.69%
Nitrogen Oxides (NO_X)	25,300	26,600	24,800	31,800	28,800	48,900	7.00%	113.83%
Volatile Organic Compounds	21,600	20,000	18,400	19,400	16,700	44,700	9.32%	77.31%
Carbon Monoxide (CO)	116,900	101,800	91,100	93,500	76,700	283,800	11.74%	65.61%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.93	1.05	0.97	$417	$3	($113)	($63)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy costs and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

2. Policy: Consider Adopting a 55 MPH Interstate Speed Limit

Consider investigating the impacts of lowering the maximum speed limit on Vermont Interstate highways to 55 MPH.

Note: This policy has complex issues needing further exploration before recommendations can be made. A summary of this policy does not appear in Volume 1, Chapter 4.

Rationale

This policy is primarily aimed at making the operation of Vermont's cars and trucks more efficient. There are also two additional energy-related benefits: increased highway safety and decreased cost of transportation. This policy also has the advantage of previous testing. It is a proven energy, money, and life saver. At one time all states had a 55 MPH speed limit, and as recently as 1995, eight states, mostly in the eastern U.S., had one. The national speed limit was initially reduced to 55 in 1974 to save energy in response to the oil crisis. It was clearly effective, but after 1987, states were allowed to increase the speed limit to 65 in rural areas; Vermont did so in April of that year.

A number of policies in this Plan are aimed at increasing the efficiency of new vehicles (for example, the policies of Increasing the CAFE Standard or applying Feebates). This policy is unique because it provides a means to increase immediately the efficiency of the existing fleet of automobiles and trucks without waiting for 10 years of stock turnover.

Between 55 MPH and 65 MPH, automobiles and trucks become increasingly inefficient. Fuel economy drops 15%-22% for cars and trucks (U.S. Congress, 1991, 157, and U.S. Congress, 1994, 253). This potential for improvement combined with the fact that 20% of Vermont's vehicle miles are traveled on interstate highways suggests that quick, substantial benefits can be achieved. These savings are confirmed by looking at the increases in motor fuel use in Vermont that correspond to the increase in the speed limit to 65 MPH. Between 1986 and 1988 (the speed limit changed from 55 MPH to 65 MPH in mid-1987), gas and diesel use increased by 37,209,553 gallons or 12.5% (see Table 4.II.6a Motor Vehicle Fatalities Nationwide and Figure 4.II.7 Vermont Gasoline Use and Vehicle Miles Traveled). Not all the 37 million gallons of increase are due to the increased speed limit. Motor fuel use had been increasing at about 3.25% per year before the increase in the speed limit, due to other factors such as increases in vehicle miles traveled (VMT). If growth in VMT continued at the 3.25% rate, that would leave between 17 to 18 million gallons of increase in fuel use due to the increased speed limit.

Not only does automobile efficiency decrease as speed increases, but automobile safety also decreases. Increased speeds lead to more accidents, and the accidents are more serious when they occur. The energy of impact in an accident increases, not proportionally to the speed of the vehicle, but with the square of the speed. The 18% increase in the speed of the auto between 55 MPH and 65 MPH results in a 40% increase in the energy of an impact at that speed. The increased energy of impact leads directly to increased fatalities and injuries. The chances of death or serious injury in an accident double for every 10 MPH over 50 MPH a vehicle travels (National Highway Traffic Safety Administration, Speed Shatters Life Fact Sheet). This is a fact, not an abstract consideration that leads to more fatalities that can be seen in the historical data. Traffic fatalities in general have been declining for about 20 years. Rural interstate fatalities, however, jumped 28% from 1986 to 1988 in the 40 states that increased their speed limit to 65 MPH during that time (Insurance Institute for Highway Safety, 1994, 14). (Some of the increase in deaths is due to other causes, such as increased VMT.) In Vermont the effects are somewhat greater. Rural interstate fatalities per million miles of

vehicle travel increased 30% since the speed limit was raised or by an average of 7 fatalities and 280

Table 4.II.6a Motor Vehicle Fatalities Nationwide

Year	Deaths		VMT (million miles)		Major Occurrences
	National	Vermont	National	Vermont	
1915	6,800			100+	
1925	21,800			193	
1935	36,369		270*	492	
1945	28,076		250	890	WWII, 40% reduction in VMT during the war. The drivers more likely to be involved in accidents were away at war.
1955	38,426	90	606	1,390	
1965	49,163	152	888	1,972	
1970	54,633	124	1,109	2,688	
1971	54,381	150	1,179	3,017	
1972	56,278	152	1,260	3,253	All time high traffic fatalities
1973	55,511	155	1,313	3,283	Oil embargo began in October, fuel prices climb
1974	46,402	127	1,280	3,059	55 MPH speed limit imposed
1975	45,853	144	1,328	3,350	
1976	47,083	117	1,402	3,416	
1977	49,510	118	1,467	3,553	CAFE fuel efficiency standards take effect
1978	52,411	127	1,544	3,775	
1979	53,254	161	1,530	3,714	OPEC oil price increases
1980	53,172	139	1,527	3,718	
1981	51,385	115	1,553	3,835	
1982	45,779	107	1,595	3,969	Recession
1983	44,452	94	1,653	4,150	
1984	46,263	115	1,720	4,393	
1985	45,901	115	1,774	4,689	
1986	47,865	109	1,835	5,028	
1987	48,290	119	1,921	5,344	55 MPH speed limit increased in 40 states and Vermont in second half of year
1988	49,078	128	2,026	5,539	
1989	47,575	116	2,096	5,764	
1990	46,814	90	2,147	5,865	Recession
1991	43,536	110	2,172	5,883	
1992	40,800	95	2,240	6,005	
1993	42,000	110	2,228	5,979	

Source: AAMA, *AAMA Motor Vehicles Facts and Figures 1994*, 64, 89; Andrew Tobias, *Auto Insurance Alert*!, 41

injuries per year (Vt. AOT memo, April 7, 1995). In Montana, where all daytime speed limits were recently removed, fatalities on interstate highways have increased by 83% (New York Times, 12/8/96, B5).

A recent study by the Vermont Departments of Public Safety and Motor Vehicles found that the 77 deaths and 4,675 injuries in 1994 affected not only the individuals and families involved, but also had significant impacts on Vermont's economy. Costs related to vehicle accidents in 1994 totaled $184.3 million (*1993-1994 Vermont Crash Cost*, 2).[xxvii] Slower speeds which save lives also save money.

Safety considerations related to a lower speed limit are even more important when large trucks are considered. In spite of the fact large trucks are driven by professional drivers, each large truck is three times more likely to be involved in a fatal accident than a passenger car (as measured by accidents per registered vehicle) and are involved in about twice as many accidents per million miles traveled as cars (Vt. Governor's Highway Safety Program, *Vermont Crash Data*, 39) (see Table 4.II.7). There are a number of reasons large trucks are less safe: they bring much more energy into an impact so injuries tend to be more severe, truck drivers have lower seat belt usage than typical citizens, and large trucks are less maneuverable and take much longer to stop than automobiles (see Figure 4.II.8). Two of these reasons can be addressed by a 55 MPH speed limit. A reduced speed reduces the stopping and reaction distance and significantly reduces the energy of impact (by 40% between 65 MPH and 55 MPH). For this reason, some states have adopted lower speed limits (such as 50 MPH or 55 MPH) for large trucks.

Table 4.II.7 1993 Vermont Vehicle Crashes
(Categorized by vehicle type and most serious consequence of crash)

Vehicle Type	Fatalities per 1000 Registrations	Injuries per 1000 Registrations	Property damage per 1000 Registrations	Total all Accidents per 1000 Registrations	Fatality Rate per Million Miles*
Passenger Car	0.20	9.8	12.2	22.1	1.83
Light Truck	0.32	8.7	13.7	22.8	N/A
Large Truck	0.67	7.9	49.2	57.8	7.7-10.2**
Motorcycle***	0.80	5.3	00.3	06.4	N/A

*National data
**Single unit trucks and tractor/trailer trucks
***Including mopeds
Source: Vt. Governor's Highway Safety Program, *Vt. Crash Data 1993*, 39; AAMA, Facts and Figures 1994, 89; and Transportation Research Board, *Truck Weight Limits*, 13

Table 4.II.8 Vehicle Stopping Distance at 55 MPH

Vehicle Type and Characteristics	Feet
Passenger Sedan	133
Truck with loaded trailer with front brakes applied	196
Truck with loaded trailer without front brakes applied	234
Truck with unloaded trailer	less than 234
Truck without trailer	324

Source: The Insurance Institute for Highway Safety, 1994, 16

This policy has the potential to achieve immediate benefits, but the policy also is reversible. The Legislature could raise the speed limit and the benefits would immediately cease. At 75 MPH, energy consumption is almost 50% greater than at 55 MPH and accidents are more likely and more serious (U.S. Congress, 1991, 157).

There are minor disadvantages related to changing the speed limit to 55 MPH such as the costs related to changing highway signs. This disadvantage, however, can be reduced by coordinating the speed limit sign change with proposals to include metric speeds on Vermont signs. Another disadvantage is the need for increased enforcement of the lower speed limit.

Currently, there is slightly more speeding on highways with a 55 MPH than 65 MPH speed limit. (See the Enforce Highway Speed Limit policy that follows.)

The major disadvantage to this policy, however, is the lack of public support for such a measure. The trend recently has been to increase and not decrease speed limits. New York state has recently increased its maximum speed limit from 55 MPH to 65 MPH. Many drivers perceive that significantly longer driving times are required by a 55 MPH speed limit. The time difference between traveling at 65 MPH and 55 MPH is not great, however. For each six miles of freeway travel, a 55 MPH speed limit will add only one minute of driving time, or a total of about 3 minutes for a typical 20 mile commute.

Of course, even these small added travel times have a cost. The additional cost to employers for transportation time is greater than the fuel savings they receive (assuming a $15/hour wage paid to those driving for work). Over the forecast period, cumulative costs of this policy to society, including energy and accident costs, are much lower than the savings gained from the policy indicating that this policy has significant value to society. (See Appendix 5. Policy Run Output Report for Adopting 55 MPH Interstate Speed Limit has this information and can be requested from DPS.)

For Vermonters to fully evaluate the energy, financial, safety, and environmental benefits of this policy and weigh them against the time costs of this policy, a strong education campaign may be required. With better information, Vermonters can better assess the relative importance of safety, sustainability, environmental impacts, and speed.

Impacts

This policy was modeled by assuming a 10 MPH reduction in speeds on the rural interstate highways in Vermont. Based on U.S. Office of Technology Assessment data, this drop in speed would result in an approximate 18% decrease in fuel use (U.S. Congress, 1991, 157). This is likely a conservative estimate, however, because it represents the energy savings when vehicle speeds are reduced from 65 MPH to 55 MPH, but because average speeds are close to 70 MPH, a 10 MPH decrease to 60 MPH would save more fuel.

To simulate the changes in non-energy transportation-related costs, the following assumptions were used. Costs due to increased travel time include increased payroll expenses for businesses. Based on Vermont Agency of Transportation data, 8% of highway vehicle miles traveled (VMT) is by trucks and 3% of automobile VMT is business-related. Using U.S. Census data, the average payroll cost per hour for transportation-related positions is $14.60 per hour (1991$) (U.S. Bureau of the Census, 1994, 546). Combining these figures results in an additional $5.4 million (1997$) per year in costs which are escalated each year to adjust for inflation. Other cost assumptions include a decrease in health-related costs. Based on Vermont fatality data from the time when speed limits increased from 55 MPH to 65 MPH, and on data from

Figure 4.II.5 Impacts of Adopting 55 MPH Interstate Speed Limit

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.27	38.27	885.25	885.26
Commercial	11.99	17.82	17.79	19.34	19.32	22.21	22.19	486.65	486.18
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.88	446.39	446.44
Transportation	42.10	60.54	58.78	64.68	62.80	70.98	68.92	1594.14	1547.87
Total	98.04	130.54	128.75	138.40	136.50	151.34	149.26	3412.43	3365.75

Table 4.II.9 Indicators of Adopting 55 MPH Interstate Speed Limit
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2852.4	46.7	146.1	183.8	181.1	188.1	185.1	16.0%	15.6%	15.8%	15.5%	15.7%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3365.8	46.7	1.37%	163.7%	173.8	217.6	215.0	222.6	219.5

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2064	61.32%	$0.087	$0.084	$0.083	$0.087	$0.086	65.58%	65.68%	65.21%	63.27%	62.77%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
(7,700)	(240)	(0.05%)	($7)	$7

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($15.41)	$344	$50,780	$56,452	$56,582	$58,679	$58,731	26.91%	26.62%	26.37%	27.62%	27.31%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,371,000	11,773,000	11,607,000	3,737,000	1.50%	163.02%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,108,000	11,407,000	11,243,000	3,689,000	1.52%	162.03%
Sulfur Dioxide (SO_2)	17,100	15,700	15,600	15,000	14,900	2,900	0.78%	87.13%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	400	0.47%	56.86%
Nitrogen Oxides (NO_X)	25,300	26,600	26,100	31,800	31,200	13,600	1.95%	123.32%
Volatile Organic Compounds	21,600	20,000	19,600	19,400	19,000	9,300	1.94%	87.96%
Carbon Monoxide (CO)	116,900	101,800	99,200	93,500	91,200	61,100	2.53%	78.02%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.03	($139)	($158)	($193)	($193)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

the Federal Highway Safety Administration, lower speeds would result in a $3.96 million (1992$) per year savings. This was also adjusted to compensate for inflation.

As discussed, energy is used more efficiently by vehicles traveling at 55 MPH than at higher speeds. As a result, energy use decreases fairly significantly with this policy. Transportation energy use falls cumulatively through 2020 by 2.9% compared to the base case, while total energy use falls by 1.4% (46.7 TBTU).

Similarly, there is an important decrease in air emissions with this policy; greenhouse gases, acid rain precursors, and ozone precursors all fall cumulatively by between 1.5%-1.9% compared to the base case. Individual pollutants which experience the greatest reduction are carbon monoxide at 2.5%, and VOCs and nitrogen oxides at about 2%. The cumulative cost reduction from these decreased air emissions is $344 million (1995$).

Economic vitality indicators are down with this policy, although one very important indicator, per capita disposable income, is up. The decline in Gross State Product and job creation is due in large part to the reduction in emergency and accident-related costs. The decrease in jobs occurs primarily in the service sector and in the finance and insurance sector, reflecting a decrease in demand in the health and insurance areas. As such, this is one case where a decrease in Gross State Product actually reflects an increase in human well-being.

The cost indicators that result from this policy are perhaps the most interesting. Cumulative energy, emissions, and related costs decrease by $1.06 billion (1995$) compared to the base case. Commercial and industrial energy costs decline by $246 million (1995$), which more than offsets the increase of about $123 million (1995$) due to increased payroll costs. In addition, this policy has a direct economic benefit for families. Household income minus energy and related costs increases by an average of $65 per year (1995$). (See Appendix 5. Policy Run Output Report for Adopting 55 MPH Interstate Speed Limit has this information and can be requested from DPS.)

This policy ranks as one of the best in the Plan for significant decreased energy use and air emissions occurring in conjunction with significant cost reductions and savings in human life, if the public opinion barrier can be dealt with.

3. Policy: Consider Stricter Enforcement of Highway Speed Limits

Consider enforcing the speed limits on Vermont highways more strictly, undertaking public education activities, increasing penalties for speeding, increasing funding for enforcement, and researching more effective enforcement technologies and practices.

Rationale

As explained under the 55 MPH Speed Limit policy, there is a loss in fuel efficiency at speeds over 55 MPH. A recent study by Vermont State Police shows that 84% of vehicles exceed the 55 mile per hour limit on interstate highways so posted; 70% exceed the 65 MPH speed limit (see Table 4.II.10 Vermont Highway Speeds). Since more than half of the vehicle miles traveled (VMT) on highways in Vermont are in excess of the speed limit, the potential for energy savings is quite large. Aggressively targeting those traveling more than 10 MPH over the limit with a strong education and publicity program, increased enforcement, and increased penalties could significantly reduce energy use in Vermont whether or not a 55 MPH limit is adopted. In fact, stricter enforcement of the 65 MPH limit would result in an immediate reduction in motor

fuel consumption.

Table 4.II.10 Vermont Highway Speeds

Highway Category	Percent of Vehicles Exceeding						
	55 MPH	60 MPH	65 MPH	70 MPH	75 MPH	80 MPH	85 MPH
Interstate Highways Posted at 55 MPH	83.9	54.6	29.1	9.3	2.4	N/A	N/A
Interstate Highways Posted at 65 MPH	N/A	N/A	69.8	37.9	14.2	3.9	1.1
Highways Posted at 55 MPH	67.6	33.5	13.3	3.3	0.9	N/A	N/A

Source: Vt. Speed Summary Report, FY95, Quarterly, 1/25/95

There are also very significant safety benefits to reducing the number of vehicles exceeding the speed limit on Vermont roads. Excessive speed was responsible for more fatal accidents than driving under the influence of drugs or alcohol in Vermont, and is the greatest single cause of accidents on interstate highways (Vt. Governor's Highway Safety Program, *Vt. Crash Data 1993*, 43, 53). As already mentioned, accidents have costs. The most significant are the loss of life and disabilities that result. The monetary costs are quite high too. Measures that save energy by reducing speeding can have equal or greater impact on highway safety and costs.

Between 1993 and 1994 there were 32 fewer highway fatalities in Vermont and 2,000 fewer injuries. The Department of Public Safety estimates that the reduction in accidents saved Vermont over $55 million in 1994. One program that likely contributed to the 1994 reduction is the Special Traffic Enforcement Patrols which focused on slowing traffic. This program paid for additional public education and enforcement, including overtime for additional patrols. It was funded with $300,000 from the National Highway Traffic Safety Administration. Unfortunately, that funding is no longer available. Since the program ended, fatalities and accidents are up substantially. While it is impossible to directly link the lowest level of fatalities in 40 years to this program, the *1993-1994 Vermont Crash Cost Study Briefing* states that it was one of the contributing factors. This suggests that relatively small investments in public education and additional speed limit enforcement can leverage significant savings in terms of lives, dollars, and energy.

Impacts

This policy was modeled by assuming a 5 MPH reduction in the speed of vehicles traveling more than 10 MPH above the posted 65 MPH speed limit on interstates and the 55 MPH limit on state highways, beginning in 1997. Travel on these roads accounts for approximately 22% of Vermont's annual VMT. Energy savings are greater for the enforcement of the 65 MPH speed limit due to vehicles' greater fuel use at higher speeds.

According to State of Vermont speed reports, 29.1% of vehicles exceed the speed limit by more than 10 MPH on roads posted at 55 MPH, and 14.2% of vehicles exceed the speed limit by more than 10 MPH

on roads posted at 65 MPH. These vehicles would experience a 9% increase in efficiency by reducing their speed by 5 MPH (U.S. Congress, 1991, 157).

No additional costs are assigned to Vermont businesses due to reduced travel times since speed limits should be met as a matter of policy. In addition, no costs were assumed for the increase in compliance. One method to ensure increased compliance is to combine public education with increased state police presence on the road, and if this method is used, costs should be included. The modeling assumed, however, that increased compliance is accomplished by raising the fees for violation. This is proposed in the Pay-at-the-Pump policy also recommended in this Plan, so no additional costs were considered. It is assumed that the speeding ticket surcharges for insurance would be sufficient to bring speeds closer to the speed limit.

As in the case of the 55 MPH Speed Limit policy, there will be a cost savings with this policy due to reduced accidents and reduced severity of accidents. For modeling purposes, a 10% reduction in accidents due to excessive speed on those roadways affected was assumed. Using a three-year average of traffic accidents and causes (see the Pay-at-the-Pump policy for more information), a 10% reduction would result in two fewer fatal accidents per year, 48 fewer accidents involving injuries, and 43 fewer accidents involving only property damage. The costs related to these accidents were generated by the Crash Cost Program of the National Highway Traffic Safety Administration, and were estimated to be $739,000 per year (1992$).

As a result of this policy, transportation energy use decreases cumulatively through 2020 by 0.35% compared to the base case, while total energy use decreases by 0.17% (5.6 TBTU). In tandem with energy use, air emissions also fall; greenhouse gases, acid rain precursors, and ozone precursors all decrease cumulatively compared to the base case by about 0.2%, while carbon monoxide and VOCs fall by about 0.3%. (See Appendix 5. Policy Run Output Report for Speed Limit Enforcement has this information and can be requested from DPS.)

Although these reductions are relatively small, the savings is quite large considering the relatively few people who regularly travel more than 10 MPH over the speed limit. These people will save money in reduced fuel costs ($57 million cumulatively compared to the base case). In addition, the cost to society from air emissions will drop by $42 million cumulatively. More importantly, human health and lives are preserved through this policy as fewer serious vehicle accidents occur.

As in the case of the 55 MPH Speed Limit policy, the Gross State Product and job creation is slightly lower with this policy compared to the base case. The elimination of an average accident on a Vermont roadway (average for all roads) reduces the Gross State Product by $7,950 (1992$). Most of the decline in the economy and jobs occurs in the health care sector and other sectors related to automobile accidents. This is clearly a case in which the GSP and other economic indicators do not track human well-being, which would increase with fewer accidents.

This policy's modest benefits in energy and air emission reductions are complemented by its ability to save human lives, its reduction of monetary costs to society, and its ease of implementation, making it a very worthwhile policy for Vermont.

Figure 4.II.6 Impacts of Enforcing Highway Speed Limits
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.27	38.27	885.25	885.23
Commercial	11.99	17.82	17.81	19.34	19.33	22.21	22.21	486.65	486.59
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.87	446.39	446.39
Transportation	42.10	60.54	60.33	64.68	64.45	70.98	70.74	1594.14	1588.59

Total	98.04	130.54	130.32	138.40	138.17	151.34	151.09	3412.43	3406.80

Table 4.II.11 Indicators of Enforcing Highway Speed Limits

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2893.4	5.6	146.1	183.8	183.4	188.1	187.8	16.0%	15.6%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3406.8	5.6	0.17%	168.0%	173.8	217.6	217.3	222.6	222.2

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2103.0	61.73%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.62%	63.27%	63.21%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
(1,000)	(33)	(0.01%)	($2)	($0)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($13.02)	$42	$50,780	$56,452	$56,452	$58,679	$58,684	26.91%	26.62%	26.58%	27.62%	27.59%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,505,000	11,773,000	11,754,000	451,000	0.18%	165.08%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,240,000	11,407,000	11,387,000	444,000	0.18%	164.10%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	300	0.08%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	100	0.06%	57.19%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,800	31,700	1,600	0.23%	125.30%
Volatile Organic Compounds	21,600	20,000	20,000	19,400	19,300	1,200	0.25%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,500	93,500	93,300	7,500	0.31%	79.81%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.04	($106)	($135)	($151)	($163)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

4. Policy: Encourage Hypercar Development

Actively pursue state partnerships with hypercar developers, taking advantage of (or creating liaisons with) research and development expertise in state universities, colleges, and interested manufacturers to encourage the development of this new vehicle technology.

This policy and its use of public/private partnerships would be modeled on the approach that has been successfully employed by EVermont, the Vermont electric vehicle project. (See Chapter 3, Section II, G.2. Alternative Transportation Fuels.) There are over 20 state businesses and state agencies involved in the program, and EVermont is currently testing 7 electric vehicles in Vermont. Those involved are becoming familiar with the technology, gaining useful information about the use of electric vehicles in Vermont's mountainous geography and extreme climate. Public awareness of the potential for electric vehicles, as a result of EVermont, is increasing. The EVermont program provides a boost to the development and use of cleaner and more efficient vehicles in Vermont. Legislation that provided financial incentives for hypercars would induce similar higher acceptance rates and faster development of these vehicles.

Rationale

Interest in transportation fuel efficiency has tended to rise and fall with the price of gasoline. In recent years, gains in miles-per-gallon ratings for new vehicles have stalled. Indeed, consumer buying preferences have shifted to utility vehicles whose fuel efficiency is considered only fair. Given the reluctance of automakers to deliver significant gains in efficiency, the State of Vermont should look beyond traditional auto suppliers and technologies to produce large efficiency gains in the transportation sector.

Fortunately, many factions in the automotive industry are engaged in a major redesign of vehicle technology, prompted mostly by federal requirements for clean air. This major shift is probably the most significant opportunity in the history of the U.S. automotive industry to redesign cars, preserving or improving their most positive features such as convenience and driving range while eliminating their negative impacts, predominantly environmental impacts and excessive energy consumption.

A novel and increasingly popular vehicle called the hypercar offers the opportunity to "leapfrog" vehicle technology and produce large, rather than incremental, efficiency gains. A hypercar is an ultralight hybrid-electric vehicle capable of averaging 150 miles or more per gallon of gasoline or other fuel. Moreover, hypercars offer safety improvements, performance, and simpler manufacturing as added benefits.

Hypercars use a "hybrid-electric drive," which achieves the benefits of electric propulsion without the drawbacks of relying solely on batteries. The wheels are driven by electric motors using battery power. Unlike traditional electric vehicles charged from the utility grid, hypercars also have an "on-board" charging system, a small (10 HP-20 HP) engine, fuel cell, gas turbine, or other power plant. The addition of a generator greatly extends the range of the vehicle. Since the generator's size more nearly matches the average requirements of the vehicle, and because it runs at optimal efficiency at all times, it uses much less fuel than typical automobile engines that need to be 10 times more powerful and rarely run at their best efficiency. Performance, however, is not sacrificed. Batteries provide the extra energy needed for accelerating or traveling up hill. In addition, the energy required to move the hypercar is much less than that of traditional automobiles because the body and many of the vehicle's components are molded from composite fibers into a single-piece structure that is lightweight, yet strong and impact-resistant. Hypercars also employ a regenerative braking system that stops the car by converting the energy wasted in braking into electricity and

storing it in the batteries for later use.

Vast energy savings can be achieved in automobiles because current vehicle technology is over designed for most of the work it performs. Because gasoline is a highly powerful form of energy, traditional vehicle designers have had little reason to make vehicles lightweight or efficient. In addition, the high peak power capability of conventional vehicles (90 MPH-120 MPH), while rarely used, requires very energy inefficient designs. Only about 15% of the energy in gasoline is used to move a vehicle; the balance is lost to waste heat, braking, friction, and air resistance. Hypercars, because of their light weight, high efficiency components, and regenerative braking, can radically improve efficiencies while producing other benefits that contribute to safety and consumer acceptance.

Hypercar design eliminates the need for many components, including the clutch, transmission, and differential. In addition, the design reduces the size of the engine, fuel, cooling system, and emissions system. There are two main benefits to elimination or reduction of these components.

- Service requirements would be greatly reduced due to vehicle simplicity (far fewer parts).
- The use of smaller, more modular components could mean that the automotive industry will follow the path taken by the computer industry.

Promoters suggest that hypercar production could be more decentralized and sales could be more direct to the public in the same manner as today's thriving computer production and mail-order sales businesses. Custom-made vehicles with components from many places could be delivered quickly to the customer. This provides opportunities for Vermont manufacturers and avoids many costs associated with traditional vehicle distribution. It is valuable, therefore, for Vermont companies to gain early experience with the hypercar in order to take advantage of the increased opportunities for decentralized suppliers of hypercar components.

Early experience with hypercar prototypes have shown a mileage range exceeding 200 MPG (Rocky Mountain Institute, 2). Swedish automaker Volvo and Hydro-Québec are also promoting combined gas turbine-battery powered vehicles. Except for a few prototypes, hypercars exist in concept only. Until their production reaches high volumes, their initial purchase price will be high. Many market barriers must be overcome, including resistance by the auto industry to change and consumer acceptance of a radically redesigned vehicle.

Advancing the hypercar from a prototype to a consumer-ready vehicle is a long term, expensive proposition. Nevertheless, significant progress beyond a 50-60 MPG automobile requires radically redesigning the automobile. Much larger gains in efficiency are necessary if Vermont's transportation energy use is to be sustainable and environmentally sound.

C. Strategy: Reduce Vehicle Miles Traveled

Reducing Vehicle Miles Traveled (VMT) is a complement to the previous strategy of increasing efficiency. The significant progress in increasing efficiency has led to a reduction in the growth of energy demand in all sectors except transportation, where the total miles traveled by vehicles increased while vehicles were becoming more efficient (see Figures 4.II.7 and 4.II.8). The net effect was that energy use, oil dependence, and energy bills continue to increase for Vermonters. Therefore, to make progress toward Vermont's energy goals, it is important that increases in transportation energy efficiency are combined with reductions in VMT.

Although transportation corridors and vehicles that use them are important to commerce, health care, education, non-motorized transportation, police and fire safety, there are a number of ways to decrease VMT without decreasing Vermonters' access to the goods, services, or activities they seek or threatening the vitality of the tourism industry in Vermont. The first approach is to eliminate VMT by increasing the number of people or amount of goods per vehicle. Two policies take this approach. The first is aimed at

Figure 4.II.7 Vermont Gasoline Use and Vehicle Miles Traveled, 1970-1994

Figure 4.II.8 Automobile Efficiency vs. Vehicle Miles Traveled, 1978-1994

increasing the occupancy of vehicles already on the roadway through carpooling or ride sharing. The second is aimed at shifting VMT to entirely different modes that can carry more people and goods more efficiently, such as public transit and rail.

Another approach to reducing VMT without decreasing access is to shift VMT to non-motorized modes of transportation. The third policy seeks to do this by encouraging cycling and walking. Yet another approach is to eliminate the need for transportation. The fourth and fifth policies describe how telecommunications and better land use planning can do this.

A final approach is to restructure transportation fees and markets so that variable costs (those that depend on the amount of travel) are not hidden in the form of fixed costs. The total cost of driving would not increase as a result of shifting fixed costs to variable costs, but the economic incentive for drivers to combine trips or cut down on unnecessary trips would be enhanced. One way of shifting fixed costs to marginal costs is described in the sixth policy regarding Pay-at-the-Pump Liability Insurance.

In order to assess changes in VMT, it is important that valid and reliable data and projections be available. (Vermont VMT figures are shown in Chapter 3, Table 3.I.3 and Figure 3.I.2 pages 3-14 and 15.) Information on annual vehicle miles traveled should be collected at a designated office in state government, with appropriate subgroups, such as automobile, truck, van. Projections of annual vehicle miles traveled (AVMT) will also be useful for planning purposes and for assessing the impacts of different policy options.

Policies considered here reflect opportunities to reduce VMT, energy use, and its impacts, while maintaining access to the goods, services, and activities in Vermont. Research and modeling of these policies indicate that VMT can be reduced without harming the economy and in many cases, reducing VMT can be beneficial to the economy.

1. Policy: Encourage the Use of Commuter Lots

Encourage the increased use of park-and-ride lots by the following measures:

1. ***Improve marketing of park-and-ride lots, including a statewide map of sites, better coordination of sites and drivers using the 1-800 number, and providing better signage at several sites.***
2. ***Improve maintenance and upkeep of the sites.***
3. ***Add lighting at sites without lights.***
4. ***Expand those sites at or over capacity.***
5. ***Build new sites along the Route 7 corridor.***
6. ***Build new sites along major commuter corridors currently under- or unserved by park-and-ride lots.***
7. ***Replace the park-and-ride site closed due to construction at the Williston exit with one at that interchange.***
8. ***Add bicycle lockers to park-and-ride sites where appropriate.***

The previous measures, with the exception of the last three, are outlined in the October 1991 TAMS Engineers report *Evaluation of Statewide Park-and-Ride Facilities*, prepared for Agency of Transportation. AOT plans to upgrade several park-and-ride lots during the next few years.

Rationale

Ride sharing is an effective means of saving money and energy. It reduces vehicle miles traveled (VMT) without reducing mobility. Park-and-ride lots and statewide coordination of ride sharing greatly contribute

to the savings from ride sharing by providing the infrastructure to allow it to occur more easily. The existing

park-and-ride lots have proven money- and energy-savings. In Vermont there are 24 lots that are saving nearly 290,000 gallons of fuel per year.[xxviii] They are relatively inexpensive to build and maintain.

There are three main methods to increase the fuel and money savings with commuter lots:

1. Increase the use of existing lots by improving the marketing, maintenance, and attractiveness of those lots. While many lots are beyond capacity, some are under-utilized, and as a whole, they average 47% use according to the TAMS data. The TAMS report suggests that better marketing, including signage, a map of sites, inclusion of the sites on the state highway map, better maintenance, and better lighting could help solve this problem. Better coordination of the park-and-ride system and a 1-800 number dedicated to ride sharing would also increase use.

   Better marketing and coordination can also increase the savings at each lot by increasing the number of people per car leaving the park-and-ride facilities. The TAMS report found that 40% of cars had 2 people, 23% had 3 people, and 35% had 4 or more (TAMS Engineers, 1991, 8). Better coordination of the park-and-ride system and occasional publicity activities such as free donuts and coffee at sites can introduce current users to others and may further cut down on the duplication of trips.

2. Expand the lots that are at or over capacity. The TAMS report suggests seven sites that are good candidates for expansion. These sites are obviously well-situated, and lack of reliable parking facilities and overcrowding not only constrain further energy savings, but also are inconvenient and discourage current users.

3. Build new sites along roads that have a large number of drivers making commutes of 30 to 40 minutes or more, such as along the Route 7 corridor. The TAMS report suggests 6 sites along that heavily used roadway. Using LCTP methods, investigators may find even more prospective sites.

Impacts

Because of the relatively smaller scale of savings achievable from this policy, the impacts were estimated without the computer model used for many other policies. The impacts of five major changes to the current park-and-ride system were evaluated. These include an increase in the utilization of commuter lots from the current 47% level to an average of 75%, the expansion of six lots at or near capacity, the creation of six lots along Route 7, the creation of 10 other lots statewide, and the reconstruction and paving of all existing lots. Relevant costs considered in the evaluations include an increase of $150,000 per year to better publicize and coordinate ride sharing statewide, costs related to land purchases equal to an average $250,000 an acre ($2,500 per parking spot) for 11 sites (many potential sites are already owned by the state), construction costs equal to $2,200 per parking spot (based on projections at the Berlin lot), and maintenance costs of $1,600 per year (based on costs at sites within Vt. AOT Region 6). Energy and cost savings were based on an average 20 MPG efficiency and $0.30 per mile cost to operate an automobile.

Greater use of ride sharing could save 8.3 million gallons of gasoline and prevent the release of 63,000 tons of carbon dioxide by 2015. The total public investment of $6.9 million is less than the costs related to air emissions alone, at $8.2 million. In addition, individuals taking advantage of ride sharing would save $49.6 million in driving expenses.

2. Policy: Shift VMT to More Efficient Modes -- Bus, Vanpool, and Train

Encourage the shift of vehicle miles traveled (VMT) from cars and trucks to vehicles that can carry more people or goods more efficiently.

This policy encourages initiatives to increase the use of trains, buses, and vanpools in Vermont when those modes are cost-effective from a societal perspective. (See the related policies on commuter lots, non-motorized transportation, and telecommuting.) Examples could include efforts by the state to upgrade rail tracks, support AMTRAK service, create tourist trains, create a commuter rail network, create vanpool and commuter bus service in Vermont, and increase local public transit service. Specific actions include the creation of a fund using a $0.05 per gallon increase in the motor fuels tax to finance societally cost- effective investments in public transportation. (See Strategy E. Policy 4: Support Commuter Buses with a Motor Fuels Tax.)

Rationale

In Vermont, the automobile and light truck are the predominant modes of transportation for people and goods, accounting for over six billion VMT each year. Cars and light trucks, however, are among the most energy inefficient modes available. The energy intensity of the automobile (the energy required to move one person one mile) is four to eight times greater than that of other motorized alternatives. Trucks require about four times more energy than trains to move the same amount of goods (the energy intensity of freight is the energy required to move one ton of goods one mile).

The energy intensity of trains, buses, and vanpools depends directly on the number of passengers or the amount of goods being moved. A commuter bus, for example, requires more than three times the energy of an average automobile, but achieves its better energy intensity because it can carry 10 times the number of people. Since the efficiency gains are dependent on ridership, the greatest gains can be captured when the ridership would be greatest: during commuting. Traveling between home and work accounts for 32% of residential VMT and these trips typically have very low vehicle occupancy: 1.1 persons per vehicle on average (Wilbur Smith Associates, 1994, 3-65, 66). The commuter lot policy has already explored the benefits of increasing the number of persons per vehicle. There are also energy and cost savings to be gained by switching to more efficient modes of travel. Figure 4.II.9 presents the energy use or intensity of various modes of tranportation, indicating the most efficient modes of commuting. In addition, significant energy savings can be achieved by switching large and heavy loads traveling long distances from trucks to rail. The energy intensity of freight transportation is given in Table 4.II.12.

This figure and table show that the modes most often used for transportation are the most inefficient. Public transportation, for example, which is much more efficient than automobile travel, accounts for only 0.7% of trips between home and work in Vermont (U.S. Bureau of the Census, 1994, 627). Nationwide, heavy trucks are responsible for about four times more vehicle miles traveled than freight rail (Greene, 1994, 96). The energy efficient alternatives are also safer. The death rate from accidents for cars is 97 times greater than for transit buses (Lowe, 1990, 15).

Vermonters often use the most inefficient modes of transportation because of what is available to them. For example, a Vt. AOT survey found that over half of Vermonters felt they lacked adequate access to local bus service, bicycle lanes, local bus service, passenger train services, park and ride lots, and car or van pools. In addition, 50% would use public transit if service were more convenient (Vt. AOT, 1995, *Vermont's Long Range Transportation Plan*, 13, 14). This suggests that an excellent opportunity exists to shift VMT from the most energy intensive modes of transport to less intensive modes, if access to those modes could be increased.

Figure 4.II.9 Energy Use by Modes of Transportation
BTU per Passenger-Mile

There are, however, several obstacles to the greater use of less energy intensive modes of transportation. The greatest obstacle is that users of the less efficient modes do not pay the full cost of traveling by those modes. Some of the costs not included or not fully included in the price of transportation are: subsidies from local property taxes to support roadways, tax breaks to fossil fuel producers, and tax exemptions for motor vehicle fuels from the state sales tax; the cost of accidents as well as police and emergency services; the cost of damage done to roadways by heavy trucks; costs associated with air emissions and damage from acid rain and global warming; and costs related to defense of oil-rich areas and shipping lanes.[xxix] The lower price for car and truck transportation that results by not including the above costs means rail must compete on an unequal basis. The lower price of energy means the incentives to use more efficient modes of transportation are reduced. (See Strategy A: Least Cost Transportation Planning and Strategy E: Internalize Costs of Transportation More Fully through Energy Taxation.)

The second obstacle to the use of more efficient modes of transportation applies mainly to car travel. More efficient modes of transportation must compete, not with the total costs of owning and operating an automobile, but with the marginal or variable costs. Since most households already own an automobile, when they make a decision regarding mode choices, they usually do so by comparing the cost of more efficient modes, the rail or bus fare for example, with the cost of the gasoline they would use in their car. A bus which costs about $0.15 per passenger mile (see below for details on costs) is more expensive than the cost of gasoline for an automobile at $0.03 to $0.08 per mile. The full benefits of a bus compared to an automobile are not considered because many of the costs of driving are assessed as fixed costs. For example, insurance costs (the risk of an accident) and depreciation do vary with the number of miles traveled, and other costs such as registration fees *could* vary with miles driven, but these are assessed monthly, quarterly, or yearly. Having paid these expenses up front, it is a waste of money to pay more for public transportation than for gas. On a per mile basis, all fixed and variable costs of owning a 1994 intermediate sized car total $0.4665 per mile over

60,000 miles or the first six years (AAMA, 1994, 56). This is much greater than the fixed and variable costs of a bus of $0.15 per passenger, so there actually is an excellent opportunity to save money and energy. If more of the automobile costs were assessed as variable costs, those who switched to public transportation would save money. (See also the Pay-at-the-Pump Insurance policy for ways to address these concerns.)

Table 4.II.12 Energy Intensity of Freight Transportation

Freight Mode	BTU/Ton-Mile	Ton-Miles Per Gallon
Truck	1,898	74
Train	443	315
Water Vessel	402	348

Source: Gordon, 1991, 33

The third obstacle to the use of efficient modes is the lower level of convenience. Commuters are constrained by the routes and times of service of buses and trains, and their travel times are often longer. If express bus service were available at peak times on high volume commuter routes such as between Essex and Burlington, commuters could be better served. Commuters also need some level of bus service late at night and on weekends. Public transit offers conveniences such as the ability to read or work during one's commute, but these generally do not outweigh the inconveniences given the current costs of public transportation. Businesses have similar convenience concerns regarding freight. Few businesses that do not already use rail have direct access to rail. In addition, the trend recently has been for businesses to reduce inventories and to receive smaller and more frequent deliveries, for which trucks are better suited.

The fourth obstacle involves the dispersed land use pattern and rural nature of Vermont. Rural areas with widely distributed housing decrease the efficiency of public transportation because of the greater distances and lower number of riders per route. In addition, rural areas have fewer industries to use freight rail.

The key to increasing the use of more efficient modes of transportation is to structure public policy and public transportation to overcome these obstacles.

To overcome the first two obstacles (that full costs are not reflected in the current transportation pricing system and that public transit must compete with the artificially low marginal costs of transportation) involves removing subsidies and tax breaks from more polluting and less efficient modes of transportation, internalizing the cost of emissions, and creating mechanisms to shift more of the costs of driving to marginal costs. (These are discussed more fully in the Transportation Energy Taxation and Least Cost Transportation Planning sections.)

At least until the changes occur, public transportation and rail will require public funding to achieve the energy and cost savings that are possible. For public transportation, the funding is needed to reduce the price below the marginal cost of driving an automobile; for rail, to make up for subsidies enjoyed by trucking such as public roadways (most rail tracks are privately owned and maintained; in Vermont, which has a high percentage of publicly owned tracks, rail companies must lease publicly owned tracks). The public funding or subsidies proposed to support public transportation and rail differ from subsidies that support car and truck transportation in that the former are meant to support transportation modes that cost the least on a societal basis; the latter, to support modes that have much greater full costs. The reason that subsidies are needed for public transportation and rail is to balance those already given to other more inefficient modes of

transportation, so that choices made by individuals are not skewed toward those that have a greater full cost but lower price. A least cost analysis (described more fully in the Least Cost Transportation Planning Strategy) can determine to what extent subsidies lower total societal transportation costs and to what extent those subsidies are justified.

The approach recommended here is to use both methods, better reflecting the full costs of transportation in the price and subsidizing public transportation. By increasing motor fuel taxes by a small amount ($0.05 per gallon), the price reflects more of the costs, resulting in a slight decrease in energy use. By using those revenues to leverage further energy efficiency, the energy and cost are multiplied and costs for taxpayers are lowered.

Either reducing subsidies given to traditional modes of transportation or increasing them to bus and rail will also help to address the obstacles related to inconvenience. To an extent, the level of inconvenience is a function of price. For example, commuters may find the extra minutes that public transportation might take to be not worthwhile when a bus fare is $0.15 per mile, but worthwhile if that fare was less than $0.05 per mile. Moreover, lower fares encourage more ridership, allowing more routes, a greater frequency of service, and more connections between modes of transportation.

Expanding the connections between modes of transportation is also important for making rail freight more convenient. Intermodal freight or the movement of goods with a combination of more than one mode of transportation, such as by rail and truck, can allow rail to serve those not directly on rail lines. Examples of intermodal transit include semi-trailers moved on rail cars and then by trucks to their final destination, double stacked containers moved by boat and rail, and Roadrailer trailers pulled by trucks or fitted with special wheels and pulled by a train. Currently only the first option is available in Vermont. Double stacked loads could operate in Vermont if certain bridge and tunnel clearances were increased. Vt. AOT is currently studying the feasibility of increasing those clearances.

The obstacles to more efficient modes of transportation from Vermont's land use and rural nature can be overcome by focusing efforts on reducing commuting and freight VMT, instances where large numbers of people and goods are moving at the same time along the same corridors. In addition, better land use planning in the future will also make public transportation a more viable alternative. (See the policy on Encouraging High-Density, Mixed-Use Land Use Planning.)

Bus Impacts

The savings from commuting and rail freight were evaluated separately. Buses were chosen instead of rail for modeling public transportation savings because over the short term they generally provide greater flexibility (routes and destinations can be changed as conditions change or if projections are incorrect) and because they tend to have lower costs. In Vermont, for example, the short term cost to upgrade railroad tracks to commuting speeds is quite high, driving up the cost per automobile VMT reduced (Vermont Rail Feasibility Study). However, the cost per VMT reduced is not the only measure of the benefit of investing in Vermont's rail infrastructure. Investing in rail transit infrastructure has long-term and non-monetized benefits that spill over to individuals and society, including benefits related to increased rail freight use, more efficient use of energy and natural resources, better air quality, lower construction and maintenance costs for roadways, and more accessible mass transit for young, elderly, and low income Vermonters. For example, Vermont Ski Areas Association has had recent success working with AMTRAK on promoting ski packages that include round trip train transportation. The long term and non-monetized benefits of increasing rail

infrastructure likely outweigh the short term costs, but to fully analyze these costs and benefits is beyond the scope of this Plan.

The cost per passenger mile of inter-city commuter buses was assumed to be $0.15 per mile, based on a conservative estimate of an average of 13.3 riders (slightly more than one-quarter capacity; savings would be much greater with higher occupancy) and a $2.00 per mile cost of the bus (American Bus Association, personal communication, June, 1995). The $2.00 per mile cost of the bus includes administration, capital, operation, and maintenance costs. Costs for parking lots were not included. Bus riders were assumed to use existing and expanded park-and-ride facilities. These facilities and the cost related to expansion of them are described in the Commuter Parking Lot policy. Vanpools and inter-city buses could also be funded with this money. Given Vermont's rural character, smaller buses and vans might be more efficient and cost-effective than buses on many routes. The cost per vehicle mile of smaller vehicles is less, but not significantly less than larger buses due to similar overhead costs and higher maintenance costs (Bate, personal correspondence, April 10, 1996). Costs and savings per passenger mile for smaller vehicles are quite similar to the estimates used for modeling this policy.

