<u>**Exhibit CS-BW-80**</u>

2009 Bennington Regional Energy Plan

Bennington Regional Energy Plan

BCRC

Prepared by the Bennington County Regional Commission

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Executive Summary

Energy is critical to every aspect of our lives. We rely on the energy we obtain from our food, the energy that is in the fuel that heats our homes and moves our vehicles, and the energy that generates the electricity that runs our appliances, machinery, computers, and telecommunication systems. Most of the energy that we use, and have come to rely upon, is derived from "nonrenewable" fossil fuels and, to a lesser extent, nuclear fuels. This energy has been abundant and cheap, but supplies are becoming scarcer and oil, natural gas, coal, and uranium ever more expensive to extract. Energy prices have been rising and will continue to rise at an increasing rate; eventually, procuring an adequate supply of these fuels to meet demand at any price will not be feasible.

Alternative energy in the form of "renewable" sources such as solar, wind, hydroelectric, and biomass-based fuels, can provide significant amounts of clean energy well into the future. Developing those resources is extremely important, but the total amount of energy that can be extracted from such resources is markedly less than what we currently obtain from fossil fuels. To maintain a good quality of life, vibrant communities, and prospering economies, we will have to develop conservation strategies that will let us use remaining nonrenewable fuels wisely to transition to a society that uses less total energy while using energy obtained from clean renewable sources as efficiently as possible.

Twenty years from now the people and businesses of Bennington County will be using less energy than we use now.

Twenty years from now the people and businesses of Bennington County will be using less energy than we use now. It is imperative that we recognize this reality and begin to prepare for the inevitable transition as soon as possible. This plan is intended to support that process by raising awareness of energy issues and advancing several basic goals and objectives:

- Reduce total energy consumption while maintaining a high quality of life and a vibrant local economy.
- Encourage energy conservation in residential, commercial, industrial, public/institutional, natural resource, and transportation sectors.
- Increase opportunities to make energy choices at the local level.
- Assure diversity in the mix of energy sources to minimize the impacts of a supply restriction in any particular fuel.
- Decrease our reliance on non-local energy sources through conservation and development and use of local renewable energy sources.
- Make energy choices that minimize adverse impacts to the environment.
- Maximize energy efficiency by matching fuel type to end use.
- Assure both an adequate supply of electricity and a secure distribution network to meet the region's needs.
- Promote a sustainable local economy and personal lifestyles that are consistent with future energy realities.

Energy use in Vermont has grown in all economic sectors over the past several decades, with growth in transportation energy (primarily motor gasoline and oil) showing the greatest increase. Our energy is derived from many sources, although petroleum sources – used mainly for transportation and space heating – account for over half of total usage. The majority of our electrical generating capacity is derived from nuclear (Vermont Yankee) and hydroelectric (mostly from Hydro Quebec) sources. Economic activity in our region depends heavily on energy, be it for operating manufacturing facilities, shipping raw materials and finished products, or powering vehicles that transport tourists to the area. As the cost of fossil fuels rise over the next several decades, residents and businesses will have to find ways to operate with less energy (conservation), while having access to reliable alternative energy supplies.

There are many technologies and practices that can dramatically reduce energy used in heating and cooling buildings, operating appliances and machinery, and in transporting people and goods. Technical and financial assistance should be readily accessible to ensure that these conservation practices are available to people, businesses, and organizations. Effective land use planning conserves energy by promoting efficient development patterns and requiring good site and building design. Public transportation, railroads, and biking and walking are efficient modes of transportation that need to be further developed and used. It also will be important to emphasize support for local businesses and economic interactions and for people to find ways to modify their lifestyles in ways that will allow them to live fulfilling lives using less energy.

Renewable energy will become increasingly important in the coming decades, and the most efficient and valuable energy sources will be the ones that are closest to the end users. Bennington County has access to a considerable amount of renewable energy: solar energy for space heating and on-site electricity generation, wind, water, and wood (biomass) for electricity generation, as well as geothermal, liquid biofuels, and other resources. Because electricity will be heavily relied upon as an energy carrier, it will be important to supplement any out-of-region generating capacity (nuclear, hydro, and other sources) with locally generated electricity. A "smart grid" that relies on many smaller scale distributed sources of electricity will need to be developed.

The Bennington County Regional Commission will continue to plan for the region's energy future and will lead educational efforts and help develop programs to implement the goals and objectives of this plan. Local governments and organizations will interact with individual people and businesses to support energy conservation and development efforts. By taking a lead in efforts to conserve energy, develop local renewable energy sources, and support a strong locally oriented economy, Bennington County can become a uniquely vibrant and successful region.

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Section I Introduction

Every aspect of our lives depends upon ***energy***, a word that is rather obliquely defined as the capacity of a system to do work. In practical terms, energy is the thing that moves our cars, heats our homes, illuminates the dark, and powers the machinery of industry. And yet, energy is much more than that. Energy allows us to walk, think, breathe, grow, and reproduce. This very same energy also is responsible for rain, wind, ocean currents, and all of the natural forces that shape the Earth. To properly plan for our region's energy future it is necessary to understand what energy is, where it comes from, and the ways in which we use it.

One of the fundamental and absolute physical laws that govern the universe, and our small corner of the universe, is the First Law of Thermodynamics, which states that energy cannot be created or destroyed. In other words, within a closed system, the amount of available energy is constant. It is not possible to create energy from objects on Earth, only to extract it from objects that already contain a finite amount of energy. The only significant external input of energy into the Earth's otherwise closed system is the energy that is continually imparted to the Earth from the Sun. Once energy is released and used to perform work, it is dissipated (but not destroyed) into forms such as heat energy. Given that the amount of energy available to us is strictly constrained by the amount of energy currently on the Earth and the amount of solar energy that we can capture and use, it quickly becomes clear that the challenge of energy planning involves determining how to safely access and use energy from different sources and how to allocate that limited resource to the many functions that require it.

Energy from the Sun

The vast majority of energy present on the Earth derives from the Sun, energy which is actually nuclear in origin, having been released from forces on the Sun as atoms of hydrogen are fused into helium. We most often think of "solar" energy in terms of the devices and architectural designs that have been developed to use the energy in sunlight for space heating, raising the temperature of water, and producing electricity. Energy from the Sun also differentially heats air masses, producing wind which for centuries has been harnessed to do work and recently has become an increasingly important way to generate electricity. The Sun's energy also evaporates water and raises it high into the atmosphere, where after falling as rain or snow and then flowing downstream, its energy can be captured and used to generate electricity in hydroelectric facilities.

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Plants use a process called photosynthesis to capture and store solar energy. The energy contained in plants has been acquired from the Sun and stored for a relatively short period of time, from a few months in the case of crops like corn to a few years or decades in the case of trees. That stored solar energy, in turn, provides all of the energy in the food that we consume either by eating plants directly or by eating animals that have consumed the plants. The energy contained in plants also can be released through combustion; the resulting energy used to heat buildings or boil water and drive turbines. With additional energy inputs, products like ethanol and methanol can be produced from plants, capturing the energy from the plants in a form that can be more easily transported and used.

This same photosynthetic process was taking place for millennia before any humans were around to make use of the solar energy being packaged in this way. In fact, deep layers of compacted organic material containing vast amounts of energy were gradually converted to coal, oil, and natural gas over a period of several hundred million years. The energy from these "fossil fuels" is derived from the Sun, just like the energy released when a wooden log is burned, but it is very dense, containing much more energy in the same volume of material. The solar energy stored in fossil fuels also is distinguished by the fact that it is "nonrenewable;" that is, once the Sun's energy is released from the fuel that source of energy is gone, whereas new farm crops or trees can be grown in a relatively short period of time.

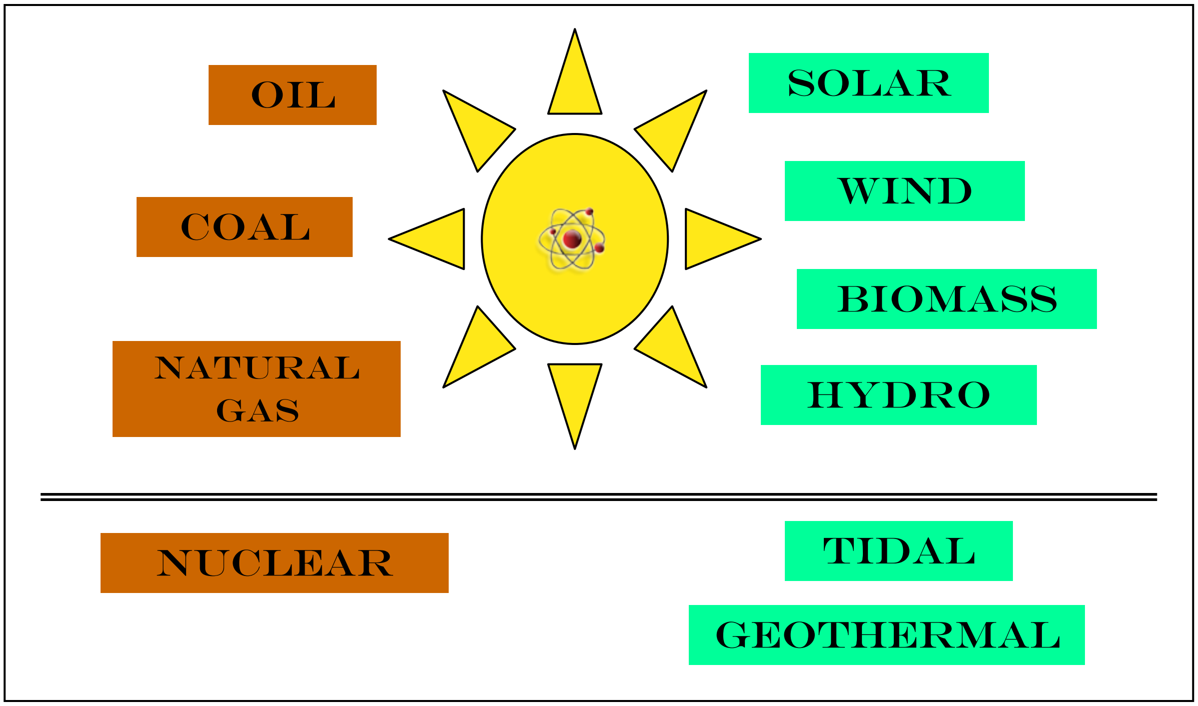


Figure 1-1. Most of the energy available to us originated from nuclear reactions in the Sun; only nuclear, tidal, and geothermal do not trace their source to the Sun. The energy sources in red are nonrenewable; once they are depleted their energy is no longer available to us. The sources in green can be considered renewable as they derive energy from ongoing solar radiation, gravity, or heat contained within the Earth.

Fossil fuels have made possible the dramatic growth in the world's population and economies over the past two centuries. Energy that took millions of years to be stored, however, has been consumed in a tiny fraction of that time. Consider, for example, that human activity consumes 3.6 billion gallons of oil every day, flowing at a rate sufficient to fill a volume the size of the Bennington Battle Monument every five minutes, and it is easy to understand that the availability and affordability oil will be a serious issue within 20 years and that within 50 years the same will be true for all other fossil fuels. That timeframe is extremely short given that we must radically change the sources of energy that we rely on and the amount of energy that we use or we will not be able to maintain our economies or an acceptable quality of life.

Other Energy Sources

Sources of energy that do not ultimately trace their existence to the Sun are limited to nuclear (from nuclear fuel on the Earth), geothermal, and tidal processes. Unlike nuclear fusion, which releases energy on the Sun, nuclear energy that has been used to generate electricity on Earth results from fission – splitting atoms apart rather than fusing them together. Fissionable elements, principally isotopes of uranium, that can be used in nuclear reactors are relatively scarce, but release huge amounts of energy during the fission process. As the demand for electricity grows and the availability of fossil fuels declines, use of nuclear fuels will accelerate, but that increased use will exhaust economically extractable uranium supplies within 50 years. Considerable research has been directed toward demonstrating the technical feasibility of nuclear fusion as a source of energy that could be used to generate electricity. Although the raw fuel (hydrogen) is readily available and the process does not produce radioactive waste, the amount of energy required to produce a sustained and controlled fusion reaction is so large that it has never been demonstrated to be a feasible source of energy.

Geothermal energy originates from nuclear decay and gravitational forces working deep within the Earth. The amount of this energy contained within the Earth is huge and can be used for space heating or to generate electricity. Energy extraction can take the form of small heat pump systems for individual homes and buildings to large electricity generating facilities that utilize the Earth's heat to boil water and drive turbines. Large-scale commercial geothermal facilities are expensive and cost-prohibitive if the heat source requires drilling to extreme depths to reach (as would be the case in this area). Nonetheless, given the amount of available energy and the minor environmental impacts, the Earth itself is a potentially important source of energy.

The oceans' tides are powered by the gravitational forces acting between the Earth and Moon (and to a lesser extent, the Sun). Energy can be extracted from these regular movements of vast amounts of water and used to generate electricity. Of course, lacking an ocean, tidal power has limited potential within Vermont, but tidal generating facilities along the Atlantic Coast could someday supply a share of the state's electricity or be used in some way to produce other fuels that can be used in our region.

Energy Carriers

A complete picture of energy development and use must include consideration of energy carriers as well as the energy sources discussed above. Fuels like gasoline and ethanol are energy carriers in that they are produced from primary sources of energy and can be transported and used more conveniently than the original petroleum or biomass product from which they are derived. Of particular importance to our energy future is the ubiquitous energy carrier, electricity (Figure 1-2). Everything from the simple light bulbs in our homes to the devices that run the world's digital and telecommunication infrastructure requires electricity. Large amounts of electricity are used to heat and cool buildings and to power appliances and machinery. With the depletion and increased cost of nonrenewable fuels and concerns over environmental quality, greater emphasis has been placed on potential uses of electricity for other uses, especially transportation related uses. Electric vehicle technology has advanced considerably in recent years; whether plug-in/electric-gas hybrids, straight

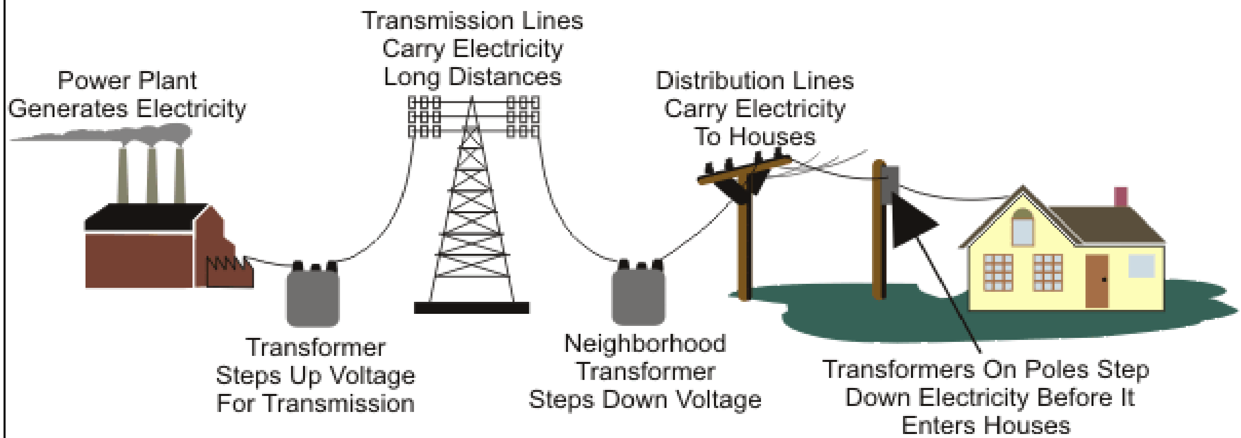


Figure 1-2. Electricity carries energy from a primary generating source to an end use such as a house, factory, or an electric vehicle. Source: US Energy Information Administration.

electrics, fuel cells, or emerging concepts such as compressed air drive systems, all obtain their power from electricity. Of course, despite their benefits and positive features, these electric vehicles do not solve the problem of fuel scarcity because they rely on primary energy sources (nuclear, hydroelectric, fossil fuels, etc.) to generate the electricity that they use. Finding ways to utilize abundant and renewable energy sources to generate electricity, therefore, is one of the great challenges facing society.

Another energy carrier that has received considerable attention lately is hydrogen, the most common element on Earth. Hydrogen has a very high energy content relative to its weight, but a very low energy content relative to its volume. The technology to extract energy from hydrogen has been developed and proven, and hydrogen can be stored with relative ease and produces virtually no pollution when used. Unfortunately, hydrogen does not occur in usable form in nature; it must be extracted from water or some hydrocarbon such as methane. Obtaining hydrogen from a nonrenewable fossil fuel such as natural gas (composed largely of methane) clearly fails to address the need to develop new energy sources, and extracting hydrogen from water is a very energy intensive process. For these reasons, most research has focused on using renewable energy sources and nuclear energy to generate the electricity that is needed to split hydrogen from oxygen in water molecules. The other great obstacle preventing hydrogen from becoming a common source of power is the fact that it is very difficult, costly, and energy intensive to transport from where it is produced to where it is used. Some researchers have suggested that liquid hydrocarbons such as methanol, produced with hydrogen (derived from water and renewably generated electricity) and carbon dioxide (from biomass sources), could be effective materials for storing and transporting hydrogen.

Challenges and Opportunities

The difficulties and challenges presented by a future that will be characterized by reduced availability of energy from the sources that we have come to rely on are many and complex. These problems and many of the solutions are national and international in scope, and while we need to have an awareness of those problems, our plan has to be directed toward addressing the issues that will have an immediate effect locally. The following points summarize some of the key challenges and opportunities that will be addressed in the next three sections of this plan:

- Bennington County, like the rest of the country and world, has developed a strong reliance on non-renewable sources of energy. The heavy use of these fossil fuels is understandable because they have been easy and inexpensive to obtain and they contain energy in very high densities. The primary use of these fuels locally is for space heating, transportation, and generation of electricity (although, unlike most states, Vermont gets a majority of its electricity from nuclear and hydroelectric facilities rather than from coal and natural gas facilities). Resource depletion combined with political and market volatility will inevitably lead to dramatic price increases and reduced availability of these energy sources within the next 20 years. Wise use of the remaining nonrenewable energy resources is critical to smooth the transition to a post-petroleum world.

- The cost of obtaining energy from oil, coal, and natural gas has been low relative to the energy yielded by those resources. Because deposits of these resources are becoming increasingly difficult to reach and refine, however, the cost – in both dollars and energy – has begun to rise. There may be vast amounts of energy locked in Canada's Athabasca oil sands or in petroleum deposits two miles beneath the sea in the continental shelf off Brazil, but huge amounts of energy are required to heat, drill, transport, and refine the raw materials. If more energy is used to obtain the fuel than exists within the fuel, there is no point in acquiring it (Figure 1-3).

