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Fueling Vermont's Future

Comprehensive Energy Plan
and
Greenhouse Gas Action Plan

Pursuant to 30 V.S.A. Sec. 202b

Volume 1 - Summary and Recommendations
July 1998

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CHAPTER 1 - INTRODUCTION

The earth belongs to the living, not to the dead. The will and power of man aspire with his life, by nature's law. . . The generations of men may be considered as bodies or corporations. Each generation has the usufruct of the earth during the period of its continuance. When it ceases to exist, the usufruct passses on the succeeding generation, free and unencumbered, and so on, successively, from one generation to another forever. We may consider each generation a distinct nation, with a right, by the will of its majority, to bind themselves, but none to bind the succeeding generation, more than the inhabitants of another country.

letter of Thomas Jefferson to John W. Eppes, June 24, 1813

. . .now, rather than distributing the wealth of the present, we are stealing the wealth of the future. . .

Paul Hawken, *The Ecology of Commerce*, 1994, 5.

Include tomorrow's child in every decision you make.

Ray Anderson, Co-Chair of the President's Council on Economic Development

From the time of Thomas Jefferson, individuals in both public and private life have been creating visions and agendas to guide decision-makers as they address issues related to business and economic activity, the environment, energy and other natural resources. Jefferson uses the authority of natural law to support his belief that each generation is entitled to use a portion of the earth's resources for a limited time, while no generation has authority to bind or encumber these natural resources for future generations who are similarly entitled during their respective lives. Hawken's timely comment on recent generations' excessive use of resources and the legacy of environmental damage and depletion we are leaving is alarming. At a public forum sponsored by the Partnership of Environmental Technology and Science, Inc., Ray Anderson offered a vision for a restorative economy that includes future generations in current decisions and integrates the environment and the economy. With new environmental technologies and serious, creative effort, commerce, and human activities can be re-designed to end waste and emissions so that nothing is made that requires future vigilance or government regulation.

This Plan, *Fueling Vermont's Future: Comprehensive Energy Plan and Greenhouse Gas Action Plan*, lays out a vision for meeting Vermont's energy needs in a manner that draws on new technologies, renewable resources, sustainable development, and increased energy efficiency gains. This Plan is an update and revision of previous Department of Public Service (DPS) efforts. In 1989, Governor Madeleine Kunin first called for a comprehensive review of all forms of energy used in Vermont and a plan to modify that energy use to improve environmental quality, affordability, and renewability. The 1991 *Vermont Comprehensive Energy Plan*, the first Vermont plan to address all forms of energy use, was the outcome of that mandate. The Vermont Legislature subsequently established the requirement for a periodically updated state energy plan (30 V.S.A. §202b). Preparing for Vermont's energy needs is closely related to efforts to control Vermont's greenhouse gas emissions, which come primarily from energy use. This document also serves as the state's *Greenhouse Gas Action Plan*, presenting policies that can reduce greenhouse gas emissions from energy related and non-energy related source categories. (Estimates of Vermont's 1990 greenhouse gas emissions were prepared in 1994 in accordance with the EPA *States Workbook*.) Policies in this Plan that are assessed using computer modeling are evaluated on the basis of their impact on sustainability, energy efficiency, security, economic vitality, and environmental soundness. Policies that promote capturing methane emissions from landfills and farm waste are, despite their small energy impacts, particularly important in reducing non-energy related emissions.

Vermont Department of Public Service, with input from the Agency of Natural Resources and the Agency of Transportation, the Public Service Board, and independent experts prepared this Plan. Public input was solicited when this project began, and public responses to the September 1997 draft have been taken into account in this final version. Output from an integrated pair of computer models, REMI and Energy 2020, also provided important input to the Plan.

What is *Fueling Vermont's Future* All About?

This is a resource document for citizens and policy makers. Volumes 1 and 2 of this Plan both follow the organization described below. Volume 1 is a summarized version, with selected tables and figures. In Volume 1, Chapter 4, specific recommendations follow most of the policies. Volume 2 is unabridged, it includes a full set of tables and figures, although Chapter 4 does not have numbered recommendations as appear in Volume 1. Chapter 5, discussion of a set of policies called the "composite case," appears only in Volume 2. Appendices 2 - 5 appear only in Volume 2.

Chapter 2 - Energy Use and Human Well-Being: Energy Goals for Vermont's Future focuses on defining and discussing the nine energy goals that are part of Vermont's state energy policy. State policy provides that energy supply and energy use should be safe, adequate, reliable, secure, sustainable, environmentally sound, efficient, and affordable, and should support economic vitality.

Chapter 3 - Vermont's Energy Use: Past, Present, and Future is divided into three major sections:

Section I. HISTORY AND BACKGROUND begins with a history of Vermont's energy use, tracing the major changes in fuel sources and uses from the time of the Native Americans to the present. Next, recent energy planning efforts and legislation on the international, national, and state levels are outlined, and the state's role in energy planning is described.

Section II. CURRENT ENERGY USE describes and graphically illustrates Vermont's recent and current energy use. Energy use is analyzed among sectors, end uses, and fuel sources, with use among fuel sources receiving the most extensive analysis. Each fuel source used in Vermont is considered individually, with accompanying descriptions of future trends and issues associated with the fuel. The state's electricity use is discussed by considering electricity as a single fuel and also by investigating the individual fuels that provide electric power. The section ends with an exploration of energy sources and technologies that are not extensively used now, but are likely to be used more in the future.

Section III. FUTURE ENERGY USE presents a base case forecast for energy use in Vermont through 2015.[1] This base case forecast represents a "business as usual" scenario, assuming that current trends continue and no changes occur in state and national energy policy. The primary purpose of the base case forecast is to serve as a comparison for impacts of various policies examined in Chapters 4 and 5, although it also illustrates well the 20 year impact of current trends. Economic, demographic, and energy use projections for Vermont are presented in this section.

Chapter 4 - Energy Options for Vermont: Policy Analyses is the heart of the Plan, focusing on specific policies that meet all or some of the state's energy and environmental goals. The analysis of many policies relies on a forecast model that projects the impacts of the policies through 2020. In Volume 1, most policies have recommended actions. In Volume 2, each modeled policy is presented with several tables and graphs that show its impacts in contrast to the base case forecast.

Chapter 4 is divided into five major policy sections:

Section I. ENERGY SOURCES AND SUPPLY outlines policies regarding wood, wind, solar, hydroelectric, and methane energy sources, as well as traditional fuel sources. In addition, policies are proposed that are related to the production and distribution of energy, competition in the electric industry, and using energy taxation to meet Vermont's energy goals.

Section II. TRANSPORTATION proposes policies that would implement least cost planning for transportation, increase the efficiency of vehicles, reduce vehicle miles traveled, reduce transportation-related emissions, and internalize the costs of transportation more fully through transportation energy taxation.

Section III. BUILDINGS AND EQUIPMENT contains the policies that seek to improve energy use in both new and existing homes, commercial buildings, and industrial facilities.

Section IV. AFFORDABILITY focuses on policies that can make energy use more efficient in low income housing. Affordability issues for all consumers are explored in other sections of the Plan as well, including the transportation section and the taxation subsections. A policy in this section proposes establishing a statewide affordability program to take effect when Vemont initiates retail competition.

Section V. GOVERNMENT ENERGY USE AND ENERGY POLICY proposes policies to improve government's energy use in buildings, equipment, and vehicles; government energy planning; and public education and information about energy use.

Chapter 5 - Charting Vermont's Energy Future: The Composite Policy Case (Volume 2 only) presents a scenario for energy use in Vermont through 2020, using a set of policies selected from the inventory modeled in Chapter 4. Policies in the composite case are modeled as though they were implemented together to illustrate their combined impacts. Impacts of this composite policy case are described, graphically illustrated, and compared to impacts of the base case scenario. In conclusion, a few areas are identified that can produce the greatest impacts toward meeting our energy and environmental goals:

- Improving transportation energy use;
- Internalizing energy costs and improving economic efficiency; and
- Increasing the use of renewable energy sources.

Highlights from Research and Policy Modeling

- Dynamic impact modeling of a set of selected policies (the composite policy case) shows that compared to the "business as usual" base case forecast, total energy use could decrease 16.2% and renewable energy use could increase 38.7% cumulatively through 2020, while greenhouse gas emissions could decrease by 53.3 million CO_2 equivalent tons or 21.4%. In addition, employment could improve by 100,000 job-years or 1.0% cumulatively through 2020 compared to the base case. (See Chapter 3 for a discussion of the base case and Chapter 5 for a full discussion of the composite policy case.)

- Transportation is the largest energy end use in Vermont, accounting for about 44% of our total energy use in 1995. The transportation sector offers the single greatest opportunity for energy savings, reduced emissions, and decreased reliance on oil. Under the composite policy case, transportation energy use could be cut by 29.8% cumulatively through 2020 compared to the base case projections.

- The marketplace operates inefficiently in one critical aspect with regard to energy prices. Many energy costs are not reflected in energy prices, resulting in inefficient choices by consumers. Projections for future energy use suggest that between 1997 and 2020 at least $19.5 billion in costs to society due to emissions from energy use will not be included in the price of energy in Vermont. (The value for air emissions costs through 2020 was developed as part of the base case forecast.) Energy costs that are more fully reflected in energy prices can make our energy use more efficient and ensure that polluters pay their fair share.

- Opportunities to replace non-renewable energy sources with renewable sources should not be missed. This is especially true when new energy sources are needed as a result of increased demand, or when old power plants are retired. Expiration of Vermont Yankee nuclear station's license in 2012 offers a rare opportunity to substantially increase our use of renewables and avoid increasing greenhouse gas emission levels.

- With implementation of policies selected for the composite case, cumulative acid rain precursors and ground level ozone precursors could be significantly reduced (by 24.1% and 29.9% respectively) through 2020 compared to base case projections.

- Greenhouse gas emissions in the state are projected to grow significantly over 1990 levels. Strong policies at the state, national, and international levels are needed if we are to control these emissions. The projected average annual growth rate for greenhouse gases between 1995-2020 can be reduced from 1.65% under the base case to 0.48% under the composite policy case.

Appendices with Supporting Information

Appendix 1. Abbreviations list and glossary.
Appendix 2. Summary of selected Vermont statutes related to energy planning efforts
Appendix 3. Energy information available to the public from Vermont Department of Public Service
Appendix 4. Energy planning by state agencies, Regional Planning Commissions and towns
Appendix 5. Detailed data tables for modeled policies in Chapters 4 and 5
Appendix 6. Vermont greenhouse gas emissions from non-energy and energy sources

ENDNOTES:

1. Chapter 3 presents the base case forecast through 2015, but the forecast was modeled through 2020. Cumulative impacts of the base case forecast through 2020 can be found in the tables in Appendix 5.

CHAPTER 2 - ENERGY USE AND HUMAN WELL-BEING: ENERGY GOALS FOR VERMONT'S FUTURE

I. PLANNING FOR VERMONT'S ENERGY GOALS

Good planning provides the structure that makes it easier for individuals, businesses, and the government to choose and do those things that support human well-being. Energy use furthers well-being, but it also can detract from well-being by producing negative health impacts, by shifting costs to future generations, or through other impacts. Good planning by individuals, businesses, and government can provide a structure for advancing society's decisions on how much and what kind of energy use best advances our well-being.

Limited natural resources, a growing world population, and growing environmental impacts are changing and will continue to change our way of life. We can no longer ignore the "side effects" of our energy choices; instead, we must strive to use energy wisely. Planning can help us do this by identifying and outlining ways to save energy and use it more efficiently.

The U.S. and other developed countries have 25% of the global population, but consume 75% of the energy used worldwide. The U.S. has only 5% of the world population, but creates 25% of global carbon dioxide emissions yearly, more than any other nation (U.S. DOE, *Energy: Our Future is Today*, 1994).

Vermont can play an important role in leading the U.S. toward a sustainable and environmentally sound energy future. Vermont's Legislature has made an important contribution to our statewide energy vision by writing into state law a number of goals that will guide future energy policy (30 V.S.A. §§202, 202a, and others; see Volume 2 Appendix 2). These policy goals direct the state to meet its energy needs in a manner that is: safe, adequate, reliable, secure, sustainable, environmentally sound, efficient, and affordable, while ensuring economic vitality.

A. Safety

Safe and healthy energy sources are those which do not harm people or put them in danger. Most energy sources entail some safety risks when they are acquired or used. Vermont's goal is to minimize those safety risks and move toward a safer energy supply.

Air pollutants are some of the biggest safety risks from energy use. In Vermont, most air pollution emissions come directly or indirectly from energy use. Airborne contaminants such as carbon monoxide, particulate matter, toxic metals and chemicals, and smog precursors such as nitrogen oxides and volatile organic compounds are released when we burn fossil fuels. Vermont's local air emissions mainly come from boilers, small, dispersed sources such as motor vehicles and home heating, and some manufacturing processes. The state's emissions from electric generation plants are from a few local sources, but are mostly from out-of-state plants. Some of these emissions, such as sulfur oxides emissions from coal plants, have significant impacts on the state.

Three serious air pollutants in Vermont are ozone, particulate matter, and toxic chemicals. Motor vehicles and related sources account for between 65%-72% of in-state emissions of ozone precursors (Vt. ANR, *Air Pollution from Motor Vehicles in Vt.*). Exposure to elevated levels of ozone causes eye and respiratory ailments and aggravates existing respiratory diseases such as asthma. Woodburning accounted for an estimated 75% of combustion particulate matter emissions in Vermont in 1990 (Vt. Agency of Environmental Conservation, *Vt. State Acid Rain*, 1987; and 1990 information in Vt. ANR's Air Quality Division's database for fuel combustion particulate matter emissions). Particulate pollution causes respiratory damage and can limit the activity of people with respiratory diseases.

Indoor air pollution has become another important safety hazard in recent years. Although energy use does not always cause indoor air pollution, making buildings and houses more airtight and energy efficient demands greater vigilance to control indoor air pollution. As Vermont pursues its goal of energy efficiency in buildings and homes, we must also take measures that simultaneously reduce indoor air pollution.

Nuclear energy development and use raise safety concerns from the radioactivity created by nuclear power plant operation. Exposure to high levels of radiation can cause many acute or chronic illnesses. Radiation exposure from nuclear energy can occur in a number of ways. Workers at certain stages in the nuclear fuel cycle risk radiation exposure. Another potential source of radiation exposure is nuclear accidents. The types of nuclear accidents that have been analyzed have a very low probability of occurrence in U.S.-designed plants when they are maintained and operated properly, but such accidents could have serious or even catastrophic consequences if they were to occur.

Radioactive waste products could also be a source of radiation exposure. High-level radioactive waste consists of spent nuclear fuel which remains radioactive for thousands of years, and will thus need to be carefully managed for hundreds of generations. Disposal or long term management of high-level radioactive waste is legally the responsibility of the federal government. However, great uncertainty exists regarding the costs, timing, and safety of the ultimate disposal of high-level radioactive waste. Nuclear energy also produces low-level radioactive waste in the form of contaminated metals, filters, resins, and other materials used at nuclear plants. Most low-level radioactive waste decays to safe levels within 100 years. Nuclear safety issues will continue to confront the state due to the presence of Vermont Yankee Nuclear Plant in Vernon and Vermont's use of nuclear energy from plants in other New England states.

Safety is the most basic element of our well-being. It is the responsibility of those who oversee all activities related to energy production and use, including government, electric utilities, energy transmission and transport companies, and each individual who uses energy.

B. Adequacy

An adequate energy supply is one that meets the energy needs of Vermont's residents and businesses, both now and in the future as our population and economy grow. The adequacy of our energy supply depends on how much energy we need. Energy, however, is not used or needed for its own sake. Energy use is important because it allows Vermonters to do the activities that they consider necessary, pleasurable, or meaningful. An adequate energy supply provides the energy necessary for our well-being.

In order to have an adequate energy supply, we do not necessarily need more energy, even if our population and economy grow. More efficient energy use can allow us to meet our needs with less energy, enabling the freed up resources to meet other needs. The goal of an adequate energy supply is really the goal of adequate home and business heating, adequate lighting, adequate transportation, and all the other goods and services that energy makes possible.

C. Reliability

Reliable energy means that consumers experience minimal interruptions in energy supply and minimal impairments in quality. Any time the demand for energy outruns the available supply, reliability is compromised. This can occur, when the energy supply is interrupted during an electric power outage or a cutoff of foreign oil. It can also occur when storage facilities, transmission capacities, and transportation capacities are not large enough or robust enough to meet the energy demand.

Quality is another important consideration in judging the reliability of an energy source. Automobile travel requires not only an uninterrupted supply of gasoline, but gasoline free from impurities such as water or dirt. Modern electronic equipment and motors are even more sensitive to problems of quality. Brownouts (sustained voltage reductions), fluctuations in voltage, and interference can damage or negatively affect the performance of such equipment. The more dependent we are on electricity or other forms of energy to provide the things that enhance our well being, the more important energy reliability becomes.

D. Security

A secure energy supply is one that will remain safe, adequate, and reliable into the future, continuing to ensure human well-being. A secure energy supply leaves us confident that our energy needs will continue to be met, even though energy needs and availability cannot be predicted precisely.

One of the best ways to ensure our confidence in a safe, adequate, and reliable energy future is to maintain a diverse energy supply. Over the long term, a diverse supply gives more options and can most easily be adjusted as circumstances change. In addition to maintaining a diverse mix of energy sources, a secure electric energy supply should include diversity in operating characteristics and the length of supply contracts. Cost effective energy efficiency investments are another important part of a diverse energy mix because they provide security and flexibility by replacing the need to acquire new energy sources. In addition, efficiency improvements lead to less energy demand, and therefore a reduced vulnerability to energy shortage.

We can increase security by depending more on local, decentralized energy resources. Decreasing our country's current reliance on foreign oil would increase our national energy security. The U.S. purchases about 50% of its oil from other nations, some of which are politically unstable. Our oil dependence is projected to increase in the future because U.S. sources of inexpensive oil are declining.

In a similar manner, all of the oil used in Vermont and New England is imported, whether from overseas or from elsewhere in North America and the U.S. Dollars would stay in Vermont and create new jobs here if the state took more advantage of local energy sources and efficiency options. In the long run Vermonters' future will be more secure if our energy supply enhances the statewide economy; in this way we ensure future jobs and economic stimulation. In addition to the economic advantages, a localized energy supply system can provide more flexibility, diversity, local citizen involvement, and security than a highly centralized system.

Assessing the security of Vermont's energy sources also means looking at our reliance on nuclear power. While the operating performance of nuclear plants is improving, a number of problems preclude long term reliance on nuclear energy beyond current nuclear plant licenses. Uncertainties over radioactive waste disposal and increasing costs of maintaining aging equipment, along with inherent safety concerns, have stopped nuclear plant construction. No nuclear plant has been relicensed to operate beyond its original 40-year license, but finding replacements for all baseload nuclear production as licenses expire will be a challenge for the electric industry and the regulatory community.

There is progress toward diversification and security as new, efficient, natural gas combined cycle generation is planned for New England's electricity, using gas from the Gulf Coast, Western Canada, and in the near future, Nova Scotia. Natural gas serves well in the transition from traditional fossil fuels as we build greater diversification and reliance on local, decentralized renewable sources and make progress toward a sustainable and environmentally sound energy future.

The Full Cost of Energy Use

Currently, individuals who use energy usually do not bear all the costs associated with that energy use. Instead, some of those costs are shifted onto other members of society, future generations, and the environment. This occurs because consumers usually pay for the cash production and distribution costs of using energy, but do not pay directly for other costs of using energy. These other costs include the indirect consequences of energy use that are or eventually will be borne by someone. Because these costs are borne by people who are outside or "external" to the contract between the energy provider and the energy user, they are called external costs. Examples of external costs or impacts include the human health costs associated with air pollution, with uranium and coal mining, and with radioactive nuclear power accidents; military expenditures for protecting foreign oil interests; local job losses or other negative economic effects due to switching from a local energy source to a non-local one; the displacement of communities due to building hydroelectric dams and flooding tracts of land; crop losses from air and groundwater pollution; damage to buildings and other structures due to acid rain from sulfur dioxide and nitrogen oxides emissions; mercury and lead contamination of lakes and fish; and perhaps one of the riskiest and most unknown external costs, the unknown climate change effects from placing carbon dioxide into the atmosphere by burning fossil fuels.

The failure of markets to include external costs in the prices of energy distorts the choices of policy-makers and consumers. If the full cost of energy use were included in prices, less energy and cleaner energy would be consumed, with less harm to present and future generations and the environment, and more savings in labor, capital investment, and present and future health and environmental costs. Market forces would ensure that cleaner energy sources with less associated costs to society would eventually displace more expensive and dirtier fuels. The advantages of renewable energy sources would become more obvious as these sources became more affordable compared to other sources.

External costs can be "internalized" into the prices of energy in several ways, including through taxes, regulations on emissions or other consequences of energy use, and efficiency standards on appliances, equipment, or buildings. (See Chapter 3 for more on the magnitude of external costs and Chapter 4 for policies to address them.)

E. Sustainability

A sustainable energy supply meets today's energy needs without compromising the ability of future generations to meet their needs or shifting the costs of current energy use to future generations. Sustainable energy does not increase options for the present generation by jeopardizing options for or transferring the costs to future generations. Instead, sustainable energy use is economically, environmentally, and socially viable on a long term basis.

To ensure that resource use is sustainable, it is not sufficient that the rate of discovery of resources is greater than the rate of use of those resources. There are a number of other important factors that determine whether our consumption of resources is sustainable. These factors include how much of a given resource exists, how long it needs to last, how fast it is consumed, whether or not it is renewable, whether other resources could replace it if it is depleted, and whether the consequences of using it affect the sustainability of other resources. We can draw several broad conclusions about sustainability.

- First, in order to achieve more sustainable energy use, we need to decrease our dependence on fossil fuels and increase our dependence on renewable resources such as wind, solar, hydro, wood, and others.

Renewable resources are not environmentally neutral, but when used sustainably, they do not create impacts on the environment that are inconsistent with continued human use.

- Second, in order not to pass the burden of our energy use on to future generations, we need to ensure that energy choices and prices reflect the full cost of energy use. In this way, external costs will not be borne by people who are not yet born. External costs subsidize the unsustainable use of energy. People making energy decisions in the marketplace would use energy less wastefully and in a less costly manner if they paid the full cost of energy use themselves. (See text box on The Full Cost of Energy.)

- Third, a sustainable energy supply that relies on renewables and incorporates the full costs of energy acquisition and use is possible only if energy efficiency is vastly improved. Future energy sources, including renewables, are not likely to be as cheap as oil and other fossil fuels have been. Thus, efficiency is important to keep energy prices affordable. If we improve efficiency, we will not need to sacrifice the benefits of energy use to achieve sustainability. (See Chapter 3, Section II, G. Potential Energy Sources and Technologies for the Future.)

To make a sustainable energy supply work, we must take a broader, more long term view than has been taken in the past. Sustainability focuses on the basic needs and well-being of every person in every community far into the future rather than on only some individuals' current choices. For sustainability to be successful, a global, long term, community-wide ethic and set of values must be adopted.

F. Environmental Soundness

An environmentally sound energy supply is one that avoids or minimizes environmental degradation. All forms of energy production and use have some negative effects on the environment. An environmentally sound energy supply is one that minimizes those negative effects through all stages of production and use while remaining consistent with Vermont's other energy goals.

In planning its energy future, Vermont needs to consider regional and global costs and risks to the environment as well as local ones. Ultimately, problems like global warming and acid rain can only be solved through cooperative national and international action, but many of the key adjustments will have to be made at the state and local levels. Because Vermont is affected by out-of-state environmental pollution (for example, acid rain and ozone), we have a strong incentive to lead the way in developing energy policies which properly account for environmental risks.

Energy production and use cause many environmental costs and risks. The categories below represent some of the most important potential environmental problems that Vermont should consider carefully in its energy planning.

Global Climate Change. The potential of global climate change continues to be one of the most threatening, long-term, high-risk problems caused by energy use. (See text box on What is Global Climate Change?) Unfortunately, many of the effects of global climate change are still unknown. They are likely to remain unknown until it is too late to mount effective mitigation strategies if they are harmful. Some scientists now believe that environmental change to the global system may not occur gradually, but instead, change may occur with little warning in a more sudden manner.

Producing and using energy accounted for 89% of U.S. greenhouse gas emissions in 1990. An average American puts nearly six tons of carbon dioxide emissions into the atmosphere annually from energy use, the largest amount of any industrial country (Shapiro, 1992, 142-3). The main sources of those greenhouse gas emissions are fossil fuels, which release carbon dioxide and nitrous oxide into the

What is Global Climate Change?

Global climate change or global warming refers to the potential warming of the earth and the accompanying climate changes caused by "the greenhouse effect." The greenhouse effect occurs when gases such as water vapor, carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (CFCs) trap and absorb heat in the earth's atmosphere that otherwise would have escaped into space. These gases act as the glass in a greenhouse does, allowing sunlight into the greenhouse but trapping some of the heat that normally would radiate away, thereby warming the greenhouse.

Except for CFCs, greenhouse gases are naturally occurring and have helped make our planet a warm and habitable environment. However, human-caused activities have substantially increased the levels of greenhouse gases since the Industrial Age. The Intergovernmental Panel on Climate Change (IPCC), a working group of the world's top climate scientists, concluded in a 1995 draft report that the observed increase in global mean temperature of 0.3-0.6 degrees Celsius over the last century is "unlikely to be entirely due to natural causes" and that a "pattern of climatic response to human activities is identifiable in the climatological record" (IPCC, 1995, cited in Brown, *State of the World*, 1996). Other evidence that the global climate system is already changing is mounting. Recent developments and research, such as the breaking off of a large part of the southern polar ice cap, the warming of Siberia, extreme winter weather in northern Europe, the recession of glaciers, rising sea levels (measured by satellite radar), and a measured shift in the timing of seasons all point to the conclusion that changes in the atmospheric chemistry are becoming recognizable (Brown, 1996, 23).

The IPCC projects that the global mean temperature will increase by 0.8-3.5 degrees Celsius by 2100 if current growth trends continue and if no climate change policies are enacted. These increases project changes more rapid than any experienced in the last 10,000 years. Global warming of this magnitude and rate would substantially alter the earth's climate and produce unpredictable effects in local temperature ranges, precipitation patterns, sea level, and the incidence of extreme weather events such

atmosphere. Among the fossil fuels, coal produces more greenhouse gases per unit of energy than oil or gasoline. Natural gas produces less carbon dioxide per unit than either coal or oil. Solar power, wind power, hydro power, nuclear power and, of course, energy conservation do not significantly contribute to global warming.

Fuelwood and other sources of biomass release carbon dioxide into the atmosphere like other fuels, but these emissions do not come from "fossil carbon." Fossil carbon is the carbon stored in fossil fuels that has been removed from the atmospheric carbon cycle and stored deep within the earth for tens of thousands of years. The carbon dioxide released from biomass sources, by contrast, comes from carbon that is already a part of the atmospheric carbon cycle. Furthermore, if biomass resources are used in a sustainable manner, their emissions of carbon dioxide are less than or equal to the carbon dioxide taken in by new biomass growth, and their use eliminates the fossil carbon emissions from the fossil sources they replace. Therefore, sustainable use of biomass for energy affects the global climate positively, not negatively. Currently, however, wood resources often are not used sustainably, and as a result, deforestation greatly contributes to greenhouse gas emissions on a global scale. Woodlands of the eastern U.S. are one of only four places in the world where more wood is growing than is being cut; all other forests are being unsustainably consumed faster than they can regenerate (Morgan, 1994, 35).

Acid Precipitation. A serious environmental risk for Vermont is the threat of damage to the state's lakes, streams, and forests from acid rain and snow. Vermont's precipitation is, on average, always

What is Global Climate Change? (continued)

as floods, droughts, fires, and heat outbreaks. Climate change could drastically affect agriculture and forestry, coastal communities, water resources, urban infrastructure, recreational options, and many other aspects of life and society. In some parts of the world, including Bangladesh, Egypt, and various Pacific Island nations, most people live and grow food within just a few meters of sea level. Risks from global warming are very high in these regions because of the possibility of melting ice and snow from the polar ice caps, which would raise the level of our oceans. The risk for natural ecosystems is also great, because many species would likely have difficulty adapting to rapid change. Heavy costs would be incurred by future generations to cope with such a quickly changing climate. The IPCC draft report cited above concludes that "projected changes in climate are likely to result in a wide range of human health impacts, most of them adverse, and many of which would reduce life expectancy."

Our understanding of climate systems is not sufficient to provide detailed local predictions of the effects of global warming. However, climate modelers generally agree that in northern locations such as Vermont, significantly warmer winters would be likely (U.S. Congress, OTA, 1991, 51). There is considerable uncertainty about changes in rainfall patterns, but the prospect of reduced water availability must be considered. Other regional resources that are vulnerable to changes in temperature and precipitation include the state's forests, agriculture, wildlife, and recreation opportunities.

There is great danger in waiting for conclusive evidence about the exact timing and effects of global climate change, because greenhouse gases in the atmosphere have very long lifetimes (120 years for carbon dioxide, 132 years for nitrous oxide). The cumulative effects of these gases over time could commit the earth to substantial changes that could take centuries to reverse (U.S. EPA, 1992, ix). Enacting effective greenhouse gas reduction policies immediately is essential to avoid this threat. (For more about global climate change issues, in Volume 2 see Chapter 3, Section I.B Recent Planning Efforts and Legislation, and Appendix 6 - Greenhouse Gas Emissions from Non-Energy Sources.)

slightly acidic; so acid precipitation is a greater problem in Vermont and the Northeast region compared to many other parts of the country.

Air Pollution. In Vermont, most air pollution emissions result directly or indirectly from energy use, as discussed above. On a per-capita basis, Vermont's emissions of the major air pollutants are similar to other states. Because of their dispersed nature and Vermont's favorable meteorological conditions, overall levels of locally-generated pollutants are comparatively low. However, wind-borne pollutants from high-emitting areas outside the state elevate the levels of longer-lived pollutants like ozone and certain toxic chemicals in Vermont. Three serious air pollutants in Vermont are ozone, particulate matter, and toxic chemicals.

Water Resources. The development and use of fossil fuels poses risks to water resources and marine life at various points along the chain from extraction to end use. Some of the more common problems include surface water discharges from mines, leachate contamination of groundwater from coal waste landfills, marine oil spills, increased nitrogen levels from atmospheric deposition, and contamination from acid rain. There is also a growing concern about potential contributions of atmospheric mercury depositions to mercury contamination of Vermont's surface waters and aquatic organisms. Nuclear energy also poses risks such as the escape of radionuclides into the groundwater. Both nuclear and fossil fuel power stations make thermal discharges from their cooling systems, potentially affecting habitats downstream.

Hydroelectric Power Use significantly alters river and stream ecosystems. Large- and small-scale hydroelectric schemes both significantly alter natural ecosystems and can reduce populations of fish, bird, and other wildlife species. Hydro projects can damage ecosystems by reducing dissolved oxygen, causing erosion, changing water levels, obstructing fish movements, and affecting birds' and mammals' habits.

Land Use, Development, and Sprawl. Facilities related to energy use and production can degrade land resources through physical disturbance and contamination. In Vermont, land is used for a wide range of energy-related purposes including transmission and distribution lines, substations, gas pipelines, highways and parking lots, fuel storage, and electrical generation.

Land use development and energy consumption are tightly related. A dispersed pattern of land use and sprawl are wasteful of both land and energy resources. Locating jobs, residences, and other facilities in compact growth centers that can be served by mass transit and carpools can reduce the consumption of gasoline, the need for additional highways and parking lots, and the need for new infrastructure, including electric transmission lines. Vermont's Land Use Development Law (Act 250) and the Municipal and Regional Planning and Development Law (Act 200) can contribute to better land use and more energy efficient development. (See also Volume 2, Chapter 3, Section I - Recent Energy Planning Efforts and Legislation, B.4 - The State's Role in Energy Planning.)

Recreation and Scenic Landscapes. Energy use affects both recreation opportunities and Vermont's scenic character. For example, hydro projects commonly threaten wild rivers and back country used for wilderness recreation. Such projects can also reduce populations of migratory species important to hunters and wildlife observers. Non-sustainable use of forests for fuelwood production can diminish their value as a tourist and recreation resource. Emissions from sulfur dioxide and other pollutants reduce visibility in Vermont in the summertime by as much as 66% compared to unpolluted levels (Vt. ANR, 1991, 23). Visibility impairment, as well as acid damage to lakes and forests, affects scenic views and recreation in the mountains.

The state's scenic landscapes can also be affected by energy-related facilities and activities. Vermont's scenic character is defined by traditional, compact townscapes and open rural landscapes; many Vermonters are proud of this character and benefit from the tourism it attracts. Energy-related facilities such as transmission lines, smokestacks, pipelines, windmills, and highways can significantly change the aesthetic character of the landscapes. Construction activities associated with energy use can also have a major impact on the aesthetics of neighborhoods for extended periods.

Nuclear Issues. Radioactive waste disposal and the possibility of large-scale accidents are serious environmental concerns associated with nuclear power. If not properly managed, nuclear power plants are a potential source of ionizing radiation that can be released to the environment. High doses of ionizing radiation have the potential of damaging cellular material in both human beings and the biotic community. Issues for the environment include radioactive waste disposal and possible accidental releases, both discussed above.

Environmental risks are associated with all energy sources and technologies. A primary purpose of this Plan is to ensure that these risks are better reflected in the energy choices of individuals, businesses, and government. Global warming is a problem that stands out as demanding special attention because of its global nature and potential for disrupting ecosystems.

G. Efficiency

Efficient energy production, delivery, and use minimizes waste and therefore requires fewer resources. Energy efficiency does not reduce comfort or convenience; it enables us to meet the same needs with less energy and environmental damage.

Efficiency measures usually involve technical solutions that improve the working of objects or systems. For example, building a more fuel-efficient car and keeping car tires properly inflated for better gas mileage are two efficiency measures. There are a host of others. Some include: efficient light bulbs, ceiling insulation, insulated water heaters, double-glazed windows that reduce heat loss, and computers and photocopying machines that shut down when not in use. There are also many efficiency measures that power plants can implement. For instance, cogenerating power systems not only create electricity, but also capture and use waste heat for more electricity or for other purposes. Re-engineering existing power plants can improve their efficiency, reducing the amount of energy wasted in power generation.

Recycling is an energy efficiency measure because it recaptures some of the embedded energy in products. Recycling uses energy, but not as much energy as creating products from raw materials. Reusing products is an even better way to recapture embedded energy than recycling because it uses no energy.

Energy efficiency projects and programs can eliminate the need for a new power plant by decreasing demand for energy without decreasing what that energy can do for us. Thus, efficiency measures can be some of the most cost-effective ways to fill our current and growing energy needs. A huge potential still untapped in energy efficiency gains.

Making energy use more efficient is a strategy that benefits everyone. Efficiency measures reduce energy costs, enhance environmental quality, improve security and sustainability, and enhance economic vitality.

H. Affordability

Affordable energy meets consumers' energy needs in an adequate manner at the least total cost to society, giving special consideration to low income groups. For low income groups, energy affordability means that individuals' energy needs are met adequately without compromising other basic needs.

Affordable energy prices meet needs at the least cost to society, but "affordable" prices are not always synonymous with "cheap" prices. The price of energy is relatively low in the U.S., but there is good reason to believe that this will not always be the case. Energy remains "cheap" because environmental, social, and other costs are not included in its price. Maintaining artificially low energy prices is not a sustainable policy in the long run, because it encourages current generations to use more resources than they might use if they were paying the full costs. Consequences of this approach are to leave financial burdens and scarcer energy resources for future generations. (See text box on The Full Cost of Energy Use, and Current and Future Issues in Energy Use in Chapter 3.)

Raising the price of energy to account for all costs would advance many energy goals but could negatively affect consumers and businesses, especially those in low income groups. One solution to this dilemma is to increase the price of energy to include all costs and simultaneously invest the funds collected in efficiency so that consumers don't need as much energy. In this way, the unit price of energy would rise, but efficiency measures would help to reduce consumers' total energy bill.

Investing in energy efficiency requires money that some people and institutions do not have. Low income and elderly people on fixed incomes find it especially difficult to make these investments. For energy to be

affordable, capital must be available to make the efficiency improvements. To the greatest extent possible, efforts should be made to minimize financial impacts on the most vulnerable energy users, and programs should be designed to give assistance when necessary. Interim programs of direct assistance may be needed to help low income groups through the time lag between higher expenses and the benefits from increased efficiency.

Incorporating all the costs of energy use in the prices of all energy sources, then, appears to be the most efficient and effective long term way to maintain and improve affordability into the future. In instances when this has not or cannot be done well, energy customers, other members of society, or society as a whole eventually pay for those additional costs. Including the full cost of energy use in energy prices will be difficult for Vermont to implement on its own. However, there are a number of ways in which Vermont can set policies to begin to move toward this goal.

I. Economic Vitality

The words "vital" and "vitality" come from the Latin word for "life." Economic vitality refers to an economy full of life, one that sustains the well-being of humans in their life and work. A vital economy is one in which Vermonters are stably employed in jobs that give them the means to meet their needs and the means to purchase goods and services that enhance their well-being. The jobs that a vital economy provides are ones which both individuals and society in general find valuable.

Energy acquisition and use can either help or hinder Vermont's economic vitality. Energy is needed to change resources into products that enhance our well-being. Energy gets Vermonters to work, powers the machines they use at work, as well as heats and lights those work places. Energy acquisition and use, however, that do not meet the goals of safety, adequacy, reliability, security, sustainability, and environmental soundness may benefit certain individuals or industries, but will not contribute to a vital economy that enhances Vermonters' well-being. Energy use that is inefficient or that is not affordable on a societal basis also detracts from Vermont's economic vitality. Every dollar spent by a Vermont business on energy is a dollar not paid to shareholders and workers, or not invested in improving the business.

The cost of energy, however, not only represents money paid out by businesses, it also represents money paid out of the state in many cases. Vermont's out-of-state oil and electric bills help pay for many high-paying jobs, but few of these jobs are in Vermont or the U.S. On the other hand, a community-based energy economy, as described earlier, keeps jobs and dollars in the state. The Vermont schools that heat with clean, efficient wood chip systems and buy those wood chips from local loggers or mills keep energy jobs and dollars in Vermont. Keeping higher-paying energy related jobs in the state increases Vermont's economic vitality.

Other states and nations, with less concern than Vermont for the environment or future generations, can place Vermont at an "economic disadvantage." Lax pollution regulations in other states can attract businesses and jobs. Concern for the environment and for future Vermonters may seem to pit "jobs against the environment" and "jobs against our children," but in the long run these are false dichotomies. As Vermont strives to improve its economy we must ensure that the economy and the energy that the economy runs on are sustainable. This requires changes in Vermont's energy use, as well as changes on a regional and national level to ensure that other states and nations do not undermine Vermont's economy by cutting corners in areas of safety, security, sustainability, or environmental soundness.

CHAPTER 3 - VERMONT'S ENERGY USE: PAST, PRESENT AND FUTURE

To understand the unique challenges and opportunities facing Vermont as we plan our energy future, this chapter focuses on Vermont's past, present, and future energy use. Section one of this chapter presents a history of Vermont's energy sources and background information about recent energy legislation and statewide energy planning. The second section analyzes Vermont's current energy use among sectors, end uses, and fuels, presents graphs of the state's energy use during the past 20 years, and outlines how future trends and issues will influence energy use. Section three presents a base case forecast of Vermont's expected energy use during the next 20 years, given expected changes in the state's economy and population. Chapter 3 thus provides a resource for future energy decisions based on information about our past, present, and possible future energy use patterns. Volume 1 is a summarized version of Chapter 3. The complete version is in Volume 2.

I. HISTORY AND BACKGROUND

Looking at our history can create a new understanding of where we have come from and the problems and opportunities that have been encountered. Reflecting on the past also sets current conditions and challenges in perspective and helps in the process of generating new ideas and solutions. See Volume 2 for a review some of the major trends and milestones in energy use and sources since the state's early settlement.

Recent Energy Planning Efforts and Legislation. The following international conferences plus legislative and regulatory milestones at the federal and state levels indicate progress and new directions in greenhouse gas reduction, energy planning, energy efficiency, reliance on renewable and alternative fuels, and the protection of environmental resources damaged by energy use.

International Conferences:

- U.N. Conference on Environment and Development — Earth Summit, Rio de Janeiro, 1991; over 150 nations signed the U.N. Framework Convention on Climate Change (FCCC), committing to voluntary actions to stabilize greenhouse gases at 1990 levels.
- Conferences of the Parties to the FCCC — Berlin, 1995; Kyoto, 1997; Buenos Aires, 1998.
- Intergovernmental Panel on Climate Change (IPCC), international forum issuing reports assessing scientific evidence and impacts of climate change in 1990, 1992, and 1995.

National Energy Legislation:

- National Energy Strategy, 1991
- Energy Policy Act (EPAct), 1992
- Clean Air Act Amendments, 1990
- State Energy Efficiency Programs Improvement Act, 1990
- Intermodal Surface Transportation Efficiency Act (ISTEA), 1991
- Energy Policy Act, 1992
- Climate Change Action Plan, 1993
- Competition in Electric Transmission Network, FERC NOPR, 1995
- National Energy Policy, 1993

Vermont's Energy Legislation:

- Environmental costs of electricity services included in planning, PSB Docket 5270, 1990
- Environmental costs to be considered in energy planning, 30 V.S.A. §218c, 1991
- Effort to quantify the environmental costs of power generation, PSB Docket 5611, 1992-
- Establishment of State Energy Policy, 30 V.S.A. §202a, 1992
- Least Cost Integrated Planning (LCIP) for state's electric and gas utilities, PSB Docket 5270 and 30 V.S.A. §218c
- Expanding role of non-utility generation in Vermont's electric supply resources, PSB Rule 4.100, federal Public Utility Regulatory Policies Act of 1978 (PURPA) , and EPAct
- Increasing competition and restructuring the electric utility industry, PSB Dockets 5854 ,and 5980, 1994-
- Lawsuit concerning radioactive nuclear fuel disposal vs U.S. DOE, in progress

State's Role in Energy Planning. Vermont's government participates in energy planning in a variety of ways. State agencies, regional planning commissions, and many cities, towns, and villages create plans that address energy issues. In addition, the Department of Public Service, the Public Service Board, the Agency of Transportation, and the Agency of Natural Resources all have roles in energy planning and development, as outlined below.

State, Regional, and Municipal Planning (Act 200). State agencies and Regional Planning Commissions are required by Act 200 (and towns are encouraged) to create land use development plans that meet a number of goals related to historic preservation, environmental quality, economic vitality, energy efficiency, and other goals. Act 200 has increased awareness and planning of energy issues at all levels of Vermont's government. State agencies are required to prepare and adopt State Agency Plans. These plans address the agencies' progress in advancing the planning goals of Act 200, some of which are related to energy and energy efficiency.

Vermont has 12 Regional Planning Commissions which, among other duties, create and implement Regional Plans and assist towns in preparing plans and in implementing recommendations (see 24 V.S.A. §4345 for information about their other duties). Each of these Regional Plans sets out goals, policies, and recommendations to direct future energy use in the region. In addition, there are currently 48 cities, towns, and villages that have municipal plans which have been adopted by the community and have obtained approval from the respective Regional Planning Commission. Local concerns about energy, air quality, utility facilities, and transportation issues are addressed in the municipal plans. (For more information about state agency, regional, and municipal planning, see Volume 2, Appendix 4.)

Vermont Department of Public Service (DPS) serves all citizens of Vermont through public advocacy, planning, programs, and other actions that meet the public's need for a safe, adequate, reliable, secure, sustainable, affordable, environmentally sound, efficient energy supply and regulated utility systems. Ongoing energy planning efforts of the Department and Public Service Board are described in Volume 2, Section I.B Recent Energy Planning Efforts and Legislation.

Vermont Agency of Transportation (AOT) works cooperatively to anticipate and meet the need for the movement of people and goods in a safe, cost-effective, environmentally sensitive, and timely manner. The Agency manages transportation projects aimed at providing safe and efficient transportation and economic opportunities for Vermonters, taking into consideration the state's natural resources, Act 200 planning goals, and local, regional, and state agency plans. A primary component of the transportation planning process is AOT's preparation and adoption of a long range, multi-modal systems plan integrating all modes of transportation. Developed with participation from public, local, and regional governmental entities, this statewide plan reflects AOT's mission and policy, policies approved by the legislature, demographic and

travel forecasts, design standards, performance criteria, and funding availability. (See Vt. AOT, *Vermont's Long Range Transportation Plan*, 1995).

Vermont Agency of Natural Resources (ANR) is composed of the Department of Environmental Conservation, the Department of Fish and Wildlife, and the Department of Forests, Parks, and Recreation, as well as a central office that includes planning, policy, and administrative staff. ANR was created in 1970 by the legislature and charged to "protect and improve the quality and balance of the environment and natural resources and to improve the opportunities to maintain health within the environment."

The central planning division at ANR facilitates planning within each department. Planning in the Department of Environmental Conservation often has relevance for or includes planning related to energy issues. For instance, the Strategic Plan of the Environmental Assistance Division (a branch of the Dept. of Environmental Conservation) outlines several goals involving recycling, pollution prevention, energy efficiency products, and consumer education about sustainable use of resources (Vt. ANR, *Strategic Plan*, 1995).

ANR has recently identified 25 outcomes or goals and a set of measurable indicators through which the Agency will track how well each outcome is being achieved. Many of the outcomes and indicators are related to energy use. The following are selected outcomes related to energy use. (See Volume 2, Chapter 3, Section I.B.4 for further information.)

