Dorset, Vermont

Energy Report and Assessment

February 2013

Prepared by the Dorset Energy Committee

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I. INTRODUCTION

The comprehensive town plan for Dorset 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, 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 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.

The ramifications of these national and international issues in a small rural town like Dorset may be difficult to grasp at first, but they are significant and demand immediate attention and action. Oil and gasoline prices have been rising and although there will be upward and downward fluctuations in the future, the overall trend in price will inevitably be toward higher prices. At some point in the future it will be necessary to transition to alternative sources for heat and to different transportation solutions. Electricity supplied from distant generating facilities also will become more limited, resulting in a need to produce more electricity within our region and to use electricity much more efficiently. Also critical 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

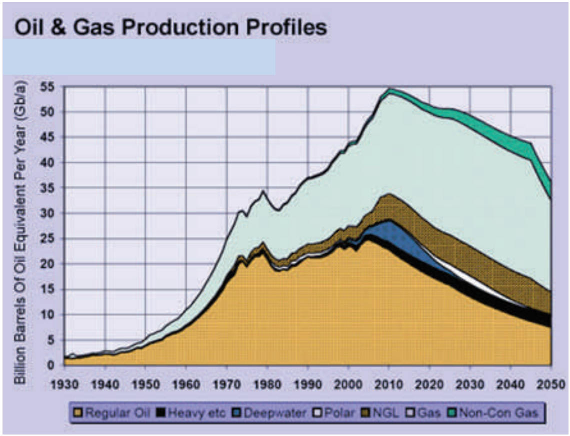


Figure 1. Worldwide production of oil from conventional sources has, or soon will peak. Petro fuels from other sources (natural gas and "nonconventional" oil and gas such as tar sands, oil shale, and deepwater sources) will replace some of the conventional production, but overall production is expected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

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 Dorset and is summarized below. A more detailed accounting of residential, commercial, and public/institutional energy use in Dorset is included in the next section of this plan.

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 has eclipsed the residential sector as the largest consumer of energy in Vermont (Figure 2). A number of factors appear to be driving this increased energy consumption. Dorset—and Vermont as a whole—has seen significant growth in both population and the number of housing units over the past 40 years. In fact, the rate of increase in both population and housing has been higher in Dorset than in the balance of the state, suggesting that energy use locally may have more than doubled during that time. Another striking trend in energy consumption in residential as well as in commercial and industrial uses is the dramatic increase in electricity use that occurred in the late 1960s to mid-1970s. In recent years, however, residential demand for electricity has stabilized, probably due to a decreased reliance on electric space heating and improvements in energy efficiency (that have offset expanded use of electrical appliances, machinery, and telecommunications devices).

The trend in Dorset toward construction of large homes, both as primary and as secondary residences, would tend to increase residential energy demand. Similarly, the increase in the number and size of vehicles maintained by an average household,

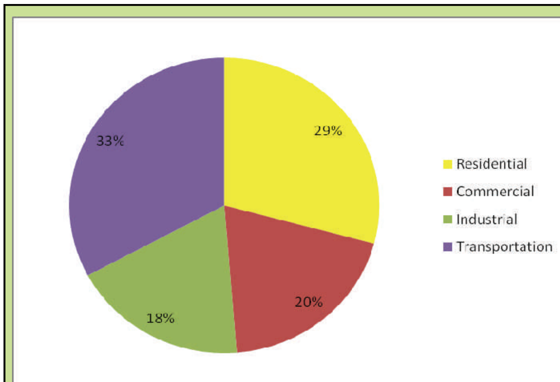


Figure 2. Relative energy consumption by sector in Vermont (2005). Because Dorset is a rural town with relatively little industry, it is likely that the percentages of energy used for transportation and residential use are higher locally.

combined with the fact that most Dorset residents must drive a considerable distance to work, school, stores, and other services contributes to a substantial increase in transportation fuel use (Figure 3).

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. Electricity constitutes a majority of commercial and industrial energy use, although fuel 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 Dorset is transmitted to the town from distant generating facilities. 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 Yankee no longer supplies electricity to Vermont utilities. Without this large influx of nuclear-generated electricity, the state has to rely on other sources—primarily from 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.

Significant changes in fuels used for residential heating have occurred in recent years. Although oil has remained the most common heating source over the past 40 years, the number of homes heated with LP gas has increased recently, and the number of homes heated with wood has increased when oil prices have risen and has decreased when oil prices have fallen. The most current data (Figure 4), however, illustrates that the majority of homes in Dorset still rely on oil for home heating, with over three-quarters relying on fossil fuels.