The commuting policy was modeled by assuming a $0.05 per gallon tax on motor fuels which would be used to fund commuter buses operating in major corridors in Vermont (those corridors best suited for such an operation include the Rutland-Burlington-St. Albans and Barre-Montpelier-Waterbury-Burlington corridors). The funds are used to buy down the bus fare so that commuters would pay about $0.04 per mile, which is less than the average cost of gasoline per mile for an automobile. Each million dollars of revenue therefore would subsidize approximately 667 thousand commuter bus miles, and would lead to an 8 million mile decrease in residential VMT. The decrease in residential VMT represents the elimination of 12 automobiles for each bus mile. This is less than the average 13.3 passengers because current automobile occupancy for commuting is approximately 1.1 persons per vehicle (Wilbur Smith Associates, 1994, 3-66). The buses were assumed to average 6 MPG; automobiles, 20 MPG. In addition, those using the buses were assumed to save $0.30 per mile in costs related to automobile use. In the early years of the program, this policy would add approximately 150 buses and vans to public transportation statewide.

For modeling purposes, the $0.05 tax was imposed in 1997, with the bus service not beginning until 1998. This time lag was necessary also for route research, preparation, and publicity. Anticipated energy and economic advantages would be slightly greater if the revenues could be recycled into the transit program more quickly. The energy and cost savings decrease in the later years as inflation erodes the value of the revenues generated by the $0.05 tax and the miles of public transportation that revenue can purchase.

This policy results in fairly substantial decreases in energy use and air emissions as more people choose public transit. The policy saves about 35.04 TBTU of energy, or 278 million gallons, cumulatively through 2020 compared to the base case. Transportation energy use falls cumulatively through 2020 by 2.3%, while greenhouse gases, acid rain precursors, and ozone precursors fall cumulatively by between 1.1%-1.7%.

These benefits occur in conjunction with monetary savings. Society saves $1.2 billion cumulatively compared to the base case with this policy through reduced energy costs, reduced air emission costs, and other reduced costs, such as less wear and maintenance on vehicles. The policy taxes of $370 million with this policy reflect the monies collected by the tax and used to fund the bus service. Per household residential energy expenditure goes down cumulatively compared to the base case with this policy by almost 1%, while disposable income goes up slightly. Gross State Product and job creation also increase with this policy.

This policy produces strong benefits to society, encouraging people both to drive less and use public transit. The policy's reduced energy use, reduced air emissions, reduced costs to society, and expanded economy make it worthwhile for Vermont to pursue.

Figure 4.II.10 Impacts of Shifting VMT to More Efficient Modes -- Commuter Bus
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.49	35.98	36.06	38.27	38.33	885.25	886.95
Commercial	11.99	17.82	17.84	19.34	19.34	22.21	22.22	486.65	486.84
Industrial	12.42	16.79	16.80	18.41	18.40	19.87	19.88	446.39	446.52
Transportation	42.10	60.54	59.21	64.68	63.02	70.98	69.36	1594.14	1557.08
Total	98.04	130.54	129.34	138.40	136.82	151.34	149.79	3412.43	3377.40

Table 4.II.13 Indicators of Shifting VMT to More Efficient Modes -- Commuter Bus
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2863.7	35.4	146.1	183.8	181.0	188.1	185.6	16.0%	15.6%	15.7%	15.5%	15.6%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3377.4	35.0	1.03%	164.7%	173.8	217.6	214.8	222.6	220.0

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2073.2	61.38%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.24%	63.27%	62.86%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
8,900	356	0.07%	($29)	$13

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($27.07)	$296	$50,780	$56,452	$56,586	$58,679	$58,795	26.91%	26.62%	26.42%	27.62%	27.32%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,398,000	11,773,000	11,652,000	2,633,000	1.05%	163.65%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,135,000	11,407,000	11,288,000	2,588,000	1.07%	162.67%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	1,300	0.35%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	300	0.31%	57.02%
Nitrogen Oxides (NO_X)	25,300	26,600	26,100	31,800	31,300	10,000	1.43%	123.72%
Volatile Organic Compounds	21,600	20,000	19,500	19,400	18,900	10,400	2.17%	87.50%
Carbon Monoxide (CO)	116,900	101,800	98,700	93,500	90,800	67,900	2.81%	77.67%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.04	($404)	($281)	($392)	($360)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

Rail Freight Impacts

Expanding the system of rail freight in the state was not modeled. The opportunity to switch from trucks to rail exists since truck counts on highways parallel to major rail corridors in Vermont show between 200 and 1,700 trucks per day. Current rail use in Vermont is equivalent to about 1,000 truck trips on Vermont highways each day (LS Transit Systems, 1993, 3-28). To achieve significant growth in rail freight, however, one of two things must occur: the price of large truck freight must more accurately reflect the full cost of that transport or state and federal funds must be used to offset an equal proportion of the full costs of rail transportation.

Implementation

Implementing the public transit policy would require passage of legislation at the state level raising the motor fuels tax and creating a dedicated fund for public transportation. Research into the most suitable routes would be required, as well as coordination with regional public transportation providers. Bus and van service could be publicly operated or contracted out to privately owned transportation companies.

Implementing the rail freight policy would require legislation and a shift in emphasis by AOT. Legislation is needed to increase user fees and lower weight limits for the heaviest vehicles on roadways, at both the federal and state level. To promote the use of rail freight within Vermont, public funding for rail improvements is crucial. Studies are needed to determine the most cost-effective rail improvements, and Vt. AOT would need to place a much greater emphasis on rail freight.

3. Policy: Encourage Non-Motorized Transportation

Encourage the use of energy efficient non-motorized alternatives to the automobile such as cycling and walking by undertaking the following actions:

- ***Continue to enforce and document compliance with 19 V.S.A. §2310 regarding the paving of shoulders to create an integrated bicycle route system***
- ***Use bicycle sensitive traffic sensors at intersections with traffic lights***
- ***Construct bike paths and create bike routes***
- ***Increase pedestrian and bicycle access to public transportation***
- ***Establish green bicycle projects***
- ***Establish police bicycle patrols***
- ***Establish green parking voucher programs***
- ***Reimburse employees for mileage when a bicycle is used for work purposes***
- ***Support efforts to build secure bicycle parking and workplace shower facilities***
- ***Require sidewalks along residential and urban roads***
- ***Improve pedestrian road crossings***
- ***Provide small "pocket" parks, resting areas, and benches for pedestrians***
- ***Internalize the full cost of driving***

(See *Florida Bicycle Facilities Planning and Design Manual*, Florida DOT, 1996 and *Handbook for Walkable Communities*, Michael Wallwork and Dan Burden.)

Rationale

Walking and cycling have great potential to complement other forms of transportation in Vermont. They are economical, clean modes of transport that require little space and no fuel. A bicycle, for example, costs about one-one-hundredth the price of an automobile, requires one-one-hundredth the energy and resources of an automobile to build, uses no fuel, has no emissions, and requires little space, both on the road and in parking lots (Lowe, 1989, 30). Furthermore, walking and biking are the only means of transportation readily available to the 25% of Vermonters who do not have a driver's license and the 16,854 households without an automobile (U.S. DOT, 1994, III-8 and U.S. Bureau of the Census, 1993, 1). Finally, there are well-documented health benefits from regular exercise such as walking or cycling.

Clearly, to increase energy efficiency, reduce pollution, and lower costs, walking and cycling are the most appropriate ways to make many short trips. There are, however, barriers that limit or rule out walking or biking as options. For some of these barriers, such as one's physical condition, the weather, the terrain, and the distance to the destination, little can be done to overcome them. There are a number of factors, however, that unnecessarily limit the use of walking or bicycling and these can be corrected.

The most important correctable hindrance to pedestrian and bicycle travel is the lack of safe, continuous routes to destinations. In addition to safe routes, walking and cycling require supporting facilities such as prompt snow removal during the winter. In winter, sidewalks are often in much worse condition than the streets. There should also be safer ways for bicyclists and pedestrians to cross rivers and other obstacles such as the Winooski River bridge in Burlington. Promoting walking and cycling also requires secure parking areas, links to public transportation systems, and showers and changing facilities at work. Finally, while there are significant savings to be gained by switching to walking or cycling for short trips, those who switch receive little cost savings because drivers do not now pay the full costs of driving. The specific recommendations that follow are meant to overcome some of the most significant correctable barriers to non-motorized transportation or to promote non-motorized transportation, thereby allowing Vermonters to take advantage of the energy and cost savings and health benefits associated with non-motorized transportation.

The are two broad options for providing continuous and safe routes for pedestrians and cyclists: 1) designating a portion of existing street space to non-motorized transport, and 2) creating separate lanes or paths for non-motorized transport. The option that is most appropriate depends on the particular situation. Sidewalks are well suited for pedestrians, but poorly suited for bicyclists. Multi-purpose paths, if they are wide enough, may satisfy the needs of pedestrians, younger riders, and occasional recreational cyclists, but they are generally not appropriate for commuters and more avid cyclists. Wider road shoulders are best suited for commuters, bicycle tourists, and more avid cyclists.

It is already state policy to provide paved shoulders on major state highways, and state law requires that shoulders be paved unless it is cost prohibitive to do so (19 V.S.A. §2310).[xxx] The Agency of Transportation should continue to enforce this existing statutory requirement. It would be easier to assess the success of, and compliance with, this policy if records were kept as to when paved shoulders were added to highways during construction, reconstruction, or resurfacing projects and when they were deemed too cost prohibitive. Such records are not currently available.

Another roadway improvement that would benefit bicyclists and help to better integrate bicyclists into the transportation network is to use traffic sensors that can detect the presence of bicycles as well as cars at signal lights.

The state supports and should continue to support non-motorized transportation through the construction of bike paths and the designation of bicycle routes. The Vermont Bicycle & Pedestrian Program provided funding for construction of approximately 28 bicycle and pedestrian path projects during the years 1991-93.

In 1994, over 50 additional projects were in a planning phase, and currently about 20 projects are under development in Burlington, South Burlington, Bennington, Colchester, Dover, Montpelier, Putney, Springfield, St. Albans, St. Johnsbury, Winooski, and elsewhere. This year, AOT's Bicycle & Pedestrian Program is working with the state's Regional Planning Commissions. Each RPC will submit two proposals and from this pool, 3-4 new projects will be selected. The Agency of Transportation should continue to develop and implement plans for a network of bicycle routes for local traffic in cities and towns throughout the state, with the aim of making it as easy for people to use non-motorized transportation as it currently is for persons who own cars to use motorized transportation. To further this goal, sidewalks and bike paths should be required in all new developments and should be added to existing infrastructure where possible.

The energy savings of bike paths and routes will depend on their location and use. While recreation paths are important for a number of reasons, it is unlikely that any energy savings can be attributed to them, since people often drive to these facilities to hike, rollerblade, or bike. Energy savings can be achieved where these paths connect with destinations such as downtown areas so commuters can use them to displace some or all of their driving or when they become abundant enough that people do not have to drive to access a recreation path. Bike routes that designate a portion of the road surface for cyclists are more likely to lead to energy savings. By separating cyclists from motor vehicles, they achieve some of the safety goals of paths, but they also allow the commuter to travel more quickly compared to cyclists on bike paths who must stop at all intersections and slow down frequently for pedestrians and slower cyclists.

To encourage walking, pedestrians must be safely separated from traffic and development must be conducive to walking. These can be difficult goals to achieve when most transportation facilities are built primarily for moving cars and not for moving people. For example, parking lots rarely provide a path for people to walk from the street or their car to their destination that is separate from the path of cars. Development that is biased toward the automobile, such as sparse or strip development patterns, can compound these problems and make walking an even less attractive option by increasing the distances between destinations.

The type of development most conducive to walking is not the post-World War II development that sets buildings near the middle of lots and surrounds them with parking. Pedestrian friendly development has more in common with the pre-War development patterns where structures were built up to the sidewalk line, with retail space below and low cost apartments above that is characteristic of many small Vermont towns. In other words, the same land use planning that preserves the unique character of Vermont's small towns is also the key to making them more pedestrian friendly. Parking issues will not disappear by adopting land uses of the last century, however. The need of motorists for parking still exists, but if that need can be met by parking in the rear of businesses and in peripheral lots, the needs of pedestrians can also be accommodated. (See the policy concerning Land Use Planning.)

Public transportation can also play an important role in increasing the use of non-motorized transportation, and the integration of public and non-motorized transportation can overcome barriers to each; public transportation alone cannot provide door-to-door service for many people and non-motorized transportation is limited by distances. Public transit can, however, overcome the barriers of distance while non-motorized transit can provide door-to-door service. The key is to integrate public transit with non-motorized transport to the greatest extent possible. Specifically, pedestrian and bicycle access to transit stops should be given priority over automobile access, and buses and trains should be capable of carrying bicycles on board (*e.g.*, bike racks on buses and baggage cars on trains).[xxxi]

Local communities should encourage the use of walking and bicycling by providing the facilities that support an integrated transportation network. In addition to roadway shoulders and sidewalks, and more dense development, bicycle parking facilities are also needed. Some cities require all new development that houses retail shops or services to provide bike racks.

Local communities can also implement green cycle programs in which safe, low cost bicycles (painted green) are available for use, by whomever needs them, in and around the downtown areas. People can pick them up and leave them at any of several designated bicycle racks within the community. Green cycle programs have been successfully employed on several college campuses. With Vermont's low crime rate and Vermonters' sense of responsibility, many small towns are excellent candidates for a green cycle program. These bicycles can be used to shorten the time to travel from remote parking areas to the downtown areas, or the time to move across town.

Increasing the use of bicycle police patrols is another energy saving use of bicycles that local communities should investigate. Several Vermont cities already use police patrols, including Burlington, Colchester, Essex, Montpelier, and South Burlington. Bicycle patrols reduce wear on police vehicles, save fuel, and can be an integral part of a department's community policing strategy.

Green transportation vouchers (described earlier in this chapter) provide employees parking fringe benefits in the form of cash for those who do not use parking facilities, thereby encouraging walking and cycling (as well as carpooling). Providing reimbursements to employees for bicycle transportation when used for work purposes (as is currently done with automobile transportation) will also encourage energy and cost savings. The city of Palo Alto, California for example, reimburses employees $0.07 per mile for business use of the bicycle (Lowe, 1989, 38). Employers can also encourage bicycling with secure bicycle parking, shower, and changing facilities.

Creating safe and attractive facilities for walking and bicycling will make it easier to use non-motorized transportation. Walking and bicycling can be much cheaper than motorized transportation. Until the full costs of driving (including parking and un-priced environmental and sustainability costs) are borne by drivers, however, the savings from non-motorized transport will not be fully passed on to people using these modes of transportation. Internalizing the unpriced costs and subsidies to motorized transportation will greatly increase the attractiveness of non-motorized transportation, without increasing the total cost of transportation. (See the Least Cost Transportation Planning section in this chapter.)

Impacts

This policy was modeled by assuming that a 0.5% reduction in residential travel could be captured by providing greater access to safe non-motorized transportation beginning in 1997. No estimates of costs necessary to achieve these savings were made. The cumulative cost savings of the policy compared to the base case, a total of $101 million (1995$), indicate that society could cost-effectively spend $101 million (1995$) during the next 23 years to achieve the 0.5% goal.

This policy produces relatively modest reductions in energy use and air emissions. Transportation energy use decreases cumulatively through 2020 compared to the base case by about 0.25% (3.97 TBTU). Cumulative reductions in air emissions range from 0.03%-0.31%.

However, as with several other policies in this section, society experiences reduced costs while achieving these benefits because of less vehicle travel. Energy costs decrease cumulatively by $43 million compared to the base case, air emission costs by $34 million, and other related costs by $24 million.

Similar to the telecommuting policy, this policy is a sound way to reduce the impacts of energy use while reducing costs to society. The policy also has the non-quantifiable benefits of improving traffic congestion and safety as fewer vehicles take to the roads, and improving human health as more people walk and bicycle.

Figure 4.II.11 Impacts of Encouraging Non-Motorized Transportation

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.27	38.27	885.25	885.22
Commercial	11.99	17.82	17.81	19.34	19.33	22.21	22.21	486.65	486.56
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.87	446.39	446.39
Transportation	42.10	60.54	60.39	64.68	64.52	70.98	70.81	1594.14	1590.17
Total	98.04	130.54	130.37	138.40	138.23	151.34	151.16	3412.43	3408.34

Table 4.II.14 Indicators of Encouraging Non-Motorized Transportation
Selected Indicators of Vermont Energy Goal, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2895.0	4.1	146.1	183.8	183.5	188.1	187.9	16.0%	15.6%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3408.3	4.1	0.12%	168.2%	173.8	217.6	217.3	222.6	222.3

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2104.5	61.75%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.64%	63.27%	63.23%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
(1,500)	(46)	(0.01%)	($3)	($1)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($16.47)	$34	$50,780	$56,452	$56,455	$58,679	$58,686	26.91%	26.62%	26.56%	27.62%	27.57%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,510,000	11,773,000	11,760,000	321,000	0.13%	165.17%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,245,000	11,407,000	11,393,000	314,000	0.13%	164.19%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	100	0.03%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	100	0.06%	57.19%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,800	31,700	1,200	0.17%	125.30%
Volatile Organic Compounds	21,600	20,000	20,000	19,400	19,300	1,100	0.23%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,500	93,500	93,300	7,400	0.31%	79.81%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	($122)	($163)	($172)	($210)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

4. Policy: Encourage Telecommuting

Encourage telecommuting as an alternative to the traditional daily commute to the workplace, particularly in areas where there are air quality problems, traffic congestion, or parking shortages.

Rationale

Telecommunications offers a unique opportunity to reduce VMT by totally removing the need for transportation in some instances. Advances in computers and telecommunications have made electronic connections between home and office an alternative to the traditional commute to the workplace. Employees can now work at home or at distributed telecommuting centers (telework sites) or satellite offices that are nearer to homes, thereby reducing the need for transportation.

"Telecommuting" refers to work, usually involving computers and other regular office resources, that is performed away form the regular office work-station. It generally requires a micro-computer at the remote site that is capable of being connected to the office site through telephone lines or internet connections. The remote site is often a home or a satellite office away from the primary office location, oftentimes in less expensive areas to build and closer to the homes of employees.

Telecommunications and telecommuting can support several worthy goals: improving air quality, reducing traffic congestion, alleviating parking shortages, and cutting gasoline consumption.

Land and office costs for the employer can be reduced as employees work at home or at less expensive satellite offices. Workers who telecommute several days a week can share office space in higher priced real estate areas. Telecommuting can give employees more flexibility to care for their families if they work at home, and can reduce or eliminate commuting times.

There are two major areas of concern about telecommuting that could limit the energy savings that are achieved. One area of concern includes workplace issues. While many telecommuters enjoy the flexibility that working at home or a satellite office permits, concerns remain about employee equity for those not given telecommuting privileges. In addition, the ability of employers to supervise telecommuters and the value of direct contact versus video and telephone conferencing are common issues.

The other major concern regards the future implications of telecommuting. With broad acceptance, telecommuting could create a sort of cultural change comparable in scale to the "Interstate Era," which transformed settlement and development patterns in the last half of this century. Some argue that telecommuting would shatter traditional workplace and employment patterns, which have generally required employees to live near their place of work. With telecommunications, workers need not live close to their place of employment. If the fewer trips to the workplace were replaced by longer trips, or if more dispersed land use patterns develop, telecommuting could actually increase VMT overall.

Impacts

This policy was modeled to show the impacts of a hypothetical, but reasonable, situation: the elimination of five round trips to work each month (substituting telecommuting) for 5% of the approximate 250,000 commuters. Since the average trip to work is 15.4 miles one way (Wilbur Smith Associates, 1994, *Vermont Transportation Usage and Needs: Survey of Vermonters*, 14), the policy results in a savings of approximately 1.135 million gallons of gasoline per year. The policy begins in the year 2000 and continues at the 5% rate

Figure 4.II.12 Impacts of Encouraging Telecommuting
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.27	38.27	885.25	885.21
Commercial	11.99	17.82	17.81	19.34	19.33	22.21	22.21	486.65	486.55
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.87	446.39	446.39
Transportation	42.10	60.54	60.35	64.68	64.48	70.98	70.78	1594.14	1589.38
Total	98.04	130.54	130.34	138.40	138.20	151.34	151.13	3412.43	3407.53

Table 4.II.15 Indicators of Encouraging Telecommuting
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2894.1	4.9	146.1	183.8	183.4	188.1	187.8	16.0%	15.6%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3407.5	4.9	0.14%	168.1%	173.8	217.6	217.3	222.6	222.2

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2103.7	61.74%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.63%	63.27%	63.22%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
(1,800)	(59)	(0.01%)	($2)	$0

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($15.86)	$41	$50,780	$56,452	$56,452	$58,679	$58,688	26.91%	26.62%	26.55%	27.62%	27.56%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,507,000	11,773,000	11,757,000	384,000	0.15%	165.13%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,242,000	11,407,000	11,390,000	377,000	0.16%	164.14%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	100	0.03%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	100	0.06%	57.19%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,800	31,700	1,500	0.21%	125.30%
Volatile Organic Compounds	21,600	20,000	20,000	19,400	19,300	1,300	0.27%	89.35%
Carbon Monoxide (CO)	116,900	101,800	101,400	93,500	93,200	8,800	0.36%	79.73%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	($122)	($83)	($175)	($203)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

for the entire period studied. The telecommuting policy illustrates that even a very modest growth in telecommuting could result in decreases in energy use and air emissions.

Transportation energy use decreases cumulatively through 2020 compared to the base case by 0.3% (4.8 TBTU). Impacts on emissions range from 0.03%-0.36% in cumulative reductions.

As with a number of other transportation-related policies in this Plan, telecommuting would result in a cost savings to society. About $78 million (1995$) would be saved over the 20 years compared to the base case (a $51 million reduction in energy costs and a $27 million reduction in operation and maintenance costs). In addition, society saves $41 million in reduced air emissions costs.

Given the fact that there is already a trend toward telecommuting, the benefits of this policy may be captured with little effort. Where telecommuting can be promoted in the near term, it is a sound way to capture some energy savings and air emission improvements while reducing costs to society. The challenge is to implement policies that encourage the best aspects of telecommuting and avoid the worst. To that end, policies should be targeted first at areas where there are air quality problems, traffic congestion, or parking shortages. In these areas, incentives offered to employers or employees for reducing commuter trips that are based on the value of avoiding, for example, road or parking capacity expansion, could be used. (See Strategy A. Least Cost Transportation Planning and Policy 3: Develop a Demonstration Project for Green/Parking Transportation Vouchers.)

5. Policy: Encourage High-Density, Mixed-Use Land Use Planning and Curtail Sprawl

Vermont's local and regional planning efforts should encourage land use patterns that reduce the need for transport and improve other energy efficiencies related to heating, cooling, and embedded energy. Specifically, high-density, mixed-use development should be encouraged in town centers and other growth centers. Low-density, single-use development that is characterized as sprawl should be discouraged.

Vermont's towns, cities, and regions should work to pass and implement municipal bylaws, zoning regulations, subdivision regulations, town plan guidelines, and other measures that promote energy savings or efficient use of energy through land use planning. Such bylaws, regulations, and guidelines would reduce transportation energy use, reduce heating and cooling needs, reduce embedded energy in infrastructure, and shift energy use to more efficient and renewable sources and systems by working toward the following goals.

To reduce transportation energy use:

- develop at increased densities, especially near town growth centers, public transit stops, and in areas with existing street, sewer, and water capacity to handle development
- use clustering of houses and buildings to shorten distances within developments
- infill (develop) vacant land parcels located within existing development
- combine different land uses within development projects and neighborhoods
- develop and support full utilization of mixed-use buildings
- provide convenience shopping and service facilities in otherwise residential neighborhoods
- allow increased use of homes for occupations
- create and improve infrastructure for pedestrians and bikers
- develop at densities that support public transit
- locate highest density development near public transit routes, and provide amenities and facilities to encourage public transit use

To reduce heating and cooling energy use:

- design developments in which buildings are oriented toward the sun
- develop south-facing slopes first
- landscape to shade buildings, parking lots, streets, and other paved areas
- design developments to take advantage of cooling breezes
- use windbreaks to protect buildings from winter winds
- avoid developing low areas where cold air drains and collects
- avoid developing locations where winds are strongest
- arrange buildings so they protect each other from the wind
- build housing with a lower proportion of outside surface area to interior space (*e.g.*, use more common walls and ceilings, compact building forms, and multi-family housing)
- encourage housing design innovations that save energy

To reduce embedded energy:

- develop at higher densities so more people can be served by sewers, water lines, streets, and other infrastructure
- develop areas that are already served by streets and utilities
- decrease design widths for state and local roads where possible
- use fewer and smaller parking spaces and lots where possible
- cluster buildings together to reduce the length of streets and utilities
- reuse existing buildings

To shift energy use to more efficient and renewable sources and systems:

- facilitate the use of district heating or other efficient production and distribution systems by developing at appropriate densities and with greater integration of uses
- facilitate the use of solar energy systems by developing so that access to sunlight is protected

In Vermont, bylaws, regulations, and guidelines that can help achieve these goals include: growth center designation, historic district and design control district designation, planned unit development and planned residential development designation that encourages clustered housing and mixed uses, density requirements, setback requirements, curb cut ordinances that discourage strip development, maximum permissible lot size, purchase of development rights, transfer of development rights, home occupation allowances, scenic and conservation easements, and public access easements.[xxxii] (See also Vt. ANR, 1991, *Vermont's Scenic Landscapes*, 29-30 and Vt. DPS, 1993, *Guide to Municipal Energy Planning*, 42-3.)

Rationale

Land use patterns define a town's transport system. Patterns of land development dictate whether people can walk or cycle to their destinations, whether they must travel many miles, and whether bus lines can attract enough riders. Thus, land use planning is a significant transportation planning strategy, and because transportation represents Vermont's largest sector of energy use, it deserves careful scrutiny for potential savings.

A town's, city's, or region's density is directly related to levels of gasoline use. Low-density development leads to a greater dependence on the automobile, more energy use, and greater pollution and greenhouse gas emissions. High-density development, by contrast, involves shorter travel distances, corresponding with more walking and cycling, more short vehicle trips, and more effective public transit. A number of studies

done since the late-1970s have demonstrated the relationship between residential density and travel mode choice (Parsons Brinckerhoff Quade and Douglas, 1993, 6). For example, gasoline use per person decreases dramatically as density increases in a study done of New York City areas. A study of cities around the world similarly has found that walking and cycling are higher in denser Western European and Canadian cities and lower in less dense U.S. and Australian cities (Lowe, 1991, 20).

Mixed-use buildings, neighborhoods, and growth centers also lead to less transportation energy use. Suburban developments in which residential buildings and neighborhoods are isolated from other uses require people to use vehicles for virtually every trip. However, when buildings and neighborhoods have a mixture of residences, workplaces, shopping, and services, people can more easily gain access to what they need without the necessity of vehicle trips. This is especially helpful for people with low incomes, whose proportion of income spent on energy can decrease if their vehicle transportation needs decrease.

However, there are also several other factors besides density and mixed-use neighborhoods that influence automobile use. These factors include the number of jobs located within a certain distance of residential areas and available pedestrian and biking infrastructure, as well as demographic factors such as household size, household income, number of workers per household, age of household head, and rate of car ownership (Parsons Brinckerhoff Quade and Douglas, 1993, 7). The relation of these factors with vehicle miles traveled per household was studied recently in Portland, Oregon. As shown in Figure 4.II.12a, increasing the pedestrian infrastructure, locating jobs closer to residences, and increasing residential density in Portland results in a direct decrease in vehicle miles traveled per household, while increasing household size, income, workers, or cars results in an increase.

Although the major energy savings of dense, mixed-use land patterns occur in the transportation sector, energy is also saved through reduced need for heating and cooling, reduced levels of embedded energy for public works and public buildings, and the installation of more efficient energy delivery systems. While some additional planning and measures are necessary to achieve reduced heating and cooling needs (as outlined above), other energy savings can be gained from dense, mixed-use development simply through the reduced levels of embedded energy in public works and public buildings. This occurs because low-density, single-use development is not designed to use resources efficiently, requiring more roads, bridges, electric, gas, phone, sewer, and water lines, schools, parks, libraries, museums, hospitals, etc. As a result, the cost of general infrastructure and embedded energy per capita rises (from both construction and maintenance), and public works, public buildings, and the capital invested in them can become duplicated, overextended, or underused. A study of Loudoun County, Virginia found that net public costs were about $2,200 per dwelling where the density was one unit per five acres, compared to $700 per dwelling where the density was 4.5 units per acre. This reflects the fact that low-density subdivisions require public services which are similar on a per capita basis to those required by higher-density areas, but convert much more land into development (Brabec, 1994, 283). High-density, mixed-use development not only uses resources efficiently and reduces embedded energy, it makes efficient energy delivery systems such as district heating (which requires a certain level of density) more feasible (Lowe, 1991, 29-31). In addition to the energy savings that can be gained from the high-density, mixed-use land patterns outlined here, there are non-energy-related benefits as well, including strong community connections and retention of open farm and forest land.

Vermont's land contains a mixture of usage patterns. Vermont is fortunate to have many traditional, compact, small- to medium-sized, mixed-use town centers. Many of these town centers are surrounded by contiguous traditional, residential neighborhoods which are often denser and have a greater level of mixed-use than most newer residential developments. These land use patterns already embody many of the ideal characteristics of a town with energy efficient transportation and infrastructure uses. Thus, the state's traditional town centers and connected residential neighborhoods provide a strong foundation on which to build further energy savings benefits.

Figure 4.II.12a Impacts of Land Use and Demographic Variables on Vehicle Miles Traveled in Portland, Oregon

Vermont also has some conventional suburban, low-density, single-use, residential development surrounding the cities and larger towns. More prevalent than these conventional suburbs, however, is a land use pattern of even lower-density, single-lot residences on rural roads. While these residences often are located on larger parcels of land than those in conventional suburbs, the land normally supports little or no farming functions. In both these land use patterns, the home is clearly separated from all other aspects of daily life, thus forcing residents to drive (often significant distances) for all their needs, increasing infrastructure costs and embedded energy, and creating development that one day could be too expensive for many to use as energy prices rise and external costs become more reflected in energy prices. Such land use patterns are encouraged not only by current land use policy, but also by artificially low transportation costs. As mentioned in other sections of the Plan, transportation energy prices that do not reflect the full costs encourage transportation and land use choices that are inefficient. Although low-density, single-use land patterns may benefit the people who live in such areas, many of the costs of these land use policies (*e.g.*, increased energy use, pollution, or infrastructure) are shifted to others. Such land use patterns should be limited by municipalities and regions in future development and efforts should be made to internalize the full costs of such development.

In addition to these land use patterns, there are also many farms in Vermont, and many undeveloped natural areas that include mountains, forests, and waterways, providing an abundance of scenic views and recreation opportunities.

The combination of traditional small towns, farms, and undeveloped natural areas not only contributes to more efficient energy use, but it also uniquely characterizes Vermont and much of New England, provides a high quality of life for residents, and attracts tourists. Furthermore, Vermont has a fairly long tradition of efforts (since the late 1960s) to preserve historic land use patterns and encourage compact growth centers (Humstone, 1995, 1-5). This tradition has led to the adoption of a number of statewide measures and mandates that encourage land use development as recommended here. Act 200, Vermont's planning and development act,

states that regional planning commissions and municipalities should:

> . . . plan development so as to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside. Intensive residential development should be encouraged primarily in areas related to community centers, and strip development along highways should be discouraged. Economic growth should be encouraged in locally designated growth areas, or employed to revitalize existing village and urban centers, or both. Public investments, including the construction or expansion of infrastructure, should reinforce the general character and planned growth patterns of the area (24 V.S.A. §4302).

Other statutes also require land use planning that preserves high-density, mixed-use development. A statewide goal of regional plans is to "reduce the wastes of financial, energy and human resources which result from either excessive congestion or excessive scattering of population," and municipal plans are required to contain "an energy plan, including . . . a statement of policy on patterns and densities of land use likely to result in conservation of energy" (24 V.S.A. §4347; 24 V.S.A. §4382).

These and other requirements and guidelines have led the state to promote and invest in the planning tool of "growth centers." A growth center is either a traditional settled area (a village or urban center) or a new area designated by the community for future growth (Humstone, 1995, 1). According to a Vermont Agency of Development and Community Affairs report, growth centers in Vermont are densely developed centers surrounded by rural open land that have a mix of uses, allow pedestrian access to goods, services, and jobs, and reflect historic settlement patterns. The report also details the maximum advisable land area for a growth center and recommended densities for residential, commercial, and industrial land uses (Research and Evaluation, 1995, 29, 33, 52-3).

Many towns and regions in Vermont have recommended or actively pursued measures to designate and plan for growth centers (due largely to the passage of Act 200). The concept of growth centers has support among many government officials, planners, developers, economic and community development specialists, environmentalists, and historic preservationists (Humstone, 1995, 3). In addition, there is increasing interest both in Vermont and across the country in traditional town centers and alternative town design. As a result, some of the greatest potential for increasing higher-density, mixed-use development in the state (with parallel energy saving benefits) lies in furthering efforts already underway in Vermont to define and plan for growth centers.

Reformulating zoning regulations has special potential to further such efforts. Zoning regulations put in place after World War II frequently create land use patterns that segregate activities and, as planner Randall Arendt has claimed, have "institutionalized the art of low-density suburban sprawl" (Arendt, 1994, 19). According to one of the leading architects of "neo-traditional" town development, conventional zoning regulations dictate three criteria for urbanism: the free and rapid flow of traffic, parking in quantity, and the rigorous separation of uses (Krieger, 1991, 96, 102). As a result, car traffic and reduced open space have become the norm. Furthermore, many of the characteristics necessary for compact growth centers such as narrow streets and smaller lot sizes are illegal today in many communities with zoning and subdivision regulations. A recent study that compared current zoning laws from 19 Vermont towns, land use patterns from four Vermont towns between 1915-1945, and standards proposed by current alternative town planners found that "patterns of historic centers could not be built today and be in compliance." In general, the report found, all dimensions of the current zoning regulations in the 19 Vermont towns are larger than the historic patterns and the alternative design standards, particularly the lot sizes, frontages, and front setback requirements (Research and Evaluation Specialists, 1995). However, alternative zoning regulations do exist that can help transform land use patterns back to the higher-density, mixed-use historic patterns. Architects Andres Duany and Elizabeth Plater-Zyberk, for example, have created a Traditional Neighborhood

Development zoning ordinance that prescribes specific physical conditions for restoring the option of developing in traditional patterns (Krieger, 1991, 102). Creating a similar set of zoning regulations specific to Vermont to use as a model for towns could help encourage more appropriate land use patterns.

Planner Randall Arendt has also suggested changes in zoning regulations that can assist in curbing standard large-lot development in rural areas. For instance, large open space requirements could be required of each parcel of land as it is developed. Using this method, 80% of each parcel could be required to remain an undivided block of land permanently restricted to farming, forestry, watershed management, wildlife habitat, informal recreation, or some combination of these. Developers would be entitled to the same number of lots they would normally receive, but would be restricted from spreading lots over the entire parcel of land. In addition, Arendt suggests many more techniques that can be used to preserve large areas of open farm and forest land and cluster development, including open space development designs, density bonuses, cluster ordinances, and landowner compacts (Arendt, 1994, 21-2, 229-42). Techniques that have been suggested to discourage large-lot residential development from encroaching upon large tracts of farmland in Vermont include agricultural zoning, agricultural districts, right-to-farm laws, and Act 250 criteria (Vt. Department of Agriculture, 1994). These types of regulations and techniques have the potential to limit low-density development in Vermont's rural areas, with corresponding reductions in transportation energy use and energy use related to infrastructure.

In Vermont, large lot development in rural areas has been encouraged by Environmental Protection Rules related to subdivisions that regulate sewage only for lots under 10 acres. Currently, the Agency of Development and Community Affairs, the Agency of Natural Resources, and other interested parties are working to gain comprehensive reform of these land-based sewage regulations. This reform is intended to eliminate the incentive to avoiding review, which has resulted in a prevalent sprawl of 10-acre lots throughout the state.

Land use patterns in both growth centers and rural areas can also achieve some of the goals described when local areas adopt Act 250 criteria into their zoning regulations. (See the text box on Act 250: Vermont's Land Use Law.) In many communities, Act 250 approval is not needed for many projects due to the small size of the projects and other factors. Several Vermont towns, including Manchester, Burlington, and Middlebury, have adopted Act 250 criteria to some degree in their zoning regulations. These towns have found that such regulations result in a more thorough and consistent review of projects outside Act 250 jurisdiction, greater consistency between local and Act 250 permits, earlier community involvement in project reviews, and shorter hearings or no hearings at the Act 250 level (Humstone, 1995, 1-2).

Revising zoning regulations is only a part of the work needed to further growth centers, however. Other growth center projects, many of which must precede the revision of zoning regulations, include hiring planners and other consultants (especially in Vermont's smaller towns), creating land use maps, resource inventories, growth studies, financial analyses, land use plans, and educating town officials and the public.

Many of these measures require funding in individual towns, although larger and medium-sized towns have been able to pursue some activities on their own in the past. Five Vermont towns got a boost for their growth center projects as a result of the Growth Center Pilot Project, funded between 1993-1995 with a small grant and administered by the Vermont Department of Housing and Community Affairs. Federal planning grant money also is available each year, and while there is strong competition for this money, the Department of Housing and Community Affairs has stated that growth center planning projects have high priority for that funding. State funding for planning grants or a set-aside amount for growth center projects would improve towns' and regions' abilities to pursue growth center projects.

Implementing land use policies that create dense, mixed-use development strongly supports some of Vermont's most important energy goals, including energy efficiency, sustainability, environmental

- state government should give priority to maintaining existing highways over new construction;
- state government should help conserve central business districts by withholding capital expenditures in aid of proposed malls and other developments that could undermine existing commercial centers;
- federal agencies that provide grants and loans for sewer, water, and wastewater treatment facilities should require local governments to design systems that channel new growth primarily into existing urbanized areas and to use pricing systems that reflect the economies of serving compactly settled areas;
- to prevent market forces from working against social goals, city and county governments should stop relying almost exclusively on zoning to control land use and make greater use of public service pricing (U.S. Congress, 1980, 42-3, 79, 82; see also Argonne National Laboratory, 1980).

Needless to say, these types of measures could further energy saving land use development. The fact such measures were taken seriously by politicians in 1980, illustrates that times of crisis produce creative solutions. In the future, as oil and other energy prices rise, a new focus on land use development could make some of the options explored in the study more popular and more essential for society to pursue.

soundness, and affordability. Funding the development of such policies will create energy and cost savings indefinitely into the future, as outlined in the section below.

Sprawl is the sort of development that happens without effective high-density, mixed-use land use planning. According to the Vermont Forum on Sprawl,

> Sprawl is low-density development that spreads or leapfrogs from compact urban and village centers along highways and into the countryside. Sprawl has resulted in the loss of valuable farmland, forest land and natural areas; air quality decline, auto dependence and reduced accessibility; higher costs for highway, utilities and education; ugly roadsides; the decline of downtowns and villages; and the erosion of community values. All of the programs, legislation, and activities that are identified in this policy and recommended for more vigorous efforts to encourage high-density, mixed -use land use are also ways to halt the spread of sprawl.

Impacts

The impacts of land use planning are difficult to model because the level of reduced transportation needs and improved efficiency will differ with each set of efforts. In addition, monetary costs of such planning

Figure 4.II.13 Impacts of Encouraging High-Density, Mixed-Use Land Use Planning
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.37	35.98	35.94	38.27	38.22	885.25	884.49
Commercial	11.99	17.82	17.76	19.34	19.24	22.21	22.10	486.65	484.62
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.87	446.39	446.47
Transportation	42.10	60.54	56.95	64.68	57.90	70.98	61.27	1594.14	1419.39
Total	98.04	130.54	126.86	138.40	131.48	151.34	141.46	3412.43	3234.97

Table 4.II.16 Indicators of Encouraging High-Density, Mixed-Use Land Use Planning
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2721.7	177.3	146.1	183.8	173.4	188.1	174.1	16.0%	15.6%	16.4%	15.5%	16.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3235.0	177.5	5.20%	145.5%	173.8	217.6	207.4	222.6	208.6

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
1942.8	60.06%	$0.087	$0.084	$0.081	$0.087	$0.082	65.58%	65.68%	63.93%	63.27%	60.79%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
(36,200)	(1,252)	(0.25%)	($11)	$31

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($29.89)	$1,301	$50,780	$56,452	$56,983	$58,679	$59,310	26.91%	26.62%	25.38%	27.62%	25.69%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	8,972,000	11,773,000	10,985,000	14,172,000	5.67%	154.28%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	8,715,000	11,407,000	10,630,000	13,959,000	5.76%	153.19%
Sulfur Dioxide (SO_2)	17,100	15,700	15,300	15,000	14,500	9,000	2.42%	84.80%
Suspended Particulates (PM-10)	6,000	3,400	3,300	3,400	3,300	1,600	1.93%	55.69%
Nitrogen Oxides (NO_X)	25,300	26,600	24,600	31,800	29,100	49,900	7.14%	115.02%
Volatile Organic Compounds	21,600	20,000	18,600	19,400	17,400	36,700	7.65%	80.56%
Carbon Monoxide (CO)	116,900	101,800	92,000	93,500	81,400	234,200	9.68%	69.63%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.93	1.05	0.98	($646)	($352)	($314)	($374)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy

and capital, operation, and maintenance cost of energy using devices

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

measures are unknown; in many cases, there are likely to be savings instead of costs due to the minimal need for additional infrastructure.

As a rough estimate, reduced transportation and energy demand from land use planning was captured through the model by assuming a 20% increase in efficiency of the residential transportation associated with *new residential construction only*. Transportation needs of existing residences were not changed for this policy, even though residents of existing communities would also see benefits as jobs and shopping were more efficiently located.

Reduced transportation and energy demand in the commercial and industrial sectors was captured by assuming a 10% increase in efficiency of the transportation associated with new construction in those sectors. No costs were associated with this policy in the modeling; however, costs would likely be incurred, especially as towns begin to change their traditional planning. Some of these costs were mentioned under the Rationale section.

The energy use reductions resulting from this policy are among the largest of any policy in the Plan. Energy is reduced by 5.2% (177.5 TBTU) cumulatively through 2020 compared to the base case, while transportation energy use falls by about 11%. All air emissions also experience significant reductions through this policy; greenhouse gas emissions and acid rain precursors both fall cumulatively by 5.5%-5.7%, while ozone precursors fall by 7.4%.

Gross State Product and job creation are lower with this policy compared to the base case. This is due to a reduced need for automobile-related products and services. Employment in sectors of the economy not directly related to the automobile remains virtually unchanged or actually grows compared to the base case.

Energy affordability indicators show the greatest improvement as a result of the policy, as transportation expenditures fall cumulatively by 11.4% (1.8 billion) and non-energy, transportation-related costs decrease by approximately $3.4 billion (1995$). Overall, society experiences significant reductions in costs with this policy. About $6.6 billion is saved through reduced energy costs, air emission costs, and other costs related to reduced VMT, such as less car maintenance and extended vehicle life. As explained, costs associated with implementing this policy were not included in the modeling. While these costs could be quite large, they could easily be offset by the $6.6 billion reduction in other costs.

6. Policy: Pay-at-the-Pump Auto Liability Insurance

Institute a private, no-fault motorcycle, automobile, and light truck liability insurance system in which the premiums are collected at the gas pump, with motor vehicle registrations, and with a surcharge on traffic violations.

This type of auto liability insurance program is often referred to as pay-at-the-pump auto liability insurance even though some of the premiums are collected at the time of registration and with traffic violations.

In Vermont, approximately $100 million worth of liability premiums are written each year (A. M. Best, 1994 Edition, A2-46-42).[xxxiii] A pay-at-the-pump insurance plan would require between $80 and $100 million, depending on potential savings and the level of coverage desired (see below for more information). Premiums collected at the pump (about $0.10 per gallon of gas or diesel) would make up about one-third of the total revenue needed. The rest would be collected from a traffic violation insurance surcharge and at the time of registration. The surcharge would vary depending on the severity of the infraction, from 100-150% of the fine for speeding, to $3,000 for DUI and Careless and Negligent Operation. The registration premium would be calculated using characteristics of the vehicle (such as purchase value, age, size, or type), its use

(such as for business), and characteristics of the owner (such as owner's driving record). Revenue and sources are presented in Table 4.II.19, Pay-at-the-Pump Premiums.

The extent of the coverage that $100 million would purchase is significantly greater than the current standard required by 23 V.S.A. §800 and §801 ($20,000 per person, $40,000 per accident, $10,000 for property damage). Determining the exact coverage requires further statistical analysis but it would be near the amounts most insurance companies recommend ($100,000 per person, $300,000 per accident, $50,000 for property damage). A three-year sampling of insurance coverage limits from a statistical agent representing 58% of Vermont's auto liability market share is presented in Tables 4.II.17 and 4.II.18. The average and median coverage levels that $100 million currently purchases are in Class 8, and it is very likely that a pay-at-the-pump insurance plan could insure all vehicles to similar Class 8 level protection. If additional liability insurance or comprehensive and collision insurance is desired by vehicle owners, it could be purchased at the time of registration or purchased independently.

At the time of registration, motorcycles, cars, and light trucks would be grouped into blocks of 2,500 or 5,000 (or possibly larger) that are representative of the Vermont driving population and vehicles. Private insurance companies would bid on these groups. The company winning the bid would be paid from an account that held the gas pump premiums, violation surcharges, and registration premiums.

As is currently the case, some oversight of the insurance industry would be required, as well as oversight of the awarded bids to see that the terms of the contracts are met and that drivers are receiving the protection they purchased.

Rationale

The total cost of owning a vehicle can be divided into fixed and variable costs. Fixed costs, which make up the greatest share of total costs are, for the most part, independent of the miles driven. They include fire, theft, collision, and liability insurance; license, registration, and taxes; and depreciation and finance charges. The variable costs vary with the amount of driving done. These costs, which include gas, oil, maintenance, and tire costs, are quite low, and make up only a small portion (20%) of the total costs of owning and operating a car.[xxxiv] The cost of fuel is the only variable cost that significantly affects our driving habits. Gasoline costs only $0.03 to $0.08 per mile for most cars and generally makes up only 12% of the total costs of owning and operating a car (see Table 4.II.20, Costs for 1994 Intermediate- Sized Car).