1. Sustainable natural resource use
2. Minimal potential for human and biotic exposure to toxic substances
3. Clean air that meets current ambient air quality standards
4. Clean earth materials
5. Healthy aquatic ecosystems
6. Good land stewardship
7. An aesthetically pleasing landscape

II. CURRENT ENERGY USE

Vermont's energy comes from many fuel sources and is used to power a diverse set of appliances, equipment, and vehicles. In this section we review the state's current sources and uses of energy; statewide energy use, energy use among sectors and among end uses over the past 20 years. Then we turn to energy use among fuels, analyzing each fuel source. Non-electric fuel sources are discussed first, followed by a discussion of electricity use and the primary fuels used to generate electricity. We also review Vermont's utility efficiency measures (or demand-side management measures) and some energy sources and technologies that are not widely used today, but that have the potential for greater use in the future. This chapter ends by examining two issues that will be extremely important for our future energy use: the full cost of energy use, and increasing competition in the electric utility industry, followed by highlights of the base case forecast. (See Volume 2, Chapter 3 for the complete text, and the full sets of Tables and Figures.)

A. Escalating Energy Use

Between the late 1950s and early 1970s, U.S. energy use increased significantly. In the mid-1970s, total use decreased for two consecutive years due to higher oil prices and conservation measures stemming from the first oil crisis, but then resumed its upward track. In the early 1980s, energy use fell again due to an economic recession, oil price increases, and gains from fuel efficiency measures in vehicles, appliances, and buildings. Because of these years of decreasing use, total energy use in the mid-1980s was at about the same

level as use in the early and mid-1970s. Since the mid-1980s total U.S. energy use resumed its strong yearly increase, except for a slight decline during the 1990 recession. The increase has been attributed to low oil prices, economic growth, and rising transportation energy use due to increasing miles traveled and the absence of gains in the average fuel efficiency of the vehicle fleet.

B. Energy Use Among Sectors

While total Vermont energy use after 1976 first decreased and then increased, these trends did not occur at similar rates in the transportation, residential, commercial, and industrial sectors. As illustrated in Figure 3.II.6, energy use in all four sectors declined from 1976 to the early 1980s, but since then has increased at a different rate for each sector.

The residential sector experienced the smallest increase of energy use since the early 1980s, with delivered energy use rising only 10% between 1980 and 1994. The more moderate increase between 1980-1994 is due mainly to increased efficiencies of equipment, appliances, homes, and buildings.

Although the industrial and commercial sectors are smaller in Vermont than in many other states, energy use in both sectors grew substantially between 1980 and 1994. Delivered energy use in the industrial sector grew 21%, while primary use grew 34% during this time frame. (Delivered energy use is the measure of energy as it enters, or is delivered to, the consumer's home or facility. Primary use is the measure of delivered energy consumption plus some of the energy lost in the generation, transmission, and distribution of electricity and natural gas.) As in the residential sector, industrial use of electricity grew at a much greater rate than its use of some other energy sources. In the commercial sector, delivered energy use increased by 47% and primary use increased by 53% between 1980-1994. Growth within both the commercial and industrial sectors was largely due to economic growth in the state following the recessions of the early 1980s. Significant opportunities for energy savings exist in these sectors.

Energy use in the transportation sector has experienced strong growth since 1980, increasing 50%. While energy use increases in the commercial and industrial sectors stemmed largely from a recovering and expanding economy, increases in the transportation sector were due mostly to a different set of factors. These factors include the following:

- Vermont's gasoline prices fell from $2.21 in 1980 to $1.14 in May 1995 in Vermont (in 1994 dollars) (Vt. DPS, Fuel Price Survey).
- While new cars made impressive gains in fuel efficiency in the 1970s and early 1980s, the total Vehicle Miles Traveled (VMT) in Vermont and nationwide continued to increase. Vermont's rural nature and dispersed land use pattern contributed to the increase in VMT.
- The number of vehicles on the road increased dramatically in the 1970s and 1980s.

Between 1970 and 1990, the number of vehicles increased 100% in Vermont, due partly to the state's 27% increase in population during the same time period. Vermont's vehicle growth rate over this time period exceeded the growth rate in the U.S., even taking into account differences in population growth (Vt. Motor Vehicle Registries; U.S. Bureau of the Census, 1994; Gordon, 1991, 21). Virtually no gains were made in the average fuel efficiency of cars sold since 1985 (U.S. Congress, OTA, 1991, 153). In the past several years, there have also been growing numbers of light trucks and vans on the road; light truck and van VMT grew at five times the rate of auto VMT between 1970 and 1985, largely because these vehicles were used to transport passengers rather than freight (Gordon, 1991, 42). This trend lowers the overall efficiency of the vehicle fleet and increases emissions.

C. Energy Use Among End Uses

Within each sector, Vermonters use energy for many purposes or "end uses," including space heating, water heating, lighting, industrial motors, aviation, etc. (See Figure 3.II.10.) Looking at Vermont's end uses during recent years shows us where our energy goes and where opportunities for energy savings lie.

Road transportation has been the largest end use of energy in the state since 1977. Energy use for space heating was relatively close to that used for road transportation through the early 1980s, but subsequently stabilized and in some years declined while road transportation use grew substantially (by about 40% between 1985 and 1994). Other end uses require significantly less energy than road transportation and space heating. Water heating, currently the next largest end use, has grown by 17% in energy consumption since 1976, while process heat for industrial purposes (the fourth largest end use) has declined by 14%. All other end uses have increased their energy consumption since 1976, most notably air conditioning (125%), motors for industrial purposes (121%), miscellaneous electricity end uses (90%), and lighting (60%).

Road transportation currently accounts for 42% of Vermont's total delivered energy use, while space heating accounts for 28%. Energy use for water heating and process heat (industrial) are about equal at 8%-9% of the total, and all other end uses have much smaller shares.

Energy consumption among end uses varies from sector to sector, as shown in Figures 3.II.13 - 3.II.16. In the residential sector, road transportation and space heating end uses have consumed close to the same amount of energy since 1976 (around 35%-40% of the total), but have started to diverge in the past several years as transportation energy use increased while heating use declined. Water heating, the next largest end use in the residential sector, required 19% more energy in 1994 than in 1976. Most other end uses experienced larger increases over the same time-frame, especially air conditioning energy (233%), miscellaneous electric uses (63%), and drying (55%).

In the commercial sector, transportation use dominates even more, as shown in Figure 3.II.14. In 1976, transportation and space heating consumed about the same amount of energy, but since then, heating energy use first declined and then rose slowly, while transportation use increased steadily (by 106%). Currently, transportation energy use accounts for 61% of total delivered use in the commercial sector, while space heating accounts for only 29%. The next largest end use, lighting, represents only 6% of total delivered energy use, but its energy use has grown substantially since 1976. All other end uses consume much less energy, but most increased rapidly between 1976 and 1994, especially air conditioning (106%), miscellaneous electric uses (104%), and refrigeration (48%).

As portrayed in Figure 3.II.15, the largest end use in the industrial sector is process heat, which currently accounts for about half the energy use in the sector. Energy consumed for process heat has declined since 1976, but consumption by all other end uses has risen substantially. Transportation energy use increased by 88% between 1976 and 1994, and now accounts for one-quarter of total industrial use. Energy use for motors, the next largest e, increased 121%, and miscellaneous electric uses and lighting energy use increased 133% and 122% respectively.

In the transportation sector, car and truck transportation energy use increased by 45% between 1976 and 1994, while transportation among the sum of all other end users remained about the same, as shown in Figure 3.II.16.

D. Energy Use Among Fuel Sources

Vermonters use a variety of fuel sources to meet our energy needs, but by far the predominant fuel used is petroleum, as shown in Figure 3.II.17. Since the early 1980s, petroleum use has increased to about its 1976

level and is continuing to grow. Total electric energy use has risen steadily since the mid-1970s, increasing 65% from 1976 to 1994, in spite of the fact that many efficiency gains have been made in electric end uses. Wood use has fluctuated over the years, and is currently at a plateau. Natural gas and LPG (propane) use have risen steadily.

With energy use come polluting emissions such as carbon dioxide, carbon monoxide, nitrogen oxides (NOXs), volatile organic compounds (VOCs), sulfur oxides (SOXs), particulates, and others as shown in Figure 3.II.21. Each fuel has a set of factors indicating the amount of these emissions that is emitted per unit of energy used. (See Volume 2, Chapter 3, Tables 3.II.1, 3.II.3, 3.III.1 - 3.III.4 for more information about energy emissions factors.)

E. Vermont's Non-Electric Fuel Sources

The discussion of fuels and energy sources used in Vermont is divided into two categories depending on whether the fuel is used to make electricity. Non-electric energy sources used in Vermont include petroleum products (motor gasoline, distillate fuel, LPG, and others), natural gas, wood, and small amounts of coal and solar energy. Each of these fuel sources is described below and in more detail in Volume 2, with an exploration of trends and issues that will influence the future use of each source. Because petroleum products comprise the largest portion of the state's energy use, they are discussed both as a group and individually below.

Petroleum Products. In 1993, Vermont used a total of 78 TBTU of petroleum products for non-electric purposes, representing 71% of our total delivered energy use (Vt. DPS). Vermont's use of petroleum products is far greater than our use of any other fuel source. Oil is the most-used fuel in the transportation and residential sectors, and currently competes with electricity for the top usage in the commercial and industrial sectors (Vt. DPS). Oil accounts for 53% of total residential delivered energy use, 49% of commercial use, and 39% of industrial use (Vt. DPS). Of our total oil consumption, about 59% occurs in the transportation sector, 24% occurs in the residential sector, and the remainder occurs in the commercial and industrial sectors (U.S. DOE/EIA, *State Energy Data Report*, 1995). On a per capita basis, Vermont uses slightly more petroleum than the U.S. average. Vermonters consumed about 135.4 million BTU of petroleum per person in 1993, while Americans consumed 131.4 million BTU.[1]

Emissions and Environmental Impacts. Emissions from oil use vary depending on the type of petroleum product used, the type of equipment or vehicle used, the level of maintenance, and other factors. However, all petroleum products emit significant amounts of several pollutants, including those that cause negative human health effects, global climate change, acid precipitation, and smog. Summaries of the emissions from the use of each petroleum product are given in the following sections. Most emissions come directly from fuel combustion, but emissions also result from oil extraction, processing, refining, distribution, and vehicle refueling.

Motor Gasoline. In 1993, Vermonters used about 37.3 TBTU of energy from motor gasoline, accounting for 34% of the state's total delivered energy use (U.S. DOE/EIA, *State Energy Data Report*, 1995, 299; Vt. DPS). (See Volume 2, Figure 3.I.2 for consumption during the past.)

Emissions and Environmental Issues. Motor vehicles that burn motor gasoline and diesel fuel are responsible for nearly 70% of the air pollution emitted in Vermont, mainly from fuel combustion (Vt. ANR, *Air Pollution Emissions Inventory*, 1993, Appendix A). The major emissions of concern from motor gasoline combustion are carbon dioxide, carbon monoxide, nitrogen oxide, volatile organic compounds (VOCs), and particulates. Smaller amounts of sulfur dioxide, nitrous oxide, and methane are also emitted by motor gasoline combustion. Chlorofluorocarbons are not emitted by gasoline combustion, but are emitted from vehicle air conditioners and during the manufacture of vehicles.

Distillate Fuel (heating oil and diesel fuel). Vermonters used 31.2 TBTU of distillate fuel in 1993, accounting for 28% of our total delivered energy use (U.S. DOE/EIA, *State Energy Data Report*, 1995, 299; Vt. DPS).[2] In Vermont, about 44% (13.8 TBTU) of the distillate fuel demand comes from the residential sector, primarily for space heating and water heating purposes. Another 32% (10 TBTU) of the demand comes from the transportation sector from diesel-burning vehicles, with the remaining demand from the commercial sector (14%) and industrial sector (10%) (U.S. DOE/EIA, *State Energy Data Report*, 1992, 311-6).

The Northeast uses heating oil much more than the rest of the country. Altogether, 11 million homes in the U.S. use heating oil, with 7.7 million of those homes in the Northeast (American Petroleum Institute, 1990, 2). In the U.S., distillate fuel represents 19% of total petroleum demand. U.S. demand for distillate fuel comes mainly from the on-highway diesel transportation sector (48%), with a much smaller amount coming from the residential sector (14%). The commercial, industrial, farm, railroad, vessel bunkering, and off-highway diesel uses each account for between 4%-7% of U.S. distillate fuel use (U.S. DOE/EIA, *Fuel Oil and Kerosene Sales*, 1995, 10).

Emissions. The emissions of greatest concern from heating oil are carbon dioxide, sulfur oxides, particulates, and volatile organic compounds. In Vermont, distillate heating oil emits more sulfur oxides (major contributors to acid precipitation) per unit of energy used than any other home heating fuel except coal. Emissions of carbon dioxide per unit of energy used are higher for heating oil than for LPG, natural gas, or motor gasoline. Particulate emissions and VOCs are both higher with heating oil than with LPG or natural gas (per unit of energy used). Emissions from heating oil combustion depend on the grade and composition of the fuel, the type and size of the boiler or furnace, the firing and loading practices used, and the level of equipment maintenance (U.S. EPA, *Compilation of Air Pollutant Emission Factors*, 1995, 1.3-1, 1.3-11-15).

Liquid Petroleum Gas (LPG). In 1993, Vermont used 6.6 TBTU of liquid petroleum gas, representing 6% of the total delivered energy consumption (Vt. DPS). The residential sector accounted for 75% of the state's 1993 LPG demand, with the remaining demand almost equally divided between the commercial and industrial sectors.

Emissions. When compared with heating oil, LPG has lower emissions per unit of energy used for every pollutant except nitrogen oxides. The major emissions of concern from LPG are nitrogen oxides and carbon dioxide.

Kerosene. Vermont used 1.6 TBTU of kerosene in 1993, representing 1.5% of the state's delivered energy use (Vt. DPS), mostly in the residential sector in 1993 (U.S. DOE/EIA, *State Energy Data Report*, 1995, 299-300).

Other Petroleum Products. Vermonters used 3.8 TBTU of residual fuel, jet fuel, and aviation gasoline for non-electric purposes in 1993, accounting for 3.5% of total delivered energy use (Vt. DPS).[3]

Natural Gas. In 1993, Vermont used 7.1 TBTU of natural gas for non-electric purposes, accounting for 6% of the state's total delivered energy use (Vt. DPS). The residential sector used about 39% of the state's total natural gas, while the industrial sector used 35%, and the commercial sector the remainder. The residential sector uses natural gas for space heating and water heating, with an estimated 8% of Vermont households using natural gas as their primary heating source and water heating source during the 1993-94 heating season (Vt. DPS, *Vt. Residential Fuelwood*, 1995, 4, 11).

Natural gas, which consists mostly of methane, is available only in the northwest corner of Vermont in portions of Franklin and Chittenden counties. The state has a single natural gas distribution company, Vermont Gas Systems, which currently serves about 27,000 customers. Natural gas use per capita in

Air Emissions from Energy Use

Figure 3.II.21 illustrates how Vermont's air emissions from energy use have changed since 1976. The most significant pollutants from Vermont's energy use are carbon dioxide carbon monoxide, nitrogen oxides, volatile organic compounds (VOCs), and sulfur oxides. The state's energy also emits smaller amounts of particulates less that 10 microns (or PM-10), nitrous oxide, and methane. All pollutants are now emitted in larger amounts than 1976 - most notably carbon dioxide, nitrogen oxides, and PM-10 which increased 22%-27% between 1976 and 1994, and carbon monoxide, VOCs, and methane, which increased 14%-15%. (Emissions levels are presented in tons per year; these tonnage comparisons best illustrate trends rather than the relative impacts of each emission.)

Carbon dioxide is emitted during the combustion of all fossil fuels. Carbon dioxide is the largest contributor to global warming; of the global warming to be brought about by the human-caused greenhouse gases released in 1990, carbon dioxide is responsible for 66% (U.S. EPA, *States Workbook*, 1992, v). While burning fuels more completely can reduce the emissions of many of the other pollutants, it cannot reduce carbon dioxide emissions. Carbon dioxide emissions can be reduced by decreasing energy use, using more efficient furnaces, vehicles, etc., or switching to fuels that emit smaller amounts of carbon dioxide.

Carbon monoxide is an air pollutant as well as a contributor to smog. Motor gasoline and diesel use emits more carbon monoxide per unit of energy used than any other fuel in Vermont. Nationwide, two-thirds of carbon monoxide emissions come from transportation sources, with the largest contribution from motor vehicles.

Nitrogen oxides emissions lead to the formation of ground-level ozone, the major constituent of smog, and contribute to acid precipitation, which acidifies lakes and streams and harms forests. Motor gasoline and diesel use emits more nitrogen oxides per unit of energy used than any other fuel in Vermont.

Volatile organic compounds (VOCs), sometimes referred to as non-methane hydrocarbons, are often toxic, and as a group they contribute to ground-level ozone. Ground-level ozone, the major component of smog, is formed from the combination of VOCs and nitrogen oxides as they react in the presence of heat and sunlight. The primary source of the constituents of ground-level ozone is auto exhaust.

Vermont, New Hampshire, and Maine is lower than much of the rest of the country, due largely to limitedavailability. Natural gas accounts for 25% of the total energy consumed nationwide, but accounts for only 18% of energy consumed in New England (New England Gas Association, *Pocket Guide*, 1995, 10).

Air Emissions and Environmental Issues. Natural gas use emits the lowest amount of almost all pollutants per unit of energy used compared to other fossil fuel sources. (See Tables 3.II.1 and 3.III.3.) Carbon dioxide and nitrogen oxides are the pollutants of greatest concern from natural gas combustion. Carbon dioxide emissions per unit of energy used are the lowest of any fossil fuel source, but these emissions are still problematic due to their contribution to global warming. Natural gas emissions of nitrogen oxides per unit of energy used are similar to emissions from LPG and higher than emissions from distillate fuel or wood use.

Wood. During 1993, Vermonters used about 7.6 TBTU of wood for non-electric purposes, representing 7% of the state's total delivered energy consumption (Vt. DPS). The majority of this wood use (84%) occurred in the residential sector, while most of the rest (11%) occurred in the industrial sector. (Additional wood was used to generate electricity; see Electricity from Wood.) Popular wood varieties for fuel in Vermont include ash, beech, yellow birch, hard maple, and oak.

Air Emissions from Energy Use (continued)

Ozone usually is not formed at the point where emissions are produced; the chemicals are typically carried some distance by wind before ozone is created. For this reason, emissions in one area can contribute to a smog problem in another area. In regions of the country where many urbanized areas are located close to one another, as in as in the Northeast, this problem is worsened. Thus, ozone is a regional problem rather than a local one. Vermont, as part of the Regional Northeast Ozone Transport Commission, is working to help mitigate the problem in the Northeast.

Sulfur oxides are health hazards and significant contributors to acid rain. Sulfur oxides emissions result from burning any fossil fuel, but the combustion of coal produces the largest amount (per unit of energy used). Nitrogen oxides and sulfur oxides react to form acid precipitation that acidifies waterways and damages plant life. Sulfur oxides can remain in the atmosphere for up to ten days after they are emitted and can be carried more than 600 miles before they are deposited as precipitation. Thus, emissions in one region can cause impacts in distant regions.

Particulate emissions consist of dust, soot, smoke, and other suspended matter resulting from the burning of fossil fuels. PM-10 emissions are of the greatest concern because they can most easily enter humans' lungs.

Nitrous oxide is a potent greenhouse gas, trapping 270 times more heat in the atmosphere than an equivalent amount of carbon dioxide emissions traps. Of the global warming effect from human-caused greenhouse gases released in 1990, nitrous oxide is responsible for 5% (U.S. EPA, *States Workbook*, 1992, v).

Methane is also a serious greenhouse gas, trapping 11 times more heat in the atmosphere than an equivalent amount of carbon dioxide emissions traps. Of the global warming to be brought about by the human-caused greenhouse gases released in 1990, methane is responsible for 18% (U.S. EPA, *States Workbook*, 1992, v).

In addition to the human health effects of energy emissions, these pollutants also are responsible for extensive environmental deterioration, damage to agriculture and wildlife, the corrosion and soiling of buildings, the degradation of visibility, and the contamination of water.

In the 1993-94 heating season, wood was the second most popular fuel source for home heating in the state (oil was first). Wood was used as a primary source of heat in about 21% of Vermont households, as a supplemental source of heat in 17% of all households, and for "pleasure burning" in fireplaces in 5% of Vermont households. About 3% of Vermont households used wood for hot water heating (Vt. DPS, *Vt. Residential Fuelwood*, 1995, 3-4, 11).

Maine and Vermont are among the top three states nationally in the proportion of total energy obtained from wood and other biomass sources. A recent study estimated that the wood energy industry produced 34,387 jobs and $1.8 billion in net income for the Northeast in 1992. Approximately 1,870 of those jobs and $85 million of the income occurs in Vermont (High, 1994, 1, 6-7).

Emissions and Solid Waste. The emissions of greatest concern from wood burning are carbon dioxide, particulates, carbon monoxide, and volatile organic compounds (VOCs). Vermont's current mix of residential wood space and water heaters emit more of these pollutants per unit of energy used than virtually any other fuel source used for heating.

Although wood use emits more carbon dioxide than any other combustion fuel source, no net carbon dioxide emissions are attributed to wood burning if forest resources are managed sustainably. The carbon found in trees is part of a process that includes carbon exchange between living organisms, the atmosphere, the soils, and the oceans. When wood is burned, the carbon that was originally captured from the atmosphere during the tree's lifetime is released back into the atmosphere. Sustainable forest practices that allow new tree growth to replace the harvested and burned trees ensure that an equivalent amount of carbon dioxide will again be captured from the atmosphere.

In Vermont, a system of sustainable forest practices is a reachable goal. An important indicator of overall sustain ability (the net annual growth compared to annual harvest) suggests that Vermont's harvest is sustainable, though there may be certain species of trees that are being harvested at non-sustainable rates. On a worldwide basis, however, carbon dioxide emissions from deforestation are a serious problem because the carbon dioxide is not being recaptured in new tree growth. Worldwide, tropical forest clearance contributes about 16% to the median annual estimate of global carbon released into the atmosphere (Dean Wang, oral presentation, 2/95).

Wood energy offers Vermont a unique opportunity to reduce carbon dioxide emissions in two ways:

- the use of sustainably harvested wood has no net emissions; and
- if wood use replaces or offsets fossil fuel use, it also offsets fossil fuel carbon dioxide emissions.

Offsetting fossil fuel carbon dioxide emissions is particularly important because burning fossil fuels such as oil and coal releases carbon (in the form of carbon dioxide) that has been sequestered from the atmosphere for millions of years. Trees and other organisms have been unable to sequester the increased levels of carbon dioxide from fossil fuel emissions, which has led to increased atmospheric concentrations of carbon dioxide and has contributed to climate change.

Although Vermont's current mix of residential wood heaters produce more particulates, carbon monoxide, and VOCs per unit of energy used than other fuel sources for heating, the pollutants from wood systems will decrease in the future as older heaters are replaced with new EPA certified systems. (See New Technologies below, and Chapter 4, Section I. Policy 1: Promote Clean, Efficient Wood Burning with New Stoves.) These new wood stoves have much lower emissions of particulates, VOCs, and carbon monoxide compared to the mix of systems currently in use in Vermont. However, emissions of these three pollutants per unit of energy used from the new stoves are still higher than emissions from the current mix of heating systems that use oil, LPG, and natural gas (Vt. DPS).

Coal. About 0.41 TBTU of coal was used for non-electric purposes in 1993 in the state, representing only 0.4% of Vermont's total delivered energy use (Vt. DPS). Slightly less than half of this coal use occurred in the industrial sector, while the remainder of the use was divided fairly evenly between the residential and commercial sectors. Coal was used as a primary or supplemental heat source in an estimated 1.5% of Vermont households in the 1993-94 heating season (Vt. DPS, *Vt. Residential Fuelwood*, 1995, 4).

Solar. During 1993, Vermont used an estimated 0.07 TBTU of solar energy, representing a very small portion of the state's total energy consumption (Vt. DPS). Vermont's usage of solar energy occurred almost entirely in the residential sector. A survey of residential heating sources in the 1993-94 heating season found that approximately 1,400 Vermont households used direct solar heat as a supplemental heating source (Vt. DPS, *Vt. Residential Fuelwood*, 1995, 4). There are an estimated 3,500 solar water heaters in use in Vermont (Solar Works, personal communications, July 1995). In addition, solar energy is used to provide lighting in these and other homes and buildings.

Solar energy can also be used to power photovoltaic (PV) panels that produce electricity. There are an estimated 300 Vermont homes that are disconnected from the utility power grid, using photovoltaic power for their electricity (Solar Works, personal communication, 7/95). Because Vermont's climate is much cloudier in the winter than in the summer, most large systems that use PVs also include an oil or propane generator that can be used as backup when solar energy is not available.

Although New England and Vermont receive less solar energy than many other locations in the country, there is still great untapped potential for solar energy use here. The section below, Potential Energy Sources and Technologies for the Future, discusses solar energy in much greater detail and explores how use of solar energy could be increased in Vermont.

F. Electric Fuel Sources

Vermont currently has 22 electric distribution utilities, ranging in size from the Village of Readsboro Electric Department with 311 customers to Central Vermont Public Service with 135,265 customers in 1993. The five largest utilities are Central Vermont Public Service, Green Mountain Power, Citizens Utilities Company, the City of Burlington Electric Department, and Vermont Electric Cooperative; these five utilities provide electricity for about 87% of all customers in the state. (For more information about electric utilities and services, see *Vermont Twenty Year Electric Plan*, 1994.)

Electric utilities are granted monopolies over service territories, which guarantees them the right to provide electric service to customers within a certain geographic area and gives them privileges such as the right to build power lines on private property. In exchange for these guarantees, utilities are subject to government regulations which require them to act as trustees for public resources. A utility must provide (and carry out the planning necessary to continue to provide) adequate electricity or gas service at reasonable prices, meeting industry standards for reliability and quality of service. Electric utilities in Vermont are required to base their supply decisions on the most societally cost-effective measures identified through a planning process called least cost integrated planning. These measures generally must include efficiency or demand-side management programs as well as traditional supply sources. (See the Utility Efficiency Programs section below for a discussion of this planning process, and Chapter 4 for a comparison of least cost planning for energy and transportation.)

New England Power Pool. All of Vermont's electric distribution utilities, along with most other utilities and a few independent power producers in New England, are members of NEPOOL, the New England Power Pool. (Vermont utilities are represented in NEPOOL by VELCO, the Vermont Electric Power Company.) Members of NEPOOL pool the operation of their electricity generation and transmission resources, allowing them to attain greater reliability at a lower cost than if they operated independently. NEPOOL is in the process of being drastically restructured under Federal Energy Regulatory Commissions orders.

Recent History of Electricity Use. Compared to the rest of the world, electricity use in the U.S. is extremely high. With only 4.6% of the world population, our country uses 27% of the total electricity consumed worldwide. On a per capita basis, U.S. electricity use is almost twice that of Japan and more than twice that of Western Europe. And, electricity use per capita in developing countries, many of which have large populations, is much smaller. In fact, the average worldwide electricity consumption per capita is only one-sixth that of U.S. consumption per capita.

Although Vermont has captured efficiency gains in electricity use during the 1990s, the state can still do much more to move toward a more sustainable electricity supply. Vermont's total electricity consumption has grown substantially since 1976. As shown in Figure 3.II.28, delivered electricity use rose 59% between 1976 and 1989, with the greatest rate of growth occurring during the strong economic years of 1986-1988.

However, growth in electricity use subsequently declined, and then actually decreased between 1989 and 1991 as a result of a slower economy and efficiency gains from utility programs. Electricity usage growth has recently resumed in Vermont.

Similarly, electricity expenditures have grown substantially since 1976, as illustrated in Figure 3.II.29. Growth in expenditures slowed during the late 1980s, due partly to moderate oil prices and an over-supply of electricity in the New England market. However in the late 1980s and early 1990s, Vermont's relatively inexpensive electricity contract with New York Power Authority phased down, and more expensive contracts with Hydro-Québec and Independent Power Producers began. This change contributed to the resumption of growth in electricity expenditures.

Electricity consumption in the residential, commercial, and industrial sectors has grown steadily in the past 20 years, except for a leveling off of residential use after 1989. As Figure 3.II.30 shows, the largest growth in electricity use occurred in the industrial sector, which grew by 121% since 1976. Electricity use in the commercial sector also grew substantially (by 78%), while the residential sector experienced slower growth (at 33%). The commercial and industrial sectors' use has risen largely as a result of new business and industrial growth in the state. Electricity use in the residential sector followed population growth (which grew by 20%) more closely than economic growth, accounting for the more gradual increase in use. About 41% of electricity consumption occurs in the residential sector in Vermont, a higher proportion than the nationwide residential use of 35%. This is due mostly to Vermont's smaller-than-average industrial sector.

Electricity use in Vermont is distributed among a number of end uses. (See Figures 3.II.33 - 3.II.35). In the residential sector, more than half of all electricity use powers water heaters and refrigerators. Water heating itself accounts about one-third of all electricity consumed in the residential sector. Electricity use for water heating has declined slightly in recent years due to high electricity prices, more efficient electric water heaters, and more competitive propane water heaters. Refrigeration electricity use has also leveled out in recent years, partly due to federal refrigerator standards that came into effect after 1990. Miscellaneous uses in the residential sector are also substantial and have shown significant growth during the past 20 years, largely as a result of consumers using more appliances such as computers, microwaves, second and third TVs and stereos, and others. Electric heating, cooking, drying, and lighting uses have all decreased or stabilized in recent years, while air conditioning electricity use continues to grow.

Lighting is the largest end use in the commercial sector, accounting for just over 40% of total commercial electricity use. In recent years, growth in lighting electricity use has stabilized partly as a result of utility efficiency programs. As in the residential sector, miscellaneous uses have also grown in the commercial sector, due to new businesses, more automation, and more use of office equipment such as computers, fax machines, and others. The earlier growth in electric heating, water heating, cooking, and refrigeration end uses has stabilized or declined slightly in recent years.

In the industrial sector, electricity to run motors accounts for about two-thirds of total usage. This end use has grown significantly since 1976, due mostly to more industrial businesses locating in Vermont. Heating used for industrial processes accounts for about 11% of industrial electricity usage, with lighting accounting for only 4%. Miscellaneous uses in the industrial sector include electricity used for cooling, refrigeration, space heating, and automation.

Fuel Sources for Generating Vermont's Electricity. Figure 3.II.37 shows changes in the shares of fuel sources that generate Vermont's electricity. Hydro and nuclear power have generated most of the state's power since 1976. Use of nuclear power has fluctuated somewhat throughout that time, but in the mid-1980s Vermont began purchasing power from the Millstone 3 Nuclear Power Plant, accounting for a subsequent rise in the use of nuclear power. Since the early 1990s, Vermont utilities have sold some of their Vermont Yankee power in order to diversify their supply mix, leading to a subsequent decrease in nuclear power use.

Use of hydropower grew substantially between 1984 and 1987, due to larger contracts with Hydro-Québec. Hydropower use fell again in the late 1980s and early 1990s because of expired contracts with the New York Power Authority. Coal consumption has fluctuated since 1976, but has fallen since 1989 as a result of an expiring contract with Ontario Hydro (which burns coal), and decreasing use of generation from the Merrimack 2 coal plant in New Hampshire. In 1998 Vermont's contract for Merrimack 2 power ended. Currently, Vermont has no long term contracts or ownership interests in coal fired power plants. Electricity generation from oil and natural gas has traditionally been low, but has increased since 1990 due to utility purchases intended to diversify their supply mixes and the low cost of oil. Wood use for electricity had been limited in Vermont to the McNeil Station, but recently rose due to the completion of the Ryegate plant which also burns wood. The growth in economy purchases (short-term purchases made from a variety of fuel sources to lower power costs) since the late 1980s is largely a result of the increased inexpensive electricity supply in the New England market. This over-supply has been caused by slack demand, an influx of power from the Seabrook nuclear plant in New Hampshire (which came on-line in 1990), new independent power producers, and savings from utility efficiency programs. (Note: In Figure 3.II.37 values after 1991 are projections. Information on Vermont Ownload Electricity Supply shown in Figures 3.II.38 and 3.II.38a gives the most recent information on fuel sources for generating Vermont's electricity.)

For purposes of comparison, distribution of Vermont's electricity supply by generator fuel is shown for 1993 and 1997 in Figures 3.II.38 and 3.II.38a. Between 1993 and 1997, hydro power's share increased from about 42% to about 47% and nuclear power's share held steady at about 34%. of the state's electricity supply. Coal was the next most used fuel with about 10% of the total during the years 1993 and 1997, while oil and natural gas dropped from about 6% to 2%, renewables held steady at about 4%, and there were small portions of system power.

This distribution of Vermont's electric supply resources differs substantially from the nationwide distribution. On a national level, coal is used to generate over half of the country's electricity, with nuclear power generating about one-quarter, and natural gas and hydro each generating about 9%. Vermont's electricity supply mix contains about five times as much hydropower and over one and one-half times as much nuclear power as the nation's 1993 supply mix.

As Vermont works to define policies and make wise decisions about electric energy use in the future, our past and current situations illustrate where our attention should be focused. Considerable potential exists for electric energy savings in all three sectors. In the residential sector, water heating stands out as having especially large potential for savings; other end uses which deserve attention are refrigeration, heating, and miscellaneous plug loads. Lighting end uses represent significant potential for savings in the commercial sector, with heating and miscellaneous plug loads representing less, but still important, potential. In the industrial sector, motors consume a great deal of electricity; work to develop and use more efficient motors deserves significant efforts.

Our attention should also be focused on which fuels we use to generate electricity, due to stricter air emissions and environmental regulations already in place, sustain ability considerations, foreign oil dependence issues, and nuclear waste disposal issues. Vermont's electricity supply is and has been generated largely by hydro and nuclear power, but the environmental and sustain ability issues associated with each of these fuel sources must be addressed as the state searches for generation sources in the future. Our use of coal has decreased in recent years and is likely to continue to do so as a result of stricter emissions regulations. Oil has traditionally been used as an electric fuel source in the Northeast, and newer technologies are available that burn oil more efficiently; however, oil use has numerous environmental, sustain ability, and foreign dependence problems. The state has potential for increased use of wood and wind energy to generate electricity, but whether the economic and regulatory climate will prove advantageous for such renewable energy plants remains to be seen.

Nuclear Power contributed about 1,935 GWh (6.6 TBTU) to Vermont's energy supply mix in 1993, accounting for 34% of the state's total electric power and 2,111 GWh or 34% in 1997.[4] About 76% of this nuclear power (1,462 GWh) was generated by Vermont Yankee Nuclear Station, located in Vernon. Vermont Yankee began generation in 1972, and is licensed to operate until 2012. The plant has achieved a high level of output, especially in recent years. About half of the energy Vermont Yankee generates is used by Vermonters, while the other half is used in other New England states.

U.S. utilities used nuclear power from 109 operable plants for 21% of their total energy input in 1993, considerably less than Vermont's usage (U.S. DOE/EIA, *State Energy Data Report*, 1995). Around the world, about 400 operable nuclear power plants exist, supplying 17% of the world's electricity (Shapiro, 1992, 155-6; Brown, Kane, and Roodman, 1994, 52). In absolute terms, the U.S. generates more nuclear energy annually than any other country (U.S. DOE/EIA, *Energy Facts*, 1992, 111).

Radioactive Waste. The ultimate disposal of the radioactive waste generated by Vermont's nuclear power use remains a significant challenge. Low-level radioactive waste includes contaminated metals, filters, resins, and other materials used at nuclear plants. Most low-level radioactive waste decays to safe levels within one hundred years. Currently, Vermont Yankee and the other nuclear plants which supply Vermont with power store their low-level waste on-site. Recently, the Texas Legislature approved a Low-Level Radioactive Waste Compact that allows Vermont and Maine to dispose of low-level radioactive waste at a Texas facility.

A more important issue is the disposal of high-level radioactive waste, which consists of spent fuel. This high-level waste must be managed for many thousands of years in order to protect present and future generations. Currently, Vermont Yankee stores its spent fuel on-site in storage pools, but if present outage and fuel management practices continue, existing storage capacity will run out in 2001. At present, Vermont Yankee has made no statement regarding spent fuel storage beyond 2001. (See Volume 2, Chapter 2, Sections A. Safety, D. Security, and F. Environmental Soundness for a discussion of human health, environmental and security hazards associated with nuclear waste. See also Volume 2, Chapter 3, Section II.F.5 Nuclear Power, Radioactive Waste.)

Decommissioning is the process of removing all radioactive components to a disposal facility and restoring the site to federally established standards after a nuclear plant is permanently shut down. Few nuclear plants have been decommissioned, and the cost for doing so is subject to ongoing increases. Funds for decommissioning are collected from customers during the operating life of the plant and set aside (invested). Vermont Yankee's decommissioning estimates have risen during the past several years. Their decommissioning estimate was $190 million in 1988, which equates to $229 million in 1993 dollars. The most recent 1994 forecast is $313 million in 1993 dollars.

Early Shutdown for economic reasons is one of the greatest planning uncertainties related to nuclear power. Currently, no commercial nuclear plant has operated longer than 31 years before shutting down. Since 1989, six U.S. nuclear plants have opted to permanently shut down for economic reasons well before the end of their 40-year operating licenses. Early shutdowns have been prompted by major technical or equipment problems, which nuclear plants often encounter as they age, that are evaluated as being too costly to repair. Early shutdown is sometimes the most cost-effective response to a problem.

In 1988 DPS prepared a report that studied the possible effects of an early shutdown of Vermont Yankee. This report analyzed what the proper economic basis should be for an early shutdown and concluded that an early shutdown was not economically advantageous at that time. DPS continues studying this topic.

Relicensing nuclear plants after their original licenses expire depends on a number of uncertain factors, including economics, plant performance, and the relicensing process. The U.S. Nuclear Regulatory

Commission is currently working on rules for the relicensing of nuclear plants. A September 1995 report from the Nuclear Regulatory Commission, however, states that the agency's reactor licensing activities are being reduced and their regulatory attention is "being drawn instead toward problems related to the aging of existing licensed reactors and decommissioning, as reactors that were once leading candidates for license renewal have been prematurely shut down" (Hart, 1995, 2).

Any license renewal procedure should take into consideration the human health risks and environmental costs of the radioactive waste created by nuclear power. In addition, license renewal should not be pursued until high-level and low-level radioactive waste disposal issues have been resolved and public acceptance of nuclear power is higher. Because the radioactive waste issue is uncertain and likely to remain so, relicensing should be viewed with great skepticism.

Replacement Power for Vermont Yankee. Vermont should plan now for how to replace the energy Vermont Yankee supplies. Vermont Yankee's license expires in 2012, around the same time that many other nuclear plants' licenses expire, and Vermont will need good energy options in place at that time to fill our electricity needs. The need for replacement energy would come earlier if Vermont Yankee faced a premature, permanent shutdown. Because we know that the power supplied by nuclear plants likely will need to be replaced within the next 20 years, Vermont now has the lead time necessary to ensure that nuclear plants are replaced in an orderly way with efficiency improvements and renewable and sustainable power sources. (See Chapter 4, Section I. Policy 3: Develop Wood and Wind Power For Replacing Nuclear Power.)

Hydroelectric Power. As shown in Figures 3.II.38 and 3.II.38a, hydroelectric power, accounts for almost half of the state's electric energy use. Of the hydropower Vermont used, Hydro-Québec supplied 67% (1,588 GWh) in 1993 and 77% (2,184 Gwh) in 1997. Vermont purchases power from Hydro-Québec under a number of firm contracts which are scheduled to increase capacity, reaching a maximum of 310 MW in 2001. The bulk of these contracts expire in 2015 with very small purchases continuing to 2020. Other out-of-state hydropower suppliers include the Niagara and St. Lawrence hydro projects owned by the New York Power Authority (NYPA). In 1993, Vermont purchased 192 GWh from these projects, but will receive less in the years ahead. Power from the NYPA hydro projects has been very inexpensive in the past and continues to be attractive for that reason.

Almost all of the remainder of Vermont's 1993 hydroelectric mix (597 GWh) came from in-state sources. Independently-owned hydro sites operating as Qualifying Facilities supplied 151 GWh of power, and hydro sites owned by utilities supplied 444 Gwh. Vermont has 19 independently-owned hydro sites, with a capacity of about 53 MW, that sell power to utilities through an independent purchasing agent appointed by the PSB. (In addition, there are several very small independent sites that sell power directly to utilities.)

Vermont uses a greater proportion of hydroelectric power than many other U.S. states, although states in the Pacific Northwest and parts of the West also use a great deal. In 1994, only 8% of the electricity net generation in the U.S. was from hydroelectric power (U.S. DOE/EIA, *State Energy Data Report*, 1995).

Environmental Impacts. There are numerous environmental impacts associated with hydropower development and use. The physical, chemical, and biological character of the river upstream, downstream, and at the dam site are altered by the construction of the dam and the operation of the hydropower facility.

Hydropower damming changes the anatomy of a river from a free-flowing environment to one which may be characterized by fluctuating water levels, impoundment (accumulation of water in a reservoir), and bypass reaches (sections of a river from which most or all water has been diverted). Across Vermont, hydropower projects impound more than 100 miles of streams. These alterations to the river anatomy obstruct water and nutrient flow, and the movement of fish and other aquatic organisms. Many fish and other aquatic organisms have evolved to live in a limited range of environmental conditions within lakes and river systems.

Hydropower facilities can be operated in ways that alter these natural conditions. Sensitivity to the timing and extent of manipulation of the naturally occurring stream flow can minimize impacts on inhabitants of the river system.

The extent of river alteration from a hydropower facility depends to some extent on the mode of operation of the facility. Hydroelectric dams operate as run-of-river or as ponding facilities. At true run-of-river facilities, water outflow equals inflow on an instantaneous basis and power is generated as the water is naturally available. At ponding facilities, water is stored in a pond and released when electricity is needed. The stream flow regime is less significantly altered at run-of-river facilities than at ponding hydropower projects. Slightly less than half of the power that comes from utility-owned hydro sites is generated from run-of-river facilities, with the remainder from ponding operations.

When water is stored and released in ponding facilities, the pond level fluctuates on a daily, weekly, and/or annual basis in response to the volume of water released. Pond level fluctuation can range from one or two feet to more than thirty feet, and it can result in shoreline erosion and poor wetland development. Shoreline erosion can cause the zone used for spawning by some fish species to become inadequate due to lack of a gently sloping shoreline. Wetlands development can be hindered by pond level fluctuations, leading to a reduction in the habitat area that would occur on a natural lake.

Both ponding and run-of-river facilities can cause changes in the aquatic environment by altering the stream flow regime. This happens in several ways. If the powerhouse section of the facility is located downstream from the dam, water flows may be diverted out of the river and carried to the powerhouse by a penstock or canal. In these cases, the riverbed is left with little or no water, creating a bypass. If the project is operated as a ponding facility, downstream flows fluctuate in response to electrical demand. The rate at which this fluctuation occurs can also impact stream life. (See Volume 2, Chapter 3, Section II. Current Energy Use, F. Electric Fuel Sources, 6. Hydroelectric Power for more discussion of these impacts.)

There are measures that can minimize the impacts of hydropower dams on river systems. Using run-of-river facilities instead of ponding facilities is advantageous because they have a smaller impact on stream flow. In addition, dissolved oxygen monitoring can be used to maintain water quality, and restrictions on minimum flows and ponding release rates can be put in place to reduce the impact of fluctuating flows and impoundment levels (Vt. ANR, *Hydropower in Vermont*, 1988, 2-1-2-7; Kathy Fallon, Vt. ANR, personal communication, 8/95). Further, hydro projects can be operated in a manner that reflects the seasonal activities in the river basin. For example, ponding facilities can restrict drawdowns during spawning season to prevent dewatering of eggs. Other operational measures can minimize effects on other aspects of riverine biology as well.

Although hydroelectric power has environmental impacts, it is a renewable energy resource which avoids air emissions and many other negative impacts caused by the use of fossil fuels. While the operation of many hydroelectric plants has not focused on maintaining a healthy aquatic environment, hydropower has the potential to be used wisely, economically, sustainably, and with reduced environmental impacts. As existing plants apply to renew their operating licenses, informed judgment can be exercised regarding the cost to these facilities of altering their operating mode relative to the benefits to be gained for the aquatic environment. Every kiloWatt-hour of electricity generated by hydropower displaces one generated by fossil fuels. Significant air emissions are avoided as a result.

New In-state Hydro. Virtually all of the economically feasible hydro sites of any significant size have already been developed in Vermont, either by utilities or independent owners. In addition, environmental regulations for hydroelectric plants are strict, and Vermonters have expressed concern about the environmental effects of in-state hydro plants. For these reasons, it is unlikely that new hydropower dams will be built in Vermont.

Relicensing In-state Hydro. License renewals involve extensive evaluations of the environmental impacts of the hydro facility by both the state and the Federal Energy Regulatory Commission (FERC). In nearly all cases, changes in operation are required to mitigate adverse environmental effects not anticipated in the original licenses and to enhance river habitats. Restrictions imposed during relicensing most likely will reduce or alter output, resulting in increased costs to customers. Early estimates suggest that environmental conditions attached to the new operating licenses will result in a 10%-20% reduction in their expected output. In some cases, restrictions may shift operations from ponding applications to run-of-river applications. As discussed above, hydro sites that have ponding operations are more economically attractive because they can produce more power during expensive peak periods. Operation during peak periods also displaces inefficient and polluting fossil generation. (See Volume 2, Chapter 3, Section II.F.6. Hydroelectric Power for more information on FERC licensing of in-state hydro projects.)

Repowering In-state Hydro. Many of the hydro facilities owned by utilities in Vermont use old equipment and could benefit significantly from "repowering," or installing new, more efficient equipment. However, the current availability of inexpensive power in New England makes it economically unattractive for utilities to repower their hydro sites at this time. Upgrading the independently-owned hydro sites known as Qualifying Facilities is more economically feasible (for developers), because these power sites receive a fixed price for their output that is not effected by market conditions. On a nationwide basis, increases in hydropower capacity that come from repowering are expected to be offset by retirements in the future (U.S. DOE/EIA *Annual Energy Outlook*, 1995, 29).

Other Benefits of Hydro Electric Generation. Hydro generation facilities provide other benefits to their owners and the regional power system. They are a low cost and reliable source of spinning reserve. Spinning reserve is back-up generation that can be brought online immediately in the case of a failure within the pool. Hydro generation plants provide a distributed source of power which reduces losses throughout the grid and provides local stability. Hydro has no fuel cost. Consequently owners and users of hydro plants are at least partially immune to the vagaries of fossil fuel price fluctuations.