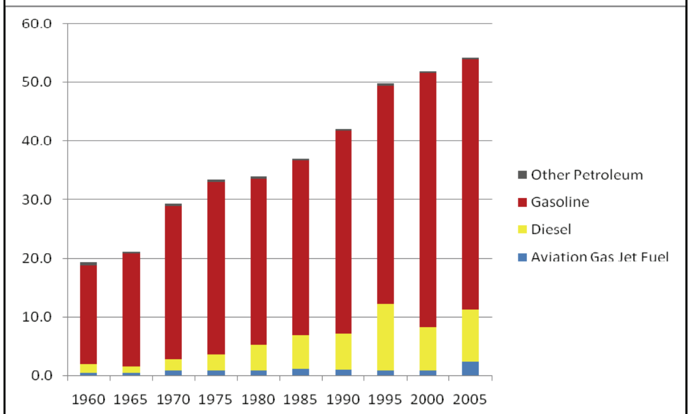
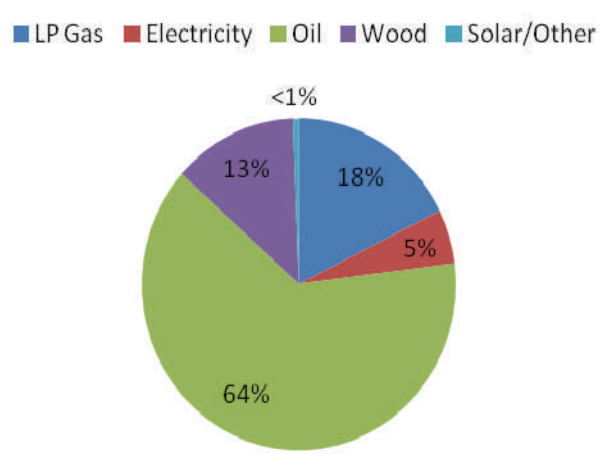


Figure 3. Increased consumption of gasoline and diesel fuel in the transportation sector is responsible for much of the growth in energy use in Vermont. Because traffic data collected in Bennington County is consistent with statewide trends, it is likely that the rate of growth in this sector is similar in our area.

Figure 4. Residential Space Heating Fuels Used in Dorset (2010 US Census)



A Challenging Future

Because energy use pervades all aspects of our lives, 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 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 should present straightforward ways for people, businesses, organizations, and our local government to wisely and efficiently obtain and use energy.

II. INVENTORY OF ENERGY USE

It is interesting to gauge the approximate level of energy consumption in Dorset. Although an exact count is not possible, recent census, housing, and employment data does allow a reasonable estimate of energy consumed by various sectors and activities in the town. For the purposes of this assessment, energy consumption was estimated in residential, commercial/manufacturing, transportation, and town government sectors.

Table 1. Estimate of Dorset'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	859	471,429	204,000	40,363	1,582,649	6,048,000
Two-Family	28	11,571	5,000	1,091	26,377	168,000
Multi-Family	5	1,286	666	182	0	25,000
Mobile Home	36	14,786	6,000	1,364	52,755	180,000
Total	928*	499,702	215,666	43,000	1,661,781	6,421,000
Cost Factor		$4.00/gal	$3.00/gal	$4.00/bag	$0.15/kwH	$0.15/kwH
Total Cost		**$1,996,288**	**$646,998**	**$172,000**	**$249,267**	**$963,150**

* Excludes vacation/seasonal homes.

This data provides a rough estimate of total residential energy consumption and costs for Dorset. The combined total cost of residential purchases of heating oil, LP gas, wood/pellets, and electricity is **$4,027,703**; with a population of 2,031, the per capita cost of residential energy use (not including transportation energy costs) is $1,983. 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. 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.