  In the same way, many renewable energy resources are very expensive to access and use. Although there is a huge amount of solar energy striking the Earth every day, relatively little of it can be captured, using today's technologies, from sunlight, wind, and

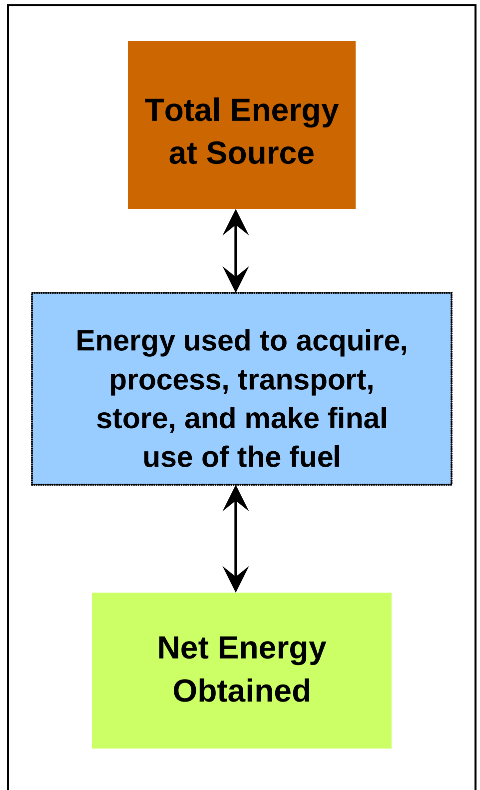


Figure 1-3. A fuel is only viable if the amount of energy it yields is greater than the amount used to obtain it (and if the cost of producing does not exceed its market value). This "net energy" yield can change over time, as in the case of oil. In the 1920's, for example, 80 barrels of oil could be produced using the energy equivalent of one barrel of oil (80:1 energy return on energy invested). With the most easily accessible oil resources depleted, the net energy yield from today's oil fields is less than 20:1 and falling. Net energy is a key consideration for all energy sources, whether renewable or nonrenewable in nature.

falling water, and the amount of energy in wood and other biomass sources is low relative to the amount that we have become accustomed to in fossil fuels. The example of ethanol as a fuel derived from corn has been used to illustrate the problem of converting incident solar energy to a useful product: the energy needed to fertilize fields, plant and harvest corn, refine grain into ethanol, and transport it to locations where it can be used equals or exceeds the amount of energy available from the ethanol. Certainly not all renewable solar energy sources are as inefficient as corn ethanol, but it does remind us that *we need to consider the efficiency of any new energy source*.

This issue of "net energy" or "energy return on energy invested" is critical when making decisions about our energy future. We must consider the return on energy and financial investments when deciding whether or not a particular source of energy is appropriate for our region.

- Human activity always has affected the Earth, and our use of huge amounts of fossil fuels over the past two centuries has had a profound and enduring impact on air quality, water quality, and climate. The impacts on climate, the so-called "global warming" that has resulted from the rapid release of billions of tons of carbon dioxide that had been locked in solid and liquid fossil fuels, has been well-documented. The disruption of natural ecosystems, human settlements, and economic activity, together with the other adverse environmental impacts of fossil fuel combustion (e.g., smog, acid rain) further compel us to seek and use alternative sources of energy.

- Our economy and lifestyle has been made possible by the vast amounts of solar energy that were stored as fossil fuels over several hundred million years. Because a majority of the most readily extractable energy from these sources has been used up in just over 100 years, we will have to adapt our economy and lifestyle in a manner that relies on renewable sources of energy. We also will have to use less energy because the amount of energy available from renewable sources is less than the amount that we have become accustomed to using from nonrenewable (fossil fuel and nuclear) sources. Greatly improved **energy conservation** in all aspects of our lives – residential, commercial, industrial, and governmental functions, as well as in all forms of transportation, will be of fundamental importance to our region.

- Transportation is an energy-intensive and complex process, whether the commodity being transported is food in a truck or electricity over a transmission line. Because we need to conserve energy in every way possible, local production of energy for use in our region will become increasingly important. We must find ways to grow more of our food locally and to wisely and efficiently use the renewable energy resources available locally for space heating, transportation, and electricity generation. It also will be critical to determine how to best allocate our land for the production of adequate amounts of both food and energy.

- Electricity is a vital part of our lives and of our regional economy. Vermont has been fortunate to have had access to sufficient amounts of electrical power supplied primarily from nuclear and hydroelectric sources. If one or more of those sources becomes unavailable in the future, new large-scale generating sources will need to be found and supplemented with locally generated electricity from renewable resources. This need will be amplified by the likelihood that local demand for electricity will increase rapidly as the energy it carries replaces fossil fuels for certain transportation, mechanical, and space-heating needs.

- Because energy use pervades all aspects of our lives, our energy planning efforts must consider everything we do: what we buy, what we eat, where we live and work, how we get from place to place, how we design, build, and heat houses and other buildings, how we use our land, how our local government functions are carried out, and more. The Regional Energy Plan must assess the energy-related ramifications of all of these activities and present straightforward ways for people, businesses, organizations, and governments to wisely and efficiently use energy.

Section II of the Regional Energy Plan will provide an overview of present-day energy use in Bennington County and Vermont. The amount of energy used for various activities will be discussed along with the energy sources and carriers involved. Observations will be made concerning potential issues related to the amount of energy used, the cost of energy, and any evident constraints. The development and use of conservation practices and technologies as well as renewable energy resources within the region will be explored together with the state of current research in these areas.

Section III of the Regional Energy Plan will provide a qualitative assessment of projected future energy availability and demand. Particular attention will be paid to energy conservation measures that can be implemented to reduce energy demand, to local sources of renewable energy, and to delivery of energy resources via electricity or other means. Consideration will be given to both remote and local sources of energy. This section also will discuss adaptations that will need to be made at the individual, household, business, and government levels to begin to adapt to a world with less net energy. Specific recommendations will focus on energy conservation and reduced energy usage through changes in transportation systems, building construction, industrial technology, land use patterns, and food production, with an emphasis on the value of beginning to develop a strong locally-oriented economic base. Appropriate policies and legislative initiatives will be advanced as well.

It is hoped that the Regional Energy Plan will be used as a resource document for local governments, businesses and organizations, individual citizens, and legislators as we integrate energy considerations into all aspects of our daily lives. Policies and recommended actions should advance one or more of the following basic **Goals and Objectives**:

1. **Reduce total energy consumption while maintaining a high quality of life and a vibrant local economy.**
2. **Encourage energy conservation in residential, commercial, industrial, public/institutional, natural resource, and transportation sectors.**
3. **Increase opportunities to make energy choices at the local level.**

4. **Assure diversity in the mix of energy sources to minimize the impacts of a supply restriction in any particular fuel.**
5. **Decrease our reliance on non-local energy sources through conservation and development and use of local renewable energy sources.**
6. **Make energy choices that minimize adverse impacts to the environment.**
7. **Maximize energy efficiency by matching fuel type to end use.**
8. **Assure both an adequate supply of electricity and a secure distribution network to meet the region's needs.**
9. **Promote a sustainable local economy and personal lifestyles that are consistent with future energy realities.**

Section II Energy Today

Vermont's total energy consumption is relatively low by national standards, using 0.2% of all energy produced and ranking 41st in per capita energy consumption. Total energy use in Vermont during 2005 amounted to approximately 167.2 trillion Btu. There is relatively little energy data available at the county level, but we can assume that per capita energy consumption is relatively consistent throughout the State. With just under six percent of Vermont's population, therefore, Bennington County uses close to 10 trillion Btu of energy annually. Energy use has grown steadily over the past five decades (Figure 2-1).

One of the most apparent trends in energy consumption is the greatly expanded reliance on electricity as a means of delivering energy to the end user. The amount of electricity used in Vermont has increased by a factor of five - to over 50 trillion Btu - since 1960. Whereas much of the State's electricity was imported prior to the mid-1970s, the Vermont Yankee nuclear plant significantly increased in-state electricity generating capacity when it came on-line.

A useful measure of energy consumption is the British Thermal Unit (Btu), the amount of energy required to raise the temperature of one pint of water one degree Fahrenheit. By referring to a standard measure of energy content, it is relatively easy to compare different fuels. A gallon of fuel oil, for example, contains 142,000 Btu, a gallon of propane 91,000 Btu, a KWH of electricity 3,412 Btu, and a 40 pound bag of wood pellets, 330,000 Btu.

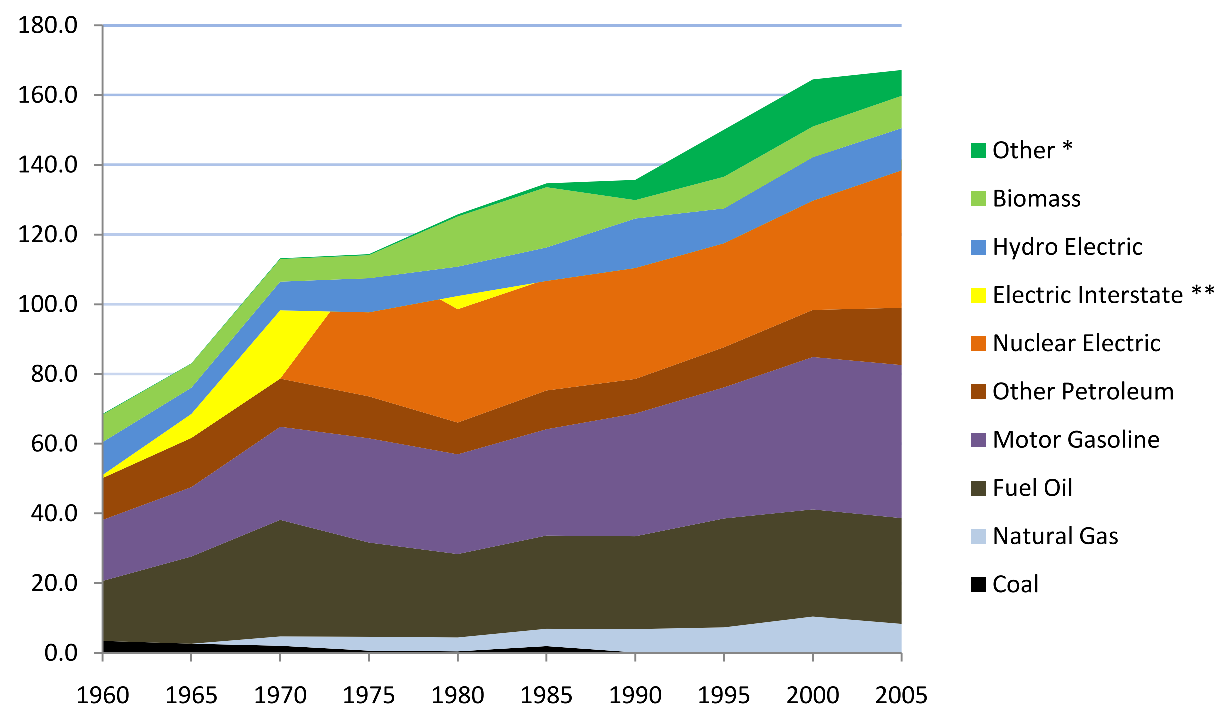


Figure 2-1. Total energy consumption in Vermont increased from 68.6 trillion Btu in 1960 to 167.2 trillion Btu in 2005. The most consistent increases during that time have been the amounts of electricity and motor gasoline (gasoline used in motor vehicles for transportation) used. Source: US Energy Information Administration.
* 'Other' includes wind, solar thermal and photovoltaic, geothermal, and net imports of electricity. ** 'Electric Interstate' is a measure of the net flow of electricity into and out of Vermont. Natural gas use is restricted to areas in northern Vermont served by a pipeline.

Gasoline used for transportation also has seen a sharp increase in consumption, from 17.5 trillion Btu to 43.9 trillion Btu since 1960. Coal has been replaced as an energy source in Vermont during this time period (Vermont is one of only two states with no coal-fired electricity generating facility, contributing to a relatively low emissions of carbon dioxide and other atmospheric pollutants). Fuel oil (used primarily for space heating and as diesel fuel) consumption increased rapidly during the 1960s, dropped off during the "oil crisis" in the early 1970s, and has slowly increased in use since that time.

The transportation sector has recently eclipsed the residential sector as the largest consumer of energy in Vermont. Although residential, commercial, industrial, and transportation all consume significantly more energy now than in the 1960s (Figure 2-2), a disproportionately large growth in transportation and commercial consumption has reduced the share of energy used in residential applications from 41% to 29% of the total. Industrial uses of energy actually peaked in the mid-1980s, dropped significantly, and have started to increase again.

Some of the increase in statewide energy consumption is due to an increase in population. The population of both Vermont and Bennington County increased at a relatively rapid rate in the 1960s and

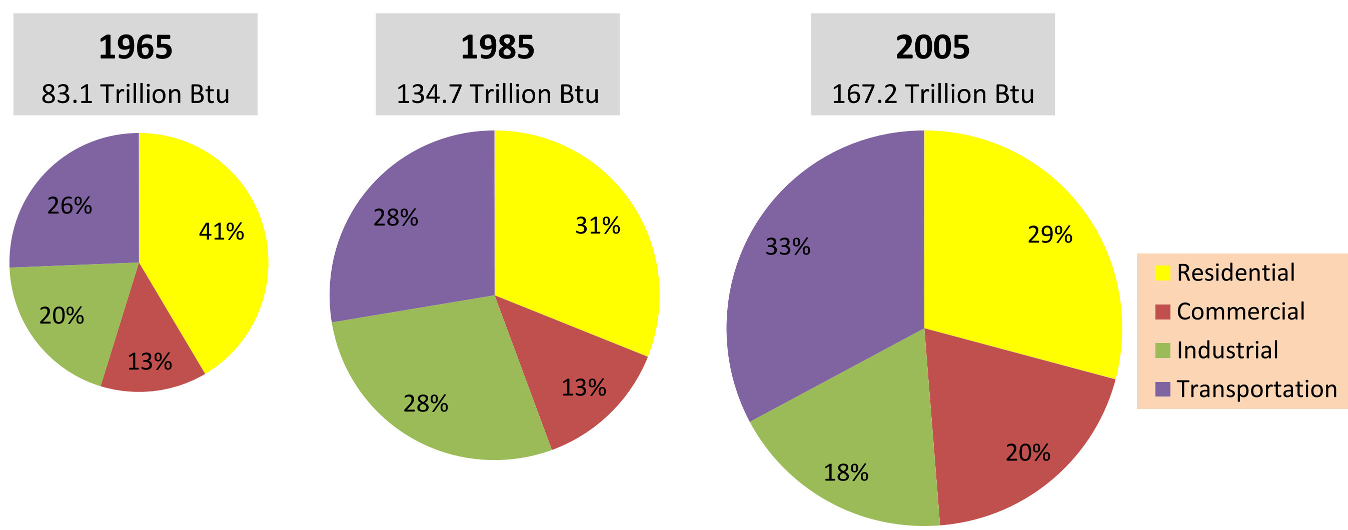
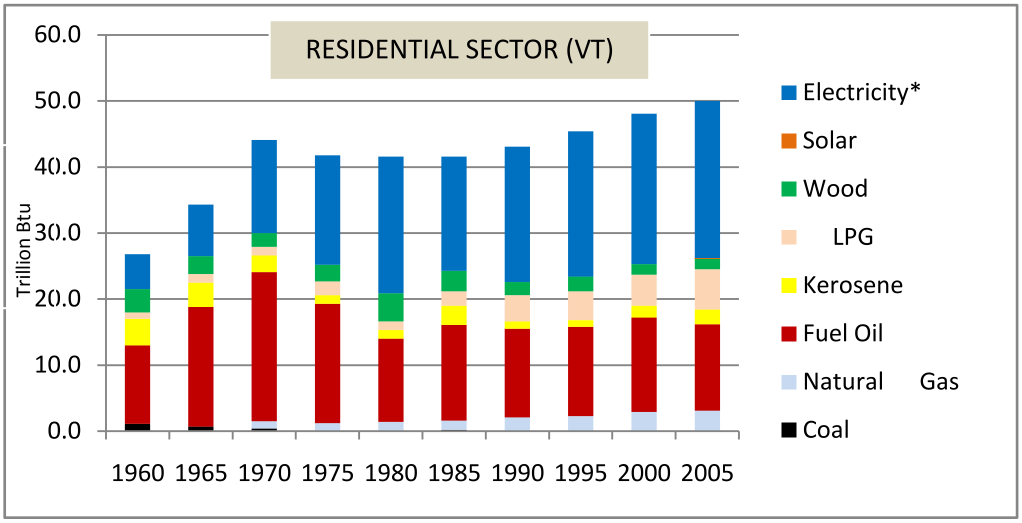
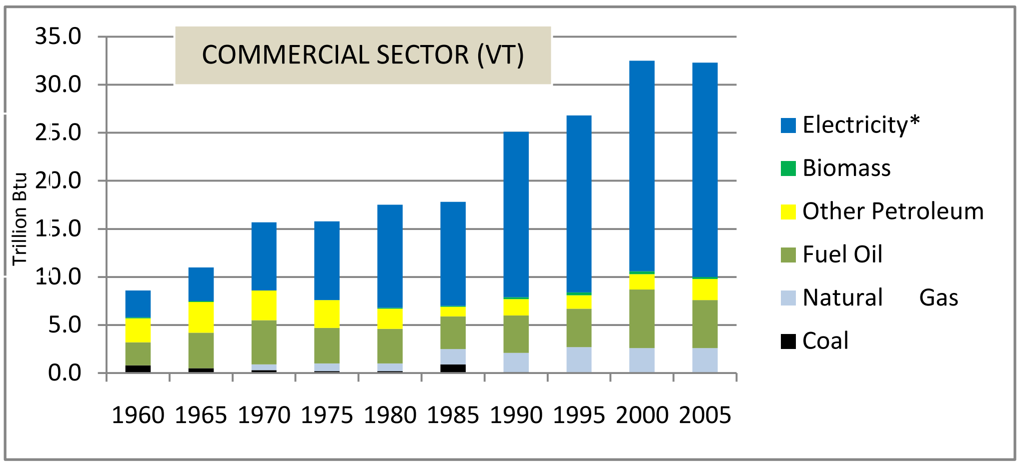


Figure 2-2. Percentage of total energy use by sector; the large increase in motor vehicle fuel use has resulted in the transportation sector becoming the most fuel consumptive in the State.

1970s, and has continued to grow, but at a significantly slower rate since the mid-1980s. Several factors appear to be contributing to a growth in energy consumption that exceeds the rate of population increase. One striking trend in energy consumption involves the increased use of electricity across residential, commercial, and industrial sectors (Figure 2-3). This additional reliance on electricity has not significantly offset consumption of primary fuels, and is apparently attributable to a greater reliance on machinery, appliances, and telecommunication and other devices that use large amounts of electrical energy. Moreover, for every KWH of electricity consumed by an end-user, another 2+ KWH are produced and lost in the system during generation, transmission, and distribution. Two-thirds of Vermont's electricity supply derives from two sources: the Vermont Yankee nuclear facility and Hydro-Quebec's generating facilities in Canada. The balance comes from a mix of in-state hydroelectric and biomass generators and purchased system power imported to the State.





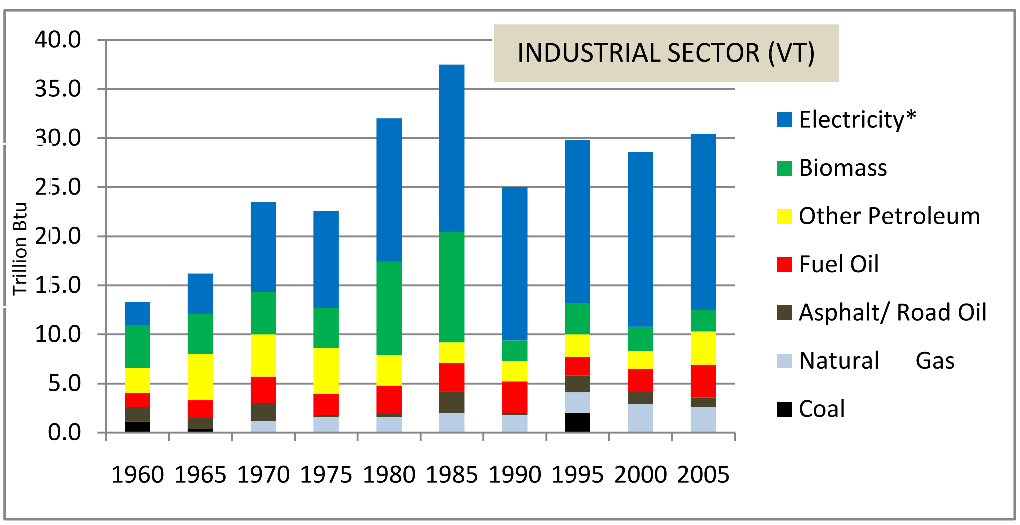


Figure 2-3. Energy consumption in Vermont has increased in all sectors since 1960. The expanded reliance on electricity (* total consumption includes both end use plus system losses) in residential, commercial, and industrial applications is especially noteworthy. Use of fuel oil and other petroleum products peaked in the 1970s, declined, and has increased again, but more slowly, since the mid-1980s. Use of wood/biomass energy tends to increase when fossil fuel prices and availability make it a more competitive alternative. Relatively low-cost petroleum and electricity has tended to suppress use of locally available renewable energy sources such as wood. Liquid petroleum gas (LPG) has become a relatively important energy source for home heating, especially in Bennington County and other areas not served by natural gas, in recent years. Solar (thermal and electric) has just started to show significant utilization.

