Exhibit CS-BW-88

2012 Bennington Municipal Energy Plan

Bennington Municipal Energy Plan

Prepared by the
Bennington Planning Commission

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TABLE OF CONTENTS

List of Tables

List of Figures

I. **Introduction**

The comprehensive town plan for Bennington includes an energy section that enumerates a number of goals and recommends additional efforts to support conservation and the wise development of renewable energy resources. The town recognizes that it is necessary to work toward a sustainable energy future in a manner that minimizes environmental impacts and supports the local economy. The purpose of this energy plan is to further those goals and recommended actions by increasing public awareness of energy issues, assessing local energy use and conservation opportunities, reducing the number of energy-related dollars exported from the town, and evaluating the potential for utilization of various renewable energy resources to meet the town's stated goals of:

- Reducing our dependence on non-renewable and imported energy sources;
- Promoting energy conservation and efficiency in residential, commercial, and industrial structures and operations;
- Reducing energy consumption in all taxpayer funded buildings and operations; and
- Developing sustainable, local renewable energy resources.

Energy is critical to every aspect of our lives. At the most basic level, we need the energy we obtain from food to survive. It is the energy contained in oil, propane, and wood that heats our homes and the energy in gasoline and diesel fuel that moves our vehicles. Energy also 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 obtain.

Previous efforts at energy planning—in Vermont and throughout the country—have been driven by things such as the "energy crisis" of the 1970s and a desire to reduce environmental damage caused by the extraction and use of fossil fuels. The issues remain the same today, but are far more pressing than ever before. The gas lines, rationing, and spiking fuel prices of the 1970s, for example, resulted because a limit had been reached in our ability to meet growing energy demand through production of domestic oil and because of a new and unstable reliance on imported oil. We are now faced with a similar situation, but one based on escalating worldwide demand for energy coupled with reaching an absolute limit in the ability to expand worldwide production of oil and gas (Figure 1). Moreover, longstanding environmental concerns with coal mining, offshore oil drilling, and acid rain and other pollution are now overshadowed by potentially catastrophic global climate change that is driven by the release of tens of millions of years of stored carbon in just a few decades.

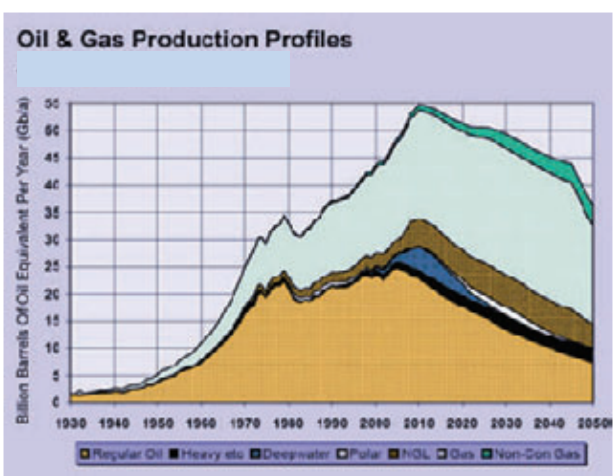


Figure 1. Worldwide production of oil from conventional sources has, or soon will peak. Petro-fuels from other sources (natural gas and "nonconventional" oil and gas such as tar sands, oil shale, and deepwater sources) will replace some of the conventional production, but overall production is expected 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.

The ramifications of these national and international issues in a town like Bennington may be difficult to grasp at first, but they are profound and demand immediate attention and action. Oil, propane, and gasoline prices have been rising and will continue to rise at an increasing rate; eventually, procuring an adequate supply of these fuels at any price will not be feasible. Consequently, it will be necessary to transition to alternative sources for heat and to different transportation solutions. Electricity supplied from distant generating facilities also will be more limited, resulting in a need to produce more electricity within our region and to use electricity much more efficiently. Also important is the fact that it will no longer be possible to count on obtaining the majority of our food from massive petrochemical-fueled factory farms thousands of miles distant; the "localvore" movement will become ever more important.

Some of our future energy needs can be satisfied through reliance on local sources of energy. Alternative energy sources such as solar, wind, hydroelectric, and biomass-based fuels can provide significant amounts of clean energy well into the future. Developing these 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.

<u>Current Uses and Sources of Energy</u>

The Bennington Regional Energy Plan contains a detailed review of regional and statewide energy data. That information provides a general understanding of how energy is used in a town like Bennington and is summarized below. A more detailed accounting of residential, commercial, and public/institutional energy use in Bennington is included in the next sections of this plan.

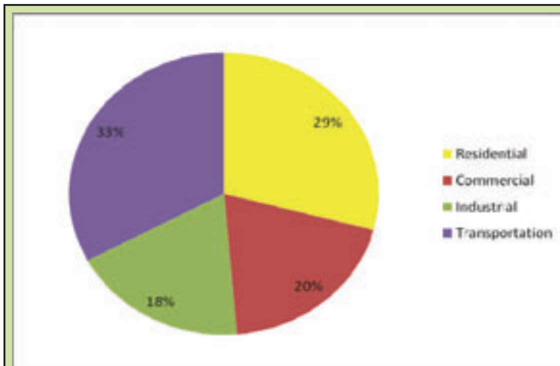
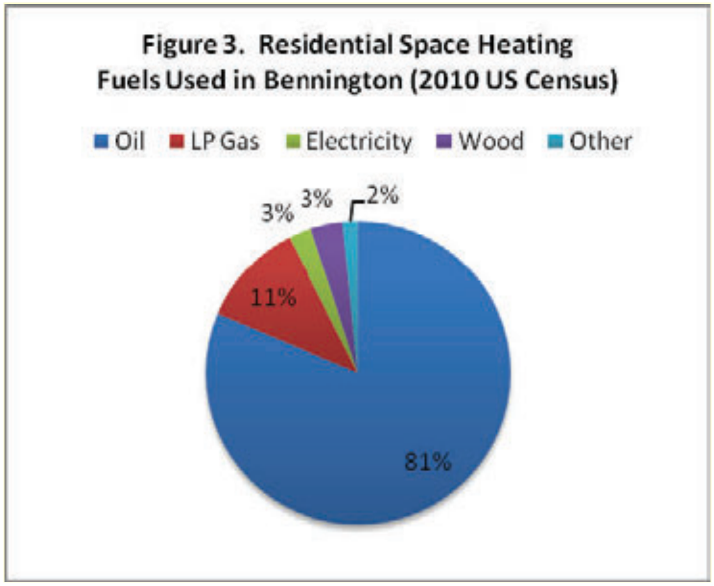


Figure 2. Relative energy consumption by sector in Vermont (2005). With its mix of urban and rural environments, it is likely that overall energy consumption in Bennington is similarly distributed among sectors.

Total energy consumption in Vermont has risen dramatically in recent decades, doubling in the four decades between 1965 and 2005. During that time, the transportation sector eclipsed the residential sector as the largest consumer of energy in the state (Figure 2). A number of factors appear to be driving this increased energy consumption. Most obvious is the amount of fuel used for transportation. The number of households having two or more cars increased by approximately 70 percent during this timeframe and large sport utility vehicles and passenger vans became more popular. Vehicle fuel efficiency standards were raised in response to the energy crisis in the 1970s, but were rolled back slightly in the mid-1980as 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 Bennington residents, for example, increased by over 30 percent between 1980 and 2010. A greater reliance on trucking (versus rail) for movement of freight probably has increased diesel fuel use. The amount of jet fuel for air travel in Bennington has been relatively small, and has declined further since a local air freight operator ceased their local operations.

Bennington also has seen significant growth in population and the number of housing units over the past 40 years. Residential energy use is approximately evenly split between space heating and the electricity used for lighting, appliances, televisions, computers, and other household devices and conveniences. Bennington residents continue to rely heavily on oil as their primary source of energy for space heating (Figure 3). In general, reliance on wood as a heating fuel increases when oil prices increase, and falls off when oil prices fall. In Bennington, however, the most significant recent shift in heating fuel use has been toward LP gas, although it appears that in the last few years, an increase in use of wood pellet fuel has occurred, a trend that may not appear in the 2010 data. As oil prices continue to rise, it is likely that additional fuel switching will occur. At current price levels for electricity, for example, electric resistance heating becomes cost-competitive with oil when oil prices exceed four dollars per gallon—posing a very real concern for the capacity of electricity generating and transmission facilities.



Electricity constitutes a majority of commercial and industrial energy use, although fuels for space heating and transportation (for deliveries, shipments to markets, and to bring customers to businesses) also are vitally important. Nearly all of the electricity used in Bennington is transmitted to the town from distant generating facilities. In recent years, approximately two-thirds of Vermont's electricity demand has been supplied by the Vermont Yankee nuclear energy facility in Vernon and at hydroelectric facilities in Canada (Hydro Quebec). While a new contract has been signed to continue procurement of electricity from Hydro Quebec, Vermont no longer receives any energy from Vermont Yankee. Without this large influx of nuclear-generated electricity, we will have to rely on other sources—including northeastern coal and natural gas facilities—to make up the balance. Because those sources are polluting and rely on non-renewable fuels, long-term prospects for affordable electricity from them are limited.

Local government, public schools, and institutions (such as Bennington College, Southern Vermont College, the campus of the Southwestern Vermont Medical Center (SVMC), the Vermont Veteran's Home, and other large residential care facilities) account for large energy expenditures. Buildings at the SVMC campus, for example, use over 700,000 gallons of oil per year and Bennington College uses several thousand tons of woodchips in its wood boiler system (displacing over 300,000 gallons of oil use). In addition to the several buildings maintained by the Town of Bennington, the municipality pays to illuminate several hundred streetlights, operates fleets of highway trucks, police vehicles, and public works vehicles and equipment. Because these are all large-scale users of energy, and because energy purchases by many of these entities affect public budgets and policies, it is particularly important for the town to develop a good understanding of their energy needs and utilization.

A Challenging Future

The use—and cost—of energy pervades all aspects of our lives, so our energy planning efforts must consider everything we do: 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. Facing a future that will lack the relatively easy, fossil fuel-based, solutions of the past, the challenge to conserve will be critical and the need to develop alternative and renewable energy sources absolute. This energy plan presents straightforward ways for people, businesses, organizations, and our local government to wisely and efficiently obtain and use energy.

II. Residential Sector Energy Conservation Strategies

There are over 5,000 residential buildings in Bennington. Consequently, strategies that lead to greater energy conservation and effective utilization of renewable energy systems in these buildings will have a substantial impact on total energy usage in the community. Those strategies should include space heating, water heating, and lighting/electric, as well as opportunities for alternative modes of transportation.

Bennington's plan for future development, as reflected in the Town Plan and Land Use Regulations, allows and encourages higher densities of development in the center of town where supporting infrastructure is available (Figure 4). This development strategy supports energy conservation objectives by limiting sprawl and thus reducing energy used for transportation and energy required for the delivery of essential services to residents. According to the Bennington Growth Center Plan the center of town can support close to 1,000 additional housing units—sufficient to accommodate projected population increases for many years into the future. Most of this development should occur in the form of "infill" on vacant lots or redevelopment of existing buildings, often including residential units as a part of a larger mixed use development.

Of course, residential development will continue to occur in more rural areas as well. Residential subdivision design should give consideration to solar orientation when laying out lots and building sites. To the extent possible, buildings should be located so as to not be shaded by topographic features or other houses or structures that may be constructed on the same or an adjacent lot. New homes constructed on existing lots should be oriented so that a majority of windows face south, while northern walls should generally have the fewest windows. Landscaping also can contribute to energy efficiency; one or more deciduous trees south of the home will provide cooling shade in the summer without blocking the sun in the winter. South sloping roofs and/or open and unshaded areas near the house provide good locations for future installation of solar hot water or photovoltaic panels.

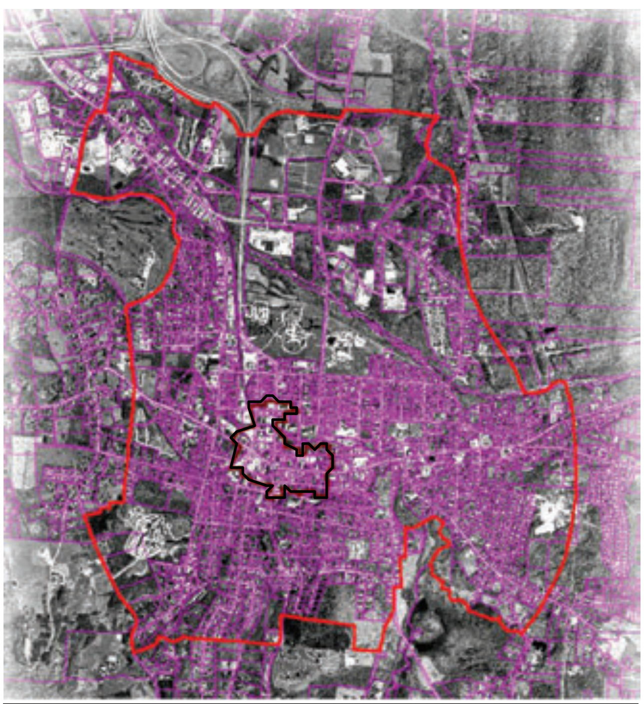


Figure 4

Downtown
Growth Center
Parcels

The town's Growth Center contains a diversity of land uses at relatively high density. The entire area is served by a network of town roads and the public water and sewer systems. The area outside the growth center is planned for lower density development with much more limited public infrastructure. There should be a clear demarcation between these areas.

A properly constructed home will significantly reduce energy used for both space heating and lighting. The resulting savings will be evident in monthly utility bills and will significantly reduce total home ownership costs. Vermont law requires all new residential construction (new homes and additions in excess of 500 square feet) to adhere to the state's Residential Building Energy Standards (RBES). Enforcement of this requirement has been challenging, however, so the town should—at a minimum– include a statement on all issued building permits that notes the requirement and refers builders and homeowners to the RBES. The town also should consider inclusion of RBES requirements in its regular building inspections, and adjust building fees as necessary to cover any additional costs. Ultimately, energy cost savings accruing to the owner of the property will greatly outweigh the small cost of additional inspections during construction. The Vermont Residential Building Energy Code Handbook, available from the Department of Public Service—Planning and Energy Resources Division, provides a complete description of RBES requirements.

The widely used "Energy Star" rating system)should be promoted as well, and builders encouraged to strive for the lowest possible Home Energy Rating Standard (HERS) score. A lower score means energy savings, with each point equivalent to a one percent reduction in energy use relative to the "standard" (100-point) home. In some cases, tax credits and more favorable mortgage terms may be available if a specified Energy Star HERS scores is obtained. Features that strongly drive good HERS scores include:

- "tight" construction with minimal air infiltration (but with fresh air ventilation systems);
- high levels of insulation throughout all exterior walls and ceilings;
- energy-efficient windows and doors;
- multiple space heating zones so that parts of the house not in use do not need to use as much energy;
- efficient furnaces (and/or use of wood or solar space heating systems) and appliances;
- extensive use of natural lighting to limit the need for electric lights and use of energy-saving CFL or LED lights.

The greatest gains in residential energy conservation in Bennington can be accomplished through improvements to existing homes. Efficiency Vermont (www.efficiencyvermont.com) offers a wealth of information on residential energy conservation; "The Energy Smart Home" is a particularly useful resource available from that organizations. Financing for home energy conservation improvements also may be facilitated if the town were to implement a "Property Assessed Clean Energy" (PACE) program (see sidebar). Bennington should research this program further and consider holding the required vote to determine whether residents would like the opportunity to take advantage of this innovative financing tool.

The best initial investment any homeowner can make in energy conservation is to retain the services of a qualified home energy auditor. The auditor will complete a comprehensive examination of the structure and give the homeowner a prioritized list of energy-saving measures organized by cost and savings that can be realized. A general list of improvements that often are identified, and which

The **Property Assessed Clean Energy (PACE)** program—recently authorized by the state—offers great promise in helping homeowners overcome the high initial cost of energy saving projects. Under this program, a town can establish itself as a PACE district, allowing residential homeowners to borrow money in amounts of up to $30,000 for weatherization and/or renewable energy improvement projects. The owner of the property then repays the loan through a surcharge on the annual property tax over a period of up to 20 years. The PACE loans are completely administered by Efficiency Vermont; the town's only responsibilities are to create the district and to assess and collect the tax surcharges. PACE loans run with the property, not the property owner, and are secured through Efficiency Vermont. Moreover, eligibility for a loan is contingent upon a technical analysis documenting that annual energy cost savings will exceed the annual surcharge.

can lead to considerable reductions in energy use and costs is presented in Table 1. Homeowners need to be made aware of the potential for savings as well as the various financial incentives (in the form of tax credits and rebates) that are available to undertake such improvements. The town should actively promote and participate in programs that provide such information including those jointly developed and implemented by Efficiency Vermont, the Bennington County Regional Commission, and local energy committees. The town also should work to ensure that weatherization programs targeted to support lower-income residents, especially those conducted through the Bennington Rutland Opportunity Council, are fully utilized by eligible residents.