If all the fixed costs were variable costs (if drivers actually had to pay $0.46 each time they drove a mile in a new intermediate-sized car), driving habits would be quite different and our total transportation costs would be much lower. Since each mile would cost an additional $0.46, there would be a strong incentive to combine trips, ride share, or use public transportation. In many cases, people would decide that their money could be better spent on activities other than driving. Yet, people who drove the same number of miles as they do now would pay no more than they currently pay.

In addition, a very significant change would occur in the area of public transportation, which tends to be much more energy efficient and less costly than automobile transportation. Buses, for example, use 75% less energy per passenger mile than a single occupant automobile, and the per person, per mile cost is less than $0.15 (Gordon, 1991, 33).[xxxv] This is quite inexpensive compared to the $0.46 for a solo driver, but more people do not take advantage of public transportation's energy and cost savings because it is quite expensive compared to the cost of gasoline use at $0.03 to $0.08 per mile. Measures that increase the variable cost of driving make buses more competitive with the costs people base their transportation decisions on when they already own an automobile: the price of gasoline.

Table 4.II.17 Vermont Liability Coverage, Single Limit

Coverage Class	Liability Coverage Limits (Dollars)	1992-1994 Average Number of Cars Insured per Year (Avg. Earned Exposure, Car-Years)	Percent of Vehicles in Coverage Class
4	45,001-70,000	73	0
5	70,000-75,000	4,619	5
6	75,001-125,000	20,812	23
7	125,001-200,000	680	1
8	200,000-300,000	49,805	55
9	Over 300,000	14,459	16

Table 4.II.18 Vermont Liability Coverage, Split Limit
(per person and per accident)

Coverage Class	Coverage Limit Per Person (Dollars)	Coverage Limit Per Accident (Dollars)	1992-1994 Avg. Number of Cars Insured per Year (Avg. Earned Exposure, Car-Years)	Percent of Vehicles in Coverage Class
4	15,000-20,000	30,001-40,000	3,542	7
5	20,001-25,000	40,001-50,000	2,602	5
6	25,001-50,000	50,001-100,000	6,392	13
7	50,001-100,000	100,001-300,000	9,207	19
8	100,001-500,000	100,001-1,000,000	26,087	54
9	Over 500,000	Over 1,000,000	525	1
1	All Other	All Other	867	2

Source: Insurance Services Office, Inc., Memo, 12/22/95

While it is not the case that all costs are assessed as variable costs, to the degree that fixed costs could be shifted to variable costs, Vermonters would experience price signals that would encourage energy efficiency without increasing the total costs of transportation. The cost of liability insurance is a good candidate for such a shift because it is a cost that varies depending on the miles driven (along with other factors). Similarly, roadway construction, registration, and license fees could be shifted to motor fuels tax. (See 4.II.E. Policy 3: Shift Registration and License Fees to Motor Fuels Tax.)

Pay-at-the-pump auto insurance is one way to encourage energy and cost savings by shifting a fixed cost, liability insurance, to a variable cost. By collecting some of the premium at the gas pump, variable costs

Table 4.II.19 Pay-at-the-Pump Premiums

(Millions of Dollars)

Source of Revenue	Low Estimate of Revenue Needed	High Estimate of Revenue Needed
$0.10 per Gallon Premium at Gas Pump	33	33
Premium Collected from Surcharge on Non-Criminal Motor Vehicle Violations (Primarily Speeding)	12	12
Premium Collected from Surcharge on Criminal Motor Vehicle Violations (Careless and Negligent, DUI, and Driving Without Operator's Permit)	18	18
Premium Collected at Registration Based on Vehicle Type and Use	17	37
Total Premium Collected	80	100

Table 4.II.20 Costs for 1994 Intermediate-Sized Car

Variable Costs Cents Per Mile and % of Total Cost								Costs Per 10,000 Miles Dollars			Total Cost in Cents Per Mile
Gas and Oil		Maintenance		Tires		Total		Variable Costs	Fixed Costs*	Total Costs	
5.6	12%	2.5	5%	1.1	2%	9.2	20%	920	3,745	4,665	46.65

* Assuming a 6 year or 60,000 mile retention cycle; costs include fire, theft, collision, and liability insurance; license, registration, and taxes; and depreciation and finance charges.
Source: AAMA, Facts and Figures 1994, 56

increase but fixed costs decrease by an equal or greater amount. Since premiums paid at the gas pump are proportional to the miles driven, drivers would have an incentive to purchase more fuel-efficient vehicles, drive less, or switch to other forms of transportation; but they would pay no more for transportation than they currently pay if they choose not to make any changes.

The insurance premium surcharge on speeding tickets would also lead to energy savings. As discussed in the two policies regarding speed limits, driving at higher speeds is both more dangerous and requires significantly more energy. By increasing the penalty for speeding, the surcharge would lower speeds on Vermont's highways, reduce fatalities, and reduce energy use. This too would lead to a further decrease of insurance costs. (See Chapter 4, Section II.B. and the two policies on speed limits for more information on the safety and energy impacts of lower speeds.)

In addition to the cost and energy savings, the savings from public transportation, and the advantages of increased safety, there are also insurance advantages to a pay-at-the-pump liability insurance. Because it sets a consistent and much higher minimum insurance level for the state than currently required by law, it alleviates the problem of underinsurance and eliminates Vermont's uninsured motorist problem. Currently, Vermonters who purchase insurance bear the costs of under- and uninsured motorists. Vermont's 1994 uninsured and underinsured motorist bill was approximately $3.5 million (Insurance Services Office, Memo, 12/22/95). A typical liability policy includes a $15 to $30 premium to cover accidents with under- or uninsured motorists. This reflects an unfair premium paid by responsible drivers for those who break the law or do not carry

insurance equal to their liability that could be eliminated by pay-at-the-pump insurance.

In 1986, Vermont enacted the legislation requiring liability insurance. The percent of uninsured drivers in accidents initially fell to 6% from an average of 21.8% before the requirement but has since risen to between 12% and 16% (Vt. Department of Banking, Insurance, and Securities, Memo, November 20, 1991).[xxxvi] Since any driver would be using fuel, if the price of the fuel included pay-at-the-pump insurance, there would be no uninsured motorists. This would eliminate the need for uninsured policies (except for accidents out-of-state), a significant savings for the drivers who now have insurance.

Pay-at-the-pump insurance would also lower insurance costs for drivers, saving them money. It would eliminate sales and some underwriting costs of auto liability insurance. Nationwide, commission and brokerage charges are 7.5% of the total liability insurance costs (A. M. Best, 1994 Edition, 325). In Vermont, that would be a savings of $7.5 million per year. There are also savings from economies of scale (writing policies for 2,500 to 5,000 vehicles or more) and from competition among insurance companies bidding for group insurance plans that could save additional money. Finally, no-fault insurance in which victims are compensated for damage by their own insurance without assessing blame would reduce civil litigation, further reducing the cost of insurance. It is estimated that a pay-at-the-pump insurance plan could save a total of 20% or about $20 million in Vermont (National Insurance, 3).

The exact savings Vermont would realize from a pay-at-the-pump insurance plan depends on two factors. The first is the ability of a pay-at-the-pump insurance plan to attain the estimated savings. Because of the lack of experience, it is uncertain how much of the potential savings can actually be achieved. The second factor is that the savings will depend on the exact level of coverage Vermont chooses to purchase. It is conceivable, for example, that the savings could be used to purchase a higher level of coverage. Pay-at-the-pump insurance was modeled in this plan without assuming any insurance cost savings. The energy savings alone provide significant economic incentive for this program, although significant insurance cost savings could be achieved.

There are also disadvantages and obstacles to pay-at-the-pump insurance. One is that no state as yet has adopted such a plan. Implementation would put Vermont in the familiar role of leader, a role that has risks. The strongest opposition may come from insurance companies. Some of the savings from pay-at-the-pump insurance come from reduced costs for brokerage, marketing, and advertising. These reduced costs for consumers are reduced revenues for insurance companies. Overall, however, the economy will benefit from the more efficient use of resources.

Pay-at-the-pump insurance also gives rise to a perception of increased government interference in the insurance industry and individual decisions. This problem is mainly one of perception, however. First, pay-at-the-pump insurance relies on private insurers to underwrite the policies. The state would have the minimal roles of collecting premiums through existing mechanisms (with gas taxes, traffic fines, and registration fees), overseeing the bidding process, and ensuring that the obligations of the contract are fulfilled. Second, auto liability insurance is already required by law, including the requirement of specific minimum coverage. Increased liability coverage (both in terms of persons covered and amount of coverage) is in the interest of drivers, since it eliminates their need to carry insurance to cover the under- or uninsured. Third, Vermonters would still be free to purchase additional coverage as they wish, either at the time of registration or from an insurance agent.

Determining Premiums In Vermont. Theoretically an insurance premium of $0.30 per gallon of gasoline or diesel fuel would cover Vermont's liability insurance needs, but collecting the premium entirely at the pump would not address equity or border issues. The equity issues arise because collecting all premiums at the

pump would not allow premiums to be distributed, depending on crash risks other than mileage traveled. The border issues arise because Vermont is a small state, and needs to consider the impact near its borders of a $0.30 increase in the cost of motor fuel. If the difference between fuel costs in Vermont and nearby states is

too great, drivers will make fuel purchases in states with lower prices, and Vermont could lose business, tax revenue, and insurance premiums.

Determining the balance between premiums collected at the pump and what each individual should contribute toward insurance premiums raises many difficult questions. What is the value of lost lives in traffic accidents? When is it acceptable to discriminate against individuals due to some characteristic of the group to which they belong? (For example, members of various groups categorized by age, sex, marital status, amount of driving, type of vehicle, geographical location, and driving record have quite different probabilities of being involved in crashes.)[xxxvii] The equity and actuarial questions would require public participation and expert analysis, but certain conclusions about pay-at-the-pump insurance can be drawn.

The loss of business and revenue due to border problems would not occur at lower gas pump premium levels. At lower levels, however, the energy savings are also reduced. The best solution would be to set the gas premium as high as possible without sending significant sales to other states. Vermont has a low gas tax compared to the other New England states and is the only state not using reformulated gasoline (which adds about $0.05 per gallon) (see Table 4.II.21, Tax Rates on Fuels). Therefore, Vermont has a price advantage over several of its neighbors and could raise its prices.

Table 4.II.21 Tax Rates on Fuels
Cents per Gallon

State	Gasoline	Diesel Fuel	LPG
Vermont	19.00	17.00	16.00
New York*	27.56	29.56	13.00
Massachusetts	21.00	21.00	9.7^
New Hampshire	18.80	18.80	18.80

* Includes approximately 5 cents for the 4% sales tax (charged on the pump price, including federal motor fuel tax)
^ 15.5% of average price from distributor to retailer set quarterly

Sources: Vt. Joint Fiscal, 1998, U.S. DOT, 1994, IV-50, and U.S. DOE, 1995, *Petroleum Marketing Monthly*, July, 164, and U.S. DOE, 1994, *End-Use Taxes*, 81

With an increase in the gasoline tax, Vermont stations in some areas could have a competitive disadvantage with stations directly across some borders. Prices along the same road often vary by $0.05 per gallon, and the Vermont DPS monthly fuel survey of 20 service stations typically shows a variation of $0.20 per gallon for regular unleaded gasoline sold within the state. The wide variation in price within the state suggests that convenience is often more significant to fuel purchase decisions than a few cents per gallon price difference.

A gas pump premium of $0.10 per gallon would ensure that persons who drive more or use heavier vehicles will pay more for insurance than those who drive less.

The equity issues related to varying risks can be resolved by matching the risk of crashes with surcharges on the violations most often related to crashes. Given the importance of life, and the fact that liability insurance can replace property but cannot change lives lost or irreversible injuries, the most important risk groups are those who cause the most serious injuries and deaths: speeders, careless and negligent drivers, and persons driving while under the influence of alcohol.[xxxviii] (See Table 4.II.22, Seven Most Common Operator Causes of Crashes in Vermont.)

For the purposes of this plan's analysis, the surcharges and fees that allow the risks of crashes to be represented in insurance premiums are assumed to be:

- a 100-150% surcharge on fines for speeding and other violations regarding operation of a vehicle, yielding $12 million in premiums (before the 1996 fine increases went into effect, fines averaged about $8 million per year);
- a $3,000 surcharge imposed upon convictions for certain criminal traffic violations (DUI and careless and negligent driving), yielding $18 million on 6,000 convictions per year;[xxxix] and
- a risk adjusted annual surcharge on vehicle registrations averaging less than $90 (possibly as low as $40 if potential savings from the elimination of brokerage costs, group insurance plans, and economies of scale can be achieved), but depending on driver history and vehicle type, yielding $17 to $37 million dollars.

Speeding, which accounts for 18% of the driver-caused fatal crashes and 15% of the total crashes would contribute about 12% of the liability insurance costs. Drunk driving and careless and negligent driving, which accounted for 44% of fatal crashes and 15% of all driver-caused crashes, contribute another 12% of liability costs. The 150% and $3,000 insurance premium surcharges may seem large. For example, what is now a $50 ticket could cost a speeder $125 if the full 150% surcharge is added. It is important to remember, however, that the surcharges represent a one-time cost. Currently, insurance premiums due to these offenses are less per year but premiums generally remain high for three or more years following a violation or conviction. In the case of the $3,000 surcharge on criminal convictions, the total costs paid are similar or slightly higher under this pay-at-the-pump liability insurance proposal than current insurance policies. Payment plans could be used to spread the costs out over time as occurs now, and therefore alleviate some of the financial burdens caused by the surcharges.

The remaining $17 to $37 million dollars needed for auto liability premiums would be assessed each year at the time of registration or licensing. Initially, this would be based in part on one's previous driving record, as well as on characteristics of the vehicle and its use. In the future, as public support and border issues permit, further energy and transportation savings could be achieved by shifting more of the costs at registration time to the gas pump.

Impacts

This policy was modeled by applying a $0.10 per gallon insurance fee (in 1997 dollars) to gasoline (not other fuels) and by reducing the cost of insurance by a similar amount by returning the income generated by the fee to consumers. The modeling and policy assumptions are quite similar to those used in the Property Tax, Police and Fire, and Registration Fee policies in the Transportation Energy Taxation Strategy.

This policy results in fairly substantial benefits in reduced energy use and air emissions. Total energy use falls cumulatively through 2020 compared to the base case by 1.34% (45.9 TBTU) with this policy, while transportation energy use falls cumulatively by about 3%. Greenhouse gases, acid rain precursors, and ozone precursors also decrease cumulatively by between 1.4%-2%.

While there are costs associated with this policy (increased gas pump prices), society recovers those costs and

more through reductions in other costs (insurance, air emissions). Per capita residential energy expenditure rises because insurance costs are considered "energy costs" as this policy is modeled. However, per capita disposable income also rises as people drive less or drive more efficient vehicles, and therefore purchase less gasoline. Other economic benefits include increases in job-years and the GSP.

Table 4.II.22 Seven Most Common Operator Causes of Crashes in Vermont; Three Year Totals, 1991-1993

Causes	Type of Crash (by Most Serious Result)			Total	% of Total
	Fatal	Injury	Property		
DUI*	69	757	323	1149	6.1
Failure to Maintain Control (Careless and Negligent)	51	738	862	1651	8.8
Excessive Speed	51	1441	1292	2784	14.8
Left of Center Line	27	338	320	685	3.6
Failure to Yield	14	1406	2179	3599	19.1
Inattentive	8	1122	1772	2902	15.4
Following Too Closely	1	791	895	1687	8.9
All Others	30	1467	2902	4401	23.3

* Includes use of drugs and alcohol, and those who had been drinking but were not above the legal limit.

Source: Vt. Governor's Highway Safety Program, *Vermont Crash Data Resource Book 1993, 1992, and 1991*, Table 3.5)

D. Strategy: Reduce Transportation Related Emissions

This strategy encompasses a set of policies that would reduce the levels of carbon dioxide and other pollutants released as a result of transportation fuel use. Driving a car or truck is probably the most energy consumptive and polluting activity a typical Vermonter undertakes. The average car emits about half a ton of non-carbon dioxide air pollution each year and five to six tons of carbon dioxide. The cumulative impact of individual vehicles is quite large. Transportation was responsible for 43% of the total greenhouse gases, 72% of the ozone precursors, and 54% of the acid rain precursors released in Vermont in 1995 (see Figures 3.III.25 and 3.III.29). Transportation fuel use, therefore, requires special consideration as Vermont seeks to reduce the costs and impacts of energy use.

The environmental damage that results from transportation energy use can be reduced by using vehicles less (see Reduce Vehicle Miles Traveled strategy), by using fuel more efficiently (see Increase the Efficiency of Vehicles strategy), and by reducing the emissions from vehicles. Noteworthy progress has been made in this last category during the past 20 years. Lead has been phased out of gasoline, significantly reducing the

Figure 4.II.14 Impacts of Pay-at-the-Pump Auto Liability Insurance
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.40	35.98	36.01	38.27	38.32	885.25	886.03
Commercial	11.99	17.82	17.86	19.34	19.38	22.21	22.24	486.65	487.47
Industrial	12.42	16.79	16.80	18.41	18.41	19.87	19.89	446.39	446.61
Transportation	42.10	60.54	59.15	64.68	62.67	70.98	68.73	1594.14	1546.46
Total	98.04	130.54	129.21	138.40	136.47	151.34	149.17	3412.43	3366.58

Table 4.II.23 Indicators of Pay-at-the-Pump Auto Liability Insurance
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2853.0	46.0	146.1	183.8	180.1	188.1	184.4	16.0%	15.6%	15.8%	15.5%	15.7%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3366.6	45.9	1.34%	163.2%	173.8	217.6	213.9	222.6	218.7

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2063.4	61.29%	$0.087	$0.084	$0.085	$0.087	$0.087	65.58%	65.68%	65.15%	63.27%	62.70%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
15,100	636	0.13%	($32)	$11

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($5.19)	$353	$50,780	$56,452	$56,196	$58,679	$58,474	26.91%	26.62%	26.86%	27.62%	27.77%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,370,000	11,773,000	11,602,000	3,622,000	1.45%	162.95%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,107,000	11,407,000	11,238,000	3,571,000	1.47%	161.95%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	14,900	1,300	0.35%	87.13%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	400	0.45%	56.86%
Nitrogen Oxides (NO_X)	25,300	26,600	26,100	31,800	31,200	13,300	1.90%	123.32%
Volatile Organic Compounds	21,600	20,000	19,600	19,400	18,900	10,700	2.23%	87.50%
Carbon Monoxide (CO)	116,900	101,800	98,800	93,500	90,500	68,900	2.85%	77.42%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.96	1.05	1.03	$204	($105)	($118)	($66)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

amount of lead in the atmosphere and the health risks from exposure, particularly for young children. Catalytic converters have decreased the unburned hydrocarbons emitted by automobiles, significantly decreasing ground-level ozone and smog. Other pollution control devices on cars prevent gasoline from evaporating and escaping into the atmosphere before it is burned, greatly decreasing the release of unburned hydrocarbons.

Most attempts to reduce emissions have focused on more thorough combustion, thereby converting unburned hydrocarbons to heat and carbon dioxide. Even the "cleanest" engine, therefore, still emits a very important pollutant: carbon dioxide. Burning fuel more completely is not a solution to pollution from carbon dioxide. Switching to fuels that emit less carbon dioxide is beneficial, but to significantly reduce carbon dioxide emissions, Vermont must reduce VMT, greatly increase the efficiency of vehicles, and switch to fuels such as alcohol or hydrogen if they are made in ways that do not release carbon dioxide from fossil carbon sources.

Vermont has a special interest in strengthening regional and national automotive pollution standards. Vermont's reputation as a clean and attractive state is threatened not only by instate automobile emissions, but also by pollution that is blown into Vermont. Pollution levels at the higher elevations of the White and Adirondack mountains, for example, have exceeded federal standards. Vermont's leadership and participation in the Northeast Regional Ozone Transport Commission, a group of 12 states and the District of Columbia working to reduce transportation emissions, is an important means for Vermont to reduce pollutants blown into the state from elsewhere.

The policies in this section utilize a variety of approaches to make transportation fuel use more environmentally sound. The first policy recommends an automobile emissions check program. Emissions control devices have been added to automobiles because they represent one of the most cost-effective ways of reducing emissions. An emissions check program is planned to ensure that those systems are working as designed. The second policy is aimed at preventing the evaporation of gasoline during refilling at service stations. Approximately 600,000 gallons of gasoline evaporate into the air each year at filling stations. This unburned gasoline represents a significant waste of energy as well as an environmental and health hazard. Unburned gasoline is much more damaging to the environment and human health than gasoline that has been completely burned.

The third policy involves the implementation in the Northeast and Vermont of a Low Emitting Vehicle (LEV) program identical to California's. The best way to reduce future vehicle emissions is to build and sell vehicles that have the lowest possible emissions. The final policy seeks to increase the use of cleaner alternative transportation fuels and electric vehicles by encouraging a market for these fuels.

1. Policy: Implement a Vehicle Emissions Check Program

Emissions control devices have been added to automobiles because they represent one of the most cost-effective ways of reducing emissions. An emissions check program ensures that these systems are working as designed.

This program would require the inspection and maintenance of automobile emissions and exhaust systems biannually. The inspections could occur at a centralized test-only facility located in each county or geographical area. Repairs, if necessary, would be done by the owner or service station and then rechecked at the test facility. Test-only facilities avoid the problem of widespread cheating experienced in states that have test and repair facilities (U.S. EPA, 1995, *I/M Briefing Book*, Sec. 4, 34). The test to be used is a "loaded transient test," meaning that a car is put onto a treadmill and driven as if it were in actual traffic conditions, such as accelerating and decelerating in simulated city and highway conditions. Emissions are

monitored during this process. The goal of the program is to ensure that the air pollution control equipment installed on a vehicle at the time of manufacture is maintained in proper operating condition.

The program would be phased-in over time, starting with Chittenden County which is currently under EPA sanctions because it does not have a testing program, and then expanding to other parts of the state. Vehicles to be tested are automobiles and light trucks built since 1980. The test would not apply to older vehicles because they do not have emissions control devices. Vehicles would be tested every two years. For vehicles that fail, the first retest after repairs are made would be free. There is also a $400 repair cost cap to set a maximum cost to drivers.

The test cost would be less than $30. Test contracts awarded in other states for centralized test-only facilities have ranged from $18 to $24 (U.S. EPA, 1995, *I/M Briefing Book*, Sec. 4, 15). An administrative charge of $5 would be added to the test fee. The contractor awarded the emissions check contract through a competitive bid process would be responsible for the capital costs of test facilities.

The 1990 Clean Air Act Amendments require an auto emission check program in all Metropolitan Statistical Areas (MSAs) with a population of 100,000 or more in the Northeast (including the Burlington, Vt. MSA) regardless of air quality, and in other areas of the country based on air quality. The reason for extra requirements in the Northeast is because of the documented interstate transport of air pollution throughout the Northeast. Vermont is currently under sanctions from the EPA for not implementing an auto emissions check program.

Rationale

Passenger cars and light trucks are responsible for more than 85% of the vehicle miles traveled (VMT) in Vermont, and a comparable portion of the gasoline consumed. Similarly, motor vehicles are responsible for nearly 70% of the air pollution created in Vermont (Vt. ANR, 1993, *Air Pollution Emissions Inventory*). Vehicle miles traveled are constantly increasing, as is the number of motor vehicles registered. Vermont has more passenger cars registered per capita than the national average and any other New England state. Similarly, the per capita annual VMTs in Vermont are exceeded by only six other states in the country (U.S. DOT, 1992, *Our Nation's Highways*, 36-7). Therefore, Vermont energy and pollution patterns are strongly affected by energy consumed and pollution created by the use of automobiles.

In the past, the principal approaches taken toward addressing the energy consumption and pollution generation of motor vehicles were through technology to increase the fuel efficiency of the vehicle, and equipment to abate its emissions (as opposed to trying to influence habits of drivers). This reliance on the installation of technology and equipment necessitates that the equipment function properly to derive the intended benefits. Vehicles with malfunctioning air pollution equipment can emit eight to ten times the pollution of a vehicle with its equipment functioning properly and can be 10% to 40% less fuel efficient. Fundamental to the approach of relying on technological solutions to emission problems is maintenance of technology and equipment already installed on the vehicle.

The expected benefits of a testing program are less air pollution as well as more efficient and reliable vehicles. Vt. ANR estimates that the repairs resulting from a statewide emissions check program would reduce emissions of carbon monoxide by 31%, hydrocarbons by 30%, and nitrogen oxides by 14%. Emissions of toxic and carcinogenic air pollutants would also decline by 30%. Fuel efficiency for those vehicles that fail would increase by an average 10% and greenhouse gas emission would decrease by a similar amount (U.S. EPA, 1995, *I/M Briefing Book*, Sec. 4, 16). An additional benefit is the creation of an infrastructure to maintain clean, efficient, and reliable vehicles.

Before vehicle test programs can be implemented, however, they must develop public support. Such programs are sometimes seen as government interference in private affairs that unfairly requires vehicle owners to pay the costs to repair ineffective pollution control devices. Moreover, to the extent that air pollution in Vermont is not seen as a significant problem, programs for checking pollution control devices are seen as unnecessary. The lack of public support has delayed the implementation of the emissions check program described here, which has resulted in sanctions against the Burlington MSA. There is a proposal submitted to the EPA to substitute a visual inspection of the catalytic converter and a test of the gas tank evaporative emissions system at the time of vehicle inspection for the more complete tests currently required by the EPA to meet the Clean Air Act requirements. If accepted, this would remove the sanctions imposed on the Burlington MSA. It is probable but not certain that the EPA will accept these tests instead of test-only emissions check programs. The proposed visual inspection and gas cap test are simple tests that can be readily added to the current inspection testing and will have a positive environmental impact, but they are not as comprehensive or beneficial as the test-only program recommended in this Plan.

The environmental and human health benefits of a thorough inspection and maintenance program warrant further consideration of a test-only emissions inspection program. There is reason to believe that public education with a full discussion of the advantages and disadvantages would lead to stronger public support for the testing program. The problems most often cited for the lack of public support are really ones of perception. It is true that repairing heavily polluting vehicles does place a burden on vehicle owners. Vehicle emissions, however, also have an impact on Vermont and Vermonters. Vermonters in the past have not supported the idea that people are *entitled* to pollute the air. As the facts become more widely known that driving is the greatest source of many pollutants and that a poorly maintained vehicle can be 10 times more polluting than one with a properly working emission system, it is likely that Vermonters would support requiring polluters to pay for the clean-up of their pollution.

With regard to the cost of repairs, on a fleet-wide basis, the costs are nearly offset by gasoline savings from improvements in fuel efficiency. It is projected that 20% of the vehicles tested would not pass the initial test. The repair costs for these vehicles are expected to average $38 (repairs to the purge system) and $70 (repairs to the pressure system) for evaporative emissions abatement repairs. Exhaust system repairs are expected to average $150. It is unlikely that a vehicle would have problems with all three systems, but since these are only average figures, some vehicles could cost more to repair. Vt. ANR proposes a cap of $400 on repairs to a vehicle's emissions system. Also, some of the repairs would be covered by warranties. On a fleet-wide average, vehicles which do not pass the initial test because of evaporative control system failure should experience a 6% increase in fuel economy after repair. Vehicles which do not pass the exhaust emissions test, on a fleet-wide average, should experience a 13% increase in fuel efficiency after repair (U.S. EPA, 1995, *I/M Briefing Book*, Sec. 4, 16). A typical car with a 10% fuel efficiency improvement would save over $160 in fuel in over two years.

Impacts

This policy was modeled by assuming that the 386,000 cars and light trucks built after 1980 are inspected with an emissions check program every other year at special test facilities, as described in this policy. The test program is assumed to be phased-in starting in 1997 in Chittenden County, and starting in 2001 in the rest of Vermont. The test is assumed to cost $30, with one free re-test after failing. The $30 fee is broken down as shown in Table 4.II.24.

While there are cumulative costs to this policy of $193 million for program implementation, this amount is dwarfed by reduced costs in other areas. Air emission costs are reduced cumulatively by $1.5 billion (7.9%) compared to the base case, ranking this policy as one of the best in the Plan for reduced air emission costs.

In addition, energy costs fall cumulatively by $63 million, with a drop of similar magnitude in the residential energy expenditure per household.

This policy option is one of the best for making Vermont's energy use cleaner. The large decreases in many of the most significant emissions, accompanied by the large reduction in air emission costs, make this policy important for the state to pursue.

Implementation

The step necessary for implementation is for the Agency of Natural Resources to promulgate the requirement for emission checking as a condition of vehicle registration. This could occur either through directives of the Legislature or regulations adopted by the Agency of Natural Resources. A program to check auto emissions in Chittenden County has been the subject of proposed legislation. A bill was voted out of the Natural Resources and Energy Committee in the House, but was held by the Appropriations Committee in the 1993-94 session.

Table 4.II.24 Emissions Check Program Cost Breakdown
(per test)

Administration	$5.00
Testing equipment	$2.20
Labor	$8.30
Building and materials	$2.95
Land and site development	$2.95
Shop materials	$1.45
Interest	$4.15
Profit	$3.00
Total	$30.00

The modeling assumed that about 20% of vehicles would fail the test. Of the 20% that fail, the average repair is assumed to be $150 (Tom Moye, Vt. ANR, personal communication, 1995).

As expected, the most important impact of this policy is its reduction of air emissions. Both ozone precursors and acid rain precursors decrease cumulatively through 2020 compared to the base case by very large amounts (11.1% and 5.7% respectively). Individual pollutants which see the largest reduction are carbon monoxide, with a huge 22.8% cumulative decrease and VOCs, with a 14.6% decrease. Energy use and greenhouse gas emissions are also reduced, although by modest amounts, due to more efficient vehicle operation.

Figure 4.II.15 Impacts of Implementing a Vehicle Emissions Check Program
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.97	38.27	38.26	885.25	884.97
Commercial	11.99	17.82	17.82	19.34	19.35	22.21	22.21	486.65	486.73
Industrial	12.42	16.79	16.79	18.41	18.40	19.87	19.87	446.39	446.32
Transportation	42.10	60.54	60.45	64.68	64.32	70.98	70.79	1594.1	1588.43
Total	98.04	130.54	130.46	138.40	138.04	151.34	151.13	3412.4	3406.45

Table 4.II.25 Indicators of Implementing a Vehicle Emissions Check Program
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2893.1	5.9	146.1	183.8	183.2	188.1	187.8	16.0%	15.6%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3406.5	6.0	0.18%	168.2%	173.8	217.6	217.0	222.6	222.2

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2102.7	61.73%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.59%	63.27%	63.23%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
1,000	(64)	(0.01%)	($4)	($8)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
$40.11	$2,640	$50,780	$56,452	$56,398	$58,679	$58,619	26.91%	26.62%	26.49%	27.62%	27.55%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,495,000	11,773,000	11,757,000	462,000	0.18%	165.13%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,230,000	11,407,000	11,391,000	454,000	0.19%	164.16%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	100	0.03%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	100	0.08%	57.19%
Nitrogen Oxides (NO_X)	25,300	26,600	22,100	31,800	24,200	131,700	18.86%	95.65%
Volatile Organic Compounds	21,600	20,000	16,100	19,400	13,600	106,400	22.18%	62.96%
Carbon Monoxide (CO)	116,900	101,800	70,200	93,500	49,900	826,300	34.17%	42.69%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	$2,462	$201	$652	$519

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

2. Policy: Continue Phased-In Implementation of Vapor Recovery at Gas Stations

Require the control of gasoline vapor loss at the time of motor vehicle refueling throughout Vermont because unburned gasoline represents a significant waste of energy and it is much more damaging to the environment and human health than gasoline that has been completely burned.

The policy would require that gasoline vapor recovery equipment known as "Stage II vapor recovery devices" be installed on gasoline dispensing pumps. These devices capture and return gasoline vapors to the underground fuel storage tanks, thereby making the fuel available for resale, rather than causing air pollution and human exposure to toxic and carcinogenic chemicals. The requirement for these devices will be phased-in over time, beginning with the larger volume stations.

Rationale

Gasoline is comprised of highly volatile organic chemicals, some of which are very toxic and are known to cause cancer in humans. Individuals are exposed to high concentrations of gasoline vapors during refueling. This occurs because filling a gas tank with, for example, 15 gallons of gas, forces 15 gallons of air saturated with these chemicals out the gas tank and into the atmosphere. Each year, Vermont loses about 600,000 of gasoline vapor (or about 0.2% of 280,000,000 gallons of gas sold) to the atmosphere in this way (Vt. ANR, 1994, *Stage II*, 1). Since refueling is a common activity, this exposure is a widespread and persistent problem. Moreover, exposure to vapor emission is not limited to those refueling vehicles. The vapors remain in the environment, resulting in elevated concentrations of these toxic constituents in the vicinity of gasoline dispensing facilities, and contributing to atmospheric chemical processes related to smog formation, acid rain, and global climate change.

Stage II vapor recovery devices would prevent pollution and human exposure to the high concentrations of gasoline vapors and their toxic and carcinogenic constituents (*e.g.*, benzene, toluene, and xylene). In addition, preventing the gasoline from entering the atmosphere each year would save energy by returning the gasoline vapors to the service station's storage tank for resale.[xl]

Stage II gasoline vapor recovery equipment was first installed more than 20 years ago. Since then, the technology has been required in many areas of the country. Many of these areas have been driven to control these emissions due to ozone pollution. Others have done so to prevent human exposure to toxic chemicals. The 1990 federal Clean Air Act Amendments require that these emissions be controlled in most areas which exceed the ozone standard, as well as in the Northeast Ozone Transport Region (which includes Vermont).

Stage II vapor recovery equipment has only a few drawbacks. Some forms of gasoline vapor recovery equipment may be perceived by the public as awkward to use initially, but the most important issue is the cost of installing the recovery devices. The cost will vary depending on site specific considerations at each gasoline station. Most of the cost is for the excavation work necessary to install vapor return piping from the pump to the underground storage tank. For a number of years, the Agency of Natural Resources has recommended that the necessary underground piping be installed whenever other site excavation work is done, so for many stations the cost is not a significant issue. For a very small number of filling stations that are barely making money, it is possible that the cost may be prohibitive. The Agency of Natural Resource's estimate to fit all stations in Vermont with an annual throughput of 120,000 gallons or more with gasoline vapor recovery devices is between $5.8 and $9 million.

This cost can be justified by the health and environmental benefits, but since the gasoline vapors would normally be lost to the environment, recovering them allows the fuel to be resold to customers, generating extra income. The pre-tax value of the fuel recovered (the amount retailers would gain from the resale of the fuel) is more than $500,000 per year. Over the lifetime of the equipment, this measure would pay for itself. Since business loans are for much shorter periods, the most likely scenario is that an average station would borrow

the money necessary for the controls, which would add less than one cent per gallon to the cost of the fuel for the period of the loan (about 5 years). After that period, the average price of fuel would drop by more than a penny a gallon, since the equipment is paid for and the $500,000 per year savings would probably be passed on to the consumers.

Impacts

This policy is modeled assuming it is phased-in between 1997 and 2000. The equipment is assumed to recapture 0.16% of gasoline pumped at service stations. Because the recaptured gasoline will be resold by service stations, their cost of fuel is reduced accordingly. The cost of installing the vapor recovery equipment is assumed to be $8 million (1995$) based on a Vermont Agency of Natural Resources estimated cost of between $5.8 - $9 million. The cost is assumed to be financed at 8% for five years.

As expected, the most notable impact of this policy is a reduction in emissions of volatile organic compounds, which fall cumulatively through 2020 by 8% compared to the base case, or 38,800 tons. This ranks the policy as among the best in the Plan for VOCs reduction. Reductions in VOCs cause ozone precursors to fall cumulatively by 3.3% with this policy, a significant amount. In addition, capturing gasoline vapors results in a small reduction in energy use; transportation energy use falls by 0.11% (1.8 TBTU).

The important reduction in VOCs with this policy is accompanied by strong cost reductions to society. Air emission costs fall cumulatively by $265 million (1.4%) compared to the base case, while energy costs fall by $30 million. After factoring in the additional costs and benefits (such as installing vapor recovery devices), the total costs of the policy (energy, related, and emissions costs) fall by $302 million.

Thus, this policy's substantial reduction in VOCs and ozone precursors, combined with its cost reductions to society and its small decrease in oil use, makes it an important policy option for cleaning up our energy use.

Implementation

The Agency of Natural Resources has already begun to implement part of this policy. They are requiring that Stage II vapor recovery devices be installed at gas stations according to the following schedule based on how many gallons of gasoline a station sells per year:

By December 31, 1997: stations pumping 1.2 million gallons or more
By December 31, 1998: stations pumping 1 million gallons or more
By December 31, 1999: stations pumping 700,000 gallons or more
By December 31, 2000: stations pumping 400,000 gallons or more

(Vt. ANR, 1997, *Closing the Loop*)

The Agency of Natural Resources estimates that by covering the filling stations with throughput of greater than 400,000 gallons per year, 73% of the gasoline vapors lost could be captured (Vt. ANR, Dave Sheppard, personal communication, March 1997).

Figure 4.II.16 Impacts of Using Vapor Recovery at Gas Stations
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.39	35.98	35.98	38.27	38.27	885.25	885.25
Commercial	11.99	17.82	17.81	19.34	19.34	22.21	22.21	486.65	486.62
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.87	446.39	446.39
Transportation	42.10	60.54	60.42	64.68	64.60	70.98	70.93	1594.14	1592.39
Total	98.04	130.54	130.42	138.40	138.32	151.34	151.28	3412.43	3410.65

Table 4.II.26 Indicators of Using Vapor Recovery at Gas Stations
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2897.3	1.8	146.1	183.8	183.6	188.1	188.0	16.0%	15.6%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3410.7	1.8	0.05%	168.5%	173.8	217.6	217.5	222.6	222.5

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2106.6	61.77%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.66%	63.27%	63.26%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
(400)	(10)	(0.00%)	($1)	$0

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($20.78)	$265	$50,780	$56,452	$56,451	$58,679	$58,683	26.91%	26.62%	26.59%	27.62%	27.60%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,517,000	11,773,000	11,769,000	141,000	0.06%	165.29%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,252,000	11,407,000	11,402,000	139,000	0.06%	164.32%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	100	0.03%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	0	0.02%	57.19%
Nitrogen Oxides (NO_X)	25,300	26,600	26,600	31,800	31,800	500	0.07%	125.69%
Volatile Organic Compounds	21,600	20,000	18,500	19,400	17,100	38,800	8.09%	79.17%
Carbon Monoxide (CO)	116,900	101,800	101,700	93,500	93,500	2,500	0.10%	79.98%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	($69)	($50)	($425)	($262)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

3. Policy: Adopt Low Emissions Vehicle Standards

Adopt a requirement that all new motor vehicles offered for sale meet emissions standards set by the State of California.

Under the federal Clean Air Act, individual states, with the exception of California, are prohibited from establishing auto emissions standards. This was a concession made to the auto industry by Congress at the outset of establishing emissions control requirements on motor vehicles in the United States. In 1977, the law was amended to allow states to adopt standards identical to the State of California, in certain situations. Amendments to the 1990 Act made this option more available.

The California Low Emissions Vehicle Program (LEV) is intended to ensure that new motor vehicles entering the fleet are the "cleanest cars in mass production." The LEV program includes a set of increasingly more stringent emissions standards that are phased-in over time (see Table 4.II.27). These standards reduce auto air pollution up to 90% over the current federal emissions standards (California Air Resources Board).

This policy has been analyzed by the states of the Northeast Ozone Transport Commission (which includes Vermont), and this commission voted to recommend to the EPA the adoption of this requirement as an integral part of the regional effort to attain the ozone health-based air quality standard (Federal Register, September, 1994). Final action is pending.

Rationale

Benefits of this policy result from using the best available emissions control technology on new cars entering service, and therefore the least emissions from motor vehicles over their operational life, significantly reducing air pollution and human exposure to toxic and carcinogenic air pollutants (see Figure 4.II.17). The benefits of this program would increase over time as more cleaner vehicles enter the fleet, and as the vehicles remain in use longer. There is also potential energy savings from the LEV standard. Vehicles being produced now to meet the first emission level of the LEV program (TLEV standards) are obtaining up to a 10% increase in fuel efficiency.

This policy faces three major hurdles. The first is the cost. The per vehicle costs will vary based on stringency of standard. The first phase standard (TLEV) was initially projected by California to be $70 in 1990. A 1993 update revised this to $19. When the vehicles were offered in 1994, there was no price differential in the market between cars meeting the California standard and cars meeting the federal standard. The second phase standard (LEV) is projected by California to have a technology cost of $170. The auto manufacturers, however, disagree with this cost estimate.

The second obstacle is that for the LEV standard to be effective and not cause significant disruptions in the automotive market, it needs regional support. If Vermont alone or a few scattered states adopted this policy, it would not improve the air pollution blown in from other states and it would be very disruptive to the automotive market. If, however, the LEV standard is part of a regional effort (Massachusetts and New York are already committed to using LEV standards), it would address the transport of pollution and create a very large market for the cleaner automobiles. It is very difficult, however, to get regional consensus on adopting the cleanest emissions standards. There will be significant pressure to compromise, which could unfortunately affect Vermont air quality as the pollution is transported by winds. Vermont's participation in the Northeast Ozone Transport Commission is necessary to find a regional solution to a regional problem (*i.e.*, ozone abatement) and to ensure it has a vote on this and other regional measures that impact Vermont's air quality.

Table 4.II.27 Scheduled Phase-In of Vehicle Emissions Standards

	Federal Standards		California Standards				
	Tier I	Tier II	CA	TLEV	LEV	ULEV	ZEV
NMHC *	0.250	0.125	0.250	0.125	0.075	0.040	0.000
Model Year	Percent of New Fleet Meeting Standards		Percent of New Fleet Meeting Standards**				
1993	--	--	100	--	--	--	--
1994	40	--	90	10	--	--	--
1995	80	--	85	15	--	--	--
1996	100	--	80	20	--	--	--
1997	100	--	73	--	25	2	--
1998	100	--	48	--	48	2	2
1999	100	--	23	--	73	2	2
2000	100	--	--	--	96	2	2
2001	100	--	--	--	90	5	5
2002	100	--	--	--	85	10	5
2003	Dependent on phase-in of Tier II	Phase-in could begin	--	--	75	15	10

*Non-methane hydrocarbons in grams per mile
**Other combinations that yield the same manufacturer average emission rate are allowed, with the exception of the ZEV standards after the year 2002. The California Air Quality Board has recently relaxed the percentage requirements for ZEV vehicles, eliminating the interim targets of 2% and 5%. They have not changed the 2003 requirement nor have they changed the overall fleet average requirements. This gives car makers more time and flexibility to develop ZEVs but does not reduce the overall fleet emissions.

Source: National Governors' Association

The third obstacle is the opposition of the automobile industry. They have opposed the LEV standard and are negotiating an alternative program; one that would have less stringent standards but broader application across the country. From a Vermont air quality standpoint, a 49 state standard is probably less desirable than a Northeast Ozone Transport Commission California LEV standard. The effect of a 49 state standard will depend to a large extent on what that standard is, but since negotiations are currently taking place, it is uncertain what would be included in the standard. Furthermore, the origins of Vermont air pollution are not well known. Most of the air pollution in Vermont is probably generated within the state and region, so a stronger regional standard would have more impact on Vermont's air quality than a weaker standard that covers more vehicles nationwide.

Figure 4.II.17 Impacts of Adopting Low Emissions Vehicle Standards
Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.40	35.98	36.00	38.27	38.28	885.25	885.53
Commercial	11.99	17.82	17.83	19.34	19.35	22.21	22.22	486.65	486.86
Industrial	12.42	16.79	16.79	18.41	18.41	19.87	19.88	446.39	446.40
Transportation	42.10	60.54	60.55	64.68	64.67	70.98	70.94	1594.1	1593.54
Total	98.04	130.54	130.57	138.40	138.42	151.34	151.31	3412.4	3412.33

Table 4.II.28 Indicators of Adopting Low Emissions Vehicle Standards
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2898.9	0.2	146.1	183.8	183.8	188.1	188.1	16.0%	15.6%	15.6%	15.5%	15.5%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3412.3	0.1	0.00%	168.5%	173.8	217.6	217.6	222.6	222.5

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2107.9	61.77%	$0.087	$0.084	$0.084	$0.087	$0.087	65.58%	65.68%	65.67%	63.27%	63.26%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
4,000	143	0.03%	($3)	($1)

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
$1,014	$1,170	$50,780	$56,452	$56,472	$58,679	$58,693	26.91%	26.62%	26.62%	27.62%	27.61%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,525,000	11,773,000	11,771,000	6,000	0.00%	165.32%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,260,000	11,407,000	11,404,000	7,000	0.00%	164.35%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	200	0.05%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	0	0.01%	57.19%
Nitrogen Oxides (NO_X)	25,300	26,600	24,000	31,800	26,900	79,400	11.37%	106.32%
Volatile Organic Compounds	21,600	20,000	19,000	19,400	16,900	36,900	7.69%	78.24%
Carbon Monoxide (CO)	116,900	101,800	93,800	93,500	75,600	276,600	11.44%	64.67%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.98	1.05	1.05	N/A	N/A	$1,076	$17,411

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020
[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost
[d] Calculated using Vt. DPS externality adders, see Appendix 5
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy

and capital, operation, and maintenance cost of energy using devices

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

Impacts

This policy was modeled by assuming that Vermont begins meeting the California LEV standards in 1997. Emissions data on the impact of LEV vehicles comes from the EPA Mobile 4A Model run by the Vermont Agency of Natural Resources' Division of Air Quality. The additional costs for vehicles to meet the standards are $170 (1990$) per vehicle to meet the LEV and ultra low emissions vehicle (ULEV) standards, and $1,350 (1990$) per vehicle to met the ZEV standard (NESCAUM, 1991, 100). It is likely that this overstates the cost of meeting the LEV and ULEV standards and understates the cost of meeting the ZEV standard.