Another obvious factor contributing to the growth in the region's energy consumption is the amount of fuel used for transportation (Figure 2-4). The number of households having two or more cars increased by approximately 70 percent between 1970 and 2000 and large sport utility vehicles and passenger vans became more popular during this timeframe. Vehicle fuel efficiency standards were raised in response to the energy crisis in the 1970s, but were rolled back slightly in the mid-1980s and there have been no significant improvements to the overall efficiency of the nation's fleet of vehicles since that time. In addition, people drive more than ever; the average travel time to work for Vermont and Bennington County residents, for example, increased by over 30 percent between 1980 and 2000.

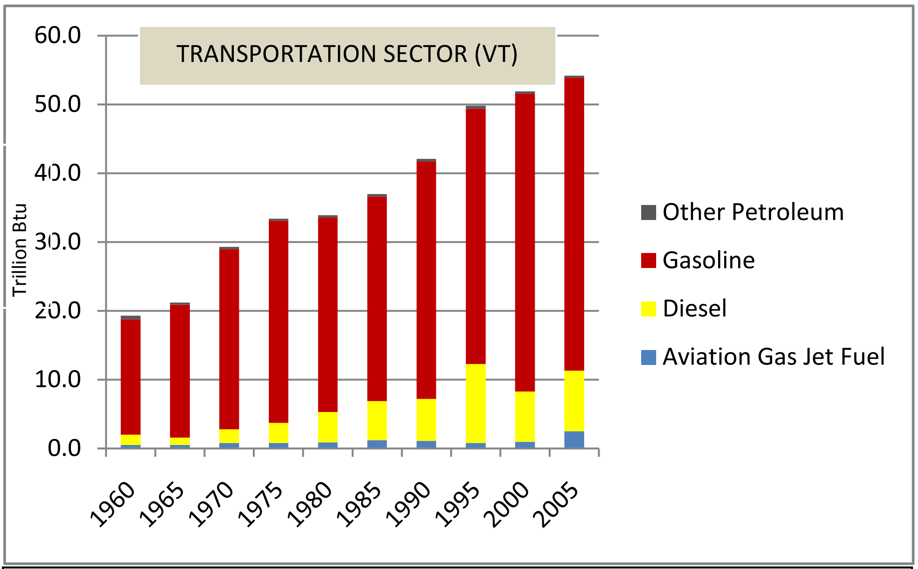


Figure 2-4. Increased consumption of gasoline and diesel fuel in the transportation sector is responsible for much of the growth in energy use in Vermont. Because traffic data collected in Bennington County have been consistent with statewide trends, it is likely that the rate of growth in this sector is similar in our region.

A closer look at sources of energy (including energy conservation) that are available and currently utilized in the region provides a basis for appreciating both needs and opportunities for the future. As noted above, residential and transportation uses account for over 60 percent of Bennington County's total energy consumption. Residential energy use is almost evenly divided between home heating and electricity (which is used for heating in some homes and many other applications in virtually all homes). Significant changes in home heating fuel choice have occurred in recent years. Fuel oil remains the most common source for home heating (Figure 2-5), used in more than 75 percent of all Bennington County households. The number of homes using LP gas as a heating source has increased dramatically, from just 387 households in 1980 to over 1,600 in 2000. At the same time, the number of households using wood or electricity has declined (from 1,710 to 960 for wood and from 825 to 489 for electricity). Although more current data is not available at this time, it is likely that the spike in petroleum prices that was experienced in the summer and fall of 2008 resulted in an increase in the number of biomass based (wood and wood pellet) home heating systems and a reduced reliance on fuel oil and LP gas.

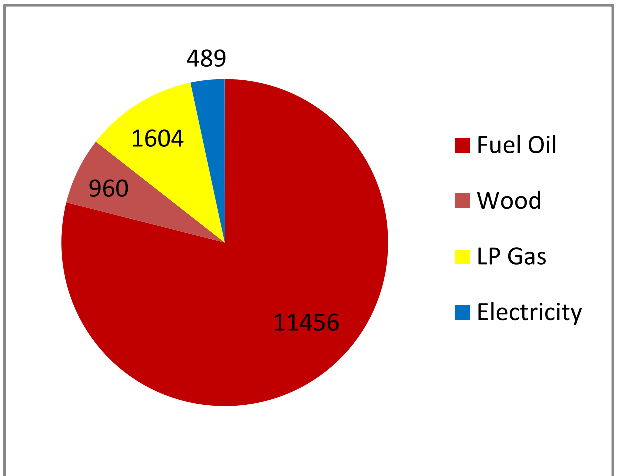


Figure 2-5. Number of homes heated with various fuels, Bennington County. Source: 2000 US Census.

Modern building materials and construction methods significantly reduce energy consumption in new buildings. Tight construction (with good ventilation), proper insulation, and high quality windows and doors greatly reduce energy used for space heating. In addition, the advantages of orienting structures to take advantage of passive solar heating are now well understood. The State of Vermont Residential Building Efficiency Standards and Commercial Building Efficiency Standards are designed to ensure that new construction conserves energy to the extent feasible. A great deal of emphasis has been placed on reducing electricity consumption in residential and commercial buildings through use of compact fluorescent and LED lights and "Energy Star" rated appliances. Efficiency Vermont, a statewide non-profit funded through a charge on consumer's electric bills, has had a demonstrable effect in curbing the growth of electricity demand over the past several years. A number of energy-efficiency consulting businesses have been established in the region and are available to test buildings and recommend specific improvements that will enhance energy conservation efforts.

Improved building techniques, insulation, windows and doors , and proper solar orientation produce significant savings in new building construction.

As noted above, energy consumption in the transportation sector has increased at a much more rapid pace than in any other sector. Based on a proportionate share of statewide consumption, over 20 million gallons of gasoline (or 800 gallons per vehicle) were burned in Bennington County in 2007. Most of this fuel was used in cars and light trucks; an additional four million gallons of diesel fuel were used by heavy trucks. As prices rose to over four dollars per gallon for regular gasoline and five dollars per gallon for diesel in 2008, people began to adjust their driving: unnecessary trips were curtailed, carpooling and alternative modes of transportation (e.g., bus, bicycle, walking) grew in popularity, and many people began considering trading their large vehicles in for smaller more fuel-efficient models. Although gasoline and diesel prices dropped significantly with the economic recession that began in 2008, long-term trends indicate clearly that petroleum prices will increase again in the future. It will be prudent to ensure that existing alternate transportation systems are available and can be improved.


10 miles per gallon or 35 miles per gallon? Fuel prices and economic conditions have affected those decisions.

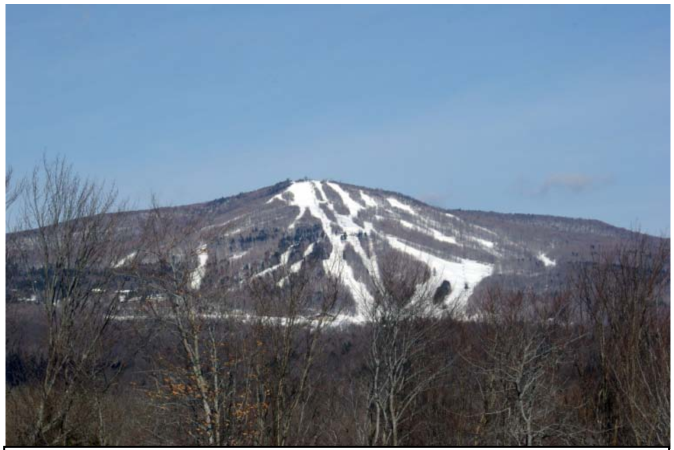
A wide range of facilities are currently available in the region to support alternative transportation, beyond the existing network of local and state roadways. Sidewalks and pathways provide safe routes for pedestrians in many of the region's town and village centers, the Green Mountain Community Network operates bus routes that serve important destinations, and the Vermont Railway's main line runs through the region from North Bennington to Dorset (currently used for freight rail traffic only). There are some deficiencies in the transportation system, particularly gaps in the pedestrian network and poor roadway conditions for bicycle travel. Specific areas of concern are identified in the Bennington Regional Transportation Plan and discussed in subsequent sections of this plan.

Land use planning in all towns in the region attempt to advance energy conservation objectives by encouraging relatively compact development patterns, with concentrated areas of residential, commercial, industrial, and institutional uses separated by open rural countryside. The Town of Bennington, for example, has just completed a project that led to establishment of a state-designated "Growth Center" in a compact area around the downtown where infrastructure and services exist and where future development can most efficiently be accommodated; the Town had to demonstrate strong conservation measures for areas outside the center.

The regional economy always has been diverse and each sector has significant energy requirements. Historically, manufacturing, tourism, and agriculture and forestry have been economic mainstays in Bennington County. While those industries still are key economic engines, recent employment growth has been most pronounced in health care, education, and retail (tourism and non-tourism related) and other services.

The Bennington Regional Plan notes that successful manufacturing enterprises require adequate and reasonably priced electricity, modern telecommunication infrastructure, and efficient transportation systems, all of which are heavily dependent on energy. Vermont energy consumption data (Figure 2-3) suggests that some fuel switching can occur between petroleum, biomass, and other sources based on price and availability, but it is clear that electricity supply is absolutely essential to manufacturing success. Of course, importing raw materials and exporting finished products requires transportation fuel – gasoline and diesel – for manufacturers whose products are marketed primarily outside the local area.

Service businesses that cater to tourists, primarily lodging establishments, food service, retail stores, and recreational venues, also require a significant amount of electricity and fuel for space heating and other functions. The large energy demands of ski areas in Bennington County and surrounding towns are particularly significant because of the amount of economic development that is driven by that industry. Just as important as the energy needed to operate these businesses is the energy, in the form of gasoline, that is required to transport tourists (currently nearly all arrive in personal cars) to the region from their homes. Large increases in energy prices or restricted supply could have significant adverse impacts on this key economic sector by raising prices and limiting the ability of tourists to travel to the area.



Bromley Mountain in Peru is one of several important ski areas in and around Bennington County.

Agriculture and forestry based businesses require energy to plant, harvest, transport, and process crops, animal products, and trees. Interestingly, farms and forests also can, and do, produce energy that can be consumed locally. Some farms, for example, are making use of methane from animal waste to provide power for their own operations and to generate electricity for retail sale. One area farm has converted much of its arable land to production of oil crops such as canola, sunflower, and soybeans, and has begun to produce vegetable oil and biodiesel fuel. Food production on local farmland also conserves energy when that food is consumed in local markets, thus reducing the energy use and costs associated with long-distance transportation of food to our region. Currently, the vast majority of food consumed in Bennington County comes from distant sources. Much of the land that was once used for agriculture in our area is no longer farmed and has reverted to forest cover, but a significant amount of the best agricultural soils have not been

State Line Farm in Shaftsbury produces biofuels at this modern facility; the evacuated tube solar collectors on the right of the picture provide heat for the building and grain processing.

developed and can be put back into agricultural use at some future time.

With nearly three quarters of Bennington County covered in forests, the amount of potential biomass energy tied up in trees is enormous. It has been estimated that approximately 350,000 cords of new tree growth takes place in county forests each year. A considerable amount of the local timber harvest is dedicated to saw log or veneer logs and some for pulpwood, although little processing takes place in the county. Enough wood biomass remains in the region's forests to supply a significant amount of the region's total energy demand, as cordwood for residential space heating, as woodchips to fuel commercial or industrial direct burn or gasification boilers, or as fuel for biomass-based electricity

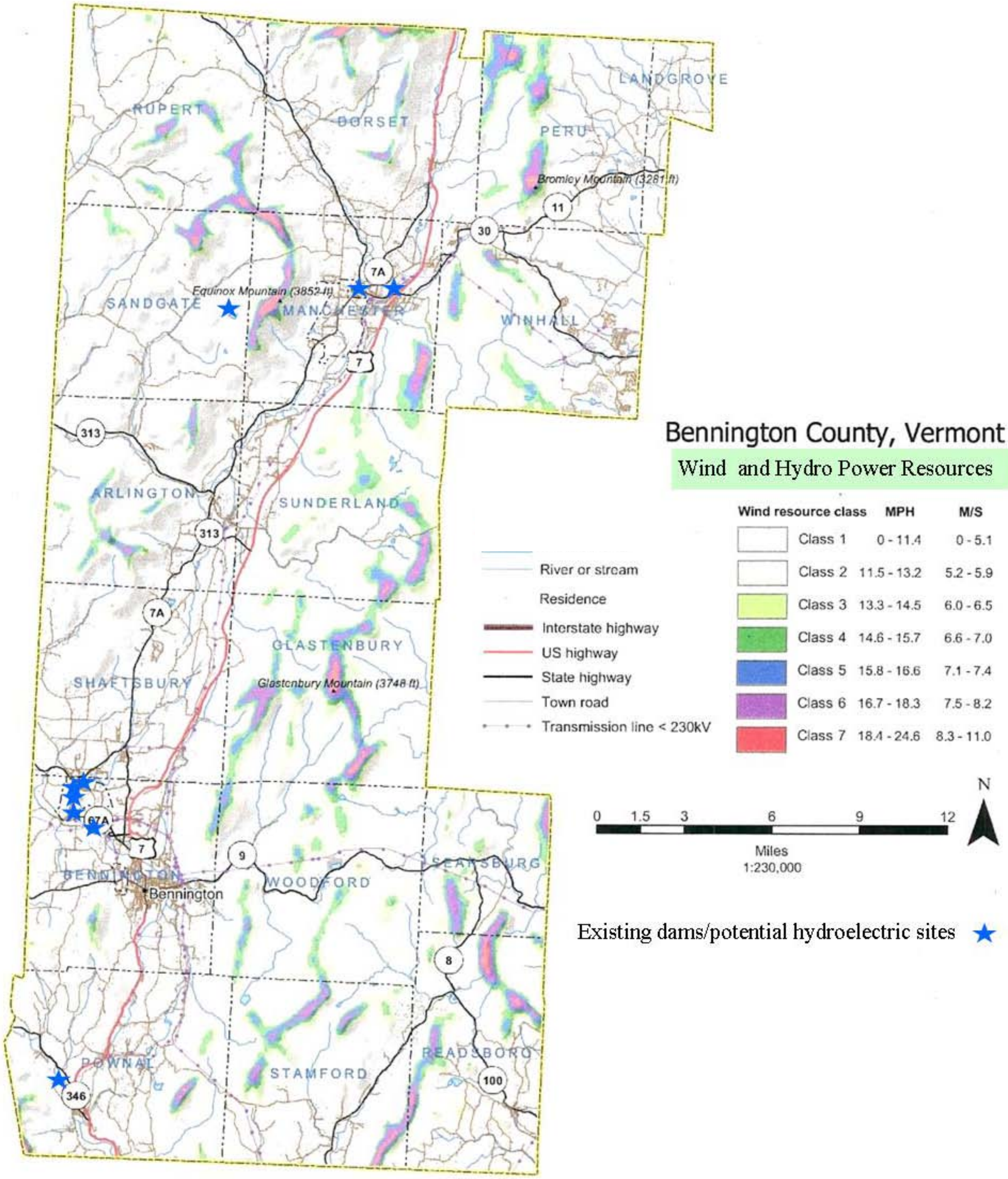
Forests cover most of Bennington County; the wood available from Bennington County and surrounding areas can provide energy for facilities such as this 400 horsepower wood boiler system at Bennington College, which has reduced oil consumption on the campus by more than 300,000 gallons per year.

generating plants. The Vermont Department of Forests, Parks, and Recreation has determined that the annual growth in recent decades has significantly exceeded removal. The amount of diesel and gasoline used to build roads to access the wood supply, harvest it, transport it, and then process it is considerable, of course, and further study is needed to determine how to sustainably harvest large quantities of trees without depleting the nutrient base of the soil.

Several local institutions have determined that biomass systems are the most efficient and reliable for their campuses. Educational facilities, in particular, have moved toward biomass systems to meet much of their heating needs. The Mount Anthony Middle and High Schools in Bennington and Bennington College are among many schools and colleges in Vermont that have converted to biomass fuel sources. The Southwest Vermont Medical Center has considered using biomass to replace some of the 700,000 gallons of oil it burns annually in its central boiler plant. Of course, all of these institutions also consume a great deal of electricity that is generated primarily from distant nonrenewable sources.

Opportunities and methods for encouraging renewable energy development in the region will be discussed in the next section of this plan; it is worth noting here that there exists significant unrealized potential for obtaining energy from wind, hydroelectric, biomass, solar, and geothermal sources in the region. These sources can produce viable energy at a small scale (individual commercial building or house) or at a large scale (producing energy for multiple buildings, as in an institutional campus or to sell to other energy consumers). Biomass (wood) fuel use in homes and at colleges and schools has been discussed earlier, and an increasing number of homeowners are using direct solar energy for production of domestic hot water and, using photovoltaic panels, to obtain electricity. A recently renovated building in downtown Bennington that now houses state offices and the Community College of Vermont has demonstrated that geothermal energy can be effectively used for space heating in the area. The map on the next page shows preliminary mapping of locations well-suited for wind turbines as well as the location of existing dams that have produced hydroelectricity in the past. The greatest local energy resource, however, remains energy conservation that can be achieved through improved efficiencies in buildings, vehicles, and in the way that we all live and work every day.

This building in downtown Bennington makes use of geothermal energy for space heating.



Bennington County's wind resource potential is concentrated along its high ridgelines. An existing facility is located in Searsburg and efforts have been made to develop a generating facility on Mount Equinox in Manchester. Considerable wind energy potential exists for small residential-scale turbines throughout the region. There used to be many active small hydroelectric facilities at dams along several waterways in the region. Recent interest has been expressed in reestablishing hydroelectric generation at the dams on the Hoosic River in Pownal, the Walloomsac River in Bennington, Paran Creek in North Bennington, and the Batten Kill in Manchester. Hydroelectric potential has been identified at many other locations throughout the region.

Section III Energy Tomorrow

Bennington County has come to rely heavily on fossil fuels, and as we have seen, the use of these valuable energy sources has been increasing over time. Given that oil, natural gas, and other such fuels are limited nonrenewable resources, it is logical to try to determine how much longer they will be available to fuel our economy and our lifestyles. The answer to that question is complex, and the amount of remaining conventional and nonconventional petroleum reserves is vast, but scientific evidence indicates that the most readily and economically available oil and gas fields have been discovered and tapped and that world production of these fuels will continue to decline and prices will continue to rise as supplies are depleted, as extraction and processing costs increase, and as demand continues to increase (Figures 3-1 and 3-2).