Table 1. Strategies for reducing energy costs in existing homes.

Space Heating

- Reduce air infiltration
- Add insulation
- Maintain or replace heating units
- Install programmable thermostats
- Replace old, inefficient windows
- Use local fuels (wood)
- Limit heating to rooms not being used
- Keep south-facing window shades open during the day in the winter and closed during the day in the summer
- Close fireplace dampers and doors on closets located on outside walls
- Reduce thermostat settings and dress warmer

Water Heating

- Install an efficient water heater, a tankless ("on demand") heater, and/or a solar hot water system
- Remove sediment from hot water tanks
- Set water temperature to no more than 120F
- Repair leaking faucets
- Insulate water pipes
- Install efficient dishwasher and clothes washer; use energy-saving settings

Lighting

- Replace incandescent bulbs with compact fluorescent (CFL) or light emitting diodes (LEDs)
- Turn off lights whenever leaving a room
- Use daylight for lighting - new or existing windows, sun tunnels, and leave windows uncovered during the day

Appliances and Home Electronics

- Replace inefficient appliances (especially refrigerator/freezer) and be sure seals are tight
- Use a toaster oven or microwave to heat small meals
- Air dry clothes when possible
- Turn electronics off when not in use; use power strips to fully cut power
- Unplug chargers (e.g., mobile phone chargers) when not in use

The magnitude of residential energy consumption in Bennington can be estimated by considering the fuel usage of a typical Vermont home. An average single family home in the northeast requires approximately 60,000 Btu (British Thermal Units) of energy per square foot for annual space heating. A gallon of home heating oil contains approximately 140,000 Btu of energy. The average annual heating oil consumption of a Vermont home—850 gallons—(where an average single family home contains approximately 2,000 square feet) is consistent with this data. An evaluation of the composition of Bennington's housing stock and heating fuel and electricity usage provides an estimate of total residential energy consumption and of potential savings (Table 2).

Table 2. Estimate of Bennington's annual residential energy use and cost.

	Residential Units	Total Oil Use (gallons)	Total LP Gas Use (gallons)	Total Wood Use (pellet bags)	Electric Use for Heat (kwH)	Non-heat Electric Use (kwH)
Single Family	3,508	2,414,850	501,800	44,280	3,080,000	24,556,000
Two-Family	638	335,900	69,160	6,096	425,600	3,828,000
Multi-Family	1,722	627,750	130,221	11,448	797,650	8,610,000
Mobile Home	510	265,200	55,328	4,925	345,800	2,550,000
Total	6,378	3,643,700	756,509	66,749	4,649,050	39,544,000
Cost Factor		$3.75/gal	$3.50/gal	$4.00/bag	$0.15/kwH	$0.15/kwH
Total Cost		**$13,663,875**	**$2,647,782**	**$265,916**	**$697,358**	**$5,931,600**

This data provides a rough estimate of total residential energy consumption and costs for Bennington. The combined total cost of residential purchases of heating oil, LP gas, wood/pellets, and electricity is $23,206,531; with a population of 15,764, the per capita cost of residential energy use (not including transportation energy costs) is $1,472. Data was obtained from the 2010 US Census and the Vermont State Data Center—Housing Statistics. The following assumptions were used in the calculations: average single-family house size of 2,000 square feet, two-family dwelling unit of 1,500 square feet, and multi-family dwelling unit at 1,000 square feet (estimates of fuel usage rounded to nearest 50 gallons of oil/lp gas and ratios used for wood and electric heating use calculations. Heating fuel usage for mobile homes were generated based on the two-family dwelling unit (larger than a typical mobile home) because of generally lower insulation values and inefficient heating geometry for mobile homes. Electric use estimated at 7,000 KwH per year for a single-family home, 6,000 KwH per year for a two-family dwelling unit, and 5,000 KwH per year for a multi-family dwelling unit and mobile home. Energy use for domestic hot water production assumed included in the space heating and/or electric usage data. "Wood" heat includes both cord wood and wood pellet fuel; for simplicity, quantities and cost are presented using only wood pellet data.

Several obvious courses of action are suggested by the data presented in Table 2. Building weatherization improvements and electric (lighting/appliance type and use) improvements can reduce energy consumption in an average home by up to 20 percent. Widespread adoption of those efficiency improvements would have two beneficial economic effects: (1) initial expenditures on improvements would provide economic opportunities for local contractors and suppliers of energy-saving products at no net cost to residents (paid for through reduced energy costs), and (2) ongoing annual savings of, in aggregate, over four million dollars—money that is largely exported from the town currently and could instead be used to bolster local economic activity. There would be a reduction in revenue to local suppliers of oil and lp gas, but those businesses could participate in efficiency improvement work as well. Of course, most residents would feel the benefit most directly through lower utility bills.

This assessment of energy use also brings to light the relationship between building size and energy use. Although not a perfectly linear relationship, an increase in oil consumption of one gallon for each additional 2.3 square feet of home size is a reasonable approximation of the relationship between the size of existing homes and consumption of energy for space heating. Similar relationships can be computed for electricity use. Energy use can be limited, therefore, by reducing the amount of space that is heated (and air conditioned and lighted), so smaller residential units will save energy and money. New construction and housing rehabilitation projects should seek opportunities to produce smaller, but functional and attractive, living spaces.

The town's current heavy reliance on nonrenewable fossil fuels also shows that Bennington needs to make considerable progress on fuel switching efforts in coming years. Oil and gas prices will continue to rise, and supply interruptions at some time in the not distant future are inevitable. It is important that residents begin to look to alternative heating fuels. In addition to taking greater advantage of passive solar heating opportunities, residents should look to the most abundant heating fuel in the region: wood. A greater reliance on wood (cordwood and wood pellets) will ensure that people can stay warm in the winter, regardless of the price or availability of imported fuels, while supporting new and expanded business opportunities in wood harvesting, processing, and transportation. The region's forests easily have the capacity to produce enough fuel to meet all of the town's space heating needs (Bennington Regional Energy Plan, 2009). Switching to wood fuels could keep millions of dollars circulating in the local economy—dollars that currently are exported to foreign suppliers. Large-scale conversion to wood fuels, however, will require careful forest resource planning to ensure sustainable harvests and also must utilize clean-burning stoves and furnaces to limit particulate and other emissions.

<u>Alternative Energy Options for Residential Properties</u>

Homeowners can complement their energy conservation efforts by obtaining some of their space heating, water heating, and electrical needs using residential-scale renewable energy systems. Solar energy technologies have developed rapidly in recent years, and efficient systems are now widely available in Vermont. Solar space heating can be both "passive" or "active." Proper building orientation and construction combined with a high ratio of south-facing windows can turn sunlight into an effective natural heating system. Active solar heating systems use special collectors to absorb solar radiation and distribute the resulting heat energy using either air or a liquid heat transfer medium. Passive solar design should be employed to the extent possible in all new construction, while active solar heating systems can be particularly effective when retrofitting an existing building that has few south-facing windows.

Solar water heating systems are less expensive than solar space heating systems and provide a relatively rapid return on investment. 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 buildings primary hot water 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 panels can be used to provide a significant share of a home's electrical needs. High initial cost and the fact that these systems do not produce much electricity during the winter months have limited adoption of this technology for residential use in Vermont. However, improved technology, including panels that rotate to follow the sun's movement, and innovative financing

Solar photovoltaic panels that automatically track the sun's movement greatly increase electrical generating capacity.

methods (including the PACE program) may make photovoltaics a more attractive investment in the near future. Generated electricity can be either used and stored on-site or tied to the electric grid, with “net metering” to offset the cost of electricity purchased from the distribution company.

Wood is another abundant renewable resource in Bennington and the surrounding area. At one time, most residential space heating in the town was accomplished with the use of local wood. As fossil fuels became more abundant and less expensive, use of wood (or “biomass”) for home heating declined. Recent spikes in the price of oil and propane have led to an increase in utilization of this reliable fuel source once again. Many homes can be heated with a single wood or wood-pellet burning stove or furnace. Cord wood is readily available from many local suppliers and requires little preparation beyond splitting and drying; the net energy yield (amount of energy produced relative to the amount invested to obtain the fuel) from heating with cord wood is among the highest of any energy source. Pellets require more energy to produce, but also burn more efficiently and are easier to store and feed into a stove or furnace.

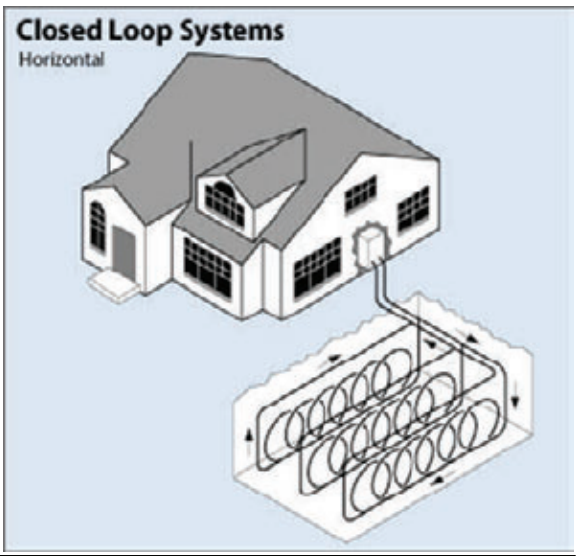


Figure 5. A standard residential geothermal heat pump system that uses heat energy within the Earth to heat and cool a home.

Small scale wind turbines can produce significant amounts of electricity for homes that are situated on hills or in other locations that receive steady and reliable wind flow. A typical 2.5 KW residential wind turbine system operating with average wind speeds of 11 mph can produce over 350 KwH of electricity per month (an average home in Vermont uses 600 KwH per month and an energy efficient home uses 400 KwH per month). As with photovoltaics, the energy produced can be stored in batteries for use on site or tied to the grid. High initial costs have been an obstacle to adoption of this technology at the individual level, but tax incentives and creative financing can make wind a more affordable option for certain residents.

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 5). Heating and cooling buildings by concentrating this naturally occurring and renewable energy source is very efficient, moving three to five times more energy than is consumed by the electrical components of the system.

III. Commercial and Industrial Energy Conservation Strategies

Bennington is the center of business and industry for the region, with over 600 commercial, manufacturing, and public or private facilities and institutions employing approximately 10,000 people in the town (Vermont Department of Labor, 2010). Those totals include an extremely diverse array of enterprises and buildings, making it difficult to estimate total energy usage. This section of the plan will deal with a broad spectrum of commercial (retail, food service, office, etc.) and manufacturing uses, while Section VI of the plan will provide information pertaining to municipal government, public schools, colleges, and the Southwestern Vermont Health Care campus.

In general, commercial and industrial businesses rely heavily on electricity to fuel their operations (statewide, just over 60% of commercial and industrial energy use is from electricity), so effective electricity conservation strategies will lead to significant cost savings while helping to ensure that generation and transmission capacities remain adequate to meet their needs. Recent conservation measures implemented through Efficiency Vermont and other initiatives have helped reduce the rate of increase in commercial/industrial electricity use after several decades of rapid growth.

In addition to on-site energy use, many businesses rely on shipments of raw materials to their facilities, exports of finished products to markets, and/or transportation of people to the region and to their establishments. 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. Many of the conservation strategies identified for specific businesses are derived from, and discussed in more detail at, Efficiency Vermont's online business section (www.efficiencyvermont.com/business).

The US Environmental Protection Agency and the US Energy Information Administration have done considerable research on commercial and industrial energy use that can be drawn upon to develop an approximation of energy use in these sectors locally (Table 3).

Table 3. Estimated commercial and manufacturing building energy consumption, Bennington, Vermont.

	Estimated Floor Area (square feet) (1)	Annual Electricity Consumption (KwH) (2)	Annual Oil/Gas Consumption (gallons) (2)
Manufacturing	1,234,000	97,649,472	1,776,960
Commercial	4,721,624	75,141,906	1,367,382
Total Consumption		172,791,378	3,144,342
Cost Factor (3)		$0.15/KwH	$3.50/gallon
Total Cost		**$25,918,706**	**$11,005,197**

(1) Floor area estimates were computed by multiplying the number of employees in each sector (2010 Vermont Department of Labor Covered Employment data) by 766 square feet (US EPA estimate of average commercial/industrial floor space per employee).
(2) Total manufacturing sector energy consumption was calculated by multiplying total floor area by 450,000 Btu/square foot (average of low and high estimates for various types of industries—data developed by E Source Companies, LLC "Managing Energy Costs in Manufacturing Facilities). Total commercial sector energy consumption was calculated by multiplying total floor area by 90,500 Btu/square foot (average for all commercial uses, US Energy Information Administration). For both sectors, resulting energy use was allocated 60% electric and 40% oil/gas. Oil and LP gas were combined for the analysis and Btu content used in the calculations (125,000 Btu/gallon is an average weighted slightly toward the Btu content of oil.
(3) Electricity cost factor of $0.15 was used to be consistent with the residential rate, although varying commercial rates apply. Because oil and gas were combined, a conservative cost factor of $3.50 was used in the calculations.

Obviously, the commercial and industrial businesses that drive much of our local economic activity rely heavily on energy. Considerable cost savings are possible and, as in the case of residential uses, those savings can be redirected toward local energy efficiency contractors and eventually toward investment in business growth. A number of generally applicable strategies should be considered by all commercial and industrial businesses, and approaches applicable to specific business type also have been identified.

General Conservation Strategies for Businesses

Any new building or building addition should be designed to meet the Vermont Guidelines for Energy Efficient Commercial Construction (Commercial Buildings Energy Standards—CBES), and those buildings should be sited to maximize solar access for heating and natural lighting. Bennington's land use plan requires new commercial and industrial businesses to be located in properly zoned districts, almost all of which are located in the town's urban growth area (Figure 6). Extension of these uses to more remote areas, where good transportation and other public infrastructure is not available, should not be permitted. Access from some industrially zoned land to the Vermont Railway spur line should be maintained so that future bulk shipments in and out of town can occur by this more energy efficient transportation mode.

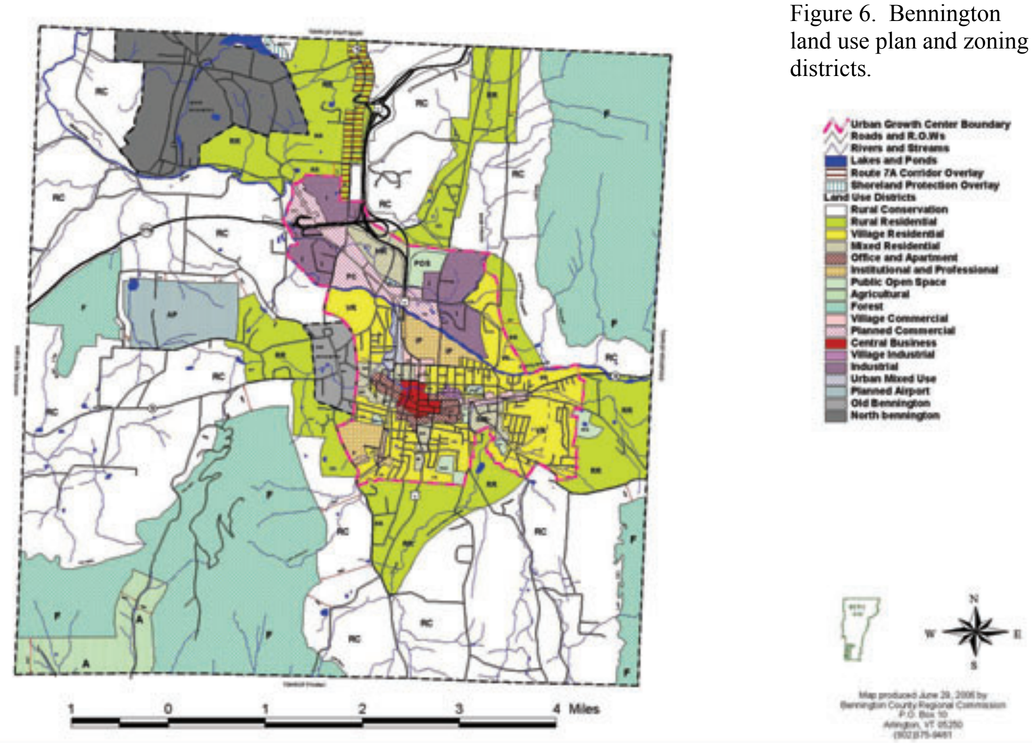


Figure 6. Bennington land use plan and zoning districts.