Not surprisingly, impacts on air emissions are the most significant benefits of this policy. Acid rain precursors and ozone precursors fall significantly (by 7.4% and 9.9% cumulatively through 2020 compared to the base case). Pollutants which experience the largest cumulative decrease compared to the base case are nitrogen oxide and carbon monoxide at about 11%, and VOCs at about 8%. These percentage reductions are among the highest of any policy in the Plan for these pollutants.

In addition to the strong emission level benefits with this policy, costs to society also decrease. Costs related to air emissions fall cumulatively compared to the base case by about $1.2 billion (6%). While there are also some increased costs related to the policy, these costs, amounting to $105 million cumulatively, are dwarfed by the decrease in costs from air emissions. This policy ranks as one of the best in the Plan for societal savings from reduced emissions.

The strong air emissions and cost reductions with this policy make it one of the better policies in the Plan for improving pollution levels from our energy use.

4. Policy: Promote Incentives for Alternative Transportation Fuels, Including Electric Vehicles

Support the use of alternative transportation fuels by changing state laws to create incentives for alternative fuel vehicles (AFVs) and encourage state agencies to add AFVs to the state fleet.

Alternative transportation fuels which would qualify for the incentives are compressed natural gas, liquefied natural gas, propane, and electricity. This policy would influence both private and public sector purchases of vehicles using these fuels. Measures influencing the private sector include the following comprehensive package of incentives for owners and operators of alternative fuel vehicles, including electric vehicles (EVs):

- exempting AFVs from the 5% purchase and use tax paid at the time of purchase;
- waiving annual registration fees for AFVs; and
- creating state income tax credits for purchasers of AFVs and for investments in refueling stations.

These tax credits and exemptions would expire (or sunset) in five years. Prior to expiration, there would likely be a review of the incentive structure, and an update package of incentives, if still needed, could be proposed at that time.

This policy also requires 10% of state vehicles purchased in 1998 and thereafter to be alternatively fueled. A bill was introduced to the Vermont House (H.272) during the 1995-96 session incorporating the main points of this policy. This bill also directs the Department of Buildings and General Services to survey state facilities to determine how AFVs can be accommodated. New state facilities would incorporate refueling equipment such as solar photovoltaic systems to charge EVs. The bill did not get out of committee. Proponents of alternative fuel vehicles are considering new ways to promote legislation and use of AFVs.

Rationale

There are many reasons to support expanded use of alternative fuels and improved efficiency in transportation:

creating more price competition among fuel types; stimulating demand for a more diverse, domestic fuel supply; reducing reliance on energy from sometimes unpredictable foreign sources; and improving air quality. Moreover, as alternative fuels gain acceptance in the Northeast, it will be especially important for Vermont to have suitable infrastructure to remain an integral part of the regional transportation network. Also, many Vermont businesses stand to gain by their position in the nascent alternative fuels industry.

Because of their limited production, AFVs typically cost more than traditional vehicles. As AFV sales volume grows, the cost per unit will drop. Legislation supporting expanded use of alternative fuels and high efficiency vehicles would provide incentives for AFVs, giving them a toehold in a market now monopolized by petroleum-based transportation fuels. Although the numbers of vehicles prompted by the bill would be modest, they would serve as examples by fleet operators in the public and private sectors and eventually for individual buyers.

Vermont presently has a paucity of incentives for alternative fuels and high efficiency vehicles. During the recent decade, legislation has been proposed that would create incentives for high efficiency gasoline vehicles, specifically by rewarding buyers of high-mile-per-gallon vehicles with reduced registration fees and by charging higher fees for low efficiency vehicles. None of these bills has passed, however. Incentive legislation would prompt demonstration vehicles and projects that otherwise might not occur. As familiarity with equipment and infrastructure such as refueling stations is built, the market for cleaner, more efficient vehicles will grow.

E. Strategy: Internalize Costs of Transportation More Fully through Transportation Energy Taxation

Transportation taxes and transportation energy taxes should be used to incorporate the full cost of driving in the price of driving and to reduce the impact of transportation energy use.

This section continues the more general discussion of energy taxes found in Chapter 4, Section I.H. Use Energy Taxation to Meet Vermont's Energy Goals and the discussion in Section II.C., Policy 2: Shift VMT to More Efficient Modes--Bus, Vanpool, and Train. The issue of transportation energy taxation deserves special consideration because, of all energy end uses, transportation results in the greatest energy consumption and pollution emissions. Moreover, it represents an end use in which the full cost of energy use is not incorporated in the price of energy. Current transportation energy prices and tax policies encourage overuse because they underprice the cost of driving. The result is that transportation is the greatest energy user and pollution emitter among all end uses (see Figures 3.III.25-29). Note: A state gasoline tax of $0.16 is used in the policy analysis and modeling. This does not reflect the 1997 Legislature's three cent increase in the gasoline tax for support of equal education funding.

A number of transportation costs are seriously under-represented in the price that drivers experience, amounting to between $300-$590 billion per year in transportation costs not borne directly by the users of the service (Apogee Research, 1994, 31-3).[xli] (See Section I. Energy Sources and Supply, Strategy H. Use Energy Taxation to Meet Vermont's Energy Goals.)

Fixed costs (those that do not vary with the number of miles driven) and hidden costs (those costs not paid for directly by drivers) encourage unnecessary and inefficient use of resources. Table 4.II.29, Per Gallon Motor Fuel Equivalents of Revenues Used for Highways, presents several of these fixed and hidden costs that states such as Vermont control.
It is a common misconception that gasoline taxes pay for roadways. Nationally, average receipts for highway expenditures in 1992 (including planning, construction, maintenance, financing, and some law enforcement and mass transit) were equivalent to $0.65 per gallon (including federal contributions). (In five states, the equivalent of more than $1.00 per gallon was spent.) Yet, federal and typical state gas taxes were closer to $0.38 per gallon. On average, an additional $0.27 per gallon would have been needed to fund highway costs

from motor fuels taxes. In Vermont, we paid $0.34 per gallon in taxes, but our expenditures were equivalent to $0.77 per gallon. The equivalent of approximately $0.41 (1992 dollars) per gallon was collected through other mechanisms such as property taxes that encourage inefficient use of resources. (See Table 4.II.29.)

This strategy is concerned with capturing or internalizing the full costs of transportation, driving in particular, into the price that is associated with each mode of transportation, using tax policy to shift these costs to users. The first policy involves reviewing Vermont's transportation tax policy and shifting transportation revenue sources (such as property or general fund taxes) to motor fuels taxes. The second policy recommends phasing out federal funding and tax exemptions that give advantages to traditional transportation fuels projects or modifying them so they reduce the cost of a broader range of transportation options and do not restrict market opportunities for new, efficient modes and alternative transportation fuels. The third policy proposes shifting transportation related fees (such as registration or license fees) to motor fuels taxes.

It is unlikely that only one mechanism (such as shifting costs to a gas tax) could satisfactorily internalize the roughly $3.00 per gallon costs not included in the price of driving. It is also very unlikely that Vermont, acting alone, would seek to increase its motor fuel taxes significantly above those in neighboring states. The final two policies address these concerns. They seek to shift transportation costs by other mechanisms so that drivers of vehicles that use the most energy and release the most emissions pay higher costs. One of these policies involve using energy taxes to encourage persons to use more efficient public transit; the other involves creating a Vermont feebate program.

1. Policy: Review and Revise State Tax Policy to More Fully Internalize the Cost of Transportation

Internalize more of the hidden costs of transportation in the price of transportation, primarily though shifting revenue sources for transportation related costs to a motor fuels tax.

- Shift the funding for the construction and maintenance of roadways from property taxes to a motor fuels tax.
- Shift transportation related costs of local fire and police services to a motor fuels tax.
- Remove the state sales tax exemption for motor fuels.
- Seek to remove the subsidies given to driving by free parking.

Rationale

The rationale for these actions is quite similar to that discussed in the more general energy taxation section. Briefly, the advantages of removing subsidies from property taxes, general funds, and free parking, and the advantages of removing the exemption of sales taxes from motor fuels are that these represent costs that are not paid directly by the user. The underpricing of transportation services that results leads to inefficient use of those resources and greater emissions. Shifting those costs to transportation users raises the price of transportation without increasing the full cost. In fact, this encourages conservation and increased energy efficiency, which reduces total costs, energy use, and emissions.

Table 4.II.29 Per Gallon Motor Fuel Equivalents of Revenues Used for Highways
All Levels of Government, 1992

Impacts: Shift Roadway Construction/Maintenance Funding from Property Tax to Motor Fuels Tax

Property tax rates in Vermont are among the highest in the nation. In addition, Vermont is among the states with the highest percentage of highway funds from property taxes (see Table 4.II.29, Per Gallon Motor Fuel Equivalents of Revenues Used for Highways). While education is the most significant use of property taxes, approximately 10% of property tax revenues are used for building and maintaining local roads. Local property taxes subsidized highway costs to the amount of $264 million between 1988 and 1992, approximately 25% of all highway revenue over that same period (see Table 4.II.29a). In 1992, property taxes subsidized transportation at a rate of $0.01 per mile. Hiding the equivalent of approximately $0.21 per gallon fuel tax in property taxes provides a significant subsidy to transportation.

Shifting these taxes to a motor fuels tax not only would reduce property taxes by an average of 10% statewide, but internalizing these costs in the price of motor fuels would also lead to lower demand and decreased energy use and emissions.

Table 4.II.29a Sources of Revenue for Vermont Highway Expenditures

Year	Property Tax	General Fund	State User Fees	Federal User Fees	Total Funds	Prop. Taxes as a % of Total Funds
1992	65.073	5.058	108.284	64.540	268.961	24.2
1991	55.449	3.734	107.776	38.282	212.445	26.1
1990	51.558	9.469	107.268	29.957	212.295	24.3
1989	49.969	6.656	94.625	35.533	196.553	25.4
1988	41.500	5.567	94.626	33.369	181.933	22.8
1987	38.950	6.146	93.035	27.313	175.645	22.2
1986	34.000	5.314	89.037	28.080	160.216	21.2
1985	26.784	6.456	84.888	32.230	156.792	17.1

Source: U.S. DOT, *Highway Statistics* 1987-1994, IV-9, 17, 48, 52

This policy was modeled by applying motor fuel taxes (equal to $0.21 per gallon in 1995 dollars) to transportation energy use. To simulate property tax relief, the revenue from the taxes was used to reduce personal taxes in the residential sector and production costs in the commercial and industrial sectors. The revenue was recycled to taxpayers in a sector neutral manner (meaning that revenue raised from each sector was returned to that sector).

This policy results in very high impacts on energy use, costs, and environmental indicators. Total energy use falls cumulatively through 2020 by 2.8% compared to the base case, while transportation energy use falls by a phenomenal 6.3%. Oil use and non-renewable energy use experience similar dramatic reductions.

While the cost of motor fuel goes up with this policy, property taxes are reduced by an equal amount, resulting in no net additional outlay by society. Energy costs (net of policy taxes) decrease cumulatively by 2.4% or $986 million compared to the base case, while air emission costs fall by 3.7% or $725 million. The economy also gets a boost with this policy, through a cumulative rise in employment (35,000 job-years), and the Gross State Product ($1.5 billion).

Figure 4.II.18 Impacts of Shifting Roadway Construction/Maintenance Funding from Property Tax to Motor Fuels Tax

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.42	35.98	36.05	38.27	38.38	885.25	887.00
Commercial	11.99	17.82	17.91	19.34	19.41	22.21	22.29	486.65	488.40
Industrial	12.42	16.79	16.81	18.41	18.41	19.87	19.90	446.39	446.81
Transportation	42.10	60.54	57.65	64.68	60.55	70.98	66.14	1594.14	1493.63

Total	98.04	130.54	127.79	138.40	134.41	151.34	146.70	3412.43	3315.84

Table 4.II.30 Indicators of Shifting Roadway Construction/Maintenance from Property Tax to Motor Fuels Tax

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2802.1	97.0	146.1	183.8	176.4	188.1	180.2	16.0%	15.6%	16.0%	15.5%	16.0%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3315.8	96.6	2.83%	157.1%	173.8	217.6	210.0	222.6	214.5

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2013.7	60.73%	$0.087	$0.084	$0.087	$0.087	$0.089	65.58%	65.68%	64.60%	63.27%	62.01%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
34,700	1,457	0.30%	($74)	$26

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($4.70)	$725	$50,780	$56,452	$55,857	$58,679	$58,274	26.91%	26.62%	27.13%	27.62%	27.92%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,205,000	11,773,000	11,406,000	7,550,000	3.02%	160.20%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	8,945,000	11,407,000	11,044,000	7,451,000	3.07%	159.16%
Sulfur Dioxide (SO_2)	17,100	15,700	15,600	15,000	14,800	4,800	1.29%	86.55%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	900	1.01%	56.52%
Nitrogen Oxides (NO_X)	25,300	26,600	25,500	31,800	30,500	27,200	3.89%	120.55%
Volatile Organic Compounds	21,600	20,000	19,100	19,400	18,400	21,500	4.48%	85.19%
Carbon Monoxide (CO)	116,900	101,800	95,900	93,500	87,400	138,300	5.72%	74.76%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.94	1.05	1.01	$197	($13)	($118)	($60)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[b] Transportation sector

[c] Policy costs include the change between policy and base case of energy cost

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy

and capital, operation, and maintenance cost of energy using devices

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

Environmental indicators also improve dramatically with this policy, in conjunction with falling energy use. Greenhouse gas emissions and acid rain precursors decline cumulatively by 3% compared to the base case, and ground-level ozone precursors fall by 4%.

This policy, as the other policies in this Plan that seek to include more of the full cost of driving into transportation energy prices, has very strong impacts on all indicators and thus is an important policy for consideration.

Impacts: Shift Police/Fire Transportation Funding from Property Tax to Motor Fuels Tax

In Vermont, only the state police are directly funded from the transportation fund. (One exception is that local police departments receive 5% of the revenues from each ticket written by them for violations on state roads.) Much of the work of local police and fire departments, however, is directly related to transportation. Transportation related costs of local police and fire departments, data suggests, are about 30% of total costs. About 16% of all fires reported in 1995 through the National Fire Incident Reporting System to the Vt. Department of Labor and Industry were vehicle fires. There are, however, many more vehicle accidents than vehicle fires. Approximately 30% of local fire and ambulance calls are related to transportation (Fire Chief Ernest Lamphere, Springfield Fire Department, personal conversation, June 1996). A rough estimate of 25-30% may also be a good estimate of the percentage of police work related to transportation and parking (Gary Bullard, Vermont Police Academy, personal conversation, July 1996).

In 1992, local government expenditures for police services were $27.9 million; expenditures for fire services were $18.3 million (U.S. Bureau of the Census, 1996, 91). In 1992, if 30% of the total had been collected by a $0.04 per gallon motor fuels tax, property taxes could have been lowered by $18.9 million statewide.

The shift of police and fire related transportation costs from property taxes to motor fuels taxes was modeled in the same way as the previous shift of construction and maintenance costs from property taxes to motor fuels taxes. In this case, however, a tax of approximately $0.044 cents per gallon on all motor fuels was used (1995 dollars).

Because the higher price of fuel causes consumers to manage their transportation energy use more efficiently, this policy results in a substantial decrease in transportation energy use, which falls by 1.4% (22.3 TBTU) cumulatively through 2020 compared to the base case. Most of this reduction in transportation occurs in the residential sector, with per capita residential energy use (including transportation) falling cumulatively by about 1%. Total oil use also falls cumulatively by 1% compared to the base case, while non-renewable energy use falls by 0.7%.

While the price of motor fuel rises with this policy to fund 30% of the police and fire services, this would be offset by an equal reduction in property taxes, which currently fund these services. Thus, while society pays the same total amount as before to fund the services, gains in many areas are achieved. Energy costs per capita decrease cumulatively compared to the base case by 0.6% with this policy, while air emission costs fall by 0.8%. In addition, the economy experiences a slight boost, with Gross State Product rising cumulatively by about $310 million.

Figure 4.II.19 Impacts of Shifting Police/Fire Transportation Funding from Property Tax to Motor Fuels Tax
Selected Impacts in 2005
Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.40	35.98	36.00	38.27	38.29	885.25	885.66
Commercial	11.99	17.82	17.84	19.34	19.36	22.21	22.23	486.65	487.05
Industrial	12.42	16.79	16.80	18.41	18.41	19.87	19.88	446.39	446.50
Transportation	42.10	60.54	59.90	64.68	63.73	70.98	69.94	1594.14	1571.85
Total	98.04	130.54	129.92	138.40	137.49	151.34	150.34	3412.43	3391.06

Table 4.II.31 Indicators of Shifting Police/Fire Transportation Funding from Property Tax to Motor Fuels Tax

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2877.6	21.5	146.1	183.8	182.0	188.1	186.4	16.0%	15.6%	15.7%	15.5%	15.6%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3391.1	21.4	0.63%	166.1%	173.8	217.6	215.8	222.6	220.8

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2087.3	61.55%	$0.087	$0.084	$0.085	$0.087	$0.087	65.58%	65.68%	65.43%	63.27%	63.01%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
7,400	312	0.06%	($22)	$1

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($5.38)	$162	$50,780	$56,452	$56,329	$58,679	$58,580	26.91%	26.62%	26.72%	27.62%	27.68%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,451,000	11,773,000	11,694,000	1,693,000	0.68%	164.24%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,187,000	11,407,000	11,329,000	1,670,000	0.69%	163.27%
Sulfur Dioxide (SO_2)	17,100	15,700	15,700	15,000	15,000	700	0.19%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	200	0.21%	57.02%
Nitrogen Oxides (NO_X)	25,300	26,600	26,400	31,800	31,500	6,200	0.89%	124.51%
Volatile Organic Compounds	21,600	20,000	19,800	19,400	19,100	4,800	1.00%	88.43%
Carbon Monoxide (CO)	116,900	101,800	100,400	93,500	92,200	30,900	1.28%	78.87%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.04	$172	($117)	($117)	($68)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] Transportation sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

Emissions of all pollutants also experience fair-sized decreases through the policy. Greenhouse gas emissions, acid rain precursors, and ground-level ozone precursors decline cumulatively by 0.7%, 0.6%, and 0.9%.

Thus, this policy achieves solid savings in energy use, cost, and environmental indicators by including more of the full cost of driving in transportation energy prices.

Impacts: Remove Sales Tax Exemptions on Motor Fuels

Removing sales tax exemptions is more fully discussed in the Energy Taxation Section earlier in this chapter. Sales tax exemptions on motor fuels act as subsidies for highway transportation. Since most products are taxed in Vermont, sales tax exemptions for energy and motor fuels lower the relative costs of energy, slightly distorting the efficiency of the marketplace by making energy-intensive options relatively less expensive. In addition, the revenue lost must be made up from other sources. A sales tax on motor fuels would generate significant revenues that would result in a reduction in other state taxes. For more information on energy sales tax, including the way in which this policy was modeled, see Section I., Strategy H. Use Energy Taxation to Meet Vermont's Energy Goals, Part 3: Types of Energy Taxes and Part 6: Impacts.

Removing the exemption of the 5% state sales tax to motor fuels (so that the sales tax is on the final sales price of the fuel) results in a 2.1% decrease in transportation energy use and emissions and a 1.0% decrease in total greenhouse gas emissions.

Remove Parking Subsidies

The cost of parking is clearly not paid by the user when it is provided for free by the employer, merchant, or community. Costs related to free parking include those for land and lost opportunities, the construction and maintenance costs of the parking lot, and the lost tax revenue to the community resulting from the public use of the land. These costs are often quite large and nationally represent one of the largest hidden costs in the transportation field. They have been discussed more fully in the Least Cost Transportation Planning strategy section, where alternatives to free parking such as Green Transportation Vouchers are suggested.

Impacts: Combined Results of Shifting Hidden Costs to Motor Fuels Taxes

Together, the tax shifting policies described earlier would add $0.32 per gallon to the cost of motor fuels ($0.21 for roadway funding property tax shift, $0.044 for police/fire funding property tax shift, and $0.07 for removing the sales tax exemption). However, because the higher cost of energy will induce greater efficiency, collecting the same revenue would require a combined tax of $0.35 per gallon. As a result of collecting revenue for highway related expenditures in motor fuels taxes, other taxes in Vermont would be reduced by $110-$115 million per year. There would be no net increase or decrease in taxes by shifting those taxes to motor fuels, but the shift would result in a net decrease in energy use, cost, and emissions because the higher price from the tax on fuels would encourage energy efficiency and conservation (see Figure 4.II.21 and Table 4.II.33).

These policies, however, would have certain negative economic effects as well. The negative effects are not due to higher costs. **All costs in each policy are already being paid; the policies merely shift revenue sources**. Moreover, the result is often greater economic efficiency as drivers make transportation choices with a more accurate understanding of the costs of those choices. What has been termed the "race to the bottom" applies to state tax policies. States often use tax breaks to attract or keep tourists, commercial sales,

and manufacturing industries. The governor of New Hampshire, for example, has proposed eliminating the state gas tax for the summer to attract tourists. Vermont has taken a similar action in the area of energy used for manufacturing: it has recently exempted energy from sales taxes to industrial customers to improve their competitiveness. Clearly, the motor fuels tax rate in neighboring states limits the amount of costs that policy makers can shift to motor fuel taxes in Vermont, because tourists and people living near the border may choose to purchase their gas in the other states.[xlii]

The competition between states for tourists, commercial sales, and manufacturing facilities creates pressure to reduce costs by reducing energy taxes (among others). This pressure is unfortunate because the lower tax rates that result do not lower costs or total revenues collected, but shift costs away from sources (motor fuels taxes) that could lower costs by encouraging efficiency and conservation. While it is in the interest of all states to reduce the costs and impacts of energy use, because of the competition, it can be in the interest of an individual state to try to lower its motor fuels taxes (and raise its fees, property tax, and general fund contributions to the transportation funds) compared to its neighbors.

To unleash the potential of states, including Vermont, to achieve the savings and reductions in energy impacts, regional and federal policy changes are needed to eliminate or avoid the competition among states, and federal policies are needed to get states to compete positively to reduce energy use and emissions, not to reduce costs, taxes, or standards.

To avoid competition among states, regional cooperation initiatives should be pursued. New England states, for example, surrounded by higher motor fuel costs in New York and Canada, could together raise motor fuel taxes while avoiding some competition. Nevertheless, one state could still prevent the others from making these cost shifts. More promising options that need further consideration involve getting the states to compete positively to reduce emissions. Examples include matching federal highway funds based on the percentage of state and local funds raised from motor fuels taxes and establishing a federal motor fuels tax/rebate for states meeting transportation emission standards.

The collection of motor fuels taxes described earlier was modeled together in this policy. Modeling assumptions were the same here as for the individual policies, except that the tax level was set at $0.35 per gallon.

This policy results in a 4.1% reduction in total cumulative energy use through 2020 compared to the base case. In the transportation sector, energy use falls cumulatively by 9.2%. Greenhouse gas emissions decrease by 4.4% cumulatively through 2020, while acid rain precursors fall by 4.3% and ozone precursors fall by 6.0%.

Figure 4.II.20 Combined Impacts of Shifting Hidden Costs to Motor Fuels Taxes to More Fully Internalize the Cost of Transportation

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.45	35.98	36.09	38.27	38.55	885.25	889.98
Commercial	11.99	17.82	178.08	19.34	19.46	22.21	22.41	486.65	491.66
Industrial	12.42	16.79	16.85	18.41	18.42	19.87	19.95	446.39	447.69
Transportation	42.10	60.54	53.95	64.68	58.75	70.98	589.16	1594.14	1353.12

Total	98.04	130.54	124.33	138.40	132.71	151.34	140.07	3412.43	3182.44

Table 4.II.32 Indicators of Combined Results of Shifting Hidden Costs to Motor Fuels Taxes

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2668.0	231.0	146.1	183.8	166.2	188.1	168.7	16.0%	15.6%	16.7%	15.5%	16.8%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3182.4	230.0	6.74%	140.5%	173.8	217.6	199.6	222.6	202.7

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
1882.4	59.15%	$0.087	$0.084	$0.092	$0.087	$0.093	65.58%	65.68%	62.99%	63.27%	60.08%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
94,600	3,983	0.81%	($200)	$70

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($4.07)	$1,740	$50,780	$56,452	$54,908	$58,679	$57,557	26.91%	26.62%	28.30%	27.62%	28.61%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	8,785,000	11,773,000	10,879,000	18,139,000	7.26%	152.79%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	8,530,000	11,407,000	10,524,000	17,898,000	87.38%	151.66%
Sulfur Dioxide (SO_2)	17,100	15,700	15,400	15,000	14,600	8,700	2.34%	85.38%
Suspended Particulates (PM-10)	6,000	3,400	3,300	3,400	3,300	1,900	2.22%	55.69%
Nitrogen Oxides (NO_X)	25,300	26,600	23,900	31,800	28,700	65,900	9.44%	113.44%
Volatile Organic Compounds	21,600	20,000	17,900	19,400	16,900	51,600	10.76%	78.24%
Carbon Monoxide (CO)	116,900	101,800	87,900	93,500	78,500	332,300	13.74%	67.15%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.90	1.05	0.96	$252	($41)	($116)	($52)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[b] Transportation sector

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[e] Household costs include energy costs, and the change in capital, operation,

[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices and maintenance costs of energy using devices that result from the policy

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995$)

2. Policy: Support Phase-Out of Federal Policies Giving Advantages to Traditional Fuels and Projects; Equalize Market Opportunities for New Technologies and Alternative Transportation Fuels

Vermont should support efforts to phase-out federal tax exemptions and funding related to transportation that do not lower total transportation costs for the whole spectrum of programs that meet the needs of Vermonters for access to goods, services, and activities.

On the federal level, there are a number of funding programs and tax exemptions, which are equivalent to funding sources, that provide an advantage for traditional transportation projects and the fossil fuels that power them. Many alternative modes of transportation, as well as emerging technologies and alternative, sustainable sources of transportation energy do not get the benefit of these subsidies. Any federal tax exemptions or funding should be directed to lower total transportation costs for the whole spectrum of programs that interact to meet the needs of Vermonters for access to goods, services, and activities. With the following federal policies in place, fuels and transportation projects that receive the funding or tax break have a competitive price advantage over alternatives. Removing the selective advantages and subsidies listed below would help internalize the full cost of transportation.

- Internalize or eliminate the energy related public costs and risks from the Overseas Private Investment Corporation (OPIC) that is funded by tax dollars and insures American oil companies against losses in investments due to political instability.

- Internalize the costs of building and maintaining the Strategic Petroleum Reserve that is funded with tax dollars to provide a supply of oil in case of disruptions.

- Eliminate the foreign tax credit for energy suppliers that allows companies to take as a credit against U.S. taxes any taxes paid to foreign countries that are greater than the U.S. rate.

- Eliminate the percentage depletion allowance for independent oil and gas companies that allows them to deduct 15% (plus 1% for every dollar oil drops below $20 per barrel, for what are called marginal production oil companies) of their gross income to reflect the declining value of their wells, independent of the actual decline in value of the wells.

- Eliminate the "passive loss" tax shelter for investors in oil and gas. This type of shelter was greatly limited for many non-energy investments as a result of tax reform in the 1980s. Gas and oil investments, however, were excluded from the 1986 Tax Reform Act.

- Eliminate immediate deductions for intangible drilling and development costs that typically make up 75-95% of the costs associated with developing an oil or gas well.

- Eliminate the 15% credit for enhanced oil recovery and eliminate expenses of tertiary injectants used in the enhanced oil recovery process. These incentives encourage the extraction of oil that generally is not economical to produce and cost the government lost tax revenues.

- Eliminate corporate income tax deductions for costs to clean up future illegal releases of pollution. Most of the costs are deductible as normal business expenses. Eliminating these deductions would internalize costs, provide greater incentive to prevent releases, and save taxpayers money.

Rationale

The primary reason to eliminate non-user fee funding and tax breaks for transportation and transportation energy use is to internalize as many of the costs of transportation as possible into the price users pay for transportation and thereby achieve economic efficiency.[xliii] As discussed in Strategy A. Least Cost Planning in the subsection on Employing Life Cycle, Full Cost Accounting, the most effective way to ensure that the full costs of transportation are considered by decision makers, citizens, and businesses is to ensure that the full costs of transportation are included in the price of transportation. When prices reflect the full costs, consumers will be much more likely to choose conservation and efficiency if they feel that their money could be better spent in other ways, and the savings advantages of lower full cost but higher priced alternatives such as public transit will be more apparent to consumers.

It is important to remember that higher prices for transportation do not mean higher total costs. Shifting more of the funding source for roadways as well as police, fire, and emergency services to transportation user fees does not increase the total costs, but reduces them because fewer people would be willing to pay for our current transportation system at its full cost, leading to conservation and efficiency. The same is true when tax breaks are removed from transportation energy sources. The revenue lost from tax breaks is currently made up by other revenue sources. The cost burden is merely being more fairly distributed so that those who use the transportation system pay for a higher share of the costs of that system.

By internalizing costs and eliminating federal tax breaks and funding for non-renewable transportation fuels, market based planning decisions can be made that take into account the full cost of those decisions. This allows alternatives (either alternative fuels or transportation projects) with lower full costs but higher prices to compete more equitably. Also, failure to eliminate public support for non-sustainable energy use further encourages the non-sustainable use.

3. Policy: Shift Registration and License Fees to Motor Fuels Taxes

Shift the fixed costs of transportation to variable costs by shifting transportation related fees, such as the registration fee and the license fee, to motor fuels taxes.

Shift the fixed costs of registration fees to variable costs by collecting a larger percentage of those fees through a motor fuels tax. Fees that could be shifted entirely include vehicle registration fees for smaller, non-commercial vehicles and license fees. Fees paid by commercial and industrial users could be partially shifted.

Rationale

Many fees for transportation are collected by the state in a manner that does not reflect miles driven on the transportation system. Because of how they are collected, they are another fixed cost of driving. As discussed above, these fees could be used to encourage conservation, efficiency, and public transportation without increasing the total cost of transportation, if they were assessed as marginal costs in the form of a motor fuels tax.[xliv]

Vermont can achieve additional energy savings and energy impact reductions by shifting much of the revenues from registration and license fees to a motor fuels tax. If the entire amount could be shifted, it would equal a $0.21 per gallon increase in motor fuels taxes (1992 dollars; $0.23 in 1995 dollars). It would be difficult to shift all these costs since some fees are used to assess damage done by the heaviest vehicles. It is unfair, for example, to assess fees for road construction and maintenance solely using a gas tax because a typical car would pay nearly the same as a very heavy truck, even though the latter causes much more

Figure 4.II.21 Impacts of Shifting Fees to Motor Fuels Taxes

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.42	35.98	36.05	38.27	38.39	885.25	887.17
Commercial	11.99	17.82	17.92	19.34	19.42	22.21	22.29	486.65	488.58
Industrial	12.42	16.79	16.81	18.41	18.41	19.87	19.90	446.39	446.86
Transportation	42.10	60.54	57.41	64.68	60.20	70.98	65.70	1594.14	1484.80
Total	98.04	130.5	127.57	138.40	134.08	151.34	146.28	3412.43	3307.41

Table 4.II.33 Indicators of Shifting Fees to Motor Fuels Taxes

Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2793.6	105.4	146.1	183.8	175.8	188.1	179.6	16.0%	15.5%	16.0%	15.5%	16.0%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3307.4	105.0	3.08%	156.0%	173.8	217.6	209.5	222.6	213.9

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2005.5	60.64%	$0.087	$0.084	$0.087	$0.087	$0.089	65.58%	65.68%	64.50%	63.27%	61.87%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
38,000	1,598	(0.32%)	($75)	$33

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($4.65)	789	$50,780	$56,452	$55,839	$58,679	$58,268	26.91%	26.62%	27.21%	27.62%	27.97%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,179,000	11,773,000	11,372,000	8,217,000	3.29%	159.72%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	8,919,000	11,407,000	11,011,000	8,110,000	3.35%	158.68%
Sulfur Dioxide (SO_2)	17,100	15,700	15,600	15,000	14,800	5,100	1.37%	86.55%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	,900	1.09%	56.52%
Nitrogen Oxides (NO_X)	25,300	26,600	25,400	31,800	30,400	29,600	4.24%	120.16%
Volatile Organic Compounds	21,600	20,000	19,000	19,400	18,300	23,400	4.88%	84.72%
Carbon Monoxide (CO)	116,900	101,800	95,400	93,500	86,800	150,400	6.92%	74.25%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.94	1.05	1.01	$201	($14)	($118)	($59)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[b] Transportation sector

[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

damage to the roadway (Sydec, Inc., 1990). Some fees on heavy users would have to remain. Nevertheless, there is significant potential to shift registration, license, and other fees to gas taxes.

Impacts

The modeling assumptions for this policy are the same as for the policy described earlier that shifts roadway construction/maintenance funding from property tax to motor fuels tax. In fact, this policy has very similar impacts. Overall energy reduction is very high with this policy, with total energy use falling by 3.1% and transportation energy use falling by 6.9% cumulatively through 2020 compared to the base case. Oil use and non-renewable energy use also decrease substantially.

The price of motor fuel rises with this policy, but registration and fees are offset by the same amount, resulting in no additional cost to society except for the costs to administer the change. The cost of air emissions decreases cumulatively compared to the base case by 4% or $789 million, while the energy costs (net of policy taxes) fall by 2.6% or $1.1 billion due to the reduction in energy use. The economy also experiences a cumulative boost in employment (38,000 job-years) and Gross State Product (0.3% or $1.6 billion).

Air emissions fall dramatically with this policy as well, mirroring the reduction in energy use. Greenhouse gas emissions decline cumulatively by 3.3% compared to the base case, acid rain precursors by 3.2%, and ground-level ozone precursors by 4.5%.

This policy is one of the strongest explored in this Plan for reducing energy use and its negative impacts while having positive affects on the economy. The policy provides an excellent way to shift some costs of driving onto the price of transportation energy, sending more accurate price signals to consumers.

4. Policy: Support Commuter Buses with a Motor Fuels Tax

Support a commuter bus network with a motor fuels tax.

This policy uses a $0.05 to $0.10 per gallon motor fuels tax to fund a commuter bus fleet so that the fare is competitive with the marginal cost of driving a car, approximately $0.04 per mile. (See also Strategy C. Reduce Vehicle Miles Traveled, Policy 2: Shift VMT to More Efficient Modes--Bus, Vanpool and Train.)

Rationale

Public transportation tends to be much safer, much less costly, and much more efficient than solo driving.[xlv] Yet, because of a lack of availability and the relative difference between the total cost of public transportation (reflected in the fare) and the marginal cost of driving (reflected in the cost of gasoline), most people do not take advantage of the cost and energy savings of public transit. (See Figure 4.II.9 Energy Use by Modes of Transportation, and the Reduce Vehicle Miles Traveled Strategy for a further discussion of these issues.) Therefore, additional incentives are required before a significant number of individuals can actually experience the safety, cost, and efficiency benefits.

The previous policies of internalizing hidden and fixed costs also have important advantages for public transportation. Increasing the marginal cost of driving reduces the difference between the marginal cost of driving and the cost of public transit. This is important because public transit (unless it is subsidized) must

compete, not with the full cost of owning and operating an automobile, but with the variable costs, and in particular, the cost of gasoline use.

The savings (in terms of lives, money, and energy) that could result from the greater use of public transit will be limited until the cost of public transit fares is more competitive with the marginal cost of driving. In the past, if any effort was made to close this gap, it was by reducing the cost of public transportation by subsidizing the fare. Another option to close this gap is to increase the marginal cost of driving an automobile by shifting transportation related costs to a gas tax. For the average car, a $2.00 per gallon increase in gasoline prices would make the cost of public transportation fares competitive with the marginal cost of driving.[xlvi]

Since the external costs of driving are estimated to be greater than $2.00, this is theoretically a possibility. The costs and fees described, however, total only a quarter of the $2.00 needed. This amount is enough to make significant progress toward internalizing costs and reducing energy use, but not enough to make public transportation fares competitive with the cost of gasoline. Even a shift of $0.50, however, is unlikely, due to the competition among states cited earlier.

One attractive alternative is to simultaneously increase the marginal cost of driving and use the funds for a decrease in public transit fares. In this way, the same goal of encouraging energy efficient and cost-effective driving choices is achieved, but without increasing the cost of gasoline by $2.00. By using revenue from motor fuels taxes to buy down the cost of public transportation, a much smaller tax increase provides a much greater incentive to use the more efficient and less costly public transportation. A motor fuels tax of $0.05 per gallon, if used for public transit, is enough to put approximately 150 additional buses and vans on Vermont roads and decrease VMT by approximately 185 million miles per year. This approach has been described more fully in the rail and bus policy of the Reduce Vehicle Miles Traveled strategy.

Impacts

This policy was modeled and impacts can be reviewed in Section 4.II.C, the discussion of Policy 2, Shift VMT to More Efficient Modes - Bus, Vanpool, and Train.

5. Policy: Consider Establishing a Vermont Feebates Program

Establish a program of sales tax surcharges and rebates on the sale or lease of automobiles and light trucks in Vermont based on vehicle efficiency.

A combination of a surcharge or fee on more inefficient vehicles and a rebate on more efficient ones is often referred to as a feebate program. Feebate programs can be revenue neutral, meaning that the total of money collected by the surcharge is equivalent to the monies rebated. The programs can also be designed to be revenue positive, meaning that the surcharge is greater than the rebate, with the balance being used as a revenue source for the government. Feebate programs can apply to new vehicles or new and used vehicles. If they apply to used vehicles, they usually apply only to vehicles that are manufactured after the beginning of the feebate program. See below for more details of state and federal feebate programs.

Rationale

Each new car purchased commits Vermont to future energy use and emissions. The average energy use and emissions for passenger vehicles (including cars and light trucks) already owned is approximately 6,000 gallons of gasoline and 120,000 pounds of carbon dioxide over the life of the vehicle. The average new car

commits Vermont to about 5,100 gallons of gasoline use and 100,000 pounds of carbon dioxide use; the average new light truck, 6,900 gallons and 135,000 pounds.[xlvii]

To reduce future use and emissions, new vehicles must be much more efficient. One major reason vehicles are not as efficient as they could be is consumers have limited incentives to purchase fuel efficient vehicles given the relatively low gasoline prices in the U.S (the reason for the underpricing of gasoline has been discussed above and in the Energy Taxation section). A 10 MPG increase in efficiency from, for example, 28 to 38 MPG, would reduce most pollutants by approximately 26%, but would save a consumer only $113 per year for gas at current prices (assuming the vehicle is driven 10,000 miles per year and gas costs $1.20 per gallon). The future savings of $113 per year is small and does not figure strongly in investment decisions when compared to the immediate vehicle costs that are often in the $15,000 to $30,000 range.

One way to encourage energy efficiency is to provide incentives to consumers who purchase energy efficient vehicles (*e.g.*, rebates), disincentives to consumers who purchase inefficient vehicles (*e.g.*, a gas guzzler tax), or both (*e.g.*, feebates) at the time of sale. Feebates, as the most comprehensive option, would provide a long term, market-based incentive to develop and purchase increasingly efficient automobiles, and would help ensure that energy use and emissions are an important factor when transportation vehicle choices are made.

A feebate program would complement other means to increase efficiency such as stronger Corporate Automobile Fuel Efficiency Standards (CAFE) and revenue shifting. In addition to sending a price signal to consumers at the time of purchase, feebates would help automobile efficiency move beyond the minimum floor set by efficiency standards by providing consumers an incentive to purchase even more efficient vehicles. Also, by using the same fee scales for both cars and light trucks, this policy could help address the problem of an overall falling fleet efficiency (in spite of the CAFE standards) due to the shift in sales from more efficient automobiles to less efficient light trucks. Total fleet efficiency has fallen recently because of the increasing market share of light trucks which must meet a CAFE standard of 20.5 MPG and a decreasing market share of cars with a CAFE standard of 27.5 MPG.

Another advantage of a feebate program is that it will not put additional burdens on low income drivers. The most efficient cars to drive (and often the least expensive to purchase) generally would have no additional fee and would probably receive a rebate.

There are a number of vehicle tax and incentive programs working in other countries. Austria, Denmark, Germany, and Sweden have such programs (DeCicco, *Feebates for Fuel Economy*, 1993, 4). In addition, the Province of Ontario, Canada has a feebate program.

A Federal Feebate Program. There are several mechanisms that can be used to create a feebate program. At the federal level, the fee portion of the program already exists: the gas guzzler tax. It was introduced as a result of the oil crisis of the 1970s. It provides a tax penalty to automobiles that have EPA combined fuel economy ratings of less than 22.5 MPG.[xlviii] This tax should be extended to cover light trucks, and the revenues used to provide a rebate for vehicles that are more efficient. Table 4.II.34 shows the gas guzzler tax levels and revenues raised in recent years.

The gas guzzler tax is important for a number of reasons, whether or not it is part of a feebate program. First, it complements the CAFE standards much as a feebate program would, and provides a marketplace incentive to raise the efficiency of the worst mileage vehicles and those emitting the most greenhouse gases (the cars that are taxed all emit more than a pound of carbon dioxide per mile driven). Second, it sends a market signal to manufacturers to increase efficiency. Automakers, except in the case of luxury vehicles, do not build many cars that are below the 22.5 MPG threshold. Because of the low price of gasoline compared to the societal costs of gasoline use, and the highly discounted value consumers place on future savings, the market does not send a similar signal to car makers. Third, it is a means for society to capture some of the

Table 4.II.34 New Car Gas Guzzler Tax
1980 - 1994

MPG	1980	1981	1982	1983	1984	1985	1986-90	1991 & later
0-12.5	$550	$650	$1,200	$1,550	$2,150	$2,650	$3,850	$7,700
12.5-13.0	550	650	950	1,550	1,750	2,650	3,200	6,400
13.0-13.5	300	550	950	1,250	1,750	2,200	3,200	6,400
13.5-14.0	300	550	750	1,250	1,450	2,200	2,700	5,400
14.0-14.5	200	450	750	1,000	1,450	1,800	2,700	5,400
14.5-15.0	200	450	600	1,000	1,150	1,800	2,250	4,500
15.0-15.5	0	350	600	800	1,150	1,500	2,250	4,500
15.5-16.0	0	350	450	800	950	1,500	1,850	3,700
16.0-16.5	0	200	450	650	950	1,200	1,850	3,700
16.5-17.0	0	200	350	650	750	1,200	1,500	3,000
17.0-17.5	0	0	350	500	750	1,000	1,500	3,000
17.5-18.0	0	0	200	500	600	1,000	1,300	2,600
18.0-18.5	0	0	200	350	600	800	1,300	2,600
18.5-19.0	0	0	0	350	450	800	1,050	2,100
19.0-19.5	0	0	0	0	450	600	1,050	2,100
19.5-20.0	0	0	0	0	0	600	850	1,700
20.0-20.5	0	0	0	0	0	500	850	1,700
20.5-21.5	0	0	0	0	0	500	650	1,300
21.5-22.5	0	0	0	0	0	0	500	1,000
22.5 & over	0	0	0	0	0	0	0	0

Gas Guzzler Tax Receipts
(Dollars in Millions)

Years	1988	1989	1990	1991	1992	1993
Gas Tax Receipts	$116.8	$109.6	$103.2	$118.4	$144.2	$152.0

Source: AAMA, 1994, 85

external costs of energy use not reflected in the market price of gasoline. The tax, therefore, encourages efficient energy use, helps reduce the environmental impact of energy use, is a small move toward a more sustainable use of oil resources, and helps lessen our dependence on oil. In addition, unlike many energy taxes which tend to be regressive, the gas guzzler tax also captures more of the full costs of energy use but is a very progressive tax that falls primarily on expensive foreign, luxury, and high performance automobiles.

The current gas guzzler tax could be improved in several ways. One important change suggested earlier would be to use the revenues generated from the tax to fund a rebate program for high efficiency vehicles, thereby providing both a push and a pull to achieve greater energy efficiency. The gas guzzler tax alone raises the "bottom of the fleet," but probably does not move the overall fleet efficiency above the CAFE minimum. Historically, the auto industry has met but not exceeded the CAFE standards average. A strong gas guzzler tax that significantly improved the mileage of the worst guzzlers would, therefore, allow the rest of the automobile fleet to be slightly less fuel efficient, while maintaining the same average. The rebate incentive could help encourage further movement above the CAFE minimum.

A second way to improve the gas guzzler tax, either as a component of a feebate program or alone, is to close a loophole. Currently, the gas guzzler tax does not apply to light trucks or sport utility vehicles. Since these vehicles are used as automobiles by most drivers, these owners avoid the tax while still driving gas guzzlers (Gordon, 1991, 119). Combining automobiles and light trucks under the gas guzzler tax could help slow or reverse the current trend of declining total fleet mileage in spite of constant CAFE standards. Declining fleet mileage is a result of drivers switching from automobiles to pickup trucks and sport utility vehicles, which have a lower CAFE requirement and no gas guzzler tax.[xlix]

The gas guzzler tax can also be updated. The tax rate has not changed since 1991. The potential for increased fuel efficiency, however, has continued to grow. (See the Transportation Efficiency strategy regarding increasing the CAFE standards for a discussion of the potential for increased fuel efficiency.) The threshold below which vehicles are taxed is approximately 82% of the passenger automobile CAFE standard. Both the CAFE standard and the threshold need to be increased to encourage further efficiency gains.

State Feebate Programs. States can also institute a feebate program, and Maryland has passed feebate legislation. States would face difficulties implementing as strong a feebate measure as the federal government, and they also face problems raised by federal fuel efficiency standards that may preempt such measures. One attractive option open to states, however, is to use their existing sales taxes to create a feebate program.

Instead of the 5% tax in Vermont, the state could implement a sliding scale sales and use tax of between 0% and 10% based on energy efficiency. The most efficient vehicles could be assessed no sales tax and the most inefficient ones assessed a 10% sales tax. Average vehicles would pay the same 5% sales tax. No money is actually rebated to consumers; instead, they pay lower sales taxes.