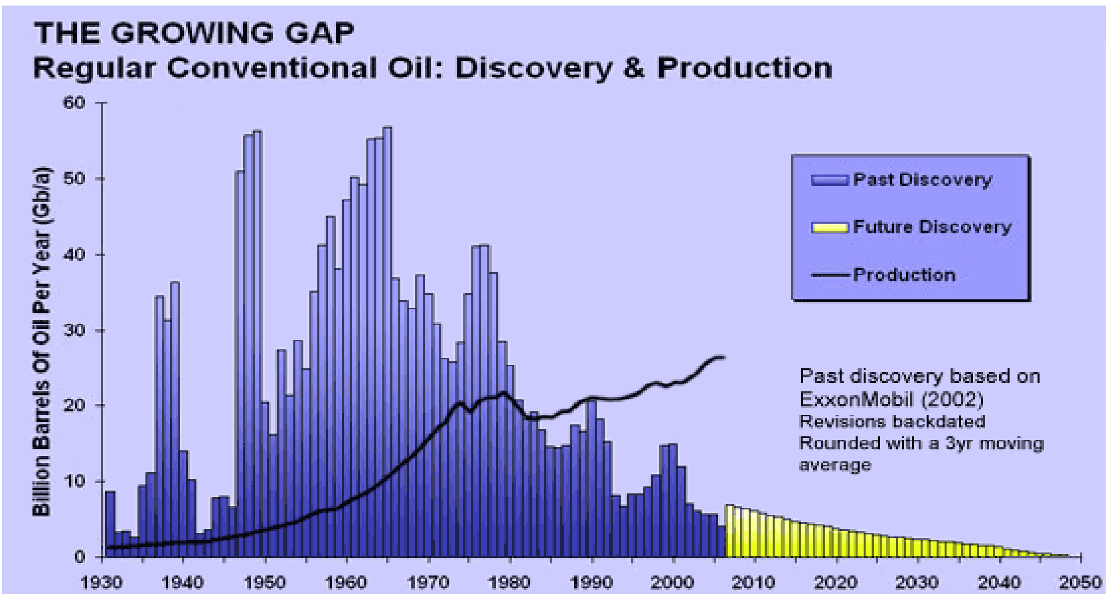


Figure 3-1. Production of oil from conventional sources has exceeded discoveries of new reserves since 1984. It is likely that worldwide production of oil is near its peak and will begin to decline as supplies are depleted.

A recent award-winning documentary film about climate change was entitled “An Inconvenient Truth.” The same moniker could be applied to our energy future. Although we will continue to have access to oil and gas for some time into the future, the cost of that energy will begin to rise at an increasing rate and within a very few years, those fuels will no longer be available to us. To illustrate the magnitude of the looming crisis, one need only to refer back to Figures 2-4 (page 11) and 2-5 (page 12) and remove oil (and diesel) and gas from those charts. It becomes immediately obvious that several fundamental changes are in our future: we will have to conserve energy and we will have to develop alternative sources of energy. Making the required transition in the short amount of time that is available will prove a daunting challenge.

The need for conservation has been understood for some time. The 1982 Bennington Regional Energy Plan was heavily focused on energy conservation, and presented plans that, if followed, would restrict growth in energy usage in the county from 5.5 trillion Btu annually (1980) to between 4.5 trillion

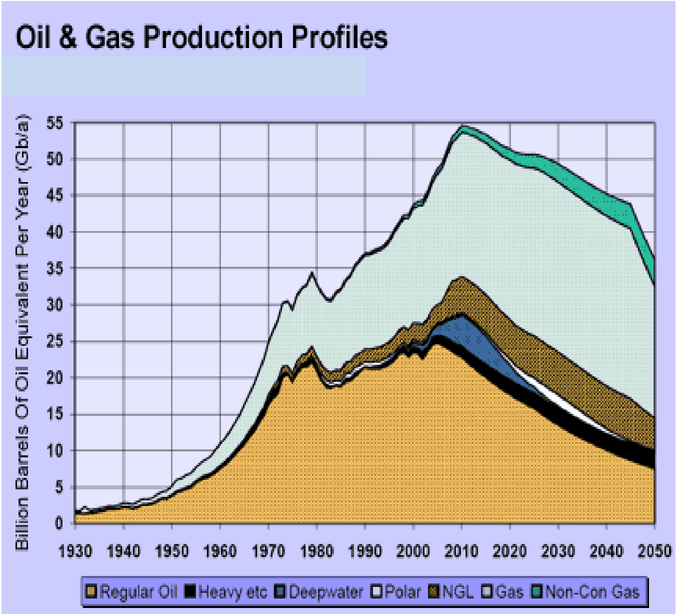


Figure 3-2. Worldwide production of oil from conventional sources has, or soon will peak. Petro fuels from other sources (natural gas and "nonconventional" oil and gas such as tar sands, oil shale, and deepwater sources, will replace some of the conventional production, but overall production is expected to begin an inevitable decline in just a few years, with a more rapid fall-off occurring in 30 years. Source: Association for the Study of Peak Oil and Gas.

Btu (actually a net reduction in energy usage) and 6.2 trillion Btu over the next 20 years. It has to be said that implementation of those strategies has been spectacularly unsuccessful. Actual energy usage in Bennington County has increased to approximately 10 trillion Btu (2005) and per capita energy use, which was projected to decrease under either scenario in the 1982 plan, has instead increased from 171 million Btu per year to approximately 270 million Btu today.

Although disappointing, it is not surprising that we have not managed to reduce our energy usage in the past two decades. Oil and gas have remained very inexpensive and, as a result, there has been no strong or sustained incentive to conserve or to switch to alternative sources of energy. However, even at today's prices, conservation and converting to renewable sources of energy can offer considerable cost savings.

Our reliance on electricity also has increased significantly, and as fossil fuels become more costly and less available, there will be an effort to switch to electricity or other energy carriers. Generation of electricity (using nonrenewable sources such as coal and nuclear or renewable sources) and transmission of electricity will, therefore, also be a very important issue in tomorrow's energy picture. The rest of this section will be devoted to energy conservation strategies, development of renewable energy resources, and issues associated with electricity and other means of transporting energy.

Conservation

As oil becomes less prominent in our energy mix, there will be a greater reliance on electricity, probably generated by nuclear, natural gas, and coal plants as well as by a mix of renewable sources (principally hydro, wind, biomass, and to a lesser extent in our part of the country, solar). It is likely that technological adaptations will allow electricity to displace many, but not all, of the functions currently served by oil and gas. In any event, greater utilization of remaining nonrenewable fuels will accelerate their rates of depletion as well as their cost, and the energy available from renewable sources will never match that which we have obtained from fossil fuels. The "inconvenient truth," then, is that Bennington County will use less energy 20 years from now than it uses presently, whether or not a conscious effort to conserve is made. Developing and implementing conservation strategies at all levels of our society and economy will ease the inevitable transition to this lower total energy future.

Residential Conservation Strategies

Space heating is the greatest energy use of residential energy, accounting for well over half of energy costs in a typical Vermont home. The use of electricity for lighting and operating the many appliances and entertainment devices common in modern houses has grown significantly in recent years. Use of renewable energy-based systems for space heating, domestic hot water production, and electricity generation can significantly reduce reliance on fossil fuels and result in considerable cost savings for homeowners; those strategies will be discussed in the subsequent section of this report that deals specifically with renewable resources. The following strategies focus on energy conservation standards and strategies for new residential construction, weatherization and other strategies for reducing energy use in existing homes, and changes in the way we use and live in our homes. Further details and helpful hints can be found at the U.S. Department of Energy (www.eere.energy.gov - see "Energy Savers Booklet") and Efficiency Vermont (www.efficiencyvermont.com) websites.

New Residential Construction

1. Residential construction (all new residential buildings and additions in excess of 500 square feet) must adhere to the Vermont Residential Building Energy Standards (RBES). Building inspections required for issuance of certificates of occupancy should include documentation that the new construction meets those standards. Banks should consider requiring conformance with those standards prior to financing new construction.
2. Builders should make use of the Energy Star rating system and strive for 5-star rated construction or better.
3. New homes should be as small as practical, super-insulated, and should take advantage of solar access to the extent possible. Municipalities can influence the size, location, and orientation of residential structures through subdivision standards and zoning incentives.
4. Passive solar heating can dramatically cut energy use and should be pursued whenever possible (Figure 3-3). A typical Vermont house uses approximately 114 million Btu for space heating in a year, whereas a well-insulated home taking full advantage of solar orientation can be heated with just 30 million Btu per year (plus the Btu provided by the sun, of course), resulting in fuel savings of approximately $2,000 per year.
5. New houses should include multiple space heating zones so that parts of the house not in use do not need to use as much energy for heating.
6. Housing affordability measures should consider long-term operating costs and value appreciation in addition to initial construction cost.
7. Manufactured houses must meet the same energy standards as traditionally constructed homes. New "green" energy-efficient modular and mobile home designs should be pursued. Traditional mobile homes have an inherently inefficient design because of their high surface area to volume ratio and low insulation values; they also depreciate rapidly and require costly and energy-intensive replacements.

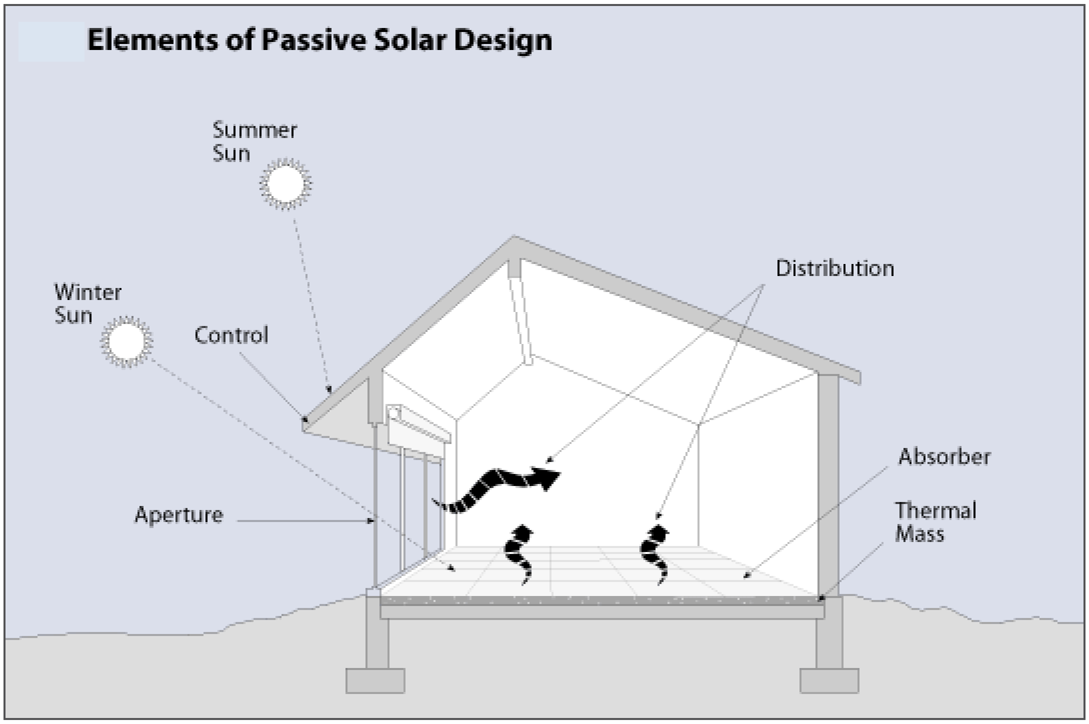


Figure 3-3. Cross-section of a passive solar home showing important design characteristics: orientation toward the south, aperture (window) where sunlight enters the building, absorber and thermal mass which store and radiate heat, distribution, the method by which the heat circulates through the building, and controls, which may be roof overhangs or window blinds to shade the windows during summer months. Source: US Department of Energy.

8. Multi-family housing offers outstanding opportunities for energy conservation and efficient sharing of energy resources. Incentives should be provided to encourage multi-family housing in appropriate locations in village and town centers.

Existing Residential Buildings

1. Retain the services of a qualified energy auditor to obtain a prioritized list of energy saving measures organized by cost and savings that can be realized.

Space Heating (55% of energy use)

2. Add insulation to attics, exterior walls, and beneath floors.
3. Use caulk, spray foam, and weatherstripping, as appropriate, to reduce air infiltration at key locations such as window and door frames, sill plates, recessed lighting fixtures, electric outlets and switches, and ducts and utility access points (Figure 3-4).
4. Replace windows with “Low-E” Energy Star rated windows or add storm windows over existing windows.
5. Window shades should be opened to the south to let the sun warm the house during the day in cold-weather months and should be closed to restrict solar heating during warm-weather months.

6. Close fireplace dampers and/or install inflatable chimney balloons to eliminate heat loss from flues.
7. Close doors to closets located on exterior walls.
8. Install programmable thermostats so that excess energy is not used for heating when people are sleeping or not at home.
9. Reduce thermostat settings (winter levels should not be higher than 65F when people are home during the day and 55F at other times) and dress warmer for comfort (an average home can save $120/year for every degree thermostat is turned down).
10. Heat only the rooms being used and seal others off if possible.
11. Heating units should be kept cleaned and regularly maintained. Consider replacing old furnaces with a more efficient variety – a 20% fuel savings is possible).
12. Reduce energy costs and use fuel that is available locally and which benefits the local economy: consider heating with a wood stove and/or furnace.
13. Install heat reflectors between radiators and outside walls.
14. Landscape using deciduous trees to provide summer shade on the south side of the house, and use coniferous plantings on the north and west to provide a windbreak against cold winter winds.

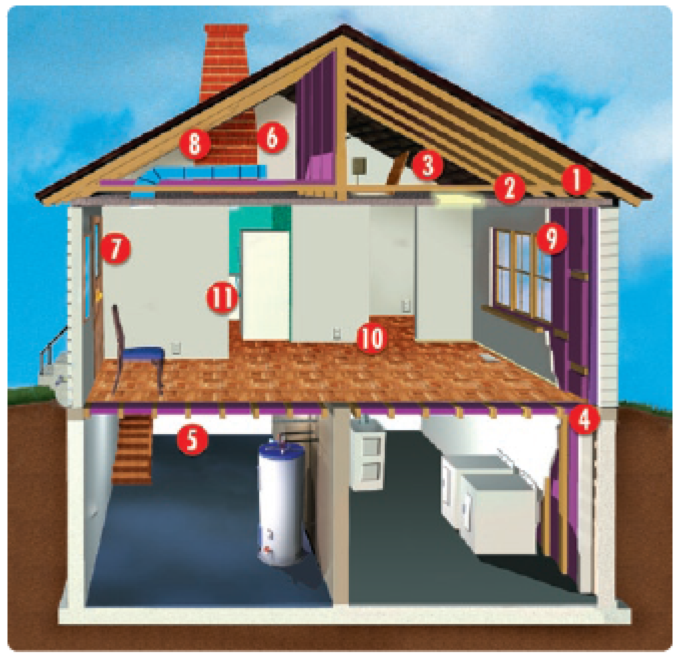


Figure 3-4. Common sources of air infiltration. Sources: US Department of Energy

2 Recessed light	**6** All ducts	**10** Electrical outlets and switches
3 Attic entrance	**7** Door frames	**11** Plumbing and utility access
4 Sill plates	**8** Chimney flashing	

<u>Water Heating (18% of energy use)</u>

15. Install an Energy Star rated efficient water heater; consider a tankless (“on-demand”) heater and/or a solar hot water system (discussed in the next section).
16. Remove sediment from hot water tanks that impede heat transfer.
17. Set water temperature to no more than 120F.
18. Install low-flow fixtures in sinks and showers (can reduce hot water consumption by 10%).
19. Repair leaking faucets.
20. Insulate water pipes.

21. Install Energy Star rated efficient dishwasher and clothes washer. Use warm or cold settings on clothes washer.

<u>Lighting (10% of energy use)</u>

22. Replace incandescent bulbs with compact fluorescents (CFLs) and/or light emitting diodes (LEDs) to save $40+ over the life of each bulb. (Figure 3-5)
23. Turn off lights whenever leaving a room.
24. Use daylight for lighting by installing large windows to let light in where needed and keep windows uncovered during the day to take advantage of natural (and free) light.

<u>Appliances and Home Electronics (17% of energy use)</u>

25. Replace old and inefficient appliances with Energy Star rated efficient appliances (replacing refrigerator/freezer yields greatest savings).
26. Air-dry dishes when using a dishwasher.
27. Ensure seals are tight on refrigerators and freezers.
28. Use a toaster oven or microwave to heat small meals.
29. Air-dry clothes outside when possible.
30. Turn televisions, computers, and other electronics off when not in use. Use power strips to fully cut power and avoid “phantom loads.”
31. Unplug chargers when not in use.

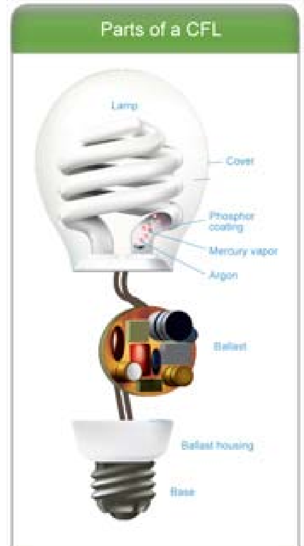


Figure 3-5. Compact fluorescent lights use about 75% less electricity than incandescent lights. New LED lighting is even more efficient.

Electricity use (in watts) of typical household appliances. Energy can be saved by turning some off when not in use and avoiding use of others (such as drying clothes outside instead of in a dryer).

- Clock radio = 10
- Coffee maker = 900–1200
- Clothes washer = 350–500
- Clothes dryer = 1800–5000
- Dishwasher = 1200–2400 (using the drying feature greatly increases energy consumption)
- Dehumidifier = 785
- Electric blanket- *Single/Double* = 60 / 100
- Fans
  - Ceiling = 65–175
  - Window = 55–250
  - Furnace = 750
  - Whole house = 240–750
- Hair dryer = 1200–1875
- Heater *(portable)* = 750–1500
- Clothes iron = 1000–1800
- Microwave oven = 750–1100
- Personal computer
  - CPU - awake / asleep = 120 / 30 or less
  - Monitor - awake / asleep = 150 / 30 or less
  - Laptop = 50
- Radio *(stereo)* = 70–400
- Refrigerator *(frost-free, 16 cubic feet)* = 725
- Televisions (color)
  - 19" = 65–110
  - 27" = 113
  - 36" = 133
  - 53"-61" Projection = 170
  - Flat screen = 120
- Toaster = 800–1400
- Toaster oven = 1225
- VCR/DVD = 17–21 / 20–25
- Vacuum cleaner = 1000–1440
- Water heater *(40 gallon)* = 4500–5500
- Water pump *(deep well)* = 250–1100

Commercial and Industrial Conservation Strategies

Our economy depends on the vitality of local commercial and industrial enterprises, and those businesses rely on energy to operate. While total commercial and industrial energy use in Vermont are comparable, commercial demand has increased dramatically over the past twenty years and industrial demand has been relatively flat. Both of these sectors, however, rely heavily on electricity, and effective conservation strategies will help ensure that electricity generation and transmission capacities remain adequate to meet their needs. Of course, many of these businesses rely on shipments of products and transportation of people to the region, and those energy demands are accounted for in the transportation sector, which has seen a very large increase in consumption of fossil fuels. Commercial and industrial conservation strategies range from building efficiency improvements to changes in operating procedures and objectives. Specific advice and tools that can support conservation efforts can be found at Efficiency Vermont's business section (www.efficiencyvermont.com/business) and at the Energy Efficiency and Renewable Energy Resources section of the U.S. Department of Energy's website (www.eere.energy.gov).

1. New buildings and additions must meet the Vermont Guidelines for Energy Efficient Commercial Construction (Commercial Buildings Energy Standards – CBES), and those standards must be enforced.
2. Buildings should be sited to maximize solar access for heating and natural lighting.
3. The location of any new commercial or industrial building should be carefully evaluated. Preferred sites are in established growth centers where transportation costs are minimized, existing infrastructure can be utilized, and public transportation and bicycle and pedestrian access for workers and customers is feasible (Figure 3-6).
4. Give full consideration to use of locally available renewable energy resources for heating, cooling, and electricity (see following section on renewable energy).
5. The same measures taken to weatherproof existing residential structures can be implemented for commercial and industrial buildings. Building owners should retain the services of a qualified energy auditor to obtain a prioritized list of energy-saving measures organized by cost and savings that can be realized.
6. Maintain HVAC and other systems to ensure optimal efficiency.
7. Rely on natural lighting to reduce the number and intensity of required lighting fixtures. Office workers should be encouraged to use no more artificial lighting than necessary. Lights should be turned off when rooms are not occupied (occupancy sensors provide a possible solution) and all lights other than minimal security lighting should be turned off when the business is not open (e.g., overnight and/or weekends). Advertising signs should be on timers or manually turned off when lighting is not necessary (late evening and during hours of bright daylight).