The energy efficiency of existing buildings can be improved using techniques similar to those available for residential buildings. Business owners should retain a qualified energy auditor to obtain a prioritized list of energy-saving measures organized by cost and savings. HVAC systems should be regularly checked and maintained to ensure they function as efficiently as possible. Every effort should be made to reduce the use of artificial lighting, through use of natural lighting when possible and by turning off lights when rooms are not occupied (occupancy sensors provide a possible solution). All lights other than minimal security lights should be turned off when the business is not open and illuminated advertising signs should on timers or manually turned off when lighting is not necessary (late evening and during hours of bright daylight). Any incandescent and old fluorescent (T-12) tube lights should be replaced with energy-efficient fluorescent or LED fixtures—incentives for replacement may be available through Efficiency Vermont. Businesses with significant customer visits (such as retail stores and restaurants) should consider installation of air lock vestibules on entry doors.

Energy consumption also can be reduced by simply setting thermostats to avoid unnecessary heating in the winter and cooling in the summer, especially through setbacks when the building is not occupied; programmable thermostats can assist in this regard. Computers and other electronic office equipment should be shut off, or at least set to "sleep mode" at the end of the work day.

Businesses can monitor their energy use with devices such as the TED 5000, to support conservation measures. In Middlebury, an "energy challenge" among local businesses was facilitated by providing each with a TED 5000 that could be monitored by staff and customers. The winning business received special recognition (and significantly reduced energy bills). A similar initiative could be developed locally with the assistance of the Bennington Energy Committee and a business organization such as the Chamber of Commerce.

When pursuing transportation efficiencies, businesses can encourage carpooling (participation in activities associated with the "Way to Go" Commuter program is a good start), and showers, changing facilities, and bicycle racks or storage areas should be provided when possible to make bicycling a more attractive option for employees. For certain types of businesses, it may be possible to allow employees to telecommute—work at home—one or more days per week. A good telecommunication infrastructure also allows many people to conduct business from local or home offices, rather than driving long distances outside of town to work.

Renewable energy options available for businesses include solar water heating systems, photovoltaic panels, biomass-based heating systems, small-scale wind generation, and methane biodigesters for electricity production ("Cow Power"). Depending on location and the amount of energy used, one or more of these systems could provide significant economic benefit to a business. On sites with adequate exposure to the south, for example, restaurants, inns, and other facilities requiring significant water heating are likely to achieve an excellent return on an investment in solar water heating.

Conservation Strategies for Specific Types of Businesses

Agriculture/Farms

Agriculture has a particularly important role to play in town-wide energy conservation efforts, as discussed in Section V. An extremely large amount of energy is expended, and money exported from the region, to acquire food. Expanded and enhanced local food production, processing, and distribution will support a critical element of the town's economy and significantly reduce overall town energy usage. Existing and future agricultural enterprises may benefit from one or more of the following strategies:

There are abundant opportunities for energy cost savings at agricultural operations; this farm is on the west side of Bennington.

- Equipment: Energy-saving projects may be eligible for rebates. Types of projects include water heating controllers, milk cooling, milk transfer systems, milk vacuum pump controllers, maple sap pumps, and more.
- Lighting Equipment, Controls & Design: Efficiency Vermont offers

rebates on overhead and task lighting for non-agricultural areas, such as farm offices.

- Agricultural Lighting: New energy-efficient linear (tube) fluorescent lighting can save an average farm 25-50% per year on lighting energy costs. Outdoor wall-mounted area LED fixtures use 75% less electricity than incandescent lights. Efficiency Vermont provides rebates on vapor-proof linear fluorescent and hard-wired CFL fixtures that keep out moisture, dust, and flies, and can be hosed down for cleaning, and exterior LED fixtures.
- Refrigeration & Controls: Agricultural operations that use walk-in coolers or freezers may be able to access rebates for installing new equipment and optimizing existing equipment for cost-savings and system reliability.
- Compressed Air: Farms that use compressed air systems for milking can save money by detecting leaks, adjusting controls, and upgrading inefficient equipment, on both the supply and demand sides.

Professional Offices

There are over 100 buildings used for professional offices in Bennington, some large and many quite small. In addition, large retail and manufacturing businesses often have sizeable integrated office units in their buildings. Conservation measures at these existing buildings can realize considerable energy savings, and modern telecommunication facilities make it likely that the number of professionals working from small offices in the area will increase, leading to further energy savings in this sector.


Numerous energy-efficiency measures were included in this office building, located on West Main Street, when it was renovated.

- Lighting Equipment, Controls & Design: Energy-efficient options are available for interior and exterior applications. Options include overhead, task , parking lot, and pathway lighting. Occupancy sensors save money by turning off lighting in occasionally used spaces like rest rooms, break rooms, meeting rooms, and storage areas.
- Heating, Ventilation & Air Conditioning (HVAC): Energy-efficient and optimized HVAC equipment and controls can reap significant long-term cost savings, increase equipment reliability, and create more comfortable and productive workspaces.
- Data Centers & IT: Server rooms and work station computers consume energy, even when not in use. Save by switching to energy-efficient equipment options and state-of-the-art cooling methods.
- Insulation & Air Sealing: Smaller office buildings may be eligible for Building Performance, a program designed to improve the comprehensive energy efficiency of buildings. Efficiency Vermont offers up to $7,500 per building (less than 10,000 sq. ft.) to help pay for energy efficiency improvements completed by a participating Building Performance Institute certified contractor.
- New Construction & Major Renovation: Efficiency Vermont offers financial and technical

assistance to help businesses optimize the efficiency of both large and small new construction and major renovation projects.

Convenience/General Stores

Numerous small convenience and general stores are located along principal thoroughfares and in urban neighborhoods. Energy savings can be critical to the profitability of these businesses.

- Refrigeration & Controls: Refrigeration is a large energy expense in convenience stores. Existing reach-in and walk-in coolers can be made more efficient by addressing air tightness, motors, compressors, and lighting. Incentives also are available for converting to systems that use outside air for cooling when ambient temperatures permit.
- Lighting Equipment, Controls & Design: Energy-efficient options are available for overhead lighting, display lighting, food cases, parking lots, and canopies. Occupancy sensors save money by turning off lighting in occasionally used spaces like rest rooms, break rooms, and storage areas.
- Heating, Ventilation & Air Conditioning (HVAC): Energy-efficient and optimized HVAC equipment and controls can reap significant long-term cost savings, increase equipment reliability, and create more comfortable and productive workspaces.
- Commercial Kitchens: Commercial kitchens and delis use a lot of energy for food preparation, dishwashing, and kitchen ventilation. An initial investment in energy-saving ENERGY STAR® qualified commercial equipment will typically be returned in savings quickly.
- Insulation & Air Sealing: Quality insulation and air sealing help to maintain comfortable temperatures, save on heating and cooling costs, and protect buildings from destructive moisture and molds.
- New Construction & Major Renovation: Efficiency Vermont offers financial and technical assistance to help businesses optimize the efficiency of both large and small new construction and major renovation projects.

Bennington's motels, hotels, and inns are important to the town's economy; a variety of energy-saving improvements can reduce operating costs.

Lodging

A variety of lodging types exist in Bennington, including historic inns, roadside motels, and larger hotels.

- Lighting Equipment, Controls & Design: Energy-efficient lighting choices include overhead and wall-wash lighting and specialty compact fluorescents (CFLs) and LEDs for guest rooms, hallways, and restaurants. Efficient lighting also gives off less heat, reducing the need for air conditioning. Occupancy sensors save money by turning off lighting in occasionally used spaces like restrooms and storage areas.
- Heating, Ventilation & Air Conditioning (HVAC): Energy-efficient and optimized HVAC

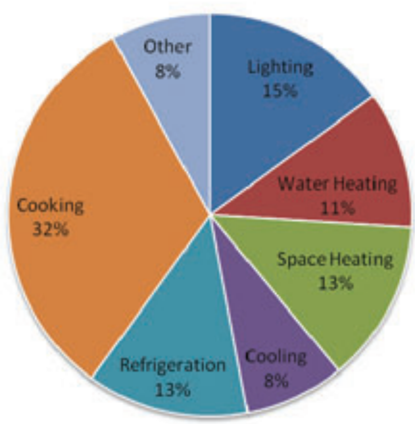
equipment and controls can reap significant long-term cost savings, increase equipment reliability, and create more comfortable guest experiences and productive spaces for employees.

- Insulation & Air Sealing: Smaller inns and bed & breakfasts may be eligible for Building Performance, a program to improve the comprehensive energy efficiency of small business and residential rental buildings. Efficiency Vermont offers up to $7,500 per building (less than 10,000 sq. ft.) to help pay for energy efficiency improvements completed by a participating Building Performance Institute certified contractor.
- New Construction & Major Renovation: Efficiency Vermont offers financial and technical assistance to help businesses optimize the efficiency of both large and small new construction and major renovation projects.
- Guest Room Refrigeration: Although small, inefficient guest room refrigerators are significant users of electricity; new, efficient units can save energy.

Restaurants

Bennington is home to over 40 restaurants. Because restaurants often use over twice as much energy as other comparably sized commercial buildings, opportunities to reduce energy consumption in this sector are very significant.

Figure 7. Energy Use in Restaurants



Source: US Energy Information Administration, Commercial Building Energy Survey.

- Commercial Kitchens: Food preparation accounts for over 30% of restaurant energy costs. An initial investment in energy-efficient equipment and training staff to use energy wisely can achieve significant savings; for example, ENERGY STAR qualified fryers and steam cookers are, respectively, as much as 15% and 50% more efficient than standard models.
- Refrigeration & Controls: Retrofitting existing walk-in coolers and freezers with efficient fan motors and installation of economizers that use "free" outdoor air for cooling can lead to major energy savings. ENERGY STAR qualified ice machines are on average 15% more energy efficient than standard machines.
- Lighting Equipment, Controls & Design: Energy-efficient alternatives are available for bright overhead lighting for kitchens, specialty compact fluorescents (CFLs) and LEDs save energy while maintaining the ambiance of dining areas, and efficient options are available for a variety of exterior lighting applications. Efficient lighting also gives off less heat, reducing the need for air conditioning. Occupancy sensors save money by turning off lighting in occasionally used spaces like rest rooms, storage areas, and walk-in coolers.
- Heating, Ventilation & Air Conditioning (HVAC): Energy-efficient and optimized HVAC equipment and controls can reap significant long-term cost savings, increase equipment reliability, and create a more comfortable restaurant.

- New Construction & Major Renovation: Efficiency Vermont offers financial and technical assistance to help businesses increase optimize the efficiency of both large and small new construction and major renovation projects.

Retail Stores

Bennington has over 110 retail stores, located primarily in the downtown and along the Northside Drive—Kocher Drive corridor. Effective and efficient lighting and space heating are critical for customer comfort and convenience and also are the key areas of focus for energy conservation measures.

- Lighting Equipment, Controls & Design: Energy-efficient lighting can improve illumination of displays while saving energy. Options are available for overhead lighting, track and spot display lighting, wall-mount fixtures, parking lot lighting, and more. Occupancy sensors save money by turning off lighting in occasionally used spaces like rest rooms, break rooms, and storage areas. LED lights use up to 80% less energy than standard halogen bulbs. LEDs also last at least 10 times longer, have the same quality light needed for display, and create less heat output, which reduces the need for air-conditioning.
- Heating, Ventilation & Air Conditioning (HVAC): Energy-efficient and optimized HVAC equipment and controls can reap significant long-term cost savings, increase equipment reliability, and create more comfortable and productive retail spaces.
- Insulation & Air Sealing: Some buildings may be eligible for Building Performance, a program to improve the comprehensive energy efficiency of small business and residential rental buildings. Providing air-lock entries and ensuring that doors remain closed when not in use significantly reduce heating and cooling costs. Efficiency Vermont offers up to $7,500 per building (less than 10,000 sq. ft.) to help pay for energy efficiency improvements completed by a participating Building Performance Institute certified contractor.
- New Construction & Major Renovation: Efficiency Vermont offers financial and technical assistance to help businesses optimize the efficiency of both large and small new construction and major renovation projects.
- Break Room Refrigeration: Replacing residential-type refrigerators can save up to $100 per year on electricity costs.

Retail stores occupy more total floor area than any other commercial use in Bennington.

Industrial Uses

The importance of manufacturing and other industrial uses to the local and regional economy cannot be overstated. An ever-present issue for such uses is the high energy consumption inherent in many of these operations. Manufacturing businesses can save money, improve work environments, increase productivity, and reduce maintenance costs by choosing energy-efficient equipment and optimizing existing equipment and processes. Energy use often accounts for the majority of the cost of industrial equipment over its lifetime, so it is usually cost-effective to invest in energy-efficient equipment in areas such as compressed air, refrigeration, motors, drives, and pumps. Efficient lighting in manufacturing and warehouse spaces will often quickly pay for itself and result in improved and often safer work environments.

Energy costs represent a high percentage of the operation costs of most industrial uses; assistance with comprehensive reviews of buildings and operating procedures are available through Efficiency Vermont.

- Lean Improvements: For large manufacturers, process improvement projects that increase business performance can also reap considerable energy savings—directly benefiting the bottom line. Efficiency Vermont can help develop a plan that will maximize savings and return on investment.
- Motors, Drives & Pumps: Energy-efficient motors can save money while increasing system productivity and reducing downtime. Variable frequency drives (VFDs) adjust motor speed according to operator input or automatic controls, resulting in significant energy savings as well as improved operation in many applications.
- Compressed Air: Air compressors can account for 10% of the electricity use in the average industrial facility. Opportunities for saving money exist in almost every compressed air system by detecting leaks, adjusting controls, and upgrading inefficient equipment.
- Lighting Equipment, Controls & Design: Lighting accounts for nearly 10% of the energy use in the average industrial facility. Options are available for overhead lighting, office lighting, and

outdoor areas. Occupancy sensors save money by turning off lighting in occasionally used spaces like rest rooms, break rooms, and warehouses.

- Heating, Ventilation & Air Conditioning (HVAC): Energy-efficient and optimized HVAC equipment can reap significant long-term monetary savings, increase equipment reliability, and create more comfortable and productive workspaces.
- Refrigeration & Controls: Installing new equipment and optimizing existing equipment can lead to large reductions in energy use.
- Commissioning Existing Buildings: For businesses in large buildings, building commissioning can ensure that heating, cooling, and other systems work efficiently together to save energy and reduce operating costs. Additional benefits include improved indoor air quality, occupant comfort, and productivity.
- New Construction & Major Renovation: Efficiency Vermont offers financial and technical assistance to help businesses optimize the efficiency of both large and small new construction and major renovation projects.
- Insulation & Air Sealing: Quality insulation and air sealing help to maintain comfortable temperatures, save on heating and cooling costs, and protect from destructive moisture and molds.

IV. Transportation Energy Conservation Strategies

The amount of energy used for transportation in Vermont has grown over the past half century (Figure 8), and now accounts for more energy consumption than any other single sector. 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. However, low fuel prices for gasoline and diesel (despite recent increases, these prices remain half to one-third of what consumers pay in many developed countries) have encouraged people to buy large fuel-inefficient vehicles; and even people with fuel-efficient vehicles are able to drive more miles so may not actually be conserving much energy relative to their SUV-driving neighbors.

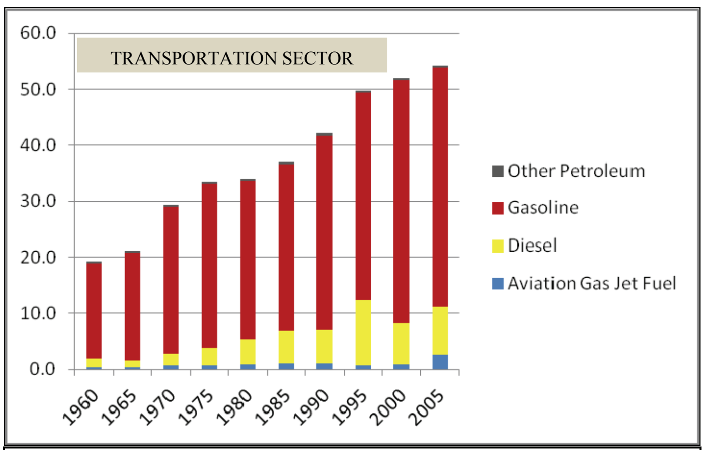


Figure 8. Increased consumption of gasoline and diesel fuel in the transportation sector is responsible for much of the growth in energy use in Vermont (statewide data, usage in trillions of Btu annually, VT Department of Public Service).