Table 2. Estimated commercial and manufacturing building energy consumption, Dorset, Vermont.			
	Estimated Floor Area (square feet) (1)	Annual Electricity Consumption (KwH) (2)	Annual Oil/Gas Consumption (gallons) (2)
Manufacturing	80,430	6,364,625	115,819
Commercial	317,124	5,046,844	91,839
Total Consumption		11,411,469	207,658
Cost Factor (3)		$0.15/KwH	$3.50/gallon
Total Cost		**$1,711,720**	**$726,803**

(1) (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) (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) (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.
Total estimated annual energy cost for Dorset-based businesses (excluding transportation) = **$2,438,523.**

Table 3. Transportation fuel use (personal and commercial/industrial) estimates for Dorset.				
		Annual Miles Driven (2)	Gallons Fuel Used (3)	Total Fuel Expenditures (4)
Number of Personal Vehicles (1)	1,763	24,682,000	987,280	$3,702,300
Commercial/Industrial Diesel Fuel Use			197,456	$789,824
Total			**1,006,736**	**$4,492,124**

(1) (1) 928 housing units * 1.90 average vehicles per unit (2010 US Census).
(2) (2) Based on 14,000 miles per year per vehicle—current estimates, Federal Highway Administration.
(3) (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) (4) Expenditures based on gasoline cost of $3.75/gallon and diesel fuel cost of $4.00/gallon.

Table 4. Estimated annual fuel consumption and cost for town government, Dorset, Vermont.			
Energy Source	Quantity Used	Cost Factor	Total Cost
Heating Fuel	2,600 gallons	$4.00/gallon	$10,400
Diesel Fuel	12,325 gallons	$4.00/gallon	$49,300
Gasoline	2,000 gallons	$3.75/gallon	$7,500
Electricity (town office)	11,678 KwH	Actual Cost	$1,909
Total Cost			**$69,109**

From this data it is clear that even in a relatively small rural town like Dorset, energy consumption and costs can be quite high. Approximate total annual energy expenditures in Dorset amount to ($11,027,459 + school expenditures). Because vacation/seasonal homes were excluded, a conservative number was used for home size, and business (such as building contractors) which do not use much energy in a building were excluded, it is likely that this estimate is actually low. The opportunity for saving a substantial sum of money through energy conservation and use of local renewable energy is very real. Every one percent reduction in energy costs saves local residents and businesses over *$110,000*; a townwide reduction in energy cost of ten percent would mean that an additional one million dollars not spent on one-time heating, transportation, and electricity costs would be available for spending in the local economy each year. Weatherization and conversion to alternative energy systems also yield benefits by supporting local businesses that provide those services and products.

III. TOWN AND SCHOOL ENERGY EFFICIENCY STRATEGIES

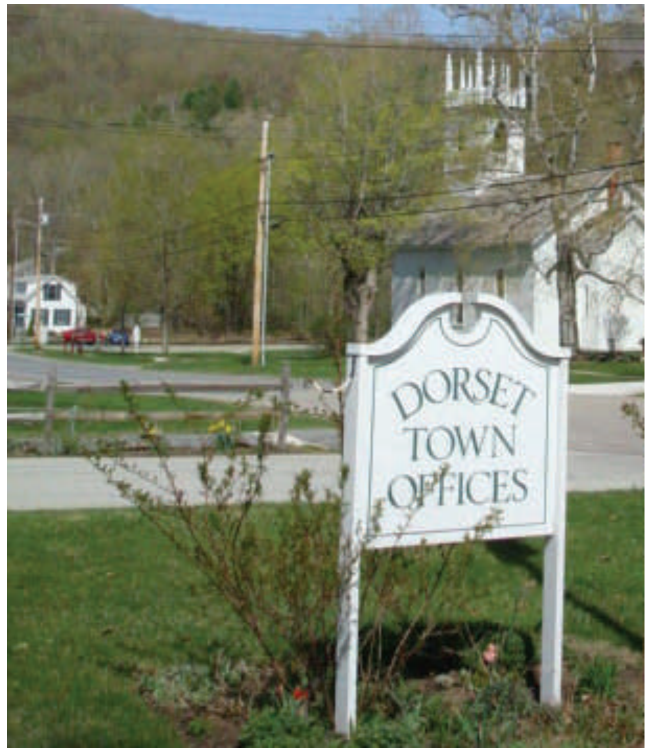
Local government and schools are significant consumers of energy and the costs associated with energy use by those entities has a direct bearing on taxes. Energy conservation and use of alternative energy systems in this sector have the potential to produce significant savings for the community and to set a visible example of responsible energy use.

The town already has taken major strides to reduce energy consumption at the town office building. An energy audit was completed and most recommendations implemented, including:

- Servicing the boiler;
- Improving ventilation;
- Installing programmable thermostats;
- Installation of energy efficient lights and office equipment;
- Air-sealing the building;
- Installing cellulose insulation in the knee wall and attic;
- Improvements to the water heater;
- Spray foam insulation in the basement and box sills.