8. Efficient fluorescent or LED lighting fixtures should replace all incandescent bulbs.
9. Thermostats should be set to avoid unnecessary heating in the winter and cooling in the summer, and should be set back when the building is not occupied – programmable thermostats can assist in this regard.
10. Computers and other electronic office equipment should be shut off, or at least set to "sleep mode," at the end of the work day.
11. Install air lock vestibules on entry doors.
12. Large employers and business groups should encourage carpooling among employees and provide incentives for ridesharing. These same groups should work with local public transit providers to ensure that bus routes and times accommodate employee commuting needs.
13. Showers, changing facilities, and bicycle racks or storage areas encourage bicycle commuting and should be provided when possible.
14. Consideration should be given to allowing employees to telecommute – work from home – one or more days per week, when possible. Other businesses may find that a four-day work week is a good solution, saving transportation costs for employees and reducing the cost of heating, cooling, and lighting buildings.
15. Businesses should obtain local materials for their manufacturing and business operations whenever possible, and should seek and develop local markets for their products.

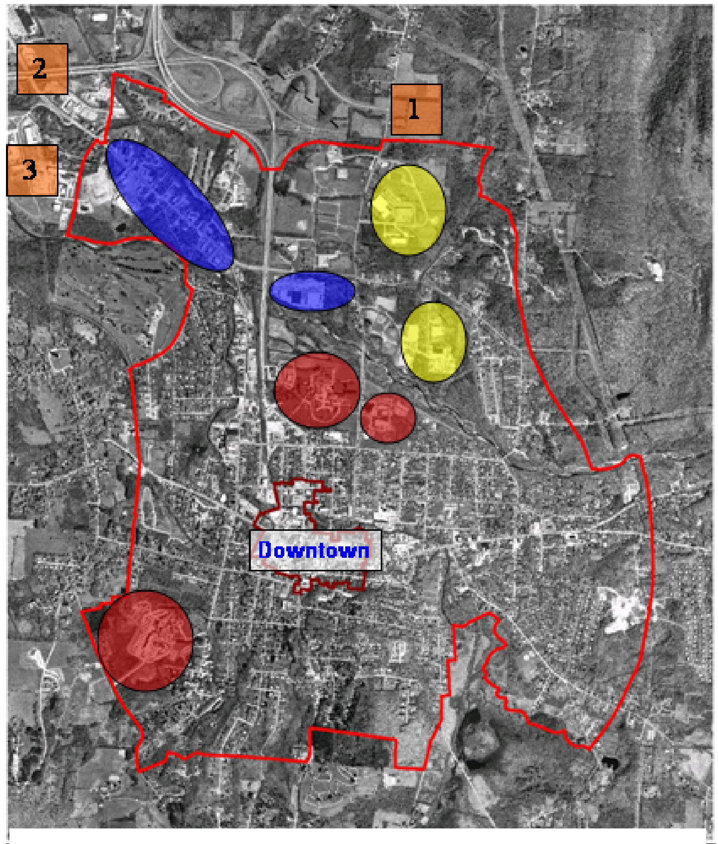
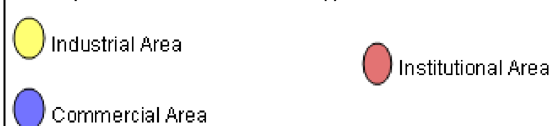


Figure 3-6. Bennington's future growth is planned for an area in and around the downtown where existing services are adequate. From the Bennington Growth Center Plan (2008).



Transportation Conservation Strategies

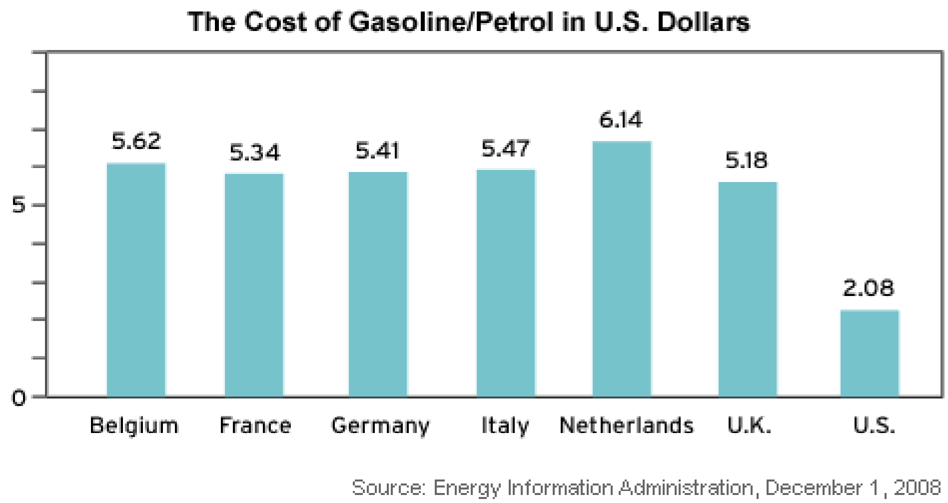
The amount of energy used for transportation in Vermont has grown more rapidly than energy use in other sector over the past 25 years. Ironically, the 1982 Bennington Regional Energy Plan projected a sharp decline in transportation-related energy consumption "simply because of higher mileage in new cars." Those more fuel-efficient cars, the Plan predicted, would result in 33% less fuel consumption between 1980 and 2000; while in reality, transportation fuel consumption increased by more than 37% from 1980 to 2005. Although significant gains in the overall efficiency of the country's fleet of vehicles have not been observed during this time period, improved technology has led to the production of some highly efficient vehicles. Low prices for gasoline and diesel, however, have encouraged people to preferentially buy large fuel-inefficient vehicles -- and to drive more miles. To achieve real energy savings in the transportation sector, market forces must provide a strong incentive for people to purchase fuel-efficient vehicles and to drive less.

The market price for transportation fuels in the United States has been consistently less than in most other developed countries (Figure 3-7), and the result has been a sprawling motor vehicle-dependent land use pattern with automobile manufacturers satisfying consumer demand for large energy-inefficient vehicles. Many countries tax gasoline and diesel fuel at a much higher rate than the federal and state governments of the United States. In establishing a fuel tax rate, those countries have attempted to capture the full cost of motor vehicle use, not just the cost of producing and distributing the fuel, but also the cost of developing and maintaining transportation infrastructure, environmental costs, the costs associated with sprawling development patterns, and critically, the cost of depleting a nonrenewable energy resource (oil). The market in those countries has responded to higher fuel costs by stimulating the production and sale of fuel-efficient vehicles, discouraging excessive driving, and promoting a land use pattern that enables people to get to important destinations with a minimal amount of driving. Revenues from fuel taxes have been used to develop high-speed rail systems for the movement of freight and passengers, establishment of effective public transit systems, and maintenance of critical highway and bridge infrastructure.

American strategies for accomplishing these same objectives - relying on regulation and public financing - have been far less effective than the market-driven European approach. The fuel taxes currently charged in Vermont and other states, for example, do not come close to providing enough revenue to pay for basic infrastructure maintenance –as evidenced by the need to spend nearly all of the recently released federal American Recovery and Reinvestment Act (aka "Stimulus") transportation funds for that purpose. Moreover, higher fuel efficiency standards have not been politically viable because manufacturers note that consumer demand for smaller vehicles is very low (as long as fuel prices are low) and many public transit systems, especially in rural areas like Bennington County, are underutilized because driving personal vehicles remains so inexpensive.

Depletion of petroleum reserves, combined with escalating international demand from developing countries, will inevitably drive fuel costs higher and prompt conservation. This effect was clearly observed in the summer and fall of 2008 when price speculation radically increased fuel costs and led many people to purchase smaller vehicles, use public transportation, and even consider relocating their homes closer to jobs and schools. In the short-term, however, all of the strategies identified in this section will be more successful if incentives and funding provided by a substantially

Figure 3-7



higher gas tax is put in place. The principal fuel tax should be federal to avoid competition between states, but states like Vermont should raise enough revenue to cover non-federal costs of infrastructure repair and investments in alternative transportation systems.

Transportation Alternatives

The high environmental costs and limited future viability of petroleum as a transportation fuel has led to considerable interest in alternative propulsion systems. The Bennington Regional Transportation Plan contains an entire chapter on alternative vehicles and fuels. Foremost among those alternatives to the car are various forms of "human-powered" transportation for local trips: walking, bicycling, or use of new aerodynamic enclosed or semi-enclosed pedal-powered vehicles. Many other vehicles that do not rely on petroleum-based fuels are being developed as well. Those receiving the most attention rely on electricity as a means of propulsion; if electricity does become a primary transportation fuel, electric generating capacity and transmission capacity will be strained unless the fuel switch is accompanied by a considerable decrease in the amount of driving.

The North Bennington train depot may once again play an important role in the region's transportation system.

In the future, we will need to rely much more heavily on transportation modes such as rail (freight and passenger) and buses to maintain mobility and provide access to and from the region. For local trips, walking, biking, and public transportation will become progressively more important. With limited public funding available, investments should be directed toward improving and expanding rail infrastructure, bicycle and pedestrian facilities, and bus service, and no funding should be provided to new capacity highway projects. Investments in maintenance of the public highway system should be completely funded by fuel taxes and should target the most critical roadway corridors and bridges.

The following strategies recognize the need to both use existing petroleum fuel sources more efficiently and to reduce overall transportation-related energy expenditures:

1. Continue to support a land use pattern that directs development to established growth centers and which locates residential neighborhoods close to business and service centers.
2. Provide adequate revenues for transportation infrastructure maintenance and development of alternative transportation modes through implementation of a federal (and to a lesser extent) state gasoline tax. Recognize that such a fuel tax is necessary to reflect the full cost of nonrenewable energy use and to influence consumer behavior to maximize economic efficiency. Most economists believe that a gas tax of at least two dollars per gallon, phased in over time, is required to effect an efficient outcome.
3. Encourage ridesharing and carpooling through education efforts and by providing incentives to employers who support such programs.
4. Invest in public transportation systems that provide regular and reliable service throughout town and village centers.
5. Improve rail infrastructure to encourage freight shipments and enable the reestablishment of passenger rail service to the region via connections to the Amtrak facilities in Rensselaer, New York.
6. Support new intercity bus service through the region with routes along the US 7 corridor and the VT 9/NY 7 corridor.
7. Maintain sidewalks and make available bikepaths that connect important destination. Maintain roadways that serve, or could serve, as important bicycle commuting or travel routes so that they are safe for bicyclists.
8. Establish educational programs, coordinated by the state, local governments, and health care organizations that will encourage people to walk or bicycle to local destinations.
9. Encourage consumers to purchase needed goods locally whenever possible and avoid travel to shopping centers located outside the region. When shopping for food or other items, seek items that are grown or produced locally, using local raw materials.
10. Encourage drivers to heed speed limits and avoid rapid accelerations and other behaviors that reduce fuel efficiency.
11. Support development of alternative fuel vehicles and the local infrastructure needed for their widespread use. Examples of local actions identified in the Bennington Regional Transportation Plan include:
    - Development of bikepaths to support bicycle and other human-powered vehicle use, as well as public education to increase awareness and understanding of the needs of these users of the transportation system. Municipalities and businesses should provide safe storage spaces for these vehicles.

- Seek additional electric generating capacity from local renewable resources to provide energy for electric vehicles.
- Support development of alternative fuels such as hydrogen/methanol or biodiesel, local production of such fuels, and the infrastructure necessary to transport and dispense the fuels.

12. Replace streetlights with roundabouts where possible to save electricity (lights) and gasoline (reduced idling).

Public and Institutional Conservation Strategies

Local governments, schools, and institutions (such as colleges, hospitals, and nursing homes) account for large energy expenditures; consequently, conservation efforts among these uses can significantly reduce regional energy utilization. Because of the large size of these facilities, it is often possible to economically implement large-scale conservation and efficiency improvements. Many schools, colleges, and hospitals, for example, have greatly reduced their reliance on imported oil by installing new boiler systems that use locally available biomass fuel (wood chips or pellets – Figure 3-8). In addition, federal and state grants are available for weatherization, electricity conservation, and installation of certain renewable energy systems. The Department of Energy's energy efficiency and renewable energy website (www.eere.energy.gov/) and Efficiency Vermont's website (www.efficiencyvermont.com) are good resources for information on energy conservation and grant opportunities. Of particular interest is the School Energy Management Program offered in conjunction with Efficiency Vermont.

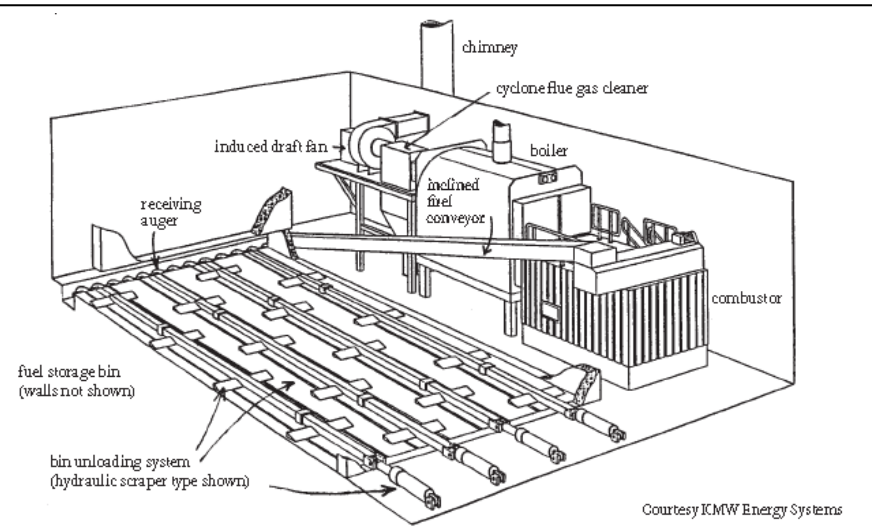


Figure 3-8. Schematic of a typical wood biomass heating system in use at many schools, hospitals, and other institutions around the northeast.

1. Investments in new buildings and equipment should consider long-term energy and other operating costs in addition to initial capital cost. New buildings should be designed to achieve high Energy Star and LEED ratings.
2. Building location and orientation should maximize potential utilization of solar energy.
3. Public and institutional facilities should be located near population and business centers to minimize the need for driving and to provide easier access for public transit routes, pedestrians, and bicyclists.

4. Boilers and other building infrastructure should be regularly maintained to ensure high operating efficiencies.
5. Energy audits should be conducted and form the basis for investments in weatherization and other energy conservation investments. The same types of weatherization improvements available for residential and commercial buildings can be undertaken for public and institutional buildings. Similarly, actions such as use of natural lighting, replacement of lighting fixtures with energy-efficient alternatives, and turning off lights and electric equipment when not in use will result in substantial energy savings.
6. Government units, schools, and other institutional uses often own and operate a large number of vehicles. Whenever new vehicle purchases are considered, strong consideration should be given to energy efficiency and resulting fuel cost savings.
7. Vehicle use should be carefully planned to minimize driving time and distance (e.g., optimizing bus routes, police patrols, snow plowing routes).
8. Police departments should consider bicycle and foot patrols in town and village center locations.
9. Municipalities can dramatically reduce electricity use by converting to LED streetlights (50% to 70% savings); although currently expensive to purchase, it is expected that costs will go down as demand increases. An inventory and review of streetlight locations also should be conducted to determine if some street lights are unnecessary and can be removed.
10. Zoning and other land use permits should require developers to make use of energy-efficient buildings and exterior lighting.
11. Public and institutional employees should be encouraged to walk and bike to work. Safe roadways, pathways, and sidewalks should be provided between schools and residential neighborhoods to encourage children to walk or bike.
12. Energy issues and conservation should be taught at all levels in school. Technical and vocational training in energy-related fields should provide skills necessary to develop and implement conservation practices.
13. Municipalities should form local energy committees and develop energy action plans to raise awareness and coordinate local conservation efforts.

Conservation Through Changes in Lifestyle and Economic Systems

For at least the last 100 years, planning at all levels has been premised on an assumption that continued high levels of growth – in economic output, and fueled in large part by population and housing growth – is both possible and good. Plans have consistently focused on developing strategies, regulations, and infrastructure that will encourage more growth. At the same time, identification and conservation of valued natural and historic resources has been advanced as a way to enhance community character, quality of life, and to further economic development (growth) goals. Most of the growth that has occurred during this time, planned or not, has been made possible by the availability of vast amounts of inexpensive, but nonrenewable, energy. Pursuing plans with these traditional growth objectives is paradoxical when confronted by the fact that society will have less energy available to it in the future than it has now.

Planning in the 21st century clearly needs a new paradigm: one that recognizes inherent limitations on growth resulting from reduced availability of energy. Moreover, it is imperative that planning begin to focus on this reality now, because 20 years from now we will be living in a very different world. And 20 years is a very short time period when faced with the need to restructure the way communities and economies function.

Although growth in certain economic sectors will be possible, it is important to recognize, and to begin to plan for, a future with no net growth (or with negative growth). There will be opportunities for future local and regional economic growth - in areas that will support the objective of developing sustainable communities, for instance. Conservation objectives, meanwhile, will need to show a greatly expanded emphasis on energy conservation and to raise the value of utilizing renewable energy resources relative to the value of not utilizing them. Such present day objectives as viewshed protection, maintenance of natural stream flows, and preservation of forests in an undisturbed state will need to be partially retracted to make way for the compelling future demand for energy from wind (i.e., turbines on ridges), hydro (dams in streams and rivers), and biomass-based energy (requiring large-scale sustainable tree harvesting).

Green Mountain Power is hoping to expand this commercial wind energy facility in Searsburg. Similar installations could be developed in other parts of the county.

Opportunities presented by developing the tools to support a local and "green" economy should be pursued, and recognizing the potential of those enterprises will provide a competitive advantage over communities that do not change their approach to economic development. The following general strategies support efforts to plan for and develop communities that will be sustainable in the future:

1. Support development of local and regional industries that produce energy through conservation and renewable sources of energy.
2. Support businesses that use local raw materials and serve local markets.
3. Preserve lands with the most productive soils for growing food and biomass crops that can be used for fuel.

4. Consider the energy-producing potential of natural resources and value those assets heavily when making decisions regarding preservation and utilization of those resources.
5. On an individual level, people should consume less meat and more plant food. (Meat production is ten times as energy-consumptive as production of grains, fruits, and vegetables).
6. People should grow food for their own consumption and/or support local organic agriculture (the average American foodstuff travels more than 1,500 miles before being consumed and petrochemical fertilizers and irrigation systems use millions of barrels of oil each year). Farmers' Markets and community gardens offer excellent opportunities for obtaining local foods and supporting local farmers and the businesses that supply materials and services to them.
7. People should avoid purchases and actions that waste materials (and energy) unnecessarily. Tap-water in reusable containers rather than bottled water, coffee in mugs rather than throw-away cups, fresh foods rather than heavily packaged and processed foods, and carrying purchases home in reusable bags rather than plastic bags.
8. Low-energy transportation choices will save energy (and money) for people. Public transportation, walking, and biking are viable options for local trips; buses and trains are an energy-efficient option for longer trips.
9. Develop recreational programs that rely on little energy use – bicycling, kayaking, Irish road bowling, and cross country skiing, for example.
10. Adopt energy-conserving behaviors at home and at work (e.g., turning off lights, limiting the use of non-essential electronics and appliances,…).
11. In general, when faced with a choice, select the options that are more local. These decisions and actions will support the type of infrastructure, economy, and community that we need to develop.

The Walloomsac Farmer's Market in Bennington offers local food products and supports area farmers and the local economy.