Inexpensive energy in the transportation sector also has facilitated a land use pattern where people live relatively far from where they work, attend school, shop, and obtain other important services. Until the era of good roads and inexpensive fuel, most people lived in close proximity to urban and village centers where goods and services were close at hand. People who lived in the countryside had to be more self-sufficient, and indeed, most were involved in some type of agricultural activity. Some people have observed that cheap and easy personal transportation has allowed people to live an urban lifestyle in rural locations.

The personal automobile has come to be seen as an indispensible component of modern life, used to get to work, shopping, school, visiting friends, recreational and entertainment venues, and more. Consequently, the amount of fuel used—and dollars spent– to drive ourselves around has become an increasingly important issue for many people. The amount of money spent on gasoline by Bennington residents, for example, is approximately equal to the amount of money spent on all fuels for home heating and electricity (Table 4). According to the 2010 US Census, the average Bennington worker commutes a total of approximately 15 miles per day; with over 8,000 resident workers, mostly

Table 4. Transportation fuel use (personal and commercial/industrial) estimates for Bennington.

		Annual Miles Driven (2)	Gallons Fuel Used (3)	Total Fuel Expenditures (4)
Number of Personal Vehicles (1)	12,118	169,652,000	6,786,080	$23,751,280
Commercial/Industrial Diesel Fuel Use			1,357,200	$5,428,800
Total			**8,143,280**	**$29,180,080**

(1) 6,378 housing units * 1.90 average vehicles per unit (2010 US Census).
(2) Based on 14,000 miles per year per vehicle—current estimates, Federal Highway Administration.
(3) Personal vehicle fuel (gasoline) consumption based on 25 miles per gallon average (US EPA); commercial/industrial estimate based on 20% of personal vehicle fuel consumption (Vermont Department of Public Service data).
(4) Expenditures based on gasoline cost of $3.50/gallon and diesel fuel cost of $4.00/gallon.

commuting in single-occupancy vehicles, commuting alone accounts for over 100,000 miles per day of travel, and over 1.1 million gallons per year (and over $4,000,000) of gasoline consumption.

There are opportunities for considerable energy and cost savings in the transportation sector. The solution, of course, is to find ways for people to reduce the amount of driving they do; the question is how that can be accomplished. Eventually, higher transportation fuel costs will affect changes in behavior, but the demand for gasoline to power our vehicles has proven to be quite inelastic. Only when prices at the gasoline pump rose rapidly from under $3.00 to $4.00 or more per gallon did people start to drive less, consider purchases of more fuel-efficient vehicles, and begin to use alternative modes of transportation. It is inevitable that fuel prices will become increasingly volatile in the future and that over time prices will begin to escalate at an increasing rate. Strategies that help people and businesses reduce their reliance on gasoline and diesel powered cars and trucks and which can begin to be implemented in the near-term should be pursued. Three principal areas present themselves as the most obvious for immediate action: strategies to encourage more walking and bicycling, efforts to support wider utilization of public transit (bus) and carpooling services, and projects and physical improvements that provide greater access to freight and passenger rail services.

Strategies to Encourage More Walking and Bicycling

Almost everyone is a pedestrian at least several times each day, even if those walking trips are confined to short excursions from a car to a store, office, or home. The benefits of walking as a primary transportation choice are numerous. From the town's perspective, much of the infrastructure needed to accommodate pedestrian mobility already exists. The town has an extensive network of sidewalks throughout its densely developed residential and commercial areas (Figure 9). Those sidewalks provide direct access between houses, businesses, schools, and shopping areas. A relatively new pathway also provides a connection from the town's center to Willow Park, the Maneely Corporate Park, and the MAU Middle School. In outlying rural areas, sidewalks are not necessary as pedestrians can walk along the sides of low traffic volume local roads. Safe walking along rural state highway segments require sufficiently wide shoulders, which exist along much of Route 9, but which are generally lacking along Routes 7A and 67A (further discussion below).

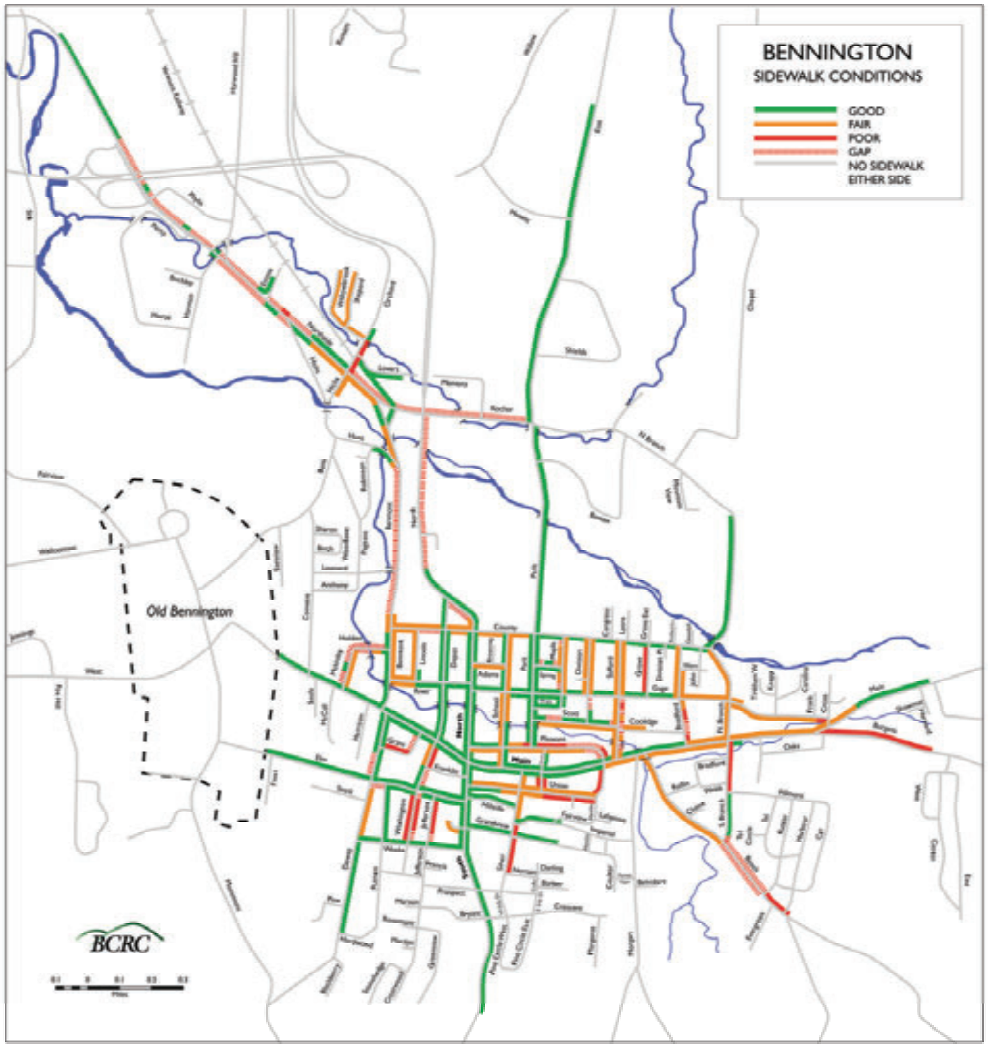


Figure 9. This map of Bennington's sidewalk network also provides information on segments in need of rehabilitation and shows areas where new sidewalk connections are needed (gaps), primarily along Benmont Avenue, North Street, Northside Drive, and Kocher Drive.

In addition to the availability of existing facilities, maintenance costs of sidewalks and pathways are very low relative to most other modes of transportation. Sidewalks and pathways can be repaired relatively easily and while specialized equipment is needed for efficient plowing during winter months, the town owns and operates such equipment already. Additional walking also has the potential to help improve the overall health of the population. People who walk at a moderate pace use over 200 calories per hour and improve their cardiac fitness; replacing some auto-based trips with walking will contribute to a reduction in obesity and heart attack risk, thus reducing expenditures on both gasoline and health care.

Walking as a means of transport does have its limitations, of course, primarily related to the distance that must be covered and the amount of material that must be carried. For many trips of a mile or less that do not involve carrying heavy loads, however, walking is an ideal way to get around and to more closely connect with the community. Strategies to encourage more walking include educational efforts and fixing existing facility deficiencies. Educational programs targeted at school children and at businesses can be effective. The "Safe Routes to School" program provides information on best walking routes between residential neighborhoods (while also identifying needed safety improvements) and helps to promote walking as a healthy transportation alternative. The "Way to Go Commuter Challenge" is an annual effort coordinated through regional planning commissions; participating businesses encourage their employees to use alternative transportation (including walking) for one full week—reports are then provided showing the gallons of gasoline and money saved by the participants. The town should support these and similar efforts.

Infrastructure deficiencies that need to be addressed to encourage more walking include the following:

- Improved and maintained crosswalks. Walking along a sidewalk or pathway is an easy and pleasant experience; the most significant challenges and impediments to walking occur at points of conflict with motorized vehicles. For this reason, it is critical to have well-marked and consistently maintained crosswalks throughout the town. It also is important to provide safe crossings at key locations where none currently exist. Funding has been made available to design and construct a safe crossing at the US 7 intersection between Northside Drive and Kocher Drive (Figure 10). Implementing this project will greatly enhance walking opportunities by creating a safe pedestrian route between high density residential areas, commercial corridors, parks, and schools.

  The BCRC and the town are in the process of studying the Northside Drive corridor; that plan should include locations and plans for safe pedestrian crossings between the two sides of that road and across side roads and commercial drives.

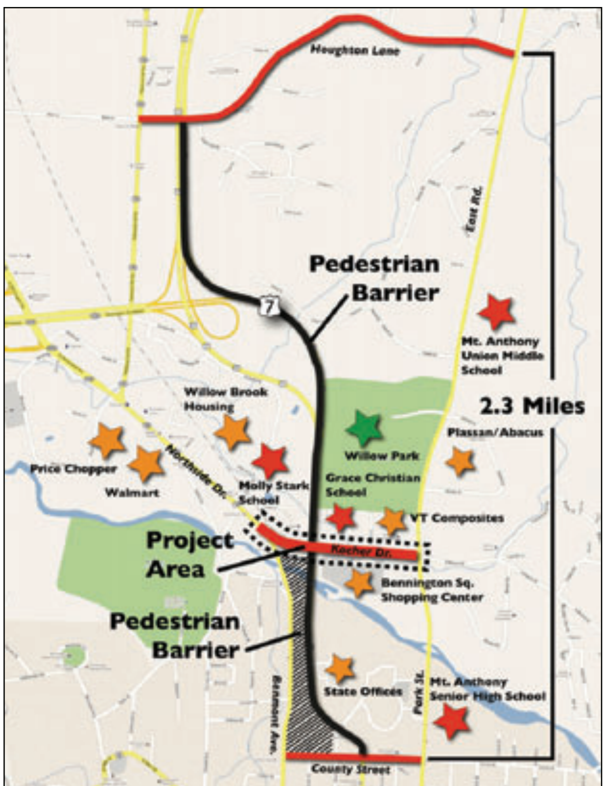


Figure 10. This map shows that Route 7 currently presents a 2.3 mile long barrier to safe pedestrian movements between the east and west sides of Bennington north of County Street.

- Provision of sidewalks where there are identified gaps in the existing system. As noted above, those locations exist in several areas of concentrated pedestrian demand: North Street, Benmont Avenue, Kocher Drive, Northside Drive, Beech Street, and the short segments shown on Figure 9. The town should continue to require sidewalk connections along these corridors when new commercial or multifamily housing projects are developed and should seek funding to complete the other sections. The town also should continue to seek to develop the network of pathways identified in the Town Plan. A particularly important pathway segment is the one proposed to run along the old rail spur from downtown to Northside Drive and potentially all the way to the Route 7A crossing. That facility could connect to another pathway running from Silk Road and the Bennington College access drive, paralleling the Walloomsac River, back to the area just south of the Route 7A/67A intersection on Northside Drive.

- Wider and maintained shoulders along sections of rural state highways where existing shoulders are unsafe. The nature of these improvements are described in more detail below (bicycle-related improvements). The towns should encourage the state to include properly constructed shoulders in state highway paving projects.

Bicycling is another way to achieve personal mobility without relying on gasoline-powered engines. Popular around the world, bicycling has numerous advantages: higher speed than walking, use of the existing system of roads, ability to carry some baggage when properly equipped, and the same type of health benefits derived from walking. A relatively inexpensive bicycle can be purchased and serviced at several local shops. For longer commutes and heavier loads, electric assist bicycles provide an excellent solution; while more expensive than most standard bicycles, they still are cheap relative to a car and the energy used in recharging them is used very efficiently by electric motors. Although bicyclists use the same roads as cars and trucks, they do have certain needs that the town should attempt to provide to encourage more bicycling.

The same programs used to promote walking (Safe Routes to School, Way to Go, etc.) can be used to educate people about the benefits of bicycling. Additional education and outreach efforts should focus on teaching bicyclists the rules of the road and ensuring that motorists are aware of the presence of bicycles and that they also understand the need to respect this additional roadway user group.


Electric-assist bicycles can be an attractive option for some trips around town.

Most bicyclists will preferentially ride on paved secondary roads with light and/or low speed vehicular traffic. Such roads are natural bikeways and require little improvement. It is important that pavement be maintained in good condition and that there not be a drop-off from the pavement edge onto a poor or non-existent shoulder. Road hazards (see discussion below) should be eliminated from these important bicycle routes. The needs of bicyclists must be considered if traffic volumes on these roads increase. It may be necessary to widen the lanes or proved a paved shoulder when increased traffic compromises safety.

State highways and Class I town highways often provide the most direct, and often the only passable route for bicyclists traveling between town centers and other important destinations. These roads are characterized by high vehicle volumes and speeds. Northside Drive is an example of a road that is important to bicyclists, but also hazardous because of conflicts with cars and trucks. Paved shoulders should be provided along these highways wherever possible. Along sections of roads having curbs (generally in urban and village centers), where shoulders cannot be reasonably provided, the outside lanes should be 14 or 15 feet in width, thus providing adequate room for an automobile and a bicycle. It is critically important to eliminate hazards on these roads, where any obstruction that can cause bicyclists to lose control or be forced quickly into the travel lane poses a very serious safety problem.

Dedicated bikeways or multi-use paths are physically separate from roads, often on their own rights-of-way. The pathway discussed above that would extend from the downtown along the rail spur and eventually to Bennington College could be built to accommodate bicycle use. If they are to be available to bicyclists, these pathways should be paved or surfaced with a firm and consistent material that will support narrow high-pressure bicycle tires. Sharp turns must be avoided as bicyclists often travel in excess of 20 miles per hour. A minimum width of eight feet with two foot graded shoulders is necessary to safely accommodate two-way bicycle traffic (along with other path users). Moreover, it is important that the paths be laid out to minimize roadway crossings.

Objects and conditions that motorists never notice can be a severe safety hazard for bicyclists. The town should consider the following hazards and related concerns when constructing and maintaining roads:

- *Drainage grates* should be located and oriented so that they will not trap bicycle tires. Even when the grate patterns are safe, however, bicyclists will attempt to avoid them because they make for a bumpy, unstable ride and can damage tires. Whenever possible, therefore, drainage grates should be positioned to allow adequate space for bicyclists for pass around them without moving out into traffic.

- *Pavement condition* should be maintained in good condition on important bicycling routes. Potholes, broken pavement, longitudinal seams, steep drop-offs at the pavement's edge, and debris are very real obstructions and hazards for bicyclists.

- *Utility covers* must be adjusted to be flush with the paved surface of the road.

- *Railroad crossings* that are not at right angles to the direction of travel on a can trap bicycle tires, twisting the bike and causing a crash. Wherever possible, railroad crossings should be at right angles to roadways. Where such an alignment is not possible, the road shoulder should be widened to permit bicyclists to cross the rail at right angles without entering the travel lane.