Electricity from Coal. Coal supplied Vermont with 555 GWh (1.9 TBTU) of power in 1993, contributing 10% of the state's electric supply.[5] Vermont's coal power came from the Merrimack 2 power station in Bow, New Hampshire, under a contract that ended in 1998. Currently, Vermont utilities have no long term contracts or ownership interests in coal fired power plants.

Since the 1970s, U.S. coal consumption has grown constantly. In response to oil embargoes and price shocks, consumers began to substitute coal for petroleum products. In 1993, coal plants accounted for about 57% of the total energy input at electric utilities in the U.S., compared to about 10% for Vermont (on an ownload basis) (U.S. DOE/EIA, *State Energy Data Report*, 1995).

Air Emissions. Burning coal produces significant amounts of several dangerous pollutants, including carbon dioxide, sulfur oxides, nitrogen oxides, trace metals, particulates (PM-10), as well as significant solid wastes (mainly ash).

Coal use in the electric utility sector emits much more carbon dioxide per unit of energy used than oil, LPG, or natural gas. (See Table 3.II.3.) Coal contains 80% more carbon per unit of energy than natural gas, and 30% more than oil. Burning coal released 2.3 billion tons of carbon into the atmosphere in 1993, or about 40% of all energy-related carbon emissions (Brown, Kane, and Roodman, 1994, 58).

Coal electric use also releases more sulfur oxides per unit of energy used than any other fuel source, and high amounts of nitrogen oxides and PM-10. Sulfur oxides and nitrogen oxides cause acid precipitation; nitrogen oxides contribute to smog; and particulate matter emissions cause human health problems. Coal burning also emits smaller amounts of carbon monoxide, nitrous oxide, organic compounds including VOCs (volatile

organic compounds) and formaldehyde, trace metals, and fugitive emissions (due to leakage, storage, etc.). The exact levels of emissions from coal combustion depend on the rank and composition of the coal, the type and size of the boiler, the firing conditions, the size of the electric load, the type of emission control technologies, and the level of equipment maintenance (U.S. EPA, *Compilation of Air Pollutant Emission Factors*, 1995, 1.1-2).

Coal burning is affected by the Clean Air Act Amendments (CAAA), which place restrictions on emissions of sulfur dioxide and nitrogen oxides. Phase I of these restrictions began on January 1, 1995, and Phase II will begin on January 1, 2000. Currently, electric utilities emit about 20 million tons of sulfur dioxide annually. The CAAA will reduce annual sulfur dioxide emissions by about 10 million tons and cap them at 8.9 million tons by the year 2000. In addition, annual nitrogen oxide emissions will be reduced by about 2 million tons (Lock, 1991, 19).

Table 3.II.3 Vt. Electric Generation Emissions Factors by Fuel
(lbs/million BTU)

	CO_2	SO_2	NO_x	PM-10	CO	VOCs	CH_4	N_2O[a]
Oil	169	1.1868	0.4790	0.0809	0.0501	0.0016	0.0003	0.0325
LPG (propane)	139	0.0002	0.1364	0.0057	0.0270	0.0109	0.0003	0.0040
Natural gas	117	0.0006	0.4788	0.0066	0.0637	0.0059	0.0003	0.0244
Wood	228[b]	0.0222	0.1550	0.1405	0.3654	0.0111	0.0010	0.0040
Coal	209	1.5500	0.2970	0.6330	0.0239	0.0014	0.0010	0.0325

[a]N_2O emissions factors represent only rough estimates. Previously used emissions factors for N_2O have recently been shown to be inaccurate. The estimates presented here were extrapolated from the reliable data that does exist.
[b]Carbon dioxide emissions for wood are zero if wood resources are managed sustainably. See the wood sections in this chapter for more information.

Electricity from Oil. Oil and natural gas supplied about 332 GWh (1.1 TBTU) of Vermont's 1993 electric supply mix, accounting for 6% of our total electric use.[6] About 57% of this power (190 GWh) came from the Commonwealth Electric's Canal 2 plant alongside the Cape Cod canal under a medium term contract held by Vermont utilities. In addition, 57 GWh came from United Illuminating's New Haven Harbor Station in Connecticut, 19 GWh came from the Yarmouth 4 unit in Maine, and 46 GWh came from the Stonybrook combined cycle facility in Ludlow, MA. Stonybrook is the only facility of the group which generates power with both oil (winter) and natural gas (summer). Utilities also purchase smaller amounts of power from oil and gas-fired units in New England under short term contracts.

Air Emissions from Oil. Oil combustion in electric utility plants produces significant air emissions; major emissions are carbon dioxide, sulfur oxides, nitrogen oxides, and particulates (PM-10). Oil electric use produces very high emissions of sulfur oxides and nitrogen oxides per unit of energy used compared to other fuel sources. (See Table 3.II.3.)

As outlined in above sections, carbon dioxide is a significant greenhouse gas; particulate matter emissions cause human health problems; sulfur oxides and nitrogen oxides cause acid precipitation; and nitrogen oxides

contribute to smog. Combustion of residual oils (the most commonly used oil in power plants) results in significantly higher particulate matter emissions than combustion of distillate oils. Oil combustion also emits nitrous oxide, carbon monoxide, organic compounds including VOCs (volatile organic compounds) and formaldehyde, and trace metals.

Electricity from Natural Gas. DOE projects that natural gas-fired power plants will show the largest increase of any electric fuel source in the future, overtaking nuclear energy as the second largest source of electricity by 2010 (U.S. DOE/EIA, *Annual Energy Outlook*, 1995, 29, 73). Total U.S. natural gas use will grow at an average of 1.2% per year (or 26%) between 1993 and 2010, the largest increase of any fuel source except renewable fuels (U.S. DOE/EIA, *Supp. to Annual Energy Outlook*, 1995, 121). In Vermont, delivered natural gas energy use is projected to increase at 3% per year between 1990 and 2015, while primary energy use is projected to increase by 8.7% per year, reflecting the large amounts of natural gas expected to be used for electric generation in the future around the region; this generation is assumed to serve Vermont in this Plan's base case forecast.[7] (See Part III of this chapter.)

Natural gas prices for electric utility plants in southern New England are expected to increase by 1.1%-1.9% per year through 2015 (Energy Ventures Analysis, 1995.) Natural gas prices will also be influenced by pressures to internalize the external costs of its use, but these costs are lower than costs for other fossil fuels.

Air Emissions from Natural Gas. Natural gas is one of the cleanest burning fossil fuel sources, but it still produces emissions. Carbon dioxide and nitrogen oxides are the major pollutants of concern from natural gas combustion. Natural gas electric utility uses produce one of the highest amounts of nitrogen oxides per unit of energy used compared to other fossil fuel sources. (See Table 3.II.3.) Burning natural gas also produces smaller amounts of carbon monoxide, particulate matter, VOCs, methane, nitrous oxide, and sulfur oxides (U.S. EPA, *Compilation of Air Pollutant Emission Factors*, 1995, 1.4-1).

New Natural Gas Technologies. There are a number of technologies that can dramatically improve the efficiency and emissions of both oil- and natural gas-fired electric plants. They include cogeneration, combustion turbines, and combined cycle plants. Increased competition for new electric generation markets should encourage these technologies. (A description of each of these is in Volume 2, Chapter 3, the section on Potential Energy Sources and Technologies for the Future.)

Electricity from Wood. Vermont used about 247 GWh (0.8 TBTU) from wood generated power in 1993, accounting for 4% of the state's electric usage, as shown in Figure 3.II.38. Wood represents the only renewable energy source besides hydro with a significant place in Vermont's current electricity supply.

McNeil Station in Burlington contributed 33% (82 GWh) of the state's wood-fired electric supply in 1993. McNeil is the largest municipally owned wood-fired power plant in the country, with a capacity of 53 MW. When it began operation in 1984, it held great promise for providing an in-state electric generation source, a market for low grade wood, insulation from fluctuating oil prices, and employment opportunities and other economic benefits. Thus far, McNeil's price has not been competitive, given low oil prices and the increase in Qualifying Facilities which generate power that must be used. However, McNeil has taken measures to improve operation procedures and reduce fuel management problems, and in 1989, added the capacity to fuel its boiler using natural gas as an alternative fuel or in combination with wood. This allows the plant to be used when wood firing is not economical. During 1994, McNeil used wood to produce 87% of its total power, with natural gas providing 11%, and oil the remainder. The percentage of power coming from wood has been increasing in recent years; in 1993, for example, wood produced 80% of the total power. About 65%-70% of the wood McNeil uses comes from in-state sources (McNeil Station personnel, 1995). McNeil station's principal owner, Burlington Electric Department, has worked with the forestry community and its fuel suppliers to develop wood harvesting guidelines that ensure the forests remain a sustainable source of energy for Vermont.

A wood-fired generation plant that began operation in 1992 in Ryegate contributed 165 GWh to the state's supply mix in 1993. Ryegate is the second large scale wood-fired facility in Vermont with a capacity of 20 MW, and it operates as a Qualifying Facility. Unlike McNeil station, Ryegate is powered only by wood.

The Northeast as a whole currently has about 830 MW of wood-fired electric generation capacity, with another 80 MW in development stages.[8] The majority of the capacity is located in Maine and New Hampshire, with 490 MW and 129 MW of capacity respectively (CONEG, *Northeast Regional Biomass Program*, 1995). On a nationwide basis, wood provided 11 TBTU of electric energy in 1992. Wood-fueled plants represent less than 1% of the total electric capacity in the U.S. Primary wood fuel sources in New England are whole tree chips (70-80%) (hardwood and softwood) and sawmill residue (20-30%), including wood and bark waste, sawdust, and green wood (MIT, 1992, 2).

McNeil Upgrade. McNeil station's owners are investigating a proposal to use waste heat from the facility to dry the wood chips it uses as fuel. Burlington Electric Department, the primary owner of McNeil, reports that drying the wood before burning would result in a 30% savings in fuel costs and would also allow the plant's boiler to make more steam than the current steam turbine can use. Adding a second, appropriately sized steam turbine would enable McNeil to use the extra steam to increase its net generation capability by 9.5 MW. The cost effectiveness of this proposal remains to be seen.

McNeil Gasification Project. Gasification technologies are some of the most efficient and cleanest large-scale technologies currently being developed. They operate by turning fuel sources such as coal, wood, and other biomass sources into a gaseous fuel for use in combustion turbines or combined-cycle technologies. (See the Energy Technologies for the Present and Future section in Volume 2, Chapter 3 for a discussion of combustion turbines and combined-cycle technologies.) Vermont has been involved in testing new wood-fired gasification technologies. In 1992, the McNeil Station owners, in collaboration with a developer of wood gasification technology, won a grant from the DOE to demonstrate a wood gasification system at McNeil Station in Phase 1 of the project, and an integrated gasification combustion turbine system in Phase 2 of the project. This system would be capable of powering a 20 MW electric generator. Construction of the wood gasifier is currently underway. When complete, this prototype will be one of the first wood gasification systems of its kind in the world, and will provide valuable information as a demonstration and experimental model.

Emissions and Solid Waste. The emissions of greatest concern from wood burning for electricity are carbon dioxide, particulates, carbon monoxide, and volatile organic compounds (VOCs). Of the pollutants emitted per unit of energy for all electric generation fuels, wood emits the highest or virtually highest amounts of these pollutants. (See Table 3.II.3.)

Although wood use emits more carbon dioxide than any other fuel source, no net carbon dioxide emissions are attributed to wood burning if forest resources are managed sustainably. (For an explanation of this point, see Wood in the section on Non-Electric Fuel Sources earlier in this chapter.)

Other significant emissions from wood-burning steam plants, carbon monoxide, PM-10, and VOCs, all have serious human health consequences. In addition, wood use emits smaller amounts of sulfur oxides, nitrogen oxides, methane, and nitrous oxide. Wood gasification may have the potential to eliminate much or all of these emissions. Wood burning also produces ash, which is very low in heavy metals and sulphate content, and is suitable for use as an agricultural and forestry fertilizer.

Internalizing external costs into energy prices would affect wood as well as all fuel sources. When external costs are not reflected in the price of energy, sustainably harvested wood is placed at a disadvantage (like all renewable fuels) because the absence of net carbon dioxide emissions is not valued. Some models which seek to include external costs into the price of energy also place wood at a disadvantage because they

account only for the carbon dioxide emitted during combustion, and not for the carbon dioxide recaptured through new tree growth (U.S. DOE/EIA, *Northeast Regional Biomass Program*, 1995, 6). Vermont's least cost integrated planning process allows utilities to assume that wood has no net carbon dioxide emissions as they compare different supply options.

Harvesting Impacts. Wood can be harvested sustainably and in a manner that has few environmental impacts. To ensure that our fuelwood use is sustainable in Vermont, we must develop and follow wood harvesting practices that use forest resources at or below the natural regeneration rate and in a manner that protects the environment over time. For more information, see the Wood section earlier in this chapter.

Vermont has made a commitment to sustainable forest practices through education, research, and tax policy. This commitment includes not only sustain ability considerations, but also includes efforts to protect the health of forests for their scenic, wildlife, recreational, and environmental values. State and county foresters, a growing network of private foresters, and the Use Value Appraisal tax program (32 V.S.A. §§ 3751-3775) have all helped improve the management of Vermont's forest land. In addition, electric generating facilities burning wood chips in Vermont are required to buy only from harvesters who follow exacting forest management standards (due to conditions imposed by the PSB in each permit).

Electricity from Landfill Gas. As solid waste decomposes in a landfill, it produces gases which can be collected and used to power small generators. In this way, landfill gas systems convert what was wasted energy and a significant pollutant (methane) into valuable electricity. The Windham County Landfill in Brattleboro (with a capacity of 350 kW) and the Burlington Intervale Landfill (with a capacity of 550 kW) are capturing methane and generating electricity. In addition, there are several smaller landfills that use landfill gas for space heating purposes.

The technology of converting landfill gas to energy has been known for at least two decades. Vermont's landfill gas projects, along with most similar projects in the Northeast, use specially designed internal combustion engines to generate electricity (SCS Engineers, 1994, 2-8). Landfill gas emissions peak several years after a landfill closes and then decline; emissions can last for 10-15 years or longer. In recognition of this fact, developers have structured the generation facilities as modular units which can be added to increase capacity and removed as emissions decrease.

Emissions. Gas emitted from landfills is composed primarily of methane (40%-60%) and carbon dioxide (30%-50%), with trace amounts of volatile organic compounds (VOCs) and toxic gases. As landfill gas escapes into the atmosphere, it contributes to global warming and can contribute to negative human health effects. The major portion of landfill gas is methane, and methane's "global warming potential" is 21 times greater than that of carbon dioxide over a 100 year time frame (U.S. Congress, OTA, 1991, 55). Landfills are the largest human-caused source of methane in the U.S., comprising 36% of nationwide methane emissions (U.S. EPA, *Landfill Methane Outreach Program*, 1994, 2).

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 into carbon dioxide and water, and converts the VOCs and other gases into less harmful substances; nitrogen oxides and carbon monoxide can also be emitted through flaring. Collecting the gas for electricity generation also offsets the combustion of other fuels in electric power plants, and results in even fewer emissions than flaring.

Future Outlook. Landfill generation potential is expected to peak in the 1990s as many landfills approach capacity and fewer new landfills are sited. Stricter regulations have prompted the closing of hundreds of landfills and mandated pollution controls on others. The two alternatives for landfill operators complying with the stricter environmental regulations are flaring the landfill gas or harnessing it for energy (U.S.

DOE/EIA, *Northeast Regional Biomass Program*, 1995, 26). Harnessing the gas for energy may begin to look more attractive to landfill operators with these stricter regulations in place.

According to ANR, most Vermont landfills are too small or do not produce enough landfill gas to make electric power production for sale through a utility cost-effective or attractive to investors. However, direct use of landfill gas as a fuel or for electricity by a nearby facility is feasible for more Vermont landfills, because selling to a nearby facility increases the cost-effectiveness of the project. Feasibility depends on the presence of a nearby facility that has a continuous need for fuel or power.

Capturing Gas from Other Sources. The Foster Brothers Farm near Middlebury produces electricity from the methane gases produced by cow manure. In addition to producing energy and reducing the amount of methane emitted into the atmosphere, this process also reduces water pollution (from runoff) and produces a high quality fertilizer as a byproduct. Manure from other animals and sewage sludge can also provide energy.

Utility Efficiency Programs for buildings, appliances, and machines reduce the need for electricity and cost less than building and operating new power plants. In the 1980s regulatory agencies across the U.S. began to encourage and then require utilities to adopt efficiency measures. This new focus on efficiency programs was called demand side management (DSM), reflecting the practice of managing and seeking to influence customers' levels of demand for electricity as an alternative means of meeting customers' energy needs.

Regulatory agencies in many states, including Vermont, require utilities to evaluate efficiency measures at the same time they evaluate new supply sources in their planning processes. If a specific efficiency program proves to be a more cost-effective way to meet customers' energy needs than generating or purchasing more power, then the efficiency program is the better investment and must be included in the utility's planning process and implemented. In this way, efficiency programs can be seen as part of a utility's supply mix, because they add supply capacity to the mix. The planning process in which utilities weigh the societal costs and benefits of efficiency programs and new supply sources is called least cost integrated planning (LCIP), and the plans produced through this process are called least cost integrated plans or integrated resource plans (IRPs). Some states use accounting techniques that reflect the environmental costs of supply sources and the reduced risk of DSM programs compared to conventional supply sources in their decision-making about cost-effectiveness.

There are many advantages to utilities' focus on DSM programs and least cost integrated planning.

- DSM programs displace the need to generate or purchase additional power, with lower air emissions, less environmental damage, and lower costs.
- Utilities' focus on DSM has created a multibillion dollar market in efficient technologies.
- DSM programs lower the energy bills of the customers who participate, especially important for low-income customers.
- DSM programs offer competitive benefits to businesses who participate, by lowering operating costs.
- Adding DSM programs to utilities' energy resource mix creates a more diversified, reliable, and flexible mix. In general, DSM programs have a lower level of risk than power plants, making them a reliable addition to utilities' resource mix.
- DSM programs provide local jobs.

- Utility DSM programs encourage citizens to learn more about their own energy use and allow them to participate in and influence decision-making about energy resources.

Utility DSM programs can involve a wide variety of measures and program designs, including energy audits and assistance in arranging services, rebates for efficient appliances or compact fluorescent lamps, low-interest loans for home weatherization or industrial retrofits, rebates for the purchase of solar water heaters, or many other measures. Vermont utilities' DSM programs fall into two broad categories: "lost opportunity programs" encourage customers to make energy efficient choices when they buy or renovate a home, commercial building, or industrial facility, and when they purchase new appliances or machinery; "retrofit programs" encourage customers to modify their existing homes, businesses, and appliances to reduce their electricity use. Utilities target different DSM programs to various customer groups in the residential, commercial, and industrial sectors. In addition, some utilities target separate DSM programs to unique customer groups such as low-income consumers or dairy farmers.

Transmission and Distribution System Efficiency Measures. Electric transmission and distribution systems offer significant opportunities for reducing Vermont's energy and capacity needs. Vermont's annual generation and purchases of electric energy is nearly 9% greater than our annual sales of electricity due to losses in the transmission and distribution system.

Through the least cost integrated planning process, Vermont utilities are required to evaluate options for improving transmission and distribution system efficiency, and to implement a program to bring the system to the level of electrical efficiency that is optimal on a present value of life cycle societal cost basis. In addition, each utility is required to implement a program to maintain transmission and distribution efficiency improvements on an ongoing basis.

A number of measures are available to improve the efficiency of transmission and distribution systems, both for retrofits and new designs. Strategic placement of capacitors on the transmission and distribution system can reduce losses and enhance system capacity. Conductors can be replaced with larger, lower-resistance conductors, thereby reducing losses and sometimes providing reliability and safety benefits. Replacing conventional transformers with amorphous metal or high-efficiency silicon steel core transformers can reduce core losses by up to 80%. These low-loss transformers offer a significant opportunity for avoided losses, and a number of major utilities are pursuing their purchases. Other efficiency measures include: increasing the voltage of distribution circuits; using load management programs to optimize the use and sizing of distribution transformers; and reconfiguring distribution systems to balance loads. An energy efficiency program called conservation voltage regulation (CVR) can also be applied to a utility's distribution system to provide electricity at the lowest practical voltage level. Field studies have shown that, in general, a 1% reduction in the voltage delivered to customers through a CVR program results in a 1% reduction in energy use (Vt. DPS, *Vt. Twenty Year Electric Plan*, 1994, 5-23). Finally, there are a number of measures still in experimental stages that could improve transmission and distribution efficiency.

Energy Efficiency Measures in State Government. In 1992, the Vermont legislature passed Act 259, which mandated a program of energy efficiency and conservation in state government. Among other things, the Act called for the use of life-cycle costing by state government in all purchases of energy-consuming items; the installation of energy efficiency measures in new and renovated state buildings; the evaluation of potential energy efficiency measures in all state buildings; an effort to reduce Vermont government's overall energy consumption by at least 20%; an effort to reduce transportation fuel consumption of workers and employees; and an evaluation of a pilot program using alternative fueled vehicles (Vt. Agency of Administration, *Vt. State Agency Energy Plan*, 1996, 5).

Progress has also been made on goals of purchasing energy efficient goods and recycling in state government. Life cycle costing, in which the life cycle total costs (including maintenance and energy costs)

of appliances, equipment, and vehicles are considered in purchases, is being performed to a partial or full extent on lighting equipment, heating systems, vehicles, water heaters, air conditioners, and appliances. In addition, the state made about $5.86 million in documented purchases of recycled products in 1994, up 33% from 1993 and up 53% from 1992. Purchased recycled items included office items as well as machinery, equipment, and various materials for roads. An Executive Order from Governor Howard Dean in 1994 mandated the development of a Clean State Program, to be managed by the Vermont Clean State Council, which monitors and sets programs for state agencies (Vt. Agency of Administration, *Vt. State Agency Energy Plan*, 1996, 20-2).

State government efficiency efforts have also included transportation measures. EVermont, the state's electric vehicle demonstration project, is testing several electric vehicles in Vermont's climate. (See text box EVermont Tests Electric Vehicles in Volume 2, Chapter 3, Section II.G Potential Energy Sources.) Vt. Agency of Transportation is working with the state's Regional Planning Commissions to develop regional transportation plans with the input of local governments. AOT also promotes vanpooling and ridesharing, funding an interest-free loan program for vanpools and helping to match people for carpools.

G. Potential Energy Sources and Technologies for the Future

There are a number of energy sources and technologies whose use will likely grow in the future. While all of these sources and technologies are used now in certain applications, increasing pressures to move toward a more energy efficient, environmentally sound, and sustainable future will likely broaden their applications. These energy sources include all renewables; some renewable sources (hydropower, wood, and methane from landfills) were discussed earlier, wind, solar energy, and hydrogen sources are fully examined below because of their importance to Vermont's future energy situation. Alternative transportation fuels also offer great promise for decreasing our dependence on oil and reducing emissions; such fuels outlined below include reformulated gasoline, gasohol, oxygenated gasoline, ethanol, methanol, natural gas, LPG, and electricity. Finally, several energy technologies also are likely to be more commonplace in future, including cogeneration, combustion turbines, combined-cycle power plants, distributed generation, improved energy storage technologies, and fuel cells.

Renewable Energy Sources. The near future will see the energy use of developing nations such as China increase dramatically. This trend, combined with the growing global environmental problems resulting from energy use, means that relying on and investing in renewable energy sources is essential for a sustainable energy future. If managed properly, renewable resources will be available indefinitely and will leave ourselves and future generations with clean air, water, and land. (See the discussion of the sustainability goal in Chapter 2.)

Renewable fuel sources are those that can regenerate (such as wood) or those that are not depleted by use (such as wind and solar).[9] To use these renewable resources sustainably, we must use them in a manner that does not place economic, social, and environmental burdens on future generations or limit their ability to meet their needs. This means that we must manage renewables such as wood and other biomass sources so that they regenerate and do not cause extensive harm to the environment.

Wind Power is a renewable, sustainable, and environmentally sound energy source. It is one of the most promising renewable energy sources for the future. The technology is well-developed and continues to improve. Today's wind turbines are much larger, more efficient, and have greater availability. Turbines can now generate up to 5 MW, compared to the 100 kW average of the late 1980s models (Jayadev, 1995, 79; Brown, 1995, *State of the World*, 60). In addition, the new machines have lighter and more aerodynamic blades, improved rotor-hub connections and drive trains, new aerodynamic and electronic blade controls, and more advanced power electronics, including some that operate at variable speeds, allowing the turbines to

operate more efficiently at a range of wind speeds. The new designs are less expensive and can be used in more moderate wind-speed areas. (Flavin, *Power Surge*, 1994, 121). The latest wind turbines are now available for operation more than 90% of the time compared to only 50-60% in the early 1980s (American Wind Energy Association, 1991, 1).

The cost of wind-generated electricity has been decreasing rapidly in recent years, and is now nearly cost-competitive with conventional electricity generation. In the early 1980s, wind-generated electricity cost about $0.20 per kWh (in 1993 dollars). For wind turbines installed in the early 1990s, the average cost is $0.07 per kWh, and a few wind developers using new technologies have signed recent contracts to sell wind-generated electricity at about $0.05 per kWh (Flavin, *Power Surge*, 1994, 121). With these most recent contracts, wind energy is starting to become cost-competitive with new generation plants fueled by natural gas or coal, which cost $0.04-0.06 per kWh. The National Renewable Energy Laboratory predicts that wind-generated electricity will be produced for $0.04 or less per kWh by 2000 (including up-front capital costs) in modest, 13 mph wind regimes. If environmental and social costs were internalized into energy prices, wind power likely would be cost-competitive today. In addition, wind power can act as a hedge against future fossil fuel price fluctuations in utilities' generation portfolios.

Wind energy has no emissions, no solid waste disposal, and no fuel delivery and storage. Worldwide, wind turbines avoid the emission of 3.25-6.5 million tons of carbon dioxide annually that would occur if conventional energy sources were used. This avoidance of air emissions is significant and it makes wind energy one of the most environmentally sound energy sources available.

However like any energy source, wind power sites have some environmental impacts. The best wind sites are often in remote areas, which causes roads and transmission facilities to be built in areas that might otherwise have remained undeveloped. Wind turbines also cause an aesthetic impact because they are large and often must be located on visually prominent ridge lines to maximize production. Although these impacts must be taken seriously, they are generally far less damaging than the environmental impacts of almost all other energy sources.

Wind energy systems have one final advantage: they can stimulate local economies by investment in local resources, which furthers Vermont's energy goal of security. Regional studies show that wind energy creates more jobs than conventional energy sources such as coal, natural gas, and nuclear power.

GMP recently has recently developed a utility-scale wind generating station (Docket 5823). The project, made possible with a $3.5 million grant, has 11 wind turbines with a capacity of 6 MW near Searsburg, Vermont. Power from the project is projected to cost about $0.07 per kWh after grant funds are taken into account. Although current plans are for developing only the 6 MW station, there is additional wind potential and incremental development at this site should be less costly than the initial development.

There are also a number of wind-related businesses located in Vermont. Atlantic Orient of Norwich does research and development related to wind energy, NRG of Hinesburg does wind testing and site evaluation, and Northern Power Systems builds remote, high-reliability wind systems. Further development of wind energy, both in and outside the state, will benefit these wind-related businesses and the Vermont economy.

Solar Power can be used for heating and lighting, and converting solar energy into electricity have great potential to help fill our energy needs. Like wind energy, solar energy is readily available and sustainable, has minimal environmental impacts, and displaces fossil fuels and energy imports.

To advance toward a more sustainable energy future, it is important to focus on using current sunshine instead of ancient sun light. Although the amount of sunshine New England receives is lower than in other parts of the U.S., there is still great potential to use the sun's energy here. Every acre in Vermont receives the

energy equivalent of nearly 5 million kWh of electricity each year from the sun (Seddon, 1988, 18). It is estimated that electricity equivalent to Vermont's 1992 electricity use could have been supplied by approximately 11,000 acres of photovoltaic modules, an area about twice the size of Lake Memphremagog. Because the solar energy available to Vermont varies throughout the year and because there are difficulties with storing energy, it generally is not economic to design solar systems in Vermont to deliver 100% of the energy needed year-round. Solar energy can be used in combination with other energy sources year-round. To explore new opportunities for using solar energy, Vermont utilities and businesses are finding ways to participate in the National Presidential Challenge, the Million Solar Roofs Initiative.

Solar Lighting, Space Heating, and Water Heating. All sizes of buildings, from small homes to apartment complexes to large commercial buildings, can be built to capture sunlight for lighting, heating, and water heating. These uses of solar energy are especially efficient because they use the energy directly with no conversion losses (except for losses associated with pumps and other devices that enhance some solar equipment).

The sun's energy is captured in buildings by either passive or active solar systems. Passive solar systems utilize architectural design and special building materials to capture and distribute sunlight. Active solar systems use non-solar energy to power mechanical devices such as pumps and fans that enhance the solar system. (For further information on these two approaches see Volume 2, Chapter 3, Section II.G. Potential Energy Technologies, 1. Renewable Sources - Solar Power.)

Passive solar buildings 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, cheapest ways to use renewable energy and reduce fossil fuel use, and emissions. Although New England does not have as much sunlight as other parts of the U.S., there is substantial solar potential to be gained by simply incorporating cost-effective passive solar heating and lighting measures into our buildings.

Solar water heating is another solar measure that can capture considerable solar energy in Vermont. Modern solar water heating technology has been in use for more than 20 years and is highly reliable. There are currently about 3,500 solar water heaters in use in Vermont (Solar Works, personal communication, 7/95). Solar water heaters in Vermont are typically designed to provide all the hot water needed in the summer, and about 65% of the hot water needed on an average yearly basis, thus requiring back-up systems.

Solar water heating is especially effective when it displaces electric water heating. Water heating is the second largest energy cost in a typical household (not including transportation costs). Solar water heaters cost more to install than other types of heaters, but their yearly fuel costs are much lower (even when a back-up system is used).

Photovoltaic Power. Photovoltaic cells (PVs) convert solar energy into electricity when sunlight excites electrons in the cell's silicon material. They can be located on the roofs and sides of buildings and homes or on land set aside for the purpose. On a much smaller scale, they can be located on many kinds of appliances and devices, from street lights to calculators.

The use of photovoltaic cells for generating electricity is growing around the world. The Million Solar Roofs Initiative, recently launched by the Clinton Administration, will jumpstart the solar energy industry and energy efficiency efforts in the U.S. Japanese and U.S. manufacturers have developed "solar tiles" that could become a common roofing material. There are now more than 30 companies manufacturing solar cells worldwide, with the market growing at a rate of 12% annually (Brown, *State of the World*, 1995, 42). U.S. growth would accelerate more if costs drop significantly or if large-scale investment in PVs occurs (U.S. DOE/EIA, *Annual Energy Outlook*, 1995, 33).

Although PV use is growing, improvements are needed to make the technology more economically competitive. By 1993, the average wholesale price of PVs had fallen to $0.25-0.40 per kWh, but projections suggest that price could fall to $0.10 per kWh by 2000 and even $0.04 per kWh by 2020 (Flavin, *Power Surge*, 1994, 156, 173). Like all technologies that use renewable resources, photovoltaics could become cost-competitive even sooner if the environmental costs of using energy were included in energy prices.

Photovoltaics offer a wide range of applications. Niche applications for PVs which are currently cost-effective in some cases include street and parking lot lights, gate controls, environmental monitoring systems, vehicle battery chargers, remote rest area lights and fans, remote stock watering pumps, irrigation controls, and others. On a much larger scale, utilities can site photovoltaic panels in one area to form a solar generation plant.

An estimated 300 Vermont homes are disconnected from the utility power grid, using only photovoltaic power (Solar Works, personal communication, 7/95). The electricity usually is not used directly, but charges a battery bank. Because Vermont's climate is much cloudier in the winter than in the summer, most large systems include a gas or propane generator that can be used to run appliances or charge the battery bank when needed. Homes in remote areas or on sites without utility power are good candidates for PV power in Vermont. The cost of extending utility power distribution lines costs between $20,000-$40,000 per mile in Vermont, which can make PVs the least-cost option for many new homes, even if they are fairly close to existing power lines (Vt. DPS, *Solar Energy Guide*, 1993, 22).

Utility-sized PV plants are not likely to be a cost-competitive near-term option for Vermont. However, falling cost, as outlined above, suggests that they will become feasible for the sunniest U.S. regions by the next century.

Alternative Transportation Fuels could substitute for gasoline and diesel. These include gasoline-based products such as reformulated gasoline, gasohol, and oxygenated gasoline. Other alternatives include ethanol, methanol. compressed natural gas, propane, and electricity.

All of these alternatives to traditional petroleum fuels are currently used as transportation fuels, all have some environmental advantages over gas and diesel, and some also could lower our dependence on petroleum. Using alternative fuels is a step toward solving some of our problems regarding the sustain ability, environmental soundness, and security of our current fuel use, and while not a complete solution, alternative fuels can make significant contributions until more definitive solutions are found. This is particularly important because transportation is the least sustainable energy end use (dependent almost entirely on non-renewable fossil fuels), the most polluting end use, and the end use with the least diverse energy sources.

Alternative fuels currently cost more than gasoline and diesel fuel (excluding external costs). Since it is unlikely that these alternative fuels will cost less than gasoline in the near future, to capture their benefits now requires public policy decisions favorable to those fuels. This was the case with the change from leaded to unleaded gasoline, and this is exactly what is happening with many of these new fuels. Reformulated gas, gasohol, and oxygenated fuels are either required in many areas or given a tax subsidy in others. The 1990 Clean Air Act Amendments require some fleet vehicles to run on fuels such as natural gas, and electric vehicles will soon be required to be sold in California. Some fuels are recipients of state and federal research and development efforts, such as Vermont's Electric Vehicle Project and Vermont Gas's compressed natural gas test vehicles.

There are other important challenges to the widespread use of alternative fuels. Many alternative fuels require modification of vehicle engines as well as fuel storage and delivery systems. Car-makers, however, are reluctant to make significant changes to the automobile when there is not a strong production,

distribution, and supply of alternative fuels. Similarly, producers of alternative fuels are unwilling to commit large amounts of capital to alternative fuels if car-makers do not design cars to run on alternative fuels. And finally, car-buyers are reluctant to purchase vehicles that are difficult to refuel. These difficulties are not, however, insurmountable. Development of a Clean Corridor and alternative fuel infrastructure linking Boston and Montreal and passing through Vermont, will promote the introduction of alternatively fueled (non-gasoline) vehicles to the general public. (See Volume 2, Chapter 3, II. G. for more information on alterative transportation fuels and Chapter 4, Policy: Promote Incentives for Alternative Transportation Fuels.)

Energy Technologies for the Present and Future, such as cogeneration, combustion turbines, and combined cycle plants are electric generation technologies that have the potential to be much more efficient, to release fewer emissions, and to reduce fuel and overall costs compared to traditional generation technologies. (For more information on these sources see Volume 2, Section II. Current Energy Use, G. Potential Energy Sources.)

Cogeneration is the simultaneous production of electric power and heat energy. For example, a combustion turbine that produces electricity and a boiler or heat recovery steam generator that recovers waste heat from the turbine and produces hot water or steam for heating or industrial processes. Because cogeneration systems produce both electrical and heat energy, they can achieve substantial savings in fuel costs, overall costs, and total air emissions. Whereas a conventional generating system is about 25%-30% efficient, when waste heat is used in a cogeneration system, the efficiency can increase to around 80%. Cogeneration systems are most efficient and successful when the heat energy is used on a continuous basis, at an industrial or other facility that needs constant, year-round thermal energy.

Combustion Turbines are being used in new and more efficient ways to produce electricity. Combustion turbines operate in the same manner as jet engines in aircraft. In a combustion turbine, fuel is introduced into a combustion chamber together with compressed air. The fuel burns and the expanding exhaust gases pass out through the turbine, turning the blades to provide power. Most combustion turbines use distillate oil or natural gas, but work is advancing on ways to extend the same technology to fuels such as coal and wood using gasification processes.

The design of combustion turbines is continuing to improve. Smaller, more versatile, more efficient turbines that use advanced metals, new blade designs, and high compression ratios are in the works. The efficiency of these turbines is already at 39% and is expected one day to approach 60%. These advanced turbines have relatively short installation times, and their varying sizes (between 48 MW and 1 MW) suit a range of applications.

Combined Cycle Power Plants utilize the most efficient large scale thermal electric generation technology. Using waste heat from the combustion turbine to produce more electricity dramatically improves the efficiency of the plant. By 1993, this technology achieved an efficiency level over 50%.

Combined cycle plants and advanced combustion turbines have environmental advantages over conventional oil- or coal-fired generators. Since they are more efficient, they require less fuel and have fewer emissions per unit of electricity produced. When burning natural gas, they emit virtually no sulfur oxides and only negligible particulates. They also cut emissions of nitrogen oxides by up to 90% and carbon dioxide emissions by up to 60% compared to conventional plants (Flavin, *Powering the Future*, 1994, 20-1).

At present, there are three utility-owned combined-cycle plants in New England. The Stonybrook facility in Massachusetts is the largest of these, and Vermont utilities own 57 MW of its capacity. In addition, there are a number of independent power producers in New England which use combined-cycle systems. The Department of Energy projects that 61% of the new U.S. electric generation capacity needed by 2010 will be

gas-fired or oil- and gas-fired combined-cycle or combustion turbine technologies (U.S. DOE/EIA, *Annual Energy Outlook*, 1995, 29).

Combined-cycle technologies have not yet replaced conventional technologies partly because they use distillate oil or natural gas, fuels that are not as cheap as the coal that fires most of the conventional plants in the country. Engineers are working to develop technologies that would use coal and wood as fuels for combined cycle plants by "gasifying" the fuels so that they can power a combined cycle system. (Vermont is involved in a wood gasification demonstration project. See the Electricity from Wood section above.) Wood and other biomass sources have the potential to be used sustainably with combined-cycle plants.

Distributed Generation is a concept in which small-scale generation and modular storage facilities are located throughout the region (in the distribution network) instead of at a central power station. The technologies envisioned as distributed generation include fuel cells, photovoltaics, solar thermal systems, wind turbines, small hydroelectric plants, landfill methane systems, biomass gasification, cogeneration systems, and battery storage units. (Some of these technologies could also be used without the involvement of utilities.) Distributed generation units potentially have environmental advantages, higher efficiencies, shorter construction times, and lower construction costs than centralized stations; in addition, such units are well-suited to the use of locally available fuels.

One of the most attractive advantages of a distributed generation system is that it would reduce the need to build and upgrade transmission and distribution lines. Utilities annually invest substantial amounts of money in transmission and distribution. The transmission and distribution system is designed to meet large peak demand requirements, and because peak demands occur infrequently, the lines are often under-utilized. Distributed generation units could be strategically located to relieve existing or anticipated transmission and distribution constraints. In this way, distributed generation would provide utilities with value both as a generation investment and as a transmission and distribution investment. Because transmission and distribution is expensive, it might be economical in some cases to pay more for electricity from small decentralized generators located near customers than to purchase bulk power for less but pay more to get it to customers.

An issue that needs to be explored in planning for distributed generation is reliability. The current, centralized generation system is reliable because if a power plant temporarily shuts down, backup power from other locations can be sent to customers through the transmission lines. However, with a distributed generation system, such backup might not exist if the transmission and distribution system was not capable of handling it. On the other hand, smaller units on an integrated grid would be easier to back up than large units due to the smaller amount of energy required, and thus necessary reserve margins could decrease. Move toward a distributed generation system could improve efficiency, utilize more local fuel resources, give people more local control and involvement over their electric energy, and (in some cases) lower the environmental burden of energy use.

Energy Storage Technologies. In order for our energy future to be sustainable, our use of renewable energy sources will need to grow and our energy storage technologies will need to improve. Many renewable sources are available only at certain times, which may not coincide with the times when we need energy. There are a number of energy storage methods currently used, and others being developed. Batteries are one of the most familiar; they can store electric energy from any source. Battery technology is quickly improving for both traditional lead-acid batteries and for newer types such as nickel-cadmium batteries. With non-electric thermal storage systems, heat is absorbed by a mass that will store it and release it later on. Masonry walls or floors can absorb heat in a passive solar home during a winter day, and release it slowly after the sun goes down. Other thermal storage systems include indoor pools, rock beds, or at a larger scale, molten sodium. Utility-scale storage technologies include compressed air energy storage and superconducting magnetic energy storage. Pumped or "ponded" hydropower are other options. Finally,

hydrogen gas, derived by electrolyzing water and stored for later combustion, could act as an energy storage means in conjunction with renewables. Renewables such as wind, solar, and hydro could produce electricity when demand is high and create hydrogen when demand is low. All energy storage technologies have a similar shortcoming; energy is lost in storage, so less energy is available later. Still, they provide a way for our energy supply to be much more versatile, especially when used in conjunction with renewables.

Fuel Cells convert chemical energy into electrical energy or electricity. Like batteries, they consist of an electrolyte and two electrodes. Fuel cells have the potential to change the electric utility industry. It is conceivable that during the 20-year scope of this Plan, electricity generated from fuel cells could become competitive with electricity produced at central power plants. If this happens, new buildings could have natural-gas-powered fuel cells providing their electricity, heating, and hot water needs. The results of a decentralized power generation process competing directly against a large, centralized, capital-intensive, regulated utility with long power plant life times are uncertain and such a possibility should be carefully monitored and explored. Currently, there are 55 200 kW fuel cell power stations worldwide.

Fuel cells combine hydrogen and oxygen to produce water, electricity, heat, and carbon dioxide (the amount of CO_2 depends on the amount of carbon in the hydrogen source). The source of hydrogen can be hydrogen gas or hydrogen-rich fuels such as natural gas, LPG, or methanol. Most fuel cells currently run on hydrogen-rich fuel because of cost, supply, and storage problems associated with pure hydrogen. When the hydrogen and oxygen are combined to form water, they release electrons that are captured to provide electrical energy. Heat and carbon dioxide are also released. The heat can be captured and used for space or water heating needs.

Fuel cells are very efficient, producing more electricity from each unit of fuel than technologies that require burning the fuel. Typical generating facilities burn fuel, then use the heat and expanding gases released from the burning to turn a mechanical generator which generates electricity. Fuel cells eliminate these steps and the inefficiencies of capturing the heat and operating a generator. Conversion efficiencies, therefore, are very high -- up to 80% in an ideal system. Practical efficiencies, however, are currently about 40% due to various internal losses. This is better than most currently operating power plants and about the same as new combined-cycle plants. The waste heat can be utilized for space or water heating, further increasing a fuel cell's theoretical efficiency to nearly 85%. Emissions are quite low since no combustion of the fuel takes place. Fuel cells produce very reliable high quality power that, because of their small size and ability to be located at a customer's site, are less prone to interruption or fluctuations in voltage and interference. Fuel cells can displace the need for upgrading transmission and distribution systems by being located along and near the end of over-stressed transmission lines. Siting of units is easier because fuel cells are modular and can fit into many settings, including industrial settings and finally, fuel cells can utilize many energy sources, including gasified fuels.

In addition to fuel cells' advantages over conventional generation technologies and methods, they are also very versatile. The greatest current disadvantages to fuel cells are their novelty and cost.

H. Current and Future Issues in Energy Use

Two energy use issues deserve special attention because they will increasingly form the context for future energy decisions. These issues are reflecting the full cost of energy use in energy prices, and competition and restructuring in the electric utility industry. An overview of these topics follows.

Full Cost of Energy Use. Currently, individuals and firms who benefit from energy use usually do not bear all the costs associated with that energy use. Instead, some of those costs are shifted onto other members of society, future generations, and the environment. This occurs because consumers usually pay for the cash

production and distribution costs of using energy, but do not pay directly for other costs of using energy. These other costs include the indirect, negative consequences of energy use that are or eventually will be borne by someone. Because these consequences are borne by people who are outside or external to the contract between the energy provider and energy user, they are called external costs.

The failure of markets to include external costs in the prices of energy distorts the choices of policy-makers and consumers. If the full cost of energy use were reflected in the price of all fuels, market forces would ensure that cleaner energy sources with less associated costs to society would eventually displace more expensive and dirtier fuels. The advantages of renewable energy sources would become more obvious as these sources became more affordable compared to other sources. Moreover, the pattern of energy use would change if prices and public policy better accounted for the relative costs, risks, and benefits associated with each type of energy and technology.

In response to the failure of the market to include all the external costs and benefits of energy use, law makers and regulators in some states and on the national level have attempted to internalize or encompass such externalities in the price of some energy sources. In Vermont, as well as in some other states, electric and natural gas utilities must reflect externalities in cost-benefit analyses through the least cost integrated planning process. Usually external costs are reflected by including adjustments (sometimes called adders) to the costs of polluting energy sources during the decision-making process. Twenty-five states plus the District of Columbia currently require consideration of environmental externalities in electric utility decision-making, with two more states considering such requirements.

On the national level, regulations that limit fuel emissions internalize some external costs. For example, the Clean Air Act Amendments of 1990 made steps toward internalizing the costs of sulfur dioxide emissions (a pollutant that causes acid rain) by giving utilities a certain number of emission allowances that effectively place a cap on how much they can emit. The allowances can be bought or sold among utilities, offering an incentive to utilities to cut their emissions and earn a profit by selling their allowances. In addition to this allowance method, there are other ways of internalizing external costs and benefits. For instance, a carbon tax would internalize the costs of emitting carbon dioxide; this would make renewable and non-polluting resources more cost-competitive. An energy tax would internalize the costs of using all forms of energy, encouraging consumers and utilities to use energy as efficiently as possible. Gasoline taxes already in place are generally intended to internalize the costs of maintaining public roadways, although these taxes in Vermont do not internalize all the costs of maintaining roadways or internalize any other costs. If tax revenues are dedicated to mitigating external effects, they can provide a double benefit. However, with the current dissatisfaction among the American public for government solutions funded by taxes, the feasibility of setting new taxes is uncertain. Efficiency standards on equipment, vehicles, appliances, generation plants, and other technologies also could internalize some of the costs of inefficient energy use and limit emissions.