Renewable Energy Resources

It has been noted that total energy use in Bennington County (and in the rest of the state and country) will of necessity begin to decline at some point over the next several decades. The growth made possible by our profligate use of nonrenewable fossil fuels will similarly slow and decline. Nonetheless, the region will continue to require and use a considerable amount of energy to support sustainable economic progress, heat our buildings, operate machinery and appliances, and facilitate transport of people and goods. Conservation and efficiency will allow us to maintain a healthy economy and quality of life using less energy; use of renewable resources will provide much of the energy that is used. We must transition from nonrenewable to renewable energy sources, and because of net energy constraints resulting from acquisition, processing, and transportation of energy, much of that renewable energy will need to be derived from local sources.

Energy from renewable sources can help address space and water heating needs, provide fuel for transportation, and generate electricity (that can, in turn, be used for heating, transportation, and many other functions). Space and water heating can be accomplished using solar energy, wood (cordwood, pellets, or chips), biodiesel, and geothermal sources. Certain biofuels, especially ethanol, methanol, and biodiesel, can be used to provide energy for various types of vehicles. Electricity is likely to become increasingly important as a way to deliver energy for a wide range of uses, and can be produced from a number of renewable sources including biomass (wood), wind, and water. Other energy carriers such as hydrogen can be produced using renewable energy. For any renewable source, however, consideration must be given to the net energy yield of the technology and the extent to which use of the resource has negative impacts (such as displacement of land that could be used for local food production). The following sections will discuss the potential and issues associated with each of these energy sources and carriers.

Solar Energy

Energy from the sun can be used to heat buildings, to heat water, and to generate electricity at either a small (for an individual building or group of buildings) or large (commercial generating plant) scale. Solar energy technologies are proven and continually being refined. They also have a relatively minor environmental impact and yield significant net energy (environmental costs and energy expenditures are primarily associated with production of solar panels and other equipment). Given the huge amount of solar energy striking the Earth's surface (the cumulative solar energy irradiating the earth's surface in a day is equal to the energy in billions of barrels of oil), there are compelling reasons to attempt to implement solar technologies wherever possible. Principal obstacles to development of solar energy facilities are cost and availability of critical materials (such as copper and cadmium-telluride for photovoltaic cells).

> An average Vermont house using oil as a heat source consumes 730 gallons of this nonrenewable fuel per year. If 50% of Bennington County's 11,456 oil-heated homes made use of solar heating and weatherization to collectively reduce their energy demand by 50%, our region would cut total oil use by 2,090,720 gallons per year and save approximately $6 million in energy costs (money that could be used locally).

Long-term solar energy solutions will rely on further research designed to develop workable technologies from more common and inexpensive materials.

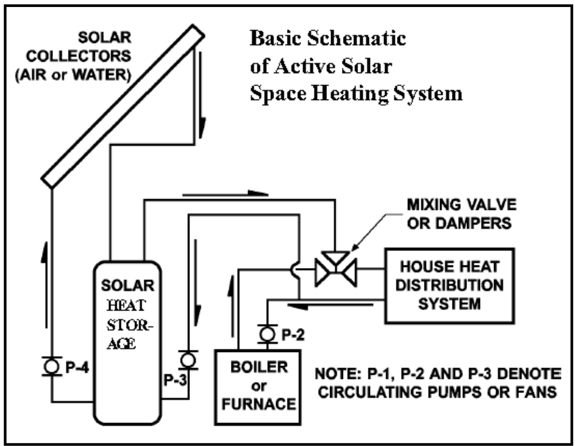


Figure 3-9. Active solar space heating systems usually are designed to supply about 50% of a building's heating needs.

Solar space heating can be either passive or active. Passive systems have been described earlier; they utilize building orientation and design to capture, store, and circulate heat derived from solar energy. Any new construction or major building reconstruction should consider passive solar design as the energy return on investment can be extremely high and substantially reduce reliance on nonrenewable energy sources. Active solar heating systems use special collectors to absorb solar radiation and distribute the resulting energy using either air or a liquid heat transfer medium (Figure 3-9). Such systems are quite expensive, but can be effective when retrofitting an existing building by selecting south facing walls or windows for placement of the collectors. The payback time of any type of solar heating system will fall as the price of oil, gas, and other heating fuels rise over time.

Solar water heating systems are cost effective and readily available in the local market. Flat panels or evacuated tubes are used to collect solar energy and transfer heat via a liquid medium to an insulated tank that in turn feeds heated water to the building's primary hot water system. With an adequate amount of sunlight, even on a cold winter day, a home's complete hot water demand can be

Solar systems (flat panels to the left of the house) can provide a majority of the hot water needs for a typical family. An average Vermont household uses the energy equivalent of 175 gallons of propane per year to heat hot water. If 50% of Bennington County's homes added solar hot water systems, the annual region-wide energy savings would amount to the equivalent of over 800,000 gallons of propane.

met by such a system. It also is possible to use a tankless water heater connected to the solar hot water storage tank to further reduce petroleum or electricity use. Collectors are most often seen mounted on roofs, but ground or wall-mounted installations should be considered where solar access is not blocked by trees or buildings because the angle of the collectors can be more easily adjusted seasonally to maximize efficiency (by keeping the surface of the collectors at close to 90 degrees to the incident solar radiation). Installations close to the ground also allow for easier removal of snow cover in the winter.

Solar photovoltaic (pv) panels, which convert solar energy to electricity, have been around for many years and have been used to provide power for small electronic devices such as calculators and sidewalk lights. Larger pv arrays can be used to provide a significant share of the electrical needs of a home or commercial building. New technologies promise to reduce the energy payback time (the time required for a pv installation to produce more energy than was required for its manufacture and deployment) to about two years. In many places the net energy yield of pv systems can be very high. Relatively few large scale systems such as the one pictured here have been installed in Vermont, however, because of high initial cost and the fact that the systems produce the least electricity when demand for electricity is at its highest (during the winter months). Nonetheless, these systems can be a significant factor in reducing the region's total energy consumption in the future.

The photovoltaic array on the south-facing roof of this house in Bennington provides most of the electricity used in the home.

Although not likely a cost-effective use of solar energy in New England, commercial generation of electricity using either large scale arrays of pv panels, or, more likely, parabolic mirrors that concentrate sunlight to produce heat – which in turn produces steam to drive turbines, show significant promise in locations with reliable long-duration sunlight. Electricity from such facilities can offset coal, natural gas, and nuclear fuel use, adding valuable years to the generating capacity of those energy sources, and can be used to produce other alternative fuels such as hydrogen and related products.

Wood (Biomass) Energy

Any discussion of renewable energy in Bennington County must include wood, which together with direct solar energy, is the most obvious and ubiquitous source of locally available energy. The 1982 Regional Energy Plan estimated that forests, just within Bennington County, could provide over 150,000 cords of wood per year for fuel (in addition to timber harvested for sawlogs, veneer wood, and pulpwood). That quantity of wood could easily satisfy all of the residential space heating needs for the region, with a significant volume of biomass remaining for use in commercial/industrial applications and for electricity generation. Forest resources in nearby areas of New York and Massachusetts provide additional resources that could be available for local energy utilization (from studies by the Biomass Energy Resource Center). Of course, prior to the rapid exploitation of fossil fuels that began in the late 1800s, space heating needs in the region were met almost exclusively by locally harvested wood. The use of wood as a heating fuel steadily declined as it was replaced by various fossil fuels. The local use of wood jumped noticeably after the increase in oil prices during the 1970s, but declined again in line with the falling cost of oil.

A recent study of the costs and benefits of using biomass (woodchips) as a primary or secondary fuel source at the Southwestern Vermont Medical Center (February 2009) documented compelling evidence that increases in oil prices will make wood-derived fuel become increasingly competitive over time (Figure 3-10). More alarming than the inevitable increase in the price of oil is the statement that all data "clearly show a problem at some point in the next 50 years that there will likely be little oil left. It should also be noted that there are political issues that surround a large portion of the world's oil supplies…that could have a significant impact on the price and availability of oil."

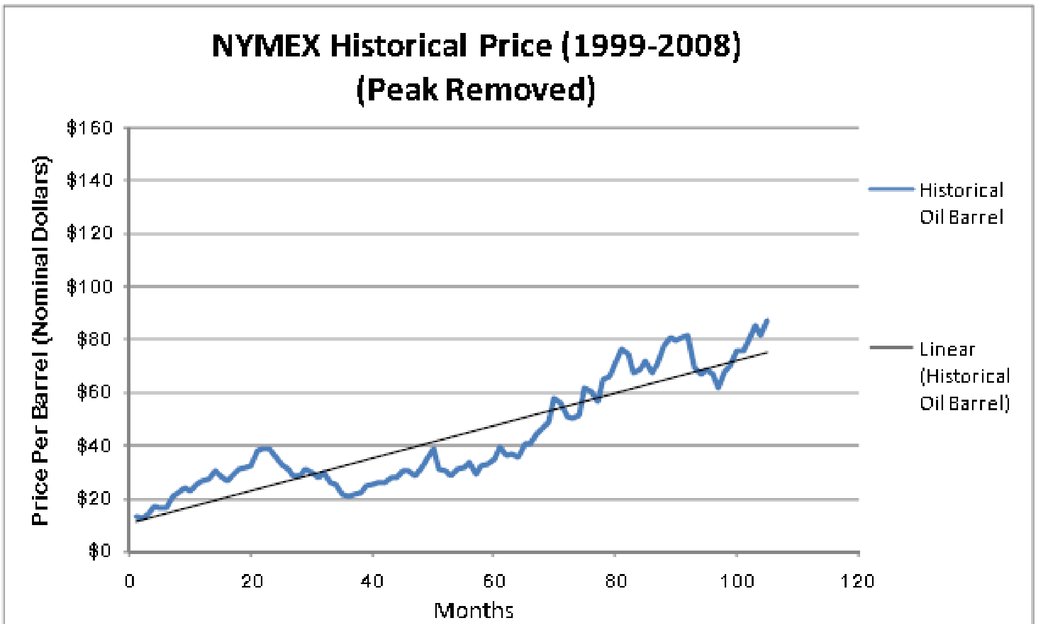


Figure 3-10. Recent oil price history shows a clear upward trend in oil prices; conservative projections indicate that oil will cost at least $5 per gallon by 2029. Wood fuel prices, because of the presence of a renewable local supply, are expected to rise, but be more stable. Source: Biomass Feasibility Study for the Southwestern Vermont Medical Center, February 2009.

Price and supply considerations, therefore, clearly argue for greater utilization of locally derived biomass fuel for space heating and, potentially, electricity generation as discussed below. A significant increase in utilization of local wood products for energy poses some serious challenges as well, however. Much of the forested land in Bennington County is not currently available for harvesting because it is located in federally designated wilderness or other protected areas. Furthermore, long-term "sustainable" harvesting of large acreages of forest land that involve complete removal of woody biomass to maximize energy yield could deplete soil nutrients and reduce future productivity and degrade certain wildlife habitats. Net energy considerations must be considered as well, because cutting, transporting, and processing trees for ultimate use as firewood, woodchips, or pellets requires a great deal of energy, mostly derived from petroleum fuels.

Despite the hurdles that must be overcome to make wood a significant, and perhaps primary, local energy source, its abundance, reliability, and the fact that reliance on this fuel provides jobs and recycles money in the regional economy suggest that planning for greater utilization of the resource should be pursued. The reduced net carbon and sulfur dioxide emissions realized through utilization of biomass rather than coal, oil, or gas provide additional reasons to pursue exploitation of this renewable resource. Research on sustainable harvesting and processing, and identification of preferred locations and extent of annual biomass removal should be conducted.

Obtaining energy from wood is a relatively simple process using simple and time-tested technologies. Many homes can be heated with a single wood or pellet burning stove or furnace. Cord wood used in stoves or furnaces is readily available from many local suppliers and requires little preparation beyond splitting and drying. Pellets require more energy to produce, but also burn more efficiently and are easier to store and feed into a stove or furnace. There are no local pellet manufacturing facilities so, at this time, pellets must be shipped in from a considerable distance (reducing net energy yield of this fuel). It is expected that additional demand for pellets locally, through purchases of new residential pellet stoves and furnaces as well as pellet-fired boilers used by businesses and institutions, will provide an incentive for a manufacturer to locate in the region.

Biomass fuels are proving to be a cost-effective heating solution for many large institutions such as schools and colleges (MAU Middle School and Bennington College being local examples) as well as industrial parks, hospitals, and other large scale users of energy. The SVMC Biomass Feasibility Study notes that the hospital campus currently burns over 700,000 gallons of oil annually – an amount equal to that burned by 1,000 average homes. Direct burn woodchip or wood-gasification boilers at such facilities can, therefore, have a dramatic impact in lessening the region's reliance on imported oil while reducing operating costs and providing demand for local goods and services. Using waste heat from biomass heating systems also can be used to generate electricity in "combined heat and power" (CHP) systems. The electricity generated from these distributed sources can provide important future generating capacity and alleviate pressure on strained electricity distribution systems, such as the "Southern Loop" that serves Bennington County.

> Use of wood from the region's forests as a primary fuel source at an institutional facility such as the Southwestern Vermont Medical Center could reduce oil consumption by several hundred thousand gallons per year.

With the likely increased reliance on electricity as a way to provide energy for everything from manufacturing to transportation and communication, the feasibility of using wood from the region's forests to generate electricity should be considered as well. A 50 MW electrical generating facility would provide an amount of electricity comparable to the amount used in Bennington County. The McNeil plant in Burlington, Vermont is a 50 MW facility; it burns close to 200,000 cords of wood annually, indicating that any comparably sized facility in Bennington County would need to get a significant share of its biomass fuel from a wider area. It is possible that a smaller facility could prove economically viable in the area, depending on the price that can be obtained for the electricity produced. Modern biomass based electric plants often use a gasification system to produce a clean burning gas to operate a turbine (Figure 3-11). Such systems also tend to be easier to operate and

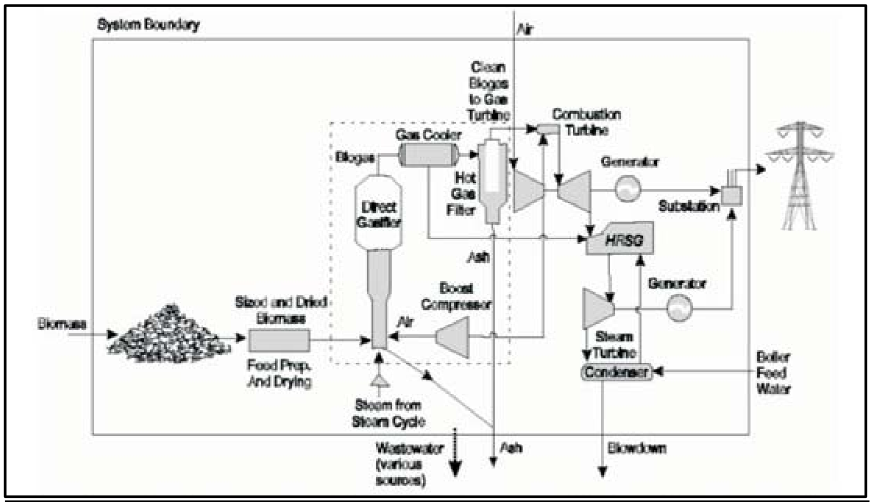


Figure 3-11. Schematic of a biomass-gasification generating facility such as the 50 MW McNeil power plant in Burlington. Source: US Department of Energy.

maintain than direct burn systems. Recent interest in such an electric generating facility in the region suggests that economic development interests should identify suitable sites giving consideration to the size of the site (for storage and processing of fuel), ease of access for fuel deliveries, and minimization of impacts on residential neighborhoods and local roads.

Wind Energy

One of the most promising sources of renewable energy, in Bennington County and around the world, is wind energy. The amount of electricity generated by wind turbines worldwide increased five-fold between 2000 and 2007, and there is tremendous capacity for growth (it is estimated that developing 20 percent of the world's wind-rich sites would produce seven times the current world electricity demand). With its extensive high elevation north-south ridges, Vermont and Bennington County have a relatively large number of sites potentially suitable for commercial wind energy generating facilities (refer back to map on page 17). Relative to nearby states, however, Vermont has seen relatively little wind energy development, largely due to state policies that discourage commercial scale development. The 6 MW Green Mountain Power wind facility in Searsburg has proven successful and efforts currently are underway to add turbines and expand generating capacity at that site.

Wind power is a proven technology, with advances in turbine technology occurring a rapid rate with the growing demand for facilities throughout the world. Wind energy also has one of the best net energy yields of any renewable source, generally in the range of 20:1 (ratio of energy return to energy invested), which is comparable to, or better than, many nonrenewable sources. Current state of the art terrestrial based systems use 2.5 MW turbines; thus eight of these turbines would be capable of generating 20 MW of power. There are sites with sufficient wind energy to accommodate such a facility in Bennington County, although a number of concerns would need to be resolved. To achieve high efficiencies, wind turbines must be large; the 2.5 MW turbines have an overall height (tower plus rotor blade) of approximately 400 feet, raising concerns over aesthetic impacts to prominently visible ridgelines (which also tend to have superior access to wind resources). Recent efforts to develop a facility on Little Equinox Mountain in Manchester and Glebe Mountain in Londonderry have faced strong opposition from some local residents and municipalities.

Simulation of an array of large scale (2.5 MW) wind turbines on the western ridgelineof the Green Mountains east of Bennington. The turbines could provide a significant share of the electric power needs of the region, but impacts on the viewsheds and remote forest lands are among the obstacles that need to overcome before such a development becomes feasible.

Commercial scale wind generation also has faced a technological hurdle caused by the fact that wind resources are intermittent; that is, if a power grid comes to rely heavily on wind-based generating and the wind does not blow for a period of time, additional generating capacity must be called into production from other sources. Such concerns can be signficantly mitigated by selection of high quality sites, development of smart grid technology to maximize efficiencies in electricity transmission, and use of new utility scale energy storage mediums. As electricity demand increases and existing generating sources that rely on nonrenewable fossil and nuclear fuels eventually decline, it is likely that commercial wind energy will have to become a signficant contributor to the region's energy mix. Consequently, studies to determine appropriate and acceptable locations for such a facility(ies) should be undertaken in the near future.

Small scale wind turbines also have potential for addressing some of the region's demand for electricity. There are numerous home and business sites that receive consistent wind flows. Several manufacturers currently produce residential scale wind turbines that can be installed with relative ease. Although the initial cost is high, recent state and federal incentives reduce the cost so that investing in a 2.5 KW system on a site with a reliable wind resource can meet a majority of a home's electricity demand with a reasonable payback period. For instance, an average home in New England uses 600

KWH of electricity per month (US DOE - Energy Information Administration), an amount that can be reduced to 400 KWH through the use of energy efficient lighting and appliances and with some modest lifestyle adjustments. A 2.5 KW turbine operating with average wind speeds of 11.2 mph can produce 357 KWH of electricity per month. At a site with an average wind spped of 13.4 mph, that output is increased to 528 KWH. Generated electricity can either be used and stored on-site or tied to the electric grid, with "net metering" to offset the cost of electricity derived from external sources. If enough small scale generators are deployed across the region, this "distributed" electricity generation will provide important capacity for the region and state. The Vermont Telecommunication Authority recently has commenced a novel plan to sponsor erection of at least 200 residential wind turbines around the state at locations that are well-suited for both electricity generation and cellular telephone transmission (a transmitter would be attached to each turbine).

Hydroelectric Energy

At one time, Vermont derived the vast majority of its electricity from hydroelectric generating facilities. Over 80 sites were used at one time or another to produce power in Bennington county alone (Potential for Hydropower Development at Existing Dams in New England, 1980). Large and small hydro facilities still contribute a significant share to Vermont's total generating capacity; approximately 800 MW of the state's 6,200 MW of electric power are derived from in-state hydro facilities and another 1,925 MW are imported through a contract with Hydro Quebec. Studies relying on divergent assumptions have determined that undeveloped hydroelectric potential in Vermont ranges from 25 MW to over 400 MW; potential at existing dam sites amounts to approximately 93 MW. Existing sites in Bennington County have the potential for producing at least 3 MW of electricity.