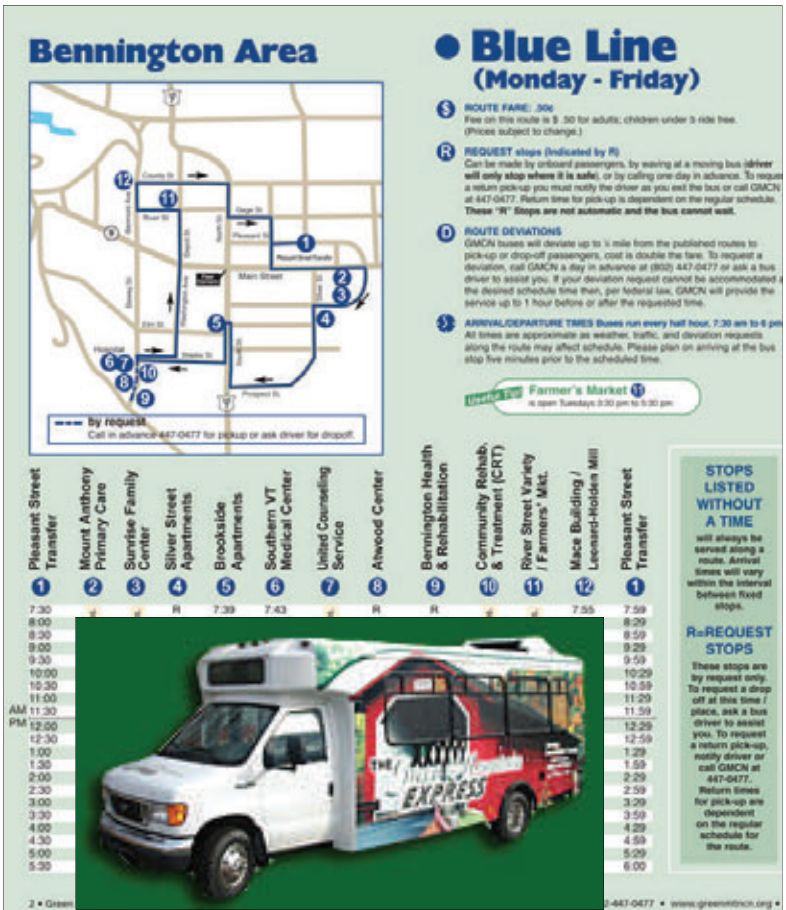
- *Bridges* and roads passing beneath bridges should be wide enough to safely accommodate bicycles. New bridges and upgrades to existing bridges should include shoulders or widened lanes for bicycles, especially on busy town and state highways. Warning signs should be posted to alert motorists and bicyclists of narrow bridges.

- *Sign posts, utility and light poles* should be set back at least one foot from the edge of the roadway so that they do not interfere with a bicyclist's ability to maintain a straight course.

- *At intersections with unimproved streets, parking lots, and driveways* pavement should be extended at least 10 feet back onto the unimproved facility to minimize the amount of debris that is drawn onto the paved surface of the road.

Strategies to Improve Utilization of Public Transit and Carpooling

Using one vehicle to move multiple people is one of the easiest and most effective ways to conserve transportation fuels. Local and regional bus services provide an energy efficient transportation alternative for many trips. The principal challenge is ensuring that the bus services are sufficiently convenient for users. The Green Mountain Community Network (GMCN) is a private non-profit organization that operates out of a facility on Pleasant Street. It maintains a fleet of small buses that cover two daily routes on weekdays, a route that runs between Bennington College and Southern Vermont College three days per week, a Saturday route, and daily bus service to Manchester and Williamstown where connections to other bus services and intercity connections can be made.



Route map and schedule of one of the several fixed route bus services operated by the Green Mountain Community Network.

The only intercity bus company offering service to Albany, NY is Yankee Trails, with two departures daily from Bennington. There currently is no intercity bus service operating along VT Route 9 to destinations east of Bennington.

Of course, the heaviest use of buses for daily transportation is provided by the school buses that serve the public elementary, middle, and high schools in Bennington. Those buses are not as heavily used as they once were, as many parents drive their children to school and many older students drive their own cars to school.

Carpools, generally used by employees commuting to work, offer similar efficiencies; every shared ride means one less car on the road burning gasoline. Consider, for example, that four people sharing an average 15-mile commute in a “gas guzzling” SUV (15 miles per gallon) would use one gallon of gasoline per day for the trip. Those same four people driving four separate “fuel efficient” compact cars (30 miles per gallon) would use a total of two gallons of gasoline each day. Over the course of a year, the savings in fuel and money can be significant. The state’s Go Vermont program (www.connectingcommuters.org) provides online ride matching services to facilitate carpooling.

Utilization of bus and carpools in Bennington is quite low for a number of reasons. Personal automobiles offer maximum convenience and flexibility for most people and, with relatively low gasoline prices, incentives to shift to less attractive bus or carpool modes of travel are limited. Carpooling to work in Bennington, in particular, is challenging because employees are scattered over a wide rural area. The most likely carpool routes for this area would likely serve Bennington residents commuting to work in the Albany, NY area, and for people from Cambridge and Hoosick Falls, NY and from northern Bennington County commuting to work in Bennington.

It is important to note that buses, in particular, offer the only transportation alternative for many people with limited incomes, disabilities, or for whom driving is no longer an option. Those services should be supported and extended as appropriate for that reason alone. However, opportunities for encouraging use of buses and carpools should be supported as well; helping people save money in difficult economic times and developing the public transit infrastructure that will be more in demand as fuel prices rise in coming years are worthy objectives.

The Green Mountain Community Network has planned its routes to best accommodate its market and provides stops at residential developments, health care centers, and commercial areas, with some stops at business centers and schools. Local businesses should consult with GMCN and determine how a route that provided commuting services might operate in Bennington. Testing such a route during the annual "Way to Go" commuter program would be a way to promote buses as a transportation option and to see how popular such a service might be in the future. In addition to active participation in the Way to Go program, businesses can provide information to employees about the Go Vermont carpool system and provide their own ride-matching services. Information about the improved park and ride lot, located adjacent to the GMCN facility on Pleasant Street, should be provided to employees as well. The town should work with the BCRC, Chamber of Commerce, and other organizations to provide this information to employers.

The demand to expand intercity bus service significantly beyond its current level is quite limited currently, but the town should support continuation of existing services as it will be easier to increase those services rather than initiate new services when demand rises in the future. One possible area for immediate expansion of intercity bus service would be by coordinating a new service with the Amtrak passenger rail station in Rensselaer, NY. Many people from Bennington drive to the rail station, and many people living in metropolitan areas (especially the New York City area) without cars, but with access to rail, would like to visit Bennington. It would be possible to operate a bus, as part of the Amtrak system—with the ability to purchase the bus and connecting rail tickets online or at an automatic ticketing kiosk, running between Manchester, Bennington, and the Rensselaer station. With no other intermediate stops, and with the ability to coordinate arrivals and departures with the Amtrak train schedule, the service would be convenient as well as energy and cost-saving (gasoline and parking costs) for Bennington residents.

A bus service like Amtrak's Thruway Motorcoach system could save energy while encouraging more public transit and rail ridership.

Increasing utilization of existing school bus routes will be a challenge, but as more parents choose alternative modes of transportation themselves, the use of the buses will increase. A useful calculator provided by the American School Bus Council (www.americanschoolbus council.org) shows the fuel and dollar savings that can be achieved through greater utilization of school buses. Bennington's public school enrollment currently is close to 3,000 students. If 2,000 of those students use school buses every day instead of riding or driving in cars (assuming the national average of 1.5 students per car), net annual fuel savings of 200,000 gallons and nearly $700,000 are realized. Schools also can organize their own carpool/ride-match systems, encouraging friends and neighbors to get into a routine of sharing a ride.

Strategies for Increasing Freight and Passenger Rail Utilization

A state owned rail line enters Bennington from New York State in North Bennington and continues northward along Vermont's "western corridor." A four mile long rail spur extends from that main line in North Bennington to downtown (at the Bennington Station restaurant). A private company, Vermont Railway, has a long-term lease to operate rail services along both of those rail lines. At the present time, there is a limited amount of freight movement on the main line, and no rail use on the spur line (other than storage of temporarily idle freight cars). There is a potential for additional freight shipping by rail, serving both existing and future businesses, and with that expanded use would come the potential for significant energy savings (Figure 11).

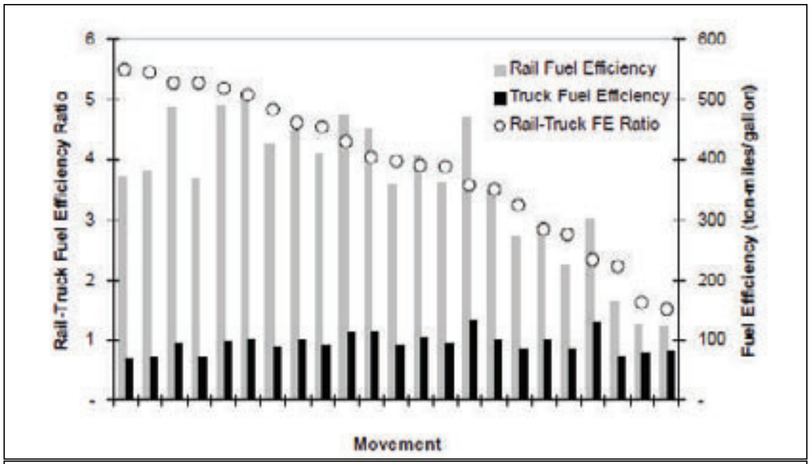


Figure 11. Relative fuel efficiencies of freight movement by rail versus truck for a variety of movements (different terrain, loads, and conditions). Rail movements are from 1.9 to 5.5 times as fuel efficient as truck

Current conditions for most businesses make truck transport necessary, but for bulk shipments, especially of commodities such as oil, grain, road salt, timber, and similar products, as well as for special items that are difficult to ship over the highway system, use of trains is sensible and should be encouraged. Because of the relative energy efficiency of rail deliveries, as fuel prices climb in the future, businesses will have an incentive to try to modify their operational plans to accommodate more deliveries by rail. The town should support projects that maintain the integrity of the existing main rail line and should preserve rail access to important industrial sites along the rail spur – at least as far south as the former Johnson Controls property. Projects that would help facilitate efficient transfers of freight between rail and truck, including development of a local transloading facility, should be supported.

The longstanding interest in re-establishing passenger rail service to Bennington gained considerable support last year with a federal and state funded project intended to complete the planning and permitting that would be necessary for a future passenger route. The project, carried out by a transportation consultant and overseen by a management team consisting of representatives from the Vermont Agency of Transportation, New York State Department of Transportation, the Bennington County Regional Commission, and the Rutland County Regional Planning Commission, evaluated several possible routing alternatives. After analyzing estimated costs, operational issues, and public support, a recommendation was advanced to more fully investigate two possible alternatives: re-routing the existing Ethan Allen Amtrak service from its current route through eastern New York to a route that passes through Bennington County on its way to Rutland (Figure 12), or establishing a new service—in addition to the Ethan Allen service—along that same route through Bennington County.

Although the capital costs of both alternatives are similar (over $100 million), the operating costs associated with rerouting the Ethan Allen service are, of course, much lower, because that alternative does not add a new train and all of the associated staffing and fuel costs. In addition, the state of Vermont provides an operating subsidy to ensure the viability of the Ethan Allen service, and would likely be required to pay an additional subsidy (the annual Ethan Allen subsidy is approximately $3-4 million) for a new service.

Although from a cost and operational standpoint the preferred alternative would clearly appear to be the one that reroutes the existing Ethan Allen line, there is a concern that there would be some less of service, and potentially some loss of revenue-generating ridership, by dropping stops in New York State. A strong argument of rerouting the service is that Vermont subsidizes the route, so the benefits of that public investment should be felt primarily in Vermont. Moreover, other passenger rail routes already serve those potentially bypassed stops in New York.

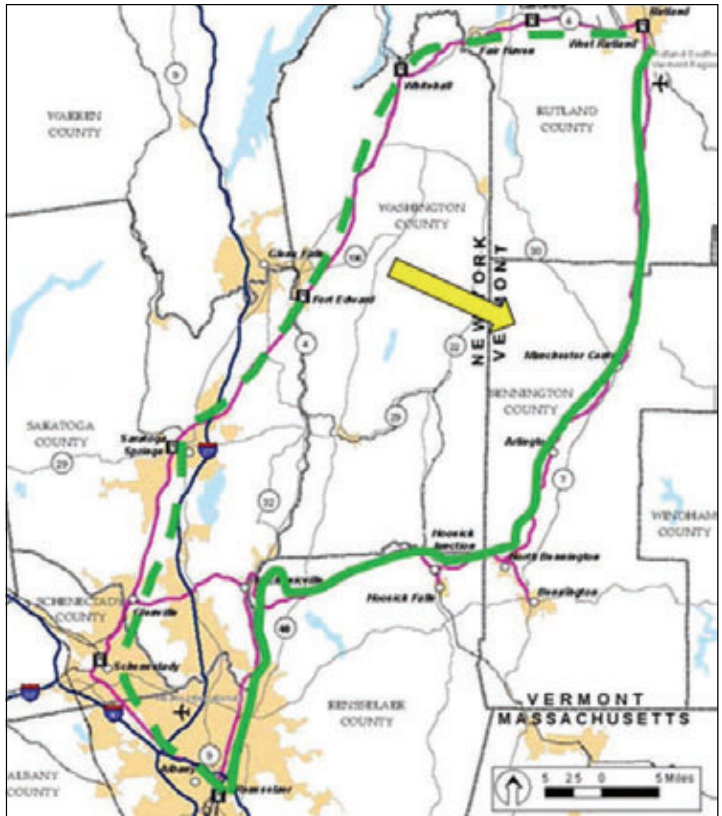


Figure 12. One possible plan for bringing passenger rail service back to Bennington: rerouting the existing Amtrak Ethan Allen service between Rutland and Rensselaer through Bennington.

Implementation of new passenger rail service through Bennington is, at best, several years away, however, and the high initial cost of the infrastructure upgrades may delay it further. Consequently, it would be sensible for the town to support an interim, or possible permanent strategy, that would provide a direct connection between the town and the main Amtrak station in Rensselaer via a bus, as discussed in the Public Transit section of this plan. That alternative would meet the objective of providing greater access to passenger rail for travelers to and from Bennington, could operate multiple times each day (the train alternative would be limited to one round trip per day), could be initiated with very little cost, and would use less diesel fuel than a train. If ridership on that connecting "rail-bus" were sufficiently large, it would make sense, from an energy use and economic standpoint, to provide the additional investment and begin train service.

Whether access to the main Amtrak rail routes is provided by a bus or a train, several accessory improvements would be necessary locally. A functioning train station with sufficient parking would have to be provided; it would be most practically to utilize the station in North Bennington because it is on the main VT Railway line. Some type of regular and reliable transportation would have to be available to people arriving at the station; the Green Mountain Community Network could revise its route schedule to meet the train and provide service to in-town lodging and other sites that would be sought by visitors. There probably also would be a market for additional vehicle rentals as many visitors would expect more mobility than what could be offered by rural public transit services.

V. Local Food and Agricultural Economy

The connection between food and energy is not widely recognized, but is nonetheless extremely significant. Food contains energy (calories—actually kilocalories—are a measure of energy) originally derived from the sun, and we rely on that energy to run our human engines. Beyond that reality, however, is the more practical issue that it takes a tremendous amount of energy (and money) to produce, transport, process, and prepare the food that we consume. In fact, ten percent of the total US energy budget is used for food production (Scientific American, January 2012).

The significance of this fact to the town and the local economy can be illustrated by considering a few simple facts. An average person consumes approximately 2,000 calories (kcal) per day; that is the energy equivalent of 7,940 Btu. Because of the high energy inputs, (farm machinery, petrochemical fertilizers, transporting the food an average of 1,500 miles to Bennington, energy-intensive processing, storage, etc.), 79,400 Btu per person per day is required to bring that food energy to our resident population. Over the course of a year, then, food production for Bennington's residents requires 456,740,560,000 Btu, or the equivalent of approximately three million gallons of oil.

The total expenditures on food are equally interesting. Vermont is estimated to spend approximately two billion dollars each year on food, or about $3,200 per year per person (Vermont Farm to Plate Strategic Plan, 2011). With a population of 15,764, Bennington residents spend approximately $50 million dollars on food, the vast majority of which is imported to the region. The corollary to this fact, of course, is that the vast majority of local dollars spent on food purchases is exported from the region.