The town also has worked with the electric utility company to replace all streetlights in the town with highly efficient LED fixtures. The new LED units use significantly less electricity and will reduce the town's annual expenditure in this area (most recently $12,000) by about one-third. The light from the LED units also is much more natural and is distributed evenly, with little wasted light or areas of overlapping illumination between adjacent lights. The town should publicize the effectiveness of the streetlight program and encourage businesses and other uses having outside lighting to replace their fixtures as well.

Energy audits should be completed for other public and town-supported buildings in town, including the fire stations, library, and historical society. The highest priority audit recommendations should be implemented as soon as possible.



The town has been very proactive in obtaining energy audits and implementing conservation measures in municipal buildings.

The town's highway department, with its trucks and heavy equipment, is the largest user of transportation energy in local government. Consequently, its budget will rise relatively rapidly 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 vehicles are used as cost-effectively as possible. Some towns have established plowing policies, for example, that limit the extent of plowing at certain times during the night. Maintenance of the town's highway infrastructure is a critical public service; as petroleum prices continue to increase and with experts predicting fuel supply disruptions within the next 20 years, it makes sense to begin to explore alternative fuel technologies. Several cities and towns have used biodiesel blends for their trucks and equipment; biodiesel use is difficult at present because of high cost and limited supply, although there is one small producer in Bennington County. Manchester began a small pilot program using biodiesel in certain equipment and Dorset could consider a similar program, with a goal of expanding use (and encouraging more local fuel production) in the future.

The Dorset School is overseen by the local school district, which has focused considerable effort on energy improvements in recent years. An energy assessment of the building was completed in 2009 and most of the recommended actions implemented. Those projects have included:

- Buses: timers on block heaters, maintaining tire pressure, and reducing idling;
- Computers—replacing CRT's with LCD monitors and using power management systems;
- Gym: weatherstripping doors and installing programmable thermostats and automatic exhaust fans;
- Kitchen: repaired vent, replaced refrigerators and freezer with Energy Star rated units, replaced vending machine;
- Boiler Room: replaced one boiler with a highly efficient unit that now handles most of the school's heating needs;
- Lighting: Replaced all interior and exterior lighting with efficient T-8 fluorescent and LED fixtures;
- Roof: replaced several sections and included proper insulation.

The school has seen considerable savings in both electricity and fuel oil use since implementing these improvements. Greater utilization of school buses by students (instead of students being driven to and/or from school in individual vehicles) has been shown to significantly reduce consumption of petroleum. A recent study in Bennington, for example, showed that each student using a bus instead of a personal vehicle saves 100 gallons of gasoline per year. Schools also can organize carpool/ride-match systems, encouraging friends and neighbors to get into a routine of sharing a ride. A carpool system would be particularly helpful for Dorset students who attend school at Burr and Burton Academy in Manchester.

An active "Farm to School" program also has been established at the Dorset School (www.dorsetfarmtoschool.org). Students learn about farming and healthy food while maintaining a garden and helping to implement a composting program. The school works with local farmers to integrate agriculture into educational programs while using locally sourced food whenever possible.

The Long Trail School is a private secondary school occupying a large building off Kirby Hollow Road. The school has replaced some lighting with efficient LED fixtures and has contacted Efficiency Vermont about possible future weatherization improvements.

IV. RESIDENTIAL SECTOR ENERGY EFFICIENCY STRATEGIES

Most buildings currently in Dorset, and most that are likely to be built in the future, are private residential structures. 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, lighting/electric, and transportation opportunities.

Dorset's plan for future development, as reflected in the Town Plan and Zoning Bylaw, allows and encourages higher densities of development in village centers and along existing highways adjacent to those areas. On its face, such development plans support energy conservation objectives by limiting sprawl and thus reducing energy used for transportation and energy required for the delivery of essential services to residents. While appropriate, the effectiveness of this plan is somewhat limited by the fact that Dorset is a rural community with relatively few local job sites or stores and a high school (used by most students) located in an adjacent town. Furthermore, the Town Plan notes that most recent residential development has not occurred as "infill" in village or village residential districts, but rather on large lots in outlying rural districts. The most effective strategies for siting new residential development in Dorset, therefore, may be those that focus on the location and solar orientation of new developments and buildings.