Fully internalizing or eliminating the external costs of energy use would significantly impact energy prices. It is difficult to predict the full impacts of future taxes, standards, and regulations on energy prices, but it is likely that the fuels with the highest full costs will have higher prices in the future. For example, in addressing the costs of global climate change, the price of coal (which has 2.04 pounds of carbon per BTU) will likely be more affected than the price of natural gas (at 1.20 pounds of carbon per BTU) (Repetto, 1992, 55). Although higher energy prices are difficult for consumers in the short run, decisions made today when energy prices do not reflect the full cost of energy use could commit Vermont and the nation to higher-than-necessary energy prices in the future.

Vermont's experience with internalizing costs (like the experience of most states) has been mainly restricted to the electricity and natural gas utility sectors and the gasoline tax. The Vermont Public Service Board (PSB) Order in 1990 that required least cost integrated planning (LCIP) of all Vermont electric and natural

gas utilities also found that environmental externalities must be included in determining which energy resources were "least cost" on a societal basis (Docket 5270). In the 1991 statute passed by the legislature that supported the Board Order, "least cost" was defined to mean minimizing "economic and environmental costs" among supply, transmission, and demand-side options (30 V.S.A. §218c). Because of the inclusion of least cost integrated planning, energy decisions in Vermont better reflect the societal costs of energy use. (For more information on applying external costs to Vermont's utility decisions see Volume 2, Chapter 3, Section II..H. Current and Future Issues, 1. Full Cost of Energy Use.)

It is no surprise that Vermont and other states have found it difficult to resolve how to value environmental and social external costs. Even if government regulators, policy makers, and economists are eventually able to create a complete valuation system for externalities in the electricity sector, the forces behind the push for increased competition and restructuring in the utility sector could hinder progress toward internalizing costs unless a method to meld competition and internalized energy costs is found. In the non-utility energy sector, even fewer external costs are currently internalized than in the utility sector. In many respects, a national system of taxation that internalizes energy costs for electric and non-electric fuels could be the easiest, most equitable, and most reasonable approach to reflect the full costs of energy use. This approach has been used successfully in many European nations. (See Volume 2, Chapter 4, Section I. Strategy H. Use Energy Taxation to Meet Vermont's Energy Goals for information on energy tax impacts.)

Eventually, the public will pay the external costs of energy use. If consumers begin to pay those costs now (or avoid them), they will spend more for energy, but they will also encourage energy efficiency and renewable energy sources. If consumers do not pay now, they keep current energy prices low but create situations that will require much more money and more drastic action in the future. Although it has proven difficult to quantify and include the full costs in energy prices, if we do not do so, the market assumes such costs do not exist -- a valuation we *know* is wrong. Internalizing the costs of energy use allows the market to efficiently allocate resources at the least cost to society, and to deal effectively with problems such as energy security, global climate change, and air pollution.

Increasing Competition and Restructuring in the Electric Utility Industry. Historically, utilities have accepted the obligation to provide electricity service to customers in exchange for exclusive rights to service territories and an opportunity to earn a reasonable return on investment capital. Government regulators act in place of market forces, limiting utilities' monopoly power, mandating rules of operation, and providing an opportunity to earn a fair rate of return. This regulated monopoly system between utilities and the government has allowed customers to receive adequate, reliable electric service at reasonable rates.

Fundamental changes are being considered in the electric utility industry that can significantly alter this system. Increasing competition in many areas of the utility industry may offer lower rates than can be accomplished under the regulated monopoly system between utilities and government. This has encouraged some to push for even more competition of the utility industry. (See Chapter 4, Strategy F: Increase Competition in the Electric Utility Industry, Policy 1: Move Toward Greater Retail Competition While Maintaining Societal Benefits.)

Vermonters and citizens from around the country must decide how competition and utility restructuring can best benefit society as a whole. Society benefits from increased competition only if cheaper electricity comes while maintaining appropriate social obligations which the utilities now carry, including long-term planning, consideration of environmental and social costs, equitable pricing to all customers, and other obligations. The task of working out how to reap the benefits from increased competition while retaining the benefits of the current utility structure is a formidable one, and it requires that citizens, planners, regulators, and utilities decide what is most important to society in our electric energy use.

III. FUTURE ENERGY USE

A. Base Case Forecast and Energy Projections

In order to better understand what Vermont's future energy use may be like, this Plan includes a base case (or baseline) forecast projecting future energy demand under a business-as-usual scenario and showing where opportunities lie for energy savings and environmental improvement. The base case also provides a point of comparison for the energy savings impacts and environmental improvements of various policies. (See Volume 2, Chapter 3, Section III. Future Energy Use, D. Baseline Forecast Overview.) Because the base case forecast represents a business-as-usual scenario, it does not describe Vermont's most likely future. Instead, it describes what would most likely happen if current trends continue and if no changes occur in state and national energy policy.

The base case forecast presents projections for energy expenditures, energy consumption, and air emissions for Vermont through 2015. Projections were made for each sector (residential, commercial, industrial, transportation), end use, and fuel type. (See Volume 2, Chapter 3, Section III. Future Energy Use, E. Baseline Energy Projections for a full presentation of the base case.)

Energy Expenditures have been rising slowly since the mid-1980s. Future expenditures are expected to rise more quickly, at 1.7% per year or 54% between 1990 and 2015, due to rising energy prices and increasing consumption levels. The transportation sector claims the largest portion of Vermont's energy expenditures, as shown in Figure 3.III.8. Transportation expenditures are currently only slightly greater than expenditures in the residential sector, at $448 million and $437 million respectively (in 1995 dollars). However, this gap is expected to increase substantially in the future as transportation expenditures increase by 66% while residential expenditures increase by only 25% between 1990 and 2015. Expenditures in the commercial and industrial sectors are also projected to grow quickly in the future, by 73% and 70% respectively; however, energy outlays in these two sectors will still remain lower than the other sectors.

Oil and electricity expenditures are currently similar in Vermont, at about $595 million for oil and $555 million for electricity (in 1995 dollars), but are expected to draw apart in the future as oil prices and expenditures rise, as shown in Figure 3.III.9. Oil and electricity purchases together are expected to comprise between 86%-87% of Vermont's total expenditures through 2015. Expenditures for natural gas and LPG are expected to rise 139% and 66% respectively between 1990 and 2015, but these expenditures remain small in comparison to oil and electricity expenditures.

Total Energy Use is expected to increase 54% between 1990 and 2015. This increase stems largely from growth in transportation energy use due to increasing vehicle miles traveled and dispersed land use patterns, and growth in commercial and industrial energy use due to projected economic output from these sectors. (See Volume 2, Chapter 3, Figure 3.III.10.)

Energy Use Among Sectors. Figure 3.III.11, depicting the state's delivered energy consumption by sector, shows trends similar to those for energy expenditures by sector. The gap between transportation and residential energy consumption will continue to widen, as transportation energy use increases by 69% while residential use grows by only 21% between 1990 and 2015. Residential use increases slowly in the future partly as a result of gains made by appliance efficiency standards and the fact that new homes are usually more efficient than old ones. Energy consumption in the commercial and industrial sectors increases fairly quickly, but remains low compared to use in the residential and transportation sectors.

Energy Use Among End Uses. Figure 3.III.12 illustrates Vermont's energy consumption by end use, including transportation as an end use. Energy consumption increases among virtually all end uses in the base case forecast, but increases faster for road transportation than for any other major end use. Road

transportation energy use rises 72% between 1990 and 2015; by contrast, energy consumption for the next largest end use, heating, rises only 30% during the same time-frame. Several end uses are projected to experience growth rates between 50%-60%, including water heating, process heat (industrial), motors (industrial), lighting, drying, and miscellaneous electric loads. These increases occur over a time period in which population increases by about 21%; thus, the state's per capita energy use grows substantially.

Energy Use Among Fuels. Vermont's delivered energy use by fuel, as shown in Figure 3.III.13, depicts the dominance of oil in our energy consumption. Oil consumption is projected to increase 52%, from 62.8 TBTU to 95.2 TBTU, between 1990 and 2015. While use of other fuels is also expected to increase (natural gas at 108% and LPG at 83%), total use of other sources remains small compared to oil.

Residential Energy Use. Within the residential sector, transportation and space heating end uses have utilized similar amounts of energy through the early 1990s, as shown in Figure 3.III.17. However in the future, the two end uses are expected to take different courses, with residential transportation energy use increasing by 62%, while space heating use increases by only 4% between 1990 and 2015. Homes are becoming increasingly efficient, but automobile efficiency is not climbing. In addition, rising personal income in the forecast creates demand for new homes (among other things), and while new homes tend to be more efficient, their locations generally require more transportation energy use. Water heating is the next largest end use in the residential sector, and its energy use is projected to increase by 53% between 1990 and 2015. Other end uses are also expected to increase, but their total energy requirement will remain low.

Commercial Energy Use. Similar to the residential sector, the commercial sector's fastest growing end use is transportation, which climbs by 72% between 1990 and 2015 (as shown in Figure 3.III.19). Heating energy use in the commercial sector experienced a decline in the late 1970s and early 1980s, probably due to conservation efforts and efficiency gains. Into the future, however, it is expected to increase substantially (99% between 1990 and 2015), unlike space heating in the residential sector which barely increases. This is partly due to the fact that commercial output (and, hence, space heating) increases steadily into the future, and because commercial energy use more closely parallels economic trends. All other commercial end uses are expected to increase by 56%-75%

Industrial Energy Use. Process heat remains the dominant energy end use into the future, increasing 54% between 1990 and 2015 (as shown in Figure 3.III.21). Transportation, the second-highest end use grows by 90% during the same time period. Industrial motors and transportation have used similar amounts of energy in the past, but in the future this gap widens, as energy for motors increases slower between 1990 and 2015.

Transportation Energy Use. Within the transportation sector, residential use accounts for a higher proportion than commercial and industrial use and is projected to remain higher, as shown in Figure 3.III.23. Transportation energy use is expected to increase 62% in the residential sector, 72% in the commercial sector, and 90% in the industrial sector, although usage in the industrial sector remains small in comparison with use in the other two sectors.

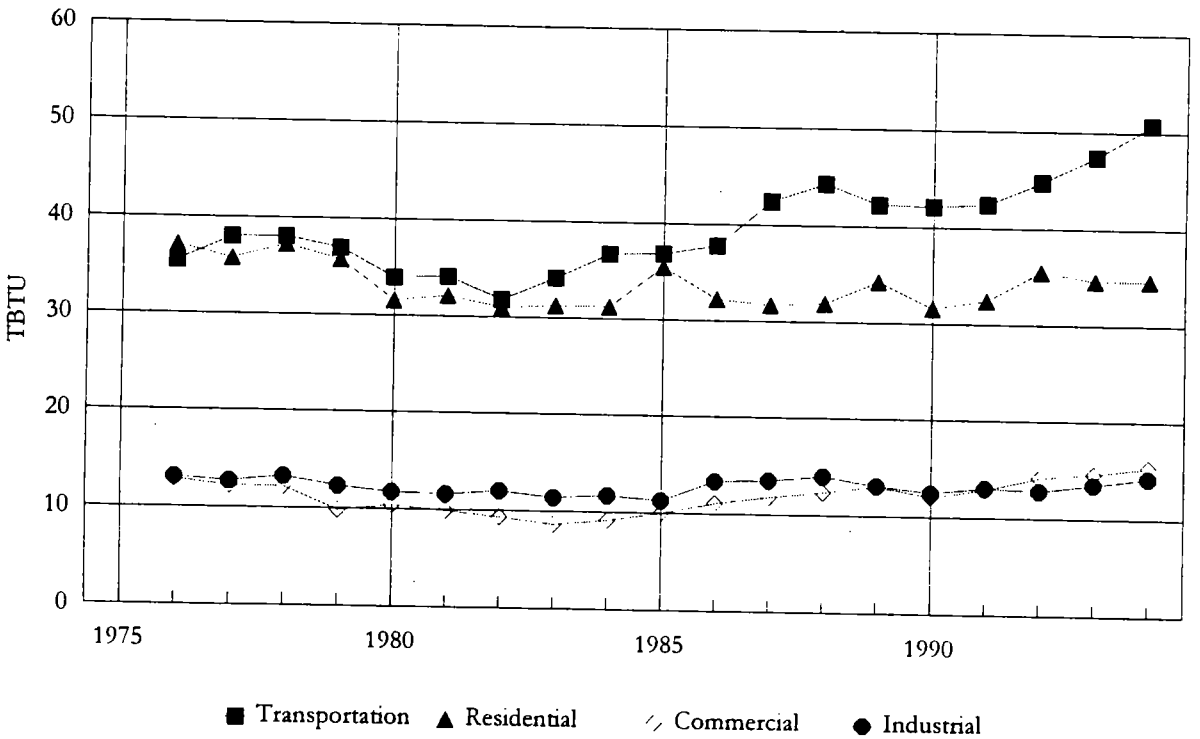
Total Air Emissions from Energy Use. As shown in Figure 3.III.25, the most significant pollutants (in terms of tonnage) resulting from Vermont's energy use are carbon dioxide, carbon monoxide, nitrogen oxides, volatile organic compounds (VOCs), and sulfur oxides. Vermont's energy use also emits smaller amounts of particulates (those less than 10 microns or PM-10), nitrous oxide, and methane. (See Volume 2, Chapter 3, Figures 3.III.26 - 3.III.29 for emissions broken down for residential, commercial, industrial, and transportation uses.)

Our emissions of four of these eight pollutants are projected to decrease between 1990 and 2015 (carbon monoxide, VOCs, sulfur oxides, and PM-10), but emissions of the other four are projected to increase

(carbon dioxide, nitrogen oxides, nitrous oxide, and methane). Carbon dioxide, nitrous oxide, and methane contribute to global warming, and Vermont is expected to experience a 67% increase in these greenhouse gases between 1990 and 2015 (in CO_2 equivalent terms). Nitrogen oxides are precursors of both ground-level ozone and acid precipitation; thus, increasing nitrogen oxides emissions cause both ozone and acid precipitation precursors to increase (by 9% and 10% respectively) during the same time-frame. In 1998, Vermont is expected to experience a slight decrease in emissions of acid precipitation precursors due to the expiration of a power generation contract with Merrimack II, a coal plant in New Hampshire. Between 2011 and 2012, an increase in greenhouse gases and ozone and acid precipitation precursors is expected due to the expiration of Vermont Yankee nuclear plant's license and the projected replacement of that power with fossil fuel sources. If renewable generation and energy efficiency options were in place in 2012 when Vermont Yankee's license expires, emissions of greenhouse gases and ozone and acid precipitation precursors would decline, remain stable, or increase much more slowly.

Note: The Following figures were prepared by the Vt. DPS. They are selected from the full set of figures that appear in Volume 2, Chapter 3 of this Plan. Values after 1991 are projections.

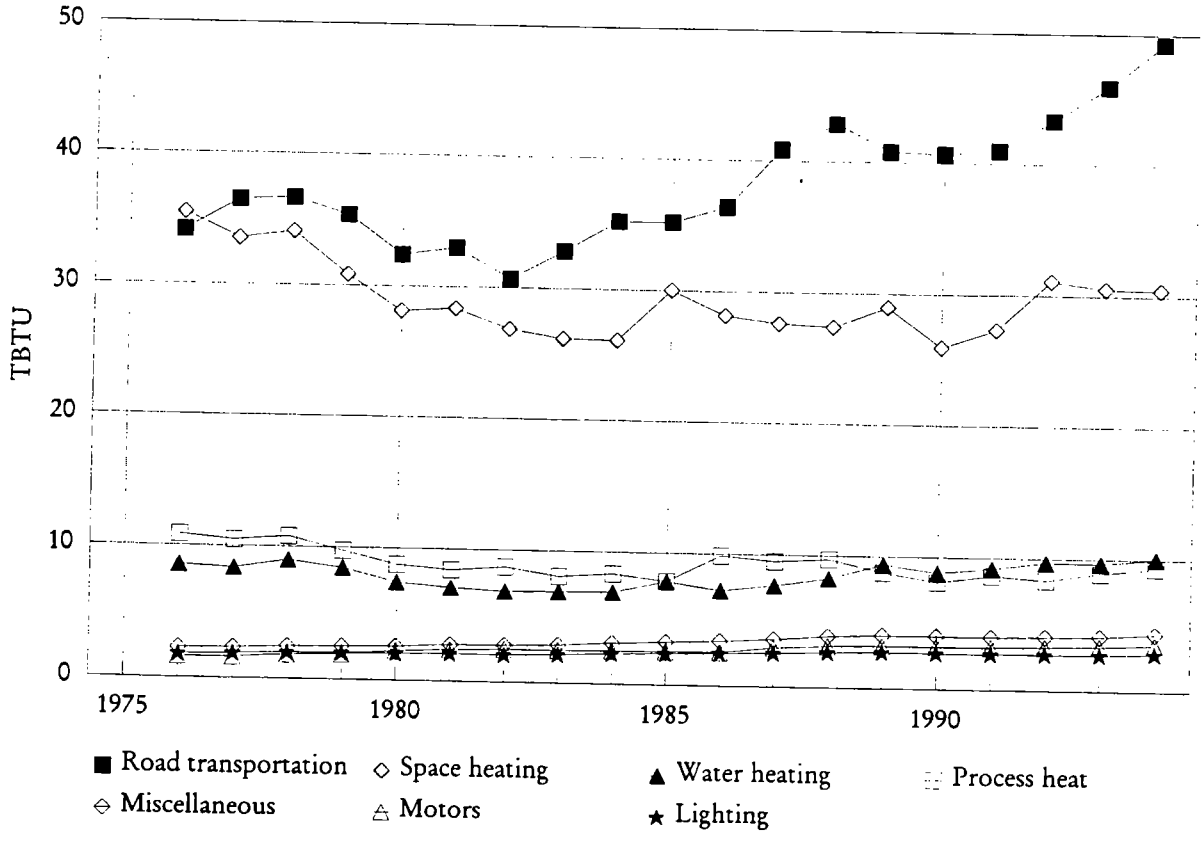
Figure 3.II.6 Vermont Delivered Energy Use by Sector
TBTU



	1976	1980	1985	1990	1994
Transportation	35.46	33.91	36.84	42.10	50.72
Residential	37.12	31.52	35.43	31.53	34.63
Commercial	12.79	10.36	9.94	11.99	15.24
Industrial	13.03	11.69	11.22	12.42	14.16
Total	98.40	87.48	93.42	98.04	114.74

Figure 3.II.10 Vermont Delivered Energy Use by End Use

TBTU



	1976	1980	1985	1990	1994
Road transportation	34.12	32.39	35.17	40.65	49.27
Space heating	35.44	28.12	30.00	25.93	30.45
Water heating	8.56	7.38	7.80	8.78	10.02
Process heat	10.84	8.75	7.82	8.08	9.30
Miscellaneous	2.25	2.53	3.20	3.96	4.27
Motors	1.58	2.21	2.50	3.18	3.49
Lighting	1.76	1.99	2.33	2.69	2.81
Refrigeration	1.21	1.32	1.52	1.66	1.67
Plane, train, marine	1.35	1.50	1.68	1.46	1.44
Cooking	0.66	0.59	0.64	0.79	0.85
Drying	0.31	0.33	0.37	0.43	0.48
Air conditioning	0.20	0.23	0.27	0.35	0.45
Total	98.29	87.34	93.32	97.96	114.50
Total w/out transportation	64.17	54.95	58.15	57.31	65.23

Note: Does not include energy used for cogeneration. Values after 1991 are projections. Source: VT DPS