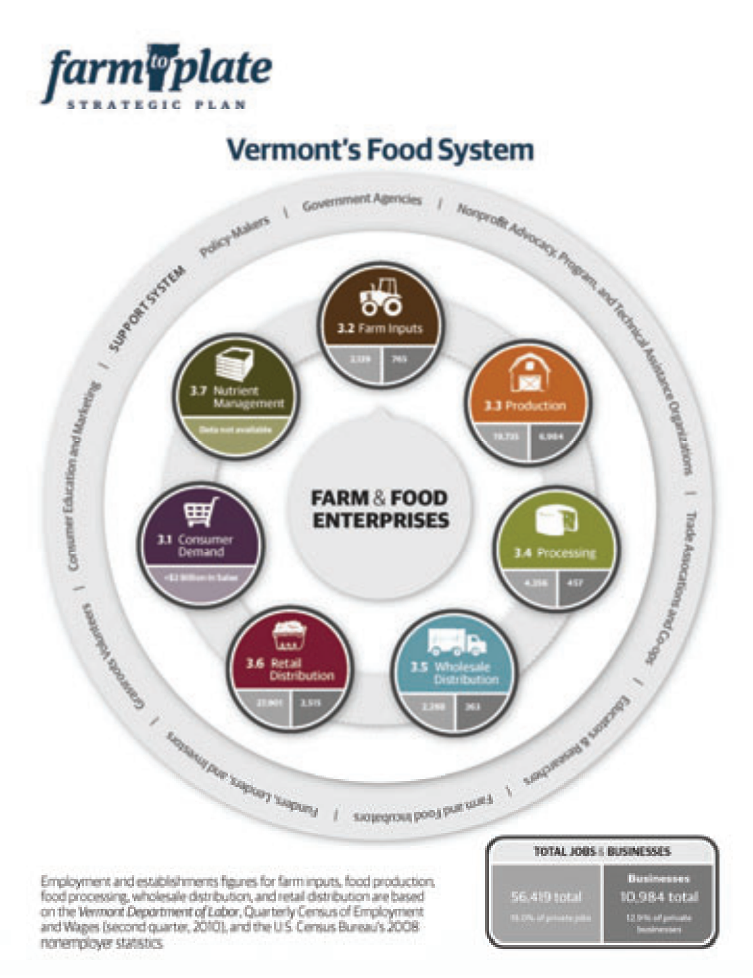


Figure 13. Food system diagram from the Vermont Farm to Plate Strategic Plan. Developing a similar plan for the Bennington area can

By relying to a much greater extent on locally produced food, and food with a higher energy yield per energy input, the town could significantly reduce overall energy use while supporting growth in a potentially important sector of the local economy. The transportation savings associated with local food production are an obvious energy conservation benefit. Consumption of more grains, vegetables, and fruits encourages greater energy efficiency since the energy inputs for those foods are significantly lower than the energy inputs required for the production of dairy, meat, and poultry products. Production methods that minimize tilling and the need for petrochemical fertilizers also improve energy efficiency.

The Bennington Farm to Plate Council is working with the BCRC and Bennington College to develop an inventory of the local food system and to begin to develop a plan for building a more robust agricultural economy. Although there are a number of small local producers and significant demand for local food, there is a need to better match those elements of the market and to ensure that all of the supporting components needed to ensure the growth of a vibrant local food economy are in place (Figure 13).

One approach may be to facilitate contracting between large food users (the local colleges, school districts, hospital, and similar institutions) and producers to help those small farmers grow their businesses and to encourage others to enter into farming. Because the cost of land can restrict entry into farming for many people, consideration could be given to allowing farmers to use prime agricultural land at some of those locations (e.g., college campuses) for little or no cost.

Once a certain level of production capacity is achieved, there will be a demand for food processing, storage, distribution, and other support services. An important aspect of the growth in local food production will also be creation or expansion of retail outlets for locally produced food so it is easily and conveniently available to the general public. Growth in this economic sector also will encourage agricultural diversification, leading to the production of a greater variety of foods.

VI Municipal and Institutional Energy Conservation Strategies

Local government, schools, colleges, and other institutional uses such as the Southwestern Vermont Medical Center all are major users of energy. The costs associated with energy use by those entities has a direct bearing on taxes and critical issues such as the cost of education and health care. Energy conservation and the use of alternative energy systems in this sector have the potential to produce significant savings and to promote economic development.

Municipal Government

The Town of Bennington relies on energy to provide services to the community. The town owns and operates several buildings, a large fleet of vehicles and equipment, and is responsible for other services such as the provision of water, disposal of wastewater, and street lighting. The town already has taken steps to reduce its energy use through use of more efficient lighting and equipment in office buildings, installation of a hydroelectric generator at the water treatment facility, and by pursuing other initiatives through Efficiency Vermont and other resources. This section will document some of the activities that consume a large amount of energy and suggest general strategies that can be pursued to save money and energy.

Municipal Buildings and Infrastructure

Energy consumption data at five municipal buildings was gathered through a project coordinated by EPA's Energy Star initiative. Those buildings support a variety of services and are used in significantly different ways, so opportunities for energy savings in each will differ. Each of the buildings requires energy for space heating (and in the case of the Recreation Center, pool water heating) and electricity for lighting, air conditioning, office equipment, and other functions. Information on energy use at the water and wastewater facilities was obtained from recent municipal records. Total energy use and estimated costs for these buildings and related infrastructure is presented in Table 5.

The town already has taken measures to conserve energy in its buildings by installing more efficient lighting and electrical equipment, undertaking basic weatherization measures, and implementing innovative projects such as the hydroelectric facility at the water filtration plant. Efficiency Vermont is available to help the town identify and implement additional conservation strategies. The "Guide to Improving Energy Efficiency in Vermont Municipal Buildings" outlines a step-by step approach and a professional energy consultant is available to work with town staff. The town should avail themselves of Efficiency Vermont's programs, complete a comprehensive energy audit of its facilities, prioritize projects based on efficiency improvements and payback time, and identify appropriate funding sources.

The Bennington Fire Station is a relatively new building, located on River Street. It houses the Bennington Fire Department's vehicles, equipment, and support offices and facilities. A large meeting room on the third floor is used for public meetings by local government and other organizations. Although the largest of the town-owned buildings surveyed, much of the building is not used on a daily basis and it includes a large garage area that is not heated to the level of the rest of the structure. As a consequence, heating fuel use is relatively low, averaging 6,222 gallons of oil per year. Electricity use at the building is significant, although the total cost is below the space heating expense. The monthly average of 8,320 kwH is typically exceeded by 50 percent during summer months (and is generally consistently lower the rest of the year), indicating that air conditioning probably is driving a significant portion of the electricity demand during warm weather. The Fire Station also uses a small amount of propane (approximately 150 gallons per year).

Table 5. Annual Energy Consumption — Bennington Municipal Buildings and Infrastructure

Building	Oil / Cost (gallons @$3.75)		Propane / Cost (gallons @ $3.50)		Electricity / Cost (kwH, rate specific to use)		**Total Cost**
Fire Station	6,222	$23,333	154	$539	99,624	$13,947	$37,819
BBC/BCIC	1,150	$4313	-	-	12,432	$1,492	$5,805
Police Station	-	-	18,420	$64,470	212,940	$27,684	$92,154
Recreation Center	-	-	34,075	$119,263	173,400	$36,414	$155,677
Town Offices	2,961	$11,104	<100	-	66,612	$9,651	$20,755
Water Department/ Filtration Plant	8,239**	$30,896	1,196**	$4,186	-	$32,911	$67,933
Water Infrastructure*	-	-	-	-	-	$33,052	$33,052
Wastewater Plant	6,216**	$23,311	647**	$2,265	-	$171,671	$197,247
Wastewater Infrastructure *	-	-	-	-	-	$5,705	$5,705
Total	**24,788**	**$92,957**	**54,312**	**$190,723**	**-**	**$332,527**	**$616,207**

* Infrastructure includes facilities such as pumping stations and other equipment that utilize electricity.
** Gallons imputed from cost information obtained from municipal records.

The "Blacksmith Shop" at the corner of South and Elm Streets, is leased to the Better Bennington Corporation (BBC) and the Bennington County Industrial Corporation (BCIC). It encompasses 3,600 square feet and includes offices for several people on the first and second floors, a meeting room, and a visitor welcome center/display area. As a renovated historic building with a high heating cost per square foot, it can be assumed that a building audit would reveal opportunities for weatherization improvements that could reduce oil use. It also is possible that operational and building use changes could reduce heating costs: automatic thermostat setbacks to 60 degrees or less when the building is not in use is one example. The town also should consider conversion to a more efficient heating system when the current system needs replacement, or evaluate conversion to an alternative heating system. A biomass (probably wood pellet) burner could reduce fuel costs, support a locally sourced energy product, and serve as a model for other municipal buildings. Electricity use averages approximately 1,036 kwH per month; electricity conservation strategies for typical professional buildings may yield some additional savings (see Section III).

The Police Department is housed in the historic stone building on South Street that used to

The Police Station must remain active around the clock every day, contributing to a high rate of electricity usage.

serve as a federal building. It includes 10,360 square feet of space, numerous office and meeting rooms, and significantly—from an energy perspective– is occupied twenty-four hours per day. The structure is heated with a propane-fired system that consumes an average of 18,420 gallons of that fuel each year. Although from a cost standpoint, propane use is the most significant at the building, it is the electricity consumption at the building that is most striking. The Police Station uses twice as much electricity per square foot as the Town Office Building and far more than the Blacksmith Shop—attributable, in part, to its non-stop operation, but moisture, especially in the basement, requires constant use of pumps and dehumidifiers. The existing heating and air conditioning systems, and the design of the ductwork, results in further inefficiencies. The town should complete a comprehensive review of this important historical building to determine how to most cost-effectively remediate these problems.

The Recreation Center, located on Gage Street, provides residents with access to a fitness center and an indoor swimming pool. The greatest energy cost associated with this 18,000 square foot building is unquestionably associated with the pool. Propane use, highest in the winter months, but substantial year-round, has averaged over 34,000 gallons per year over the past several years. Planned renovations at the facility will help to reduce fuel consumption, and the town should seek opportunities to find alternative ways to provide heat for the pool. The recreation center in Springfield, Vermont installed solar collectors to provide heating of their pools and reduced propane costs by $30,000. The orientation of the roof and openness of the property suggests that a solar pool-water heating project could yield benefits with a relatively rapid payback time, although the structure of the roof imposes some limitations; nonetheless, the town should investigate the potential for such a project.

The Town Office Building, located on South Street, includes the Town Clerk's office and most of the administrative activities that support the full range of services offered by the municipal government. The offices are housed in a renovated historic house—with additions—that occupies 6,214 square feet. Space heating is provided by an oil-fired system that, during the sampling period, used an average of 2,961 gallons of oil per year. It is likely that further weatherization work on the building would yield significant savings in space heating costs. The building also could be a candidate for an alternative fuel heating system, as discussed for the Blacksmith Shop. Because there is a cluster of public buildings on South Street (the three town buildings plus the county courthouse), there may be opportunities for innovative use of small-scale wood pellet based district heating; such a facility was recently constructed to heat a cluster of new and existing housing units at Dartmouth College. Electricity use at the building is fairly consistent year-round, averaging just over 5,000 KwH per month (refer to Section III for strategies to reduce electricity use at professional offices).

The town operates public water supply and wastewater disposal systems that cover defined areas, primarily in the state-designated growth center. This infrastructure is essential to allow the type of concentrated development pattern that is consistent with the Town Plan and which leads to long-term energy savings. Both functions require considerable energy inputs, both to heat buildings and to operate equipment (Table 5). The water system, for example, utilizes numerous pumping stations that require a considerable amount of electrical energy and the wastewater treatment facility is far and away the largest user of electricity owned by the town. As noted earlier, the town has taken steps to limit energy consumption; the hydroelectric generator at the water filtration plant and the decision to compost biosolids at the wastewater treatment plant are two examples.

The wastewater treatment plant is the municipality's largest user of electrical energy.

Efficiency Vermont has assigned an energy efficiency expert to work with the town; although responsible for a full-range of efficiency reviews, consulting on the wastewater plant has been assigned a high priority. The town should actively engage with this expert and immediately begin an assessment of its facilities, including the wastewater facility.

Municipal Vehicles and Equipment

The town operates a sizeable fleet of vehicles and heavy equipment that use gasoline and diesel fuel. Total expenditures on fuel for the twelve months ending in July 2011 were over $200,000 (Table 6), and with rising costs that number can be expected to increase significantly in the current and ensuing years. Vehicle replacement, upgraded equipment, and operating policies and practices may lead to energy savings in certain areas.

Table 6. Fuel cost - municipal vehicles and equipment.

Department	Inventory	Annual Fuel Cost
Police	9 vehicles: 5 SUV - 4 sedan	$54,607
Fire	6 trucks and one sedan	$3,348
Recreation	1 pickup truck and 2 mowers	$3,350
Senior Center	2 vans	$2,904
Highway	10 dump trucks, 9 pickup trucks 16 pieces heavy equipment	$113,291
Water	6 pickup trucks, 1 dump truck, 2 pieces heavy equipment	$16,293
Wastewater	4 pickup trucks 5 pieces heavy equipment	$9,194
Planning and Code Enforcement	1 sedan	$547
Total		**$203,534**

Several municipal departments (Fire, Recreation, Senior Center, Planning and Code Enforcement), use relatively little fuel for transportation and to operate their equipment, but others (Police, Highway, Water, and Wastewater) depend heavily on those fuels to accomplish their work. All municipalities are facing the challenge of rising gasoline and diesel prices and some have started to implement a range of conservation strategies.

The Bennington Police Department has specific requirements for the types of vehicles it operates. It currently uses three SUVs (Chevrolet Tahoes) and five sedans (Chevrolet Impalas). The department has indicated a preference for SUVs because of their capacity and greater durability. Of course, a vehicle like the Tahoe is not at all energy efficient, particularly in the typical stop and go traffic in which they operate in town. An increasing number of cities and towns have started to integrate gas-electric hybrid vehicles into their police department fleets. Popular models are the Nissan Altima hybrid for sedans and the Ford Escape for SUVs. It would appear that there are significant opportunities for savings through purchases of more fuel efficient vehicles when cars and SUVs from the existing fleet are retired. The Ford Escape hybrid, for example, has a retail list price approximately $6,000 lower than a Tahoe and is rated at roughly twice the fuel economy. If driven 30,000 miles per year, the annual fuel savings per vehicle would be approximately $3,500. Another fuel-saving technology being adopted by many police departments involves installation of "anti-idling" systems in police vehicles. These devices, such as those sold by "Energy Extreme," allow full electrical capability for three hours or more with the engine shut off, resulting in demonstrated cost-savings of over $3,000 per year and a payback time of less than one year. Finally, if resources permit, it would be beneficial to have some officers patrol the densely developed center of town on foot and bicycle. All of these changes would not only save fuel, but would visibly demonstrate to the community the town's interest in providing an important service while being fiscally and environmentally responsible.

Many municipalities, including the New York City Police Department, have begun purchasing hybrid vehicles to save money and reduce environmental impacts.

The Highway Department, with its dump trucks, pickup trucks, and array of heavy equipment is the largest user of transportation fuel in the local government. Consequently, its costs will rise more rapidly than any other department as gasoline and diesel fuel costs increase. Whenever a vehicle or piece of equipment is replaced, the town should give careful consideration to fuel economy. In addition, policies and procedures should be implemented that ensure that the vehicles are used as cost-effectively as possible. The town's road plowing practice, which limits the extent of plowing at certain time of the night, is one good example of such a policy. Maintenance of the town's highway infrastructure is, and always will be, a critical service. Petroleum diesel prices will continue to increase, and experts have indicated that disruptions in the supply of diesel are likely at some time in the next 20 years, so it makes sense to begin to explore alternative fuel technologies. Several cities, such as Portland, Oregon, are beginning to use biodiesel in many of their vehicles and heavy equipment (using "B100" - 100% biodiesel - in the summer and "B50" - 50% biodiesel/50% - in the winter months). Biodiesel use is difficult at present because of high cost and limited supply. Fortunately, the technology does exist in the area, with one local producer in Shaftsbury. Bennington could begin with a pilot project operating one vehicle or piece of equipment on biodiesel for part of a year, and, based on the success of that program, expanding its use (and encouraging greater local production) in the future.

The Water and Wastewater Departments together spend over $25,000 per year on transportation fuels. The town should give full consideration to energy efficiency when purchasing new vehicles and should explore alternative fuel technologies as they become available.

Streetlighting

New LED streetlights like this one will be installed throughout the town, saving energy, and saving the town about $30,000 per year.

The town currently spends **$140,875** on streetlighting, paying a tariff to Central Vermont Public Service for 675 streetlights located mostly in the downtown and surrounding neighborhoods. Approximately 570 of those lights are 70W high pressure sodium lights, with the remaining lights mostly 150W high pressure sodium units and a few 300W high pressure sodium units. The town has recently taken advantage of a program coordinated by Efficiency Vermont whereby all of those streetlights will be replaced with new energy efficient LED streetlights (the town also has identified 12 streetlights that are not necessary and which will be removed altogether).