This is an attractive option for several reasons. Mechanisms for collecting state sales taxes are already in place, so little additional state effort is necessary. Since no money would be returned to purchasers (the rebate would be a tax credit in the form of lower sales and use taxes), there is no problem of how to return the rebate. Also, this feebate program could achieve wide support since the cost of most vehicles would remain the same (if they are of average efficiency) or decline (if they are more efficient than average). The only additional effort would be to determine the proportion of vehicles sold in the state at each efficiency level so that tax rates could be set to ensure that sales tax revenues do not decline as a result of the program.

Maryland has passed similar legislation. It uses surcharges and tax credits to Maryland's 5% titling/sales tax. Maryland's program divides vehicles into three groups: "Gas Sippers" with a fuel efficiency above 35 MPG (EPA adjusted); "Gas Guzzlers" with a fuel efficiency below 21 MPG in Phase 1 and 27 MPG in Phase 2 (EPA adjusted); and the remaining vehicles with efficiencies between those of the "Sippers" and "Guzzlers" (see Table 4.II.35). Maryland's tax was meant to be revenue positive, meaning that there are more vehicles in

the Guzzler category than Sipper category so that the state would receive an additional $5 million per year initially, and $30 million in Phase 2.

Maryland, however, has not been able to enforce its feebate program because of the possibility of federal preemption. The matter likely will be settled in court. At issue is whether feebates based on mileage of vehicles are a violation of current U.S. federal law which preempts states from setting their own fuel economy standards.

There are a number of solutions to this problem. One, the court could rule that a feebate program (that uses the EPA efficiency data) is not an efficiency standard. Two, Congress could clarify the issue by changing the legislation so that it is clear that feebates are not subject to preemption. Three, other surrogates for efficiency can be used to determine the fee or rebate that are clearly not subject to federal preemption.

Table 4.II.35 Adjustments to Maryland's 5% Titling Tax

Passenger Cars and Multipurpose Vehicles

Program Phase	Tax Surcharge for Gas Guzzlers	Tax Credit for Gas Sippers
Phase 1, 1993-1994	$100 if MPG is below 21	$50 if MPG is above 35
Phase 2, 1995 and later	$50 times the number of MPG below 27, but not more than 1% of the car price	$50 times the number of MPG above 35, but not more than 1% of car price

Note: MPG is defined as the EPA adjusted weighted average of the city and highway fuel economy ratings as printed on the new vehicle's sales sticker. Differences between a vehicle's adjusted average MPG and the guzzler and sipper thresholds are rounded to the nearest whole MPG for computing the surcharge.

Source: DeCicco, 1992, *Maryland's Gas Guzzler Tax*, 3

Examples include average carbon dioxide emissions per mile, engine displacement, or vehicle weight. Any one of these would avoid the federal preemption of states setting fuel efficiency standards, would be as easily implemented, and would lead to the purchase of more efficient vehicles and energy savings.

Feebate Program Concerns. There are several concerns about feebate programs that need to be addressed. To avoid shifting vehicle purchases to light trucks and sport utility vehicles, a feebate program should apply to both automobiles and light trucks. Under some feebate programs in which the fee for the largest light trucks is quite high, it is conceivable, but much less likely, that a shift from light trucks (that receive a surcharge) to heavy trucks (that do not) could occur. The frequency of this occurring would depend strongly on the amount of the surcharge since vehicle costs for heavier vehicles are quite high. Even with a high surcharge, it is not clear that vehicle efficiency would be greatly impacted since the efficiency of smaller heavy vehicles is comparable to that of the largest light vehicles. An alternative that would eliminate these concerns is to apply the gas guzzler tax or feebate program to all vehicles. This would have the added benefit of internalizing more of the costs of road freight, and would boost the more efficient rail freight.

Another frequent criticism of feebate programs is that they favor foreign vehicles over American ones. There are a number of responses to this position. One, the concern that favoring more efficient automobiles favors foreign (primarily smaller, Asian-made) vehicles is only partly true. The gap between the efficiency of foreign

and American fleets is closing. Using Maryland's program as an example, more American-made cars in the compact and midsize categories qualify for rebates or incur no surcharge than foreign vehicles (Maryland Representatives Chris Van Hollen and Brian Fosh, personal correspondence, March 1995). Two, the criticism assumes that U.S. automobile manufacturing is static and cannot respond by building more efficient automobiles and fewer less efficient vehicles. Any strong feebate program would likely be phased-in over time, allowing American manufacturers time to adapt. Three, the balance of trade deficit related to vehicles, including trade in cars, trucks, chassis, bodies, and parts was $46,672 million in 1993 ($35,367 million excluding trade with Canada); the deficit related to crude oil and petroleum products was $45,290 million (U.S. Bureau of the Census, 1994, 1330). The trade deficit due to oil is arguably of greater concern, given our oil dependence, the instability of oil-rich governments and regions, and the roughly equal dollar amounts of the trade deficits for oil and automobiles. While it is possible that more dollars (and therefore jobs) may be sent overseas by purchases of more efficient vehicles, the greater efficiency of those vehicles would prevent oil dollars from being sent overseas, having an offsetting effect.

One potential problem unique to state feebate programs is that vehicles can easily cross state boundaries. To prevent consumers from purchasing inefficient cars at out-of-state dealerships to avoid the surcharge, owners can be required to pay the surcharge the first time they register their vehicle in Vermont. A more difficult problem, however, is how to prevent persons from other states from purchasing efficient vehicles in Vermont. Vermonters could conceivably end up subsidizing many of the efficient cars sold in New England if the rebate was large (greater than about 10% of the vehicle cost). There are at least three solutions to this problem. One is to limit the rebate program to the sliding sales and use tax mentioned earlier. As long as the rebates were less than or equal to the 5% sales and use tax, there would be no advantage to purchasing vehicles out-of-state; purchasers from New York or Massachusetts would have to pay a state sales and use tax in those states when the vehicle is registered there, and purchasers from New Hampshire can already buy the more efficient vehicles without a sales tax. Since there would be no savings, there would be no incentive to purchase an efficient vehicle in Vermont.

If the rebate was significantly greater than 5%, a second option is to refund the portion greater than the sales and use tax to Vermont residents only and at a later time; for example, at the time of registration one year later or with income tax returns. This option is somewhat less attractive because it has greater administrative costs and a delayed rebate would not be as effective as an immediate one.

The third alternative is to rely on federal feebate programs. A federal program that was uniform across all states could avoid the problem faced by state programs in individual states.

Impacts

This policy was not modeled, but the last *Vermont Comprehensive Energy Plan* studied the savings from a very strong feebate program of $100 per mile per gallon fee or rebate for cars on each side of the federal 27.5 MPG CAFE standard. The feebate program was projected to reduce energy demand in the residential transportation sector by roughly 4 TBTU or roughly 14.2% by the year 2000. Per capita residential energy demand was projected to decline by 6.5% relative to the base case in the year 2000, and residential expenditures on energy, by 5.6%. Greenhouse gas emissions would have declined by roughly 4% while acid rain precursors would have declined by 5% relative to the base case emissions in 2000.

III. BUILDINGS AND EQUIPMENT

A. Strategy: Improve Efficiency and Indoor Air Quality in New Homes

This plan has committed to taking advantage of prime opportunities to improve energy efficiency in Vermont. One such opportunity occurs when buildings are under construction or when major renovations occur. These prime opportunities allow for efficiency to be included concurrently with other work, commonly at far less expense than energy-only improvements because efficiency is incorporated into design and construction efforts already underway. Inability to intervene at these times creates lost opportunities and means buildings have greater energy expenses for their owners or occupants, with environmental and economic ramifications for the state.

Policies that can capture energy savings are of three types:

- establishing building code and equipment standards;
- improving, coordinating, and standardizing utility DSM programs; and
- creating market value for efficient construction, and assuring that higher capital costs of new construction will be affordable to home buyers and renters.

These policies reduces non-transportation residential energy use in a cost-effective manner, with modest benefits to the economy and emissions reductions.

1. Policy: Implement Residential Building Energy Standards for New Construction

Vermont should implement a statewide residential building energy standard based on the 1995 Council of American Building Officials, Model Energy Code (CABO/MEC), with Vermont-specific modifications to maximize savings for Vermont home buyers and provide predictability and consistency for builders and designers.

1997 legislation established statewide, residential building energy standards (RBES) that apply to residential new construction and major renovation, based on the CABO/MEC standard recommended by the U.S. Department of Energy. The CABO/MEC standards cover both single-family residential new construction and multi-family buildings, primarily addressing the thermal integrity of buildings; that is, the heat-retaining ability of the building shell. Satisfaction of the guidelines in Vermont's new Residential Building Energy Standards is presumed to be compliance with criterion 9(f) in Act 250 proceedings if the code is updated periodically as required by the statute. For buildings over three stories, CABO/MEC refers to the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) code for commercial construction.

After an extensive cooperative effort supported by a DOE grant, utilities, builders, architects, Home Builders Association of Northern Vermont, Department of Labor and Industry and the DPS proposed 1996 legislation for residential building energy standards that exceeded the 1995 CABO/MEC standards. Vermont's residential building energy standards include heightened 1995 CABO/MEC standards to cover Vermont builders' current practices and equipment efficiencies (such as for water heaters or heating systems) above current national standards. The standards apply to both Act 250 and non-Act 250 projects. The state's right to oppose installation of electric resistance heat, as established under Act 250 is retained. CABO/MEC and Vermont's new standards provide for compliance either by inclusion of certain prescribed minimum efficiency levels for building components, or by calculating total building performance, with all system components considered together.
Recommended measures in the Vermont residential building energy standard should, in general, be based on a life-cycle cost analysis that should ensure no added cost to the consumer on a monthly basis, when mortgage

payments and energy/utility payments are added together. Vermont standards are to be reviewed by Labor and Industry and DPS, with an advisory committee, every three years. The first update is to include indoor air quality and a ventilation standard for new homes. Code enforcement relies on self-certification by builders and the consumers's right of action.

Rationale

Vermont presently has a patchwork of energy requirements. Except for the City of Burlington, which has an energy efficiency ordinance for residential and commercial buildings, the only standard for assuring efficiency in residential new construction is Vermont's land use control law, Act 250. Roughly 40%–50% of residential new construction (including single-family and multi-family structures) is reviewed under the Act 250 process. Although Act 250 has successfully restricted installation of electric resistance space heat, and been successful in establishing a high level of thermal efficiency in permitted projects, there is the potential that a code could improve the overall level of energy efficiency and provide greater statewide consistency in efficiency standards.

Although there is significant evidence that Vermont has one of the highest levels of standard building practice in New England (see discussion under Significant Issues below), a code has the potential to "bring up the bottom" in currently non-regulated housing and create an ongoing process for identifying and standardizing new efficiency measures as they emerge. The code should give consumers a consistent indicator appropriate for the product they are buying, and it should provide some predictability to builders seeking permits.

The residential building energy standards and the well defined method for its updating and modification will help improve the effectiveness of both gas and electric utility demand side management (DSM) programs. The standards will be a baseline for utility program planning purposes. DSM programs will add incentives to promote adoption of measures beyond those incorporated in the new construction RBES. In addition, utility DSM programs can help consumers and builders with training and compliance–assistance strategies increasing effectiveness of the standards and attractiveness of utility DSM programs.

Significant Issues

First, adoption of a code or standard must increase the energy efficiency of residential new construction in the state. To achieve this, there must be an assurance that the level set in a new code is not below existing building practice. The new Vermont Residential Building Energy Standards passed by the 1997 legislature is a heightened version of the 1995 CABO/MEC that will increase the energy efficiency of all residential new construction in the state. The established update procedure will assure that progress continues in the future. A study defining baseline construction practices was completed in June, 1993 (Faesy, 1993). This study showed that the average home being built in Vermont at that time would comply with the 1992 CABO/MEC standard.

Standard permit requirements for Act 250 projects are now above the 1995 CABO/MEC level. In 1995, three Vermont electric utilities, Citizens Utilities, Central Vermont Public Service, and Green Mountain Power, conducted a baseline study of residential building practices statewide. This study affirmed that on the average, homes are being built with higher levels of overall energy efficiency. However, this study pointed out that many new homes are still substandard, causing their occupants unnecessarily high energy bills.

If a legislated standard is applied to Act 250 and non-Act 250 projects, this standard has to be carefully set to increase overall efficiency statewide. It is likely that a legislated standard would have to be above the 1995 CABO/MEC level to raise average building practices in the state.

Second, providing high quality training and enforcement is as important to actually securing efficiency gains as

the level of efficiency required by the code. Most states that have an energy code also have a residential health and safety code in place. This means that in other states an inspection by a building code official typically happens prior to occupancy. Vermont, however, does not have a statewide residential health and safety code. There is almost no infrastructure of building code officials to implement an energy code in the manner of other states.

Builders themselves certify that each home they build meets or exceeds the minimum standard. In order for consumers to have some confidence in a builder's certification, consumers must have a means to determine whether the home complies with the standard. One such mechanism is of a home energy rating for the completed home. If the rating identifies whether and by how much a home exceeds the standards, it would become both a useful compliance and customer education tool.

Adoption of a code that relies on builder self-certification could blend well with utility DSM programs that offer home energy ratings as part of their program. In such a scenario, home energy ratings for a significant percentage of new homes would likely be purchased through utility programs. Widespread use and acceptance of such a rating system could provide a concrete measurement and identification tool which would encourage homeowners and homebuilders to build more efficient homes.

2. Policy: Statewide Residential New Construction DSM Program for Premium Homes

Implement a statewide residential premium efficiency program that reaches a majority of new homes built in Vermont and provides assistance to builders in meeting and exceeding the current, adopted Residential Building Energy Standards. Premium efficiency homes are new homes with distinguishing improvements in thermal and electrical efficiency and better indoor air quality. An Energy Star rating reflecting the new home's efficiency level supports this policy.

Utility residential new construction DSM programs should be standardized, coordinated, and focused so that Vermont's electric and gas utilities are implementing a uniform and coordinated statewide DSM program that:

- provides assistance to home builders in identifying and incorporating efficiency options;
- offers technical assistance to builders on how to build high efficiency homes;
- verifies the "as-built" performance of completed homes;
- promotes effective implementation and periodic update of a residential new construction energy efficiency building code.

Two Vermont electric utilities, Washington Electric Cooperative (WEC) and Central Vermont Public Service, have begun conducting such a program. Green Mountain Power and Citizens Utilities Company are in various stages of implementing a similar program.

The WEC program offers a comprehensive energy assessment of each new home processed through the program. In addition to an analysis of the likely energy performance of the proposed new home, an energy specialist also makes recommendations on how to improve the efficiency of the home. To offset the cost of this analysis and to encourage participation in the program, WEC charges an up-front "Energy Assessment Fee" of $300 to each new connecting customer prior to providing electrical service. If the home meets the program performance standard upon final inspection, WEC then pays an incentive that more than offsets the assessment fee. Homes that participate in the program are also provided with a home energy rating, which may qualify them for a 2% increase in the usual debt-to-equity ratio of the property loan. This means that the slightly higher costs of building a more efficient home can be covered in the mortgage. The modestly higher loan payments would be offset by lower energy costs.

DPS is working with a number of Vermont electric utilities, Homebuilders of Northern Vermont, and other groups to develop a statewide residential new construction program that will build on the experience of WEC

Fu The Governor's Task Force on Energy Efficiency Standards for New Residential Construction made the following recommendations in the Fall of 1995:

and CVPS, reach a high percentage of eligible customers, and provide two levels of efficiency investment with corresponding incentives. A new construction program of this sort should be designed to promote effective implementation of a residential new construction energy efficiency building code, and it should promote a very efficient "Energy Star home" which will increase builder, customer, and lender acceptance of new efficient construction practices. This model is an effective way to implement residential new construction DSM programs statewide.

Rationale

Currently, utility new construction DSM programs are inconsistent with each other and have changed unpredictably from year to year. Participation has generally been low. With the exception of the program run by Vermont Gas Systems, new construction DSM programs have focused primarily on electrical energy measures, overlooking efficiency options for other types of energy systems. With a code-coordinated program approach, this policy has the potential to reach a high proportion of new homes in the state and significantly affect the market by educating consumers, builders, and designers.

The WEC Energy Assessment Fee Program, under way since July 1994, already has over 50% participation and is addressing energy efficiency comprehensively for each new home in the program. A program modeled after WEC's, emphasizing aggressive marketing instead of charging a fee would mean that many new homes would go through an energy analysis, and assistance in code compliance would be offered by the utility. Consumers could compare their final home energy rating with the builder's assurance of code compliance and have evidence of whether the home met or exceeded the standard.

Perhaps the most powerful rationale for adopting a consistent, statewide approach is that with a code in place and provisions for code updating a part of Vermont law, utilities can improve building practices. This is accomplished by eventually incorporating into the code those efficiency measures for which utilities presently pay incentives.

Significant Issues

The services offered by this program would help educate consumers, builders, and designers about basic code requirements and about higher levels of efficiency needed to receive the "premium efficiency" designation. Once a builder learned to incorporate these techniques, such as air sealing and modified framing techniques, and became familiar with new materials, the incremental time and effort to include efficiency improvements would be small.

Energy Rated Homes of Vermont is currently developing the capability and technical expertise to meet demand for delivering the assessment fee program. Further research and development is underway to equip its computer modeling system to analyze the energy performance of proposed homes and to make it compatible with any energy efficiency building standard that is adopted. Utilities, the Department of Energy, and the DPS have an interest in making these software tools more efficient and economical to use.
In the fall of 1995, a Governor's Task Force was appointed to make recommendations about a Vermont residential energy code. The Task Force included in its final report a recommendation that a "premium efficiency home" be defined and clearly identified as a target for increasing the level of thermal efficiency and simultaneously improving both the electrical efficiency and indoor air quality of new homes. The "premium efficiency home" could easily be defined so that it was consistent with utility efficiency savings goals, and home energy rating systems could be adapted to certify eligibility for the "premium" designation. The utility Residential New Construction DSM Program could thus offer builders an easy way to increase marketability of their homes, providing increased incentive for builder participation.

In order to build upon the tradition of effective voluntary adoption of building efficiency practices, the Task Force strongly recommends that regulated energy utilities, the Department of Public Service, homebuilders and building material suppliers, Energy Rating systems and Energy Efficient Mortgage programs, related professional associations, financing institutions, and real estate professionals, work together to define, provide training and development support to, and publicize to consumers the concept of a "Premium Level of Energy Efficiency" that meets the following criteria:

- Attains a level of efficiency significantly above that required by the code.

- Defines that level of efficiency so that it is consistent with the Energy Rated Homes of Vermont rating scale, the U.S. Environmental Protection Agency (EPA) "Energy Star" home, and the "energy scorecard" used by a number of Vermont electric utilities to rate a home's electrical energy efficiency.

- Provides adequate mechanical ventilation, and has undergone a "blower door" test as part of its certification process.

- Becomes eligible for a further improved "debt–to–equity" ratio in recognition of its lower operation costs.

The Governor's Task Force on Energy Efficiency Standards for New Residential Construction believes that the existence of a voluntary category of an efficient home that substantially exceeds the required code will help move the level of energy efficiency included in residential new construction upward by educating consumers and rewarding the builders of high efficiency homes by helping them market their product.

3. Policy: Increase Efficiency of New Manufactured Housing

Increase the efficiency of manufactured housing and mobile homes sold in Vermont.

This policy involves developing at a state or Northeast regional level a dialogue among energy regulators, utilities, and producers of manufactured housing and mobile homes. The dialogue would involve offering

incentives to manufacturers who are raising the level of efficiency for manufactured housing delivered to markets served by the utilities.

Rationale

Homeowners have very little choice about the energy efficiency options available when they buy a manufactured home or mobile home. One successful method used by utilities in the Pacific Northwest to increase efficiency in this market is to approach manufacturers directly and offer an incentive to build and sell more efficient units. Incentives would have more impact if they were applied on the manufacturing level since efficiency measures, such as more insulation or tighter construction, are not readily apparent to consumers when purchasing these units, and they are difficult to add or correct after the unit is manufactured.

Significant Issues

Vermont should identify interested parties instate, such as a statewide utility working group, affordable housing advocates, the Department of Housing and Community Affairs, and similar groups in New Hampshire, Maine, and perhaps New York and Massachusetts. Packages of measures would be identified and priced. Then incentives could be negotiated directly with the manufacturers. Interested parties in a county in Washington state successfully negotiated with manufacturers of factory-built homes and encouraged them to increase the efficiency of the units they sell in this particular service territory. Similarly, utilities and

efficiency advocates worked with appliance manufacturers and developed the "Golden Carrot" competition for high efficiency refrigerators. The winning manufacturer received a multi-million dollar prize, and participating utilities had the winning refrigerator marketed exclusively in their territories for a period of time.

4. Policy: Expand the Vermont Home Energy Rating System

Vermont should continue to promote an independent energy rating service, consistent with the U.S. DOE process for promoting Home Energy Rating Systems throughout the U.S.

Energy Rated Homes of Vermont (ERH–VT) is a nationally recognized non-profit home energy rating system, one of six in the country. This type of service was referenced in the National Energy Policy Act of 1992 as the type of rating service that should be developed nationwide (U.S. Congress, 1992, 102-486). The rating system would provide the information for judging efficiency levels of a home, serving as the basis for making improvements or getting access to special mortgage terms which recognize the value of lower energy costs in helping homeowners afford regular loan payments.

The ERH-VT program has been in existence since 1987. It encourages investments in energy efficiency by giving homes a rating based on their energy efficiency, quantifying the economic value of energy efficiency improvements to a home, and providing access to financing through the Energy Efficient Mortgage Program. The home energy rating system also provides recommendations for cost-effective steps to improve the efficiency of the building's design and major appliances. The ratings, from one star (lowest) to five stars (highest), represent the home's level of energy efficiency and provides homeowners, builders, lenders, Realtors, and prospective buyers with information about a home's energy ranking and likely energy cost. There are indications that, at least with certain consumers, the rating makes a rated home a more attractive purchase option. Hundreds of Vermont homes have been rated so far, with the cost per rating ranging from $300-$400.

Energy Rated Homes of Vermont has been formally recognized by secondary mortgage markets and national financing agencies (Freddie Mac, Fannie Mae, HUD, and Veterans' Administration) and the Vermont Housing Finance Agency's Energy Efficient Mortgage (EEM) Program. The EEM program is being offered to home buyers and refinancers by lending institutions throughout Vermont.

Rationale

For existing high efficiency homes, the Energy Efficient Mortgage Program provides lenders the opportunity to account for a home's energy efficiency in the underwriting process by
allowing them to consider the borrower's below-average energy bills when they determine how much a borrower can afford for monthly payments. This allows the home buyer to purchase a home with a higher initial cost but lower operating costs.

For homes not considered energy efficient, the energy rating provides information used in the EEM Program to add to the mortgage an amount to finance the cost of energy improvements. The recommended energy improvements will produce energy savings that more than offset higher mortgage payments, providing the home buyer with a positive cash flow.

Energy Rated Homes of Vermont (ERH-VT) has worked with most Vermont lenders and currently works on a regular basis with lenders who handle about 80% of Vermont mortgages. ERH-VT has helped facilitate the underwriting of over 650 Energy Efficient Mortgages. The mortgages offered borrowers more financing choices and made existing Vermont homes more affordable.

Vermont should support ERH-VT, and any other non-profit offering comparable services in Vermont, by providing assistance in developing the following capabilities:

- Develop a home energy rating capability that can clearly identify compliance with any adopted residential energy efficiency building code.
- Develop a "Premium Home" standard and designation, consistent with the rating system that provides a visible, marketable assurance to customers that a home is highly energy efficient, safe, and affordable.
- Develop a program to educate builders on the latest energy efficiency technologies and techniques.
- Establish a network of home energy raters throughout the state who can implement utility residential new construction DSM programs and other services that use the energy rating tool.
- Refine the existing home energy rating system to reduce the cost per rating and allow for use in code compliance.

Many of the policies in this Plan for the residential sector involve a significant role for a home energy rating system. This service is at a critical time in its development and has significant potential as a useful tool for improving the efficiency of Vermont's residential building stock in many ways. The home energy rating system can be used to label new and existing homes to reveal their energy performance much like miles per gallon (MPG) ratings for cars or the federal energy label on appliances.

Vermont is fortunate to have a Home Energy Rating System in place and should expand this capability and use its full potential to move the market toward a more efficient housing stock.

Figure 4.III.1 Impacts of Residential New Construction Policies

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.10	35.98	35.26	38.27	37.03	885.25	864.94
Commercial	11.99	17.82	17.81	19.34	19.33	22.21	22.21	486.65	486.51
Industrial	12.42	16.79	16.79	18.41	18.39	19.87	19.87	446.39	446.23
Transportation	42.10	60.54	60.55	64.68	64.72	70.98	71.04	1594.14	1595.01
Total	98.04	130.54	130.24	138.40	137.70	151.34	150.15	3412.43	3392.69

Table 4.III.1 Indicators of Residential New Construction Policies
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2886.5	12.5	146.1	183.8	183.1	188.1	186.7	16.0%	15.6%	15.5%	15.5%	15.3%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3392.7	19.7	0.58%	117.4%	173.8	217.6	216.5	222.6	220.5

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2108.1	62.14%	$0.087	$0.084	$0.084	$0.087	$0.086	65.58%	65.68%	65.98%	63.27%	63.80%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
4,000	171	0.03%	($9)	$3

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($6.00)	$167	$50,780	$56,452	$56,486	$58,679	$58,705	26.91%	26.62%	26.29%	27.62%	27.02%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,441,000	11,773,000	11,628,000	2,162,000	0.87%	163.31%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,181,000	11,407,000	11,270,000	2,028,000	0.84%	162.42%
Sulfur Dioxide (SO_2)	17,100	15,700	15,800	15,000	15,100	0	0.00%	88.30%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	1,100	1.33%	56.19%
Nitrogen Oxides (NO_X)	25,300	26,600	26,300	31,800	31,200	7,900	1.13%	123.32%
Volatile Organic Compounds	21,600	20,000	19,900	19,400	19,100	4,500	0.94%	88.43%
Carbon Monoxide (CO)	116,900	101,800	101,600	93,500	93,100	6,600	0.27%	79.64%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.03	$216	$109	($77)	($55)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories
[a] Cumulative impacts, 1997-2020
[d] Calculated using Vt. DPS externality adders, see Appendix 5

[b] Residential sector
[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices
[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy
[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

5. Impacts of Residential New Construction Policies

Residential new construction policies were modeled by creating a composite of several policy options, including increasing the efficiency of space heating, water heating, cooking, and drying.

The modeling of the space heating component has two parts. First, a 15% increase in space heating efficiency is assumed starting in 1998. This reflects an advancement to Four Star Plus homes. Second, an electric fuel switching DSM program begins in 1997 and runs through the end of the study. It assumes a 50% reduction in the share of the new electric space heating that is installed for reasons other than price.

The electric hot water fuel switching DSM program modeling is similar to the electric space heating program. It begins in 1997, and assumes that the share of electric water heaters installed for reasons other than price is cut in half.

Costs for the space and water heating programs are as follows: $865/per customer (1994$) from 1997 to 1999; and $365/per customer (1994$) from 2000 to the end of the study. It is assumed that 3,500 customers per year participate. In addition to these direct costs, utility overhead is assumed to be $20,000, plus $225 per customer (1994$).

Also modeled was a program that targets two specific uses of hot water: clothes washers and dishwashers. This program assumes a growth in participation from 1% in 1997 to 29% in 2005. It is assumed that these households purchase new horizontal axis washers and high efficiency dishwashers. These washers result in a 16% increase in the efficiency of residential hot water systems. There is no utility rebate or subsidy for this program. Capital costs for the program are assumed to be $30 (1994$) per million BTU of energy used.

The cooking DSM program is assumed to begin in 1997. It involves increasing the efficiency of newly installed residential cooking devices by 24.2% over 1994 values. Participation in the program is assumed to increase from 1% in 1997 to 10% in 2002 and later. There is no utility rebate for this program. The capital costs for the program are assumed to be $249 (1995$) per million BTU of energy output.

The drying DSM program is also assumed to begin in 1997. It involves increasing the efficiency of newly installed residential dryers by 60% over 1994 levels. Participation in the program is assumed to grow from 25% in 1997 to 80% in 2005. As with the previous program, there is no utility rebate. Capital costs are assumed to be $109 (1995$) per million BTU of energy used.

The major benefits of this composite policy include a reduction of residential energy use (excluding transportation) by 2.3% (20.3 TBTU) cumulatively through 2020, translating into a 0.58% reduction in total cumulative energy use. In addition, per household residential energy expenditure during the same period is significantly reduced with this policy, by an average of $47 per year or $1,087 (1.5%) cumulatively (1995$). The economy also benefits from this policy, with small increases in job-years, Gross State Product, and disposable income. Cumulative program costs related to the policy are $133 million, but society experiences reduced energy costs of $252 million and reduced air emission costs of $167 million. Finally, this policy reduces greenhouse gases, acid rain precursors, and ground level ozone precursors all by about 1% cumulatively.

B. Strategy: Improve the Efficiency of Vermont's Existing Housing Stock

Through a combination of policies, including both lost opportunity and retrofit efforts, cost-effective savings could be captured from Vermont's existing residential building stock. A key means for accomplishing this is increasing the average level of efficiency in existing buildings to the equivalent of a Four Star Home Rating. There has been considerable effort in Vermont over the last 30 years to improve the energy efficiency of the

state's 271,000 homes (U.S. Bureau of the Census, 1994, 738). Per-household energy consumption for heating has declined since 1975 as homes are built more efficiently and improvements are made in the combustion efficiency of heating equipment.[1] Consumption of petroleum heating fuels has actually declined by 28% since 1972, despite a sizeable increase in Vermont's housing stock (U.S. DOE, *State Energy Data Report, 1993*, 1995).

Still, most Vermont households were constructed during an era of inexpensive energy supplies, and there are many opportunities to save money, increase comfort, and reduce pollution by improving the efficiency of residential housing further. For example, the State Weatherization Program, which specializes in improving the heating and electrical efficiency of low income housing, is able to cut heating bills by about 20% on average, for homes in Vermont that are served by the program (Levins, 1994, xv).

The policies proposed here attempt to take advantage of prime opportunities to improve efficiency of existing homes. These opportunities typically occur when a property is sold, refinanced, remodeled, renovated, or when equipment, such as a heating system or refrigerator, is replaced. A concerted effort to get building owners to include efficiency improvements at such times makes good sense because buyers or owners are likely to have access to capital at the time of purchase, renovation, or replacement, and the incremental cost of an efficiency improvement is small and affordable. (See Chapter 4, Section III. D. 4. Financing Mechanisms for Cost-Effective Energy Efficiency and Renewable Energy: Performance Contracting and ESCOs.)

If these approaches for improving energy efficiency in Vermont's existing housing stock were coupled with the policies proposed under the residential new construction strategy outlined above, the Vermont residential sector would have a comprehensive support system for encouraging high levels of energy efficiency. In fact, programs that support new construction efficiency complement efforts to improve the efficiency of existing housing, and vice versa. Examples include financing for energy improvements, developing networks of retailers specializing in high-efficiency refrigerators and lighting products, and a home energy rating system. Also, utility residential new construction DSM programs have recognized the opportunity to offer energy efficiency assistance when homes are remodeled or renovated, as well as when they are first being constructed.

The policies described below can achieve a steady increase in dollars saved by homeowners and renters, decreasing environmental impacts from the inefficient consumption of energy.

1. Policy: Time-of-Sale Energy Efficiency Requirement

Vermont should continue to explore the feasibility of having both single-family homes and multi-family housing meet a minimum energy efficiency level at the time-of-sale.

This policy would establish a standard for energy efficiency for existing houses, when they are sold. It would be phased in, perhaps by setting an effective date that is several years in the future to allow time to develop an infrastructure to provide the needed remodeling services and to allow owners to begin upgrading their homes in anticipation of the law. The law should be structured so that a home not meeting the minimum standard (approximately equivalent to a Four Stars Home Energy Rating) could comply by including the costs of compliance in the financing of the property, perhaps with funds for the upgrade set aside in an escrow account for installation within a set period of time. A home energy rating system could be one method to determine whether a home has met the standard. (See Strategy A. Improve Efficiency and Indoor Air Quality in New Homes, Policy 4: Expand the Vermont Energy Rating System.) Exemptions could be made for existing homes requiring very expensive improvements to meet the standard, historic homes, log homes, and others where it would not be cost-effective to bring them up to standard. (See Section IV. Affordability.)

This policy will also increase the energy efficiency and improve housing affordability for residents of multi-family housing (see Section IV. Affordability and Policy A.1: Energy Efficiency Standards for Multi-Family Rental Housing).

Rationale

A study performed for the DPS in June 1993, indicated that bringing the average existing home up to a Four Stars energy rating level would save approximately 25% on the energy use for each home (Faesy, 1993). The predictable time-of-sale approach to energy efficiency improvements takes advantage of the opportunity to include the costs of these investments in the purchase price of the building, which is typically financed. Since most energy efficiency measures have a positive cash flow when they are financed over the life of a mortgage, a homeowner can often finance otherwise costly efficiency improvements that will actually *reduce* a household's monthly expenses compared with the "no-action" option of slightly lower mortgage payments but higher energy bills.

Significant Issues

While this policy would increase the affordability of housing, generate new jobs in construction, and improve Vermont's environment and economy, it should be implemented in tandem with innovative approaches to make capital available for financing energy efficiency improvements and with a simplified process for enforcement for single-family and multi-family buildings.

Making capital accessible would help create a market specializing in efficiency upgrades and is likely to produce a niche industry supporting efficiency improvements in the existing housing stock. Other policies discussed under this strategy will outline other mechanisms through which economic incentives and innovative financing techniques can help facilitate implementation of this policy.

Legislation would be crafted to permit exemptions for existing homes requiring very expensive improvements to meet a standard. Possible exemptions might include historic homes, log homes, and others where it would not be cost-effective to bring them up to standard.

Minnesota has had a time-of-sale energy efficiency standard in effect for a number of years that applies to multi-family housing. The City of Burlington has received funding from the U.S. Environmental Protection Agency (EPA) as a part of its Old North End Enterprise Zone Community to assist in the development and initial implementation of a time-of-sale rental housing energy code for the city.

Utility DSM programs could be designed in a way that helps the customer comply with the code (by providing a Home Energy Rating to evaluate cost-effective efficiency improvements) and targets incentives for increased electric and natural gas efficiency that are cost-effective under the utility's requirement to provide service at the lowest cost.

2. Policy: DSM Program Support for a Time-of-Sale Standard

Utility DSM programs should include a standardized offer of energy services, appropriate for the time of property sale, that targeting high use electric customers and encouraging fuel switching or thermal improvements.

At the time-of-sale, utilities would offer, at no charge, a home energy rating along with improvement-arranging services and a small incentive for fuel switching and other cost-effective efficiency measures for electrically heated homes. The rating would provide specific recommendations for efficiency improvements, along with estimates of costs. The rating could also help homeowners borrow the amount to cover the cost of efficiency upgrades by qualifying them for an Energy Efficient Mortgage.

Rationale

Probably the best opportunity for implementing cost-effective measures like fuel switching is at the time-of-sale or when refinancing a home. The improvement cost can be financed over a long enough period to produce a positive cash flow for the borrower, after paying lowered energy bills and the loan payment. If utility DSM programs focus on this opportunity, they could keep costs for incentives low and get greater participation in their residential high use and fuel switching programs.

Utility involvement in a time-of-sale program would provide property owners with expert guidance in acquiring quality efficiency improvements at competitive prices. For high use electric customers, the utility role could involve support for the home energy rating, which would present the property owner with a process for analyzing and financing recommended improvements.

DPS should continue working with electric utilities and Energy Rated Homes of Vermont to develop a program based on a set of services that all utilities could offer which are appropriate for the time of property sale. Central Vermont Public Service is offering the services and incentives described above to a number of its customers who are considering selling electrically heated homes.

3. Policy: Discount Mortgage Rates for Energy Efficient Homes

Vermont should have a home financing program offering a lower rate for existing homes that improve their energy efficiency by 10 points on the Energy Rated Homes scale or for new homes that meet or exceed a Four Stars Plus rating or the proposed premium energy efficiency designation.

The value and desirability of energy efficient housing will dramatically increase when linked to preferential mortgage rates. This market incentive, combined with the other policies discussed above that promote efficiency in residential new construction and retrofits, could significantly improve the acceptance of energy efficient homes and enhance incentives to design and build them.

Rationale

The goal of this effort is to enhance the incentive to retrofit homes to a high level of energy efficiency. Although information from home energy ratings is valuable for educating property owners that an efficient home will cost less to operate, the substantial incentive of a lower mortgage rate is a compelling reason to purchase high efficiency housing or make improvements to a home.

Implementation

The VHFA may be able to establish a pilot project, providing this lower interest rate within its existing financing structure. Potentially, funding might come from a slight increase in the interest level charged for less efficient homes. Arguably, the reduced operating costs in an energy efficient home improve the

householder's ability to meet mortgage obligations. To the extent there is a lower default rate for efficient homes, funds would come from an actual risk reduction to mortgage holders.

Both Rhode Island and Alaska have experimented with similar concepts through their state housing finance agencies. In Rhode Island, a non-profit energy conservation company offers free home energy ratings and incentives to reduce mortgage closing costs if a home buyer agrees to put money aside to make energy efficiency improvements. In addition, borrowers are eligible to obtain up to $5,000 over the cost of the mortgage to make recommended efficiency improvements. In Alaska, the state housing finance agency grants a lower interest rate if the home has a Four Stars Plus home energy rating. In both states, representatives say that these reduced rates substantially improve participation in the energy efficient mortgage programs.

4. Policy: Promote Energy Efficient Products Through a Statewide Trade Ally Program

Set up a statewide trade ally program to transform retail markets and consumer buying habits to favor high efficiency consumer products.

Under this policy, a utility supported, statewide program would identify and label high efficiency consumer products. The program would recruit trade allies -- retailers, distributors, and manufacturers -- who would agree to promote high efficiency products. A complementary marketing campaign would educate consumers about the energy and money saving benefits of labelled products. The program would act as a catalyst for the introduction and promotion of these high efficiency products. This program would support markets for qualified products by enhancing manufacturers' efforts to increase sales volumes in Vermont's relatively small market (compared with urban areas). A network of trade allies would be cultivated in a nondiscriminatory manner, covering all regions of the state.

This policy would combine the resources of utilities that would otherwise operate individual trade ally programs. A main feature would be offering uniform terms to trade allies. Moreover, marketing to consumers would feature a single, identifiable campaign. Uniform terms offered to trade allies through a statewide approach would cover incentive levels and qualifying products, eligible customers, marketing support, and other factors. Utilities would offer financial incentives or other inducements to encourage their customers to purchase qualifying products. Objective criteria would be used to determine whether a product qualifies (*e.g.*, refrigerators at least 15% more efficient than the minimum federal standard or lighting products with desirable features, such as a high power factor).

Many products could be featured: refrigerators, lighting products, air conditioners, washing machines, and others.

Rationale

During the last two decades, manufacturers of consumer goods have produced energy-consuming products that are more efficient than their mainstream counterparts. In many cases the improved products emerged in response to consumer demand, due in part to higher energy or utility costs. In other instances, federal laws have set standards that at first were designed only to eliminate grossly inefficient products from the market and which later were modified to promote meaningful improvements in overall efficiency for whole classes of products. Virtually all products that have significant energy use have come under federal standards since 1988. Examples of products subject to energy standards include: furnaces and boilers, air conditioners, water heaters, refrigerators, freezers, and lighting products.

Vermont utilities have made various attempts to promote high efficiency products, but in many cases trade allies have been perplexed by varying incentive schemes, different qualifying products, and complex paperwork. As a result, utility programs were too confusing to make participation attractive.

Under a jointly operated program, consumers would be guided by a consistent marketing theme and conspicuous product labelling. Use of labelling would create a positive identity for high efficiency products. Combined with persistent and professional promotion and suitable incentives, labelled products should increasingly gain the recognition and acceptance from buyers.

Vermont utilities already have experience with inter-utility cooperation for "point-of-sale" promotions of high efficiency products. In recent years many Vermont utilities have cooperated to promote lighting products and appliances. To take advantage of this experience, lighting products and appliances could be labelled first, and eventually other products would be added to the program's portfolio, including air conditioning, water and space heating, electric motors, etc. The program would also identify emerging technologies or product enhancements that represent significant improvements in efficiency. The program would concentrate on accelerating the acceptance of promising technologies.

A program that labels efficient products would complement other programs supporting high levels of residential energy efficiency. A labelling program would establish a network of trade allies where products are easily identifiable and available, making them more accessible to building contractors and home buyers participating in new construction and retrofit programs described earlier in this chapter. For example, there has been limited availability of high efficiency lighting fixtures, which has impaired their consumer acceptance. Such a program could focus on ensuring their availability.

Significant Issues

Despite its small population, Vermont has a unique situation when it comes to promoting high efficiency products. There are about 271,000 households statewide served by 21 electric utilities with a patchwork of territories, making the region fragmented from a retail market perspective. A statewide consumer marketing campaign will overcome differences in program designs among individual utility territories.

Many utilities hired mail order contractors to quickly enter consumer markets for popular high efficiency products, such as compact fluorescent lamps, but mail order programs have limited long term appeal. While mail order programs helped create an instant market for some efficiency products, they presented an unconventional way to buy everyday consumer products such as light bulbs. Without inducement from a utility, it is unlikely that most consumers would shift their buying habits to mail order sales. One side effect of the utility sponsored mail order programs was frustration by many retailers who viewed the programs as a diversion of trade to out-of-state companies. The challenge, then, is to build positive relations with retailers and to present consumers with high efficiency alternatives in stores where they traditionally shop.

Because market transformation is the goal of this effort, this program should focus on the important but temporary role of utility intervention in the market. Ultimately, the goal is to make a self-sustaining market for high efficiency products, requiring little ongoing utility involvement.

While the necessity for utility promotion of particular technologies may diminish as they gain acceptance in the marketplace, the need to identify and then promote new products is likely to be ongoing. Developing instate expertise with high efficiency products and consumer markets would be a valuable resource. Keeping abreast of new technologies and industry dynamics will permit the program to respond promptly to new equipment introductions or market conditions. In addition, this effort will allow interested parties, including regulators and utilities, to remain informed on matters relating to the development and implementation of federal equipment efficiency standards that have produced large energy savings for many classes of products but are currently under attack in Washington. In fact, a one-year moratorium on issuing any new refrigerator standards was invoked by Congress in 1996, and long term energy standards for many other products are also threatened.

Most utilities and regulators recognize the benefits of statewide cooperation for market transformation programs. The challenge, then, becomes structuring a program so that it has adequate resources and autonomy to perform its job. Marketing, staff expertise, relations with trade allies, and other factors are vital for the program's success.

Marketing is fundamental to this program's success. An attractive label or logo that identifies high efficiency products is crucial. The logo or label would be used to distinguish products that have special energy and economic value compared with less efficient alternatives.

In order to take on the challenge of market transformation, program staff need to be well experienced in consumer marketing and have a thorough understanding of utility DSM programs. Ability to develop and maintain relations with all trade allies -- manufacturers, wholesalers, and retailers -- is important. Accepting guidance from program sponsors, such as utilities, while operating independently is also important.

Implementation

One way to set up a program of this type in the Statewide Efficient Products Program is proposed in the DPS statewide Energy Efficiency Plan, *The Power to Save: A Plan to Transform Vermont's Energy Efficiency Markets.*

5. Policy: Diversify the Vermont Weatherization Program

The Weatherization Program should develop new and expand upon existing partnerships with energy service providers, such as utilities and bulk fuel companies and provide an expanded and diversified package of services to non-low income as well as low income Vermonters.

While continuing to provide high quality services to low income households, the expanded program would package and provide expanded energy services to non-low income, single- and multi-family households. The new and diversified resources that could be offered by the Vermont Weatherization Program include electric and natural gas utility DSM programs, and energy efficiency financing. The technical expertise that has matured among weatherization providers in recent years would be key to attracting and effectively coordinating the resources of non-weatherization groups when energy improvements are underway in low income and non-low income households.

As part of the diversification effort, the Weatherization Program could take advantage of the expertise it has cultivated and create for-profit enterprises to provide energy efficiency services to the non-low income residential and small commercial sectors. Potential markets include efficiency enhancements for residential and small commercial properties; for example, energy auditing, air sealing, installing insulation, solving ventilation problems such as excessive indoor moisture and ice dams, and lighting upgrades.

Rationale

Diversification of services and revenues would strengthen the Weatherization Program operation over the long term, diminishing its exposure to over reliance on state and federal revenue sources. One way to augment Weatherization Program revenue is to realize the long expressed intent to diversify its services into for-profit operations.

At present, the Weatherization Program provides unique access to low income households for other providers of energy services, specifically electric and gas utilities and lenders. Weatherization providers should continue to tailor programs so that they can package the resources of these other groups to maximize the level of energy efficiency services targeted at low income households. This will avoid redundant efforts and would expand

penetration into a population group that has traditionally been hard to reach -- low income households.

Utilities have already developed "piggyback" relationships with the Weatherization Program and lighting and water heating measures are installed when the Weatherization Program is providing its services to the household. This relationship should be expanded to capture more cost-effective opportunities for utilities, including fuel conversions, heating system improvements (for the gas utility), appliance replacement, and other measures.

Providing increased services to low income households will help the Weatherization Program broaden its financial base and deliver better services to the people it currently serves. In addition Weatherization providers have identified several potential markets outside low income housing where they can apply their skills and equipment. The development of a "packaged" delivery of efficiency services may also make them attractive providers of these services in a wider market. Market niches include services correcting common building problems such as indoor air qualify, roof-ice dams, basic weatherization and air sealing, fuel conversions, and DSM contracting services.

Developing effective marketing campaigns is an important part of the success of a diversification effort. There are many segments of residential housing where services could be marketed, including single-family, small multi-family, and large multi-family projects, including subsidized housing projects. Mixed-use buildings, such as storefronts in older neighborhoods with apartments upstairs, could also benefit.

There are several reasons for diversifying the services and revenue sources for the Weatherization Program and doing so in the near future. For one, significant cuts in federal support for the Weatherization Program are possible. Although Vermont lawmakers, acting with foresight, approved a state revenue source in 1990, the program still relies on the U.S. Department of Energy for about one-quarter of its revenue. Budget cutting at the federal level may cut that support in half in the next two years. The extent of future cuts remains unclear. Moreover, action by the Vermont General Assembly in 1996 permits the Fuel Assistance Fund to dip into Weatherization revenues if there is a shortfall in federal funding.