Residential subdivision design should give consideration to solar orientation when laying out lots and building sites. To the extent possible, building envelopes 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.

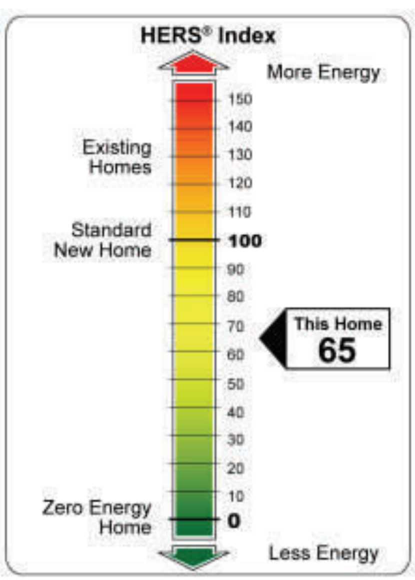


Figure 5. The Energy Star rating system for new residential construction. Proper construction, heating/cooling, appliances, and lighting yield lower scores (improved energy conservation).

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). The town includes a statement on all issued building permits that notes the requirement and refers builders and homeowners to the RBES Guidelines. Compliance with RBES could be improved through periodic inspections during construction by the town's zoning administrator; a certificate of occupancy being issued only if all RBES requirements are met.

The widely used "Energy Star" rating system (Figure 5) 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.

In addition to solar orientation, energy-saving characteristics of new homes include features such as:

- "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 ;
- 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.

An obvious (but often overlooked) determinant of energy usage in a house is the size of the structure. 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 in a Vermont home—850 gallons—(where an average single family home contains approximately 2,000 square feet) is consistent with this data. 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 used for cooling, lighting, and other home features.

Of course, an extremely energy efficient new home uses less energy per square foot (a home with a HERS rating of under 50, for example, could be expected to use less than 30,000 Btu per square foot). The linear relationship between building size and energy consumption still exists, however, although the "slope" is less (i.e., each 5 square feet adds an additional gallon of oil (or the Btu equivalent in a different fuel) consumption.

Although people will continue to build houses sized according to their needs and/or desires, a number of municipalities around the country have attempted to recognize the fact that large houses lead to much greater energy consumption in their communities. Some cities, for example, have residential building codes that assess progressively higher permit fees as house size increases, unless the larger size is offset by progressively lower (better) HERS scores. A town such as Dorset could adopt a sliding fee schedule for zoning permits based on house size, with a portion of the fee refunded if, upon completion of construction, the homeowner produces a HERS rating certificate that shows that the home is very energy efficient. Additional revenues from such a fee system could be used for municipal energy conservation projects.

Sample Zoning Fee Schedule Based on House Size and Energy Efficiency			
House Size	**Zoning Fee**	**HERS Score**	**Refund Amount**
Less than 1500 sq ft	$100	> 80	0
		60 - 79	$50
		< 60	$100
1500 - 2500 sq ft	$250	> 80	0
		60 - 79	$100
		< 60	$200
2500 - 4000 sq ft	$500	> 80	0
		60 - 79	$125
		< 60	$300
More than 4000 sq ft	$1000	> 80	0
		60 - 79	$200
		< 60	$500

The town also should review its land use regulations to determine if adequate opportunities for two– and multi– family housing exist in suitable locations. In addition to lower construction cost, multi-family units offer opportunities for enhanced energy efficiency through innovative layout of units, heating and air conditioning systems, and other shared infrastructure.

With close to 1,300 existing housing units, the greatest gains in residential energy conservation in Dorset can be accomplished through improvements to existing homes. A number of organizations and programs provide advice and incentives for making energy-saving home improvements. Efficiency Vermont (www.efficiencyvermont.com) offers a wealth of information on residential energy conservation and convenient booklets such as "The Energy Smart Home." Financing for home energy conservation improvements also may be facilitated if the town implements a "property Assessed Clean Energy" (PACE) program—discussed further in the next section. 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 can lead to considerable reductions in energy use (and costs) include:

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 over 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

Alternative Energy Options for Residential Properties

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 building's primary hot water system. It also is possible to use a tanklless 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 produce the least electricity when demand for electricity is highest (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 methods (discussed below) 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.

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

Wood is another abundant renewable resource in Dorset 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.