Figure 3.II.13 Vt. Residential Delivered Energy Use by End Use
TBTU

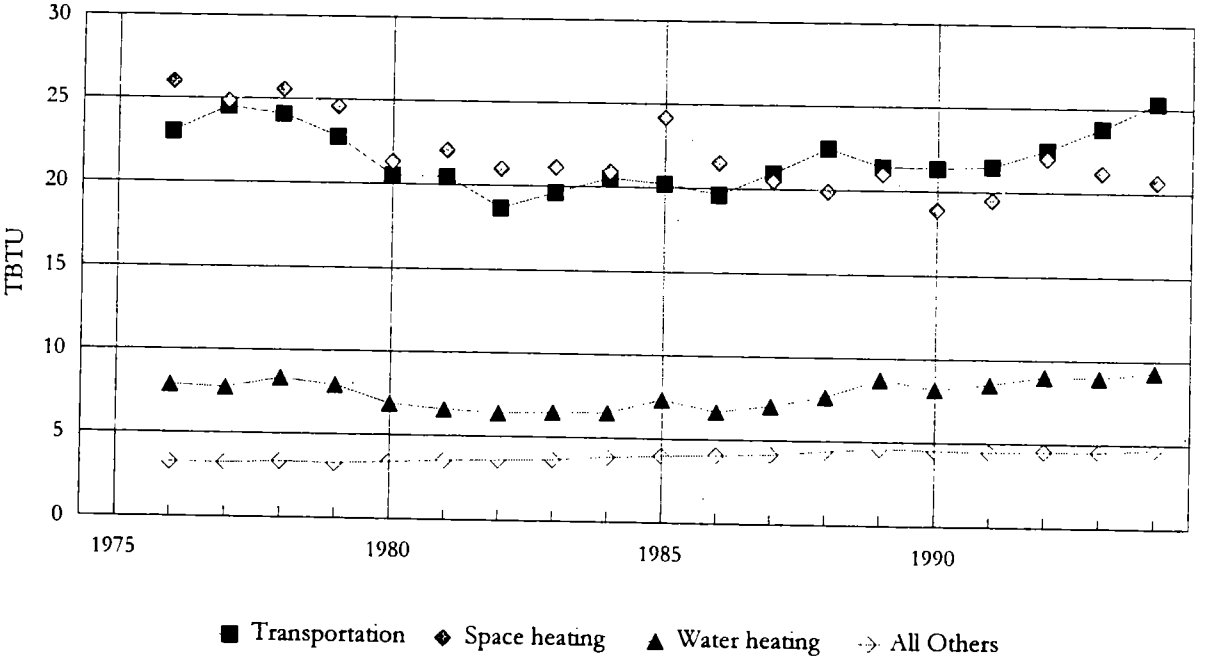


Figure 3.II.14 Vt. Comm. Delivered Energy Use by End Use
TBTU

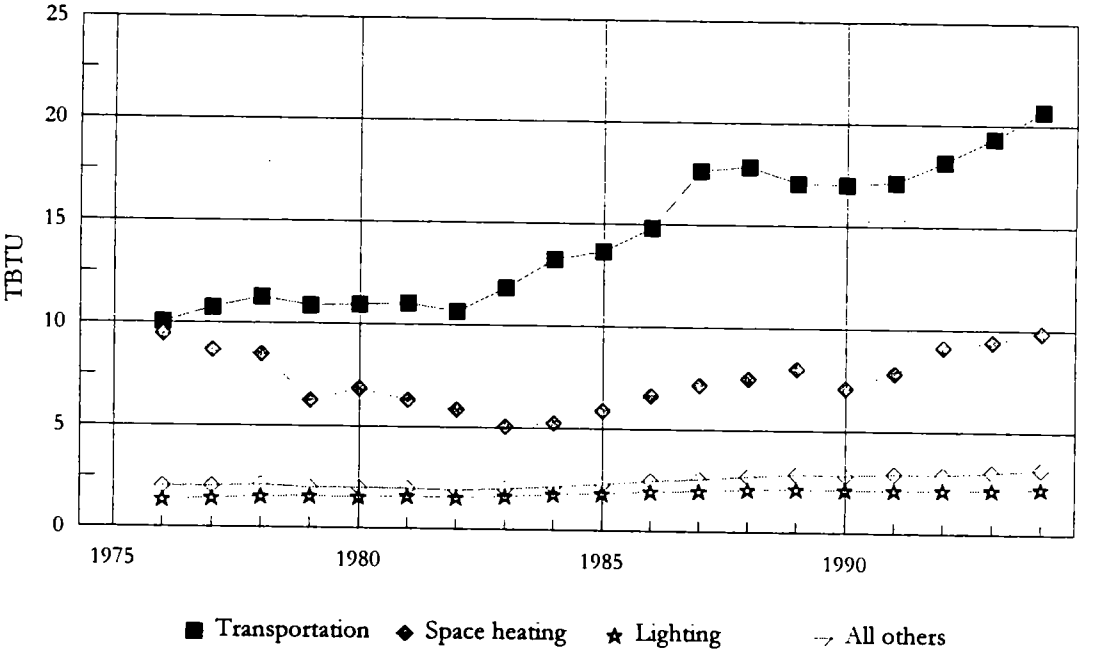


Figure 3.II.15 Vt. Industrial Delivered Energy Use by End Use
TBTU

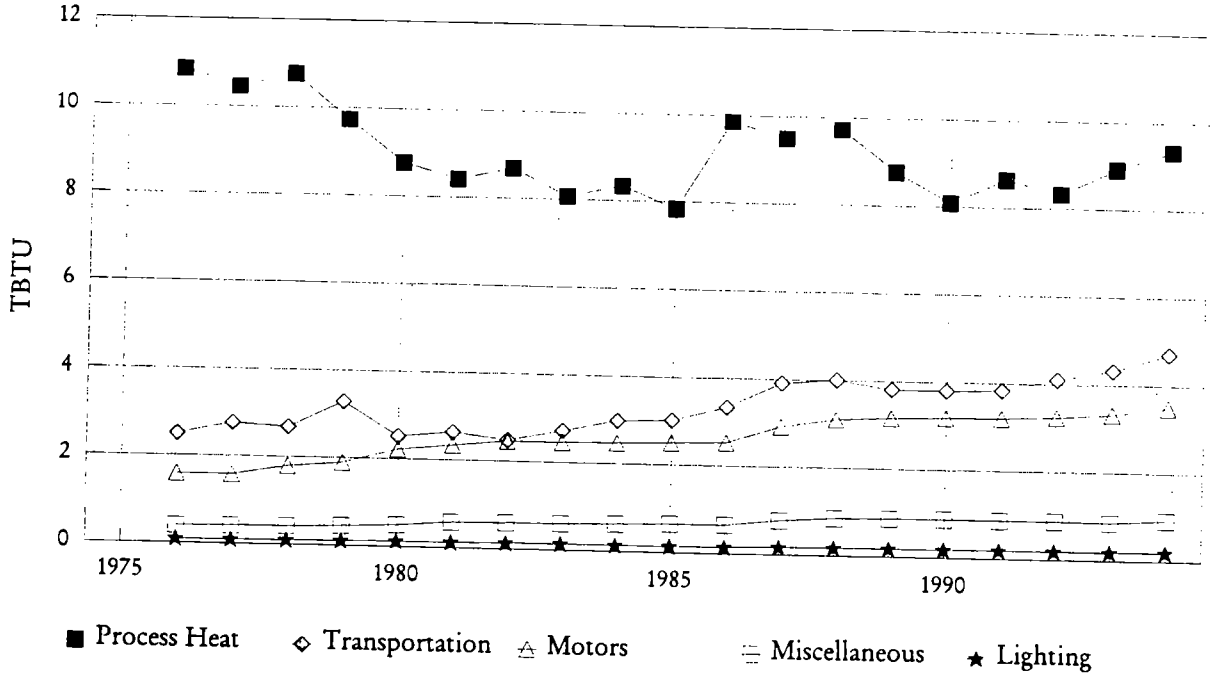


Figure 3.II.16 Vt. Transportation Delivered Energy Use by End Use
TBTU

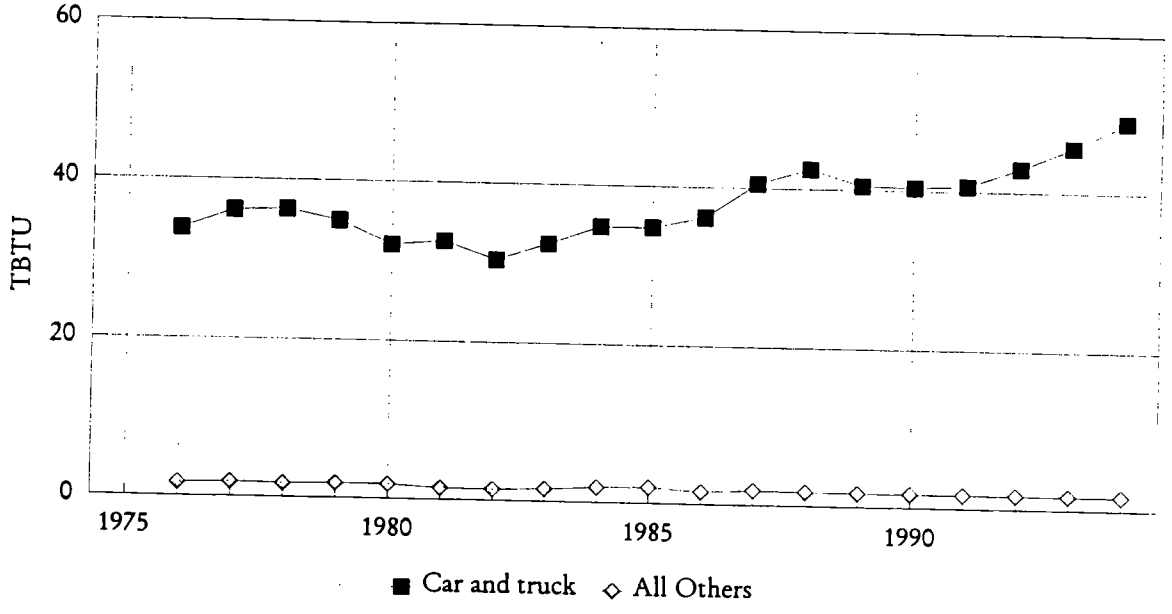


Figure 3.II.17 Vermont Delivered Energy Use by Fuel
TBTU

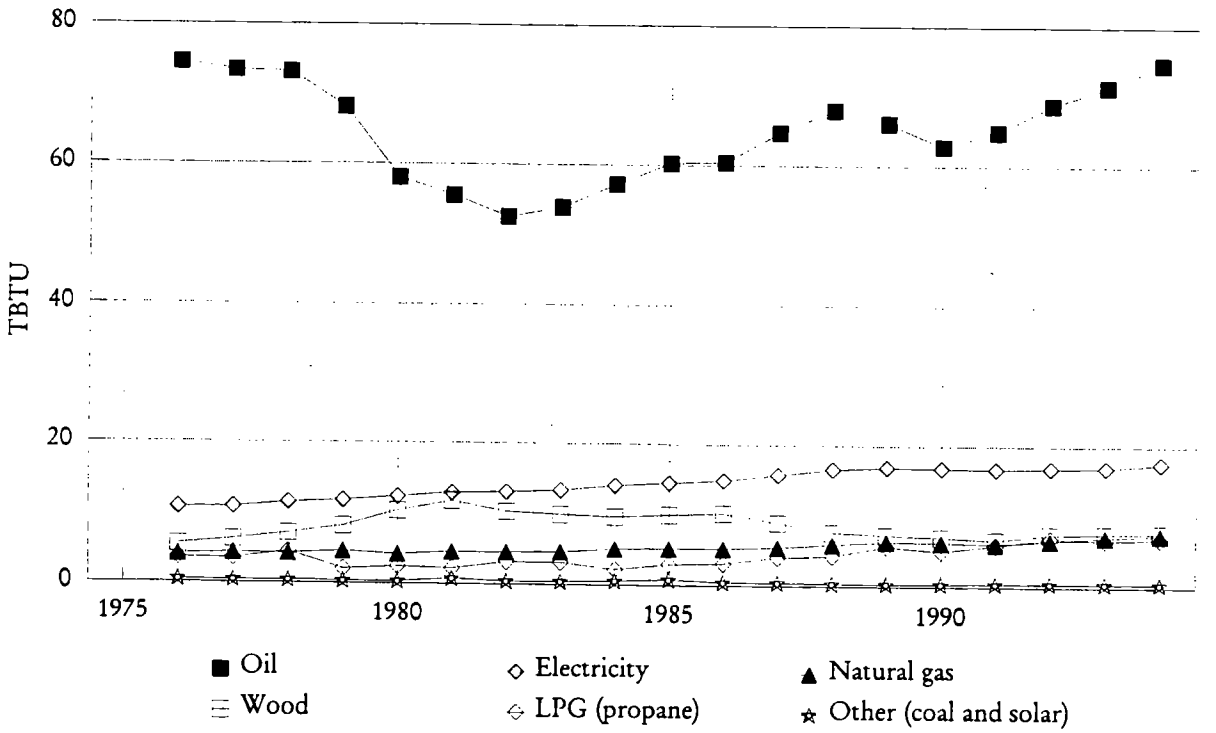


Figure 3.II.21 Vermont Emissions from Energy Use
TBTU

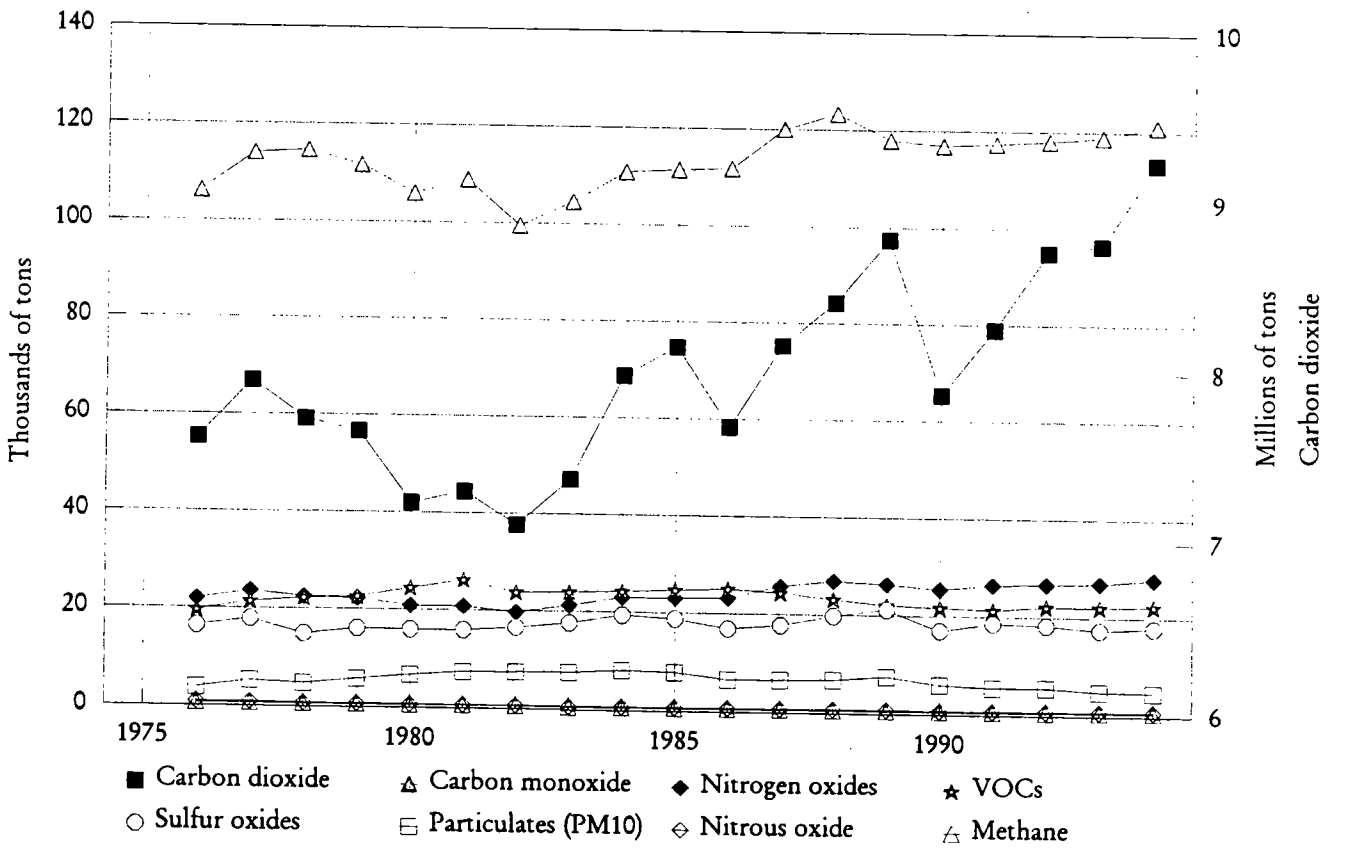


Figure 3.II.28 Vermont Primary and Delivered Electricity Use
TBTU

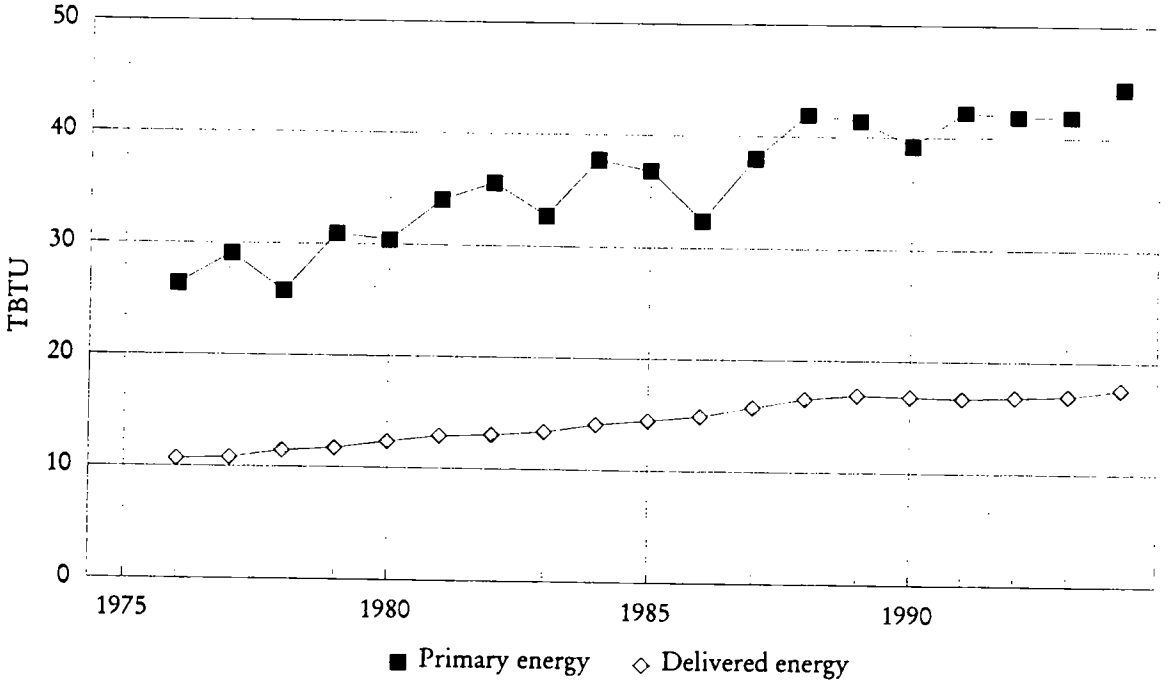


Figure 3.II.29 Vermont Electricity Expenditures
Millions of 1995 dollars

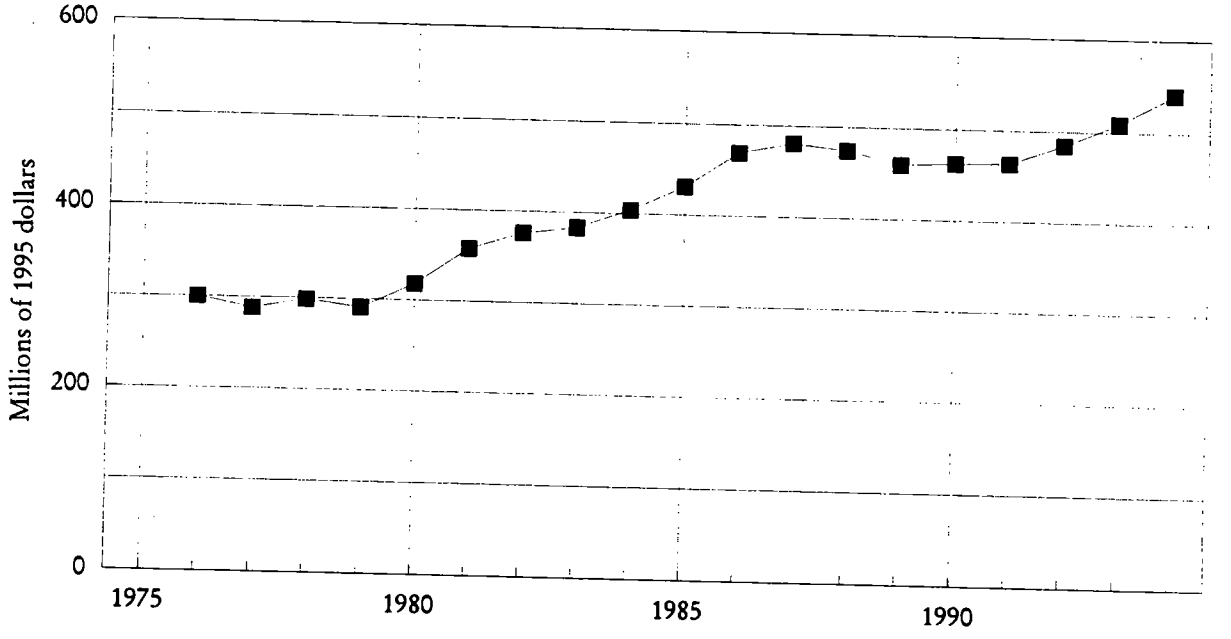


Figure 3.II.30 Vermont Delivered Electricity Use by Sector
TBTU

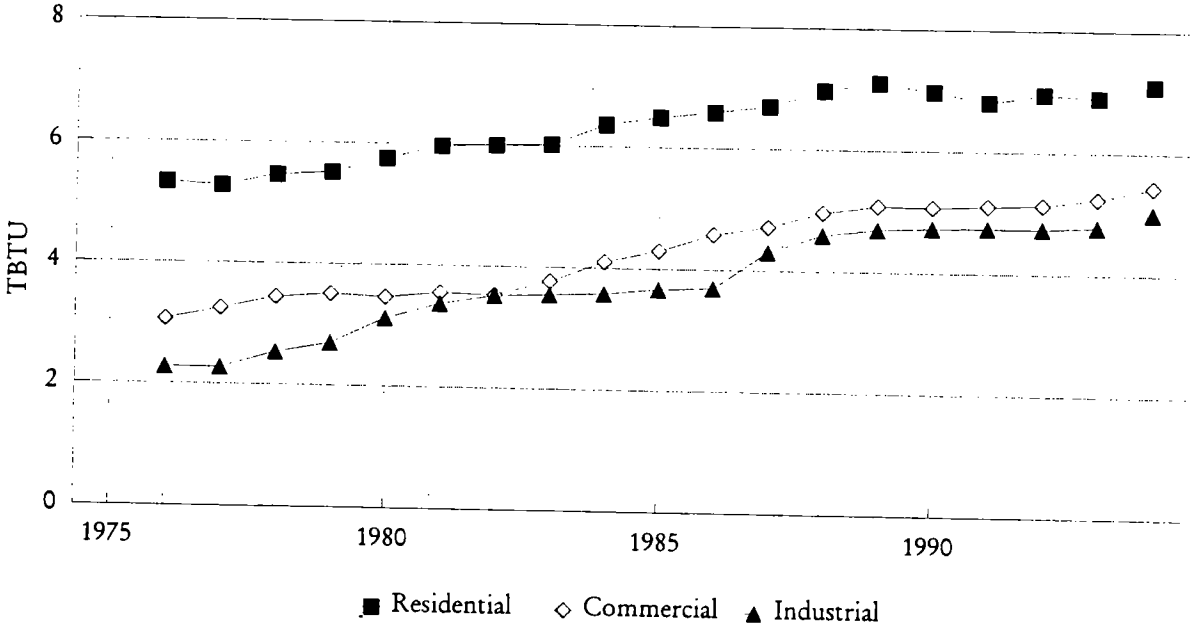


Figure 3.II.33 Vt. Residential Delivered Electricity Use by End Use
TBTU

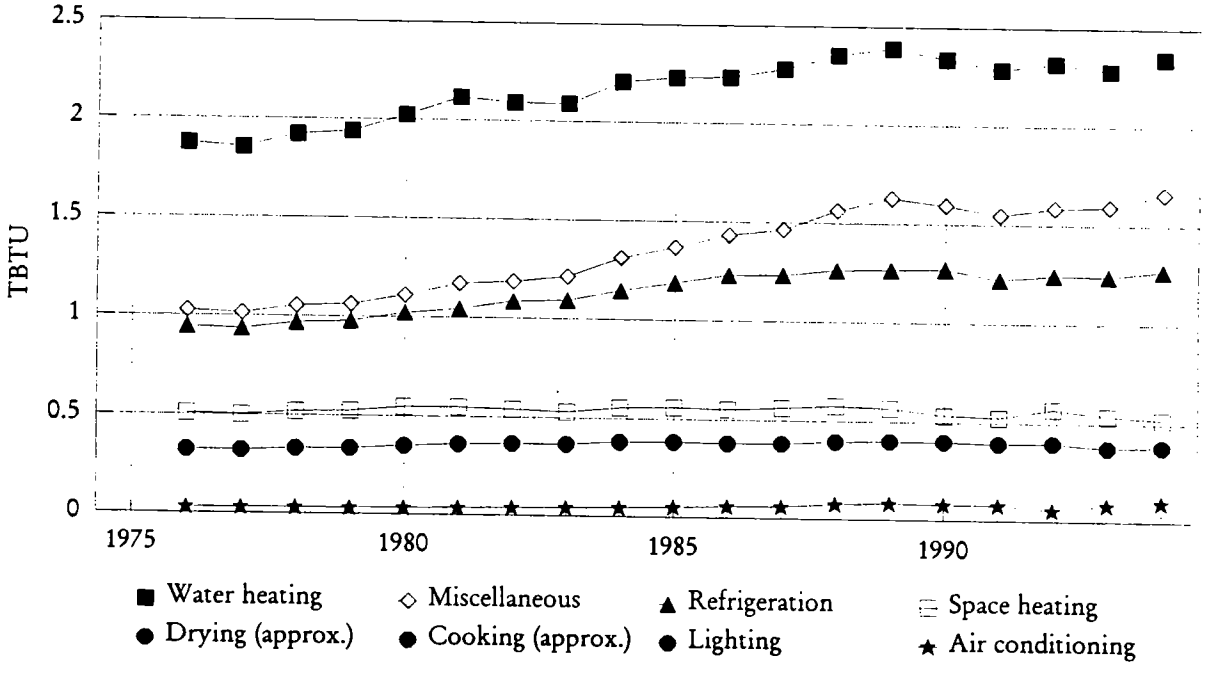


Figure 3.II.34 Vt. Commercial Delivered Electricity Use by End Use
TBTU

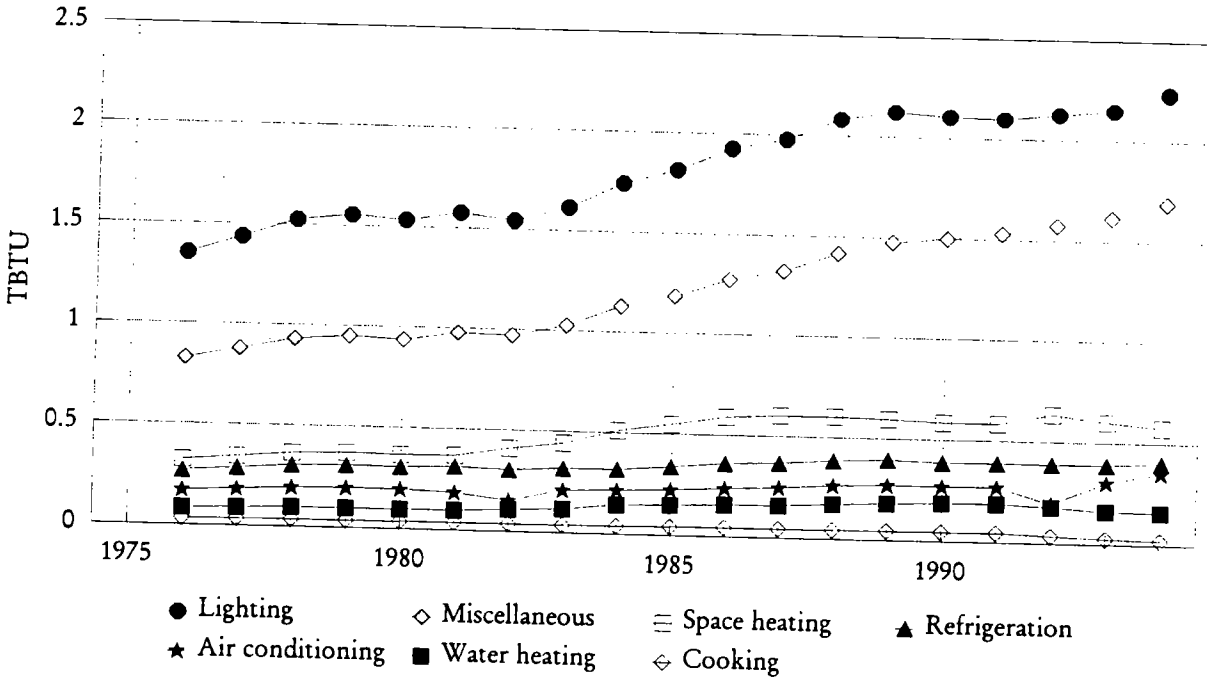


Figure 3.II. 35 Vt. Industrial Delivered Electricity Use by End Use
TBTU

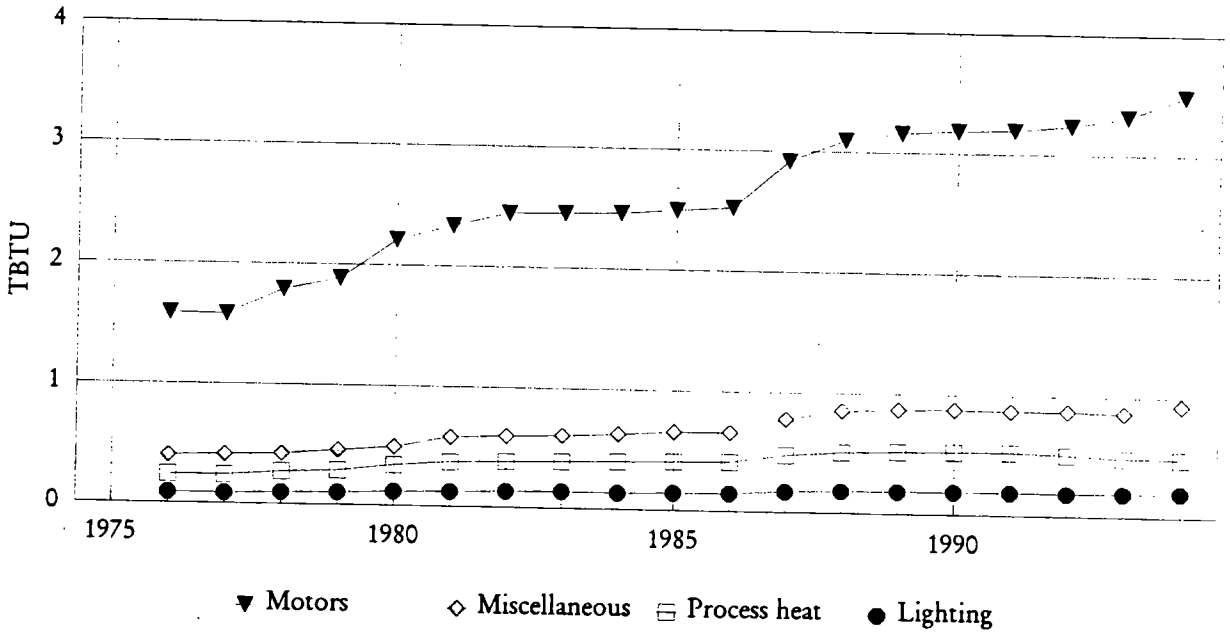
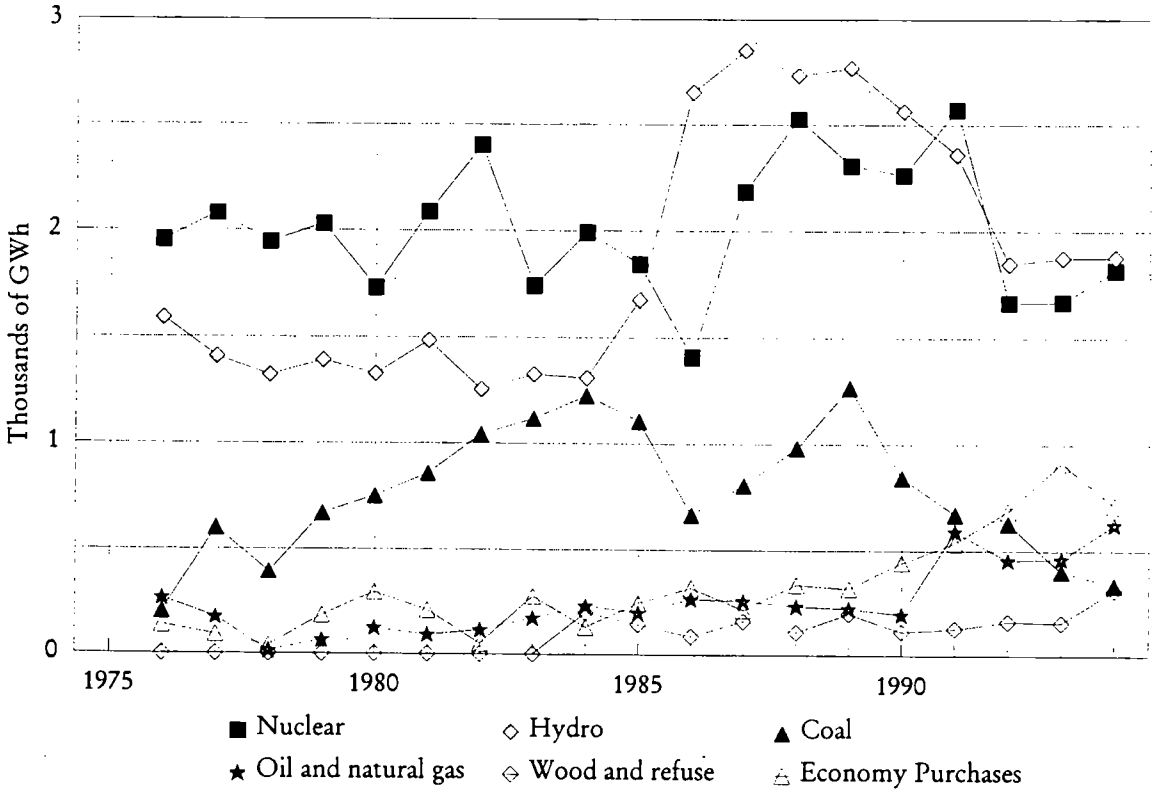


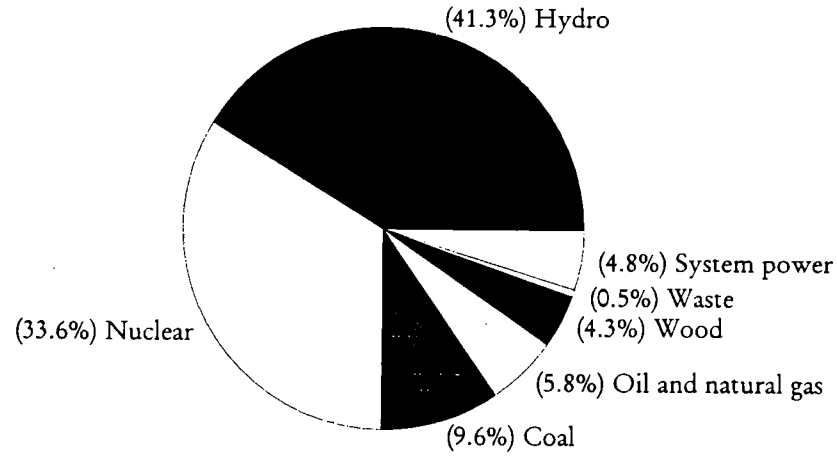
Figure 3.II.37 Vermont Delivered Electricity Use by Fuel
Thousands of Gwh



	1976	1980	1985	1990	1994
Nuclear	1,953.8	1,730.1	1,842.9	2,262.3	1,817.0
Hydro	1,587.9	1,326.8	1,674.5	2,563.7	1,875.5
Coal	199.4	751.2	1,106.1	842.3	332.4
Oil and natural gas	263.5	120.1	196.1	190.5	622.1
Wood	0.0	0.0	140.1	105.8	302.7
Refuse	0.0	0.0	0.0	5.0	5.9
Economy Purchases	133.5	292.0	241.5	439.5	712.2
Total generation and purchases	4,138.1	4,220.2	5,201.2	6,409.1	5,667.8
Transmission losses	(486.0)	(247.0)	(435.0)	(460.0)	(491.0)
Sales to out-of-state utilities	(387.0)	(213.0)	(392.0)	(993.0)	(130.0)
Total delivered use	3,265.1	3,760.2	4,374.2	4,956.1	5,046.8

Note: Values after 1991 are projections. "Economy purchases" are short-term purchases from a variety of fuel sources. The total generation and purchases shown for 1994 differs slightly from the total ownload in a subsequent Figure. This difference occurs because the value shown above is the result of a forecast that uses long-term economic and price trends, while the ownload value reflects what Vermont utilities would have used if they operated independently of NEPOOL. Values for each fuel source also differ. In 1994, as reflected in the ownload values, Vermont purchased more low-cost nuclear and hydro power than predicted in the forecast. These low-cost purchases displaced the use of some more expensive power from oil, natural gas, and wood resources.

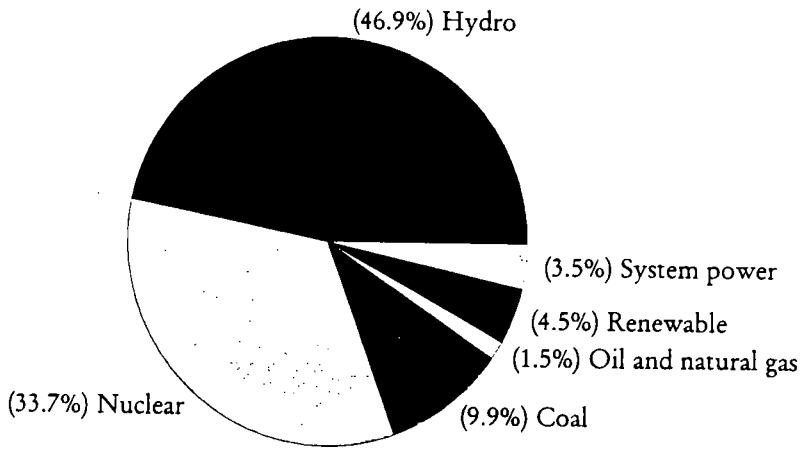
Figure 3.II.38 Vermont Ownload Electricity Supply, 1993



Fuel	Source	GWh	Percent
Hydro	Hydro-Quebec	1,588	
	NYPA	192	
	Vermont utilities	444	
	IPPs	151	
	Out-of-state plants	2	
	Total	2,377	41.3%
Nuclear	Vermont Yankee	1,462	
	Other plants	473	
	Total	1,935	33.6%
Coal	Merrimack II	555	
	Total	555	9.7%
Oil & Natural Gas	In-state oil plants	10	
	Other oil plants	291	
	Natural gas	31	
	Total	332	5.8%
Wood	McNeil plant	82	
	IPP - Ryegate plant	165	
	Total	247	4.3%
Waste	VT-NH waste plant	31	
	Total	31	0.5%
System Power	New England plants	133	
	Ontario Hydro	142	
	Total	275	4.8%
Total		5,752	

Note: "Ownload Electricity Supply" represents what Vermont utilities would have used if they operated independently of NEPOOL. The waste power that appears on Vermont's ownload is used by customers in the small region of New Hampshire that CVPS serves. "System power " means power supplied by other utilities under contracts that do not specify a particular source and includes power generated from nuclear, coal, oil, or other fuels. Ownload supply represents energy generated in or delivered to Vermont and will always be higher than delivered consumption due to losses. Source: VT DPS

Figure 3.II.38a Vermont Ownload Electricity Supply, 1997



Fuel	Source	GWh	Percent
Hydro	Hydro-Quebec	2,184	34.9%
	NYPA	82	
	Vermont utilities	480	
	IPPs	186	
	Out-of-state plants	1	
	Total	2,934	46.9%
Nuclear	Vermont Yankee	2,108	
	Other plants	3	
	Total	2,111	33.7%
Coal	Merrimack II	621	
	Total	621	9.9%
Oil & Natural Gas	In-state oil plants	13	
	Other oil plants	44	
	Natural gas	36	
	Total	92	1.5%
Renewable	McNeil plant	74	
	IPP - Ryegate plant	169	
	Searsburg Wind	5	
	VT-NH waste plant	32	
	Total	280	4.5%
System Power	New England utility	175	
	Power Marketer	44	
	Total	219	3.5%
Total		**6,257**	

Note: "Ownload Electricity Supply" represents what sources Vermont utilities would have used if they operated independently of NEPOOL. The waste power that appears on Vermont's ownload is used by customers in the small region of New Hampshire that CVPS serves. "System power " means power supplied by other utilities under contracts that do not specify a particular source and includes power generated from nuclear, coal, oil, or other fuels. Ownload supply represents energy generated in or delivered to Vermont and will always be higher than delivered consumption due to losses. Source: VT DPS

Figure 3.III.8 Vermont Energy Expenditures by Sector
Millions of 1995 dollars

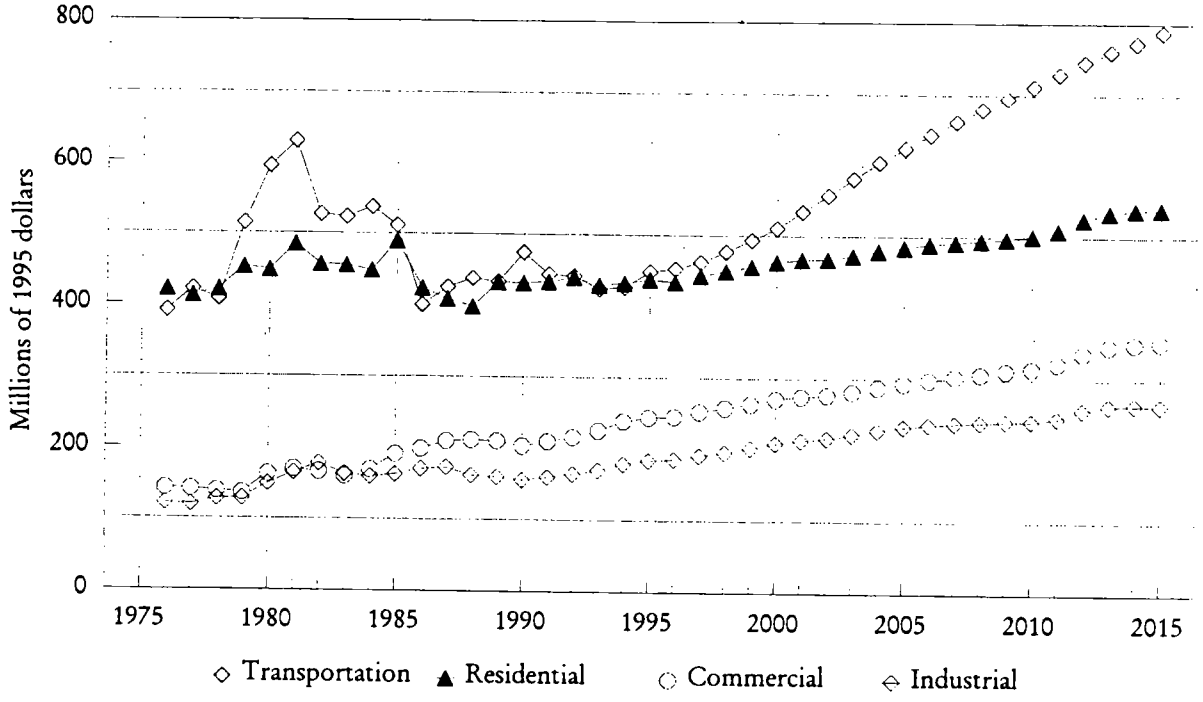


Figure 3.III.9 Vermont Energy Expenditures by Fuel
Millions of 1995 dollars

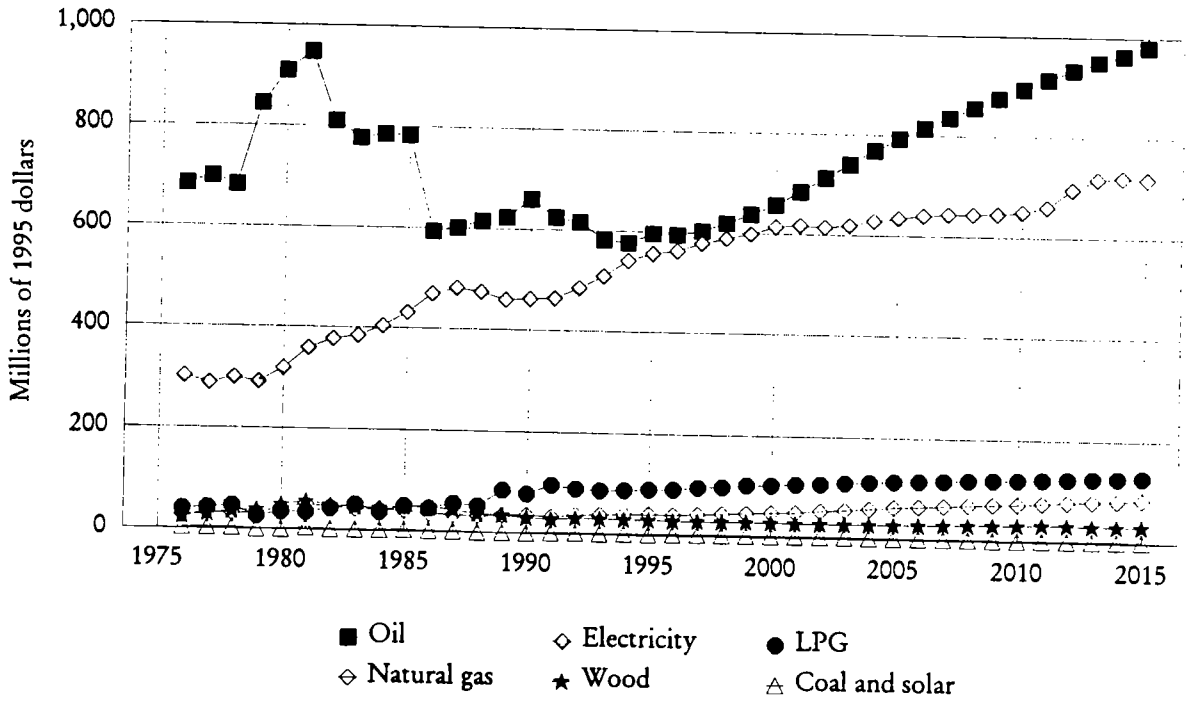


Figure 3.III.11 Vermont Delivered Energy Use by Sector
TBTU

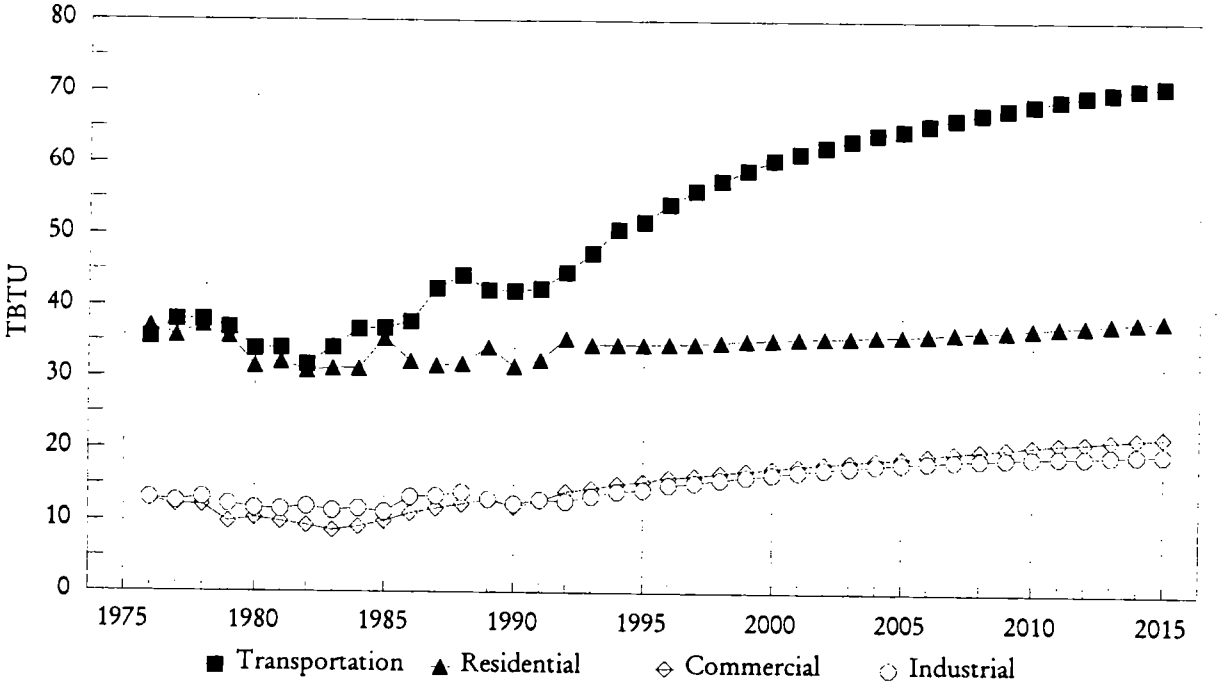


Figure 3.III.12 Vermont Delivered Energy Use by End Use
TBTU

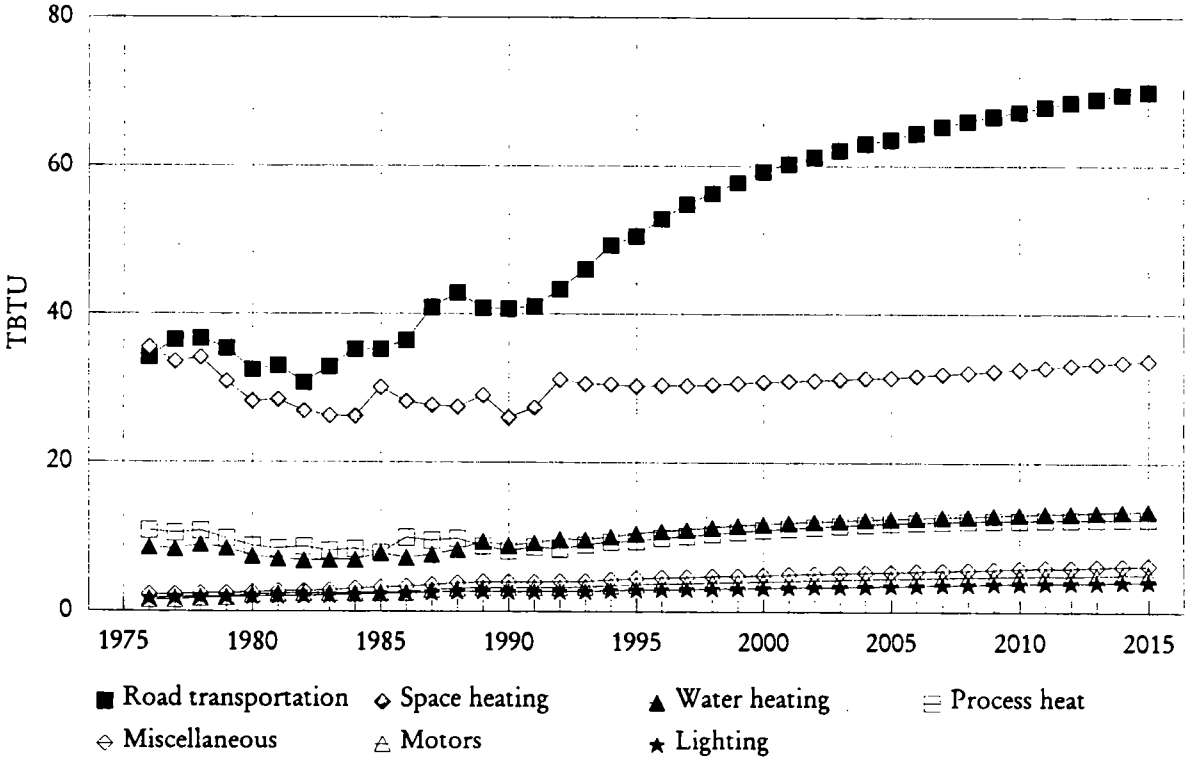


Figure 3.III.13 Vermont Delivered Energy Use by Fuel
TBTU

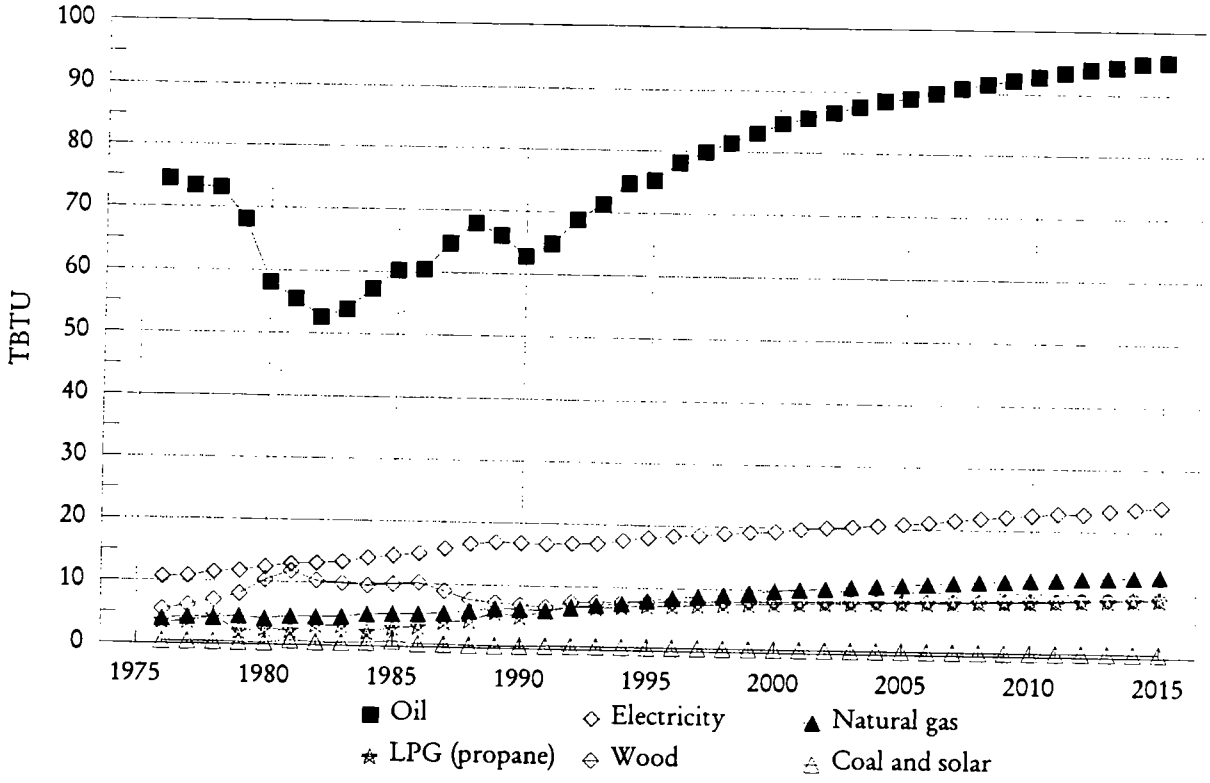


Figure 3.III.17 Vt. Residential Delivered Energy Use by End Use
TBTU

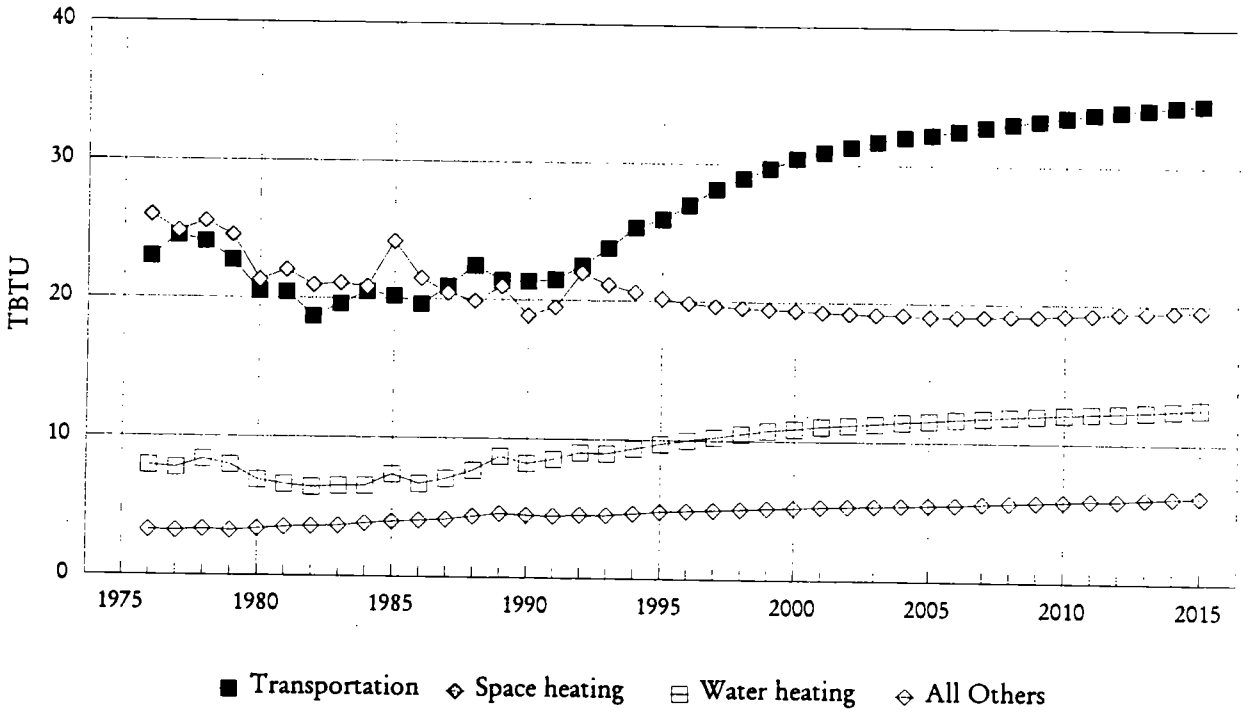


Figure 3.III.19 Vt. Commercial Delivered Energy Use by End Use
TBTU

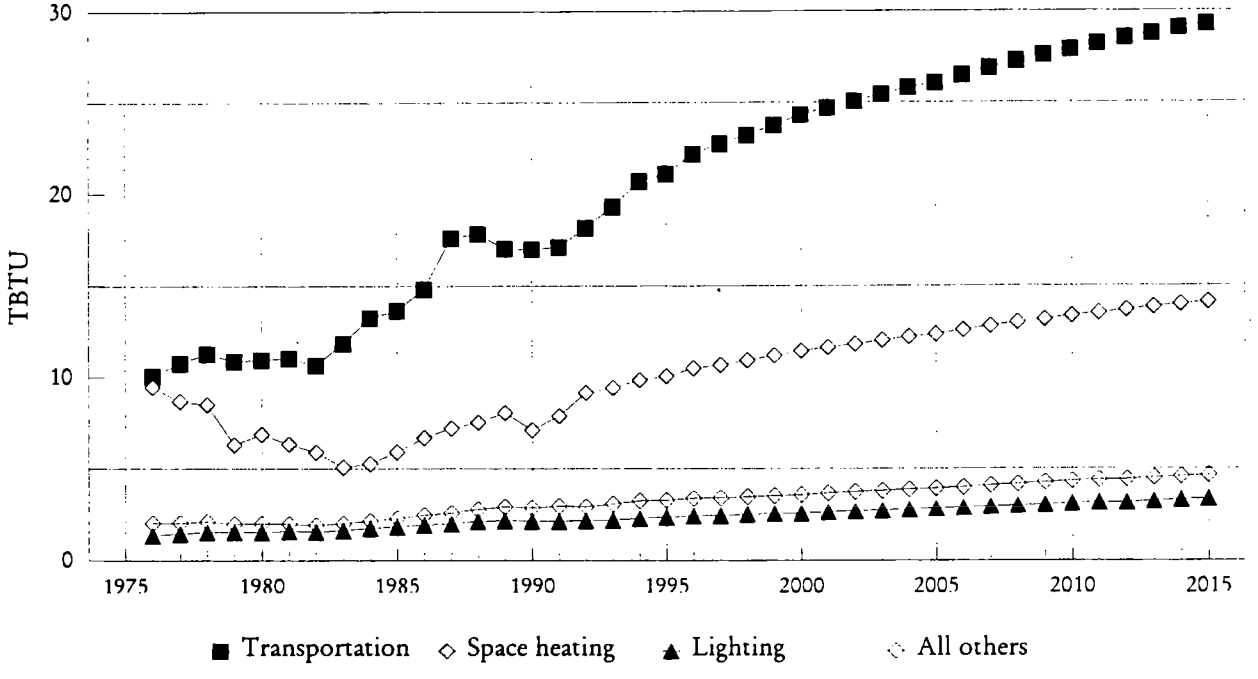


Figure 3.III.21 Vt. Industrial Delivered Energy Use by End Use
TBTU

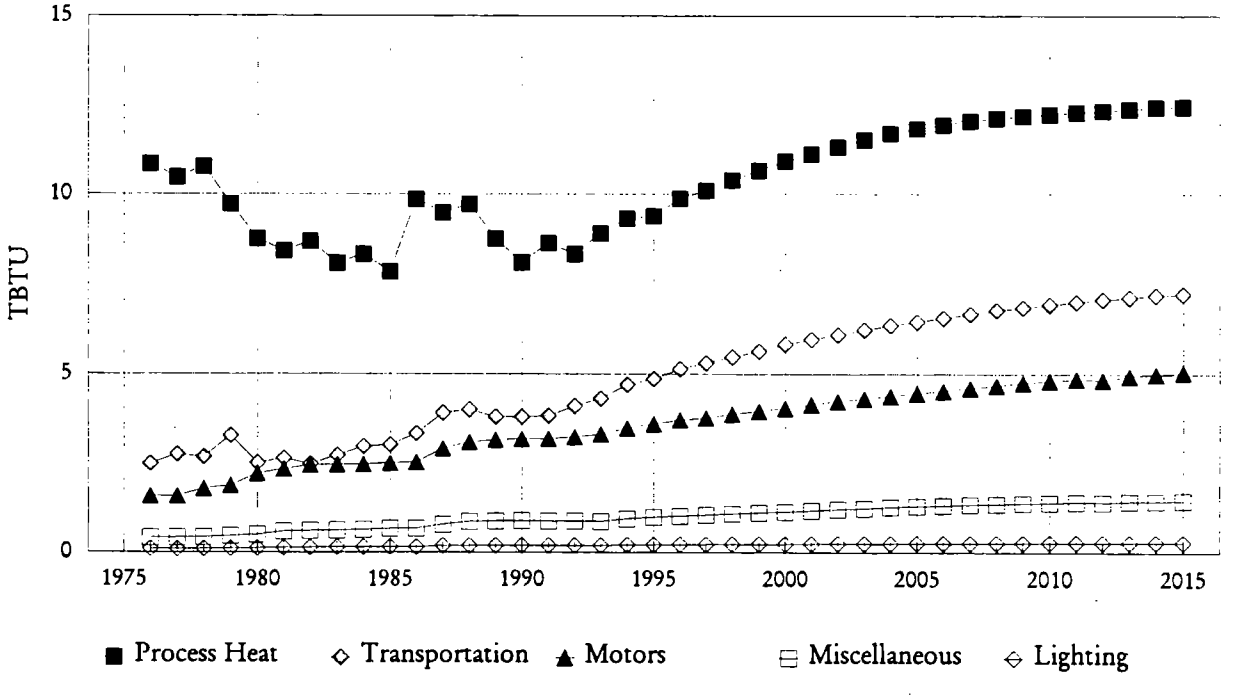


Figure 3.III.23 Vt. Transportation Delivered Energy Use by Sector
TBTU

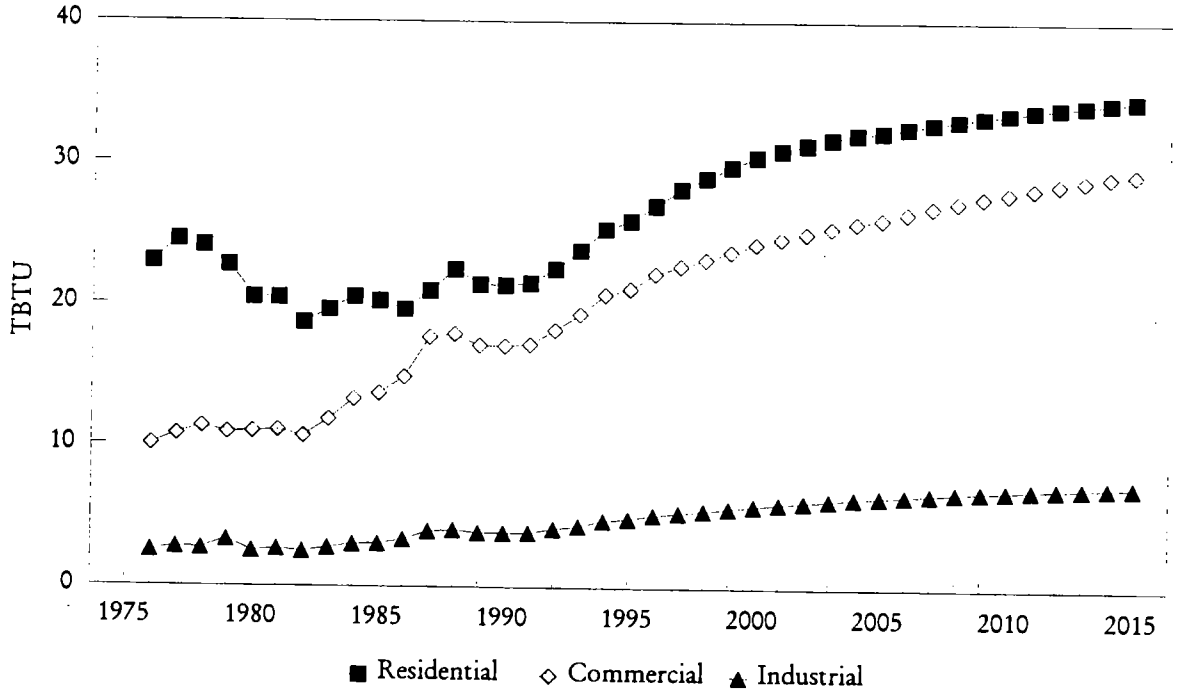
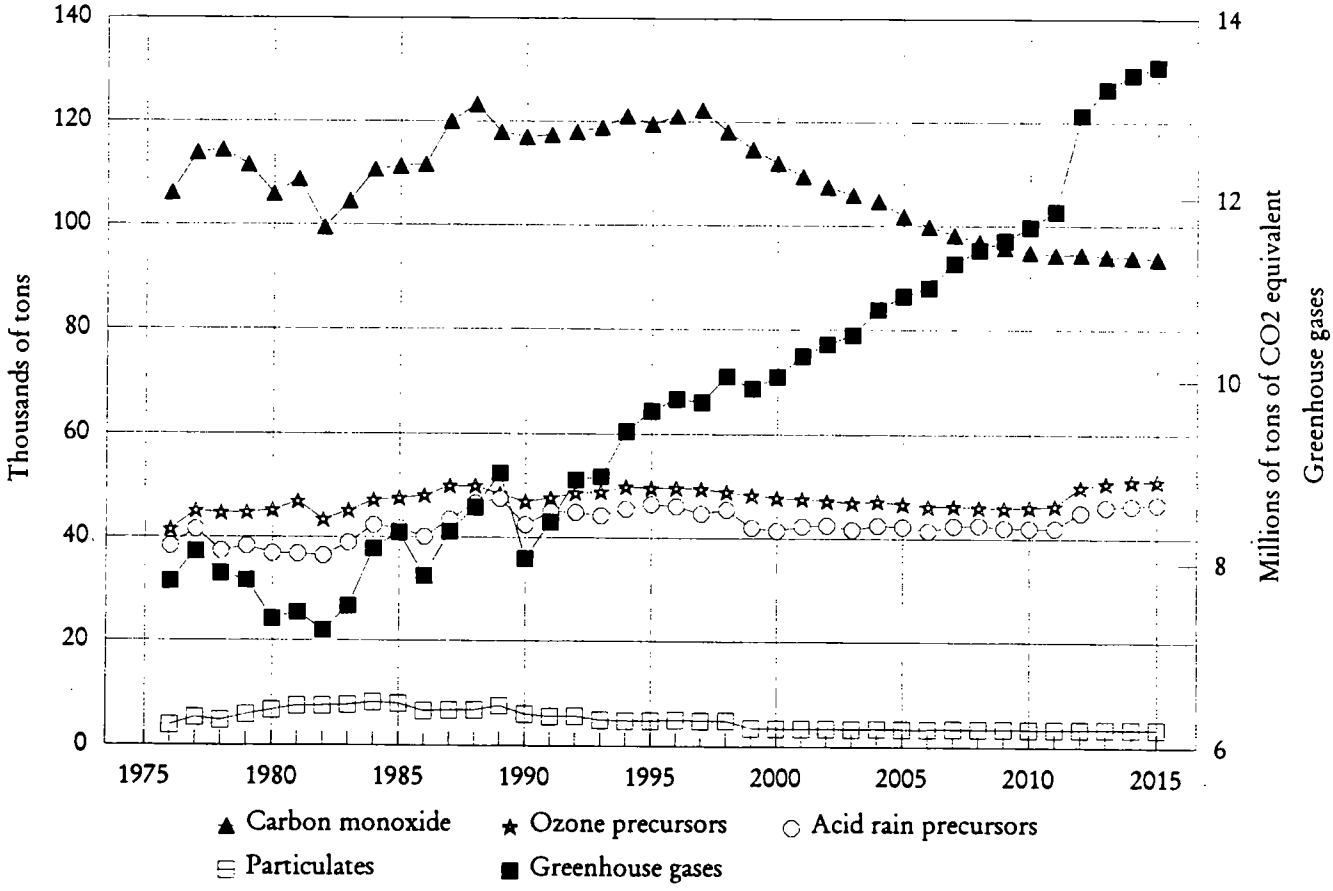


Figure 3.III.25 Vermont Emissions from Energy Use
Tons



ENDNOTES:

1. Calculated by dividing 1993 U.S. petroleum use (33,842.2 TBTU) by 1993 population (257.6 million) (U.S. DOE/EIA, *State Energy Data Report 1993*, 1995, 21; U.S. DOE/EIA, *International Energy Annual 1993*, 1995, 113). Vermont value calculated by dividing 1993 petroleum use (78 TBTU) by population (576,000) (Vt. DPS).

2. Heating oil and diesel fuel are both distillate fuels. Like gasoline, distillate fuel is refined from crude oil. Heating oil is sometimes called light fuel oil or number two heating oil.

3. Energy use among these end uses, together with the numbers reported for kerosene, LPG, distillate fuel, and motor gasoline, come to slightly more than the 78 TBTU given earlier for total petroleum use in Vermont. This is due to the fact that values for motor gasoline, distillate fuel, kerosene, jet fuel, aviation gasoline, and residual fuel come from the State Energy Data Report of the U.S. Department of Energy, while values for LPG and total petroleum use come from estimates of the Vermont Department of Public Service. Vt. DPS values were used whenever possible for consistency with other non-petroleum energy consumption values which are also DPS estimates.