During its 15 year history, the Weatherization Program has evolved from teams of semiskilled workers to its present status, in which the technical skills and installation methods of its workers are among the state's best in the field of residential energy improvements. "Blower door" testing for locating cold air leaks, air sealing, duct sealing, indoor air quality, specialized insulation techniques, and heating system analysis have become specialties of Weatherization staff, and the Program should now be able to capitalize on the expertise it has cultivated.

Where owners of rental housing find paying for cost-effective energy savings to be a barrier, Weatherization staff could package financing in a manner that has dollar savings from energy improvements pay for a loan. Partnerships could be built between the Weatherization Program and financing agencies. Already, a loan fund targeting energy improvements for multi-family properties is under development by the Weatherization Program. These expanded levels of service might apply to the traditional population of Weatherization clients and to any new markets that are selected.

Finally, expanding into mixed-use buildings could produce a for-profit market niche, particularly in older neighborhoods where multi-family housing and older commercial buildings are commingled. The Program's familiarity with aging building stock could be used to great advantage here since many issues about a building envelope's thermal performance would apply, regardless of whether a building is residential or commercial.

Significant issues

Broadening the focus of the Weatherization Program raises technical and organizational issues. Historically, Weatherization has been strong in providing services to single-family and small multi-family housing units.

Expanding to larger multi-family complexes calls for new skills to cover larger heating systems, energy management systems, and complicated building envelopes, all of which are within the grasp of those who provide services under the Weatherization Program.

Moving from the non-profit into the for-profit sector will also require planning. It will be important to select market niches where its expertise can be sold and to fairly price services to make the Weatherization Program competitive in those markets. Care must be taken to avoid any appearance of its subsidized operations inappropriately supporting for-profit ventures. (See Section IV. Affordability, Policy 3: Reinvent Weatherization Services Delivery to Low Income, Multi-Family Housing. This policy focuses on the Weatherization Program providing more comprehensive services to its core market -- low income households.)

C. Strategy: Increase Efficiency in Commercial and Industrial New Construction

Efficiency in commercial and industrial new construction should be increased so that measures and designs that are cost-effective on a life cycle basis are included in new buildings. Measures that are cost-effective from a societal perspective (taking into consideration all benefits and costs to society including externalities) should be actively promoted by utility programs.

This strategy includes three complementary policies that will promote known and readily identifiable efficiency measures in commercial/industrial building design and construction. They provide a framework for advancing commercial construction and industrial design even further, toward the identification and inclusion of higher levels of cost-effective energy efficiency and healthy indoor environment using "integrated building design." First is the adoption of a statewide energy code to raise energy efficiency levels in commercial buildings not already covered by existing energy standards. The second policy calls for comprehensive, statewide utility DSM programs targeting commercial and industrial buildings and their energy systems. Efficiency levels regularly used for Act 250 permits and the proposed code provide a starting point or baseline. The third policy proposes to develop an information and education network serving building designers, contractors, utilities, trade allies, owners, operators, energy service companies (ESCOs), and others involved in the commercial and industrial buildings sector to stimulate communication and innovation in support of the first two policies.

The integrated building design approach attempts to evaluate the building's embodied or embedded energy (energy consumed by a product, from raw materials to refining, processing, transportation, and disposal of building components over its lifetime) as well as the sustainability and environmental impacts of all the components of a new building. In an integrated building design approach, factors such as cost, embodied energy, material reusability, recycled content, chemical content, availability, etc. are evaluated on a project-specific basis. Decisions are made based on the economic and environmental priorities of the building owner

and occupant. The concept of integrated building design would be launched as part of the Information Clearinghouse, described in the third policy in this strategy.

Very high levels of energy savings can be achieved over a building's life cycle using this integrated approach. This strategy would produce cost-effective energy systems and would focus on air quality for a healthy environment for occupants. Moreover, the level of efficiency would exceed that associated with stand-alone codes and traditional DSM programs. In addition, such an approach can incorporate renewable energy and generating systems, as well as the eventual use of technologies such as cogeneration and fuel cells which may be a part of a distributed generation strategy that a utility implements at some future date.

The DPS is exploring the potential for promoting the integrated building design approach in Vermont. Although it is too early to quantify potential savings with any precision, the building related policies outlined in this strategy are adaptable for promoting an integrated design approach and individual efficient technologies.

1. Policy: Adopt a Commercial New Construction Energy Efficiency Code

Adopt a commercial building energy code, based on the ASHRAE Standard 90.1 or the multi-state code project to raise the baseline of commercial construction in Vermont.

A modified ASHRAE/IES Standard 90.1-1989 (hereafter ASHRAE 90.1) would serve as the basis for Vermont's commercial new construction code, modified to account for existing commercial codes and building practices in the state. ASHRAE 90.1 is a nationally recognized energy efficiency standard. It applies a set of energy efficiency criteria to a building's lighting, heating, ventilating and air conditioning systems, and the building envelope. Developed by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) in cooperation with the Illuminating Engineers Society (IES), ASHRAE/IES standard is used in many states, including Vermont, as the basis for energy efficiency codes or standards. When modified to account for Vermont's existing building practices, codes, and standards, and current compliance issues, the ASHRAE code would be recognized as the universal, minimum standard for energy efficiency in Vermont buildings. The multi-state code project is working toward development of a code that incorporates the best portions of various standards, including ASHRAE 90.1 and may be an alternative choice.

Rationale

Vermont presently has several efforts that support efficiency in commercial development, but these efforts are not consistent, comprehensive, or complementary. The reasons for pursuing the adoption of a statewide commercial energy code are fivefold:

- only about 50% of commercial construction is covered by existing energy standards;
- there is a federal requirement for a code;
- it would streamline energy codes and standards because Vermont has four different energy efficiency standards;
- there would likely be general acceptance by building professionals and public agencies of a nationally recognized standard such as ASHRAE 90.1 or a multi-state developed code as the basis for the code; and
- a streamlined standard would save more energy.

The National Energy Policy Act of 1992 calls on states to adopt a commercial energy building code with provisions that meet or exceed ASHRAE/IES Standard 90.1–1989. Vermont does not currently have a statewide code for all projects. While there is no current penalty for failure to adopt ASHRAE 90.1, eligibility for certain types of federal funding could eventually be tied to the code.

Vermont currently has four separate regulations for commercial energy efficiency:

- Act 250;
- Department of State Buildings' Energy Conservation Standard for New and Existing State Buildings (which applies to all buildings receiving state funding);
- Burlington Electric Department's Energy Efficiency Guidelines for customers in its service territory; and
- a standard for publicly funded buildings.

Together, these four regulations are estimated to cover about 50% (on a construction-cost basis) of all commercial and industrial construction in the state. Code adoption presents the opportunity to address energy efficiency in the other half of commercial construction with significant potential to increase the efficiency of the state's building stock.

Adoption of a national standard such as ASHRAE 90.1 or a multi-state developed code would take advantage of established training and compliance tools. Since ASHRAE 90.1 is the basis for the State Buildings' Standard and Burlington's commercial energy efficiency ordinance, some familiarity with the standard already exists in Vermont.
Developing commercial energy codes can be an arcane process, given the complexity and variety of facilities and the diversity of parties involved. Stakeholders include design professionals, government agencies (such as the DPS and the Department of Labor & Industry), building contractors, and equipment suppliers. All these stakeholder would offer input so that the adopted code, ideally, is practical and meaningful from all perspectives. By incorporating a standard adopted at a national level, many issues would already be resolved.

The ASHRAE 90.1 standard was developed in the 1980s and does not reflect many currently accepted energy efficient design and construction practices. Vermont's adoption of ASHRAE 90.1 would simply establish a minimum baseline or safety net, ensuring that structures attain a minimum level of efficiency. The state level adoption process should consider higher standards where commercial construction already exceeds the ASHRAE standard. The task of updating ASHRAE 90.1 is now underway on the national level. Recent estimates set the adoption of a new national standard by ASHRAE somewhere near the end of the century. Vermont is currently participating in a regional, multi-state task force that is developing an improved commercial energy code, based on ASHRAE 90.1 and providing for simplified compliance and enforcement. This code is slated for release in 1997.

An energy efficiency code, if adopted as part of the Vermont Fire Protection and Building Code, would include renovation, remodeling, and additions as indicated under Section 3 of that code. (How an energy code applies to remodeling and additions is discussed further in Policy D.1: Adopt a Statewide Energy Code for C&I Remodeling, Renovations, and Additions.)

A prime motivation for a commercial code is saving energy. For commercial and industrial energy users, energy savings can translate into multiple benefits, including increased competitiveness, lower operating costs, and improved profitability.

Significant Issues

Issues generally related to Vermont's adoption of a commercial new construction energy efficiency code include:

- thoughtful integration of the proposed energy code with Act 250;
- integration with utility DSM programs;
- establishing training and education programs;
- procedures for reviewing plans and performing site inspections; and
- a process for regular review and update of the code based on the input of a representative body of technical experts and parties involved with building design and construction.

Other issues are involved with code adoption and enforcement, including: limitations of ASHRAE 90.1, current practices regarding energy efficiency in construction, progress made on a new code by the multi-state task force, and the many existing standards already in place in Vermont. In addition, the elements of code implementation need to be taken into account. These are outlined below.

Integration with existing standards. The adopted code should not supplant any existing regulations that mandate higher energy efficiency levels. However, consideration should be given to how these higher efficiency factors could be included in the new code to gain uniformity. For example, the requirement for using "best available technology" in Act 250 should not be displaced by a model code, which by definition represents a standard of common practice, compared with the higher level of practice existing with Act 250. (See the text box on Act 250.)

Training and education. Statewide education and training are necessary to achieve the energy efficiency improvements related to a new energy efficiency code. Groups targeted for training include state personnel who oversee code implementation and enforcement, engineers and architects responsible for designing facilities in compliance with the code, contractors who in many cases assume responsibility for design as well as construction of facilities, and building operators who ultimately maintain and replace the components of the facilities over their lifetimes. Four separate training courses tailored to the expertise and needs of these groups would be beneficial. Developing and delivering code training should be a collaborative effort by state agencies such as the Department of Public Service and the Department of Labor and Industry, the state's chapter of ASHRAE, representatives of other professional associations, and the state's regulated energy utilities. Funding sources for this training include one or more of the following sources; direct DPS staff assistance, a grant obtained by DPS, contributions from utility DSM programs, and contributions by participants.

Plan review and compliance verification. Enforcement of an energy efficiency code is challenging due to the complexity of energy efficient building design. Most likely, review of building plans, coupled with evaluating compliance documentation provided by project managers, is best for ensuring code compliance with the intended design.

Compliance verification and options for plan review and site inspection. Options for establishing plan review and site inspection include delegating the job to the Department of Labor and Industry (L&I), the Department of Public Service Energy Efficiency Division (EED), or private companies (perhaps in conjunction with a utility-supported effort). Additional options include having designers self-certify their work and national plan review. A brief overview of these compliance and review alternatives follows.

- The L&I option establishes a single point of contact, existing site inspection capability, and infrastructure. However, L&I would require additional personnel to do this work.

- DPS–EED is knowledgeable about energy efficiency codes, is a party in the Act 250 process for

energy efficiency review, and could perform a review under L&I to maintain the single point of contact. The DPS–EED lacks a site inspection capability and additional staffing would be required.

- Some states have established private plan review and inspection coupled with utility incentives for participation. Assisting customers with energy efficiency projects gives utilities opportunities to achieve their DSM goals. Utilities are generally not interested in being enforcers for building codes. The plan review and inspection mechanisms would still need to be established outside the utilities. There has been some resistance to utility involvement in this part of the design process by engineers practicing in the state.

- Self-certification presumes licensure of designers. No license is required to design commercial buildings in Vermont, and therefore knowledge that is essential for effective self-certification may be lacking in Vermont.

Compliance verification and site inspection. On-site verification of overall building compliance is hampered by several factors including:

- construction timing; for example, sheetrock may be completed prior to inspection, making it difficult to check wall insulation;

- substitutions; similar equipment is often substituted for what was specified due to cost and availability, and nameplate ratings of equipment from two different manufacturers are rarely the same;

- lack or inaccessibility of information; nameplates can be difficult to locate, and some rated components are internal to a larger piece of equipment and therefore inaccessible to a field inspector; and

- some portions of code compliance are operational in nature and could not be properly evaluated by field inspection; for example, variations in mechanical-system operation under an automated control sequence are based on a number of factors that cannot be reviewed in a single site visit.

Resolving these issues and determining the best methods for verifying compliance should be undertaken by a committee of stakeholders working toward the adoption of the commercial and industrial new construction building efficiency code.

A relatively new approach to verification that may improve building efficiency is the "commissioning" method. It can also demonstrate whether a new building is operating suitably. Building commissioning utilizes a "shake-down" period at the end of construction when the operation of a building's systems is evaluated by a professional. Commissioning is a practical method for reviewing design, verifying installation, and optimizing the operation of a building's new energy systems.

Vermont should establish a site inspection capacity as discussed above, while working to implement private sector building commissioning as an alternative for verification of code compliance.

Code Revisions and Interpretations. Whatever method for formal code adoption is selected, it will benefit Vermont to establish a committee, empowered by the legislature, to review and propose code revisions. This committee could preside over the code process, permitting it to keep abreast of technical advances, providing code interpretations (ASHRAE's turn-around time on interpretations is currently 18 months), and facilitating code compliance, plan review, and how sites are inspected.

Implementation

Steps for implementing this policy include: distribution to stakeholders and their review of a DPS-funded study on the issues associated with commercial code adoption in Vermont; establishing consensus among stakeholders through an evaluation of different approaches; and drafting and passing enabling legislation. A complete system for adopting, updating, and supporting an energy efficiency code for commercial and industrial new construction could result from these steps.

2. Policy: Statewide Commercial and Industrial DSM Programs

Develop utility DSM programs for commercial and industrial new construction that uniformly promote comprehensive DSM measures on a statewide basis. These programs should cover Act 250, non-Act 250, commercial, and industrial facilities.

Utility DSM programs promoting higher efficiency in new commercial and industrial facilities would become more uniform and comprehensive under this policy. These programs could encourage efficiency levels beyond those required by a proposed, statewide efficiency code. (See the previous policy). These DSM programs would support uniform incentive structures and a more effective network of trade professionals and trade allies, reduce lost opportunities, and use codes and standards to establish a statewide baseline.

Rationale

The reasons for developing comprehensive statewide utility DSM programs in the commercial and industrial sectors include the need to reduce lost opportunities; the use of codes and standards to establish a statewide baseline; and efficiencies of scale and resulting program cost reductions.

Reduce lost opportunities. The diversity of existing DSM programs, coupled with inconsistent interpretations of baselines, results in lost opportunities (and sometimes unnecessary incentives) for energy efficiency in commercial and industrial new construction. The development of programs which interface with code and standard compliance processes will establish the utilities as a logical point of contact for customers during design and compliance stages. Administering the programs in a uniform way across the state will increase program recognition as well as strengthen the logical point of contact.

Codes and standards to establish a baseline. Act 250 and an energy efficiency code can provide a consistent baseline on which DSM incentive levels and design assistance packages can be based.

Most utilities are already involved in the Act 250 process, providing applicants with an "ability-to-serve letter" under Criterion 9(J) of Act 250 related to Public Utility Services. The ability-to-serve letter provides initial involvement for utilities and could be leveraged to promote a statewide standard for compliance with Criterion 9(F), Energy Conservation, as well. This standard would be useful to design and construction industries and to building owners, both in obtaining the best available technology and in streamlining the Act 250 process. Inspection of Act 250 projects to ascertain permit compliance will help to ensure that energy efficiency measures are implemented. In addition, commercial and industrial DSM programs would help utilities establish a strong customer link during project inception by helping applicants through the Act 250 permit process.

Utility participation in establishing a statewide code will help ensure that the code reflects current construction practice in Vermont and results in a realistic baseline of efficiency, which utilities can use for customers developing non-Act 250 DSM projects. Central Vermont Public Service is currently using portions of the ASHRAE-based State Buildings Standard for this purpose. The fact that a utility has adopted a non-mandatory standard as a program baseline indicates the need for the establishment of a statewide code on which the non-Act 250 portion of its DSM program can be based.

Recognizing the requirements of individual industries active in Vermont, utilities should seek to optimize DSM performance by sharing program resources and cooperating with transfer of information about energy technologies and production processes for industrial customers.

Efficiencies of scale and program cost reductions. Efficiencies of scale are linked to statewide comprehensive DSM programs due to improved consistency; reduced administrative efforts by applicants, regulators, and utilities; and the reduction in educational needs once parties have been through the program the first time. These efficiencies should result in reduced program costs and/or increased savings for all parties.

Vermont's largest electric utilities are demonstrating how utilities can use their role in Act 250 to support higher efficiency. Act 250 already mandates energy efficiency levels beyond standard practice in Vermont, providing an opportunity for Vermont's gas and electric utilities to be key players in helping commercial and industrial customers obtain levels of efficiency needed to receive Act 250 permits. For example, Central Vermont Public Service (CVPS) has a program that uses criteria to determine an energy efficiency baseline for commercial new construction, and the company provides guidelines for efficiency measures which typically represent best available technology under Act 250. These guidelines, referred to as "Typical Efficiency Measures" or "Typicals," serve as a basis from which Act 250 applicants can work. The "Typicals" encompass not only energy efficiency levels addressed in the ASHRAE standard, but they also look at the overall performance of energy systems and buildings in terms of usefulness and occupant comfort. Green Mountain Power has agreed in principle to participate in this program, but has not yet established the "Typicals" or other program elements developed by CVPS.

The DPS and utilities are establishing the parameters for contracting with qualified inspection personnel to carry out a field review to verify implementation of the Act 250 permit conditions established under the "Typical Efficiency Measures." These efforts should be expanded beyond the state's largest utilities in order to achieve a statewide program.

The "Typical Efficiency Measures" developed for use with Act 250 permitting provide a model for a similar program for non-Act 250 DSM projects. Vermont's utilities should participate in the code adoption described in the previous policy. A new statewide efficiency code would provide a baseline for the development of a separate set of non-Act 250 efficiency measures.

Utility demand side management programs targeting industrial users should continue to be tailored to the processes, equipment, and facilities unique to each industry. Areas where the highest potential savings exist in industrial facilities include efficient motors, variable speed drives, process controls, increased feeder sizing, power factor correction, drive-train modifications, process heat, and improved operation and maintenance. Where possible, utilities should use information and program replication for companies in similar industries to achieve economies of scale and optimum educational value for that sector.

Significant Issues

These programs must meet the criteria established under the *Vermont Twenty Year Electric Plan* including permanence, strong market penetration, comprehensiveness, promotion of all-fuel efficiency, cost-effectiveness, statewide consistency, open architecture, inclusion of trade allies, and coordination with state policies. The 1994 *Vermont Electric Plan* provides specific program principles and standards applicable to statewide commercial and industrial new construction and replacement and remodel/renovation programs. Compliance with these criteria will benefit the state by providing uniform, predictable programs across the many service areas of the state, and it will benefit the utilities by reducing development and training costs.

Implementation

CVPS is currently implementing the Act 250 compliance program by supporting customers early in the project development phase. The company guides customers through the energy portion of Act 250, using the "Typical Efficiency Measures." This approach should be adopted by other large utilities in the state and made available to the smaller utilities as the need arises. Once the compliance process is in place, an inspection capability to verify installation of measures must be established.

Refinement of the "Typicals" should be an ongoing process reflecting experience as well as new life cycle, cost-effective technologies.

Development of a statewide approach for the non-Act 250 track should begin prior to the adoption of a statewide code, as demonstrated by CVPS's use of the State Buildings Standard in its work with non-Act 250 projects. Utilities should participate in the code adoption process to ensure that the code provides a useful baseline for their non–Act 250 program.

Implementation of the industrial programs is ongoing for each utility and will become part of the discussion between DPS and individual utilities when a company proposes its Integrated Resource Plan.

3. Policy: Establish an Energy Efficiency Partnership and Information Clearinghouse

Through a non-profit government/industry partnership, establish an information clearinghouse and provide product information, technical assistance, and energy efficiency education services to professionals who design, build, and operate commercial and industrial buildings.

An energy efficiency partnership could operate a clearinghouse to disseminate information about code requirements, high efficiency equipment, technologies, and construction practices. Initially, this information clearinghouse could receive support from utilities in return for delivering the educational and training components of their DSM programs. This policy is in the early stages of development and should be viewed as a long-term objective.

The energy efficiency information clearinghouse should include a telephone and Internet accessible database that addresses energy efficiency issues in a user friendly format. The database should contain information about product availability, innovative technologies, energy efficiency codes, efficient design practices, and programs and resources available to support efficiency in the commercial and industrial sectors. Equipment information should use the federal equipment standards as a basis, including equipment that exceeds the standards and has "best available technology" applications.

Other functions of the partnership are providing advice, training, and technical assistance to improve building commissioning and promoting sound energy management, energy cost accounting, and preventive maintenance procedures. The partnership could disseminate energy management protocols, energy cost accounting systems, and preventive maintenance procedures to assist building operators with monitoring and controlling energy costs. Educational materials should be developed and tailored to specific building types

and energy end uses. The partnership will develop a database of governmental and private organizations, trade associations, and consumer groups that assist specific market sectors with energy management needs.

This energy efficiency partnership could provide training in energy efficient design and construction, focusing on Act 250 requirements, the existing ASHRAE-based codes, and an ASHRAE-type code for commercial baseline practices and equipment. The partnership could also provide a forum for stakeholder input into the code adoption and implementation process.

Activities that could be supported through the information clearinghouse include monitoring the development and commercialization of emerging products and technologies; participating in technology transfer activities; and participating in regional and national efforts to promote and commercialize higher efficiency equipment, appliances, and services. Design competitions would be another means of obtaining progressive implementation of highly efficient building designs.

Initial tasks for the partnership clearinghouse include:

- using existing information, including federal efficiency standards, to develop an information database;
- contacting equipment suppliers to obtain information on product availability within the state;
- developing training programs and materials which address design, construction, and operation of energy efficient facilities based on interest expressed from parties within the state;
- providing information on energy efficiency equipment, services, and utility DSM programs; and
- developing a list of national and international design competitions as well as an instate design competition to foster awareness of energy efficiency, and disseminating this information to interested parties.

Rationale

There are many groups in Vermont currently involved in the design, construction, and operation of facilities, and these groups reflect a broad range of knowledge with regard to energy efficient building practices. In order to address the information needs of the diverse nature of commercial and industrial construction in the state, a multi-faceted approach is necessary, including

Educational programs. Programs tailored to increase knowledge of energy efficiency in specific sectors are needed. Although many programs are currently available in the state, not all potential attenders are aware of them. In addition, the gaps in the existing education and training programs need to be identified and addressed.

Information clearinghouse. An information clearinghouse would provide information on all aspects of energy efficiency to anyone involved in the design, construction, or operation of facilities in the state.

Design competitions. The benefits of carefully designed competitions include statewide, national, and even international publicity for innovative designs and leading edge approaches to building energy efficiency, which may then be adopted into general practice.

Implementation

A partnership and information clearinghouse involving the DPS, utilities, professional associations, and others should pursue these activities will fulfill the needs of participants and users, while spreading the work load and expenses. Gradual development of a more formal organization allows those involved to define it to suit their

needs. The partnership should be broad based and would initially include the Department of Public Service, other state agencies, non-profit organizations, private energy service companies, the state's electric and gas utilities, trade allies, suppliers, and others.

4. Impacts of Commercial New Construction and Retrofit Policies

Commercial new construction and retrofit policies were modeled together to determine combined savings. (For a discussion of retrofit policies, see the next section.) Modeling was performed by creating a composite of several policies: a commercial lighting standard and DSM programs for water heating, cooking, and space heating in the commercial sector.

The lighting standard was modeled by increasing the efficiency of lights by 21% in 2000 over the 1999 levels, and then by an additional 10.5% in 2009. The capital costs of the fixtures reflect the cost to meet the higher standard and an additional 5% to reflect the administrative costs of this policy.

The water heating DSM program begins in 1997 and runs through the final year of the study. It affects only new electric water heaters, simulating a 66% increase in efficiency of these devices over 1994 levels. The assumed participation rate is 85%. The additional capital costs to meet the higher efficiencies (those costs that are greater than the cost of current practices) are 60% subsidized by utilities. This subsidy is reflected in energy prices in the policy impacts. The remainder of the additional costs is reflected by increases in capital and operation and maintenance costs of energy-using devices.

The cooking program is a DSM program similar to the water heater program. It begins in 1997 and runs till the end of the study, affecting only electric cooking. The efficiency of newly installed devices is increased by 25% over 1994 levels. As in the case of the water heater program, 60% of the additional costs are subsidized by utilities and reflected in the energy costs. The rest of the additional costs is reflected in increased related costs. An 85% participation rate is also assumed.

As in the case of the water heater and cooking programs, the electric space heat DSM program begins in 1997 and runs through the end of the study. It simulates an increase in the efficiency of electric space heat by 15% over 1994 levels. Also, a 60% subsidy and 85% participation rate are assumed, as above.

This composite policy results in a significant reduction in commercial energy use (excluding transportation), which falls by 4% (19.3 TBTU) cumulatively through 2020. Total cumulative energy use, as a result, falls by 0.5%. The commercial energy expenditure including transportation falls dramatically, by 3% or $421 million during the period. The economy also benefits from this policy, with modest increases in job-years, Gross State Product, and disposable income. Costs of the policy amount to $182 million cumulatively, but energy costs are reduced by $305 million and air emission costs by $149 million. In addition, there is a decrease of $24 million in taxes. The commercial sector pays sales tax on energy used, unlike the residential and industrial sectors, so substantial energy savings also result in lower tax revenues. Finally, there are environmental benefits resulting from this policy: greenhouse gases, acid rain precursors, and ground level ozone precursors all decrease by around 1%.

Implementing this set of commercial new construction and retrofit policies is a cost-effective way to reduce energy use in the commercial sector, while providing a modest boost to the economy and benefits to the environment.

Figure 4.III.2 Impacts of Commercial New Construction and Retrofit Policies

Selected Impacts in 2005

Energy Impacts, TBTU

Sector	1990	2000		2005		2015		Cumulative to 2020	
		Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case	Base Case	Policy Case
Residential	31.53	35.39	35.37	35.98	35.98	38.27	38.29	885.25	885.47
Commercial	11.99	17.82	17.44	19.34	18.62	22.21	21.09	486.65	467.34
Industrial	12.42	16.79	16.79	18.41	18.39	19.87	19.86	446.39	446.19
Transportation	42.10	60.54	60.56	64.68	64.74	70.98	71.10	1594.14	1595.88
Total	98.04	130.54	130.16	138.40	137.74	151.34	150.34	3412.43	3394.89

Table 4.III.2 Indicators of Commercial New Construction and Retrofit Policies
Selected Indicators of Vermont Energy Goals, 1997-2020

SUSTAINABILITY

Total non-renewable energy used[a] (TBTU)	Non-renewable energy saved rel. to base case[a] (TBTU)	Non-renewable energy per capita (MMBTU)					% of energy from renewable sources				
		1990	2005 Base	2005 Policy	2015 Base	2015 Policy	1990	2005 Base	2005 Policy	2015 Base	2015 Policy
2881.4	17.6	146.1	183.8	182.7	188.1	186.4	16.0%	15.6%	15.6%	15.5%	15.6%

ENERGY EFFICIENCY

Total Energy used[a] (TBTU)	Energy saved rel. to base case[a] (TBTU)	Energy saved as a % of base case use[a]	2015 sector energy use as a % of 1990 sector energy use[b]	Total energy use per capita (MMBTU)				
				1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
3394.9	17.5	0.51%	175.9%	173.8	217.6	216.6	222.6	220.8

SECURITY

Energy from oil[a] (TBTU)	% of energy from oil[a]	Total energy expenditures/GSP (1995 $/1995 $)					Energy from oil (TBTU)				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
2107.4	62.08%	$0.087	$0.084	$0.083	$0.087	$0.086	65.58%	65.68%	66.00%	63.27%	63.66%

ECONOMIC VITALITY

Jobs created relative to base case[a] (job-years)	Change in GSP relative to base case[a] (Mil. 1995 $)	% Change in GSP relative to base case[a]	Avg. change in GSP/capita rel. to base case[a] (1995 $)	Avg. change in per capita disp. income rel. to base case[a] (1995 $)
7,200	423	0.09%	$0	$5

AFFORDABILITY

Policy costs per MMBTU saved[ac] (1995 $/ MMBTU)	Societal savings from reduced emissions[ad] (Mil. 1995 $)	Avg. income per household after energy and energy related expenses[e] (1995 $)					Average residential energy expenditure as a % of low income wage[f]				
		1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.
($6.98)	$149	$50,780	$56,452	$56,428	$58,679	$58,669	26.91%	26.62%	26.63%	27.62%	27.67%

ENVIRONMENTAL SOUNDNESS

Pollutant	Emissions (tons)					Emissions reduction rel. to base case[a] (tons)	Emissions reduction as a % of base case[a]	2015 sector emissions as a % of 1990 emissions
	1990	2005 Base	2005 Pol.	2015 Base	2015 Pol.			
Greenhouse Gases (CO_2 eqv.)	7,120,000	9,523,000	9,394,000	11,773,000	11,611,000	2,795,000	1.12%	163.08%
Carbon Dioxide (CO_2)	6,939,000	9,258,000	9,137,000	11,407,000	11,254,000	2,637,000	1.09%	162.18%
Sulfur Dioxide (SO_2)	17,100	15,700	16,000	15,000	15,000	400	0.11%	87.72%
Suspended Particulates (PM-10)	6,000	3,400	3,400	3,400	3,400	200	0.20%	57.02%
Nitrogen Oxides (NO_X)	25,300	26,600	26,100	31,800	31,200	9,500	1.36%	123.32%
Volatile Organic Compounds	21,600	20,000	20,000	19,400	19,400	(300)	(0.06%)	89.81%
Carbon Monoxide (CO)	116,900	101,800	101,800	93,500	93,600	(700)	(0.03%)	80.07%

Greenhouse gas intensity, GHG/GSP (tons CO_2 eqv./1995 $)					Policy Costs/GHG Reduction[c] (1995 $/ton CO_2 eqv.)			
1990	2005 Base	2005 Policy	2015 Base	2015 Policy	2000	2005	2015	Cumulative[a]
0.98	0.98	0.97	1.05	1.03	($93)	$144	($38)	($44)

Note: All data uses delivered energy; greenhouse gases (GHG) include CO_2, NO_x, N_2O, CH_4; see Appendix 5 for more data and explanation of categories

[a] Cumulative impacts, 1997-2020

[b] Commercial sector

[c] Policy costs include the change between policy and base case of energy cost and capital, operation, and maintenance cost of energy using devices

[d] Calculated using Vt. DPS externality adders, see Appendix 5

[e] Household costs include energy costs, and the change in capital, operation, and maintenance costs of energy using devices that result from the policy

[f] $12,590 fed. poverty line for family of 3, minus $919 Social Security (1995 $)

D. Strategy: Improve Efficiency in Commercial and Industrial Facilities by Targeting Retrofits and Lost Opportunities

This strategy requires implementing four related policies which overcome barriers to incorporating cost-effective efficiency measures in existing facilities. The first policy targets the remodeling and renovation construction market in Vermont. Approximately half of the construction in Vermont (measured in dollar value) consists of modifications to existing structures. When buildings or equipment are already undergoing renovation, an excellent opportunity is created to incorporate energy efficiency measures. Extending the commercial and industrial energy code to renovations of existing structures will help ensure that this opportunity is not lost. It would also establish an efficiency baseline for remodeling work, raising the efficiency of the state's building stock over time.

The second policy, development and implementation of a statewide, utility supported DSM program will also help prevent lost opportunities in remodeling and equipment replacement markets. This utility program would complement the energy code by providing customers with support services, design assistance, incentives, and financing which are linked to the permit and code compliance processes. This policy's goal is to help building owners comply with and exceed the requirements of the code. By targeting cost-effective opportunities for equipment retrofit and early retirement, a business' energy use is reduced and its competitive position is enhanced by lower operating expenses. (The Commercial and Industrial Market Opportunities Program in the DPS Statewide Energy Efficiency Plan *The Power to Save: A Plan to Transform Vermont's Energy Efficiency Markets* offers another way to act on this policy.)

The third policy focuses on targeting DSM commercial and industrial retrofit programs to service areas where transmission and distribution systems are constrained or near capacity. This policy helps defer capital investment in what are often very expensive upgrades in the transmission and distribution system.

The final policy in this section encourages investment in energy efficiency for the commercial, industrial, non-profit, and public sectors. This policy promotes third-party financing and "performance contracting" to procure cost-effective energy efficiency improvements. By linking financing to anticipated energy savings, businesses and public institutions can reduce operating costs.

Commercial retrofit policies were modeled in conjunction with commercial new construction policies, and the resulting impacts are discussed in the section above.

1. Policy: Adopt a Statewide Energy Code for Commercial and Industrial Remodeling, Renovations, and Additions

Vermont should address energy efficiency in the remodeling of commercial facilities through adoption of a statewide baseline energy code that applies to remodeling and renovation markets.

Applying a statewide energy code based on ASHRAE/IES 90.1–1989 (ASHRAE 90.1) or the code developed through the multi-state project to renovations and equipment retrofits would require cost-effective improvements to building envelope, mechanical, and lighting systems when a facility is undergoing significant modifications. (Elements of this policy are described in detail in the previous section of this Plan.) An energy section could be added to the 1994 Vermont Fire Prevention and Building Code, which applies to

> all matters concerning the construction, alteration, addition, repair . . . use, location, occupancy and maintenance of all public buildings and premises.

Adding an energy efficiency requirement to this code would mean efficiency improvements would occur as part of renovation jobs.

Carefully defining when an energy remodeling and retrofit code applies is important and could be established through a dialogue among stakeholders, the Department of Labor and Industry (L&I), the DPS, and utilities. One threshold used in other states is modification of more than 50% of an area. For example, if a tenant were to modify more than half of one floor in a multi-level office building, the entire floor would have to be brought up to code, but the building envelope, other floors, and any central systems would not be affected.

Rationale

As noted earlier, a survey of construction permits during 1994-95 indicated that nearly 50% of the commercial construction activity in the state, on a construction-cost basis, consists of remodeling and renovation of existing facilities. From the perspective of energy efficiency, only a minor portion of the projects is currently addressed under existing codes and standards. This lack of coverage results in significant lost opportunities for the state to reduce energy consumption and cut back operating costs.

Adoption of an energy code covering remodeling/renovation is a first step in realizing savings. When coupled with utility DSM programs and a statewide enforcement mechanism, it is possible that lost opportunities associated with remodeling and renovations could be nearly eliminated.

Implementation

Vermont should adopt a commercial and industrial energy efficiency code with provisions for renovation and remodeling work. The DPS and L&I would involve stakeholders in developing and establishing the code and setting a threshold level for applying it. Attention should also be given to acquiring resources to support implementation and enforcement of the code, discussed above in Strategy C. increase Efficiency in Commercial and Industrial New Construction.

2. Policy: Statewide DSM Programs for Commercial and Industrial Equipment Replacement, Remodeling, and Renovation

Vermont should develop comprehensive, statewide utility DSM programs to improve coverage and uniformity of commercial and industrial DSM programs that minimize lost opportunities in the market-driven renovation and equipment replacement markets.

The design of utility demand side management (DSM) programs would be altered to capture more cost-effective energy savings in existing commercial and industrial facilities when they are remodeled or when equipment is replaced. Major objectives in redesigning utility DSM programs would be consistency statewide in marketing, incentives, and participation terms for all utility programs. Having statewide, consistent programs would make it easier to understand the programs, and it would be simpler for more customers and trade allies to participate. This would allow utilities to achieve greater customer participation. Individual marketing and delivery strategies could be adopted to overcome barriers that are impeding adoption of measures in specific sectors, such as lack of funding for educational institutions or the desire for facility uniformity in national franchises. Customers should understand that efficiency enhancements can easily be added to other renovation/remodeling work. The Commercial and Industrial Market Opportunities program in the DPS Statewide Energy Efficiency Plan *The Power to Save: A Plan to Transform Vermont's Energy Efficient Markets* offers a way to implement this program.
The program design would optimize timing; that is, knowing when utility resources are best offered to a customer planning a renovation. This moment is likely to occur when a permit is sought for renovation/remodeling, when plans are flexible, and a program can influence what level of energy efficiency

can be optimally achieved. Timely assistance from a DSM program that helps a customer with code compliance and system design is mutually beneficial to the customer and the utility. This program will be designed to coordinate closely with project design and/or construction teams, providing design and engineering assistance to assure that energy saving opportunities are identified early enough to make them likely for adoption.

For Act 250 projects, the "Typical Efficiency Measures" described above with the new construction policies above also apply to renovations. Non-Act 250 review would be addressed under the ASHRAE 90.1-based or multi-state code proposed in Policy 1 above.

Rationale

The long-term objective of this policy includes fundamentally changing the commercial and industrial renovation/remodeling markets. This means making gains in comprehensiveness and efficiency in equipment and system replacements, improving HVAC system and motor-sizing practices in the equipment replacement/remodeling markets, and raising the efficiency of equipment stocked and promoted by vendors.

While utility DSM programs targeting equipment replacement already exist, a substantial number of lost opportunities are still occurring. Confusing terms for both trade allies and customers, along with misdirected marketing, are causing these lost opportunities. Utilities should apply what they have learned from their commercial and industrial retrofit programs to the admittedly more complex renovation/remodeling markets. Uniform DSM programs that gain customer acceptance on a statewide basis will enhance the effectiveness of DSM in the commercial and industrial sectors.

Moreover, statewide programs with uniform features will be easier to develop, implement, and monitor for effectiveness. Improved efficiencies should result in cost reductions and/or increased savings. Other expected benefits include lower program and administrative costs for utilities, reduced regulatory oversight, and improved monitoring and verification.

There is a real opportunity to make utility DSM programs in this market sector more simple and accessible to customers, dealers, designers, installers, and builders. The adoption of this approach will increase the societal benefits of DSM programs by supporting a statewide efficiency-services network, improved program design, streamlined administration, and greater customer recognition in a cost-effective manner.

Implementation

Program designs should be straightforward. DPS should promote adoption of the Commercial and Industrial Market Opportunities Program proposed in the DSP Statewide Energy Efficiency Plan *The Power to Save: A Plan to Transform Vermont's Energy Efficient Markets.*

Utilities should continue to provide comprehensive energy audits for their large commercial customers and should contribute to the training programs anticipated under the energy efficiency partnership and information clearinghouse policy to increase awareness and application of efficiency measures by their smaller customers. (See Strategy III.C: Increase Efficiency in Commercial and Industrial New Construction.)

3. Policy: DSM Retrofit Programs in Transmission and Distribution Constrained Areas

Utility DSM retrofit programs should be strategically implemented to avoid or defer capital utility investment in areas where utility transmission and distribution (T&D) systems are constrained.

Utilities should refine their ability to target DSM services to portions of the service territory where it is less expensive to gain energy resources through efficiency than to upgrade transmission and distribution systems serving that area. The significant capacity to secure substantial efficiency savings from commercial and industrial customers would be focused in transmission- and distribution-constrained areas. Programs that use retrofit and lost opportunity strategies would be intensively promoted in portions of utility territories when T&D systems are near capacity.

Rationale

Although this Plan generally advocates a high priority for acquiring efficiency by focusing on lost opportunities, there are situations where aggressive retrofit strategies can help avoid or delay significant expense for T&D upgrades. Such strategies can provide cost-effective, avoided-capital costs in addition to energy savings. This policy also helps avoid or defer the environmental and aesthetic impacts of new or upgraded T&D facilities.

Implementation

Each electric and gas utilities should identify those areas in their respective service territories where facilities are approaching their capacities. Fast-growth areas would receive special attention. At the same time, the utility should review a portfolio of DSM programs and DSM contract delivery services to assure that an optimal mix of retrofit and lost opportunity measures is available for prompt deployment in identified areas.

4. Policy: Financing Mechanisms for Cost-Effective Energy Efficiency and Renewable Energy: Performance Contracting and ESCOs

"Performance contracting" and ESCOs provide a market-oriented system for securing cost-effective energy savings wherever potential energy efficiency gains are sufficient to pay for the project in a reasonable time. Such approaches should be promoted in a manner that assures they will direct capital toward increasing efficiency with a minimum of additional utility or public support.

Businesses specializing in financing and installing energy efficiency measures for large energy consumers could be used to gain efficiency savings. These businesses, known as Energy Service Companies (ESCOs) share the financial rewards from efficiency improvements between themselves and the client who owns or operates the facility. Appropriate markets for this "performance contracting" approach include schools, government buildings, and low income, multi-family housing. In this way, benefits are shared by the parties, and efficiency and cost-effective energy systems are promoted.

This policy envisions the use of ESCOs or "performance contracting," both of which work well with large scale efficiency improvements in large facilities. ESCOs offer a variety of services and work with building owners who have opportunities for substantial savings but insufficient capital and expertise to acquire these savings. ESCOs operate on the principle that many investments in efficiency offer potential savings that are sufficient to cover the capital cost of the project and provide a return. The ESCO identifies these savings, provides the engineering and installation services, and the capital for the project. When complete, the building owner shares the financial reward from the energy savings with the ESCO. The savings are calculated to cover the expenses of technical assistance, financing, and a profit for the ESCO as well.

ESCOs have operated minimally in Vermont, though they are present in the state and have been used as financing entities in some utility DSM programs. One Vermont utility, CVPS, has encouraged its customers to use an ESCO to secure savings from energy improvements (such as fossil fuel efficiency and fuel

switching), although it does not offer direct incentives. Generally ESCOs work with fairly large customers.

"Performance contracting" refers to paying for capital investment with energy savings, but it does not necessarily rely on one ESCO-style corporation for all the necessary services. Both approaches could be adapted for unconventional markets, such as public facilities: schools, government buildings, etc.

Rationale

The commercial market for ESCOs is expanding in Vermont, and as it does, the DPS and the state's utilities can make use of this market to deliver their programs. There are projects in the state that lend themselves to the use of an ESCO to procure energy efficiency measures that could not otherwise be obtained. The approach defined in this policy reduces overhead costs associated with large ESCOs, keeps dollars in Vermont, and generates jobs in building design and construction as well as the financial institutions.

This policy also promotes the use of "performance contracting," coupled with third-party financing, to procure cost-effective energy efficiency improvements. The DPS and utilities could work with market sectors that are not typically served by ESCOs to get cost-effective financing for energy efficiency measures. Examples include trade associations or professional organizations that would obtain financing for their members' energy efficiency improvements in the same way they buy health insurance or otherwise represent their members' interests to gain an advantage in the marketplace.

Appropriate markets for this "performance contracting" approach include:

Schools. With expected cutbacks in state construction aid and federal funding for energy efficiency, schools need to maximize savings from energy efficiency measures. The School Energy Management Program (SEMP) is working on a standard Request For Proposals (RFP) for schools that are ready to enter into performance contracts. In this case, SEMP would serve as the oversight organization. (See Chapter 4, Section V. A., Improve Government's Energy Use, Programs, and Policy - Efficiency Programs for Public Institutions.)

Government buildings. The Vt. Department of Buildings and General Services has identified facilities that need energy efficiency upgrades that cannot be funded via the capital construction budget. Some of these projects have been earmarked for implementation using a third-party financing approach. Enabling legislation is required before this approach can proceed. This approach has been used with success in other states.

Low income, multi-family housing. One party advocating for energy efficiency could represent the multiple interests of the multi-family, low income housing sector. Public housing authorities, property managers, financing agencies, utilities, tenant associations, and others have roles in this housing sector. A skilled and resourceful organization could sort out individual roles and design projects to lower financing and operating costs for the mutual benefit of parties involved. As in the case with schools, diminishing federal support makes it particularly important to lower operating costs of public housing. Savings gained through energy efficiency in these facilities will ultimately support the goal of affordable housing.

Implementation

Legislation should be proposed to permit the use of performance contracting and third-party financing for projects where it is cost-effective. The DPS, with cooperation from utilities, should assist in the facilitation of performance contracting and third-party financing of energy efficiency measures. Recent federal cuts to the Institutional Conservation Program make the development of this policy particularly important. (See also the discussion of performance contracting in policy Government Energy Use in Buildings, Equipment, and Vehicles in Chapter 4, Section V.)

IV. AFFORDABILITY

A. Strategy: Promote Energy Efficiency for Low Income Housing and Affordability in an Increasingly Competitive Market

This strategy focuses on low income housing and bringing energy bills to their lowest practical level, through the coordinated delivery of comprehensive energy efficiency services, while improving comfort, safety, and affordability of low income housing. The strategy will be accomplished by initiatives involving program development, regulatory policy, and legislation.

Energy expenses are a major burden on Vermont's low income households. With typical annual heating bills of $600-$1,000 and electric bills of similar amounts, it is common for a low income household to spend $1,200 to $2,000 a year on energy (not counting transportation) or 15%-25% of its income.

The intent of this strategy is to pursue policies that reduce the energy burden on low income households. Approximately 24,000 Vermont households, or about 10% of Vermont's primary residences, receive state assistance in paying energy bills (Vt. Department of Social Welfare, 1996). In addition to the benefit of lowering energy costs for low income households, energy suppliers (utilities included), property owners and managers, and ultimately, taxpayers could benefit indirectly. Energy suppliers would see less bill collection activity, and property managers would find their rental units more affordable and rentable. If housing is more affordable, pressure to provide public subsidies could be lowered, benefitting taxpayers as well.

Public subsidies for fuel assistance are at risk. The federal government has been the major supporter of the state's Fuel Assistance Program but is has reduced its support in the recent past. Congress could end its support entirely. Responding to federal funding uncertainty, the Vermont General Assembly created the Home Heating Fuel Assistance Trust Fund in 1996. Its primary revenue source is federal grants, and if federal support falls short, the Vermont Weatherization Trust Fund will make up the difference. Yet even at previous, higher levels of federal support, the Fuel Assistance Program only paid half or less of a typical heating bill for a low income household.