Penstock controls at one of four dams on Paran Creek in North Bennington. Other existing dam sites that can be redeveloped to produce electricity include the dam at Lake Paran, the Vermont Tissue dam on the Walloomsac River in Bennington, the dam at the old tannery site on the Hoosick River in Pownal, and dams on the east and west branches of the Batten Kill in Manchester.

The operation of a hydroelectric facility is quite simple, relying on a volume of water (flow) falling over a distance (head) to turn a turbine and generate electricity (Figure 3-12). Because hydroelectric generation does not require purchase of any fuel (it is similar to wind generation in this way), opeating and maintenance costs are very low. Initial construction costs can be very high, however, if new dam construction is required. Environmental concerns, primarily related to fish habitat, and permitting also pose impediments to development of new hydro sites. In addition, construction of dams is very energy intensive, significantly reducing net energy yields – and prolonging payback times –

for development of new sites. For these reasons, initial efforts should focus on redevelopment of hydrolectric generation at existing dam sites. At the same time, studies should be undertaken to evaluate the potential for hydroelectric generation at other sites around the region.

There are two basic methods to manage water flow through a hydroelectric facility: run-of-river or store-and-release. In run-of-river mode, flow entering the impoundment equals the flow released, thus maintaining natural seasonal flow rates downstream of the facility. In store-and-release mode, water is released on a cyclical basis to match patterns of peak demand, resulting in flows that are alternately lower and higher than normal seasonal flow rates. Because new dams affect water temperature, dissolved oxygen content, and other water quality characteristics and because store-and-release mode results in unnatural flows, hydroelectric development projects in the region should focus on run-of-river operations at existing dams. If new dams are considered at some point in the future, it will be important to ensure that the region's most important natural streams and fish habitats are protected. At the same time, the critical importance of energy generation from a renewable source should be given considerable weight in any siting and development decisions.

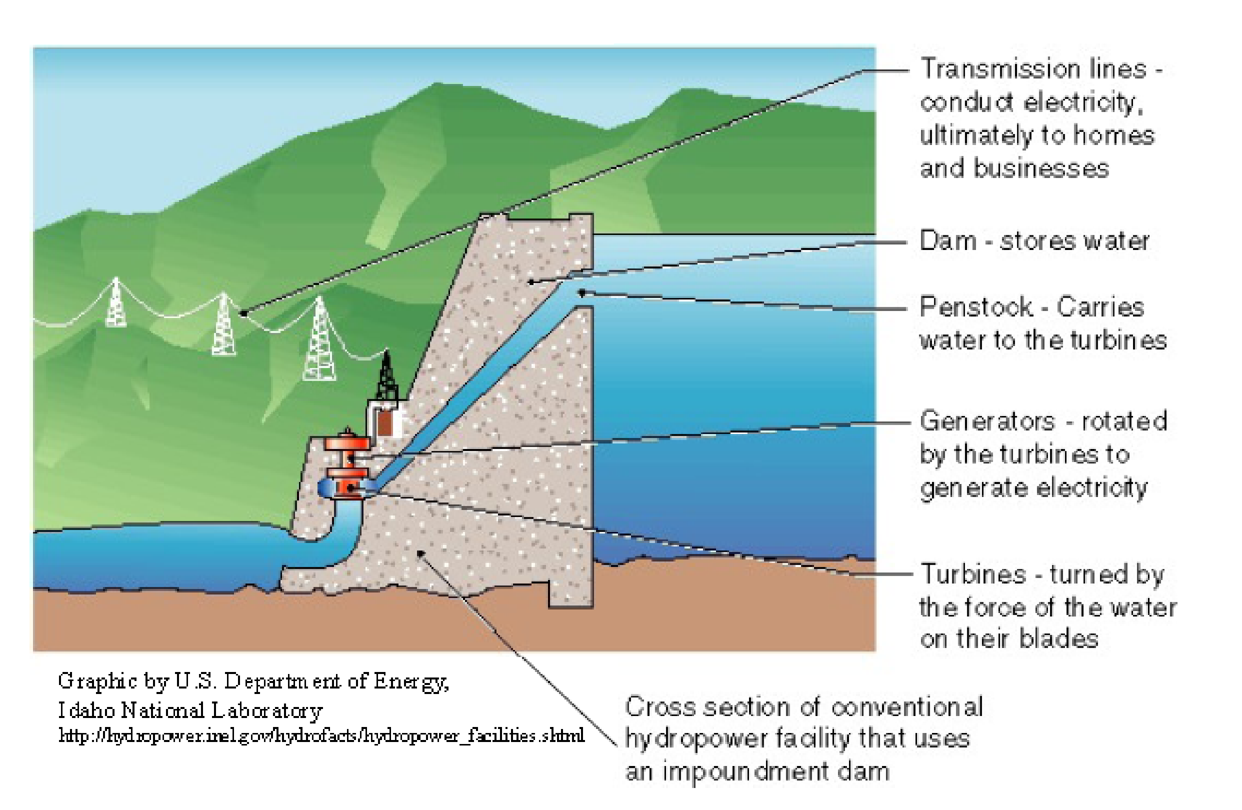


Figure 3-12. Schematic of a typical hydroelectric generating facility at an impounded site along a river.

The Town of Bennington recently demonstrated an efficient use of hydropower at its main water plant, using the energy from water entering the system to generate electricity for the plant. Similar applications may be possible whereever large volumes of water are flowing in a concentrated area, such as in a conduit pipe.

Liquid Biofuels

Gasoline and oil are very desireable energy sources because they are portable sources that contain energy at very high densities. Recent research and development efforts have been focused on attempts to produce liquid fuels from crops that have some of the same advantageous characteristics as petroleum fuels. Liquid biofuels already in production and showing some promise for various applications include ethanol and biodiesel/vegetable oils. Most of the emphasis has been on using these biofuels in the transportation sector, 10% ethanol is commonly blended into gasoline and "flex fuel" cars can run on an 85/15 blend of ethanol to gasoline. Ethanol does have a much lower energy density than gasoline, however, so increasingly high ethanol blends will realize progressively lower mile-per-gallon standards.

Ethanol can be produced from a variety of feedstocks. Sugar cane is used in Brazil with considerable success as its net energy yield is realtively high (approaching a 10:1 energy return on energy invested). Most ethanol produced in the US has used corn grain as a feedstock, and the energy inputs required to grow, harvest, process, and transport the corn to produce ethanol yields returns of no more than 1.3:1 – a return that is not viable without government subsidies. Both sugar cane and corn grain based ethanol also displace large acreages of productive cropland that would otherwise be dedicated to production of food. According to calculations by the Union for Concerned Scientists, if all of the corn grown in the U.S. were used to produce ethanol, with nothing left for food and aminal feed, the resulting ethanol would displace only about 15 percent of domestic gasoline demand. In addition, increased demand for ethanol fuel from Brazil has led to deforestation (as forests are cleared for cropland), negating many environmental benefits of using biofuels rather than petroleum products.

New research and development into the production of ethanol from cellulose – which may include fast-growing crops such as switchgrass and waste from agricultural (e.g., the corn stalk) and forest crops. Cellulosic ethanol can, in theory, be produced using much less energy and from crops that can be grown on lands that are not crucial for food production, resulting in a higher net energy yield and significantly reduced environmental impacts. Nonetheless, in Bennington County production of ethanol from any source is likely to be minimal because the limited supply of good agricultural land will be needed for food production and marginal cropland and forestland will yield higher energy benefits and economic returns if used to grow biomass for use in space heating and electricity generation applications.

A number of agricultural crops contain relatively large amounts of oils that can be easily acquired through mechanical pressing and used directly as a fuel (vegetable oil) or processed into biodiesel. Once local farm already has demonstrated that this process is viable in Bennington County and can be used in a variety of applications. Biodiesel can be used either as a stand-alone fuel or blended with petroleum diesel in vehicles and machinery (including some space heating boilers). Many people have demonstrated that, with some modifications, diesel vehicles can operate efficiently burning clean vegetable oil.

Common crops that can be grown in our area and used to produce oil and biodiesel fuels include soybeans, canola, and sunflowers. Net energy yields depend on the productivity of a particular site and the amount of transportation required to end users, but can range from 3:1 to 6:1. A logical application for biodiesel fuel is in agriculture; farmers can dedicate a share of their land to production of oil crops which they can refine into biodiesel to run their machinery, thus avoiding the need to purchase petroleum diesel fuel. The net energy benefits of such an application are optimal because transportation energy costs are minimal.

The most promising research in biodiesel production involves the use of algae as a feedstock. Algae increases its biomass rapidly relying on only water, sunlight, and carbon dioxide, and algae can be grown in fresh or salt water. With some species of algae containing approximately 50 percent oil, and the remaining biomass potentially available for conversion to ethanol, net energy yields are potentially quite high. Research in this area is in its early stages and commercial production of algae-based fuels is unlikely in Bennington County due to limited resources, but this form of biofuel may become a significant imported energy source for the region if vehicles, equipment, and machinery are modified to allow utilization of biodiesel fuels (currently, the corrosive qualities of biodiesel limits the amount that can be used in standard vehicle engines, furnace boilers, and other devices). It is likely that biodiesel (and/or vegetable oils) will at least be an important fuel for local agricultural operations in the future.

The vegetable oil pressing and biodiesel processing facility at State Line Farm in Shaftsbury demonstrates the potential for liquid biofuels in the region.

Geothermal Energy

The Earth contains a tremendous amount of natural heat, and this energy can be harnessed for human use in a number of ways. In locations with considerable tectonic activity, this energy can be used to either directly heat buildings or to produce steam to drive turbines for electricity generation. Bennington County does not have access to these high temperature geothermal resources, but, like most places in the country, can use the lower temperature geothermal resources to heat (and cool) buildings through use of heat pump systems.

Geothermal heat pump systems include a series of tubes installed several feet below the ground surface (a heat exchange unit), the heat pump that removes heat from the exchanger during the winter or adds heat from the building in the summer, and a distribution system to move heated or cooled air throughout the building (Figure 3-13). Heating and cooling buildings by concentrating this naturally occuring and renewable energy source is very efficient, moving three to five times more energy than is consumed by the electrical components of the system.

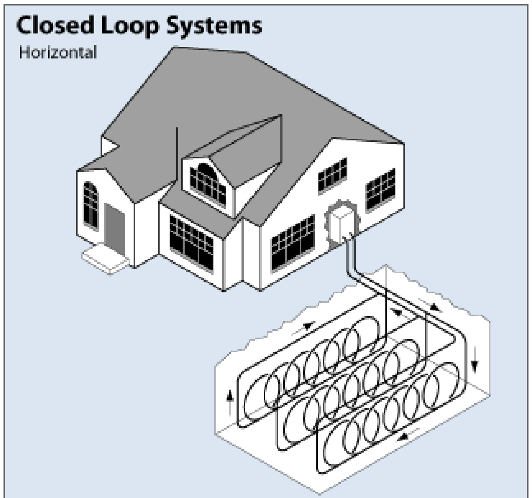


Figure 3-13. A standard residential geothermal heat pump system that uses heat energy within the Earth to heat and cool a home. Source: U.S. Department of Energy.

Although initial costs for intsalled geothermal heat pump systems are quite high, their efficiencies lead to relatively rapid payback times. This Earth-based energy system can be very effective and can supply significant amounts of energy to even large structures. A large new academic building at Bennington College, for example, will rely on a geothermal heat pump system to meet its space heating and cooling needs. Buildings and sites will need to be evaluated on an individual basis; for example, a geothermal system may be excessively costly and even unnecessary for a well-designed building on a site with good access for passive and active solar heating. With several thousand geothermal heat pump systems installed each year in the United States, it is likely that this technolgy will become increasingly important in the local market.

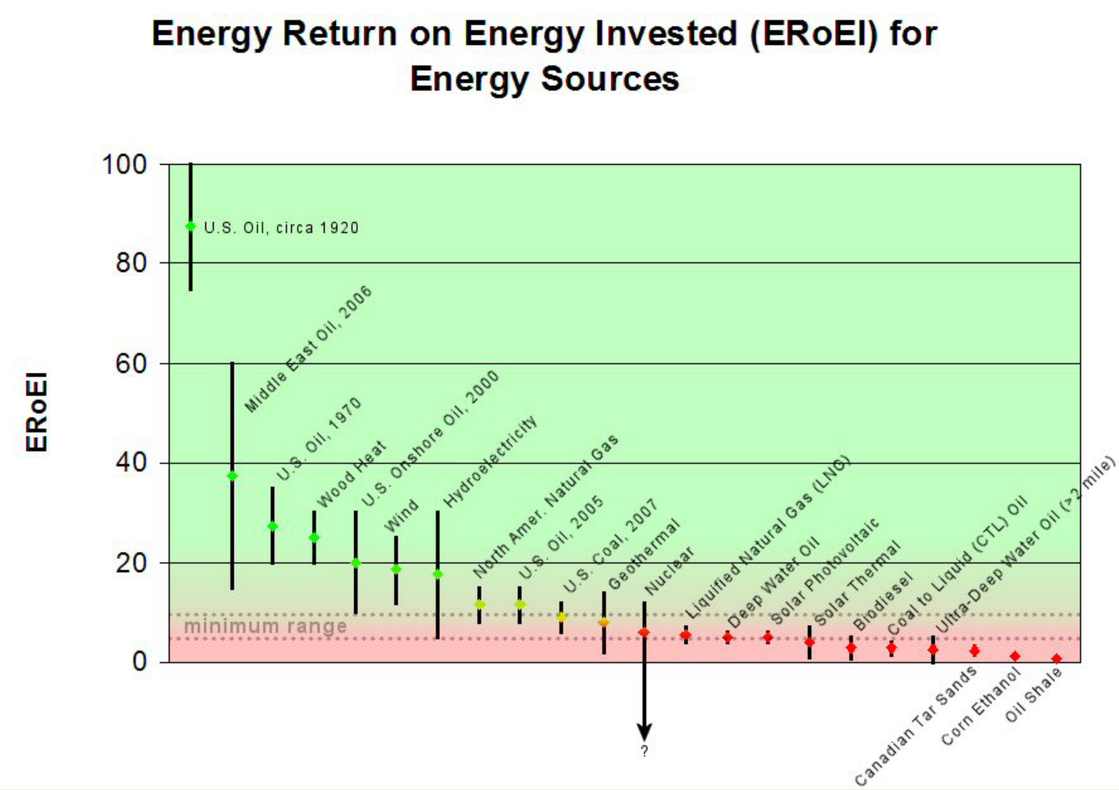


Figure 3-14. When evaluating the potential of any of the energy sources discussed above –renewable or nonrenewable – it is critical to determine whether the net energy is sufficiently high to make it viable. Historical easily recoverable oil had a very high ERoEI, while resources requiring energy-intensive extraction, processing, and transportation (e.g., tar sands, ethanol, and oil shale) have very low net energy yields. To be viable over the long-term, net energy yields must be at least in the 5:1 to 8:1 range.

Energy Carriers

With inevitable increases in the cost and decrease in the availability of the liquid fossil fuels (oil, natural and lp gas, and motor gasoline and diesel) that have fueled our lifestyles and economy over the past 100-plus years, it is expected that attention will increasingly be turned to electricity to supply energy needs. Electricity can be used to power motors in vehicles, machinery, and appliances, and to heat and cool buildings and water. Some of the benefits and limitations of using electricity in these applications have been discussed earlier in this report. The most significant concern with electricity use in general, and with scenarios that forecast growing electricity use in the region in the future, is that electricity is only a means of delivering energy; it is not a source of energy. Vermont currently has large contracts that supply adequate electricity at reasonable cost levels. However, the Vermont Comprehensive Energy Plan (Vermont Department of Public Service, 2009) focuses sharply on the "emerging supply gap" resulting from expiration of contracts with Vermont Yankee (nuclear plant in Vernon, Vermont) and Hydro Quebec (hydroelectric power from Canada). It is possible, but not certain, that both of these contracts will be renewed. In any event, however, the reliance on these two generators for two-thirds of the state's electricity shows how tenuous are any plans for electricity to easily step in and meet demand for expanded future energy needs (Figure 3-15).

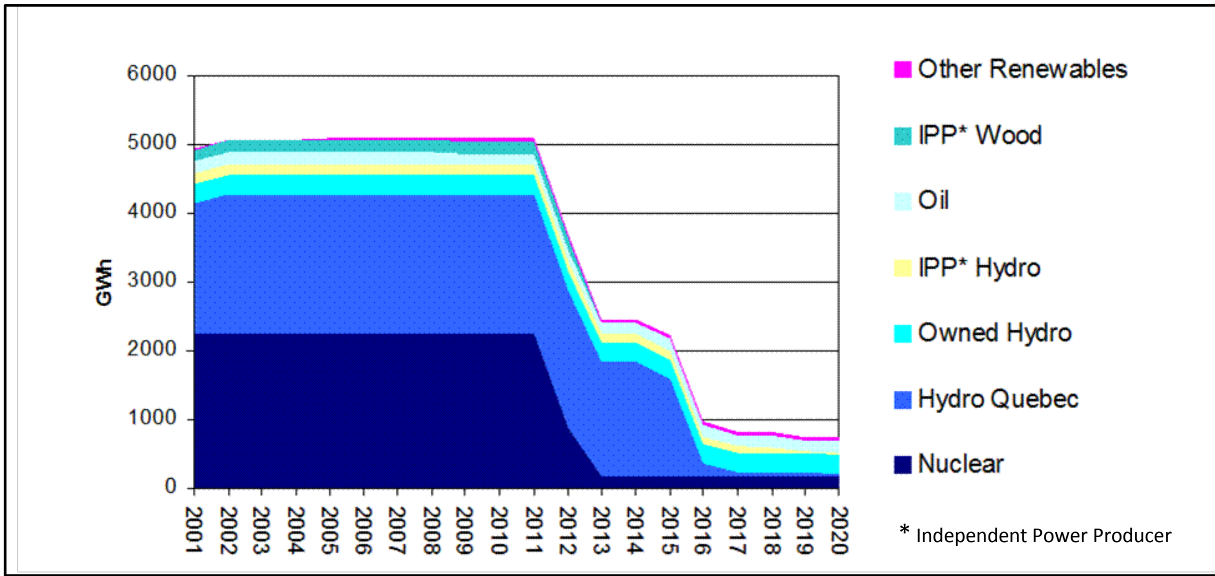


Figure 3-15. Sources of electricity for Vermont consumers. Vermont (and Bennington County) relies on contracts with Vermont Yankee (Entergy) Nuclear and Hydro Quebec for two-thirds of its electricity needs. Without those sources, higher cost (and higher polluting) sources will have to be relied upon. Because most power plants in the northeast use coal and natural gas as energy sources, long-term prospects for affordable electricity from such facilities are limited.

Peak electricity demand in the region has continued to grow over time, even though increases in overall demand have moderated in recent years. An expected steady growth in future demand, however, indicates that Vermont must secure and diversify sources of electricity generating capacity. Surveys have shown that most Vermonters support continued to acquisition of energy from Hydro Quebec because it is a relatively clean renewable source that is not subject to signficant price spikes.

The state should atttempt to secure another long-term contract to replace the current contract that expires in 2016. Nuclear-derived electricity from Vermont Yankee is much more controversial, and continued reliance on this source requires both a new contract and a recertification of the facility (currently set to expire and be decommissioned in 2012). Although nuclear power plants present some real safety and cost concerns, and while fissionable uranium is a nonrenewable resource that cannot be relied up for long-term solutions, it would be difficult and expensive for the state to effectively replace the lost capacity were the facility to close in three years. If Vermont Yankee is deemed safe to continue to operate, it should continue to meet a large share of the state's electricity needs for the ensuing twenty years, providing generating capacity while other sources of electricity are brought on line.

Vermont Yankee produces 650 MW of electricity, meeting about one-third of the state's demand.