The new LED streetlights are much more energy efficient, with a 37W unit replacing the 70 units, and 52W and 89W LEDs replacing the old 150W and 250W high pressure sodium units. The light from the LED units also is much more "natural" and is distributed evenly, with very little wasted light or areas of overlapping illumination between adjacent lights. This streetlight replacement program will reduce electricity use by approximately 50% while saving the town over 20% on its streetlighting bill. The electric distribution company, CVPS, also benefits because it achieves comparable savings on the amount of electricity it must purchase. The town should use this program to publicize the availability of this to businesses and institutions that have overhead lighting on their properties.

Public Schools

The Bennington School District maintains three public elementary schools in town and the Mount Anthony Union District maintains the local public middle school and high school. The schools are of varying age and the relative energy efficiency of each is partially attributable to the original design and construction of the buildings. Each of the schools has participated in at least one Efficiency Vermont and/or Vermont School Energy Management Program review, and a number of efficiency improvements have been implemented, several of them quite recently. The transportation section of this plan identified methods to conserve energy through encouragement of more walking, bicycling, carpooling, and use of school buses rather than personal vehicles, so this section will focus primarily on space heating and electrical use in the school buildings themselves (Table 7).

One of the most obvious differences between the schools is the cost of heating the facilities. The three elementary schools are older than the middle school and high school, and the elementary schools rely solely on oil for space heating. The secondary schools, on the other hand, each derive a significant portion of their heat from wood chip (biomass) based boilers that greatly reduce the utilization of more expensive heating oil. Annual heating costs at both the middle school and high school average approximately $0.63 per square foot, while annual heating costs at the elementary schools range from $1.04 per square foot at Molly Stark to $1.63 per square foot at Bennington Elementary.

All of the schools have recently benefited from lighting system upgrades, with older interior fluorescent lights being replaced with energy-saving T-5 and T-8 lights, and inefficient exterior flood-lights replaced with highly efficient LED lights. Estimated energy savings from these upgrades amount to 153,000 KWH, and $25,000, annually between the three elementary schools and an additional $18,000 in savings at the high school. The most recently constructed school building, Mount Anthony Union Middle School, also benefited from $52,000 in energy conservation incentives (light and heating controls and other measures) during its construction several years ago.

Table 7. Annual energy use at Bennington's public schools.

School	Oil (gallons)	Oil Cost	Woodchips (Tons)	Woodchip Cost	Electricity (KWH)	Electricity Cost	Propane (gallons)	Propane Cost	Total Cost
Bennington Elementary	21,000	$67,059	-	-	180,000	$35,302	-	-	**$102,361**
Molly Stark	14,000	$54,238	-	-	380,000	$59,911	-	-	**$114,149**
Monument	9,000	$29,250	-	-	120,000	$19,429	-	-	**$48,679**
MAUMS	13,000	$43,137	810	$52,555	958,000	$114,476	3,500	$5,100	**$215,268**
MAUHS	20,000	$76,590	1,100	$65,924	1,600,000	$185,686	6,900	$11,843	**$340,043**
Total	**77,000**	**$270,274**	**1,910**	**$118,479**	**3,118,120**	**$414,804**	**10,400**	**$16,943**	**$820,500**

Notes
Square feet of floor space in each school: Bennington Elementary—41,200; Molly Stark—52,000; Monument—24,000; MAUMS—150,000; MAUHS 225,000.
Fuel and electricity consumption data obtained from the facilities director for each school district; in some cases consumption was averaged over more than one year. Cost data was obtained from annual reports using the most recent year's actual costs.

Despite the fact that the school administration has made a concerted effort to reduce energy use and costs, there always are additional opportunities for savings. The most modern school, MAUMS, predictably, has the fewest such opportunities, while each of the elementary schools would clearly benefit from improvements such as HVAC system upgrades, window replacements, and additional insulation. The facility staff at the school districts also identified solar panels, to provide hot water and to be integrated with the heating systems, as being beneficial future improvements. The challenge noted by school staff is obtaining the funds to cover the initial capital costs of such work. The schools should take advantage of any energy incentive programs and grants that become available and also should complete energy audits and life cycle analyses to determine when investment in energy conservation is fiscally appropriate.

Hospital Campus

The Southwestern Vermont Health Care's (SVHC) main campus in Bennington includes a full-service 99-bed hospital, a 150-bed nursing facility, a medical office building, cancer treatment center, and smaller buildings housing additional administrative and medical functions. SVHC currently is in the final stages of developing a plan for modernization of its facilities, and those plans include replacement of the aging oil boilers, along with other improvements that will affect energy use on the campus. At the present time, SVHC consumes an average of 725,000 gallons of (# 6) heating oil per year and uses an average of 12,388,283 KWH of electricity—clearly, medical facilities are among the biggest energy users in most communities, and certainly in Bennington. Consider, for example, that SVHC annually uses as much oil as nearly 1,000 average houses and as much electricity as several thousand houses. Fortunately, SVHC recently has placed a strong emphasis on energy efficiency, having cooperated with Efficiency Vermont in conducting a comprehensive analysis of its facilities and considering alternative options for replacing its heating plant.

SVHC has commissioned several studies to evaluate alternative solutions for replacing the heating plant. That facility until recently was also used to provide energy for a large institutional laundry, but all laundering is now done off-site. In addition, the oil boilers currently power the steam chiller, but a decision has been made to convert to an electric chiller system, thus further reducing future need for energy derived from the heating plant. By removing the laundry function, converting to an electric chiller system, and installing more efficient oil boilers that utilize #2 heating oil rather than #6 heating oil, SVHC is projected to lower its oil consumption by over 200,000 gallons per year (Table 8). Of course, the new chiller system will add considerably to the already high electricity costs (and additional off-site and transportation energy usage can be attributed to the outsourced laundry function).

The main campus of the Southwestern Vermont Health Care uses a lot of energy; planned improvements could significantly reduce energy costs.

Table 8. Current and projected future annual energy use under two different scenarios at Southwestern Vermont Health Care's Bennington campus.

Scenario	Oil (gallons)	Oil Cost	Woodchips (tons)	Woodchip Cost	Electricity (KWH)****	Electricity Cost****	**Annual Energy Cost**
Current Facility*	725,000	$2,718,750	-	-	12,388,283	$1,207,001	**$3,925,751**
New Heating Plant, All Oil**	510,000	$1,912,500	-	-	13,007,697	$1,267,351	**$3,179,851**
New Combined Woodchip/Oil Plant***	75,818	$284,318	7,272	$363,600	13,007,697	$1,267,351	**$1,915,269**

* Current facility uses #6 heating oil; usage data based on most recent ten-year average, and includes laundry and steam chiller operated from the oil boilers.
** New Heating Plant would use #2 heating oil, laundry now off-site and electric steam chiller.
*** Combined woodchip/oil system would use woodchip boiler as a primary (85%) energy source with oil-boilers as a backup (new boilers burning #2 oil).
**** Electricity costs based on average of 2010 and 2011 data; a conservative five percent increase is applied to account for the fact that there will be an increase in electricity consumption when switching chiller systems.

It is clear that the most energy-efficient and cost-effect option, from an operational standpoint, is the new system that uses a woodchip-based boiler with new oil boilers as a backup. That option, however, is the most expensive to construct initially and SVHC must be able to justify the higher cost. An analysis completed for SVHC by the Biomass Energy Resource Center shows that, factoring in the cost of financing as well as expected rates of increase in both oil and woodchips, the annual savings associated with the woodchip/oil system exceed $1 million annually—with the savings increasing annually as the cost of oil increases at a greater rate than the cost of biomass.

SVHC should continue to pursue a biomass based central utility plant, along with other energy conservation measures recommended by Efficiency Vermont. The reduced expenditures on imported oil together with greater spending on locally sourced biomass feedstock would have a positive effect on the medical center's finances as well as the local economy. The environmental benefits associated with reduced emissions of pollutants is another reason to pursue these alternative energy and conservation strategies.

College Campuses

Bennington is home to two college campuses, Bennington College and Southern Vermont College (the Community College of Vermont, a non-residential school housed in a downtown office building is considered, for the purposes of this analysis as part of the commercial sector). Colleges use a considerable amount of energy for heating residential and academic buildings, and to power the lights, computers, and other special equipment required at such institutions.

Several years ago Bennington College installed a biomass heating system to serve as the primary heat source for most of the college's buildings. According to a study of that system conducted by the Biomass Resource Center, the college uses approximately 4,000 tons of woodchips annually ($208,000 at current prices), displacing approximately 350,000 gallons of oil use. Oil boilers still are used as a supplement and back up to the primary biomass system. The college has reported that the biomass system has been reliable and has saved several hundred thousand dollars per year in fuel costs. The college's facilities director has reported that the campus uses approximately 3,186,000 KWH of electricity per year, at a total cost of $552,000. Bennington College has worked with Efficiency Vermont to implement a wide array of measures to reduce electric usage, and, in addition to its biomass heating system, has constructed a new building that is highly energy efficient and which uses a geothermal heating system. Many of the older buildings on campus would benefit from air-sealing, insulation, and other weatherization work; projects that will be taken on as funding becomes available.

Southern Vermont College is a smaller campus (in terms of both student enrollment and buildings); with approximately half of the number of residential students, two main academic buildings, and a field house/gymnasium, so it's energy consumption is significantly less than that of Bennington College. Because the campus does not have a biomass boiler system like Bennington College, it's heat energy must be provided by oil and propane gas—and the campus uses approximately 16,000 gallons of propane and 15,000 gallons of oil per year. Annual electricity consumption amounts to 703,000 KwH per year at a cost of $130,000. Many of SVC's buildings are relatively new, although the main academic building (The Mansion) is a historic stone building that certainly could benefit from weatherization work—the design and historic nature of the building will complicate any such work, however. The college should consider options for an alternative energy based heating system.

As noted earlier in this report, both colleges are interested in using local food in their dining halls, and both have considerable acreages of prime agricultural land on their campuses. It would make sense for the colleges to explore ways to allow and encourage more cultivation and processing of food at appropriate locations on their campuses.

VII Commercial Renewable Energy Opportunities in Bennington

The amount of money spent on energy in Bennington—as pointed out in previous sections—suggests that real economic benefits can be realized if some significant portion of that energy is generated from local sources. Moreover, the inevitable transition from nonrenewable to renewable energy must focus on local resources because renewable energy sources have relatively low energy densities compared to fossil and nuclear fuels, meaning that energy loss through acquisition, processing, and transport must be minimized. Available resources that potentially can provide for some of the area's energy needs include: biomass (wood and field crops), water (hydroelectric), wind, and direct solar radiation. In addition to supporting local businesses and keeping energy dollars circulating in the local economy, utilization of these renewable resources would provide significant environmental benefits by reducing the amount of pollutants emitted by fossil fuel combustion, reducing energy lost through long-distance transmission, and supporting good management of natural resources. Developing those resources now also will help provide energy security for the community, assuring availability of the energy needed to sustain economic prosperity well into the future.

Energy from renewable sources has many applications. It 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, wind, solar, and water. Other energy carriers such as hydrogen also can be produced from 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 diversion of land resources from other productive activities).

Specific alternative energy systems available for residential, commercial, and institutional uses were discussed earlier. This section of the plan will focus on commercial production of energy from renewable resources that can be sold to a wide range of users. The potential for developing and utilizing locally derived biomass, hydroelectric, wind, and solar energy is considerable.

Biomass Energy Potential

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 Bennington Regional Energy Plan estimates that forests, just within Bennington County, could sustainably 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 (Biomass Energy Resource Center data).

Although widely available, a significant increase in the utilization of local wood products for commercial energy production poses some serious challenges. 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 involves complete removal of woody biomass to maximize energy yield could deplete soil nutrients, 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 source of heat energy, its abundance, reliability, and the fact that reliance on this fuel provides jobs and recycles money in the local economy suggest that planning for greater utilization of the resource should be pursued. The reduced net carbon and sulfur dioxide emissions realized through combustion of biomass rather than coal, oil, or gas provides an additional reason to pursue greater use of this renewable resource. Research on sustainable harvesting and processing, and identification of preferred locations and extent of annual biomass removal should be supported.

Obtaining energy from wood is a relatively straightforward process using simple and time-tested technologies. Space heating in homes and small businesses can be accomplished with wood or wood-pellet burning stoves or furnaces. Cord wood is readily available from local suppliers and requires little preparation beyond splitting and drying. Pellets require much 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 the net energy yield of this fuel). Growing demand for pellets may provide an incentive for a manufacturer to locate in Bennington; the town should ensure that opportunities exist in appropriate locations for such a facility.

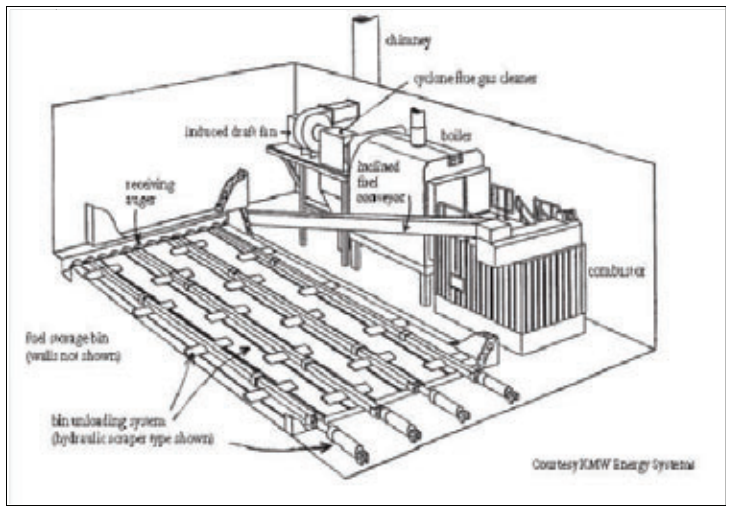


Figure 14a. Schematic of a typical wood biomass heating system in use at many schools, hospitals, and other institutions around the northeast.

Biomass fuels are proving to be a cost-effective heating solution for many large institutions, including the local middle school, high school, and Bennington College, and other large energy users are considering biomass systems as well. The typical biomass heating system uses chipped low-grade wood, either in a direct burn or gasification process (Figure 14a). A number of municipalities, including Montpelier and Brattleboro in Vermont, have recently begun to explore biomass based "district heating" systems that generate electricity that can be sold through the grid while using the excess heat by the process to heat buildings located in a concentrated area such as a downtown (Figure 14b). It is likely that a similar

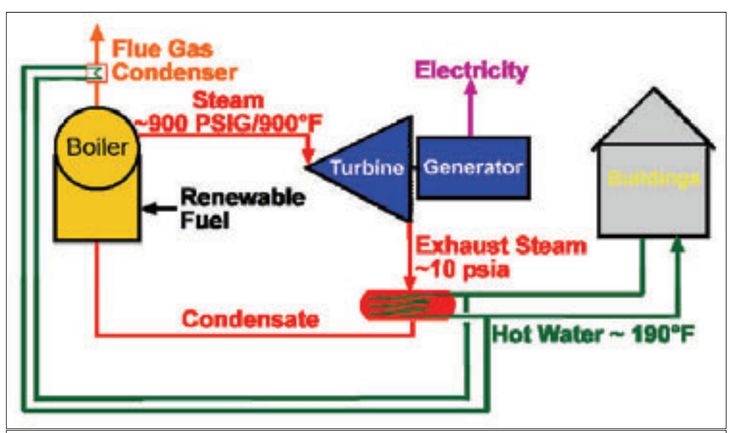


Figure 14b. Diagram of a district heating/CHP system that burns woodchips to produce heat for a number of buildings while also generating electricity, thus maximizing overall efficiency.

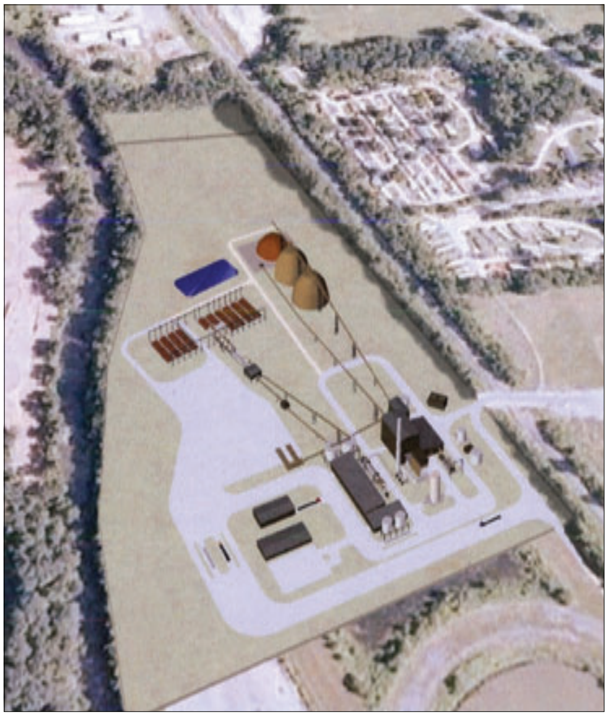


Figure 15. Site plan for a biomass-based electricity generating facility; waste heat from the process would be used in an on-site pellet manufacturing process. A similar project proposed for Fair Haven, Vermont, would also use excess heat to support a 10-acre greenhouse to supply year-round local food.