4. On an ownload basis; see Figure 3.II.38 for an explanation of ownload. In addition, Vermont purchased about 275 GWh from Ontario Hydro and NEPOOL system power in 1993; some small fraction of this power was likely generated from nuclear sources.

5. On an ownload basis; see Figure 3.II.38 for an explanation of ownload. In addition, Vermont purchased about 275 GWh of power from Ontario Hydro and NEPOOL system power in 1993; some of this power was likely generated with coal.

6. On an ownload basis; see Figure 3.II.38 for an explanation of ownload. In addition, Vermont purchased about 275 GWh from NEPOOL system power in 1993; some of this power was likely generated by oil.

7. Vermont and U.S. natural gas consumption projections are based on different natural gas price forecasts.

8. The Northeast includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

9. Although fossil fuel sources may eventually regenerate, they do so over time frames that are so vast that they are non-renewable for all practical purposes.

CHAPTER 4
ENERGY STRATEGIES, POLICIES, and RECOMMENDATIONS

This chapter summarizes strategies and policies that are fully discussed in Volume 2, Chapter 4. Recommendations are part of the policy presentations in this volume of the Plan, identifying key actions 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 Chapter 2. Vermont can implement many of these actions, but in some cases Vermont can only promote regional or national action.

This chapter is organized into five major sections: Energy Sources and Supply, Transportation, Buildings and Equipment, Affordability, and Government Energy Use and Energy Policy. In each section the strategies, policies, and recommendations represent the direction that Vermont should take in attaining its energy goals and greenhouse gas reductions. Organization of this chapter is consistent with the organization of Chapter 4 in Volume 2, with a very few exceptions. Some policies that are discussed individually in Volume 2 are combined and summarized in this volume. Also, some policies that are analyzed in Volume 2 have complex issues that need further exploration before recommendations can be made. For these few policies only the name is included in this volume; refer to Volume 2 for information about the policy. With these variations, strategies and policies presented in Chapter 4 of Volume 1 and Volume 2 are organized in the same way; versions in Volume 1 are summaries with recommendations while the complete analysis and modeling impacts are presented in Volume 2.

Note: This chapter in Volume 1 is a summarized version of the strategies and policies that are analyzed in detail in Chapter 4 of Volume 2, with these exceptions. In Chapter 4 of Volume 1, Section I. Energy Sources and Supply, Strategies A. and B. and several policy summaries have been combined.

I. ENERGY SOURCES AND SUPPLY

DPS recommends a set of strategies, policy options, and actions that will affect both traditional and renewable sources of energy. These recommendations 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.

This chapter begins with strategies and policies that recommend increased use and promotion of renewable energy sources; specifically the expanded use of wood, wind, solar, hydro, and methane energy. Greater use of energy from wood, wind, solar, some types of hydro, and landfill and farm methane would increase the sustainability of energy supply, 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 and reduce the impact of current energy use on future generations and the environment. For example, 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 increases the security of our energy supply.

Another strategy and policy set recommend reduced reliance on petroleum, coal, and nuclear energy use, and the expansion of natural gas use when it replaces other fossil 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 reduce the environmental impacts of energy use if it

Recommended Energy Strategies and Policies

I. ENERGY SOURCES AND SUPPLY

Strategy A: Promote Sustainable Use of Wood and Wind Energy
- Policy 1: Promote Clean, Efficient Wood Burning with New Stoves
- Policy 2: Promote Commercial and Industrial Use of Wood Energy
- Policy 3: Develop Wood and Wind Power for Replacing Nuclear Power
- Policy 4: Promote Renewable Resources and New Technologies with a Renewable Portfolio Standard

Strategy B: Promote Use of Solar Energy
- Policy 1: Shift Clocks Toward the Solar Day (RUD)
- Policy 2: Increase Solar Lighting and Heating Applications
- Policy 3: Increase Solar Water Heating Installations
- Policy 4: Promote Development of Photovoltaics and Encourage Their Use

Strategy C: Support Appropriate Uses of Hydroelectric Power and Methane Sources
- Policy 1: Support Appropriate Use of Hydroelectric Energy
- Policy 2: Increase Appropriate Use of Landfill Methane Energy
- Policy 3: Increase Appropriate Use of Farm Methane Energy

Strategy D: Reduce, Monitor, and Support Selected Uses of Traditional Fuels
- Policy 1: Reduce Use of Petroleum Energy and Establish Emissions Standards
- Policy 2: Reduce Use of Coal Energy
- Policy 3: Support Appropriate Use of Natural Gas Energy
- Policy 4: Monitor the Use of Nuclear Energy

Strategy E: Encourage Efficient Production and Distribution Technologies/ Infrastructure
- Policy 1: Encourage Cogeneration
- Policy 2: Encourage District Heating and Cooling
- Policy 3: Encourage Distributed Utility Services
- Policy 4: Be Prepared to Act of Proposed Projects to Expand Gas Pipelines and Storage to Unserved Areas
- Policy 5: Investigate Feasibility of Rehabilitating and Reactivating Old City Gas Distribution Systems
- Policy 6: Promote Integrated Electric Utility Broadband Communication Networks (RUD)

Strategy F: Increase Competition in the Electric Utility Industry
- Policy 1: Move Toward Greater Retail Competition While Maintaining Societal Benefits

Strategy G: Use Energy Taxation to Meet Vermont's Energy Goals
- Policy 1: Review Current Energy Goals and Energy Taxes and Assess their Consistency

II. TRANSPORTATION

Strategy A: Least Cost Transportation Planning
- Policy 1: Consider Adopting the Principles of Least Cost Transportation Planning
- Policy 2: Consider Studying the Full Cost of Transportation in Vermont
- Policy 3: Develop a Demonstration Project for Green Parking/Transportation Vouchers

Strategy B: Increase the Efficiency of Vehicles
- Policy 1: Increase Federal CAFE Standards
- Policy 2: Consider Adopting a 55 MPH Interstate Speed Limit (RUD)
- Policy 3: Consider Stricter Enforcement of Highway Speed Limits
- Policy 4: Encourage Hypercar Development

Strategy C: Reduce Vehicle Miles Traveled
- Policy 1: Encourage the Use of Commuter Lots
- Policy 2: Shift VMT to More Efficient Modes - Bus, Vanpool, and Train
- Policy 3: Encourage Non-Motorized Transportation
- Policy 4: Encourage Telecommuting
- Policy 5: Encourage High-Density, Mixed-Use Land Use Planning and Curtail Sprawl
- Policy 6: Pay-at-the-Pump Auto Liability Insurance (RUD)

replaces other fossil fuels, but will worsen air emissions considerably if it replaces fuels such as hydro or nuclear power. Factors that affect these policies include increasing competition in the electricity marketplace and decreasing reserves of fossil fuels.

Recommended Energy Strategies and Policies (continued)

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
- 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 Program for Premium Homes
- Policy 3. Increase Efficiency of New Manufactured Housing
- Policy 4. Expand the Vermont Home Energy Rating System

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 and Information Clearinghouse

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 Transmission and Distribution Constrained Areas
- Policy 4. Financing Mechanisms for Cost-Effective Energy Efficiency and Renewable Energy: Performance Contracting and ESCOs

IV. AFFORDABILITY

Strategy A. Increase Energy Efficiency for Low Income Housing

- 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 an Energy 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

(RUD) means specific recommendations for this policy are still under development.

Increasing the efficiency of the production, distribution, and use of energy is the focus of another strategy and set of policies. The growing number of energy supply and generation options available is considered, including smaller, more distributed electric generation, cogeneration, district heating, and investigating the feasibility of rehabilitating old gas distribution systems.

The strategy on competition in the electric utility industry focuses on recommendations for reforming Vermont's electric industry, if retail competition is allowed to move forward. Wholesale competition is already being enhanced by activities at FERC pursuant to EPACT '92. With careful direction, competition could help meet statewide energy goals. Competition could reduce future costs, and it could provide an opportunity to ensure that progress is made in other areas, such as increasing the use of renewable energy sources, enhancing energy efficiency programs, and improving environmental protections. Finally, competition can improve the value that customers find in their electric service.

As traditional distinctions between regulated and non-regulated fuels fade, and a steadily increasing number of states pass restructuring legislation, Vermont must continue to work on the key components of new retail competition proposals to present to the 1999 Legislative Session.

The last strategy in the Energy Supply and Sources section recommends a review of Vermont's energy goals and energy taxation system to assure they are well aligned and result in consumer choices that are societally beneficial in the long term. 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 important 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. Major energy benefits from energy taxes arise because the tax substitutes for the unpriced external costs of energy use. Consumers receive a price signal that more accurately reflects the cost. If energy prices are closer to the full costs of that use, individuals and businesses can determine the most efficient options to reduce the costs to themselves and society. This encourages conservation, efficiency, and fuel switching to cleaner or more efficient fuels. 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. (For more information on energy taxation see Volume 2, Chapter 3, H. Current and Future Energy Issues, the section on Full Cost of Energy Use and in Chapter 4, I. Energy Sources and Supply, the strategy on Using Energy Taxation to Meet Vermont's Energy Goals.)

A. Strategy: Promote Sustainable Use of Wood and Wind Energy

Note: In this volume, strategies and policies related to sustainable use of wood and wind energy have been combined. In Volume 2, Chapter 4, Section I. Energy Sources and Supply, there are separate strategies and policy sets for promoting sustainable use of wood energy and promoting wind generated electric energy.

Wood is by far the most widely used local, renewable energy source in Vermont. There are significant environmental advantages to expanding the use of wood, Vermont's pre-eminent biomass fuel. 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.[1] 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 most fossil fuels. The sulfur dioxide and nitrogen oxide emissions from wood combustion are much lower than those from oil and coal. With the newer technologies for burning wood, other emissions 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).

Vermont's wood resources are quite large. Forest covers approximately 77% of Vermont's total land area, up from only 25% 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, regenerate, and not lead to erosion of topsoil and significant loss of soil nutrients or irrecoverable damage to any species. This reduces the maximum annual sustainable harvest from 12 million tons.

Sustainable forest use also includes reasonable resource allocation. Wood is harvested for several markets, including solid wood products, composites and laminates, pulp and paper, and residential and industrial fuel. Vermont Department of Forests, Parks & Recreation has long maintained a policy of promoting the highest and best use of wood, principally in solid wood products. The forest in Vermont is home to a certain volume of wood unsuitable for use in solid wood products or composites and laminates. This so-called low-grade wood is typically allocated to pulp and paper markets. Vermont enjoys a fuel market in addition. The goal is to ensure that all wood is allocated to the highest value market possible. To this end, it is not acceptable that wood suitable for higher value product use is allocated to a lower value market. It is neither acceptable nor sustainable for wood that is suitable for pulp and paper, composites and laminates, or solid wood markets to be used for fuel.

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 scenic, wildlife, recreational, and environmental values. 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, McNeil Station and other electric generating facilities that burn wood chips are required to buy only from harvesters who follow exacting forest management standards.

There are two major uses for wood as an energy source-- generation of electricity and direct heat— which can occur simultaneously in wood cogeneration facilities. The policies below recommend increasing both uses for wood energy and making these 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.

This policy calls for accelerating the replacement of older, more polluting wood stoves with newer, more efficient EPA-approved models. Vermont Department of Public Service (DPS), Agency of Natural

Resources Air Pollution Control Division (ANR APCD), and Department of Forest, Parks and Recreation are already working to promote a variety of clean burning, energy efficient wood energy projects.

Environmental advantages of wood energy are achieved by offsetting carbon dioxide emissions from fossil fuel use and lowering acid rain precursor emissions. Using Vermont's wood resources sustainably and more efficiently means that more fossil fuel use can be displaced. Achieving the environmental benefits of wood energy requires using the cleanest and most efficient wood energy technologies available. There is a risk that 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.

In February 1988, U.S. Environmental Protection Agency (EPA) implemented regulatory standards limiting the emissions of new wood stoves and fireplace inserts.[2] 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. 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, EPA certified wood burning stoves also reduce non-particulate air pollution and its associated health problems, and they 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. EPA standards for emissions also 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.

Recommendations

1. DPS and Agency of Natural Resources Air Pollution Control Division (ANR-APCD) and associated interest groups should develop up-to-date public information materials on the advantages of newer EPA certified stoves and implement a public education/outreach program.

2. DPS and ANR-APCD, and Forest, Parks and Recreation should work with the Conference of New England Governors (CONEG), which has run a trade-up wood stove program, so that Vermont has a "Trade Up Wood Stove Program."

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 using existing and emerging technologies.

Managing the by-products of wood processing, known as the wood residue stream, is a critical part of sawmill and wood product manufacturing. The capacity to dispose of wood residues and its cost plays a part in business competitiveness. Vermont has about 100 commercial sawmills, 100 small sawmills, and nearly

600 wood product manufacturing companies that have a demand for thermal and electrical energy as well as a substantial volume of wood residues. At present, many sawmills use their residues to produce process steam to dry lumber. A few wood product manufacturing firms use their residues to generate space heat as well as process steam. A growing number of businesses in the forest products industry, saw mills, veneer mills, pulp and paper processors, have biomass energy technologies that use wood by-products for cogeneration and cost effectively generate electricity and process heat. Savings are greatly enhanced since wood residue not used as fuel represent a disposal cost.

Vermont has seen the successful development of clean, efficient wood chip fired heating systems 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 systems, a Vermont wood chip combustion system manufacturing company has been established. (See Volume 2, Chapter 3 for more information about wood chip heating.)

Institutional, commercial, and industrial facilities are using wood energy systems, 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 McNeil Generation Station to the hilltop community in Burlington. (See Strategy E. on Efficient Production & Distribution Technologies and Infrastructure that follows and Policy 2: Encourage District Heating and Cooling.)

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 being developed. 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 DPS, Department of Forest, Parks & Recreation, Agency of Natural Resources, Department of Economic Development, Coalition of Northeast Governors (CONEG), Vermont Wood Manufacturers Association, and local and regional groups.

Recommendations

3. DPS should continue work with the Department of Forest, Parks and Recreation, Agency of Natural Resources, Department of Economic Development, CONEG, Vermont Wood Manufacturers Association, and the associated network of partners to enhance their joint promotion of commercial and industrial projects that use sustainably harvested wood or wood residues to produce energy and heat.

4. DPS should continue to work with Forest, Parks, and Recreation to promote new small scale biomass cogeneration projects that cost-effectively produce electricity and process heat or steam.

5. DPS should continue work with the Department of Forest, Parks and Recreation to initiate more projects that put clean, efficient wood fired systems into schools, state office buildings, and other publically supported buildings.

6. DPS, Department of Forest, Parks and Recreation, and other interested parties should support ongoing work at the Vermont Gasification Project, a demonstration wood gasification facility sited at Burlington's McNeil Generation Station, as it progresses through its testing phases and approaches full operation. (See Policy: Develop Wood and Wind Power For Replacing Nuclear Power.)

3. Policy: Develop Wood and Wind Power For Replacing Nuclear Power

When Vermont Yankee and other New England nuclear plants' licenses expire early in the next century or if these plants retire prematurely, renewable sources such as wood and wind energy need to be ready to replace this generation in order to keep greenhouse gas emissions from growing dramatically.

> **Note: This policy combines three similar policies discussed in Volume 2, Chapter 4, Section I., Strategies A. and B. Combined policies are I.A.3. Replace Vermont Yankee Power with Two-Thirds Wood Gasification; I.A.4. Replace Vermont Yankee Power with Wood Gasification and Wind Power; and I.B.1. Replace Vermont Yankee Power with One-Third Wind Power.**

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. When these nuclear plants retire, Vermont and New England will have to cut power use or increase renewable fuel use in order to avoid major increases in emissions levels. Current expectations are that nuclear power in New England will be replaced with natural gas combined cycle generation. Therefore, the sources that actually replace power from nuclear plants will determine, to a large extent, whether Vermont and New England make progress towards sustainable and environmentally sound energy use. 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.

Vermont has been a leader in the testing of wood and biomass generation technologies. A project currently underway at Burlington's McNeil Generation Station sites 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. (See Volume 2, Chapter 3 for more on the McNeil Generation Station.) Because Vermont will have valuable experience with wood gasification, the state has a good opportunity to continue its leadership role in developing this new technology and replacing nuclear power with power generated from state-of the-art wood gasification technology.

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). 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, located in California, where 16,000 turbines represent more than 1,700 MW of generating capacity.

There are many advantages to wind energy use, including no air emissions, few environmental impacts or external costs compared with traditional fuels, availability of efficient new technologies, modularity, costs that are nearly competitive with traditional fuels, costs that remain relatively fixed over time (due to no energy price fluctuations), and contributions to local economies. Risk of future operational constraints as a result of efforts to control air emissions is also eliminated, along with environmental impacts associated with mining, drilling, transporting, and leakage of fossil fuels. Disadvantages include the need for further research and development, need for back-up generation sources because of the wind's intermittent nature, visual impacts, impacts on wilderness recreation, potential impacts on wildlife (especially birds), and potential noise impacts for humans or wildlife living close to the turbines. Many of these disadvantages can be mitigated by careful design, siting, and construction.

Wind technology has improved rapidly in recent 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. Unlike larger, non-modular power production technologies, wind turbines can be erected in small increments as needed, and Green Mountain Energy Resources is funding an additional wind machine at its already-permitted wind farm in Wyoming for every 5,000 customers who sign up for its services in California.

Declining costs for wind generation have made it nearly competitive with conventional generation, having 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 could be produced for $0.04 or less per kWh (including up-front capital costs) in modest, 13 mph wind regimes.

Compared to most other states, Vermont has significant wind power. There is potential for both small-scale, non-grid connected systems in Vermont, and utility-scale installations of several MegaWatts in size. Vermont's prime wind resource is located along ridge lines; any project taking advantage of the prime wind sites will also need transmission lines to get the energy to the grid or to customers. (For information of the technical feasibility of replacing large blocks of power with wind power see Volume 2, Chapter 4, Strategy B. on Wind Generation and the policy Replace VY Power with One Third Wind Power.) Green Mountain Power was awarded a $3.5 million grant to assist in the construction of a 6 MW wind power project, with 11 wind turbines. This project, located near Searsburg, Vermont, is expected to produce power for $0.07 per kWh after grant funds are taken into account.

Along with wood, wind is one of the best choices for Vermont's future renewable energy use. When Vermont Yankee Nuclear Station closes due to license expiration in 2012 or possibly sooner if economic, safety, or market factor lead to earlier closure, Vermont should be ready to replace a significant portion of the state's nuclear generation with power generated from new technologies that use wood or wind and significantly reduce green house gas emissions.

Recommendations

7. When the DPS prepares the forthcoming shutdown study for Vermont Yankee, opportunities for replacing nuclear generation with wood and wind generation should be explored. (See policy: Monitor Use of Nuclear Energy.)

8. Vermont should vigorously pursue policies to encourage cost-effective development of wood, biomass, and wind energy, particularly the current projects at Burlington's McNeil Station and GMP's Searsburg Wind Station. (See Policy: Promote Commercial and Industrial Use of Wood Energy.)

4. Policy: Promote Renewable Resources and New Technologies with a Renewable Portfolio Standard

Adopt a strong renewable energy portfolio standard that will promote electric generation in the near term from wood, biomass, wind, hydro, solar, and other renewable resources as well as new emerging technologies when the Vermont market for electricity is opened to more competition.

Note: This policy combines three similar policies discussed in Volume 2, Chapter 4, Section I., Strategies A. and B. Combined policies are I.A.5. Renewable Portfolio

Standard with Wood Gasification; I.A.6. Renewable Portfolio Standard with Wood Gasification and Wind Power; I.B.2. Renewable Portfolio Standard with Wind Power.

Vermont and New England should adopt a portfolio standard for electricity generation from renewable resources/technologies that need further commercialization. These resources include wood, biomass, wind, hydro, solar, photovoltaics, and fuel cells. (The standard should include fuel cells even though they do not use renewable fuels, because they are modular, relatively clean, and are a bridge to biofuel technology development.) Developing a renewable portfolio standard is a key component of electric restructuring plans that have been and will be proposed to the Vermont Legislature. (See Strategy F: Increase Competition in the Electric Utility Industry.) The Clinton Administration has proposed a national renewable portfolio standard.

Without a renewable portfolio standard and other comparable features, increased competition in the electricity market is likely to encourage greater use of older, more polluting coal- and oil-fired plants, and renewable fuels using new technologies such as wood gasification could be significantly disadvantaged. On the other hand, if the electric industry is restructured in a way that is friendly to renewables, wood gasification plants could gain market share. A renewable portfolio standard will 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 will provide resource diversity, giving Vermont and New England a competitive advantage in developing renewable technologies and enabling the region to respond 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.

As energy markets become increasingly competitive, Vermont should take strong steps to ensure that renewable and sustainable generation takes place inside Vermont to gain benefits for the Vermont economy. The recommended action is essential for capturing the economic and environmental benefits of instate renewable generation.

Recommendation

9. Vermont and New England should adopt a portfolio standard for electricity generation from renewable resources/technologies as the region moves to a restructured electricity industry with new suppliers competing in a more open energy market place. This two part portfolio standard should be established for all suppliers selling electricity at retail in Vermont. The first part is a standard or requirement for having existing, commercialized renewable resource technologies in the supplier's generation resource portfolio. The second part of the standard or requirement is for a small portion of renewable resources and emerging technologies that are very close to commercialization such as photovoltaics, wind generation, new wood or biomass technologies, and fuel cells.

B. Strategy: Promote Use of Solar Energy

Solar energy is a clean, abundant, and renewable fuel source. 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. It can provide natural lighting, space heat, hot water, and electricity. Solar energy is underutilized due to a number of factors: the cost of solar installations; 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. (See Volume 2, Chapter 3.II.H. Current and Future Issues in Energy Use, Full Cost of Energy Use.) Policies in this strategy and the strategy Use Energy Taxation to Meet Vermont's Energy Goals address these concerns.

1. Policy: Shift Clocks Toward the Solar Day

Shift clock time one hour ahead to take full advantage of existing sun light.

> **Note: This policy has complex issues needing further exploration before recommendations can be made. See Volume 2, Chapter 4, Section I.C.1. for a discussion of this policy.**

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.

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 Volume 2, 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, benefits from reduced fuel and electricity costs as well as savings from downsizing heating and cooling equipment often offset the construction costs.

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.

Recommendation

10. DPS should promote increased use of solar applications in building designs by:

- increasing information and education available to builders and homeowners;
- providing incentives for solar design; and
- using regulatory mechanisms such as Act 250 and building codes.

3. Policy: Increase Solar Water Heating Installations

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

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 Volume 2, Chapter 3 for more about solar water heaters.)

Recommendations

11. DPS, in cooperation with Agency of Labor and Industry should ensure that, in situations where it is cost-effective, DSM programs include solar water heaters as measures offered to customers, with adequate financing and incentives provided to ensure wide customer acceptance.

12. Vermont should adopt a combination of a limited tax credit program, low- or no-interest loan program, and a rebate program to reduce the cost of solar water heating systems, making them more widely available to low and middle income groups. Oversight and implementation of this program must assure that subsidies are given only in situations where the measure is cost-effective.

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

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

Photovoltaic (PV) 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. PV systems can also 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 and are not connected to the utility power grid (Solar Works, 7/95). 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 is not 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 15 kW of electricity can become "customer-generators" and have "net metered" service. Legislation passed by the 1998 Vermont Legislature permits Vermonters with small-scale, renewable energy systems such as photovoltaic panels, wind turbines, and fuel cells (when fueled by renewable sources) to literally run their electric meters backward when they generate more power than they use. If a net metering system uses more electricity during a billing period than it generates, the customer-generator pays the utility for the kilowatt

hours used minus the kilowatt house generated. If the system generates more electricity than it uses, the utility grants the customer-generator a credit for the excess kilowatt hours, applying the credit to the next billing period in the calendar year. Net metered customers pay customer service charges and other monthly fees, like other retail customers. These small-scale renewable energy systems must also meet safety standards set by the Public Service Board or the National Electric Code.

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. Average wholesale price of PVs fell to $0.25-0.40 per kWh by 1993, and the price is projected to fall to $0.10 per kWh by 2000 and $0.04 by 2020 (Flavin, *Power Surge*, 1994, 156, 173). This price drop can be credited to improved manufacturing process and increasing demand in competitive markets (driven by renewable portfolio standards and promoted by net metering provisions). With these projected rates, PVs are likely to be feasible for the sunniest U.S. regions in the next two decades. If the electricity market is opened up to increased competition and a renewable portfolio standard is required for New England, development of PV systems could and should be hastened in this region.

In addition to PV power plants, PV-powered homes and applications related to the Million Solar Roofs initiative, there are niche applications for PVs that 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.

Recommendations

13. Vermont should promote the use of photovoltaics (PVs) in all applications where they are cost effective, encouraging customer-generators who are setting up small-scale PV systems with net metering.

14. DPS should support continued research and development of photovoltaics to advance technologies that will result in reduced costs for this type of generation, while continuing to advocate for including the full cost of energy produced from fossil fuels in the market price.

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

Small-scale (up to approximately 20 MW), instate hydroelectric and methane energy are similar in that they are both local, renewable fuels and the technology for both is well developed. Unlike wind and solar energy, they do not require extensive commercialization assistance. Small-scale hydroelectric and methane sources are both at a disadvantage because economic considerations often work against them when they are compared to traditional fuel supply sources. This is largely due to the fact that external costs of energy use are not included in energy prices. In fact, Vermont's hydro power production is being reduced somewhat to bring it into compliance with environmental laws and standards. If environmental costs were included in the prices of fossil fuels, hydroelectric and biomass generation sources would be more cost competitive due to their lower environmental costs.

Small-scale, instate hydro power currently is Vermont's largest renewable, non-emitting source of electricity. If this hydro power 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 this hydro power 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 small-scale hydro, wood, wind, and solar, is an instate fuel source that has the potential to be used in a decentralized fashion. While energy from methane currently is not widely used in Vermont, technologies for its use are quite mature. The renewable portfolio standard, recommended in an earlier policy is a very effective way to promote the capture and use of landfill and farm methane. Net metering provisions, recently passed by the legislature, provide strong incentives for capturing methane from agricultural waste and using it to generate electricity. Since methane is an extremely potent greenhouse gas, capturing and using it has very positive impacts on reducing greenhouse gas emissions and improving energy efficiency, key goals of this Plan.

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.

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. Disadvantages associated with hydro power use include its seasonality and variability in stream flow, limited underdeveloped potential in Vermont and New England, and its environmental impacts on river habitats that can be severely damaging if projects are not carefully constructed and managed. Although many hydro power projects built in the past have not focused on minimizing environmental impacts, hydro power has the potential to be used without creating serious environmental degradation. When used in this way, hydro power can be a better energy choice in comparison to other traditional fuels. (See Volume 2, 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. (See Chapter 3 and Volume 2, Chapter 3 for more information on Electric Fuel Sources.) Of this amount, the vast majority has come from Hydro-Québec, a much smaller amount from a large number of relatively small instate sources owned by utilities and independent power producers, and the remainder from relatively few out-of-state sources. (For more information on in-state hydropower projects and their status with respect to FERC licensing see Volume 2, Tables 3.II.2A-C.)

The potential for expanding Vermont's instate hydro power generating capacity is very limited because nearly all the environmentally sound and economically feasible sites have already been developed. In fact, some developed sites might not be viable at current market rates, but for their QF contracts. Given the environmental and economic constraints on the development of new hydro projects, the greatest potential for additional hydro power lies either in repowering (upgrading the generation potential by installing new, more efficient turbines and making other changes) or 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. Significant increases in electric production from instate hydro power are unlikely unless the greater environmental and social costs of competing fuels are considered.

Many existing hydro power plants are coming up for relicensing by the Federal Energy Regulatory Commission (FERC), and sites that have been unlicensed may now be included in the licensing process. This process typically requires mitigation to make the facilities comply with the Federal Clean Water Act and the National Environmental Policy Act, and may require increased river flow conditions or changes in the timing of power production to address water quality concerns. Each of these may degrade project

economics. 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 G: Use Energy Taxation to Meet Vermont's Energy Goals and Section II, Strategy E: Internalize Costs of Transportation More Fully Through Taxation Energy Taxation.)

Recommendation

15. DPS should work with the New England states on legislation and regional energy planning procedures in support of appropriate small-scale, instate hydro and other renewable resources by:

    - assuring that the full costs of non-renewable energy sources are internalized at least for planning purposes;
    - identifying monetary values for externalities and societal costs imposed by all types of energy, particularly traditional fossil fuel sources;
    - establishing "cap and trade" systems for emissions, or by designing a carbon- or BTU-based energy taxation plan.

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.

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 U.S. 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.[3] 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).

Landfill methane is a statewide, localized energy source that can be used for electricity generation or for direct heating. 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; 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. Disadvantages include the facts that emissions of landfill methane do not continue indefinitely; they 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 Volume 2, Chapter 3, Electricity from Landfill Gas.)

Newer, larger landfills are required to collect and dispose of their methane emissions. Disposal is often accomplished by "flaring" the gas, a process that converts methane to carbon dioxide and water while changing VOCs and other gases into less harmful substances. 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. (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.

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. Vermont currently has two landfills that generate electricity: the Windham County Landfill in Brattleboro and the Burlington Intervale Landfill. In addition, there are several smaller landfills that use landfill gas for heating purposes.

The potential for Vermont's landfill methane to be used further as an energy source 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.

Recommendation

16. DPS should work with Agency of Natural Resources and solid waste planners to require the recovery of landfill methane from solid waste sites throughout the state, wherever economically feasible, for use in electricity generation or for direct heating.

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.

Methane is emitted from the decomposition of garbage in landfills, and it 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.

Farms offer an opportunity to capture methane emissions from animal wastes through the use of a methane digester. Capturing and utilizing methane from agricultural waste produces involves storing manure in a pit and capping it for methane collection. This process can also be used at sewage treatment facilities or manufacturing plants that produce organic waste.

Recent legislation passed by the 1998 Vermont Legislature permits Vermonters with small-scale, renewable energy systems, including systems that generate electricity with methane from manure, to literally run their electric meters backward when they generate more power than they use. Systems that generate electricity from methane can be as large at 100 kW; systems using other renewable resources such as photovoltaic panels, wind turbines, and fuel cells — when fueled by renewable sources are limited to 15 kW of generation. (See Policy: Promote Development of Photovoltaics and Increase Their Use for more information on renewable, small-scale generation that qualifies for net metering.)

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.

Recommendations

17. DPS, Department of Agriculture, and ANR should continue exploring the possibility of obtaining U.S. DOE funding for a proposed project that will demonstrate to the agricultural community both the physical and economic feasibility of capturing and utilizing methane from agricultural waste products to generate electricity and produce heat on the farm.

18. DPS, Department of Agriculture, and ANR should continue supporting the ongoing, successful and singular efforts of the Foster Brothers Farm , in Middlebury, that produces electricity from their methane digester to meet the farm's electrical needs and uses the by-product of this process as a high quality soil additive to spread on their fields or sell as a commercial potting soil additive or as bagged cow manure for retail markets.

19. DPS should support efforts by Vermont farmers and their utility to set up net metering systems, enabling farmers who generate electricity from methane collected from the farm's manure to feed excess power back to the utility.

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

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 U.S. — oil, coal, and nuclear energy — have 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 the adoption of emissions standards for transportation end uses and electric generation, internalization of the full costs of energy use in energy prices, increasing the efficiency of the uses of these traditional fossil fuels - thereby reducing their consumption, redirecting 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, having only some of the problems associated with the use of traditional fuels, could be part of a mitigation strategy if it replaces other fossil fuels.

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

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

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 that follows includes five strategies with policies and recommendations to study ways to internalize more of the costs of fuel use in fuel prices; reduce petroleum dependence and overall energy use by increasing the efficiency of vehicles; reducing vehicle miles traveled (VMT) without compromising public access needs; and reduce transportation related emissions.

Electricity generation from oil has accounted for only about 4%-5% of Vermont's total electricity generation in recent years, and most of this power comes from out-of-state oil plants. However, if retail competition and customer choice for electricity generation takes hold in Vermont, oil fired generation in other states could be marketed directly to Vermont consumers. New England currently has many older oil fired plants; with increased competition, electric power from these older, more polluting plants could be priced lower than power from newer, cleaner plants because the older plants 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 establishing strong emissions standards and pursuing policies that ensure that any oil generated electricity used by Vermonters meets these emissions standards. Emissions standards are 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.

Recommendations

20. Vermont should investigate strategies, policies, and recommendations that decrease transportation energy use. (See Section II Transportation.)

21. Vermont should consider studying methods for internalizing more of the total costs of oil use in oil prices through taxes. (See Section II, Strategy E: Internalize the Costs of Transportation More Fully Through Transportation Energy Taxation.)

22. 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.

23. 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. 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.

24. 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.

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.

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. 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 Volume 2, Chapter 3.)

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 Volume 2, Chapter 3, 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.

If retail competition for electricity sales occurs, coal generated electricity from other states may be marketed directly to Vermont consumers. 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 restructuring the electric industry could result in older, more polluting coal plants operating more frequently than at present.

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.

Recommendations

See Recommendations 22 - 24 above under Policy 1: Reduce Use of Petroleum Energy and Establish Emissions Standards.

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.

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 in Chittenden and Franklin Counties. (For more information about natural gas, see Volume 2, 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 (pipelines) in Vermont to bring natural gas to new customers, the fact that natural gas is not renewable and is difficult to use sustainably, land use impacts of the pipeline, 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. 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 Volume 2, Chapter 3, Table 3.II.3.) Natural gas emissions of carbon monoxide from electric generation are also similar to those of oil fired plants.

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 in its existing territory is underway.) A new pipeline through Vermont is another option, although two proposals in the recent past for new pipelines in Vermont have not come to fruition. 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 or new technologies such as the latest combustion turbines or combined cycle plants are used, all of which improve efficiency and emissions. (See Volume 2, 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. Gas could be drawn south from Chittenden County or to southern Vermont from pipelines in New York or Massachusetts. This idea has been discussed since the mid 1980s.

Liquified natural gas (LNG) is another component of the region's gas supply. Distrigas of Massachusetts supplies LNG to a growing number of utilities in the region, and supplies of LNG to Brattleboro could be part of the replacement of MegaWatts from nuclear power.

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 Volume 2, 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 oxide 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.[4] 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.

Recommendation

25. 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. (See also recommendations 22 - 24 under the Policy to Reduce Use of Petroleum Energy and Establish Emissions Standards.)

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.

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 restructured 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 U.S. 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.

High-level radioactive waste (mostly spent fuel) is a most pressing and disturbing issue associated with nuclear power. The federal government has collected more than $11 billion nationally 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. Currently, most 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 or very long term 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, national 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 submitted.

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 the Senate and is awaiting conference action. Meanwhile, opportunities for disposal remain at the existing facility in Barnwell, South Carolina, and at the Envirocare Inc. facility in Utah.

With the advent of restructuring, 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 in the U.S. 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. The market should bear the full risk of forward looking resource commitments related to nuclear power.

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 indicating 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 (CPG) process established in 30 V.S.A. §248. In order to exercise the rights NRC has stated in its rule, nuclear license renewal should be specifically included in Section 248. The CPG determination would consider environmental and cost issues, while consideration of the safety of license renewal will probably remain within federal jurisdiction. Although it is not expected that new nuclear generation requiring state approval will be pursued in the foreseeable future, DPS should pursue legislation establishing a CPG 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), the thousands of MegaWatts generated by nuclear power will need to be replaced. Generation from renewable fuel sources would avoid growth in carbon dioxide emissions. (See I. Energy Sources and Supply, Policy 3: Develop Wood and Wind Power for

Replacing Nuclear Power.) It is very likely that a significant portion of the replacement generation will come from natural gas. DPS is evaluating alternatives for the MegaWatts generated from nuclear power, trying to utilize renewable resources where ever possible.

A large percentage of our region's electricity generation comes from nuclear plants (an average of 30% over the past decade). The fuel for 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. Strong emissions standards, particularly a New England carbon dioxide cap and a "cap and trade" system, are very relevant to nuclear power and assuring that nuclear generation is not replaced with electricity from fossil fuel generation. Recently, nuclear plant owners and other experts have opened discussions involving the sale of existing nuclear plants and consolidation of ownership among a relatively small group of operators competing in wholesale electric markets. This issue could affect the funding of decommissioning. U.S. NRC rules for decommissioning rely on the owners' status as a utility with captive customers. If ownership evolves to a more entrepreneurial structure, NRC and state regulators will have to pay attention to decommissioning funding provisions to assure that public safety and consumers are protected.

Recommendations

26. DPS should plan and evaluate alternative types of generation to replace the MegaWatts that are currently produced at Vermont Yankee Nuclear Station, trying to replace as much nuclear power as possible with generation from renewable sources and assessing a range of other alternatives.

27. DPS should closely monitor nuclear safety issues as restructuring of 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.

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

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

    - Since the federal government has failed 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 and seek recovery of damages from the federal government to hold Vermonters harmless from failure of the federal government to perform.

    - 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 should consider methods for withholding Vermont Yankee payments into the Nuclear Waste Fund.

30. DPS should support legislation requiring a certificate of public good (CPG) 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.

    - Least cost planning practices with externalities included should be applied in the analysis comparing nuclear power with alternatives.

- Full costs of both the front end and back end of the nuclear fuel cycle must be considered, including costs associated with uranium mining, milling, enrichment, fabrication, and transportation.

31. DPS should prepare a new Vermont Yankee shut down study.

32. Vermont Yankee should prepare and submit its plan on how to resolve the issue of on-site spent fuel storage as called for in the 1994 *Vermont Electric Plan*.

33. Vermont should urge the federal government to redirect nuclear research dollars that are related to life extension of existing or deployment of new nuclear fission plants to cost-effective renewable and sustainable fuel sources and technologies.

E. 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.

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, heat is a by-product of the electrical generation, although in some cases, 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. See Section I.A., Policy 2: Promote Commercial and Industrial Use of Wood Energy.

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, either stack gases or low pressure steam. If this energy could be recaptured and used, efficiency would be increased and total 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.

A 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 restructured electric industry 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 Volume 2, Chapter 3.)

Recommendations

See Recommendations 3-6 in Section I. Energy Sources and Supply, Strategy A, Policy 2: Promote Commercial and Industrial Use of Wood Energy.

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- or wood-fueled systems are increased due to the larger size of the system. Green Acres housing complex in Barre is an example of a multi-building development that has been retrofit to use a wood fired district heating system.

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.

McNeil Generation Station in Burlington is an example of a power plant located close to a demand center that is being considered for a district heating/cogeneration project, known as the Community Renewable Energy or CORE Project. Planning discussions are in progress with the University of Vermont and Fletcher Allen Health Care regarding links to their heat plants. 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, with condominium developments pooling propane supply systems. The next logical step is installing a DHC system for a set of buildings.

Recommendations

34. DPS should continue its work with the CORE Project, promoting cost effective district heating and cooling systems and cost effective expansions and improvements of the systems now operating, including expansion of the district heating systems now serving state office complexes in Montpelier and Waterbury, several colleges, and the University of Vermont. Some 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.

35. DPS should continue its work with the CORE Project and other interested parties on grant opportunities for a feasibility study and demonstration district heating and cooling project for McNeil Generation Station and the hilltop community in Burlington - including University of Vermont (UVM) and Fletcher Allen Health Care (FAHC).

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.

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 restructuring of the electric industry, further analysis of how a utility can cost-justify investments in nontraditional distributed utility investments will be needed. (See Volume 2, Chapter 3 for more on distributed generation.)

Recommendation

36. DPS and the state's utilities should work together on protocols as well as demonstrations of techniques and technologies that represent least cost approaches to the concept of a distributed utility.

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.

Recommendation

37. Vermont should investigate projects proposing expansion of natural gas pipelines into the state and projects proposing to build local distribution systems and storage facilities for liquified natural gas

(LNG) and propane (LPG) that is brought in by truck, so long as these projects meet statutory siting requirements.

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.

Recommendation

38. DPS should prepare a summary, including maps, for the abandoned manufactured gas systems in Montpelier, Springfield, Barre, St. Johnsbury, Rutland, and Bennington. Feasibility of rehabilitating and reactivating these system should be addressed with interested parties.

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. See Volume 2, Chapter 4, Section I.F.6. for a discussion of this policy.**

F. 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.[5] 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

DPS 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.

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:

- 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 - *The Power to Save: A Plan to Transform Vermont's Energy-Efficiency Markets* (May 1997)

Recommendations

39. DPS and the PSB should continue to work cooperatively with state government, the legislature, the state's utilities, industry, public interest groups, and other stakeholders toward reform of the regulation of Vermont's electric utility industry, bringing to Vermont consumers the advantages of increased retail competition, while preserving the following public benefits:

    - Sustaining high quality, reliable electric service;
    - Assuring public health and safety;
    - Providing safeguards against concentrations of market power;
    - Preserving environmental quality;
    - Improving progress on statewide energy efficiency programs and demand side management, as proposed in Public Service Board Docket 5980, *Vt. DPS Statewide Energy Efficiency Plan*;
    - Promoting renewable resources and emerging new technologies;
    - Improving customer protections;
    - Equitably assuring the benefits of competition to all utility customers; and
    - Assuring safe nuclear power station operation and decommissioning.

40. DPS should support appropriate voluntary initiatives proposed by any Vermont utility that are constructive, preparatory steps toward a more open and competitive marketplace. Such initiatives include :

    - unbundling of services;
    - disclosure of billing information (generation resources, emissions, etc.); and
    - internal reorganization.

41. DPS should lead a strong public education campaign during and after the transition to greater competition in the electric industry, assuring that all Vermont consumers get clear, complete and comparable information about different options for energy service, informing consumers about the full costs and environmental impacts of different generation fuels, prohibiting any false claims about energy and environmental impacts, and assuring that consumers get energy from the suppliers they choose.

42. DPS should monitor and participate in regional and national groups addressing the issues related to restructuring the electric utility industry.

43. DPS should work to advance components of a restructured electric industry, as identified in S.62.

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

Vermont should give consideration to moving toward developing an energy taxation system that begins internalizing the social and environmental costs associated with fossil fuel use and supports development of renewable energy technologies and energy efficiency investments. Extensive research by DPS shows that energy taxes are an effective tool in progressing toward the state's energy goals for several reasons.

- 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 energy savings by reinvesting the revenue in more efficient homes and vehicles, thereby increasing Vermont's economic vitality.

- Eliminating some tax exemptions enjoyed by fossil fuels could promote progress toward Vermont's energy goals and increase revenue earmarked for energy efficiency projects or for return to taxpayers.

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 important 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. These concerns about current taxes include the impact of taxes on the economy as well as the wise and efficient use of tax dollars, local concerns regarding the over dependence 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. (Also see Section II - Transportation, Strategy E: Internalizing Costs of Transportation More Fully Through Transportation Energy Taxation.)

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 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.

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. 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. 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.

Energy taxes are one of the most efficient means of reducing energy impacts. They raise revenue and reduce energy impacts 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.

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 taxes; and
- using energy tax revenues to fund cost-effective programs aimed at reducing the total societal cost of energy use.

Property Taxes. In 1993, about $65 million of property tax revenue was spent on roadways in Vermont (U.S. DOT, *1993 Highway Statistics*, 1994, 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. Although energy taxes can be used to replace many types of taxes, it is particularly important that energy taxes replace 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.

Tax Revenue Shortfalls. Fluctuating tax revenues reflecting economic cycles 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. Energy taxes could be used to create a "rainy day fund," a substantial reserve fund to smooth out the fluctuations in available revenue and help stabilize Vermont's difficult to predict tax revenues. 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. 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. New Hampshire, for example, has proposed eliminating that state's gas tax for the summer to attract tourists, and on our side of the Connecticut River, energy sales to industrial customers are now exempt from Vermont sales tax. (See Volume 2, Chapter 4, Section I, Strategy H: Use Energy Taxation to Meet Vermont's Energy Goals.)

There is a potential conflict between internalizing of external costs (using taxes or other mechanisms) and maintaining economic competitiveness with states and 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. 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 .

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.

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

Vermont should consider investigating the following five energy tax proposals as options to be considered for internalizing the costs of energy use and raising revenue, possibly replacing or reducing other taxes or returning the revenue to Vermont taxpayers.

- Carbon tax at $100/ton with revenues returned to taxpayers or held in a Rainy Day Fund. (See Volume 2, Chapter 4, Table 4.I.37 for carbon content of fuels and further information.)
- BTU tax applied to the energy content of fuels with revenues returned to taxpayers or held in a Rainy Day Fund. (See Volume 2, Chapter 4, Table 4.I.27 for energy content of fuels and further information.)
- Begin charging sales tax on motor fuels and apply the 5% tax to the sales price of gasoline and diesel fuels sold in Vermont for motor vehicle use, with revenue returned to taxpayers.
- Energy Sales Tax - 5% tax applied to the sale price of fuels sold to the residential, industrial, and transportation sectors (the commercial sector already pays an energy sales tax), with revenues returned to taxpayers, held in a Rainy Day Fund, directed to Weatherization, or invested in cost effective efficiencies.
- Gross Fuel Receipts Tax increase of between 0.25% and 1.0% applied to the current gross receipts tax, with revenue funding the Weatherization Program.

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."

The carbon tax offers an effective way to control CO_2 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. 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 Volume 2, Chapter 2. Since 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 for CO_2 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 CO_2 sources, automobiles, are relatively small compared to those of large boilers, and typically range from four to eight tons of carbon dioxide per year. However, the cumulative impact of the emissions of millions of automobiles 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 CO_2.

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. 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.

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 hydro power;
- switching to fuels with no net carbon dioxide emissions such as wood or other biomass fuels used sustainably; and
- switching to fuels with lower carbon content.

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 CO_2 emissions, internalizing costs and raising the price of polluting fuels. 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.

BTU Tax is quite similar to a carbon tax and is often discussed 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. Renewable energy resources are typically exempt from proposals for a BTU 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.