Reducing energy consumption is not the only solution to cutbacks in energy subsidies, but it is an important one. Reduced energy use lowers a household's exposure to fluctuating support levels arising from the perennial debate over the Fuel Assistance Program. It also reduces to some degree the need to increase tax-supported programs to pay heating bills. It is not anticipated, however, that efficiency programs themselves, or other actions, will eliminate the need to help those with low incomes pay energy bills.

For several years regulated utilities have employed least-cost integrated planning (LCIP) in their operations. This concept has encouraged a utility to meet a customer's energy needs at the lowest cost, typically combining efficiency services and traditional energy supply. One goal is to avoid or delay the need for additional power supply from more expensive sources. This kind of long range planning allows utilities to minimize future investment, holding down the amount that needs to be collected in rates.
An analogous approach should be applied to providing energy services to low income households. Assuming a household spends $1,800 annually for heat and utilities, over a period of 10 years total energy expenditures would be $18,000. For most low income households, a portion of that energy budget would be paid with taxpayer supported subsidies.

Policy makers should examine how to determine the optimal mix of energy services to meet the needs of low income households; that is, the best mix of cash subsidies to pay bills and efficiency services to reduce them. Quality efficiency services can reduce a low income household's energy consumption by an average 20%. In the example cited above, savings of $3,600 could be accumulated over ten years, according to simple

calculations. The average cost of a weatherization job is $3,300, and many of the measures will continue to save energy beyond the 10-year period (Vermont Office of Economic Opportunity, 1996).

Most of the policies discussed below revolve around the unique capabilities of the Vermont Weatherization Program to provide quality efficiency services to low income households. With poor households as their clientele, program personnel understand the needs of low income households and the barriers that commonly block their participation in traditional energy and financing services. The Weatherization Program can serve as a bridge between low income households and energy efficiency services and establish networks of resource providers that will support efficiency improvements in low income housing. Linking providers of services and equipment with financial resources should produce market sectors specializing in low income energy services. Moreover, property owners and managers with low income properties will have access to expertise and resources through the Weatherization Program that previously had been limited. The Weatherization Program would also be a valued partner of utilities and other energy suppliers who, by themselves, would have difficulty reaching low income customers.

The last two policies in this section address the interests of small scale consumers and low income consumers as the electric utility industry evolves toward a more openly competitive marketplace. By forming an Energy Consumers' Cooperate or ConsumerCo, thousands of energy consumers, including low income households, can gain market power and achieve discounts for energy and energy services and products. In addition, preparations can be made for a statewide program to target assistance for some portion of the electric bill of low income households if and when Vermont initiates retail competition.

1. Policy: Energy Efficiency Standards for Multi-Family Rental Housing

Energy standards should be developed that prompt improvement at the time-of-sale of multi-family rental housing, resulting in lower energy costs for tenants and property owners.

Legislation would require that multi-family properties be upgraded, if needed, to meet a reasonable level of energy efficiency when they are sold. The requirement would be implemented several years after passage of the legislation to allow support services to develop and create financing packages to support the standard. Sellers would likely undertake improvements prior to selling, or when offering to sell, a qualifying property. Alternately, the buyer could agree to complete improvements needed to meet an energy standard, with the estimated cost of the improvements factored into the selling price of the property. This policy has most of the features detailed earlier in the time-of-sale policy under the strategy for the residential sector in the Buildings and Equipment section. (See Chapter 4, Section III.)

The Weatherization Program could either act directly as a service provider or as a coordinator of other resources, such as utility DSM services and financing through a "packaging" method that simplifies the process for property owners. The role of the Weatherization Program is more fully explained under Policy 3: Reinvent Weatherization Services Delivery to Low Income, Multi-Family Housing.

Home energy ratings could serve as the standard for judging the energy performance of individual buildings with a specific rating level needed for a property to meet the standard. Links between home energy ratings and specialized mortgage terms would help property owners secure financing for any improvements needed. Although this policy does not specifically target low income properties, it would include them and all others.

Businesses specializing in providing efficiency services to multi-family housing would likely emerge with the support of DSM and Weatherization programs. Training programs and access to start-up capital for business will help create these new businesses that demonstrate the economic and employment benefits of a time-of-sale standard. Financing comparable to energy efficient mortgages would support the housing improvements needed to meet the standard.

Rationale

Vermont's multi-family housing stock can be roughly divided into two categories: privately owned and operated apartment buildings, and larger public housing projects, commonly constructed with taxpayer subsidies and managed either by a private owner or a public housing authority. Many, though not all of the second category of properties qualify for rental housing or energy subsidies. Arguably, property owners who benefit from government subsidies should be obliged to participate in programs, under equitable terms, that make rental units more affordable for tenants. Energy efficiency programs are a good example.

A good portion of Vermont's multi-family rental housing consists of older properties in villages and cities. Built when energy was comparatively inexpensive, many have minimal insulation or other efficiency features. Heating systems may be old or may have been converted to electric heat after oil prices surged in the 1970s. Energy improvements that have been done are often patchwork in nature, lacking comprehensiveness. Moreover, the dilemma of motivating property owners to make their buildings more efficient remains, especially when tenants pay heating or utility bills, leaving no direct incentive for the owner to invest in efficiency improvements. A time-of-sale requirement would prompt the improvements to occur.

One objective of this policy is to support development of the resources needed by rental property owners to undertake the improvements. It is anticipated that building contractors would emerge who specialize in energy upgrades to multi-family housing and that financial resources, foreseen as an addition to the buyer's mortgage, would provide capital to complete the work that brings rental property up to an energy standard.

As in the other strategies in this Plan that rely on energy ratings, the use of a rating system should eventually make the overall efficiency of a rental building a factor in the property's sale price. Moreover, energy improvements can be a catalyst for other property improvements. Owners may make electrical, structural, and other improvements simultaneously, helping to raise the overall condition of the building stock in this sector. Improvements that enhance health, safety, and structural integrity would be valuable byproducts of the energy improvements.

An energy efficient rental property has advantages over substandard buildings from the perspective of a property owner and manager. Safety and health hazards, a legal liability for the owner, can be corrected when energy work is done. For owners who pay some or all of the energy bills, operating costs are lower. This improves the owner's ability to cover expenses for the property and helps profits. This is also beneficial from the lender's perspective. Lower operating costs allow owners to charge rents that are competitive with others in local rental markets. For tenants who pay their own heat and utility bills, lower energy costs may encourage longer-term tenancy, compared with high-cost energy rentals, such as electrically-heated ones, where vacancies are common.

Significant Issues

A debate would no doubt accompany any legislation calling for energy standards for rental housing, focusing on whether a government mandate is needed to achieve high levels of energy efficiency, or whether normal market forces could produce similar results. Arguably, a legislated standard would accelerate the rate of energy improvements in low income housing.

Development of the market to support accelerated rates of efficiency improvements is a necessary accompaniment to a time-of-sale standard. The growth of businesses specializing in energy efficiency retrofits must be supported through the development of lending programs that will help finance these improvements. Training programs and access to start-up capital for business will help create new businesses that demonstrate the economic and employment benefits of such standards.

2. Policy: Energy Efficiency Services Integrated with the Fuel Assistance Program

Support for the best mix of efficiency services and fuel assistance grants could make energy more affordable for low income households.

This policy proposes a two-part response to the dilemma faced by low income households faced with high energy bills. For one, a suitable level of Low Income Home Energy Assistance Program (LIHEAP) grants would be provided to eligible households to help pay energy bills. Second, energy efficiency services would be made an integral part of LIHEAP, with suitable financial resources to support an accelerated rate of weatherizing low income housing. Eligible households would be targeted for comprehensive efficiency services that would minimize energy bills and provide for conversions to lower-cost energy sources where they are cost-effective.

Historically, persons seeking fuel assistance were asked on the program application whether they wanted to be referred to the Weatherization Program for services. More recently, the Department of Social Welfare and the Weatherization Program have cooperated on a pilot program that targets households with excessive energy bills for weatherization. In fact, the 1996 General Assembly required all LIHEAP recipients to accept weatherization service, with priority given to households with excessively high energy bills or those receiving emergency fuel assistance.

Services would include comprehensive delivery of energy efficiency measures, *e.g.*, heating and electric efficiency. Examples include high efficiency lighting, replacement of inefficient appliances (particularly refrigerators), insulation and air sealing, and review of space and water heating systems with potential for fuel conversions where cost savings justify the conversions. The improvements would be accomplished by the Weatherization Program, drawing from electric and gas utility resources, and any other special financial resources developed to service the low income housing sector. (See discussion under "Reinventing" the Weatherization Program.)

Rationale

This policy implements a least cost approach to meeting the energy needs of low income households. It recognizes the need for helping low income households pay heating and utility bills, yet seeks to assure that those bills are minimized by virtue of highly efficient uses of energy in households served by LIHEAP. Energy efficiency services must be an integral part of LIHEAP to assure that only efficient energy consumption is subsidized, minimizing the burden on taxpayers, and maximizing the benefit to low income households. By applying a least cost strategy, LIHEAP administrators would ensure that subsidies are applied to efficient uses of energy, reducing the household's vulnerability to high energy expenses. Delivery of the efficiency services by the Weatherization Program would support efficient use of all energy types, including natural gas, LPG, oil, and electricity.

Significant Issues

The legislature's decision to require Fuel Assistance households to accept weatherization services did not address how to serve Weatherization's expanding workload. Recently about 1,200 weatherization jobs are completed annually. The number of households receiving LIHEAP grants has ranged from 20,000 to 24,000 annually, with many having received weatherization services previously. DPS and the Vermont Agency of Human Services are administering a new REACH grant that will support an expansion in Weatherization Program services. This funding from the U.S. Health and Human Services Agency is being used to build a

partnership for the Weatherization Program, LIHEAP, agents of delivery such as Community Action Agencies, and the Vermont Energy Investment Corp. (VEIC) for on-site service delivery. The REACH grant is for $880,000 for the period that extends to fall 2000.

3. Policy: Reinvent Weatherization Services Delivery to Low Income, Multi-Family Housing

The skills, services, and infrastructure of the Weatherization Program should be offered for large, multi-family housing. "Reinventing" the Weatherization Program's multi-family services by broadening the program's capability would be initiated in three areas: financing, technical analysis, and program resources/delivery. The revised program would increase weatherization activity in large multi-family housing projects while continuing to service single-family homes.

The Weatherization Program would change the way comprehensive energy efficiency services in multi-family housing are analyzed and delivered. Weatherization-retained experts would coordinate technical analysis and energy improvement services. In addition, the breadth of weatherization services would be expanded to encompass utility DSM services and financing to support capital intensive measures.

A long term commitment by the multiple parties involved in providing services and resources would be critical to making the program sustainable. Utility DSM services would be among the resources contributing to the comprehensive efficiency services. Efforts would be made to have utilities and energy providers participate throughout the state, making the work on individual projects as comprehensive as possible. The Residential Low Income program proposed in the DPS Statewide Energy Efficiency Plan *The Power to Save: A Plan to Transform Vermont's Energy Efficiency Markets* incorporates the idea of the Weatherization Program offering services to single-family and smaller multi-family housing with the enhanced capability to offer services for larger, multi-family housing (five or more units). (See Strategy B. Improve Efficiency of Vermont's Existing Housing Stock, Policy 5: Diversify the Vermont Weatherization Program.)

Once individual projects are identified, the Weatherization Program would retain technical experts whose responsibilities include preparing comprehensive energy analyses of housing projects on a unit-by-unit basis. Building envelope, heating and cooling systems, lighting, and appliances would be reviewed to determine if cost-effective upgrades or fuel conversions were appropriate. Health and safety concerns could also be addressed, with particular attention to indoor air quality issues. The technical analyses would result in a list of recommended energy improvements.

With measure recommendations in hand, the project coordinator would proceed to implement them, drawing resources from the parties who have made a commitment to participate. For example, the gas utility may contribute to thermal efficiency measures and heating system upgrades, the electric utility to lighting and refrigeration improvements.

Capital for the improvements may come from federal or state agencies which provide financing for large housing projects. Because many housing projects receive federal housing support, knowledge of rental support subsidies and their constraints and permitted uses is crucial. The federal housing subsidies occur in many forms and may be used creatively to support energy efficiency improvements or conversions to less expensive heating systems. In certain circumstances, such as converting from electric heat to a less expensive heating system, housing subsidies or utility allowances may be used to pay for capital improvements and operating costs, which should be lower. Other energy efficiency improvements could be supported in a similar fashion.

Commissioning newly installed energy systems would also be undertaken to ensure proper operation. Comprehensive projects will undergo an inspection following project completion to assess the installation of energy efficiency measures and ensure proper operating and maintenance procedures are in place. Inspection and commissioning will involve testing the installation and performance of major energy using equipment and

associated controls. This testing will ensure that all equipment was installed as specified, that it is operating according to manufacturers specifications, and that all controls are properly programmed. To ensure that customers complete the inspection process, comprehensive participants will not receive incentives until all inspection work is completed and any noted deficiencies are corrected.

Other funding sources would be developed or expanded to support energy improvements in multi-family housing. The newly created Weatherization Program loan fund targets multi-family housing, seeking to overcome barriers faced by owners of low income rental property. Financial resources from public-financed agencies, such as Vermont Housing Finance Agency or federal lenders (Rural Economic and Community Development Service), would also be sought to support energy improvements in multi-family housing in which the lenders hold an interest.

U.S. DOE's Rebuild America Program awarded DPS a grant of $115,000 in 1996, and with additional funding from the State Office of Economic Opportunity and Vermont utilities, the Weatherization Program is being enhanced to include a one-stop shopping service for larger, multi-family housing (five or more units). Under the Residential Energy Efficiency Program (REEP), property managers can merge the functions of technical analysis, contract management, and financing into a single operation.

A list of prospective housing projects already exists. Vermont's two largest electric utilities, Central Vermont Public Service and Green Mountain Power, have produced inventories of multi-family housing projects within their territories. The list would be expanded to cover other large housing projects throughout the state.

The designers of an expanded Weatherization Program should bear in mind the anticipated, yet undefined, changes in the electric utility industry. Historically a monopoly industry, electric suppliers expect to begin competing for customers, a shift that will have ramifications for low income customers. If the transition is improperly managed, rates could increase for customers with less market power, including low income households. With competition, there will likely be a variety of service offerings to customers, which might include energy sales and provision of efficiency services. The expanded Weatherization Program should be flexible enough to take advantage of prospective changes in the markets for electricity and energy efficiency services.

The expanded program would initiate information and education programs, seeking to educate and train persons involved in technical analysis and delivery of efficiency services.

Rationale

Historically, the Weatherization Program has delivered energy improvement services to single-family and smaller multi-family housing, lowering energy bills, increasing comfort, and providing safer conditions for low income households. However, with limited exceptions, larger multi-family housing projects have not received comprehensive energy efficiency services from Weatherization because of the complex nature of their funding and management. Few persons understand how to effectively command available resources to analyze the energy needs of multi-family housing, to coordinate delivery of multiple energy programs for comprehensiveness, and to arrange financial resources to complete the job. Moreover, organizing the many parts into a single project can be a lengthy undertaking. All these factors make the role of a "deal maker" a critical resource for accomplishing the job. This proposal would establish the role of a coordinator of comprehensive energy efficiency services in multi-family housing.

The coordinated approach is in contrast to the status quo, where individual parties, including utilities, have developed independent programs to serve the multi-family housing sector from their own vantage point. The programs have often lacked comprehensiveness and have sometimes created redundant administrative expenses. Generally, the utilities' programs have been autonomous and not designed to complement others that may have similar or overlapping objectives. Nevertheless, they do represent a resource that could

contribute to comprehensive efficiency service to the targeted housing sector: low income, multi-family housing.

Another barrier that the "reinvented" Weatherization Program can address is known as "split incentives" or the "renter's dilemma." When the person making decisions about investments in energy efficiency for a residence or an office is distinct from the person who lives or works at the premise, conditions are set for "split incentives." A landlord could make investments in energy efficiency, but the landlord doesn't get direct benefits from this investment, so these investments are not made.

Tenants, whose average stay at an address is 15 months, do not make long term investments in efficiency. The Weatherization Program can remediate this type of situation and encourage property owners to invest in energy efficiency by offering aggressive rebates.

4. Policy: Encourage Development of a Consumers' Cooperative or Consumerco

Market power of thousands of energy consumers, including low income households, should be consolidated into an energy consumers' cooperative with bulk-buying discounts for energy and efficiency services.

The energy consumers' co-op, a private, non-profit, membership organization, would have a dual mission: delivery of energy at a substantial discount and providing attractively priced and financed energy efficiency services and products to members. Discounted or free charter memberships will be used to attract initial members.

A membership drive would be undertaken in cooperation with grassroots organizations, food co-ops and existing cooperatives in the state, Seniors' groups, and Community Action Agencies. Low income households receiving Fuel Assistance would be invited to join. Marketing to sustain and expand membership would be an ongoing activity. Using the buying power of numerous members, the cooperative would negotiate discounted fuel prices with local fuel suppliers to supply members. Heating system repair could be part of the contract. The cooperative would seek per gallon prices below retail pricing, consistent with other fuel-buying cooperatives in the Northeast. A nominal charge, a few cents per gallon, would be assessed to support co-op administration. Initially, home heating oil and kerosene would be targeted; propane, wood, and

other fuels would be added in step with member demand. Once established, the Consumerco could offer members energy efficiency products, featuring high efficiency alternatives that can be hard to find in normal retail outlets. This co-op could also provide energy efficiency services, such as weatherization.

Restructuring of the electric industry also presents an opportunity. The Consumer could negotiate contracts with a power supplier to deliver electricity, and perhaps energy efficiency services, on favorable terms to its members.

Rationale

A co-op for energy would be one way to reduce the burden of energy costs for members. Discounts greater than those typically offered by fuel suppliers to retail customers could be available. Member prices could be a fixed margin over wholesale fuel prices or pre-fuel-season buying could allow for a level retail price over an entire heating season, with the benefit of paying a predictable price for the entire season. Discounted energy prices would be one way to mitigate declining Fuel Assistance Funds used by low income households to pay energy bills.

The prospect of expanding efficiency services into the unregulated fuel sector is positive. During the past ten

years there has been increasing sophistication and infrastructure building for efficiency among regulated utilities, but comparable services for bulk fuel customers have not emerged. A Consumerco could promote a stronger marketplace for efficiency goods and services in the bulk retail fuel industry.

Significant Issues

The co-op must market itself as a low cost energy provider to attract a sufficient number of customers. Marketing, in cooperation with several existing organizations such as food co-ops, seniors' groups, DSW, and CAPs will be key.

5. Policy: Establish a Statewide Affordability Program to Take Effect When Vermont Initiates Retail Competition

Should Vermont initiate retail competition, a statewide assistance program funded by all consumers should take effect at the same time.

Addressing concerns for vulnerable electricity customers, DPS should work to target assistance for some portion of the electric bills of low income households through a sustainable, non-discriminatory wires charge applicable to all electric customers, regardless of electricity supplier. This program should serve a population similar to the Telephone Lifeline population, provide increased benefits to lower income levels, and include incentives for energy efficiency. This type of home energy assistance program is proposed in the Public Service Board's Report and Order in Docket 5854, *The Power to Choose: A Plan to Provide Customer Choice for Electricity Suppliers*.

DPS should work with the legislature on establishing a broad-based, statewide affordability program that would take effect when Vermont initiates retail competition and target assistance for some portion of a low income household's electric bill.

V. GOVERNMENT ENERGY USE AND ENERGY POLICY

A. Strategy: Improve Government's Energy Use, Programs, and Policy

The functions of government are related to energy use in two major ways. First, state government is an energy consumer. Second, it is the responsibility of government to shape and implement sound energy policy and programs for the general good of everyone. The programs and policies should make it possible for government entities to perform sound energy planning, to set regulations, and to educate and inform the public. State government can also advocate for the good of Vermonters by lobbying or discouraging certain national energy policies and programs.

It is important for government to take a proactive role in energy issues for several reasons. Government can lead by example: wise energy use in government buildings and vehicles acts as a model for residents and business owners and sets a goal toward which they can work. In addition, many efficiency measures not only reduce energy use, they reduce costs over the lifetime of the measures. When the measures are installed in public buildings, the result is important savings in public dollars. Therefore, government should encourage efficiency in other public buildings and among businesses and residences through planning, regulation, and education.

The role of state government as an energy consumer is discussed in the first policy below: Government Energy Use in Buildings, Equipment, and Vehicles. The second policy, Government Energy Planning, makes recommendations for planning at all levels of government, from national to municipal levels. Finally, government programs and projects to improve energy education are outlined in the third policy, Public Education and Information. The state's role in setting regulations is discussed throughout this Plan, including the Energy Sources and Supply, Transportation, Buildings and Equipment, and Affordability sections.

1. Policy: Government Energy Use in Buildings, Equipment, and Vehicles

Support energy-saving programs and projects already under way for government energy use, including the work of DPS, ANR, Dept. of Buildings and General Services, and the Clean State Council, and develop new programs and projects to address areas not covered by current efforts.

Key elements of this policy are:

- An inter-agency task force including members from the Department of Public Service (DPS), Agency of Natural Resources (ANR), Agency of Transportation (AOT), the Department of Buildings and General Services, and other groups should meet regularly to focus solely on energy issues in Vermont government.

- This proposed task force should investigate ways to ensure that the Vermont Energy Conservation Standard building code is used for all new state buildings, state-funded buildings, and additions or major renovations to state buildings, and that the Building Life Cycle Costing computer program is widely used by builders of such facilities.

- This proposed task force should investigate the potential of using performance contractors to carry out energy improvements in state buildings, establishing a revolving loan fund for efficiency improvements to state and other public buildings, and finding new funding sources to maintain a program similar to the School Energy Management Program.

- DPS should collaborate more strongly with the Purchasing Division of the Department of Buildings and General Services to assist as needed or as appropriate with life cycle costing purchasing practices and should review and make recommendations about externality cost estimates in life cycle costing.

- DPS should develop, distribute, and maintain an up-to-date, comprehensive description of the life cycle costing method, with appropriate data and documentation (including externality cost estimates, and fuel price escalation).

- Clean State Council, in the Environmental Assistance Division of ANR, should continue their recycling efforts and create stronger mandates and an enforcement structure for purchasing recycled products by all branches of state government and its contractors.

- State agencies, as they write their upcoming Environmental Assessment Plans, should follow the lead of ANR's prototype plan and recommend similarly strong transportation energy savings measures, including measures involving vehicle management and employee commuting practices.

- Clean State Council Automotive Subcommittee should continue their efforts in studying how state government purchases, manages, and maintains its vehicles and should make recommendations for improvement.

Rationale

State government is a major energy consumer. Energy is consumed in the buildings housing the executive, legislative, and judicial branches of state government; in the equipment, machinery, and appliances used both inside and outside state buildings; and in all state vehicles. In addition to the energy- and cost-saving benefits that can be garnered by state government (and the public) when energy is used efficiently, government can also act as an effective model for residents and business owners if its energy use is as wise as possible. (See Section III., Strategy D., Policy 4: Financing Mechanisms for Cost-Effective Energy Efficiency and Renewable Energy: Performance Contracting and ESCOs.)

Table 4.V.1 Energy Use by State Buildings and General Services FY96

Fuel/Energy Type	Quantity	Cost	Percent of Total
Electricity	23,303,855 kWh	$2,104,821	74%
Wood	8,213 Tons	237,791	8%
#6 Fuel Oil	339,822 Gal.	190,077	7%
Natural Gas	311,343 CCM	165,056	6%
#2 Fuel Oil	177,729 Gal.	119,145	4%
Propane Gas	49,038 Gal.	32,069	1%
Diesel	23,447 Gal.	13,748	0%
Total		$2,862,708	100%

Note: There are approximately 200 state government buildings with a total area of 1,992,480 square feet ($1.44/SF) that house approximately 5,000 employees ($572.50/employee).

Source: Vt. Department of State Buildings and General Services
The ideas suggested in this policy focus mostly on government energy use at the state government level, although some ideas apply to other public buildings, such as schools. Suggestions for improvements to

government energy use on the local level are discussed under the government energy planning policy.

The first section of recommendations below focuses on energy use in buildings, outlining efficiency measures for state buildings, the state building standard, two financing methods for energy efficient improvements (performance contracting and a revolving loan fund), efficiency programs for other public institutions, and purchasing options for more efficient energy use (life cycle costing and recycled product purchases). Finally, the vehicles section outlines ways that state-owned vehicles can be better managed and ways to encourage energy-saving employee commuting practices.

Efficiency Measures for State Buildings. There are many measures that can improve energy efficiency and lower embedded energy levels in buildings. Some of the measures outlined in this section involve employee or maintenance practices that can be implemented with little or no change to the building or equipment, while other measures involve the installation of new equipment or the use of new products in buildings. (For a summary of the energy savings measures that have already been installed or achieved in state buildings see the *Vermont State Agency Energy Plan* by the Agency of Administration, 1996.)

Efforts to increase the use of energy efficient equipment and improve embedded energy levels in products in state government are currently being made by the Vermont Clean State Program. As part of this program (created by Executive Order 06-94 in 1994), the Clean State Council prepared a Materials Management Plan that recommends measures to purchase, use, and reuse products that promote resource conservation and pollution prevention. Governor Dean signed a memorandum that mandated many of these recommended measures as of January 1996, and the remainder of the measures were implemented by January 1997.

Some of the Clean State Council's measures that improve energy efficiency and embedded energy are as follows:

- Purchase computer equipment with "Energy Star" ratings.
- Purchase goods and services through contracts that maximize resource conservation and energy efficiency.
- Continue to expand the use of life cycle cost analysis in purchasing lighting components, electric water heaters, electric appliances, copiers, etc.
- Use products and supplies that have been source-reduced, reused, or recycled.
- Encourage the adoption of standards (including recycling standards) for procurement, use, and management of equipment and supplies by the state legislative and judicial branches.
- Reduce paper use.
- Make double-sided copies.
- Use recycled paper
- Test recycled plastic products.
- Require employees to separate recyclables.
- Recycle cafeteria materials.
- Require contractors of new state buildings to file scrap materials recycling plans.

In addition to their Materials Management Plan, the Clean State Council has created a plan to improve information and education about resource conservation among state employees. Some of their recommended measures include: educate employees and purchasing workers about advantages of recycled products, increase the use of surplus property, write articles for government publications highlighting environmental procurement opportunities, encourage the use of e-mail for more reports and memos, and increase the practice of turning off lights and computer monitors when not in use (Vt. Clean State Council, 1995).

The Executive Order that created the Clean State Program also directed the Agency of Natural Resources to

prepare a prototype state agency pollution prevention and resource conservation plan and assist other state agencies in preparing similar plans. ANR published this plan in 1996. The plan recommends energy conservation measures (along with other measures) in several categories, including transportation, buildings and grounds, and office equipment. Recommendations in these categories have especially strong potential to improve energy conservation in state government. Some of ANR's recommendations in the buildings and grounds section include:

- Design new buildings and office space to conserve energy.
- Control the temperature throughout buildings to achieve heating and cooling system balance and to maximize comfort.
- Reduce thermostat settings in foyers.
- Replace worn wooden sashes with better sealing units.
- Weatherstrip windows and doors to reduce heat loss.
- Insulate water heaters and pipes.
- Upgrade to energy-efficient lighting systems where not already done.
- Replace incandescent bulbs used in exit signs with LED lighting.
- Use the energy conserving standby feature on photocopy machines.
- Disconnect the internal lights and ballasts in beverage vending machines.
- Designate recycling stations in each building (Vt. ANR, *Comprehensive Environmental Assessment*, 1996).

Measures that the ANR plan does not include, but which could have great potential in some buildings, are converting buildings that heat with inefficient systems or non-renewable fuels to more efficient systems or cleaner or renewable fuels, such as wood; implementing measures that can reduce the need for air conditioning, such as tree plantings and awnings; and considering improvements such as additional building insulation and energy management systems (which control temperature and air flow), especially in older buildings.

Thus, through work under way by the Clean State Council, the Agency of Natural Resources (with their state agency prototype plan), and the Department of Public Service (with a number of projects described below), progress is being made toward more efficient energy use in state buildings. However, because the work under way is not consolidated and because some efforts focus on many issues (not just energy efficiency), energy issues do not always receive the inter-agency focus they need for strong implementation. It is also possible that, due to the fragmented approach, progress is not being made toward the first priority items that would most cost-effectively capture the most energy savings.

A task force that focused solely on energy issues in state government could improve this fragmented approach. The task force could act as a subgroup of the Clean State Council, or could be formed by the Department of Public Service, but in either case it should include members of DPS, ANR, AOT, and the Department of Buildings and General Services. This group could not only develop programs for state agencies to achieve some of the goals listed above, it could also set comprehensive goals, prioritize programs based on the cost-effectiveness of energy saving measures, and work to further some of the measures described below, including state building standards, energy efficiency in public institutions, the purchase of energy efficient equipment, and the use of transportation energy reduction methods for employees. Although DPS already works on many of these issues (to a greater or lesser extent), a more coordinated and comprehensive approach, with the input and support of other state agencies, could help to move implementation forward more quickly.

State Building Standard. In 1991, the Departments of Public Service and State Buildings began work on developing an energy efficiency standard for new state buildings. The resulting Vermont Energy Conservation Standard is a building code based on a national standard (ASHRAE 90.1), but adapted for Vermont. The standard was initially developed only for new state buildings, but later was broadened to cover additions and major renovations to state buildings, and building construction that uses state funding.

A tool available to builders that can assist in meeting the standard is the Building Life Cycle Costing computer program, developed for the U.S. Dept. of Energy. This program provides economic analyses of capital investments that are expected to reduce long term operating costs of buildings or building systems.

Because there is no mechanism in place for enforcement or review of use of the building standard, the extent of its use is difficult to track. This is especially true of state-funded buildings. Clearer definition of "state-funded buildings," as well as additional assistance to and oversight of state and state-funded building contractors, would place the standard in greater use.

Performance Contracting. Performance contracting is based on the principle that energy-efficient projects done correctly will pay for themselves from the savings produced. Under a performance contract agreement, an outside party (often an energy service company, or ESCO)) typically conducts an energy audit, designs cost-effective, energy-saving capital improvements, obtains bids, manages the construction, guarantees energy savings, and finances and maintains the improvements. (Capital improvements to buildings can include heating and water heating equipment, lighting, and building envelope improvements.) The customer pays for the improvements from the resulting energy savings. Performance contracts are often structured as a lease, but with a guarantee that payments will not exceed energy savings. Thus, the "performance" of the energy improvements dictates which improvements are installed.

Performance contracting includes the following benefits:

- Guaranteed energy savings finance project costs, leading to minimal financial risk for the customer.
- After the performance contractor has been paid, the installed equipment continues to provide energy savings to the customer.
- All required services are obtained by the customer from a single ESCO or contractor.
- Design and construction phases are closely coordinated, which can accelerate project schedules.
- Monitoring of energy use after installation provides immediate evaluation of equipment performance and the ability to maintain energy savings (ONRL, 1992, *Energy Performance Contracting*, 1992, 18).

Performance contractors often are interested only in large projects that have the potential for large energy savings and capital investments that have a high return. Because performance contractors tend not to make energy investments that have a slower rate of return, many potential energy savings are lost. Thus, performance contracting generally cannot capture all cost-effective efficiency improvements.

However, for organizations short on capital and energy efficiency expertise, performance contracting can improve energy efficiency. In addition, there are cases in which customers who have smaller potentials for energy savings can join other similar customers in the same area and search for a contractor willing to take on the entire collection of customers (Weedall, 1986, 85).

Performance contracting can be especially useful to state and local governments, because they can become models of energy efficiency without assuming financial risk or taking on the work of hiring contractors for all phases of the project. In Vermont, the Department of Public Service has proposed that the state use performance contractors to carry out energy improvements in state buildings. And the 1996 Legislature authorized $1 million for performance contracting to be implemented by the Department of Buildings and

General Services. These efforts have the potential not only to result in significant energy savings, but to do so in a manner which saves money and boosts commercial sector energy service companies.

Revolving Loan Fund. A revolving loan fund has the potential to provide financing for energy-saving improvements. With a revolving loan fund, a pool of loan funds would be established (through bonds, energy taxes, or another form of financing) to be loaned for energy efficiency improvements to state buildings and possibly other public buildings. The efficiency improvements could be chosen from a list pre-approved by the state, and could include such measures as roof, wall, floor, and hot water pipe insulation, high-efficiency lighting fixtures, high-efficiency furnaces and air conditioners, economizing controls for air conditioning, and automatic setback thermostats. The payback schedule of the loans could be based on the energy savings achieved through the investments. Loan payments paid back to the fund would then be recycled and loaned out to new customers. A revolving loan fund has the potential to be useful with smaller projects or with projects in which the energy improvements are fairly simple, especially if performance contracting covers larger, more complex projects. In such cases, the customer may be able to work with an energy service company or other contractor directly.

Efficiency Programs for Public Institutions. One program that has assisted Vermont schools and other public institutions for several years with energy conservation grants is coming to an end due to a lack of funding. The Institutional Conservation Program (ICP), under way since 1980 in the state and administered by DPS, provided federal matching grants (or partially matching) to schools, hospitals, and universities to fund energy conservation measures or technical assistance. Between 1980 and 1994, 536 buildings were upgraded using ICP funds, and in 1995, 10 new grant recipients were approved. Altogether, $6.5 million in federal funds, along with $10.3 million in applicant funds, were used to bring about an estimated $100 million in energy savings.

Another successful project, the School Energy Management Program (SEMP), has worked with school boards and administrators to implement energy efficiency measures in schools across the state. The program, based at the Vt. Superintendents' Association and overseen by DPS, previously has been funded by oil overcharge funds collected through the settlement of federal lawsuits and through income generated by services to schools.[li] Since the program's creation in 1993, it has assisted more than 50 Vermont schools with energy-related projects such as the conversion of heating systems from electricity to wood, the installation of insulation, energy efficient windows and lighting, energy management systems, and the development of a statewide wood chip purchasing effort for Vermont schools. SEMP has provided project management, consulting, assistance with grant pursuits, and public education, depending on schools' individual needs. Although the oil overcharge funds have nearly been exhausted, funding has been found to continue SEMP for another year.

In today's climate of declining federal funding for many programs (including the ICP), and with the approaching end of the oil overcharge funds, new sources of funding will likely be needed for efficiency assistance programs if they are to continue. Even if a revolving loan fund were established and/or performance contracting were more widely used, the type of work done through SEMP would still be necessary to coordinate and educate about efficiency and efficiency projects. Two of SEMP's greatest strengths have been the program's flexibility and ability to assist schools in different ways, and its base at the Superintendents' Association, which was helpful in enlisting schools. This model could be useful for a program that extended to other public buildings and institutions in addition to schools. Future funding sources for such programs could be a surcharge on energy purchases, a utility surcharge, or others. The Department of Public Service and the task force mentioned above should actively pursue the potential for such funding sources.

Life Cycle Costing for Purchases. Life cycle costing is a decision making tool that allows for a more thorough comparison of different products during the purchasing process. With life cycle costing, a product's purchase and installation price, annual operation, maintenance, and energy costs, periodic equipment replacement costs, and salvage or disposal costs are considered, along with fuel price escalation, inflation, and the projected life

span of the product. In the most complete type of life cycle costing, external costs are also considered. Using life cycle costing to compare options gives a better sense of the full cost of each product, and often can identify energy-efficient items that are more cost-effective than less efficient products which have a lower initial cost. Using life cycle costing to compare and purchase items can result in significant cost and energy savings.

The Purchasing Division of the Vermont Department of Buildings and General Services uses life cycle costing when purchasing some products they provide to state agencies. For example, purchases of water heaters are always subjected to life cycle cost analysis, while purchases of refrigerators and stoves sometimes receive a life cycle cost analysis. Lighting purchases have been subjected to life cycle cost analysis in the past, but currently are not because energy efficient lighting purchases are now the standard.

The Purchasing Division's life cycle costing purchasing practices could be improved by stronger collaboration with the Department of Public Service. DPS has the ability to assist in educating purchasing employees in life cycle costing methods and creating lists of energy efficient products. In addition, DPS and ANR prepared externality cost estimates to use in purchasing decisions and construction planning by state government starting in 1992. This issue should be revisited to determine whether these externality estimates should be updated and to discover to what extent externality estimates are being used in life cycle costing analyses by state government. DPS should be proactive in moving forward on these issues.

In addition, the Department of Public Service should develop, distribute, and maintain an up-to-date, comprehensive description of the life cycle costing method, with appropriate data and documentation (including externality cost estimates, fuel price escalation, etc.). In this way, purchasing managers in the public and private sectors will be informed and encouraged to use life cycle costing when making energy-using investments.

Recycled Equipment and Products. Recycling and purchasing recycled goods is an important energy savings strategy because each product we use contains "embedded energy," the energy used to create and deliver the product. Reducing embedded energy levels by reusing products, using recycled products, and recycling what we use can result in significant energy savings to society, although we may not experience the energy savings directly.

As outlined above, the Vermont Clean State Council is working to institute recycling practices and purchasing guidelines into state government, and significant savings have been achieved from the Council's recycling efforts. In 1995, more than $190,000 was saved in state government from avoided disposal costs and revenue received from recycled materials. In addition, the state recycled 588 tons of paper, 1,372 tons of cardboard, 32 tons of glass, tin, and plastic, 42 tons of scrap metal, 12,210 gallons of oil and antifreeze, and recycled or retreaded 1,910 tires (Vt. ANR, *Recycling Report*, 1995). These savings are the result of many different projects involving employee education, innovation and dedication among employees, and statewide requirements.

Recycling efforts in state government can be strengthened by putting recycled purchasing requirements in place. For example, the Seattle city government has a "Buy Recycled Ordinance" that mandates the purchase of products that meet recycled content standards, including products such as paper, building insulation, cement with fly ash, lubricating oils, latex paint, products made from recycled glass, plastics, etc. The ordinance further mandates that not only the city, but also its vendors, contractors, and consultants, use recycled contents and reusable products. Because the Seattle government also has strong guidelines to recycle what they use, their recycling practices approach a closed-loop system (U.S. DOE, *Procurement Works*, 1994). Recycling has the greatest opportunity for success when recycling is combined with the purchase of recycled products in this way. Purchasing recycled products is especially important currently in order for recycled products to gain a wider share of the market and reduce production costs.

Because the Vermont Clean State Council already has numerous recycling projects under way, they should continue their work on encouraging recycled product purchasing. In addition, the Council should consider creating stronger mandates and an enforcement structure for purchasing recycled products by all branches of state government and its contractors.

Energy Use in Government Vehicles. As discussed in the Buildings section above, the Clean State Council and the Agency of Natural Resources have both produced recommendations for resource conservation and pollution prevention. Some of these recommendations focus on saving energy through management of state-owned vehicles and encouragement of energy-saving employee commuting practices. For instance, ANR's draft Environmental Assessment Plan (which will act as a prototype for other state agencies as they create similar plans) makes the following recommendations:

- Develop criteria for the purchase of state-owned vehicles, including criteria for usage needs (in order to match purchase with appropriate vehicle type), fuel type, efficiency, reliability, safety, and cost.
- Purchase two alternatively fueled vehicles by July 1998.
- Purchase the smallest and most fuel-efficient vehicles consistent with intended use.
- Implement good management practices for the fleet, including recycling waste oil and antifreeze, using re-refined oil and retreaded tires, etc.
- Ensure that vehicles are tuned up regularly to minimize air emissions.
- Develop and promote incentives to encourage more employees to ride share to and from work.
- Develop electronic bulletin boards for potential ride sharers to communicate and for listing instate and out-of-state trips with ride share opportunities.
- Permit more employees to telecommute and use flex time to reduce commuting (Vt. ANR, *Comprehensive Environmental Assessment*, 1996).

Although these recommendations only apply to ANR's operations, they could (if widely adopted) significantly improve transportation energy use throughout the rest of state government. State agencies should follow the lead of ANR's recommendations when writing their Environmental Assessment Plans and include similar transportation energy savings measures in their plans.

As part of the Clean State Council's efforts, an automotive committee was formed to examine how state government purchases, manages, and maintains its vehicles. At present, Vermont is one of the few states not operating a centralized fleet of vehicles; rather, individual agencies independently purchase (from a list of approved dealerships) and maintain their own cars and trucks. The automotive committee has recommended that selection of state vehicles contain a life cycle cost test, including fuel economy. In addition, the committee recommends that vehicles be maintained using re-refined lubricants and rebuilt parts with service provided by automotive businesses that voluntarily comply with environmental standards set by the State Division of Purchasing. The Clean State Council has also recommended that state agencies should examine vehicle budget requests for opportunities to purchase alternate fuel vehicles, and encourage the use of public transportation, car-pooling, walking, and biking to work.

Several measures recommended above are analyzed further in the Transportation section of this plan. (See Section II. for policies regarding public transit, car-pooling, walking, and biking to work, the green transportation vouchers policy which explores how state employees could receive a monetary benefit for ride sharing, biking, or walking to work, and the policy regarding commuter park-and-ride lots.)

2. Policy: Government Energy Planning

Vermont should support ongoing energy planning efforts at national, New England, statewide, regional, and municipal levels and develop additional projects and programs to strengthen these efforts.

National Actions. The federal government should:

- Focus Department of Energy planning efforts on promoting energy efficiency and renewable, sustainable energy resources, by directing federal promotion, research, and development subsidies to these areas;
- Support levels of congressional funding which sustain and expand the benefit of the Low Income Home Energy Assistance Program and the Weatherization Program.
- Encourage congressional leaders to promote levels of efficiency in federal building and equipment purchases to save dollars and serve as models for the state and local levels and the private sector.
- Develop a national energy taxation strategy that works toward including the full costs of energy use in energy prices, while reducing other tax burdens on corporations and individuals; and
- Continue to develop, enforce, and plan for strong environmental protection from energy emissions, using mechanisms such as auto emission restrictions, vehicle fuel efficiency standards, the Clean Air Act Amendments, and SO_x, NO_x, and CO_2 caps.

New England Actions. New England and Northeastern organizations should:

- Focus more strongly on reducing the region's dependence on petroleum and thus strengthen security;
- Support siting of natural gas pipelines in a way that diversifies Vermont's energy supply resources and broadens availability of national gas in the region.
- Continue to coordinate and plan for electric utility restructuring, explore the potential impacts on electricity prices, and develop common methods for disclosing to consumers information about the power they are buying;
- Participate in regional discussions and planning to replace aging or out-of-service nuclear units with an appropriate mix of energy resources.
- Support policies that more fully internalize the costs of energy in all energy prices; and
- Broaden the scope of transportation planning to consider more energy and environmental issues.

Statewide Actions. All state agencies should:

- Continue to prepare State Agency Plans and strengthen the energy goals and policies in these Plans.
- Continue work on reforming the electric industry, building on the progress made in the Board's Order and Report in Docket 5854, utility filings and work done in the 1997 legislative session.

Department of Public Service should:

- Continue statewide electric energy planning efforts during and after the transition to a restructured electricity market in order to address strategies for meeting statewide statutory electric energy goals and to recommend and set policies;

- Plan and prepare for retail competition in the natural gas market if properly guided and structured.
- Maximize efforts to implement policies in the *Vermont Twenty Year Electric Plan* and the *Vermont Comprehensive Energy Plan*;
- Strengthen support to regional and town planning by designating a staff person as a liaison between the state and regions, by providing model energy plan sections, by offering incentives, and by developing partnerships in energy efficiency and renewable energy initiatives; and
- Expand public input into the energy planning process through greater use of new telecommunications technologies and other strategies.

Agency of Transportation should:

- Collaborate with DPS and ANR to guide planning and decision making that meet Vermonters' transportation needs while working toward the state's energy goals and maintaining and improving environmental quality.

Regional and Town Actions. Regions and towns should seek to strengthen the energy and transportation sections of their regional and town plans by including in them and undertaking some of the following measures. (Most of these measures appear in a current regional or town plan; localities where they appear are listed after each measure.) This list of measures is not meant to be exhaustive of the measures in all Vermont plans nor comprehensive of all sound energy measures, but simply illustrative of some good initiatives localities could undertake. Some of the measures likely will be more appropriate than others in individual regions and localities.

Transportation Measures:

- Create, maintain, improve, and promote bicycle paths, bicycle lanes, recreation paths, sidewalks, pedestrian areas, and other such facilities; (many plans)
- Create, improve, and promote public transit services and park-and-ride lots; (many plans)
- Create and promote aggressive ride sharing programs and provide information on ride sharing to employers and the public (fliers, brochures, ride share maps, ride share matching bulletin boards at town halls, etc.); (Central Vermont Region, Danville)
- Perform a study of commuter travel patterns and corridors;
- Operate town vehicles on alternative fuels; (Burlington)
- Maintain town vehicles at peak efficiency; (Burlington)
- Encourage truck travel to shift to rail freight transport; (Central Vermont Region)
- Limit road expansion; (Southern Windsor Region)
- Create a trip reduction ordinance as part of the zoning ordinance, requiring new development to limit car trips by Travel Demand Management measures or by supporting local ride sharing or public transit; (Burlington, Two Rivers-Ottauquechee Region)
- Encourage employer-based incentives to employees who ride share, use public transit, and travel less (preferential parking at work sites for ride share vehicles, in-house ride share matching, incentives for ride sharing, a guaranteed-ride-home program, in-house public transit information, sale of discounted transit passes through payroll deduction, parking vouchers as benefits, a designated transportation coordinator for employers with 30 or more on-site employees, increased use of flexible work schedules, compressed work weeks, and telecommuting); (Central Vermont, Rutland, and Windham Regions)
- Create a Transportation Management Association or similar entity to coordinate, monitor, encourage, and assist employers and public bodies in implementing demand side transportation measures such as those listed here; (Central Vermont Region)

- Encourage planning processes that include Travel Demand Management measures in decisions, that use least cost decision making, and that take steps to include the full costs of energy into decision making.