"combined heat and power" (CHP) system in Bennington could be effective, although it would require considerable study and capital funding. Another obvious challenge would involve siting the facility: it would need to be close enough to the downtown (or some other concentration of buildings) to effectively provide heat, and yet located so that truck traffic, noise, and the visible steam plume would not adversely impact the immediate area. The benefits of these co-generation facilities are considerable, however, with overall operating efficiencies of closet to 90 percent, so the possibility should be seriously considered.

A project using biomass to generate 29.5 MW of electricity (with a portion of the excess heat used to dry sawdust that would then be compressed into pellets) was recently proposed for construction in Pownal (Figure 15). Although that project has been withdrawn from consideration, some useful information was obtained during the initial review process. In general, the amount of wood required for a facility of that size leads to inefficiencies unless much more of the excess heat is used productively. In addition, the amount of truck traffic, and the amount of fuel needed to procure and process the wood, argues for a smaller sized facility. It is likely that the best large-scale biomass application in Bennington would be for a combined heat and power facility, whether near the downtown, at the Southwestern Vermont Medical Center, Southern Vermont College, or serving some other institutional use.

Biomass also can be used to produce liquid fuels. 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 a common gasoline blend 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. 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 product ethanol yields very poor, uneconomic, net energy yields. Moreover, the large acreages required to produce sufficient corn removes productive land from food production, thus increasing food prices and, unfortunately, increasing the energy inputs necessary to grow and transport food. New research involving the production of ethanol from cellulose—including crops such as switchgrass, corn stalks, and low-grade wood– holds promise for significantly improved net energy yields and reduced environmental impacts. It is possible that some cellulosic ethanol production could be supported from locally grown crops in and around Bennington, but most agricultural and forest land are more efficiently for producing food and for growing biomass to be used for space heating and electricity generation.

A number of agricultural crops contain relatively large amounts of oil that can be easily acquired through mechanical pressing and used directly as a fuel (vegetable oil) or processed into biodiesel. One farm in Shaftsbury 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). With some modifications, diesel vehicles can operate efficiently burning clean vegetable oil. A logical application for liquid biofuels in Bennington is for agriculture. Farmers can dedicate a share of their land to production of oil crops such as sunflowers, canola, and soybeans which they can then 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 costs are minimized. A business opportunity may exist for a local farmer to specialize in oil crops and biodiesel production and sell the fuel to other farmers and users of diesel equipment in the local area.

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

Hydroelectric Energy Potential

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 just in Bennington County. 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 dam sites in Bennington County (Figure 16), most of which are in Bennington and North Bennington, have the potential for producing at least 3 MW of electricity.

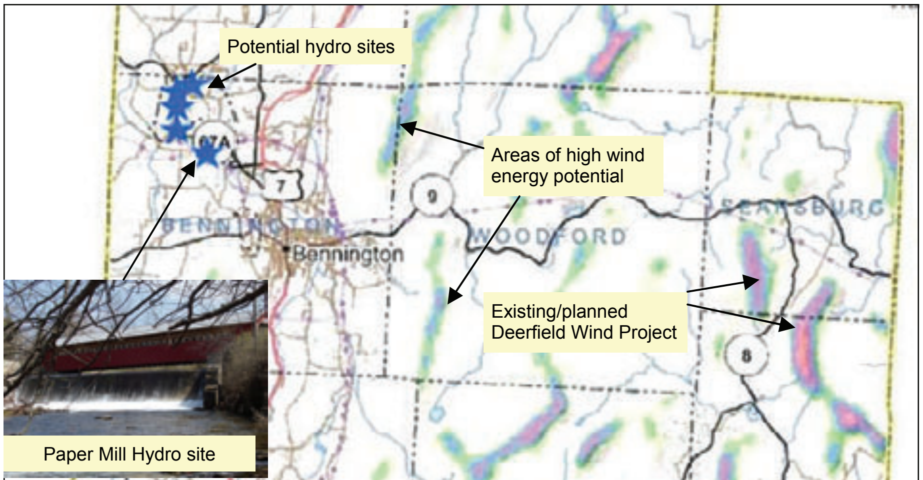


Figure 16. Recent interest has been expressed in reestablishing hydroelectric generation at the dams on the Walloomsac River in Bennington and Paran Creek in North Bennington. Bennington County's wind resource potential is concentrated along its high ridgelines. An existing facility, with a major expansion planned, is located just a few miles east of Bennington in Searsburg.

The owner of the "Paper Mill" dam on the Walloomsac River in Bennington has completed all of the environmental permitting required to re-establish electricity generation at that site. Testing of river bottom sediments and site and building remediation plans were completed with assistance from EPA Brownfields funding. Three turbines have been purchased and the former penstock, raceway, and other infrastructure will be rehabilitated for use. The generating capacity of the dam will be approximately 400 KW; the owner is establishing a local "net metering" group to purchase the power generated at rates identical to standard residential rates. Information learned from the Paper Mill project should prove useful in future efforts to restore generating capacity at other dams, such as those along Paran Creek.

There also are many opportunities for smaller "microhydro" projects in the area. The Town of Bennington recently completed installation of a system at its main water plant, using energy from water entering the system to generate electricity for the plant. A resident of Pownal has recently developed a 65 KW hydro system using energy from a small stream on his property. Similar small-scale projects may be possible at numerous locations in Bennington.

<u>Commercial Wind Energy Potential</u>

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. 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 (Figure 16). The Deerfield Wind facility, located several miles east of Bennington in Searsburg, currently generates a maximum of 6 MW of electricity, with an expansion approved to add 15 new 2 MW turbines (36 MW total generating capacity).

Wind power is a proven technology, with advances in turbine technology occurring at a rapid rate because of the growth in 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, which is comparable to, or better than, many nonrenewable sources. To achieve high efficiencies, wind turbines must be large (2.0—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 (see photo simulation next page). 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 generation 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 mitigated to some extent by the selection of high quality sites, development of smart grid technology to maximize efficiencies in transmission, and use of new utility scale storage mediums.

Sites available for commercial wind projects in Bennington are quite limited (Figure 16), located along the ridge of the Green Mountains at Harmon Hill and Bald Mountain, and access to those sites would be difficult and would raise concerns over impacts to remote forest lands. Given that an increasing share of electricity will have to be generated from local renewable sources in the future, however, the town should consider carefully any proposals for commercial-scale wind generation that are put forward.


Commercial wind generating projects like this one in Searsburg could provide a significant share of the electric power needs of the area, but impacts on viewsheds and remote forest lands may limit the potential for development of such sites in areas near Bennington.

Small scale wind turbines also have potential for addressing some of the region's demand for electricity, as discussed in the section on residential energy strategies. If enough small scale generators are deployed, this distributed electricity generation will provide important capacity for the region and state. Of course, it will take at least 1,000 residential-scale turbines to produce as much electricity as a single commercial-scale turbine.

<u>Solar Energy Potential</u>

The benefits of passive solar space heating and hot water and photovoltaic systems for individual buildings or properties has been discussed earlier. In addition, there is significant potential for utility scale production of electricity from solar energy. Solar energy technologies are proven and continually being refined. They also have a relatively minor environmental impact and produce energy by capturing ambient sunlight (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 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 used in photovoltaic cells).

State and federal incentive programs have spurred interest in solar-based electricity generation. A project planned for the former Green Mountain Racetrack in Pownal will generate 2.2 MW when operating at capacity. That installation points to one of the principal challenges of utility scale solar generating facilities: obtaining a site that maximizes solar access. The Pownal site is located in a relatively narrow valley where shadowing and fog/cloud cover will limit electricity production. The Pownal project also will use fixed angle solar panels that are optimized for productivity during midsummer. A more efficient facility would be located in an expansive open area where access to direct sunlight could be maximized throughout the year. Use of "sun tracking" technologies that keep the panels oriented at right angles to incoming solar radiation throughout the year and throughout the day also would greatly improve efficiency and cost-effectiveness.

A fixed panel solar array such as this one is planned for construction in Pownal in 2012. It will include 370 solar arrays covering 12 acres of land and produce 2.2 MW at capacity.

A smaller commercial solar photovoltaic project was proposed in Bennington several years ago. The site considered at that time was at the municipally owned landfill off Houghton Lane. A 2009 report produced for the EPA titled *Solar Power Installations on Closed Landfills: Technical and Regulatory Considerations* identified some potential issues for landfill-based solar installations, including steep slopes, thin landfill caps, structural settlement, and landfill cap maintenance, any of which could hamper development. But the EPA concluded that these issues could be resolved as many landfill sites may be suitable for solar development. Indeed, several municipalities are proceeding with such developments, including a 5.6 MW project in Canton, Massachusetts. That project will take a nonperforming municipal asset and convert it into a facility that will generate direct revenue and a reduction in town energy bills. The project will create construction jobs and permanent jobs in the town. The Houghton Lane landfill site is actually quite well-suited for a solar energy facility. Bennington should remain open to similar projects, at the landfill or elsewhere, in the future and should discuss innovative financing and energy purchase agreements with any potential developer.

VIII Summary and Recommended Actions

Energy is fundamental to all aspects of our lives. Whether it be the energy in the food we eat, the energy that heats and light our buildings, the energy that propels our cars, trucks, buses, and trains, or the energy that drives the engines of our industry, our quality of life is inextricably tied to the availability of sufficient and affordable energy. The information provided in this plan illustrates the staggering amount of energy that is used—just in Bennington—and the tremendous outlay of financial resources that such energy use entails (Table 9). Rising costs and uncertainties associated with future supplies of nonrenewable fossil fuels make it imperative that concerted efforts be made to conserve energy, modify the way we live and conduct business, and develop new sources of local renewable energy. Numerous ways to begin to reduce energy use or expand our use of alternative energy are outlined in each of the preceding sections and are summarized below.

While conservation, adaptation, and development of new sources of energy are critical to maintaining our quality of life, it also is important to recognize that there are important opportunities for economic development that can be realized from those same activities. Primary investment in building weatherization, electrical efficiency, alternative vehicles and transportation systems, and small and commercial scale renewable energy development would lead to new jobs and economic growth. Just as significant is the fact that resulting savings on energy expenditures—money that currently is being exported from the local economy—would be available to be reinvested in local economic activity. Energy expenditures in all sectors of Bennington's economy amount to roughly 100 million dollars per year. Another 50 million dollars is spent on food that, for the most part, is imported to the region (with local dollars exported). Taken together, that 150 million dollars presents a host of economic development opportunities. If home weatherization projects, commercial, manufacturing, and municipal and institutional efficiency projects, reductions in use of transportation fuels, expanded production and consumption of local foods, and greater reliance on local renewable energy (biomass, hydroelectric, wind, and solar) can reduce energy expenditures by ten percent, the local economy would benefit in the amount of 15 million dollars per year.

Table 9. Estimated Energy Expenditures—All Sectors—Space Heating, Electricity, Transportation, Town of Bennington.

	Oil and LP Gas	Wood/Biomass	Electricity	**Total**
Residential	$16,281,657	$265,916	$6,628,958	**$23,176,531**
Commercial and Manufacturing	$11,005,197	-	$25,918,706	**$36,923,903**
Municipal Government	$215,511	-	$473,402 (includes streetlighting)	**$689,913**
Public Schools	$287,217	$118,479	$414,804	**$820,500**
Hospital Campus	$2,718,750	-	$1,207,001	**$3,925,751**
Colleges	$540,000	$208,000	$682,000	**$1,430,000**
Total Space Heating and Electricity	**$31,048,332**	**$592,395**	**$35,183,996**	**$66,965,155**
Residential Transportation Fuel Expenditures:				$23,751,280
Commercial/Industrial Transportation Fuel Expenditures:				$5,428,800
Municipal Transportation Fuel Expenditures:				$203,534
Total Transportation Fuel Expenditures:				**$29,383,614**
Total Energy Expenditures				**$96,349,212**
Estimated Expenditures on Food				**$50,000,000**
Total — All Energy and Food Costs for Bennington				**$146,349,212**

<u>Recommended Actions</u>

Oversight and Land Use Planning

1. The town should maintain and support its municipal energy committee. That committee should pursue implementation of this plan, advocate for energy conservation and renewable energy projects, and report on a regular basis to the Select Board.
2. Continue implementing land use planning policies that encourage efficient development with high density mixed-used development in the designated growth center and low density development that does not require extensive infrastructure or services in rural areas.
3. All developments should be planned to take maximum advantage of opportunities for utilization of solar energy.

Residential Energy Conservation

4. The town should require and verify that all new residential building meets the state mandated Residential Building Energy Standards.
5. The town should promote use of the "Energy Star" building performance rating system and related building practices that limit energy consumption in new and remodeled homes.
6. The town should consider establishment of a Property Assessed Clean Energy (PACE) district to provide an additional method for residents to finance energy improvement projects.
7. Energy education programs sponsored by Efficiency Vermont, the Bennington County Regional Commission, and other organizations—particularly those that focus on home weatherization improvements and energy savings—should be supported and widely publicized.
8. Programs that provide funding for weatherization of the homes of lower-income residents should be supported.
9. Efforts to assist homeowners to safely switch to alternative space heating systems, including wood burning stoves and fireplaces, should be supported.
10. Make sure that residents have access to information about alternative energy systems available for residential uses, as well as financing options available for purchase of those systems.

Commercial and Industrial Energy Conservation

11. All new commercial and industrial buildings must meet the state mandated Commercial Building Energy Standards.
12. Direct access to rail service from industrially zoned land should be maintained.
13. Business owners should be encouraged to obtain the services of an energy auditor and to adjust their operations to minimize energy use.
14. Employees should consider alternative ways of commuting to work and employers should provide facilities to encourage bicycling, walking, and carpooling. Local business groups and the town should promote participation in the annual "Way to Go" commuter program.
15. Commercial and industrial business owners also should seek opportunities to integrate alternative energy systems into their operations.
16. The town should make sure that incentives offered through Efficiency Vermont are widely publicized to businesses.

Conservation Strategies for Transportation

17. The town should encourage conservation through promotion of alternative transportation modes:
    * Continue to improve and maintain the town's network of pedestrian facilities.
    * Make sure that roadway construction and maintenance projects include accommodations for bicycle travel.
    * Support wider utilization of the local public transportation system, carpooling, and school buses.
    * Support expansion of intercity bus travel, including a direct bus connection to the Amtrak rail station in Rensselaer.
    * Continue to participate in rail planning projects designed to return passenger rail service to the region and promote commercial and industrial development that can use rail for freight shipments.

Local Food System

17. Support efforts to develop a more robust local food and agricultural system; participate in efforts to match food producers with large institutional and other consumers.

Municipal Government Energy Conservation

18. Pursue energy audits at municipal buildings focusing on weatherization work at older buildings such as the town office building and old blacksmith shop and heating and electrical upgrades at the police station.
19. Consider alternative energy systems such as a small biomass district heat project to heat public buildings in the downtown, solar hot water production at the recreation center, and a demonstration project with liquid biofuels for some town equipment.
20. Consider purchase of more fuel efficient vehicles for all departments; hybrid sedans and SUVs might be particularly effective for the police department, as would new anti-idling technologies.
21. Publicize the successful LED streetlight conversion and encourage business owners to make similar changes on their external lights.

Conservation Strategies for Schools and Institutions

22. The public schools should regularly participate in the School Energy Management Program reviews and continue to work with Efficiency Vermont to obtain incentives for weatherization and efficiency improvements.
23. The Southwestern Vermont Medical Center should continue to work with Efficiency Vermont to improve energy conservation at its campus and should seriously consider the financial, environmental, and economic benefits of converting its primary heating fuel to biomass.

Renewable Energy Development

24. The town should support efforts to develop appropriate cost-effective biomass energy resources and help promote combined heat and power biomass projects.
25. Support projects that help farmers produce oil seed crops and produce liquid biofuels that can be used to operate equipment and machinery on their farms.
26. Actively support reestablishment of hydroelectric generating facilities at existing dam sites.
27. Support cost-effective and properly sited wind energy facilities after careful study and consideration of public concerns.
28. Consider hosting a solar energy project at the town’s capped landfill site.