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. Raising the motor fuels tax could be used to reflect more accurately the cost of transportation in the price drivers pay, thereby influencing their energy use. If the principle behind the carbon tax and BTU tax is "the polluter pays," the principle behind the motor fuels tax 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.

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. 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; they are used as revenue raising mechanisms for the state. Sales tax exemptions can work against energy goals. 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. 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.

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. 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.

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.

Concerns about Affordability and 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.

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 state 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.

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 this case, funding is 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. Cost per home weatherization is assumed to be $2,392 (1994$).

Recommendations

44. Vermont should review its current energy goals and energy taxes and assess their consistency, assuring that Vermont's energy taxes are directed toward achieving Vermont's energy goals. Revenue raised by energy taxes should be used to lower other taxes or to purchase cost-effective improvements in energy efficiency.

45. Vermont should consider investigating the following five energy tax proposals as options to be considered for internalizing the costs of energy use and raising revenue, possibly replacing or reducing other taxes or returning the revenue to Vermont taxpayers.

    - Carbon tax at $100/ton with revenues returned to taxpayers, possibly through a subsequent year's reduction in personal or corporate tax rates. (See Volume 2, Chapter 4, Table 4.I.37 for carbon content of fuels and further information.)

    - BTU tax applied to the energy content of fuels with revenues returned to taxpayers, possibly through a subsequent year's reduction in personal or corporate tax rates. (See Volume 2, Chapter 4, Table 4.I.27 for energy content of fuels and further information.)

    - Begin collecting sales tax on motor fuels and apply the 5% tax to the sales price of gasoline and diesel fuels sold in Vermont for motor vehicle use, with revenue returned to taxpayers, possibly through a subsequent year's reduction in personal or corporate tax rates.

    - Energy Sales Tax - 5% tax applied to the sale price of fuels sold to the residential, industrial, and transportation sectors (the commercial sector already pays an energy sales tax). Biomass and solar fuels are exempt from the sales tax. Revenues could be returned to taxpayers, directed to Weatherization, or invested in cost effective efficiencies.

    - Gross Fuel Receipts Tax increase of between 0.25% and 1.0% applied to the current gross receipts tax, with revenue directed to the Weatherization Programs.

46. Vermont should promote regional cooperative initiatives, possibly through the Northeast Ozone Transport Region, and federal policy changes to avoid competition between states and achieve savings and reductions in energy impacts that are possible through internalizing of external costs. Federal policy could be improved in two 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.
- federal block grants for states that internalize external costs would be one option for encouraging states to compete positively in emissions reductions.

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 spend on 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. It is the one area in which the growth in energy use has not slowed and shows no signs of slowing. (See Volume 2, Chapter 2 and the section on Environmental Soundness; Chapter 3, Section II on Current Energy Use and Figure 3.III.29; and Chapter 4, Section II Transportation.)

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 higher, 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). However, more than 135,000 Vermonters rely on other drivers or alternate forms of transportation to meet their transportation needs, and 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 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.

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 the most emphasis 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 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 (VMT) without decreasing access to goods, services, and activities. Past increases in efficiency have been negated by increases in vehicle miles traveled. (See Volume 2, Chapter 4, Figure 4.II.7 Automobile Efficiency vs. VMT, 1978-1994). Policies that fall under this strategy seek to reduce the need for travel. Greater use of commuter lots, shifting to more efficient modes — bus, vanpool, and train, more attention to non-motorized transportation options, encouraging telecommunications, and better land use planning and vigorous efforts to curtail sprawl are the policies that can 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 last 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.

These strategies illuminate important public policy changes that can significantly contribute to Vermont moving toward its energy goals.

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.[6]

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.

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 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. 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. 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.

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.[7]

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.

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.

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.

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 are ranked so that the most cost-effective ones can be implemented first.

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 transportation planning tool that includes a broad range of options and comprehensive consideration of costs to accomplish this task. By giving citizens better information about the costs and impacts of transportation options, LCTP encourages citizens to participate in the transportation decision making process. Both LCTP and traditional transportation planning include public hearings as well as local and regional input in the planning process. LCTP moves ahead 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.
- 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.

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).

These characteristics and advantages of LCTP could have direct impacts on Vermont's energy use. LCTP may be the most effective single action Vermont could take to achieve its energy goals, including sustainability, environmental soundness, affordability, and economic vitality. The following specific policies are important steps to a comprehensive Least Cost Transportation Planning process. They involve adopting the principles of LCTP for the state's transportation planning, studying the full cost of transportation in the state, and initiating a demonstration project green parking/transportation vouchers as an initial step in an ongoing study of transportation options to meet Vermonters' needs for access to goods, services, and activities at the lowest cost to society.

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.

Recommendation

47. 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.

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.

A 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. The proposed study should consider all costs, in accordance with a life cycle costing methodology, full cost accounting, as well as who pays the costs. The 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.

Recommendation

48. Vermont should consider studying the full cost of transportation in this state, using a multi-agency approach that combines AOT's experience with transportation, ANR's expertise with environmental impacts, Department of Housing and Community Affairs' knowledge of local government units and land use planning, DPS's experience with energy use, impacts, and external costs, and the planning momentum generated by the Vermont Forum on Sprawl.

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.[8] 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.[9]

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. There are options that achieve the same goals as building a parking garage, but at a lower cost. One of the most promising is the green parking 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. 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 they called it 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.

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.

One advantages of this proposal offers is flexibility. 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.[10] 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.

Federal ISTEA transportation funds meant to encourage alternative modes of travel could potentially be used to fund 80% of the cost of this green voucher project for the first five years. However, this policy makes sense with or without federal assistance. 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 is likely to be opposed 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 a 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. Furthermore, 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.

Recommendation

49. Vermont should develop a pilot demonstration program for green parking/transportation vouchers, possibly offering this demonstration project for state and city employees in Montpelier.

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. (Five years of oil consumption at current Vermont levels are represented by 1.9 billion gallons.) 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.

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 Volume 2, Chapter 4, Table 4.II.5 for 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. DOT, NHTSA, 7/97.)

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.[11]

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 (AOT memo, 1/24/95). 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.

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. 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, and both should be held to a 40 MPG standard.

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.

Recommendation

50. Vermont should advocate for federal implementation of increased CAFE standards to 45 MPG for cars and 30 MPG for light trucks or a 40 MPG standard for both to take effect in 2005.

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. See Volume 2, Chapter 4, Section II.B.2. for a discussion of this policy.**

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.

There is a loss in motor vehicle 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 Volume 2, Chapter 4, 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. In tandem with energy use, air emissions fall.

There are also 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 excessive speed is the greatest single cause of accidents on interstate highways (Vt. Governor's Highway Safety Program, *Vt. Crash Data 1993*, 43, 53). Accidents have costs. The most significant are the loss of life and disabilities that result. Monetary costs are quite high too. Measures that save energy by reducing speeding can have equal or greater impact on highway safety and costs.

In 1994 there were 32 fewer highway fatalities in Vermont and 2,000 fewer injuries than in 1993. 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 that 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.

Recommendation

51. Vermont should aggressively target those traveling more than 10 MPH over the limit with a strong education and publicity program, increased enforcement, and increased penalties.

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 Volume 2, 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 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.

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. 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, Vermont should look beyond traditional auto suppliers and technologies to produce large efficiency gains in the transportation sector.

Fortunately, many components of 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 concept 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, good 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 of the hypercar 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.

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. Until 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. Larger gains in efficiency that are feasible with the introduction of the hypercar are necessary if Vermont's transportation energy use is to be sustainable and environmentally sound.

Recommendation

52. Vermont should work to develop partnerships, prepare the market, and other actions to expeditiously advance the hypercar so it becomes a consumer-ready vehicle.

C. Strategy: Reduce Vehicle Miles Traveled

Reducing Vehicle Miles Traveled (VMT) is a complement to the previous strategy of increasing efficiency. 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 dramatically, exceeding efforts to make vehicles more efficient (see Volume 2, Chapter 4, Figures 4.II.7 and 4.II.8). The net effect is 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.

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 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 - by encouraging cycling and walking. Another approach is to eliminate the need for transportation. Telecommunications and better land use planning can, in some instances, do this.

The policies considered within this strategy 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 (see Volume 2, Chapter 4) 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 improving the marketing of these lots, producing a statewide map of them, coordinating lots and drivers using a 1-800 number, improving signage and maintenance, add lighting and bicycle lockers where appropriate, expanding lots that are at or over capacity, and building new sites along major commuter corridors currently under- or unserved.

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.[12] They are relatively inexpensive to build and maintain.

There are three main actions that can 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 1991 TAMS Engineers report "Evaluation of Statewide park-and-ride Facilities," (Vt. AOT).

2. Expand the seven sites that are at or over capacity. These sites are obviously well-situated. Lack of reliable parking facilities and overcrowding limits further energy savings and discourages current users.

3. New sites could be built along heavily used roads that have a large number of drivers making commutes of 30 to 40 minutes or more, such as the Route 7 corridor.

Greater use of ride sharing could save millions of gallons of gasoline and prevent the release of tons of carbon dioxide. In addition, individuals taking advantage of ride sharing would save millions in driving expenses.

Recommendation

53. AOT should encourage the increased use of park-and-ride lots in any or all of these suggested ways: improve the marketing of these lots, produce a statewide map of them, coordinate lots and drivers using a 1-800 number, improve signage and maintenance, add lighting and bicycle lockers where appropriate, expand lots that are at or over capacity, and build new sites along major commuter corridors currently under- or unserved.

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. 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. Several such efforts are already in place. Specific actions include the creation of a fund using an increase in the motor fuels tax to finance societally cost- effective investments in public transportation.

In Vermont, automobiles and light trucks 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 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.

Vermont should expand the system of rail freight in the state. 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). In addition, significant energy savings can be achieved by switching large and heavy loads traveling long distances from trucks to rail. (In Volume 2, Chapter 4, Figure 4.II.9 presents Energy Use by Vehicle for Commuting, and Table 4.II.12 presents Energy Intensity of Freight Transportation.) Vermont should expand connections between modes of transportation as a way to make 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. Several potential options could be explored:

- 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.

Vermonters often are limited to the most inefficient modes of transportation because of what is available to them. An AOT survey found that about 60% of Vermonters felt they lacked adequate access to local bus service; 67% felt they lacked adequate access to bike lanes. In addition, 50% would use public transit if service were more convenient (Vt. AOT, 1995, *Vt'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.

The key to increasing the use of more efficient modes of transportation is to structure public policy and public transportation to overcome several obstacles that are barriers 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.[13] 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 the Strategies on Least Cost Transportation Planning and Internalizing Costs of Transportation through Transportation 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 is more expensive than the cost of gasoline for an automobile

at $0.03 to $0.08 per mile. Full benefits of a bus compared to an automobile are not considered because many of the costs of driving are assessed as fixed costs. If more of the automobile costs were assessed as variable costs, those who switched to public transportation would save money.

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. 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.

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. (See Strategy: Transportation Taxation and Transportation Energy Taxation, Policy: Support Commuter Buses with a Motor Fuels Tax.)

Recommendations

54. In the long run, Vermont should work toward:

    - removal of federal and state funding and tax exemptions for the more polluting and less efficient modes of transportation;
    - internalizing more of the cost of transportation — particularly the cost of emissions; and
    - creating mechanisms to shift more of the costs of driving to marginal costs.

    With these changes, options to choose more efficient and cost-effective transportation modes, such as the bus, vanpool, and train, compare more fairly with Vermont's predominant modes of transportation for people and goods.

55. In the short term, Vermont should give consideration to increasing the motor fuel taxes. This increase in the cost of gas would better reflect the full cost of transportation. Furthermore, the revenue raised can be used to support public transportation, possibly a commuter bus fleet, so that the fare is competitive with the marginal cost of driving a car, approximately $0.04 per mile.

56. Vermont should focus on expanding public access to more efficient modes for commuting and freight particularly where large numbers of people and goods are moving at the same time along the same corridors.

57. Vermont should expand connections between modes of transportation as a way to make 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.

58. Vermont should recognize that traditional modes of transportation enjoy subsidies and market advantages as a result of federal and state policy and increase subsidies to bus and rail as a way of addressing the obstacles related to public inconvenience for more efficient modes of transportation.

Lowering bus and rail fares will encourage more ridership, allowing more routes, greater frequency of service, and more connections between modes of transportation.

59. Vermont should expand the system of rail freight in the state, particularly in areas where highways with heavy truck traffic run parallel to Vermont's major rail corridors.

60. Vermont should consider promoting and implementing public transit policy by passing legislation raising the motor fuels tax and creating a dedicated fund for public transportation. Research into the most suitable routes is 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.

61. Vermont should consider promoting and implementing a rail freight policy. 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. Vermont should consider legislation to increase user fees and lower weight limits, as set at both the federal and state levels, for the heaviest vehicles on roadways.

3. Policy: Encourage Non-Motorized Transportation

Encourage the use of energy efficient non-motorized alternatives to the automobile such as cycling and walking.

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 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.

There are two broad options for providing continuous and safe routes for pedestrians and cyclists:

- designating a portion of existing street space to non-motorized transport; and
- 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).[14] 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 should continue to support non-motorized transportation through the construction of bike paths and the designation of bicycle routes. AOT's Bicycle & Pedestrian Program 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, with provisions for winter snow removal in time for people to get to work and school.

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, roller blade, 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.

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 4.II.C., Policy 5: Encourage High-Density, Mixed-Use Land Use Planning and Curtail Sprawl.)

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 (bike racks on buses and baggage cars on trains).[15]

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. 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 reducing 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.)

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.

Recommendation

62. Vermont should 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; and
- internalize the full cost of driving.

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.

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. (See the strategy on Least Cost Transportation Planning and Policy 3: Green Parking/Transportation Vouchers. Also see *Vt. Telecommunications Plan* (1996) Chapter 3, Section IX. Commerce.)

Recommendation

63. Vermont should continue implementing policies that encourage the best aspects of telecommuting and avoid the worst, targeting areas where there are air quality problems, traffic congestion, or parking shortages. In these areas, incentives based on the value of avoiding road or parking capacity expansions could be offered to employers or employees for reducing commuter trips.

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; and
- 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 (use more common walls and ceilings, compact building forms, and multi-family housing); and
- 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; and
- 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; and
- 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.[16] (See Vt. ANR, 1991, *Vermont's Scenic Landscapes*, 29-30 and Vt. DPS, 1993, *Guide to Municipal Energy Planning*, 42-3.)

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.

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.

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. 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.

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. 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).

Changes in zoning regulation can assist in curbing the trend to 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. 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, ANR, 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 Vermont's land use and energy goals when local areas adopt Act 250 criteria to some degree into their zoning regulations as Manchester, Burlington, and Middlebury have done. 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).

Other growth center projects 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 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 this 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 soundness, and affordability. Funding the development of such policies will create energy and cost savings indefinitely into the future. (See Section V. Government Energy Use and Energy Policy.)

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.

Recommendations

64. All agencies of state and local government, Regional and Municipal Planning Commissions, businesses, and public interest groups should renew commitment to actions, many of which are summarized in this policy, that are fully consistent with high-density, mixed-use land use planning, as required in Act 250 and Act 200, to preserve the character of the Vermont landscape.

65. DPS, ANR, Housing and Community Affairs, AOT, and other areas of state government should work together and with private organizations such as the Vermont Forum on Sprawl to support efforts to curtail sprawl.

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.

> **Note: This policy has complex issues needing further exploration before recommendations can be made. See Volume 2, Chapter 4, Section II.C.6 for a discussion of this policy.**

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. In 1995, 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. (See Figure 3.III.25 that is included in this volume and in Volume 2, Figure 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 above, Strategy C: Reduce Vehicle Miles Traveled and its set of policies), 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 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 through implementation of an automobile emissions check program, preventing the evaporation of gasoline during refilling at service stations, implementation in the Northeast and Vermont of a Low Emitting Vehicle (LEV) program identical to California's, and by supporting a market for alternative transportation 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. 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, 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.

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 has been under sanctions from the EPA for not implementing an auto emissions check program.

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. 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 vehicles that fail (and are repaired) would increase by an average 10% and greenhouse gas emissions would decrease by a similar amount (U.S. EPA, 1995, *I/M Briefing Book*, Sec. 4, 16). An additional benefit is the creation of a stronger infrastructure to maintain clean, efficient, and reliable vehicles.

Before vehicle test programs can be implemented, they must develop public support. Lack of public support has delayed implementation of an emissions check program, which resulted in sanctions against the Burlington MSA. A proposal was submitted to EPA to implement a visual check of the catalytic converter and a test of the gas tank evaporative emissions system at the time of vehicle inspection as an interim substitute for the more complete tests currently required by the EPA to meet the Clean Air Act requirements. This visual inspection was accepted, and sanctions imposed on the Burlington MSA have been removed. The visual inspection and gas cap test have been added to the current inspection testing for cars and light trucks built since 1980, and there are positive environmental impacts, although they are not as beneficial as the comprehensive test program recommended in this Plan.

This policy is one of the best for making Vermont's energy use cleaner. Large decreases in many of the most significant emissions, accompanied by a large reduction in air emission costs, make this policy important for the state to pursue. Individual pollutants that would see the largest reductions are carbon monoxide and VOCs. Energy use and greenhouse gas emissions are also reduced due to more efficient vehicle operation.

Recommendations

66. DPS, ANR, and AOT should work on public information and education about vehicle emissions. 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 will support a full fledged emissions check program as part of requiring polluters to pay for the clean-up of their pollution.

67. ANR should continue its work toward establishing emissions 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.

68. ANR and AOT should continue to work together, building on the current visual inspection program, and progressing toward a comprehensive vehicle emissions check program.

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.

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 prevent pollution and human exposure to the high concentrations of gasoline vapors and their toxic and carcinogenic constituents (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.[17]

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). 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, ANR has recommended that the necessary underground piping be installed whenever other site excavation work is done. ANR'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.

This policy ranks among the best in the Plan for VOCs reduction. Reductions in VOCs cause ozone precursors to fall a significant amount. In addition, capturing gasoline vapors results in a small reduction in transportation energy use.

Recommendations

69. Agency of Natural Resources should continue the phased implementation of this policy. Stage II vapor recovery devices are being installed at gas stations, based on how many gallons of gasoline a station sells, according to the following schedule:

    by Dec. 31, 1997: stations pumping 1.2 million gallons or more per year;
    by Dec. 31, 1998: stations pumping 1 million gallons or more per year;
    by Dec. 31, 1999: stations pumping 700,000 gallons or more per year; and
    by Dec. 31, 2000: stations pumping 400,000 gallons or more per year. (Vt. ANR, 1997, *Closing the Loop*)

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 Volume 2, Chapter 4, 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.

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. 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 the 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 (ozone abatement) and to ensure it has a vote on this and other regional measures that impact Vermont's air quality.

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 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.

Recommendation

70. Vermont should consider adopting the California Low Emissions Vehicle Program (LEV) to ensure that new motor vehicles entering the fleet are the "cleanest cars in mass production," having the best available emissions control technology and therefore the least emissions from motor vehicles over their operational life and significantly reducing air pollution and human exposure to toxic and carcinogenic air pollutants.

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 that 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.

EVermont, the Vermont electric vehicle project that started in 1994, involves over 20 state businesses and state agencies in a federal program supported by Advanced Research Projects Agency (ARPA) to study 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.

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 few 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.

Under the National Energy Policy Act, New England states are urged to work through DOE's Clean Cities and Clean Corridors programs to develop a regional strategy for creation of an alternative fuel infrastructure. Vermont and the New England states should work on the Clean Corridor connecting Boston and Montreal, as recommended in the New England Transportation Initiative (NETI).

Recommendations

71. DPS, AOT, and ANR should continue working together to promote legislation incorporating a comprehensive package of incentives for owners and operators of alternative fuel vehicles, including electric vehicles (EVs).

72. Vermont and the New England states should work on the Clean Corridor connecting Boston and Montreal, as recommended in the New England Transportation Initiative (NETI).

E. Strategy: Internalize Costs of Transportation More Fully Through Transportation Energy Taxation

Vermont should consider using transportation taxes and transportation energy taxes to incorporate the full cost of driving in the price of driving and to reduce the impact of transportation energy use. (See also Section I in this chapter, Strategy G: Use Energy Taxation to Meet Vermont's Energy Goals, the transportation policy Shift VMT to More Efficient Modes — Bus, Vanpool, and Train, and for the full discussion of policies in this strategy, see Volume 2, Chapter 4, Section II.E.) 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 Volume 2, Chapter 3, Figures 3.III.25-29).

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).[18] (See Section I, Strategy: Use Energy Taxation to Meet Vermont's Energy Goals.) Fixed costs (those that do not vary with the number of miles driven) and hidden or external costs (those costs not paid for directly by drivers) encourage unnecessary and inefficient use of resources. (In Volume 2 Chapter 4, 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 mechanisms such as property taxes that encourage inefficient use of resources.

This strategy is concerned with capturing the full cost of transportation, and driving in particular, to the price of driving, using tax policy to shift these costs to users. The first policy involves reviewing Vermont 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 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 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 involves 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 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. While education is the most significant use of property taxes, approximately 10% of property tax revenues are used for building and maintaining local roads.

Shifting roadway construction and maintenance funding to a motor fuels tax would reduce property taxes by an average of 10% statewide, and internalizing these costs in the price of motor fuels would lead to lower demand and decreased energy use and emissions.

This policy results in very high impacts on energy use, costs, and environmental indicators. Oil use and non-renewable energy use experience 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. This policy can reduce greenhouse gas emissions, acid rain precursors, and ground-level ozone precursors. Like other policies in this Plan that seek to include more of the full cost of driving into transportation energy prices, this policy has very strong impacts on all indicators and thus is an important policy for consideration.

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 they write 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. In addition, approximately 30% of local fire and ambulance calls are related to transportation (Fire Chief Ernest Lamphere, Springfield Fire Department, 6/96). 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, 7/96).

While the price of motor fuel rises with this policy to fund approximately 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. Total energy use would decrease, and emissions of all pollutants and greenhouse gases also decrease with the implementation of this policy. 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.

Remove Vermont Sales Tax Exemptions on Motor Fuels. 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 could result in a reduction in other state taxes. (Removing sales tax exemptions is also addressed in Section I Strategy: Use Energy Taxation to Meet Vermont's Energy Goals.)

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. (See Strategy A: Least Cost Transportation Planning, Policy 3: Develop a Demonstration Project for Green Parking/ Transportation Vouchers.)

Recommendation

73. Vermont should give serious consideration to implementing policies to internalize more of the costs of transportation in the price of transportation, primarily though shifting revenue sources for transportation related costs to a motor fuels tax. Key steps for accomplishing this are:

    - shifting funding for construction and maintenance of roadways from property taxes to a motor fuels tax;
    - shifting transportation related costs of local fire and police services to a motor fuels tax;
    - removing the state sales tax exemption for motor fuels; and
    - removal of subsidies given to driving, such as parking for free.

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.

There are two main reasons to internalize the costs and eliminate tax breaks to non-renewable transportation fuels. One is so market based and planning decisions are made while taking into account the full costs of those decisions. This allows alternatives (either alternative fuels or transportation projects) with lower full costs but higher prices to compete more equitably. Another is to reduce public support for non-sustainable energy use. Finally, when selective public support, through tax exemptions or funding, gives an advantage to transportation projects with higher full costs or to non-renewable fuels, the public support is working against Vermont's energy goals and the interests of the general public.

Recommendation

74. Vermont should give serious consideration to supporting 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.

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.

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.[19]

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 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.

Overall energy reduction is very high with this policy. The price of motor fuel rises with this policy, but registration and fees are reduced by the same amount, resulting in no additional cost to society except for the costs to administer the change. Air emissions fall dramatically; greenhouse gas emissions and acid rain precursors also decline.

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 of the costs of driving onto the price of transportation energy, and thus sends more accurate price signals to consumers.

Recommendation

75. Vermont should give serious consideration to exploring options for shifting the fixed costs of registration fees to variable costs by collecting a large percentage of the following fees through a motor fuels tax:

    - registration fees and license fees for smaller, non-commercial vehicles could be shifted entirely; and
    - fees paid by commercial and industrial users could be partially shifted.

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 Strategy C: Reduce Vehicle Miles Traveled, Policy 2: Shift VMT to More Efficient Modes — Bus, Vanpool, Train.)

Public transportation tends to be much safer, much less costly, and much more efficient than solo driving.[20] 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. Therefore, additional incentives are required before a significant number of individuals can actually experience the safety, cost, and efficiency benefits. (See Strategy C: Reduce Vehicle Miles Traveled for a further discussion of these issues and Volume 2, Figure 4.II.9 for the energy use (BTU per passsenger mile) of various modes of transportation.)

Previous policies that promote internalizing hidden and fixed costs 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.

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. Several policies recommended in this Plan close this gap with an increase to the marginal cost of driving an automobile, by shifting transportation related costs to a gas tax. (See Section I, Strategy G: Use Energy Taxation to meet Vermont's Energy Goals.)

This policy recommends using a $.05 to $.10 per galleon fuel tax to simultaneously increase the marginal cost of driving and using these funds to decrease public transit fares. By using revenue from motor fuels taxes to buy down the cost of public transportation, the goal of encouraging energy efficient and cost-effective driving choices is achieved with a small tax increase. 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. (See Volume 2, Chapter 4, Section II, Strategy C. Reduce Vehicle Miles Traveled, Policy 2: Shift VMT to More Efficient Modes.)

Recommendation

See Recommendation 55 in Strategy C. Policy 2: Shift VMT to More Efficient Modes.

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.

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.

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. A 10 MPG increase in efficiency from, 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).

One way to encourage energy efficiency is to provide incentives to consumers who purchase energy efficient vehicles (rebates), disincentives to consumers who purchase inefficient vehicles (a gas guzzler tax), or both (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. This type of program would not put additional burdens on low income drivers. The most efficient cars to drive (and often the least expensive to purchase) would have no additional fee and would probably receive a rebate.

States could 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. The 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. In addition, 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.

Recommendation

76. Vermont should give serious consideration to modifying the current sales and use tax and create a Vermont Feebates Program to provide incentives at the time of sale to consumers who purchase energy efficient vehicles and disincentives to consumers who purchase inefficient vehicles.

III. BUILDINGS AND EQUIPMENT

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

A prime opportunity to improve energy efficiency occurs when buildings are under construction or when major renovations occur. These events allow for efficiency to "piggy-back" on other work, commonly at far less expense than energy-only improvements. 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 reduce 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 the statewide residential energy building code 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.

In 1997 Vermont 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 building--the heat-retaining ability of the building shell. Satisfaction of Vermont's new Residential Building Energy Standards is also presumed to be in 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.

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 standard, based on a life-cycle cost analysis, that should ensure that higher monthly mortgage payments are offset by lower energy/utility payments. 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. Enforcement relies on self-certification by builders and the consumer's right of action.

The residential building energy standards (RBES) 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 offer incentives to promote adoption of measures beyond those incorporated in the new construction RBES. In addition, utility programs can help consumers and builders with training and compliance-assistance strategies, increasing effectiveness of the standards and attractiveness of utility DSM programs.

Adoption of standards that rely on builder self-certification could blend well with utility DSM programs that offer home energy ratings as part of their program. (The following policy under this strategy describes DSM

programs that include a home energy rating for many new homes built in the utility's service territory.) 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.

Recommendations

77. DPS, Department of Labor and Industry, electric and gas utilities, Home Builders of Northern Vermont, and other established participants should proceed with implementation of the Residential Building Energy Standards.

78. Department of Labor and Industry, DPS, and the advisory committee should prepare the 1998 updates to the RBES including the specified indoor air quality and ventilation standard for new homes.

2. Policy: Statewide Residential New Construction DSM Program for Premium Homes

Implement a statewide residential premium efficiency program that reaches a majority of homes being 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; and
- promotes effective implementation and periodic update of a residential new construction energy efficiency building code.

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 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 rating to increase builder, customer, and lender acceptance of new efficient construction practices.

In the fall of 1995, a Governor's Task Force was appointed to make recommendations about a Vermont residential energy code. The 1995 Governor's Task Force that proposed the RBES included in its final report a recommendation that a premium efficiency home be 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.

Recommendation

79. Electric and gas utilities, DPS, homebuilders and building material suppliers, Energy Rating systems, and Energy Efficient Mortgage programs, related professional associations, financing institutions, and real estate professionals should work together to define, provide training and support, 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 current Residential Building Energy Standards;
    - defines that level of efficiency to be consistent with the Energy Rated Homes of Vermont rating scale, the U.S. 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; and
    - becomes eligible for a further improved debt-to-equity ratio in recognition of its lower operation costs, and an option for discounted mortgage rates.

3. Policy: Increase Efficiency of New Manufactured Housing

Increase the efficiency of manufactured housing and mobile homes sold in Vermont.

A state or regional dialogue among energy regulators, utilities, and producers of manufactured housing and mobile homes would examine offering incentives to manufacturers to raise the level of efficiency for manufactured housing delivered to markets served by the utilities.

Homeowners have very little choice about energy efficiency options 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 has been to approach manufacturers directly and offer an incentive to build and sell more efficient units. Incentives have more impact if 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.

Recommendation

80. Vermont should identify interested parties instate, such as a statewide utility working group, affordable housing advocates, Department of Housing and Community Affairs, and similar groups in other states such as 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.

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 and the only one currently operating in Vermont. This type of service was referenced in the National Energy Policy Act of 1992 as a 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 Department's support for a home energy rating system, consistent with DOE standards, is also available to any non-profit entity that offers this service in the state.

Since 1987 the ERH-VT program has encouraged investments in energy efficiency by rating homes 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 recommends 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.

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 lend, as part of 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.

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.

Recommendations

81. DPS should support ERH-VT, and any other non-profit entity 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.
    - Prepare to recognize in ratings a Premium Home standard and designation, consistent with Recommendation 79.
    - Develop a program to educate builders on the latest energy efficiency technologies and techniques.
    - Establish a network of home energy raters throughout the state.
    - Refine the existing home energy rating system to reduce the cost per rating and allow for use in code compliance.

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 and other equipment.[21] 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 that it serves (Vt. OEO, 1996, 11).

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. Programs that support new construction efficiency also complement efforts to improve the efficiency of existing housing, and vice versa.

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 home 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 (which should be 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 Policy 4.III.A on Expanding the Vermont Home 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.

Minnesota has had a time-of-sale energy efficiency standard in effect for a number of years that applies to multi-family housing. Burlington has implemented a time-of-sale rental housing energy code, and DPS is working with the city under a $100,000 grant from Oil Overcharge Funds to implement the standards. 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.

Recommendation

82. DPS should review and evaluate the effectiveness of Burlington's time-of-sale ordinance and explore the feasibility of a statewide requirement for both single-family home and multi-family housing to meet a minimum energy efficiency level at the time-of-sale.

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

DSM programs should include a standardized offer of energy services, appropriate for the time of property sale, targeting high use electric customers and encourage 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, as appropriate, incentives 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. This program could be modeled on the services and incentives that Central Vermont Public Service is offering to its customers who are considering selling electrically heated homes.

The rationale for intervening at this point of sale is similar to that for the previous policy. 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 program could involve support for the home energy rating, which would present the property owner with a process for analyzing and financing recommended improvements.

Recommendation

83. DPS should continue working to develop a program based on a set of services appropriate for the time of property sale that all utilities could offer.

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.

The VHFA may be able to establish a pilot project, providing this lower interest rate within its existing financing structure. 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.

Recommendation

84. Vermont Housing Finance Agency (VHFA) should work with Energy Rated Homes of Vermont and the statewide Residential New Construction DSM Program to develop a VHFA 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 premium energy efficiency designation. Similar offers from other lenders should also be pursued.

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 or consumer supported, statewide program would identify, label, and promote high efficiency consumer products. The program would recruit a nondiscriminatory, statewide network of trade allies -- retailers, distributors, and manufacturers -- who would agree to stock and advertise high efficiency products. A complementary marketing campaign would educate consumers about the energy and money saving benefits of labeled 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).

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 --both home buyers and building contractors-- would be guided by a consistent marketing theme and conspicuous product labeling, and trade allies could be offered uniform terms and incentives. Labeling would create a positive identity for high efficiency products. Combined with persistent and professional promotion and suitable incentives, labeled products should increasingly gain the recognition and acceptance from buyers.

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 much less ongoing utility involvement, although as new technologies or market barriers arise further action could be necessary.

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 labeled 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.

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. One way to set up a program of this type is the Statewide Efficiency Products Program, proposed in the DPS Statewide Energy Efficiency Plan *The Power to Save: A Plan to Transform Vermont's Energy Efficiency Markets.*

Recommendation

85. DPS should work with utilities, retailers, distributors, manufacturers, and interested parties toward establishing a statewide program to transform retail markets and consumer buying habits to favor high efficiency consumer products.

5. Policy: Diversify the Vermont Weatherization Program

The Weatherization Program should develop new and expanded 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, this program can be expanded to package and provide a range of energy services to non-low income, single- and multi-family households. New and diversified resources that the Vermont Weatherization Program can offer include delivery of electric and natural gas utility DSM programs and energy efficiency financing. The technical expertise that has matured among weatherization providers in recent years is 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.

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. As part of a diversification effort, the Weatherization Program has taken advantage of the expertise it has cultivated and created 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.

The Weatherization Program is coordinating efforts with a group of utilities that serve 82% of the electric customers of the state through the Residential Energy Efficiency Program (REEP) to reduce energy use and costs in low-income multifamily housing in Vermont. REEP was established in 1997 through a partnership with utilities, Vermont's Office of Economic Opportunity, DPS, and the Vermont Housing Finance Agency, to overcome the barriers to energy efficiency specific to this type of property. REEP also leverages the resources of multiple partners, and increases the efficiency of service delivery. By the close of 1997, REEP has:

- provided over $46,000 in direct incentives;
- saved over 920,000 kWh of electricity and 4365 CCF of natural gas for participating utilities; and
- reduced utility expenses for some of Vermont's lowest-income households.

REEP outreach to other public and private organizations will enhance the scope of its efforts in the coming years.

Note: A policy that focuses on the Weatherization Program providing more comprehensive services to its core market -- low income households -- is included under the Affordability section that follows.

Recommendation

86. DPS and the Weatherization Program should continue support for REEP and expansion of the Weatherization Program so that it develops new and expanded partnerships with energy service providers, such as utilities and bulk fuel companies, and provides a full and diversified package of services to non-low income as well as low income Vermonters.

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 account 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, such as raw materials, 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 that may be a part of a distributed generation strategy that a utility implements at some future date.

Although it is too early to quantify potential savings with any precision, building related policies outlined in this strategy are adaptable for promoting an integrated design approach and individual efficient technologies.

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.

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.

ASHRAE/IES Standard 90.1-1989 (hereafter ASHRAE 90.1) would serve as the basis for a new Vermont commercial construction code, with modifications 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. A 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 appropriate alternative choice.

Vermont presently has several efforts that support efficiency in commercial development, but these efforts are not consistent, comprehensive, or complementary. There are several reasons for pursuing the adoption of a statewide commercial new construction energy code. 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.

A commercial new construction 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 in the policy under the next strategy.)

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.

Recommendation

87. DPS, Department of Labor and Industry, the state's chapter of ASHRAE, building contractors, equipment suppliers, the state's energy utilities, and other stakeholders should begin the steps for developing and adopting a commercial building energy code, based on the ASHRAE Standard 90.1 or the multi-state code project for the purpose of raising the baseline of commercial construction in Vermont.

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 the statewide commercial and industrial new construction energy 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.

Reducing 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. Programs that interface with the code and standard compliance processes would establish the utilities as a logical point of customer contact during design and compliance stages. Administering the programs in a uniform way across the state would increase program recognition as well as strengthen the logical point of contact.

Establishing a Baseline. Act 250 and the proposed commercial/industrial new construction energy efficiency code can provide a consistent baseline for DSM incentive levels and design assistance packages. 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 (CVPS) 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.

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. "Typical Efficiency Measures" also provide a model for a similar program for non-Act 250 DSM projects.

Utility DSM 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.

Recommendation

88. DPS should work with utilities on development of commercial and industrial new construction DSM programs that promote comprehensive DSM measures on a statewide basis for both Act 250 and non-Act 250 commercial and industrial facilities.

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.

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.

Recommendation

89. DPS should establish an initial energy efficiency partnership and information clearinghouse involving other state agencies, non-profit organizations, private energy service companies, the state's electric and gas utilities, trade allies, suppliers, and others. Initial tasks for the partnership clearinghouse include:

    - develop an information database using existing information, including federal efficiency standards;
    - contact equipment suppliers to obtain information on product availability within the state;
    - develop training programs and materials that address design, construction, and operation of energy efficient facilities;
    - provide information on energy efficiency equipment, services, and utility DSM programs; and
    - develop instate design competitions to foster awareness of energy efficiency and a list of national and international design competitions; publicize this information.

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

This strategy requires implementing four related policies that 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, will also help prevent lost opportunities. Development and implementation of statewide, utility supported DSM programs for commercial and industrial remodeling, renovation, and equipment replacement markets would complement the commercial and industrial 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 strategy promotes third-party financing and "performance contracting" to procure cost-effective energy efficiency improvements for commercial and industrial facilities in the non-profit, and

public sectors. By linking financing to anticipated energy savings, businesses and public institutions can reduce operating costs.

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.

A recent survey of construction permits indicates 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.

Recommendation

90. DPS and Department of Labor and Industry should involve interested stakeholders in developing and establishing commercial and industrial energy efficiency code with provisions for renovation and remodeling work The code should define a threshold level for applying it. Attention should also be given to acquiring resources to support implementation and enforcement of the code, as discussed above in the commercial and industrial new construction strategy.

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 should be enhanced 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 should be consistent statewide in marketing, incentives, and participation terms for all utility programs, making it easier to understand the programs and simpler for customers and trade allies to participate. 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 DSP Statewide Energy Efficiency Plan *The Power to Save: A Plan to Transform Vermont's Energy Efficient Markets* offers a way to implement this program.

This program must be designed to optimize timing; that is, finding the "critical moment" for offering resources 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 commercial/industrial market opportunities program also helps a customer with code compliance and system design. This program should be designed to assist market forces in this regard and 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 projects would be addressed under the ASHRAE 90.1-based or multi-state code proposed in Policy 1 above.

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.

There is a real opportunity to make 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.

Recommendations

91. 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.*

92. 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 Commercial and Industrial New Construction strategy above.)

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 would be intensively promoted in portions of utility territories when T&D systems are near capacity.

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.

Recommendation

93. Each electric and gas utility should identify those areas in their respective service territories where facilities are approaching their capacities. Fast-growth areas would receive special attention. The utility should also review a portfolio of available 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.

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 public facilities such as: schools, government buildings, etc.

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.

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.

Recent federal cuts to the Institutional Conservation Program make the development of this policy particularly important. (See also the discussion of performance contracting in the policy Government Energy Use in Buildings, Equipment, and Vehicles that follows.)

Recommendations

94. DPS should propose the use of performance contracting and third-party financing for projects where it is cost-effective.

95. DPS, in coordination with DSM programs, should assist in the facilitation of performance contracting and third-party financing of energy efficiency measures by pre-screening contractors, providing sample contracts, and establishing clear guidelines for performance contractors to follow.

IV. AFFORDABILITY

A. Strategy: Increase Energy Efficiency for Low Income Housing

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 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 planning" in their operations. This concept has encouraged a utility to meet a customer's energy needs at the lowest total 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, thus holding down the amount that needs to be collected in rates.

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. Assuming a household spends $1,800 annually for heat and utilities, over a period of 10 years total energy expenditures would be $18,000. Quality efficiency services can reduce a low income household's energy consumption by an average 20%. In this example, savings of $3,600 could be accumulated over ten years. 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 low income 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.

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

Energy standards should be developed that prompt improvement at the time-of- sale for multi-family rental housing, resulting in lower energy costs for tenants and property owners.

Burlington has an ordinance requiring multi-family properties to be upgraded, if needed, to meet a reasonable level of energy efficiency when they are sold. This type of requirement could produce enormous energy savings for Vermonters throughout the state who live in multi-family rental housing. 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 discussed above in Strategy B. Improve the Efficiency of Vermont's Existing Housing Stock, Policy 1: Time-of-Sale Energy Efficiency Requirement.)

The Weatherization Program could 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 the policy Reinvent Weatherization Services Delivery to Low Income, Multi-Family Housing that follows in this strategy.

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 needed improvements. 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.

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.

Recommendations

96. Draft legislation should be developed, calling for time-of-sale energy standards for multi-family rental housing to accelerate the rate of energy improvements.

97. Vermont should support the growth of businesses specializing in energy efficiency retrofits and development of lending programs to help finance these improvements.

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.

- A suitable level of Low Income Home Energy Assistance Program (LIHEAP) grants would be provided to eligible households to help pay energy bills, and

- 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. 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. 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, specifically, heating and electric efficiency measures such as 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 the policy Reinvent Weatherization Services Delivery that follows.)

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.

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.

Recommendation

98. DPS, Department of Social Welfare, the Weatherization Program, and other interested parties should support the best mix of efficiency services and fuel assistance grants to make energy more affordable for low income households.

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 serve 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. 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 A. Improve Efficiency of Vermont's Existing Housing Stock, Policy 5: Diversify the Vermont Weatherization Program.)

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.

Once individual projects are identified, the Weatherization Program would retain technical experts to prepare comprehensive energy analyses of housing projects on a unit-by-unit basis, including health and safety concerns and recommended improvements. With measure recommendations in hand, the project coordinator could proceed to implement them, drawing resources from the parties who have made a commitment to participate. For example, the gas utility could contribute to thermal efficiency measures and heating system upgrades, and the electric utility could implement lighting and refrigeration improvements. Capital for the improvements may come from federal or state agencies that provide financing for large housing projects. Comprehensive projects should also undergo an inspection following project completion to verify proper installation and to ensure proper operating and maintenance procedures are in place.

Other funding sources could 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), could 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.

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. An expanded Weatherization Program, along with the REEP Program, should be responsive to changes anticipated in the markets for electricity and energy efficiency services.

Recommendation

99. DPS should continue working with REEP and the Weatherization Program to increase the services and activities offered for large, multi-family housing and broaden the program's financing, technical analysis, and program resources/delivery.

4. Policy: Encourage Development of an Energy 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 by 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.

A Consumerco is one way to reduce the burden of energy costs for members. Discounts greater than those typically offered by fuel suppliers to retail customers would likely 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 the decline in Fuel Assistance Funds. Feasibility of expanding efficiency services into the unregulated fuel sector should be explored.

Recommendation

100. DPS should continue to monitor the progress of a Consumerco as a low cost energy and efficiency services provider.

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.*

Recommendation

101. 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

State government is a major energy consumer. Energy is consumed in 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. It is also the responsibility of government to shape and implement sound energy policy and programs for the general good of everyone. 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 state and federal government to take a proactive role in energy issues both to lead by example, and to reduce its own costs of operation.

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, AOT, 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.

Efficiency Measures for State Buildings. Many measures can improve energy efficiency and lower embedded energy levels in buildings. Some can be implemented with little or no change to the building or equipment, while others involve new equipment or the use of new products. Efforts by state government as well as Vermont utilities and businesses to participate in the National Presidential Challenge, the Million Solar Roofs Initiative show how new technologies can improve energy efficiency throughout the state. (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 were implemented by January 1997. In addition, the Clean State Council has created a plan to improve information and education about resource conservation among state employees. Recommended measures include: educate employees and purchasing workers about advantages of recycled products, and encouraging the use of e-mail for more reports and memos (Vt. Clean State Council, 1995).

Under the Executive Order that created the Clean State Program, the Agency of Natural Resources has prepared a State Agency Pollution Prevention and Resource Conservation Plan and will assist other state agencies in preparing similar plans. 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 designing and upgrading existing buildings and lighting (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 a building to more efficient heating systems or cleaner renewable fuels, such as wood; measures that can reduce the need for air conditioning, such as tree plantings and awnings; and improvements such as additional building insulation and energy management systems (which control temperature and air flow), especially in older buildings.

Through the Clean State Council and the Department of Public Service progress is being made toward more efficient energy use in state buildings. However, these efforts should be consolidated and focused on many issues (not just energy efficiency). 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 be formed by the DPS, but in either case it should include members of DPS, ANR, AOT, and the Department of Buildings and General Services. This group could 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 it could work to further some of the measures described below. 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 move implementation forward more quickly.

State Building Standard. In 1991, DPS 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.) Customer pays for 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 provides the following benefits:

- guaranteed energy savings that finance project costs, and minimize financial risk for the customer; and
- continued energy savings, a single point of responsibility, and other benefits (ONRL, 1992, *Energy Performance Contracting*, 1992, 18).

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. The Department of Public Service 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.

Revolving Loan Fund. A revolving loan fund should be established (through bonds, energy taxes, or another form of financing) for energy efficiency improvements to state buildings and possibly other public buildings. 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 can be useful with smaller projects or with projects in which energy improvements are fairly simple.

Efficiency Programs for Public Institutions. Based at the Vt. Superintendents' Association and overseen by DPS, the School Energy Management Program (SEMP) has worked with school boards and administrators to implement energy efficiency measures in schools across the state. 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.

In today's climate of declining federal funding, new sources of funding are 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 pursued by Department of Public Service and the inter-agency task force mentioned above.

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.

Purchasing Division of the Vermont Department of Buildings and General Services uses life cycle costing when purchasing some products for state agencies. Their 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 externality estimates be updated, and to discover to what extent externality estimates are being used in life cycle costing analyses by state government. In addition, 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, fuel price escalation, etc.) for purchasing managers in the public and private sectors.

Recycled Equipment and Products. Recycling and purchasing recycled goods is an important energy savings strategy because each product we use contains embedded energy, 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.

Vermont Clean State Council is working on recycling practices and purchasing guidelines for state government, and significant savings have been achieved from the Council's recycling efforts. The Council should continue their numerous recycling projects as well as their work on encouraging recycled product purchasing.

Energy Use in Government Vehicles. Clean State Council and ANR 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 (Vt. ANR, *Comprehensive Environmental Assessment*, 1996). These recommendations 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.