Replacing the Vermont Yankee generating capacity is a daunting challenge and it may not be possible to fully replace all of the capacity. In addition to the electricity supplied by Vermont Yankee and Hydro Quebec, the state receives about 10 percent of its electricity from in-state hydroelectric facilities and 5 percent from in-state biomass generating faciliities (principally the McNeil plant in Burlington). In the short-term, any supply gap probably will be made up from fossil fuel and nuclear based generators in the northeast. Coal and natural gas powered facilities are the most abundant, and it is expected that liquified natural gas will play an increasingly important role in meeting New England's electricity needs for the next twenty or more years. There exists an adequate supply of coal to continue to generate electricity for the region for many years, but increasing rates of resource exploitation as worldwide demand expands and as other fuels are exhausted limit the time horizon and quality of coal that will be available. Coal also is among the most polluting energy sources, releasing chemicals that cause acid rain and which acclerate global warming. Although some recent national policy discussions have advocated for greater reliance on nuclear energy, growing demand, declining fuel stocks, and high construction costs and permitting difficulties limit future prospects for significant growth in nuclear generated electricity.

In addition to a concerted effort at conservation in all energy sectors, the most feasible future sources of electricity for the region come from smaller renewable resource based generating facilities distributed throughout the area where the primary energy resources – primarily wood, wind, and water in our area – are located. The state and federal government must recognize the important role these energy sources will have to play in our future and provide sufficient financial incentives, while removing regulatory barriers, to encourage their devlopment in a responsible, but expeditious and profitable manner. Vermont's Clean Energy Development Fund and federal "American Recovery and Reinvestment Act" funds have begun to direct investment in this direction. Small renewable generators – such as photovoltaic and wind energy systems scaled for individual homes and businesses – can make a difference over time and should be encouraged as well; recent state rebate and federal tax credit programs have been helpful and will be even more attractive as electricty prices increase over time. Another distributed energy strategy with a role to play in the future is "combined heat and power" (CHP) facilities, where excess heat from a boiler facility that runs year-round (such as at a hospital) is used to generate electricity that can be fed into the regional power grid.

Electricity generation and the adequacy of fuel supplies is one concern, transmission of that power is another. Vermont's "southern loop" transmission system that serves Bennington County is facing some serious stresses, as stated by the Vermont Electric Company (VELCO), the state's electricity transmission company:

> *Southern Vermont electrical transmission facilities have limited ability to support increased electrical demand and are unable to withstand failures of, or to have preventive maintenance conducted on, key components at present demand levels. The reliability of the regional bulk transmission system that connects southern Vermont, southwestern New Hampshire and northwest Massachusetts is as risk at existing demand levels, with increasing reliability risk as regional electrical demand levels increase.* (VELCO Southern Loop Leadership Problem Statement)

Central Vermont Public Service (CVPS) and VELCO recently completed installation of a synchronous condenser that alleviates problems along the southern loop (Figure 3-16), although longer-term solutions will be required to support anticipated increased system demand. In addition to ongoing investigations into transmission and distribution line upgrades and continued efforts by CVPS and Efficiency Vermont to reduce demand through conservation, implementation of "smart grid" technology ultimately will be necessary to efficiently manage electricity transmission, distribution, and utilization.

A smart grid will be supported by many smaller generating facilities (including renewable energy based and CHP systems), distributed throughout the grid at locations closer to where the electricity is consumed. Advanced technologies will allow a two-way flow of electricity and information and will be capable of monitoring everything from power plants to customer preferences to individual appliances; these technologies will enable delivery of real-time information and enable the near-instantaneous balance of supply and demand. The Department of Energy has identified five key smart grid technology features:

1. Integrated communications, connecting components to open architecture for real-time information and control, allowing every part of the grid to both "talk" and "listen."
2. Sensing and measurement technologies to support more accurate and rapid monitoring, time-of-use pricing, and demand management.
3. Advanced components to provide for superconductivity and storage of electricity.
4. Control methods to monitor essential components enabling rapid diagnosis and precise solutions to any event.
5. Improved interfaces and decision support for system operators and managers.

An extremely large investment in research and development will be required to implement smart grids and considerable federal funding has been directed toward this effort recently. It is important to note that this important new way of using electricity will rely on many new small generating facilities, distributed throughout the grid -- and most certainly within Bennington County -- as well as conservation through reduced demand. The technological aspects of demand management will need to be combined with ongoing conservation efforts to achieve a successful solution.

Figure 3-16. The stressed "southern loop" electricity transmission network and projects/lines that have been identified as possible candidates for infrastructure upgrades required to support existing peak loads and future demand growth.

Electricity also can be produced at its point of use – in vehicles, buildings, and appliances – by using the chemical energy in hydrogen to generate electricity in a fuel cell. Although technologies designed to use hydrogen as a stand-alone fuel can be employed, the relative versatility and efficiency of fuel cells make this source of hydrogen-generated power a more attractive future energy source. Fuel cells use hydrogen (or hydrogen-rich fuel) and oxygen to create electricity by an electrochemical process (Figure 3-17) and convert fuel into electricity two or three times more efficiently than power plants or internal combustion engines do while producing far fewer toxic emissions or noise.

Hydrogen is potentially a very good fuel source because it is the most abundant element on Earth. Unfortunately, hydrogen does not exist in usable form (diatomic hydrogen – H_2) in nature, but is generally bonded to other elements (in water, hydrocarbons, and other more complex molecules). To extract the hydrogen requires energy and to make any inroads to solving long-term energy shortages, the energy used for the extraction will need to come from renewable sources. Electricity from a hydroelectric facility, for example, can be used to separate hydrogen and oxygen in water. The

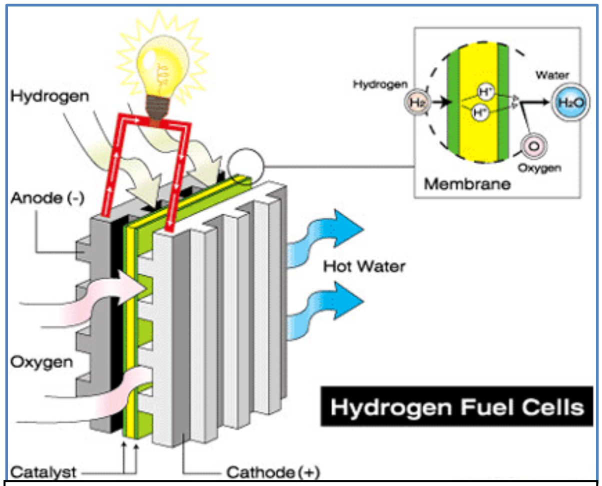


Figure 3-17. Schematic of a hydrogen fuel cell. Current technology allows production of electricity with minimal environmental impacts. Storage and transport of the fuel (hydrogen) still present challenges. Source: Rocky Mountain Institute.

hydrogen can then be stored (addressing one of the principal shortcomings of intermittently produced renewable energy) and transported, ultimately releasing its energy to produce electricity in a fuel cell. The energy thus obtained can be used in a variety of applications – to fill a fuel-cell powered automobile at a hydrogen filling station, for example.

The great obstacle in the middle of this process, however, is that hydrogen has a very low energy density by volume so storage and transportation of hydrogen is complicated, energy intensive, and expensive. One solution to this problem involves production of hydrogen (using renewable energy sources) at or very near fueling stations or buildings where the fuel cells are in use; such systems are only possible in discrete locations where the energy source and hydrogen source are both readily available. Another approach is to utilize other chemicals as hydrogen storage media to allow for transportation in pipelines or standard fuel trucks, and then extracting the hydrogen as it is fed into the fuel cell.

If hydrogen does prove to be a significant player in the region's energy future, it probably will as a transportation fuel. Because of net energy constraints, however, this future is anything but certain and will require major technological and engineering breakthroughs as well as a huge investment in infrastructure. Nonetheless, the region should remain aware of progress in this field and be open to processes that could facilitate hydrogen production and use.

Section IV Action Plan

Efforts to meet the goals and objectives set forth in this plan will be successful only if local residents, governments, businesses, and organizations understand and accept the significance and severity of the impending energy crisis. When there is a general understanding of the need to effect fundamental changes in the way we use energy and conduct our lives, Bennington County can begin to successfully transition in ways that will allow our communities to thrive as the amounts and sources of available energy change. Without such an appreciation of this looming new reality, individual and collective decision-making will continue to focus on short-term issues at the expense of long-term progress and prosperity. The most important first step toward successful implementation of this plan, therefore, is a concerted and broad-based educational effort to increase energy awareness throughout the county.

Numerous specific recommendations for using less energy and for using energy more efficiently have been presented throughout the first three sections of this plan. This section will summarize action steps that should be taken by various parties to advance the region's energy goals and objectives. Also included are specific policy statements that the BCRC should advance during participation in the review or development of any new plans or projects. A list of organizations that can provide information, technical assistance, and financial or other support related to energy matters concludes the plan.

Bennington County Regional Commission

Regional Policies

1. The value of energy conservation and development of renewable energy resources should be given significant weight when evaluating new projects and programs.
2. All practical energy conservation measures should be taken during the siting, design, and construction or reconstruction of buildings; specific practices and guidelines identified in this plan should be followed.
3. Use of renewable energy systems and other innovative energy efficiency technologies are encouraged in the construction or reconstruction of buildings.
4. Commercial and industrial uses should include energy conservation and efficiency in their business plans and operating procedures.
5. Town govermenments, state agencies, school districts, and large institutional uses should include energy conservation and efficiency in their plans and day-to-day operations; building design and the purchase and use of equipment and vehicles should include considerations of energy conservation and efficiency.
6. Energy conservation and efficiency in the transportation sector should be promoted through fuel taxes, effective land use planning, investments targeted to encourage use of alternative transportation modes (bicycle and pedestrian, public transportation, rail), and funding for infrastructure to support alternative fueled vehicles.
7. A high priority should be given to allocation of resources for organizations and programs that offer assistance in planning and financing energy conservation projects.

8. Improvements that will enhance the reliability of the “southern loop” electricity transmission system should be supported, along with sound proposals for distributed generation of electricity and combined heat and power facilities.
9. Projects that advance deployment of “smart grid” technology in the region should be supported.
10. Recognize and support economically and environmentally sound development of the region’s renewable energy resources.
    a. Biomass for space heating and generation of electricity should be utilized provided that expanded use of the region’s forest resources is accompanied by appropriate management plans.
    b. Small and large scale wind energy facilities are appropriate in the region; development of commercial wind energy facilities should be preceeded by a public process that identifies suitable sites and sizes for such facilities.
    c. Development of hydroelectric potential is encouraged, especially at existing dam sites.
    d. Passive and active solar heating of buildings is strongly encouraged.
11. Plans and projects that require significant energy inputs must consider projected fuel availability and costs over a timeframe of twenty or more years; projects with an excessive reliance on nonrenewable fossil fuels should not be pursued.
12. Economic and social initiatives that lead to greater reliance on local markets for food, raw materials, and finished products should be supported.

<u>Actions</u>

1. Maintain the regional energy committee to oversee energy planning, educational and informational programs, and technical support to local governments. Seek continuing funding for regional energy planning.
2. Develop and implement an energy education program designed to reach specific audiences, including: municipal governments and school districts, businesses and organizations, and individuals.
3. Advocate for energy conservation and sound development of renewable energy resources at hearings and regulatory proceedings.
4. Provide technical advice and support to town energy committees.
5. Develop and maintain a list of energy conservation and efficiency resources, consultants, and contractors.

Municipalities

1. Establish a municipal energy committee to oversee development of energy plans and implementation projects.
2. Larger towns should consider hiring a part or full-time energy/sustainability coordinator to lead energy conservation and efficiency efforts within town government and to develop local energy education programs.
3. Develop a comprehensive muncipal energy plan that includes:

a. An inventory of existing municipal assets, energy use, and locally available energy resources;
b. Specific strategies for reducing municipal energy consumption (buildings, vehicles, machinery and equipment, lighting, and operations);
c. Policies, regulations, and incentives to encourage energy conservation in site planning and building design;
d. A resource guide to assist local residents and businesses in obtaining advice and assistance in improving energy conservation and efficiency.

4. Complete a comprehensive energy audit to identify short and long-term actions that will save energy.
5. Establish programs that offer financial support, through loans or other means, to residents and businesses seeking to make conservation improvements or to develop a renewable energy resource.

Schools and Colleges

1. Ensure that new buildings, additions, and reconstruction of existing buildings include energy conservation measures and incorporate solar and other renewable energy technologies as appropriate. The School Energy Management Program offers technical support in the areas of building construction, renovation, equipment acquisition, electricity usage, general energy efficiency, and biomass heating systems.
2. Acquire energy efficient vehicles and carefully plan school bus routes to minimize driving distances. Students should be encouraged to walk, bike, or use the bus rather than relying on individual automobile trips to get to and from school.
3. Energy issues should be integrated in the curriculum through all grade levels. Specific training in skills needed in energy-efficient building construction (weatherization/insulation, design, installation, and repair of solar and other renewable energy systems) should be taught in vocational programs. Colleges should offer opportunities to develop expertise and experience in energy conservation/efficiency and sustainable economies.

Commercial, Industrial, and Institutional Uses

1. Ensure that new buildings, additions, and reconstruction of existing buildings include energy conservation measures (Commercial Building Energy Stanrdards) and incorporate solar, biomass, and other renewable energy technologies as appropriate. Specific strategies are identified in this plan.
2. Businesses and institutions should retain the services of experts to conduct comprehensive energy audits that will lead to recommendations for building and operational improvements to promote energy savings.
3. Business organizations and groups should organize energy workshops that will provide information and facilitate contacts with experts in energy assessments, building and HVAC contracting, and operations.

4. Large businesses and organizations should include energy planning and coordination as a fundamental role in their organizational structure.
5. Strong consideration should be given to use of local resources and development of local markets whenever possible.

Individuals

1. Learn about energy issues and be an advocate for energy conservation and efficiency.
2. Complete a home energy audit and make cost-effective weatherization improvements. Seek technical advice and funding (income-eligible weatherization programs, state and federal tax credits for conservation and renwewable energy improvements, rebates on Energy Star appliances and lighting, and other programs) for home improvements.
3. Consider energy use and costs when making decisions about vehicle purchases and use as well as where to live (i.e., proximity to work, school, services).
4. Plant a vegetable garden at home or as part of a community garden and learn to store and prepare home-grown produce. Patronize local farmers' markets.
5. Buy local products and support local economic progress whenever possible.
6. Limit spending on unnecessary items to ensure availablity of adequate funds for home heating and other critical energy purchases.
7. Participate and volunteer with local groups that are working on energy conservation and local food/economy projects.

State and Federal Government

1. Provide funding in the form of rebates, tax credits, baseline pricing for distributed electriicty generation, grants, and loans, as appropriate, that are adequate to ensure that investments in conservation and renewable energy offer a reasonable payback period and provide sufficient incentives.
2. Enact fuel taxes (larger at the federal, smaller at the state level) to encourage conservation, provide funding for infrastructure maintenance, and support development of public transportation, rail, and other alternative transportation systems and technologies.
3. Avoid major capital investments in facilities and projects that rely on large scale use of fossil fuels.
4. Provide grants and incentives to encourage research and development in renewable energy fields.
5. Ensure that enabling legislation gives local governments the necessary tools to provide financial support and regulatory incentives/requirements for energy conservation and use of renewable energy systems.
6. Review and modify, as appropriate, environmental regulations and economic development programs to give considerable weight to the need to develop sound new energy sources.

<u>Resource Organizations</u>

Alliance for Climate Action/10% Challenge – Community energy organizing and programs to achieve target goals to reduce greenhouse gas emissions, 802-865-7375, www.10percentchallenge.org.

American Council for an Energy Efficient Economy – Consumer Guide to Home Energy Savings, Green Book: The Environmental Guide To Cars and Trucks, Guide to Energy-Efficient Office Equipment, 202-429-0063, http://aceee.org.

Bennington County Regional Commission – Regional planning agency; energy committee develops energy plans and implementation programs. 442-0713, www.bcrcvt.org.

Building Green, Inc -- Environmentally responsible building design and construction. www.buildinggreen.com.

Biomass Energy Resource Center – Consulting on biomass and cogeneration projects. 802-223-7770, www.biomasscenter.org.

Efficiency Vermont – Financial and technical assistance for energy savings for Vermont residents, businesses, and towns, efficient lighting and appliance rebates, EnergySmart home energy analysis CD, list of home energy auditors and weatherization contractors, municipal services, commercial efficiency standards, energy efficiency improvements to school facilities and operations and more. 888-921-5990 http://efficiencyvermont.org.

Energy Star – Appliance efficiency ratings and advice on energy improvements. www.energystar.gov

Fairwind Vermont — Vermont citizens groups supporting development of sensible wind power in the state. windfair@sover.net or 802-824-3642.

Farmers' Markets – Walloomsac (Bennington): www.walloomsac.org
Manchester: www.manchestermarket.org
Dorset: www.dorsetfarmersmarket.com

Kilawatt Partners – A seven-step procedure for institutions to reduce their energy use and bills. 802-985-2285, www.kilawatt.com.

Renewable Energy Vermont – Trade association for Vermont renewable energy dealers. 802-229-0099, www.REVermont.org.

Rocky Mountain Institute – Energy consultants, researchers, and program developers. 970-927-3851, www.rmi.org.

School Energy Management Program – Provides free assessments of a school's energy efficiency and life-cycle cost analysis for various renewable projects. 802-229-1017, www.vtvsa.org.

Sustainable Energy Resource Group – Consults with communities on energy organizing, planning, and programs, conducts energy audits, provides discounts on efficiency and renewable products and services through its Energy Alliance. 802-785-4126, www.SERG-info.org.

US Department of Energy – Information on energy science and technology, federal energy programs, advice for homeowners, businesses, and more. www.energy.gov.

US Energy Information Administration – Statistics and information on energy sources, use, forecasts, and more. www.eia.doe.gov.

Vermont Biodiesel Project – A public/private collaboration designed to help accelerate growth of the emerging biofuels industry in Vermont. 802-388-1328 www.vtbiodieselproject.org.

Vermont Green Building Network – Promoting green building in Vermont, www.vgbn.org

Vermont Green Purchasing Contracts – Assists schools and municipalities in obtaining environmentally preferable products, 802-828-2211, www.bgs.state.vt.us/facilities/engineering.htm.

Vermont Department of Public Service – State agency dealing with energy issues and planning. 802-828-2811, www.publicservice.vermont.gov.

Vermont Energy and Climate Action Network -- VECAN helps start and support town energy and climate action committees in their efforts to save energy, reduce greenhouse gas emissions and advance renewable energy projects, www.vecan.net.

Vermont Energy Education Program – In-school energy education curriculum and hands on learning tools. www.veep.org.

Vermont Energy Investment Corp. –Promotes cost-effective energy efficiency and renewable energy technologies, www.veic.org.

Vermont Energy Star Homes – Financial and technical assistance to build energy-efficient homes, www.vtenergystarhomes.com

Vermont Interfaith Power & Light – Promoting conservation, efficiency, and renewables in congregations and communities across Vermont. 802-434-7307, www.vtipl.org.

Vermont Natural Resources Council -- Promotes greater investment in clean, renewable energy supplies and action to combat climate change. 802-223-2328, www.vnrc.org.

Vermont Office of Economic Opportunity – Low-income weatherization and fuel assistance programs. Local office: **Bennington-Rutland Opportunity Council, Inc. (BROC):** 802-447-7515, www.broc.org.

Vermont Peak Oil Network – A statewide network of individuals and groups working across Vermont on issues of relocalization and sustainability. www.vtpeakoil.net

Vermont Public Interest Research Group – Statewide energy and consumer interest advocates. 802-223-5221, www.vpirg.org.

Vermont Rideshare – Promoting commuter carpooling. 800-685-7433, www.VermontRideShare.org.

Walloomsac Transition Forum – Promoting sustainable energy and local economies, http://wiki.benningtonlocal.org.

Weatherization Assistance Program Technical Assistance Center – Information and resources for professionals and homeowners (especially low-income, elderly and people with disabilities) interested in saving energy by weatherizing their homes or businesses, www.waptac.org.