Energy Resource Measures:

- Study the potential for and promote the use of renewable sources and distributed generation options in the locality, including wood chip, solar, and wind systems, methane generation from sewage plants, landfills, and farms, cogeneration, etc. (many plans)
- Perform a study of existing and proposed energy sources, environmental and monetary costs of current and possible future sources, problems, needs, and opportunities; (Southern Windsor Region)
- Encourage towns and residents to use renewable energy sources; (many plans)
- Promote development and use of local resources, products, and energy sources; (Bennington Region, Danville)
- Reduce property tax assessments on property improvements designed to take advantage of renewable sources; (Danville)
- Encourage active sustainable management of town and private forests for local wood energy use; (Danville)
- Require/encourage new solid waste facilities and large landfills to capture methane for electrical energy or heat use; (Upper Valley-Lake Sunapee and Southern Windsor Regions)
- Inventory and map existing dam sites for consideration of development or improvement of run-of-river hydroelectric facilities; (Southern Windsor Region)
- Encourage commercial and industrial energy users to investigate the option of using waste heat; (Burlington)
- Institute recycling in schools, town offices, garages (for recycling oil), and other municipal buildings, and require that recycled paper and other materials be purchased; (many plans)
- Create local ordinances that require recycling by businesses and residents or make recycling services more widely available (many plans).

Home and Building Measures:

- Encourage energy conservation, energy audits, and weatherization programs in homes and buildings; (many plans)
- Require applicants for new building permits to submit a plan for energy conservation and for recycling construction materials; (Danville)
- Use an energy rating system for new residential construction; (Middlesex)
- Perform energy audits of municipal buildings; (many plans)
- Encourage participation in electric utilities' energy efficiency programs (many plans).

Land Use Measures: (See Chapter 4, Section II.C., Policy 5 Encourage High-Density, Mixed-Use Land Use Planning and Curtail Sprawl for more land use planning measures.)

- Support high density, mixed use town and growth centers; (many plans)
- Revise zoning regulations to support growth center development; (several plans)
- Encourage development in areas that have adequate transportation facilities and other infrastructure.

Student and Public Education Measures:

- Create and/or promote curriculum units on energy to teachers and schools; (many plans)
- Provide energy and energy efficiency information in town and school libraries; (Danville)
- Provide energy efficiency construction and housing information to area builders, developers, architects, and customers when building permits are issued or at the time-of-sale; (Middlesex)
- Form a Conservation Commission that holds workshops for builders and the public on energy efficient buildings; (Danville)
- Make energy presentations at and create energy projects for local community and business organizations; (Burlington)
- Encourage more public involvement in energy issues, and encourage energy choices and decisions to be made at the local level.

Structural/Organizational/Other Measures:

- Create an Energy Committee to implement the energy goals in town plans; (Middlesex)
- Require life cycle costing in decision making for government purchases of energy-using appliances, equipment, vehicles, etc.;
- Develop and use energy efficient lighting standards for street lights; (Montpelier, Burlington)
- Establish guidelines for tree heights and tree species in towns to maximize energy efficient heating and cooling; (Burlington)
- Discourage tree cutting within denser town limits; (Burlington)
- Encourage local lenders to participate in low interest financing for energy efficient investments and in the Energy Efficiency Mortgage Program; (Danville)
- Encourage new businesses that specialize in alternative energy products or systems; (Danville)
- Promote contact between the business community and state or federal energy programs (such as the federal Green Lights program);
- Become partners with the Department of Public Service or other state agencies for grants on special energy projects;
- Require community and technical review of social, environmental, and economic impacts of energy facility proposals or of energy-intensive developments or industries; (Two Rivers-Ottauquechee, Southern Windsor, and Windham Regions)
- Explore ways in which communities could be involved in and affected by restructuring in the electric utility industry (*e.g.*, how are the utility/ies serving specific localities likely to be transformed in a restructured environment, what are likely to be the effects on customers, how will the town meet local energy goals in a restructured environment, could the town provide/become an energy aggregator that consolidates customers into groups for stronger buying power, etc.);
- At the regional level, develop a model energy element for town plans that addresses the needs, issues, and concerns of rural Vermont towns (Windham Region).

<u>Rationale</u>

Vermont has a strong tradition of planning at all government levels. This tradition is especially beneficial for energy planning, because most energy decisions require a long term perspective and attention to non-energy considerations such as safety, security, affordability, and environmental quality. In addition, energy planning allows the public and government to review how energy affects our lives, form a vision of a desirable energy future, and build a framework from which to undertake energy projects. Good energy planning should capture broad based citizen input that reflects the needs and values of the community, and in doing so, should raise the energy consciousness of citizens.

Coordinated energy planning at the national, New England, state, regional, and local levels of government is especially important, because certain policies or projects can be best implemented at certain levels. In addition, certain policies cannot succeed unless they are supported at multiple levels.

It is particularly important that transportation planning and decision making address energy issues. Transportation energy use represents the largest energy end use, and the fastest growing one, in Vermont. Furthermore, transportation infrastructure investments result in energy costs and impacts that are many times greater than the original investment.

National Government. There are many actions that can best be addressed on a national level or a large regional level. Smog and acid rain, for example, can occur hundreds of miles from the pollution source. Because of this, local efforts to reduce acid rain precursors may have no impact on a region's pollution problems. National actions involving standards and taxes also can eliminate competition between states that vie to offer the least protective measures to attract businesses. Finally, national actions can provide consistency of standards so that manufacturers do not have to meet standards that vary from state to state.

Environmental protection against energy-related emissions is one of the most important areas in which national action will continue to be needed, for the reasons listed above. A healthy environment and protection of human health everywhere are in the long term public interest of the nation. Similarly, a national energy taxation scheme that includes the full costs of energy in energy prices would provide long term energy affordability and efficient use of energy resources, an important national public interest. The economic impact of such an energy taxation strategy could be mitigated by reducing other tax burdens by an equal amount. (For a more detailed description of these ideas, see the Energy Taxation strategy, Chapter 4, Section I.H.) Finally, promoting renewable energy resources and energy efficiency at the national level, while reducing or discontinuing support of fossil fuels and nuclear energy, would have an enormous effect on similar energy strategies at more local levels across the country, and would begin to move the country toward a more sustainable energy future.

New England and Northeastern Organizations. Because New England and the Northeast have distinct regional characteristics and resources, energy planning at these levels can accomplish goals not possible at other levels. A few of New England's unique characteristics that impact energy planning, for instance, include the region's relative isolation from domestic petroleum markets, greater availability of fuelwood and higher use of wood energy, lower use of natural gas, higher electricity prices, and the presence of air pollution resulting from energy use both locally and in other U.S. regions. Planning that considers these and other regional differences can focus more clearly on appropriate policies. Several organizations are currently working on regional projects.

The New England Governors' Conference, Inc. (NEGC) is a regional non-profit organization whose Board of Directors is comprised of New England's six governors. NEGC addresses many issues, including energy. One of the most important energy projects NEGC has pursued in recent years is the Regional Energy Assessment Project (REAP), started in 1990 and partly funded by U.S. DOE. REAP was developed to provide an ongoing assessment of New England's energy situation, formulate policy directions for the region, and contribute to an integration of regional planning with the national energy planning process. The states and the NEGC assessed the planning needs and capabilities in the states and the region, and compiled, with public input, a listing of regional energy issues that need to be addressed. The states and the NEGC established such planning capability at both the NEGC's offices in Boston and in the state capitals (NEGC, 1996, i). This involved:

- developing and installing energy and economic modeling systems,
- calibrating these models to the state and regional situations,

- building an historical energy database,
- preparing an initial "base case" outlook for the years 1993-2010,
- testing the model by considering several scenarios on different energy policies, and
- releasing a summary report on key trends in New England's energy future.

With funding from U.S. EPA's Environmental Technology Unit, NEGC also completed the Restructuring & Environmentally Sustainable Technologies Project. This project assessed the possible impacts of electric industry restructuring on the development of environmentally sustainable technologies in the region, and makes specific recommendations, for both state and federal governments, on ways to promote and support these technologies For further information see *Sustainable Electricity for New England*, the R/EST Project report, by Tellus Institute.

Other recent energy-related activities of NEGC include a meeting between New England state environmental and public utility commissioners to discuss impacts of open access to electric power transmission; a study on the impacts of a competitive electric power marketplace on environmentally sustainable programs and technologies; a conference on clean air; the review of a proposal for a new natural gas pipeline from Canada; and a resolution on competition in electric power markets and the environment. As a part of NEGC's consideration of electric power competition, the Commission resolved to support development of enforceable, uniform standards for disclosing to consumers the price, fuels source, and environmental characteristics of their electricity purchases. As a part of this resolution, The Governors explicitly encouraged the New England Uniform Disclosure pilot project of the National Council on Competition in the Electric Industry to develop consensus across the region, so that, when retail choice is available, consumers will have the benefit of consistent, easily understandable information. The pilot is a forum for stakeholders--state regulators, advocates, power producers and marketers and utilities--to propose workable methods of uniform disclosure.

NEGC and the six New England states also recently sponsored the New England Transportation Initiative (NETI), an 18-month undertaking to recommend actions to guide transportation policy and support economic and environmental goals for the region. The final report, including a Plan of Cooperation, was completed in February, 1995. The Plan of Cooperation supports several types of actions that are also recommended in this Plan, including support of low emissions vehicles (LEVs), alternative fueled vehicles, travel demand management planning, growth management planning, telecommunications, and rail and bus oriented projects. (Travel demand management is similar to demand side management for electric utilities. See the strategy on Least Cost Transportation Planning, Chapter 4, Section II.A.). However, the Plan of Cooperation does not endorse a goal of reducing vehicle miles traveled, as recommended in this Plan, though it does advocate

> minimizing VMT growth in congested areas by reducing peak-period demand and providing transportation alternatives . . . [and pursuing] multi-modal capacity expansion (Cambridge Systematics, 1995, 2-3-2-13).

The Plan of Cooperation also does not address broad energy issues, such as increasing energy consumption, sustainable energy use, and the security problems of petroleum dependence (although it mentions the importance of moving toward alternative fueled vehicles). Addressing such problems and exploring more energy efficient policies would make future regional transportation planning efforts more effective.

The Coalition of Northeastern Governors (CONEG) is another regional non-profit organization, supported by a Policy Research Center. The Research Center studies regional issues, especially those related to economic and environmental conditions and resources of the Northeast, and encourages solutions to regional problems. The Energy Working Group of CONEG, of which the Department of Public Service's Commissioner is a member, has recently been focused on utility restructuring. CONEG, along with NEGC, recently gave input on the FERC Environmental Impact Statement regarding open access to the electric transmission system, arguing for strong mitigation efforts for any resulting negative environmental impacts. CONEG also is working on additional issues that involve energy use, such as regional biomass use (including biomass for alternative

transportation fuels), high speed rail, LIHEAP funding, source reduction, and transportation issues (CONEG, March-April 1996).

In general, New England and Northeastern organizations, initiatives, and planning groups could improve the region's energy situation and move toward a better energy future by focusing to a greater extent on reducing the region's dependence on petroleum, strengthening transportation planning that addresses energy issues, and supporting policies that internalize the full costs of energy in energy prices. The latter of these goals has been more fully discussed in many other places in this Plan; however, it is especially valuable to pursue this goal on regional and national levels because states which internalize energy costs differently compete for businesses and residents on unequal ground.

Department of Public Service. The role of the state in energy planning is outlined in Chapter 3. While much of the statewide energy planning is done by DPS, the Agencies of Transportation and Natural Resources also have planning functions which address or affect energy issues. In addition, all state agencies are required to prepare and adopt State Agency Plans to report on progress toward Act 200 planning goals, some of which are related to energy and energy efficiency.

Energy planning at DPS is likely to undergo changes in the near future as electric utility restructuring takes hold. (See the Competition and Restructuring in the Electric Utility Industry section in Chapter 3.) Because the details of a restructured electric utility environment are currently under discussion in Vermont, the exact form of the new environment and the state's planning function within it are not yet clear. In addition, with the number of uncertainties and steps remaining in the Public Service Board restructuring Docket and the subsequent legislation needed, the possibility that restructuring will be delayed or will not occur in Vermont cannot yet be ruled out. However, the general process for statewide planning is laid out in Vt. DPS, *Position Paper*, 1996, and *Restructuring the Electric Utility Industry*, 1996.

As outlined in the position paper, during the transition to a restructured industry, DPS will continue to monitor macroeconomic energy issues and develop appropriate planning mechanisms to respond to problems at the statewide level. Important issues include adequacy and reliability of electric power to meet present and future power needs of Vermont and New England, the price of electricity and its volatility, efficient and least cost electricity service, consumer education and protection, nuclear issues, market power issues, stranded cost issues, and the increased risk of additional pollution in a restructured marketplace.

After competitive forces have taken hold in Vermont's electricity market, DPS believes its planning efforts for the electric industry will refocus mostly on regulated company requirements, core demand side management (DSM) programs, energy policy, renewables development, energy emergency planning, and nuclear, consumer, and market power issues. In the restructured environment, distribution companies likely will continue to be regulated and will be required to continue least cost integrated planning for transmission and distribution and for distributed generation. State planning will be needed to support and guide this. In addition, statewide energy efficiency activities will continue in some form (possibly funded through a system benefits charge), and this will need a planning foundation. Supply planning likely will be transformed from its current process in the regulated environment. Generation, distribution, and retail companies in the restructured industry will perform their own planning and forecasting for future generation needs, investments, contracts, purchases, customer demand, etc. Some aspects of current supply planning probably will be replaced to some extent by requirements imposed on the market for environmental quality, diversification of resources, or other standards. For example, retail companies may be required to purchase a certain percentage of renewable resources, to provide energy efficiency programs, and/or to provide a program for low income customers. DPS is likely to continue to research and prepare statewide forecasts of energy needs and supplies, as well as analyses of prices and avoided costs for monitoring and policy-setting purposes. DPS may require access to companies' load, energy, and resource data for this work.

In addition, DPS is likely to continue to research and write the *Vermont Electric Plan*, the *Vermont Comprehensive Energy Plan*, and the *Vermont Telecommunications Plan*. Strategies for meeting statutory electric energy goals will still need to be addressed at a statewide level after the market has been restructured. While the *Electric Plan* will still define issues for the regulated companies that remain after restructuring (such as distribution companies), it is also likely to monitor statewide electricity use and recommend policy options that both meet statutory goals and address current and potential future problems with the restructured market. The *Comprehensive Energy Plan* currently provides policy ideas and supporting impact data to citizens, legislators, and others. Efforts that could improve the usefulness, import, and impact of the Plan include facilitating greater citizen participation at all stages of the process, educating citizens and elected officials about policies and their impacts, identifying parties interested in implementing the recommended policies as the Plan is being written, and putting in place a structure that will move forward implementation of the policies after the Plan is written. Finally, future editions of the *Telecommunications Plan* should continue to explore telecommunications policies that have the potential to reduce energy use.

DPS also should strengthen the support it gives to regional and town planning. This support could be provided in a number of ways, as resources permit. A planner at DPS could be designated as a liaison between the state and regions to actively participate with regions as they rewrite the energy sections of their regional plans, and to provide ideas, examples, and statistical information. DPS could also create model regional and town energy sections, and/or collect and distribute good energy sections from regional and town plans that already exist. As an incentive for regions and towns to create good energy sections, DPS could offer a prize to the region and town with the best energy section in their plan. The prize would be especially effective if it was in the form of a grant to be used to implement one of the energy goals in the region's or town's plan.

Finally, DPS should investigate ways to strengthen public input into the planning process. Options to be investigated could include using the Internet and other telecommunications technologies for education, promotion, and holding public hearings, expanding promotional materials about public input, and reviewing and suggesting improvements to the public input processes of regional planning commissions.

Agency of Transportation. Planning performed and projects undertaken by AOT have a strong influence on statewide energy use, due to the fact that 43% of Vermont's energy use occurs in the transportation sector. AOT planning and projects shape the ways in which we use energy for transportation, and transportation energy use seriously affects several of Vermont's energy goals, including sustainability, environmental quality, efficiency, security, and affordability (as outlined in Chapter 2). However, AOT's planning and decision making processes do not adequately address energy issues.

In 1994, AOT, the DPS, and ANR signed a Memorandum of Understanding outlining ways in which they would cooperate as agencies. This cooperative relationship was to include exchanging information about energy, environmental, and transportation issues, meeting periodically, sharing data and program options, co-sponsoring the development of data, analysis, and research projects, and providing opportunities for the others to review and comment on relevant plans. Although the Agencies and Department have worked together jointly on some projects, cooperation on other projects or topics has not been as successful.

Currently, cooperation is mostly restricted to a project-by-project basis and review of each other's plans, with little discussion occurring on more general issues.

Vermont's energy use situation could benefit greatly from stronger collaboration between the Agencies and Department and from resolution of policy approach differences. AOT's *Long Range Transportation Plan* (1995) rejects strategies that could decrease energy use and improve air emissions, such as reducing vehicle miles traveled and using least cost transportation planning (Vt. AOT, *Vermont's Long Range Transportation Plan*, 1995, 57, 139, 145-6). Such strategies are explored in this Plan because of their strong potential to move toward several of the state's energy goals. Currently, minimal progress towards Vermont's energy goals is being achieved in the transportation sector.[lii] The Memorandum of Understanding among AOT, DPS, and ANR provides an excellent avenue to work cooperatively toward policies that fulfill transportation needs while working toward energy goals and maintaining and improving environmental quality.

3. Policy: Public Education and Information

The Department of Public Service and other entities should maintain and improve programs and projects involving information for the general public, school-based education, and professional education.

The major components of this policy are:

- The Energy Efficiency Division of the DPS should update and expand its collection of free energy efficiency material on a regular basis and should expand ways to advertise its availability to the public, including availability through the Internet.

- DPS should improve its public outreach by holding brief seminars that teach practical energy conservation skills and knowledge, and by holding seminars for specific groups who need special types of energy knowledge.

- DPS should monitor, advocate for, and if necessary undertake a strong and impartial public education program during and after the state's transition to restructured electric and natural gas industries.

- As state agencies aided by the Clean State Council or DPS meet energy efficiency goals outlined in the Government Energy Use policy, they should develop the full education potential of their programs by publishing information about their accomplishments.

- The Vermont Energy Education Program should seek to expand the number of the Energy-Scientist-in-the-Classroom Residency Programs it offers to upper elementary and junior high classes, continue to hold and expand attendance at their teacher training courses, and should ensure that the teachers who attend their courses continue to have support and updated information.

- DPS should work with the Department of Education to update and revise the transportation energy issues in the high school driver's education curriculum.

- DPS should expand and promote more strongly its collection of school-based energy education materials.

- School libraries should ensure that they have a variety of recent books about energy issues, including the environmental and economic consequences of energy use.

- A government/industry partnership should be formed to promote and develop new energy efficiency

education programs for building trades professionals, create an information clearinghouse, and promote design competitions.

Rationale

Energy education and information is an essential component of a long term solution to the energy challenges faced by Vermont. Consumers, builders, businesses, public officials, and policy makers can make sound energy decisions only if they have accurate knowledge about energy sources and impacts. In addition, today's students will make better energy decisions as adults if energy education is introduced and reinforced at early ages and throughout their school experience.

Information for the General Public. Access to and promotion of energy information is important for consumers, businesses, public officials, and policy makers when they make energy decisions. It is especially important to ensure that people are better informed about the economic and environmental consequences of energy use and transportation energy use.

The Department of Public Service offers a number of resources to the public. DPS houses the largest, most up-to-date library in the state on energy issues, with more than 5,000 volumes. Topics covered include energy supply (all fuels), energy demand (including demand side management), engineering and operations, economics and demographics, environmental impacts, planning, codes and standards, rates and regulations, as well as serial publications (most from the federal government), NEPOOL publications, government publications (Vermont and other states), and many periodicals, catalogs, and other miscellaneous information. The library is open to the public as a reference library; holdings do not circulate, but may be used on-site or copied (for a small fee.)

In addition, the Energy Efficiency Division of DPS has a collection of information available for free to the public. These booklets and pamphlets, as well as the statewide plans and reports available to the public for free, are listed in Appendix 3. (Information available to the public from DPS can be made available in alternate formats for those who require it.) The public can address energy efficiency questions to the Energy Efficiency Division through an 800 number (1-800-642-3281). Efficiency experts of the Division also are available for speaking and other events.

DPS's promotion of the availability of the above resources has fluctuated over the years, due to funding, Departmental focus, and other factors. Some topics have received substantial attention, while others have not. For instance, the Energy Efficiency Division has actively promoted wood chip heating systems to schools in the past several years, and currently has many brochures and pamphlets about wood energy, two recent videos about wood chip gasification systems in Vermont, and experts who actively work on promoting wood energy. However, other energy issues have not received such focused attention and promotion from DPS. To improve this variability, the Energy Efficiency Division should update and expand its collection on a regular basis, and should develop ways to advertise its availability to the public.

DPS should also improve public outreach in the form of brief seminars (which would last from a few hours to few days) that would teach practical energy conservation skills and knowledge. Potential topics could include comparison shopping for energy efficient appliances or homes, energy efficient building and retrofit techniques, interior and exterior home maintenance, or more specific topics such as wood stoves and solar systems. Discussion of more general energy policy issues would also present opportunities to engage citizens on issues in controversy. Courses could be offered through a number of avenues, such as Community College one-day sessions, Church Street Center sessions (in Burlington), or sessions in conjunction with environmental or other organizations. DPS should also target seminars that address specific groups who need special types of energy knowledge. For example, legislators, regional planning commissions, town planning energy groups, public or private sector purchasing agents, and others could benefit from focused energy presentations from

DPS.

The restructuring of the electric industry and the likelihood of similar change in retail natural gas sales have brought forth another energy issue on which consumers will need to be well informed. (See Chapter 3 for a description of restructuring.) Retail gas sales will likely be competitive as well. Especially during the transition to a new market, impartial public education should be provided so that consumers can understand the changes taking place and make informed choices in a competitive market. Competition will be most effective if consumers seize the opportunity to make good decisions about new energy choices. The Department of Public Service should monitor, advocate for, and if necessary undertake a strong and fair public education program during and after the transition to a competitive market.

There is also education potential in this Plan's policy describing Government Energy Use in Buildings, Equipment, and Vehicles. (See Chapter 4, Section V.A.1.) As state agencies accomplish the energy efficiency goals described in this policy, they should develop the full education potential by publishing information about their programs and accomplishments. This can provide both education and encouragement for consumers and businesses to take similar actions.

School-Based Education. Elementary and secondary education about energy issues and choices is essential for raising new generations with a stronger energy awareness. Students who are exposed to energy issues early and repeatedly throughout their school lives will make better energy decisions as adults. It is especially important to teach students about energy conservation, renewable and sustainable energy sources, the environmental consequences of energy use, the problems with reliance on fossil fuels, and the problems with transportation energy use, because these issues will gain importance during their lifetimes.

Curricula that focus on energy and build energy issues into other disciplines are the cornerstone of school-based energy education. To supplement traditional curricula, the Vermont Energy Education Program (VEEP) recently began "Energy-Scientist-in-the-Classroom Residency Programs," in which an energy expert and the classroom teacher lead the class through hands-on, interdisciplinary activities related to energy. (See the text box on the Vermont Energy Education Program.) This curriculum model is an excellent one for teaching upper elementary and junior high students about the issues mentioned above. VEEP should seek to expand the number of the energy residency programs offered to Vermont classes, funded through school/industry partnerships. VEEP also has developed teacher training courses in energy issues (see below), through which energy curricula reach students. In addition, issues involving energy conservation, recycling, and renewable resources are taught through the environmental education curricula used in the state, including the Environmental Learning for the Future program, used in about 1/3 of Vermont's schools.

One area of curriculum development that deserves special attention is the high school driver's education course. Because transportation represents 43% of total delivered energy use in Vermont, it is important to educate new drivers about the problems with transportation energy use. Driver's education courses should teach students about the benefits of sharing cars, sharing rides, public transit, energy efficient vehicles, alternative fuel vehicles, the efficiency value of good vehicle maintenance, and the relationship between efficiency and vehicle speed. The Department of Public Service should work with the Department of Education to update and revise the high school driver's education curriculum so that these issues are included in a relevant way for students.

While energy curricula are essential, good teacher training is perhaps even more essential. Investments in teacher training have far-reaching effects over long time frames. VEEP has been successful in holding energy education college courses for teachers, with more than 160 teachers enrolled in their course since

- A VEEP college course held at Lyndon State College drew 58 educators who work with students in grades K-14. The educators participated in hands-on investigations about energy, its generation, and potential effects on our environment and economy. Between 1990-94, similar college courses drew 110 teachers from grades 2-8. Through these teacher courses, thousands of Vermont students subsequently have participated in energy education activities.

- The Energy-Scientist-in-the-Classroom Residency Program was designed and piloted in three schools in 1995. These residencies place an energy scientist in a classroom for 10 days over an extended period of time (mini-residencies involve five days during a concentrated period). The energy scientist, team-teaching with the classroom teacher, leads the class through hands-on activities involving sources and uses of energy, the movement of energy, energy conservation, and renewable, non-renewable, and sustainable energy sources. The residencies usually culminate with student teams designing, building, and testing working solar collector models outdoors.

- Two summer science institutes that educate teachers about electricity and associated environmental and economic impacts involved 20 schools and 36 participants in 1995.

- The Solar Sprint Workshop for middle school teachers, held in 1995, introduces participants to the workings of solar cars, building a solar car in the classroom, and running the Solar Sprint car race project.

- A new college course was developed, in collaboration with Lyndon State College and the St. Johnsbury School District. This course is a three-credit, graduate level, science methods course which incorporates some of the curriculum of the VEEP college course mentioned above (Vermont Energy Education Program, 1995).

1990. VEEP also runs summer science institutes that educate teachers about electricity and environmental and economic impacts, and has recently helped develop a graduate level, science methods course on energy. In addition, the Vermont Energy Efficient Construction Training Opportunities and Resources program (VECTOR) has trained vocational school teachers in the past; some of these teachers are likely still involved in energy teaching curricula. However, there is a need to follow-up with these and other teachers to ensure that they continue to have support and up-to-date materials. VEEP should ensure that the teachers who attend their courses continue to have such support, and should continue to hold and expand attendance at their teacher courses. Finally, the Vermont Institute for Science, Math, and Technology (VISMT) currently is applying for a grant that would be used to provide Internet training and technical support for educators, which would provide another avenue through which they could access energy information.

Resources available to teachers from the Department of Public Service include a collection of videos and slide shows, and many pamphlets, booklets, and other materials about various energy topics available for free. (A list of these materials is in Appendix 3.) *Energy Education Resources: Kindergarten through 12th Grade* by the U.S. Department of Energy and available from DPS, is a listing of energy education materials (many of them free) that teachers can request from different sources. DPS could improve its school education outreach by adding more school-based materials to its collection of information available, including samples of energy curricula. In addition, DPS should be more proactive in promoting such resources to teachers.

Finally, school libraries should ensure that they have a variety of recent books about energy issues, including the environmental and economic consequences of energy use. Many of the materials available for free from DPS would be good additions to secondary school libraries.

Professional Education. Educating Vermont's building trade professionals, similar to training teachers, has the potential for far-reaching effects. Improving building trade professionals' knowledge of the economic value of energy efficient building and explaining available technologies are critical to implementing many of the recommendations in this plan.

Training for building professionals currently occurs through a couple of avenues. The Department of Public Service participates in the Act 250 permitting process, since one of the permitting criteria regards energy efficient technology. (See the Chapter 3 text box on Act 250.) This permitting process is an educational tool because it teaches contractors and architects about energy efficient building and what measures are required to receive permits. The education they receive through this process has the potential to inform their other work in similar ways.

In addition, DPS gives a small grant to Energy Rated Homes of Vermont each year for training builders about energy efficient home building. Energy Rated Homes serves as a phone-in information clearinghouse for home builders, and assists about 150 builders and 100 homeowners annually (Richard Faesy, Energy Rated Homes of Vermont, phone conversation, June 1996).

There are also some projects which will or may occur in the future that will have education components for building professionals. A recent grant to the Chittenden County Regional Planning Commission will establish an information clearinghouse in Burlington about wood fired district heating projects. In addition, the Department of Public Service was part of a group that studied and recommended the adoption of statewide energy efficiency building standards during the 1996 Legislative Session. The Residential Building Energy Standards bill was passed in the 1997 session. With statutory building standards, there is good potential for receiving a federal grant to educate building trades instructors, contractors, and architects about the standard and energy efficient building techniques.

In spite of these efforts, there is a need for a more extensive, coordinated program to train building trades professionals. As outlined in the Buildings and Equipment section, a government/industry partnership should be formed to promote and develop new energy efficiency education programs for building trades professionals, create an information clearinghouse (*e.g.*, providing product information, technical assistance, etc.), and promote design competitions. The partnership would provide these services to the building design and construction communities, and to owners and operators of commercial and industrial buildings. Members of the partnership should include the Department of Public Service, other state agencies, utilities, energy service companies, non-profit organizations, and others. (See the policy in the Buildings and Equipment section for more details.)

ENDNOTES:

i. Carbon dioxide emissions per BTU from wood are slightly greater than coal, but when harvested sustainably, there are no net emissions.

ii. Not all wood burning appliances must be certified. Most conventional fireplaces, masonry stoves, furnaces, boilers, cookstoves, and some pellet-burning appliances are exempt from the regulation. These appliances may or may not have high efficiencies and low emission rates.

iii. Wood has no net greenhouse gas emissions when harvested sustainably. (See Chapter 4, Section I.A., the strategy to Promote the Sustainable Use of Wood Energy, and Chapter 3, Section II.E.8. for a discussion of this point.)

iv. Based on extrapolating solar insolation data from Burlington, VT of 1,173 BTU per square foot per day average and the assumption that 77% of Vermont lands are forested (Leigh Seddon, Solar Works, personal communication, June, 1996).

v. The Global Warming Potential (GWP) of a greenhouse gas is a comparison of its heat-trapping ability compared to that of carbon dioxide during a 100 year time frame. The GWP of one ton of methane is 24.5 times that of one ton of carbon dioxide (U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994*, 1995, ES-2). The original source of this value is Intergovernmental Panel on Climate Change (IPCC), *Radiative Forcing of Climate Change: The 1994 Report of the Scientific Assessment Working Group of IPCC: Summary of Policy Makers*, 1994. This is an update of the previously published value of 11 found in IPCC, *Climate Change: The Supplemental Report of the IPCC Scientific Assessment*, 1992. Due to timing of modeling, research, and publication, the GWP of 11 was used for calculating methane-carbon dioxide equivalents in this Plan. Other values cited in this Plan include 21 by the U.S Congress, Office of Technology Assessment, 1991, 55.

vi. The five landfills chosen for modeling include: C.V., Palisades, Waste USA (Casella's), Chittenden Solid Waste District, and Town of Randolph. Emissions of methane from these landfills were estimated by the Vt. Agency of Natural Resources using the Landfill Air Emissions Estimation Model, an EPA model (Vt. ANR, Doug Elliott, personal communication, 1996).

vii. Under a "business as usual" scenario, greenhouse gas emissions in 2015 are projected to be 3.5 million tons greater (37%) than in 1997. Slightly less than one-third of the growth (about 1 million tons) is due to the assumed replacement of electricity from nuclear power plants with power from natural gas combined-cycle plants. Approximately another one-third of the growth in emissions (1.2 million tons) is from projected growth in transportation, and the remaining one-third results from growth in the residential, commercial, and industrial sectors.

viii. FERC Order 888 is comparable to a series of FERC orders that promote competition in the natural gas industry.

ix. On the federal level, gas is taxed at $0.183 per gallon and diesel at $0.243 per gallon.

x. There are other sales tax exemptions that could apply to the sales tax on energy. Examples include

exemptions for state and municipal governments, non-profit organizations, and others found in 32 V.S.A. §9741, subdivision 34.

xi. While energy taxes are an excellent means to internalize unpriced energy costs, internalizing unpriced energy costs does not ensure that the revenue generated in all cases compensates those who bear the unpriced costs. In cases where the unpriced costs do not fall evenly on a society, or if they fall on other societies such as future generations, additional mechanisms are required to ensure that compensation is provided or that damage is prevented. For example, benzene emissions from service stations and automobiles may lead to cancer in some individuals. These individuals will not be justly compensated by, for example, a general reduction in income or payroll taxes. In this case, energy tax policy is one aspect of a total package aimed at meeting Vermont's energy goals. (See Chapter 4 policy regarding Gasoline Vapor Recovery.)

> Energy sustainability concerns are another area where energy taxes can be a significant part of, but not the whole solution. For global warming and resource depletion, the costs are primarily borne by future societies. Those who will suffer the costs will not receive the benefits of an energy tax that reduces current taxes. An additional mechanism is needed to ensure that future generations are compensated for lost opportunities due to current energy use.

xii. All dollar equivalents of foreign currency are calculated using the mid-month average exchange rate for the 12 months of 1995. Carbon taxes can be expressed in terms of dollars per ton of carbon or per ton of carbon dioxide. To convert from values expressed in tons of carbon dioxide to tons of carbon, multiply by 3.667.

xiii. LCTP is also referred to as integrated transportation planning (ITP), just as energy planning is referred to as least cost integrated planning (LCIP) or integrated resource planning (IRP).

xiv. "Level of Service" refers to an A-F ranking of roadways and intersections used to describe driver satisfaction with a number of factors that influence the degree of traffic congestion. These factors include speed and travel time, traffic interruption, freedom of maneuverability, safety, driving comfort, convenience, and delay (Wilbur Smith Associates, 1994, 3-51).

xv. Calculated assuming, very conservatively, that the average car has 4 seats and using 1.6 persons per vehicle (Wilbur Smith Associates, 1994, 3-65).

xvi. There are a number of sources to determine many of the costs mentioned in the text, including *The Costs of Transportation* by Apogee Research, Inc., *The Price of Mobility: Uncovering the Hidden Costs of Transportation* by P. Miller and J. Moffat, *Transportation Cost Survey* by Todd Litman, *Full Cost Pricing of Highways* by Lee, and *Applying Least Cost Planning to Puget Sound Regional Transportation, Phase I and II Reports* by Dick Nelson and Don Shakow.

xvii. Examples of similar studies in other cities and states or nationally include: Apogee Research, *The Costs of Transportation*, 1994; Baily, *Making the Car Pay Its Way*, 1992; Federal Railway Administration, *The Social Cost and Environmental Externalities of Transportation Systems*, 1993; Hanson, *Results of a Literature Survey and Summary of Findings: The Nature and Magnitude of Social Costs of Urban Roadway Use*, 1992; Lee, *Full Cost Pricing of Highways*, 1994; Litman, *Transportation Cost Survey*, 1992; MacKenzie, Dower, and Chen, *The Going Rate: What it Really Costs to Drive*, 1992; and Miller and Moffet, *The Price of Mobility: Uncovering the Hidden Costs of*

Transportation, 1993.

xviii. Ideally, the parking cash benefit should reflect the full cost of parking and would be much greater than $30 per month. Providing a cash benefit greater than that rate at area lots would shift state employees into those lots. Since the City of Montpelier currently charges $30 per month for parking spaces, if the rate were greater than $30, state employees could cash out their parking privileges with the state and purchase parking from the city for less money, shifting the state parking problem downtown.

xix. There are many ways to implement this program. For example, state lots could require daily window permits that could be purchased from vending machines with cash or "green tokens" (in this case the vouchers would be tokens) upon entering the lot. The tokens allow flexibility for employees who want to participate in the "cash out" program but who may need to drive occasionally.

xx. The *Montpelier Parking and Shuttle Study* was conducted in the fall of 1992 when the legislature was not in session, when the Days Inn lot (now the Capitol Plaza lot) provided available free parking because Days Inn was out of business, and when the Taylor Street lot was underutilized (development proposals have been made for this lot). Since then the parking situation in Montpelier has not improved.

xxi. Calculated amortizing costs over a 30 year lifetime, using $9,000 for capital costs, $0.5 millon per acre land costs, operation and maintenance cost of 3% of capital costs, and a 2.5% of fair market value tax figure (depreciating the value of the building taxes over 30 years).

xxii. This suggests that employer subsidized parking is wasteful because employees are not willing to pay as much as employers for parking spaces.

xxiii. If the value of the voucher is raised above $30 per month, it must be coordinated with changes in the cost of nearby lots.

xxiv. Since the difference between test results and actual mileage is predicted to increase in the future, new testing procedures that better reflect current driving conditions should be sought. While the current standards allow the relative comparison of different automobiles, which is sufficient for evaluating the costs and benefits of this proposal, an updated standard would ensure that the comparisons adequately reflect true driving conditions, and would therefore lead to additional savings as automakers seek to make vehicles more efficient in congestion and at higher speeds.

xxv. Air bags were invented in the 1950s and by the 1960s they had been proven effective in over two million miles of testing (Advocacy Institute, 2). They did not, however, achieve significant market penetration until 1990 when they were required by law. Legislation was also required to bring about energy efficiency savings: the U.S. Congress, Office of Technology Assessment concludes,

> Probably the most convincing evidence of the effectiveness of CAFE standards is the family of graphs of actual versus required levels of corporate fuel economy. These show that Ford, General Motors, and (to a lesser extent) Chrysler . . . increased their fleet fuel economy in virtual lockstep with the level required (U.S. Congress, 1994, 142).

xxvi. Calculations are based on sales data for Vermont from *Facts and Figures 1994* published by the American Automobile Association. Assumptions include: 120,000 mile lifetime of vehicles, an efficiency of 85% of the CAFE standard, a 1.1 MPG increase in the CAFE standard for cars each year for the 5 years reaching 33 MPG in 1995, and a 0.8 MPG increase each year for light trucks (an equivalent 20% increase in efficiency) reaching 24.5 in 1995. The total fuel use was then compared

to that of the average efficiency of vehicles sold (about 28.1 for automobiles and 21 for light trucks). The difference was 75 million gallons of fuel.

xxvii. The study, using a National Highway Traffic Safety Administration computer model and state and national data, includes medical, emergency, vocational rehabilitation, productivity, insurance administration, workplace, legal, and court costs.

xxviii. Calculated using data from the TAMS Engineers report (including the number of cars in Park-and-Ride lots and the average commute) and assuming 260 working days per year and an average fuel efficiency of 20 MPG.

xxix. Of particular concern for rail are the recent increases in weight limits on Vermont and national highways. Higher weight limits and exemptions up to 100,000 pounds for logging trucks shifts traffic better suited for rail (because of the heavy weight and damage caused to roadways) to trucks, which are less efficient (LS Transit Systems, 1993, 3-43, 48). Vermont state cost allocation studies have found that large vehicles do not pay their fair share for the damage they cause to roadways. One study recommends increasing fees for the heaviest three-axle single unit trucks and the heaviest five-or-more-axle combination trucks (Sydec, Inc., 1993, 1). The heaviest tractor-trailers on Vermont roads receive tax subsidies of between $1,788 and $5,900 because they do not pay their share of the damage costs. Longer trailer lengths are also a major concern. There are proposals to increase the permitted length from 48 feet to 53 feet.

xxx. 19 V.S.A. §2310. Pavement of highway shoulders

(a) It is the policy of the state to provide paved shoulders on major state highways with the intent to develop an integrated bicycle route system. This shall not apply to the interstate highway and certain limited access highways.

(b) Any construction, or reconstruction, including upgrading and resurfacing projects on these highways shall include paved shoulders unless the agency deems certain sections to be cost prohibitive.--Amended 1993, No. 61 §21, eff. June 3, 1993.

xxxi. The Vermonter passenger rail service recently acquired this capability.

xxxii. Purchase of Development Rights refers to the purchase by public and/or non-profit entities of land, usually farmland, for the purpose of restricting the use of the land to farming or other activities. When development rights are purchased, a conservation easement is placed on the land, while the property owner continues to farm or perform other activities to which all parties have agreed. In this way, farmers and property owners are compensated for the development value of the land while continuing to use it for agricultural or other purposes. A Transfer of Development Rights (TDR) program identifies areas of a town or region which are most suitable for higher-density development and designates them as "receiving zones." Similarly, open farm and forest lands that are desirable to preserve are identified and designated as "sending zones." Development rights on land in the sending zones are then "sold" to developers and "transferred" to land in the receiving zones. TDR thus allows development to be concentrated in more compact town and growth centers, protects open farm and forest lands from development, and allows landowners in sending zones to realize some financial gain on their property. According to some planners, for TDR to be successful, landowners in receiving zones must be required to purchase development rights from sending zones. In addition, TDR requires sufficient growth and development potential in the receiving zones to provide an incentive for developers (Arendt, 1994, 96, 142; Vt. Department of Agriculture, 1994, 23-6; Vt. ANR, *Vermont's Scenic Landscapes*, 1991, 30).

xxxiii. Not included in the total is a 2% premium tax that goes into the state general fund.

xxxiv. Expenditures are based on a 1994 intermediate-sized car, purchased and used for 6 years or 60,000 miles. Since depreciation and finance charges are the greatest fixed expenses, older vehicles will have lower fixed costs and higher maintenance costs.

xxxv. The cost of commercial interstate and commuter bus service is approximately $2.00 per mile (American Bus Association, personal communication, June, 1995) or $0.10 to $0.15 per passenger mile (depending on whether the bus is one-half or one-third full).

xxxvi. Since it is illegal to drive without insurance, people do not report that they are doing so. Police check for insurance when an accident occurs and so the figures for those uninsured are based on the percent of drivers involved in accidents who did not have insurance. It may be the case that those involved in accidents are representative of the population in general.

xxxvii. Drivers under the age of 25 have the highest rate of crash involvement of all age groups, and two out of three drivers involved in crashes are male. The likelihood of crashes also varies with where one lives, the type of vehicle one drives, and the amount and type of driving done. A large percentage of crashes can be traced to violations of motor vehicle laws. Between 1991 and 1993, drunk drivers caused 27.5% of all fatal crashes. Excessive speed, following other cars too closely, and failure to yield or stop are also common causes of accidents (Vt. Governors' Highway Safety Program, 1994, 76). (See Table 4.II.22 Seven Most Common Operator Causes of Crashes.)

xxxviii. Speeding, careless and negligent driving, and driving while under the influence are the three most frequent causes of fatal crashes (combined, they are responsible for 68% of fatal driver-caused crashes), and they also account for 30% of all driver-caused crashes. In addition, speeding and DUI are the two most frequent citations given to drivers involved in crashes (Vt. Governors' Highway Safety Program, 1994, 126). Interestingly, the next most frequent citation given to those involved in a crash is operating without insurance. This is a problem that pay-at-the-pump insurance eliminates.

xxxix. There are about 5,000 to 7,000 criminal motor vehicle related convictions each year. Drunk driving accounts for between 3,000 to 4,000 convictions; reckless or careless and negligent driving accounts for slightly less than 1,000 convictions (Vt. Governors' Highway Safety Program, 1994, 124-5). Other criminal violations such as operating without a license make up the remainder of the total. A $3,000 surcharge on an average of 6,000 drivers convicted of these criminal driving offenses would generate another $18 million dollars.

xl. Stage I vapor recovery devices already capture the vapor emissions that used to occur between tanker trucks and storage facilities such as the filling station's underground storage facilities.

xli. These figures equate to a public cost of automobile transportation of more than $1,000 per person, per year, even with most of the infrastructure already in place (Brown, *Vital Signs*, 1994, 88). One author reports that internalizing the $315 billion cost to society would require a $3.00 per gallon increase in the cost of fuel to cover the full cost of transportation (ECONorthwest, *Least-Cost Planning*,1995, B-4).

xlii. The problem of competition also applies to policies that shift fixed costs of transportation to marginal costs using motor fuels taxes such as those described in the following policy.

xliii. It may be necessary to internalize transportation costs over a number of years to minimize the impact on the individuals and businesses dependent on transportation subsidies and tax breaks.

xliv. In this way, this policy is similar to the shift of insurance costs to motor fuels taxes discussed in the

Pay-at-the-Pump Insurance policy under the Reduce VMT strategy.

xlv. The death rate is 97 times greater for cars than transit buses (Lowe, 1990, 15). For cost and efficiency, see Lowe, 14, the Reduce VMT Strategy, and Figure 4.II.9.

xlvi. If gasoline costs $1.20 per gallon, the marginal cost of a 20 MPG vehicle is $0.06 per mile. If gasoline was $3.00 per gallon (in increase of about $1.80), the same 20 MPG vehicle would cost $0.15 per mile, the equivalent of a public transit fare. More efficient vehicles or more passengers per vehicle would require a greater increase in gasoline prices before public transit was competitive with gasoline on a per mile basis.

xlvii. New vehicle estimates are based on fleets meeting the current CAFE standard of 27.5 MPG for cars and 20.5 MPG for light trucks. The actual mileage drivers achieve is approximately 15% less than the standard. The actual efficiency of the existing fleet is approximately 20 MPG. A 120,000 mile vehicle lifetime was also assumed.

xlviii. It is important to remember that the EPA combined figure is unadjusted, meaning it does not represent the actual mileage that can be expected. The figures used on automobile stickers, which are closer to what drivers can expect, are adjusted about 15% lower than the EPA combined figure. Therefore, the tax is on cars that regularly get about 19 MPG, not 22.5 MPG.

xlix. A possible exception to the expansion of the tax to light trucks is the case of 12 or 15 passenger vans with permanent seats. It would be counterproductive to try to capture external costs from vans that are used to decrease those external costs by increasing the passengers per vehicle.

l. A brief history of some of the education and incentive programs to increase the energy efficiency of residential structures is included in the *Vermont Twenty Year Electric Plan*, 1994, Appendix 4, 1-6.

li. "Oil overcharge funds" or "petroleum violation escrow" (PVE) funds are amounts provided to the states in settlement of law suits initiated by the federal government to restore to consumers, money overcharged by oil companies in the 1970s and 1980s.

lii. Some progress has been made in recent years, including improvements in vehicle safety and stabilization of some emissions in the statewide transportation sector. However, lack of progress toward energy goals is indicated by the facts that energy use has quickly increased in the transportation sector, that statewide vehicle miles traveled has dramatically increased, that transportation is the fastest growing statewide end use of energy, that federal vehicle efficiency standards have not improved, that statewide carbon dioxide emissions from transportation have overtaken carbon dioxide emissions from other sectors, that the Vermont Legislature recently rejected a strong vehicle inspection and maintenance program, and that no progress has been made in including more of the full costs of gasoline use into gasoline prices.