At present, Vermont is one of the few states not operating a centralized fleet of vehicles; individual agencies independently purchase 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. 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 Chapter 3 in Volume 2. (See the Transportation section of this chapter for policies regarding alternative fueled vehicles and supporting infrastructure, public transit, car-pooling, walking, and biking to work, the green parking/transportation vouchers, and commuter park-and-ride lots.)

Recommendations

102. DPS, ANR, AOT, the Department of Buildings and General Services, and other groups should form an inter-agency task force that meets regularly to focus on energy issues in Vermont government.

103. This proposed inter-agency task force should investigate ways to ensure that:

- 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
- Building Life Cycle Costing computer program is widely used by builders of such facilities.

104. This proposed inter-agency 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.

105. DPS should collaborate more strongly with the Purchasing Division of the Department of Buildings and General Services to assist as needed and appropriate with life cycle costing purchasing practices and should review and make recommendations about externality cost estimates in life cycle costing.

106. 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, discount rates, and fuel price escalation).

107. Clean State Council should continue their recycling efforts and strengthen efforts to increase purchasing recycled products by all branches of state government and its contractors.

108. State agencies, as they write their upcoming Environmental Assessment Plans, should follow the lead of ANR's plan and recommend similarly strong transportation energy savings measures, including measures involving vehicle management and employee commuting practices.

109. 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.

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.

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 is 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. National actions involving standards and taxes also can put states on a level playing field and eliminate the "race to the bottom" as states cut out environmental protection and vie to attract business. Finally, national actions can provide consistency of standards so that manufacturers do not have to meet standards that vary from state to state.

Protecting environmental quality against energy-related emissions is one of the most important areas in which national action will continue to be needed. A healthy environment and protection of human health everywhere are in the long term public interest of the nation. Vermont relies on the federal Clean Air Act and 1990 Amendments that established national air quality standards in the state's planning for protecting the quality of our environment and our air.

Also of critical importance to national public interest is a national energy taxation scheme that includes the full costs of energy in energy prices. This type of national action would vigorously promote long term energy affordability and efficient use of energy resources,. 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. Energy Sources and Supply) 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.

With funding from U.S. EPA's Environmental Technology Unit, NEGC also completed the Restructuring & Environmentally Sustainable Technologies Project. This project assessed possible impacts of electric industry restructuring on the development of environmentally sustainable technologies in the region, and made recommendations for both state and federal governments on ways to promote and support these technologies. The 1997 report of the R/EST Project is *Sustainable Electricity for New England.* 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.

NEGC and the six New England states also 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 above, Section II Transportation and the strategy on Least Cost Planning for Transportation Planning.)

The Coalition of Northeastern Governors (CONEG) is another regional non-profit organization, supported by a Policy Research Center. Its Energy Working Group has been focused on utility restructuring. Its Research Center studies regional issues, especially those related to economic and environmental conditions and resources of the Northeast, and encourages solutions to regional problems. Their resolution of 2/1997 states:

> The Coalition of Northeastern Governors believes that particular attention must be paid to improving air quality to protect public health and the environment. CONEG supports competition in the electric industry which would reduce rates and provide greater choice for all customers. However, increased electric generation from sources with limited controls, whether from changes in the industry or other causes, could exacerbate the existing problem of air transport of pollutants to the Northeast. Equitable environmental requirements should apply across the country, and one region should not adversely impact another.

CONEG, along with NEGC, 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 has also worked on issues 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).

Department of Public Service. The role of the state in energy planning is outlined in Volume 2, Chapter 3 and Chapter 4, Section V. While much of the statewide energy planning is done by DPS, the Agencies of Transportation (AOT) and Natural Resources (ANR) also have planning functions that 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. The exact form of the new environment and the state's planning function within it are not yet clear. However, the general process for statewide planning is laid out in the Department's filings in Docket 5854, particularly Vt. DPS, *Position Paper*, 1996, and *Restructuring the Electric Utility Industry*, 1996. 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 especially market power issues. For example, we would foresee the need to make periodic adequacy assessments. 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. 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 will likely continue to research and write the *Vermont Electric Plan*, the *Vermont Comprehensive Energy Plan*, and the *Vermont Telecommunications Plan*. Future editions of the *Telecommunications Plan* should continue to explore telecommunications policies that have the potential to reduce energy use. DPS is also working with the Vermont Forum on Sprawl, since actions to curtail sprawl and increase energy efficiency are closely related. Participating in the Development Cabinet is also a high priority and another avenue for addressing the interrelated issues of growth, energy efficiency, protection of our compact towns and surrounding open land, the environment, and air quality.

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. For example, 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. 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. 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, 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 are working together jointly on some projects such as EVermont, cooperation on other projects or topics has not been as successful. Currently, cooperation is mostly on a project-by-project basis and review of each other's plans. 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), for example, lacks 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.

Little progress towards Vermont's energy goals is being achieved in the transportation sector, except for recent improvments in vehicle safety and stabilization of some emissions. Because transportation is the greatest single end use of energy in the state, state energy goals should be part of the transportation planning process. The Memorandum of Understanding among AOT, DPS, and ANR could be the basis for cooperative efforts to implement policies that fulfill transportation needs while working toward energy goals and maintaining and improving environmental quality.

Regional and Town Actions. Under Act 200, state agencies and Regional Planning Commissions are required (and Municipal Planning Commissions are encouraged) to create land use development plans that meet a number of goals related to historic preservation, environmental quality, economic vitality, energy efficiency, and others. Under Act 250, developers are granted a permit for commercial and residential developments after showing that the development will meet standards related to environmental quality, infrastructure requirements, congruence with town and regional plans, and others. Both Act 250 and 200 have increased awareness and planning of energy issues at all levels of Vermont's government.

Since January 1991, state agencies have been preparing and adopting State Agency Plans as a result of Act 200. The Council of Regional Commissions reviews State Agency Plans to assure that the coordinated planning process that is at the heart of Act 200 is being followed and that statutory requirements are met. Several of the Act 200 goals relate to energy and efficiency, and the current set of State Agency Plans addresses these energy efficiency in various ways.

Vermont's 12 Regional Planning Commissions create and implement Regional Plans; assist towns in preparing plans and in implementing recommendations; appear before District Environmental Commissions to participate in the Act 250 permitting process.

Act 200 Regional Plans provide extensive information about the particular region of the state and present the 16 Act 200 goals with the Regional Commission's goals, policies, actions, and recommendations for achieving them. These Regional Plans, once approved by the Council of Regional Commissions, serve as models for the member Municipal Planning Commissions as they prepare their Act 200 Plans, which are based on the Act 200 goal set.

Each Regional and Municipal Plan has an energy section. In addition to addressing the Act 200 goal — to encourage the efficient use of energy and the development of renewable energy resources — the energy section typically contains a discussion of types of energy that have been and are available, with general projections about what the energy situation looks like in the future. Energy related issues are also covered in the sections about natural resources, air quality, transportation, and public facilities. (See Volume 2, Appendix 4.)

Recommendations

110. Vermont should encourage the federal government on the following national actions:

- focus DOE efforts on promoting energy efficiency and renewable, sustainable energy resources;
- support congressional funding to sustain and expand the Low Income Home Energy Assistance and Weatherization Programs;
- encourage congressional leaders to promote efficiency in federal building and equipment purchases;

- develop a national energy taxation strategy that works toward including the full costs of energy use in energy prices, while reducing other taxes on corporations and individuals; and
- enforce strong environmental protection from energy emissions, using auto emission restrictions and caps on SO_x, No_x, and CO_2, vehicle fuel efficiency standards, and the Clean Air Act Amendments.

111. Vermont should work with the New England states and Northeastern organizations in coordinating efforts on the following actions:

- reducing the region's dependence on petroleum;
- support siting of natural gas pipelines to diversify Vermont's energy supply resources and national gas in the region;
- prepare for electric utility restructuring;
- participate in regional discussions to replace aging or out-of-service nuclear units with an appropriate mix of sustainable energy resources;
- development of a Clean Corridor and alternative fuel infrastructure linking Boston and Montreal and passing through Vermont;
- 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.

112. All Vermont's state agencies should:

- continue to prepare State Agency Plans, strengthening energy goals and policies in these Plans; and
- continue work toward reforming the electric industry, building on progress made in the Board's Order and Report in Docket 5854, utility filings, and work done in the 1997 and 1998 legislative sessions.

113. DPS should:

- continue statewide electric energy planning efforts during and after the transition to a restructured electricity market;
- plan and prepare for retail competition in the natural gas market;
- continue to implement policies in the *Vermont Electric Plan* and the *Vermont Comprehensive Energy Plan*;
- strengthen support to regional and town planning; and
- expand public input into the energy planning process.

114. 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.

115. Regions and towns should strengthen the energy and transportation sections of their Regional and Municipal Plans providing a sample of good initiatives localities could undertake. These measures appear in current Regional or Municipal Plans, providing a sample of good initiatives that could undertake. Localities where they appear are listed after each measure.

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, in-house public transit information, sale of discounted transit passes, parking vouchers as benefits, 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; and (Central Vermont Region)
- encourage planning processes that include Travel Demand Management measures that use least cost decision making, and that take steps to include the full costs of energy into decision making.

Energy Resource Measures:

- promote the use of renewable sources and distributed generation options in the locality, including wood chip, solar, and wind systems, methane generation from landfills and farms, cogeneration, etc. (many plans)
- study 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 improvements designed to take advantage of renewable sources; (Danville)
- encourage 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)
- encourage commercial and industrial energy users to investigate cogeneration opportunities to use waste heat; (Burlington)
- institute recycling in schools, town offices, garages (for 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 (many plans)
- 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; and discourage tree cutting within denser town limits; and (Burlington)
- encourage local lenders to participate in low interest financing for energy efficient investments and in the Energy Efficiency Mortgage Program; (Danville)

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 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).
- 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; and (Middlesex)
- form a Conservation Commission that holds workshops for builders and the public on energy efficient buildings. (Danville)

Land Use Measures: (See Policy: 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; and (several plans)
- encourage development in areas that have adequate transportation facilities and other infrastructure.

3. Policy: Public Education and Information

DPS and other entities should maintain and improve programs and projects involving information for the general public, school-based education, and professional education.

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. 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. DPS offers a number of resources to the public. DPS houses an up-to-date library on energy issues, with more than 5,000 volumes as well as energy pamphlets and information available for free to the public, and experts available for speaking and other events. Contact DPS at (1-800-642-3281) or via the internet http://www.state.vt.us/psd.

During the likely electric and gas market transitions, impartial public education will be needed. Competition will be most effective if consumers are well informed and to make rational decisions about new energy choices. DPS will undertake a strong and fair public education program during and after the transition to more competitive gas and electric markets.

School-Based Education. 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, environmental impacts of energy use, the importance of reducing our reliance on fossil fuels, and the issues surrounding transportation energy use, because these topics 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. 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.

Because transportation represents 43% of total delivered energy use in Vermont, it is important to educate new drivers about 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. DPS 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.

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) is using the Internet training and technical support for educators, which would provide another avenue through which they could access energy information.

Resources available to teachers from DPS include a collection of videos and slide shows, and many pamphlets, booklets, and other materials about various energy topics available for free. *Energy Education Resources: Kindergarten through 12th Grade* by the U.S. DOE 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 including appropriate materials available for free from DPS.

Professional Education. Educating Vermont's building trade professionals, like training teachers, can have far-reaching effects. Improving their 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 Act 250 permitting process teaches contractors and architects about energy efficient building, what measures are required to receive permits, and informs their other work in similar ways. (See Volume 2, Chapter 3 text box on Act 250.) 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.

Additional projects offering education for building professionals include Chittenden County Regional Planning Commission's wood fired district heating projects, and as a result of Vermont's adoption of statewide Residential Building Energy Standards for residential new construction, DPS is now administering a $200,000 grant from DOE that provides support for training for 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 DPS, other state agencies, utilities, energy service companies, non-profit organizations, and others. (See II. Buildings and Equipment, Policy: Establish Energy Efficiency Partnership & Information Clearinghouse.)

Recommendations

116. DPS should maintain and improve its public education and information activities in the following ways:

- update and expand its collection of free energy efficiency material on a regular basis and should advertise its availability to the public;
- improve public outreach by holding brief seminars that teach practical energy conservation skills; and
- undertake a strong and impartial public education program during and after the state's transition to restructured electric and natural gas industries.

117. 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.

118. Vermont Energy Education Program (VEEP) should expand the number of the Energy-Scientist-in-the-Classroom Residency Programs offered 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.

119. DPS should work with the Department of Education to update and revise the transportation energy issues in the high school driver's education curriculum.

120. DPS should expand and strongly promote 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.

ENDNOTES:

1. Carbon dioxide emissions per BTU from wood are slightly greater than coal, but when harvested sustainably, there are no net emissions.

2. 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.

3. 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.

4. 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.

5. FERC Order 888 is comparable to a series of FERC orders that promote competition in the natural gas industry.

6. 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).

7. "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).

8. 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.

9. 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.

10. If the value of the voucher is raised above $30 per month, it must be coordinated with changes in the cost of nearby lots.

11. 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.

12. 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.

13. 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., 1990, 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.

14. 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.

15. The Vermonter passenger rail service recently acquired this capability.

16. 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

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APPENDIX 1 - ABBREVIATIONS LIST and GLOSSARY

I. ABBREVIATIONS LIST

AAMA	American Automobile Manufacturers Association
AFUE	annual fuel utilization efficiency
AFV	alternative fuel vehicles
ANR	Vermont Agency of Natural Resources
AOSIS	Alliance of Small Island States
AOT	Vermont Agency of Transportation
APCD	Vermont Air Pollution Control Division
ARPA	Advanced Research Projects Agency
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.
BC	base case
BTU	British Thermal Unit
CAAA	Clean Air Act Amendments
CABO/MEC	Council of American Building Officials, Model Energy Code
CAFE	Corporate Automobile Fuel Efficiency Standards
CEP	Comprehensive Energy Plan
CFCs	chlorofluorocarbons
CH	hydrocarbons
CH_3CH_2OH	ethanol
CH_3OH	methanol
CH_4	methane
C&I	commercial and industrial
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
CONEG	Coalition of Northeastern Governors
CVPS	Central Vermont Public Service Corporation
CVR	conservation voltage regulation
DHC	district heating and cooling
DMV	Vermont Department of Motor Vehicles
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPS	Vermont Department of Public Service
DSM	Demand side management
DU	distributed utility
EED	Vermont Department of Public Service, Energy Efficiency Division
EEM	Energy Efficient Mortgage Program
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
EPAct	National Energy Policy Act of 1992
EPRI	Electric Power Research Institute
ERH-VT	Energy Rated Homes of Vermont
ESCO	energy service company
ETBE	ethyl tertiary butyl ether
EV	electric vehicle

EWG	Exempt Wholesale Generator
FERC	U.S. Federal Energy Regulatory Commission
GHG	greenhouse gas
GMP	Green Mountain Power Corporation
GRP	gross regional product
GW	GigaWatt (one million kiloWatts)
GWh	GigaWatthour (one million kiloWatthours)
GSP	gross state product
GWP	Global Warming Potential
HEAT	Vermont Home Energy Audit Team
HELP	Vermont Home Energy Loan Program
HP	horsepower
HQ	Hydro-Québec
HVAC	heating, ventilation, and air conditioning
ICP	Institutional Conservation Program - Schools and Hospitals
IES	Illuminating Engineering Society, Inc.
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power producer
IRP	integrated resource plan
ISTEA	Intermodal Surface Transportation Efficiency Act
kW	kiloWatt (1,000 Watts)
kWh	kiloWatthour (1,000 Watthours)
kW-yr	kiloWatt-year
L&I	Vermont Department of Labor & Industry
LCC	life cycle costing
LCIP	least cost integrated resource plan
LCTP	least cost transportation planning
LEV	California Low Emissions Vehicle Program
LIHEAP	Low Income Home Energy Assistance Program
LNG	liquid natural gas
LOTS	local option taxes
LPG	liquid petroleum gas
LUST	Leaky Underground Storage Tank Program
MIT	Massachusetts Institute of Technology
MPG	miles per gallon
MSA	Metropolitan Statistical Area
MTBE	methyl tertiary butyl ether
MW	MegaWatt (100 kiloWatts)
MWh	MegaWatthour (100 kiloWatthours)
N_2O	nitrous oxide
NARUC	National Association of Regulatory Utility Commissioners
NEGC	New England Governors' Conference, Inc.
NEPEX	New England Power Exchange
NEPOOL	New England Power Pool
NETI	New England Transportation Initiative
NOPR	Notice of Proposed Rule Making
NO_x	nitrogen oxides
NRC	U.S. Nuclear Regulatory Commission
NUG	non-utility generation or generator
NYPA	New York Power Authority (formerly PASNY)

OECD	Organization for Economic Cooperation and Development
OH	Ontario Hydro
OPEC	Organization of Petroleum Exporting Countries
OPIC	Overseas Private Investment Corporation
ORNL	Oak Ridge National Laboratory
OTA	U.S. Office of Technology Assessment
OTC	Ozone Transport Commission
OTR	ozone transport region
PASNY	See NYPA
PC	preferred case
PCB	polychlorinated biphenyls
POM	polycyclic organic materials
PM10	particulates under 10 microns
PSB	Vermont Public Service Board
PSC	Vermont Public Service Commission
PUHCA	Public Utility Holding Company Act
PURPA	Public Utility Regulatory Policies Act
PV	photovoltaic
PVE	Petroleum Violation Escrow Account
QF	qualifying facility
REA	National Rural Electrification Act
REAP	Regional Energy Assessment Project
REMI	Regional Economic Models, Inc.
RFP	Request For Proposal
RPC	Regional Planning Commission
SCADA	system control and data acquisition
SCETS	State Comprehensive Enhanced Transportation System
SEMP	School Energy Management Program
SO_x	sulfur oxides
SPR	Strategic Petroleum Reserve
TBTU	trillion British Thermal Units
T&D	transmission and distribution
TDM	transportation demand management
TDR	transfer of development rights
TLEV	transitional low emissions vehicle
TSP	total suspended particulates
ULEV	ultra low emissions vehicle
VECTOR	Vermont Energy Construction Training Opportunities and Resources
VEEP	Vermont Energy Education Program
VELCO	Vermont Electric Power Company
VEPPI	Vermont Electric Power Producers, Inc. (formerly Vermont Power Exchange (VPX))
VGS	Vermont Gas Systems, Inc.
VHFA	Vermont Housing Finance Agency
VIECAP	Vermont Industrial Energy Conservation Advisory Program
VISMT	Vermont Institute for Science, Math, and Technology
VMT	vehicle miles traveled
VOC	volatile organic compound
VPPSA	Vermont Public Power Supply Authority
V.S.A.	Vermont Statutes Annotated
WEC	Washington Electric Cooperative
ZEV	zero emissions vehicle

II. GLOSSARY

Access charge: In a restructured electric utility environment, an access or wires charge could be levied on a power supplier, or its customers, for access to a transmission or distribution system. It is a charge for the right to send electricity over another's wires.

Acid precipitation: Acid rain and snow pose a serious environmental risk for Vermont's lakes, streams, and forests. Vermont's precipitation is, on average, always slightly acidic.

Anthropogenic emissions: Any emissions resulting from human activities.

Avoided cost: A utility's avoided cost is its incremental costs of electric energy or capacity or both that the utility would generate itself or purchase from another source if it did not use an alternative resource. This alternative resource may be a specific supply or demand side resource under consideration, or it may be a generic decrement to electric load, as appropriate to a given analysis.

Baseload: The minimum load over a given period.

Baseline forecast or base case: The baseline forecast is used to outline future energy demand under a business-as-usual scenario and show where opportunities lie for energy savings and environmental improvement. A base case does not describe the most likely future. It describes what would most likely happen if current trends continue and if no changes occur in state and national energy policy. Other scenario, incorporating new policies, new technologies, alternative economic conditions, and other assumptions, are contrasted to the base case.

Biodiversity: Biological diversity or the variety of species in a given area.

Biomass: Organic matter that is available on a renewable basis including forest residues, agricultural crops and wastes, wood and wood waste, animal wastes, livestock operation residue, and aquatic plants. Useful energy can be derived from the direct combustion of biomass or flammable gases derived from biomass for generation of electricity, mechanical power, or industrial process heat. In this report, biomass usually refers to wood and wood waste.

British Thermal Unit (BTU): The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. It is commonly used as a measurement for the energy content of different fuels. One kWh equals 3,412 BTU.

Capacity: The maximum power that a machine or system can produce or carry under specified conditions.

Capacity factor: The ratio of the average load on a machine or equipment during a specified time period to the capacity rating of the machine or equipment.

Carbon tax: A tax on fossil fuels based on the individual carbon content of each fuel. Under a carbon tax, coal would be taxed the highest per MBTU, followed by petroleum and then natural gas.

Carbon cycle: The sum of all reservoirs and flows of carbon on Earth. The flows tend to be cyclic in nature. Carbon removed from the atmosphere (one reservoir) and converted into plant tissue (another reservoir) is returned back into the atmosphere when the plant is burned.

Carbon dioxide: A colorless, odorless, incombustible gas formed during respiration, organic decomposition, and combustion -- particularly combustion of fossil fuels. Carbon dioxide is the largest contributor to global warming. In 1990, carbon dioxide was responsible for about 2/3rds of the global warming brought about by human-caused greenhouse gases. While burning fuels more completely can reduce the emissions of many other pollutants, it cannot reduce carbon dioxide emissions. They can be reduced by decreasing energy use, using more efficient furnaces, vehicles, etc. and switching to fuels that emit smaller amounts of carbon dioxide.

Carbon monoxide: A colorless, odorless, extremely poisonous gas, CO is formed by incomplete combustion of carbon or a material containing carbon such as gasoline. Carbon monoxide is an air pollutant as well as a contributor to smog.

Carbon reservoir or sink: A physical site within the carbon cycle where carbon is stored, such as the atmosphere, oceans, Earth's vegetation and soils, and fossil fuel deposits.

Chlorofluorocarbons: A family of inert gases, including CFC-11, CFC-12, and CFC-13. CFCs are a family of chemicals that contribute to the breakup of ozone molecules in the stratosphere, depleting the ozone layer that protects the earth from damaging ultraviolet radiation.

Climate: A statistical collection and representation of the weather conditions for a specified area during a specified time interval, usually decades.

Clean Air Act: 42 U.S.C. Section 7401 and following as amended established national air quality emission standards, to be implemented by participating states, which are designed to reduce air pollution. Congress enacted the Clean Air Act because of growing awareness of the serious public health effects resulting from air pollution.

Cogeneration: The simultaneous production of electric power and heat energy. A cogeneration system might include a combustion turbine that produces electricity and a boiler or heat recovery steam generator that recovers waste heat from the turbine and produces hot water or steam for heating or industrial processes.

Combined cycle plant: A combined cycle plants utilize the most efficient large-scale thermal electric generation technology available today. Combined cycle technology uses the excess heat produced by a combustion turbine to power and additional turbine that produces even more electricity. Using the waste heat from the combustion turbine to produce more electricity dramatically improves the efficiency of the plant. Combined cycle plants and advanced combustion turbines have environmental advantages over conventional oil- or coal-fired generators. Since they are more efficient, they require less fuel and have fewer emissions per unit of electricity produced.

Combustion turbine: Combustion turbines operate in the same manner a jet engines in aircraft. In a combustion turbine, fuel is introduced into a combustion chamber together with compressed air. The fuel burns and the expanding exhaust gases pass out through the turbine,
turning the blades to provide power. Most combustion turbines currently use distillate oil or natural gas, but work is advancing on ways to extend utilize coal and wood with a gasification process. Turbines see their greatest use at times of peak electricity loads, because they are relatively inexpensive to build but more expensive to operate. Smaller, more versatile, more efficient turbines that use advanced metals, new blade designs, and high compression ratios similar to day's jet engines are in the works.

Commercial sector: Retail stores, offices and businesses that use energy primarily for lighting, heating and air conditioning.

Cooperative utility: A group of persons organized to supply electric energy to members in a specified area, generally exempt from federal income tax laws and usually financed by REA.

Cream-skimming: Cream-skimming occurs when a DSM program or measure is implemented that has a high energy-savings-to-investment ratio instead of implementing a DSM program or measure with a smaller ratio but larger total energy savings.

Cycling (intermediate) unit: A generating unit whose output is varied over time (usually hours or days) to follow changes in demand between base and peak periods.

Deforestation: Converting forest land to other vegetation or uses, such as cropland, pasture, and when dams are constructed, reservoirs.

Delivered energy use: As compared with primary energy use, delivered energy use is the measure of the energy consumed as it enters (or is delivered to) the consumer's home, building, or vehicle. Delivered consumption is the measure most often used in reports of energy use, as it provides a baseline for comparison with other sources.

Demand side management (DSM): The planning, implementation, and monitoring of electric utility activities designed to reduce power strategy of influencing customer use of electricity to reduce the utility's load when those load reductions are more cost-effective than available supply side resources. Because DSM is a way of meeting the utility's load requirements, DSM opportunities are referred to as energy resources.

Demand side resources: Efficiency or conservation measures. Energy savings can be considered a resource in the sense that they make it possible to serve increased demand without obtaining new supplies.

Deregulation: The modification or elimination of regulation from a previously regulated industry or sector of an industry.

Direct access: The ability of a retail customer to purchase electricity directly from the wholesale market rather than through a local distribution utility. (See Retail competition.)

Disaggregation: The functional separation of the vertically integrated utility into smaller, individually owned business units (i.e., generation, transmission, distribution). (See Divestiture.)

Distributed generation: A planning concept in which small scale, perhaps renewable, generation and modular storage facilities are distributed throughout the transmission and distribution system.

Distillate fuel: Refined fuel oil, grades one, two, and four, which are primarily used for space heating are one type of distillate fuel. The other type is highway diesel engine fuel, uses in diesel cars and trucks, railroad engines and some farm machinery.

Distribution: Delivering electric energy from the transmission or bulk power system to the consumer's home or business through low voltage distribution lines; also that portion of utility plant used for that purpose, or expenses relating to that plant.

Distribution Utility (Disco): In a restructured environment, the Disco is the regulated electric utility entity that constructs and maintains the distribution wires connecting the transmission grid to the retail customer. The Disco can also perform other services such as aggregating customers, purchasing power supply and transmission for customers, billing customers, and offering other regulated energy services to retail customers.

Divestiture: In a restructured environment, divestiture is the stripping off of one utility function from the others by selling (spinning-off) or in some other way changing the ownership of the assets related to that function. Most commonly associated with spinning-off generation assets so they are no longer owned by shareholders that own the transmission and distribution assets. (See Disaggregation.)

Efficiency: Efficient energy production, delivery, and use minimize waste and therefore requires fewer resources. Energy efficiency does not reduce comfort or convenience, but instead meets the same needs with less energy and environmental damage.

Emission factor: A coefficient that relates actual emissions to activity data as a standard rate of emission per unit of activity. Emission factors are often based on a sample of measurement data averaged to develop a representative rate of emission for a given set of operating conditions.

End use: The light, heat, cooling, refrigeration, motor drive, or other useful work produced by equipment that uses energy or its substitutes.

Energy efficiency: Producing more work from the same amount of energy/electricity: decreasing energy requirements while customer end use service is held constant. Programs designed to use electricity more efficiently.

Energy forecast models: This Plan is based on a pair of linked computer models that forecast the course of Vermont's economy and energy demand. The forecast model developed by Regional Economic Modeling, Inc. (REMI) provides the economic and demographic assumptions that are used by an energy forecasting model, ENERGY 2020. Both models have the ability to perform separate policy simulations or to work together to produce an integrated analysis.

Energy intensity: Relative indicator for the amount of energy used, on a per person or per unit output basis, and a measure of the economic importance of energy use for a particular period or state in particular the amount of energy required per unit of a particular product or activity, usually expressed in term of BTU per $ or gross state product.

Energy services company (ESCO): Businesses specializing in financing and installing energy efficiency measures for large energy consumers.

Ethanol: In addition to mixing with gasoline to form gasohol, ethanol can be burned directly in automobiles. Ethanol boosts the performance and efficiency of engines, but it requires more storage capacity or more frequent refillings because it contains less energy per gallon of fuel.

Exempt wholesale generator: A company engaged exclusively in the generation or selling of electricity at wholesale. Under provision of the federal EPAct of 1992, and EWG is exempted from the organizational restrictions mandated in PUHCA.

Externalities: The costs (and benefits) of energy that are not paid for by utilities or their customers. Externalities are the environmental and other costs (or benefits) that result from the generation, transmission, distribution, or reduction in use of energy, and that are external to the economic transaction between the utility supplier and the customer, whether wholesale (distribution utility) or retail (ratepayer).

Externality adder: An adjustment used in cost-benefit analyses in utility least cost planning to reflect the external costs of polluting energy sources.

Fossil fuel: A solid, liquid, or gaseous fuel material that has been formed in the ground by chemical and

physical changes in plant and animal residues under high temperature and pressure. Coal, petroleum, natural gas, and any fuel derived from them are fossil fuels.

Gasification plant or system: Gasification technologies are some of the most efficient and cleanest large-scale technologies currently being developed. They operate by turning fuel sources such as coal, wood,and other biomass sources into a gaseous fuel for use in combustion turbines or combined-cycle technologies.

Gasohol: Gasohol is a blend of 90% gasoline and 10% ethanol (grain alcohol). It is made by fermenting corn, but is also can be produced from other biomass sources.

Global warming: Also known as global climate change, this term refers to the potential warming of the earth and the accompanying climate changes caused by "the greenhouse effect." The greenhouse effect occurs when gases such as water vapor, carbon dioxide, methane, nitrous oxide, and CFCs trap and absorb heat in the earth's' atmosphere that otherwise would have escaped into space. These gases act as the glass in a greenhouse does, allowing sunlight into the greenhouse but trapping some of the heat that normally would radiate away, thereby warming the greenhouse.

Global Warming Potential (GWP): 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; the GWP of one ton of nitrous oxide is 320 times that of carbon dioxide (EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994*, 1995, ES-2). The original source of these values is IPCC, *Radiative Forcing of Climate Change. The 1994 Report of the Scientific Assessment Working Group of IPCC: Summary of Policy Makers*, 1994. This work is an update of the previously published values of 11 for methane and 270 for nitrous oxide found in IPCC, *Climate Change: The Supplemental Report to the IPCC Scientific Assessment*, 1992. Due to timing of modeling, research, and publication of this Plan, GWP values of 11 and 270 were used for calculating carbon dioxide equivalents.

Greenhouse gas: Any gas that absorbs infrared radiation in the atmosphere.

Greenhouse gas intensity: The amount of greenhouse gases emitted.

Heat rate: The number of BTU's of the source fuel required to produce a Kwh of electricity.

High-level radioactive waste: High level radioactive waste consists of spent fuel and must be managed for many thousands of years in order to protect present and future generations. (See Low-level radioactive waste.)

Hydroelectric power: Electricity generated by turbine driven by falling water. There are several types of hydro sites. Run-of-river facilities generate power as the water flows through the facility. Sites that can operate as ponding facilities can store water behind dams for use during peak load periods.

Independent power producer: IPPs are non-utility companies that generate electricity. Some IPPs are authorized as Qualifying Facilities (Qfs).

Industrial sector: The manufacturing, construction, mining, agriculture, fishing, and forestry establishments.

Integrated resource planning (IRP): A public planning process and framework within which costs and benefits of both demand and supply side resources are evaluated to develop the least-total-cost mix of utility resource options. In many states, such as Vermont, IRP includes a means of considering environmental

damages caused by electricity supply/transmission and identifying cost effective energy efficiency and renewable energy alternatives. (See Least cost integrated planning.)

Investor-Owned Utility (IOU): A company, owned by stockholders for profit, that provides utility services.

kiloWatthour (kWh): A unit of energy equivalent to using one kiloWatt of electricity for one hour, equal to 3,412 BTUs.

Least cost integrated planning (LCIP): The effort to meet an electric utility's projected demand at the lowest overall cost to society including unpriced environmental costs. In this long range planning process, energy efficiency is included as an energy source. LCIPs are also known as integrated resource plans (IRP).

Life cycle costing: A process in which the life cycle total costs (including maintenance and energy costs) of appliances, equipment, and vehicles are taken into consideration as part of the purchasing decision.

Load: The amount of service or electric energy delivered to or required at a specific point or points on a utility's system. Load is determined by customer end uses.

Load shape: A load shape is a graphical representation of electricity use (including transmission losses) for each hour of the day.

Lost opportunity programs: Vermont utilities' DSM programs fall into two broad categories: "lost opportunity programs" encourage customers to make energy efficient choices when they buy or do major renovations a home, commercial building, or industrial facility, and when they purchase new appliances or machinery. Over the long term, more efficiency can be gained with lost opportunity programs. Many efficiency savings can only be captured cost-effectively during new construction or when customers make appliance and machinery changes. Finally, lost opportunity programs save energy and money not only through immediate savings, but also because the need for retrofit measures in the future is reduced. The other major type of DSM program is retrofit programs.

Low-level radioactive waste: Low level radioactive waste includes contaminated metals, filters, resins, and other materials used a nuclear plants. Most low level radioactive waste decays to safe levels within 100 years.

Marginal cost: Cost to produce one more unit.

Market based price: A price set by mutual decisions of many buyers and sellers in a competitive market.

Methane: Methane is the chief component of natural gas. It is also a serious greenhouse gas, trapping 11 times more heat in the atmosphere than an equivalent amount of carbon dioxide traps.

Methanol: Like ethanol, methanol is an alcohol fuel in which oxygen in the fuel helps ensure more complete combustion. Methanol can be made from natural gas, coal, oil, or biomass.

Municipal utility: A provider of utility services owned and operated by a municipal government.
National Energy Policy Act of 1992 (EPAct): The culmination of several years of effort to define a national energy strategy, signed into law by President Bush in 1992.

New England Power Pool (NEPOOL): NEPOOL was established in the early 1970s to provide a power pool in which many of the day-to-day operations of power generation are closely integrated with the other operations of New England utilities to improve reliability and reduce cost.

Nitrogen oxides: Nitrogen oxides emissions lead to the formation of ground-level ozone, the major constituent of smog, and contribute to acid precipitation, which acidifies lakes and steams and harms forests. Gasoline and diesel use emit more nitrogen oxides per unit of energy used that any other fuel in Vermont. Nitrogen oxides can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections.

Nitrous oxides: Nitrous oxides are a potent greenhouse gas, trapping 270 time more heat in the atmosphere that an equivalent amount of carbon dioxide emissions.

Operating reserve: Refers to quick amount of generation capability utilities can bring on line within 10-30 minutes in response to supply or demand emergencies.

Ownload electricity supply: Vermont's ownload electricity supply represents the amount of electricity that Vermont utilities would have used if they operated independently of NEPOOL. Ownload supply refers to energy generated in or delivered to Vermont.

Oxygenated gasoline: With two additives that increase the oxygen content of gasoline, combustion is improved, especially in older vehicles. The additives are ethyl tertiary butyl ether (ETBE) and methyl tertiary butyl ether (MTBE), which is regularly used to boost the octane of fuels.

Ozone transport region: Ozone pollution is carried from one state to another by prevailing winds, particularly in the Northeast. The Clean Air Act Amendments of 1990 call for establishment of ozone transport regions where emissions control measures are required.

Particulates: A wide array of small pieces of solid and liquid matter found in the atmosphere, including soot, dust, organic matter, and other materials.

Peak load: The largest demands in the load under consideration during a specified period.

Performance based regulation (PBR): Any rate setting mechanism which attempts to link rewards (general profits) to desired results or targets. PBR sets rates, or components of rates, for a period of time based on external indices rather a utility's cost of service. PBR is a form of rate regulation that is intended to provide utilities with better incentives to reduce their costs than does cost of service regulation.

Performance contracting: Paying for capital investment with energy savings, typically under the direction of an energy service company (ESCO).

Photovoltaic power: Photovoltaic cells convert solar energy into electricity when sunlight excites electrons in the cell's silicon material. Photovoltaic cells can be located on the roofs and sides of buildings and homes or on land set aside for the purpose. On a much smaller scale, they can be located on many kinds of appliances and devices, from street lights to calculators.

Poolco: Poolco refers to a specialized, centrally dispatched spot market power pool that functions as a short term market. It established a short term market clearing price and provides a system of long term transmission compensation contracts. It is regulated to provide open access, comparable service and cost recovery.

Power pool: Two or more interconnected electric systems planned and operated to supply power more reliably and economically for their combined load than would be possible separately. A power pool coordinates short term operations to maintain system stability and achieve least cost dispatch. Coordinating short term operations includes the aggregation and firming of power from various generators, arranging exchanges between generators, and establishing (or enforcing) the rules of conduct for wholesale

transactions. The pool may own, manage and/or operate the transmission lines (wires) or be an independent entity that manages the transactions between entities.

Primary energy use: As compared to delivered energy use, primary energy use is measure of the delivered energy consumption plus the energy lost in the generation, transmission, and distribution or electric energy and natural gas. Electric generation plants that use fossil fuels and nuclear power require roughly three times the amount of energy input as is produced in output, and this is reflected in measures of primary energy use.

Proven reserves: A quantity of a natural resource that geological and engineering information indicates with reasonable certainty can be recovered in the future from known deposits under existing economic and operating conditions.

PURPA: The Public Utility Regulatory Policy Act of 1978. Among other things, this federal legislation requires utilities to buy electric power from private "qualifying facilities," at an avoided cost rate. This avoided cost rate is equivalent to what it would have otherwise cost the utility to purchase or generate that power themselves. Utilities must also offer customers who choose to self-generate a reasonably priced back-up supply of electricity.

Qualifying facility (QF): To become a QF, an independent power supplier had to produce electricity with a specified fuel type (cogeneration or renewables) and meet certain ownership, size, and efficiency criteria established by the Federal Energy Regulatory Commission. More specifically, QFs are power plants that use renewable fuel sources or cogeneration systems to generate up to 80 MW or use cogeneration systems of any size and deliver at least 5% of their waste heat energy to a thermal host for heating or production processes. Under PURPA, QFs were allowed to sell their electric output to the local utility at avoided cost rates.

Radiative forcing: Changes in the global balance of incoming solar radiation and outgoing infrared radiation caused by a radiative forcing agent, such as clouds and greenhouse gases. This results in changes in the global climate.

Reformulated gasoline: Reformulated gasoline is produced by altering the chemistry of gasoline in the refining process. Reformulated gas burns cleaner than unleaded gasoline. It contains less butane so it is less likely to evaporate and escape into the atmosphere during storage and while fueling vehicles. It also contains less benzene (a carcinogen) and contributes less to smog.

Reliability: Electric system reliability has two components - adequacy and security. Adequacy is the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customer at all times, taking into account scheduled and unscheduled outages of system facilities. Security is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system facilities.

Renewable energy: Energy obtained from sources that, if managed properly, are essentially inexhaustible.
Renewable fuel sources: Renewable fuel sources are those that can regenerate (such as wood) or those that are not depleted by use (such are wind and solar). Using these renewable resources sustainably means consuming them in a manner that does not place economic, social, and environmental burdens on future generations or limit their ability to meet their needs. Therefore, renewables such as wood and other biomass sources must be managed so that they regenerate and do not cause extensive harm to the environment. Although fossil fuel sources regenerate, they do so over time frames that are so vast that they are non-renewable for all practical purposes.

Research and Development (R&D): Research is the discovery of fundamental new knowledge. Development is the application of new knowledge to develop a potential new service or product. Basic

power sector R&D is most commonly funded and conducted through the Department of Energy (DOE), its associated government laboratories, university laboratories, the Electric Power Research Institute (EPRI), and private sector companies.

Residential sector: Private households, which use energy primarily for space heating, water heating, air conditioning, lighting, refrigeration, cooking, and drying clothes.

Resource mix: Generating units, power contracts and DSM programs used to meet needs of electricity customers.

Restructuring: The reconfiguration of the vertically integrated electric utility. Restructuring usually refers to separation of the various utility functions into individually operated and owned entities.

Retrofit programs: Vermont utilities' DSM programs fall into two broad categories: "retrofit programs" encourage customers to modify their existing homes, businesses, and appliances to reduce their electricity use. The other major type of DSM program is the lost opportunity program.

Retail competition: Also called retail wheeling or direct access, this system allows more than one electric provider can sell to retail customers, and retail customers are allowed to buy from more than one provider. In other words, retail competition gives power producers access to a utility's transmission lines and distribution system for the purpose of selling electricity directly to the utility's customers. Electricity customers could then choose among different power suppliers. The stated goals of retail competition are to increase efficiency and lower costs by spurring competition. However, it is not clear whether retail competition would achieve these goals without significant new rules and protections. (See Direct access and Wholesale competition.)

Retail wheeling: (See Direct access, Retail competition, and Wholesale competition).

Retrofit program: A program operated by a utility directed toward upgrading existing equipment, systems or operations to a higher level of efficiency. Typically achieved by utilities offering technical assistance, financial incentives or direct installation of equipment. A program targeting the comprehensive upgrading of energy consuming systems, such as commercial lighting, is an example.

Risk adjustment: An adjustment, up or down, to the cost of a supply or DSM option to reflect its effect on the uncertainty or riskiness of the total supply/demand portfolio. (Vermont PSB Docket 5270 has for the present established a presumption that there should be a 10% *downward* risk adjustment to the cost of DSM measures in least cost planning.)

Sequester: To isolate and remove something or the process by which carbon dioxide is removed from the atmosphere and retained for some period in a carbon reservoir.

Strandable Costs: Also referred to as Stranded Costs/Assets/Investments or Embedded Costs Exceeding Market Prices. In a restructured electric utility environment, strandable costs represent the uneconomic portion of a utility's generation assets (e.g., its regulatory assets, purchased power contracts, and generation plants). Currently, utilities recover the embedded costs of these assets from customers through cost-based rates. However, the uneconomic portion of these costs may become "stranded" in a competitive market to the extent that utilities can not recover them from customers. Regulatory questions involve whether such costs should be recovered by utility shareholders, customers, or both, and how they should be recovered.

Stranded benefits: Public interest programs and goals which could be compromised or abandoned by a restructured electric industry. These potential "stranded benefits" might include: environmental protection, fuel diversity, energy efficiency, low-income ratepayer assistance, and other types of socially beneficial programs.

Strategic petroleum reserve: An oil storage reserve created by the U.S. Government in 1975 in response to oil supply disruptions. The purpose for the strategic petroleum reserve was to stabilize the economy and ensure the continued supply of oil during times of future disruptions. The SPR currently holds 592 million barrels.

Sulfur oxides: Sulfur oxides result from burning any fossil fuel, but the combustion of coal produces the largest amount (per unit of energy used). Sulfur oxides are health hazards and significant contributors to acid rain.

Supply side resource: A resource option that can provide additional electrical energy or capacity to the utility. Supply side resources include utility owned generating facilities; electricity purchased from other utilities, cogenerators, or independent third parties; transmission or distribution improvements; and the life extension or upgrading of existing facilities of the utility through technological improvements, including fuel switching, for more efficient production and delivery of electricity.

Sustainable: A term used to characterize human activities that can be undertaken in such a manner as to not adversely affect environmental conditions (soil, water quality, climate) necessary to support those same activities in the future.

Transmission: Transporting electricity in bulk from the sources of supply to other principal parts of the system or to other utility systems, also that portion of utility plant used for transmission.

Transportation sector: Cars, buses, trains, etc. that are involved in the process of moving people and goods.

Turbine: An enclosed rotary type of prime mover in which the heat energy in steam or hot gas is converted into mechanical energy by a high velocity flow against successive rows of radial blades fastened to a shaft.

Unbundling: Disaggregating electric utility service into its basic components and offering each component separately for sale with separate rates for each component. Unbundling is a critical feature in restructuring the electric utility environment. For example, generation, transmission, and distribution could be unbundled and offered as discrete services.

Utility: A public service business or regulated entity that exhibits the characteristics of a natural monopoly. For the purposes of electric utility restructuring, a utility refers to the regulated, vertically integrated electric company.

VELCO: Vermont Electric Power Company, a company owned by some of Vermont's retail utilities that oversees common transmission facilities and acts as Vermont's representative to the New England Power Pool (NEPOOL).

Vermont Electric Power Producers, Inc. (VEPPI): The current state purchasing agent designated by the PSB to aggregate the electric output of Vermont QFs, and to allocate the energy and costs to Vermont utilities at the statewide avoided cost rates as calculated by DPS and approved by PSB. As necessary, VEPPI enforces performance provisions. (Formerly the purchasing agent was Vermont Power Exchange (VPX.))

Vertical integration: An arrangement whereby the same company owns all the different aspects of making, selling and delivering a product or service. In the electric industry, it refers to the historically common arrangement whereby a utility would own its own generation plants, transmission system, and distribution lines to provide all aspects of electric service.

Volatile organic compounds: VOCs are often toxic, and they contribute to ground-level ozone. Ground-level ozone, the major component of smog, is formed from the combination of VOCs and nitrogen oxides as they react in the presence of heat and sunlight.

Watt: The electrical unit of power, equal to one Ampere flowing continuously across a potential of one Volt. One horse-power equals about 746 Watts.

Wheeling: The transmission of electricity by an entity that does not own or directly use the power it is transmitting. Wholesale wheeling is used to indicate bulk transactions in the wholesale market, whereas retail wheeling allows power producers directs access to retail customers. This term is often used colloquially as meaning transmission.

Wholesale competition: Wholesale competition within the electric industry generally means that each utility can purchase wholesale power from a variety of sources, and in turn suppliers or producers of power can sell to any utility. (See Retail competition.)

Wholesale power market: The purchase and sale of electricity from generators to resellers (who sell to retail customers) along with the ancillary services needed to maintain reliability and power quality at the transmission level.

Wind energy: The kinetic energy of wind converted into mechanical energy by wind turbines (i.e., blades rotating from a hub) that drive generators to produce electricity for distribution.

Wires charge: A broad term which refers to charges levied on power suppliers or their customers for the use of the transmission or distribution wires. (See Access charge.)

World ultimate resource reserves: For petroleum, this is the technically recoverable oil resources assuming existing technology, including reserves already used, proved reserves, future additions to reserves in existing fields, and estimated undiscovered resources. The world ultimate resource reserves for petroleum are estimated at 2.3 trillion barrels.

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