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

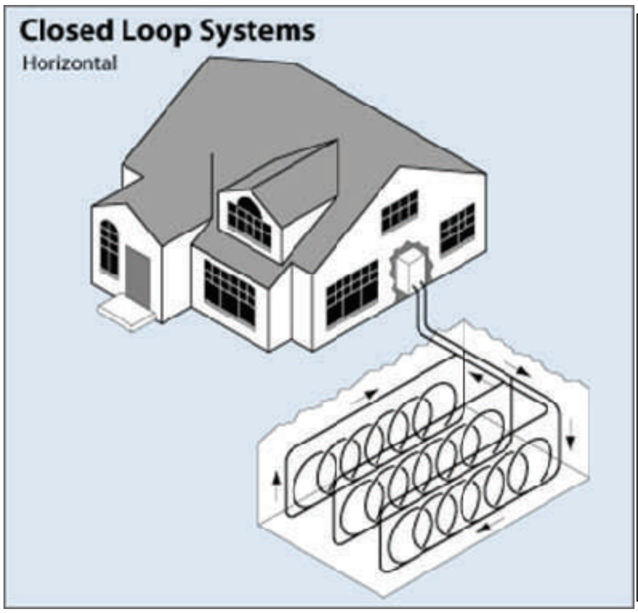


Figure 6. A standard residential geothermal heat pump system that uses heat energy within the Earth to heat and cool a home. There is growing interest in geothermal in the area. Several new buildings have used geothermal systems and some local contractors now are equipped to install the systems.

<u>Property Assessed Clean Energy (PACE) Program</u>

The initial cost of many residential weatherization or renewable energy system is prohibitive for many homeowners. State rebates and federal tax credits that have become available recently can significantly reduce this initial investment and greatly shorten payback times. It is uncertain, however, whether funding for these programs will continue to be available in the future. The Property Assessed Clean Energy (PACE) program—under legislation recently enacted by the state—offers great promise in helping homeowners make energy conservation improvements or purchase a renewable energy system. Under this program, a municipality, upon voter approval, can borrow money and then make loans to homeowners in amounts of up to $30,000 for the improvements. The owner of the property then repays the loan through an assessment on the annual property tax over a period of up to 20 years. PACE loans would be available for qualifying projects, as determined by Efficiency Vermont. Dorset has studied and recently approved formation of a PACE District covering the town. Residents should be able to take advantage of PACE financing in the near future. Information will be available by the town and the Dorset energy committee.

V. COMMERCIAL/INDUSTRIAL ENERGY STRATEGIES

Dorset is primarily a residential community, but it does contain over 100 commercial and industrial "establishments," employing nearly 700 people (Vermont Department of Labor, 2010). The majority of those businesses, and the majority of the employees, are in the services sector. Of particular note in the services sector is that employment in the "leisure/hospitality" and "schools" categories is particularly high, reflecting the relatively large size and activity levels in those buildings (school energy strategies discussed separately in Section III) . Not surprisingly, the manufacturing sector data also suggests the use of relatively large facilities. Of course, many agriculture/forestry, construction, and transportation businesses rely on heavy vehicles and equipment even though they may not utilize large buildings or large numbers of employees. Many, but not all, of the other businesses are smaller and a significant number may be home occupations or sole proprietorships.

Commercial and industrial establishments in Dorset, by sector.

Sector	Establishments
Agriculture/Forestry	5
Construction	20
Manufacturing	8
Services	64
Retail	5
Transportation	3
Information	3
Financial and Real Estate	7
Professional/Technical	15
Leisure/Hospitality	13
Schools	2
Local Government	1

In general, commercial and industrial businesses rely heavily on electricity to fuel their operations (statewide, 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 growth 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). Efficiency Vermont also has supported a local outreach program that provides information on energy conservation and efficiency programs. Businesses and organizations having participated in this program include: HN Williams Store, Town of Dorset, Mettowee Mill Nursery, Dorset Elementary School, East Dorset Fire and Rescue, Wood and Signs, Dorset Union Store, Long Trail Auto, J.K. Adams, Dorset Congregational Church, Dorset Firehouse, Wilson House, Dydo and Company, Aeolus Animal Hospital, Dorset Library, Natural Bridges, and Vermont Renewable Fuels.

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. Dorset's land use plan requires new commercial and industrial businesses to be located in properly zoned districts along Route 7/7A and 30; extension of these uses to more remote areas should not be permitted. Access to the Vermont Railway line from commercial/industrial zones in East and North Dorset is particularly important and should be maintained.

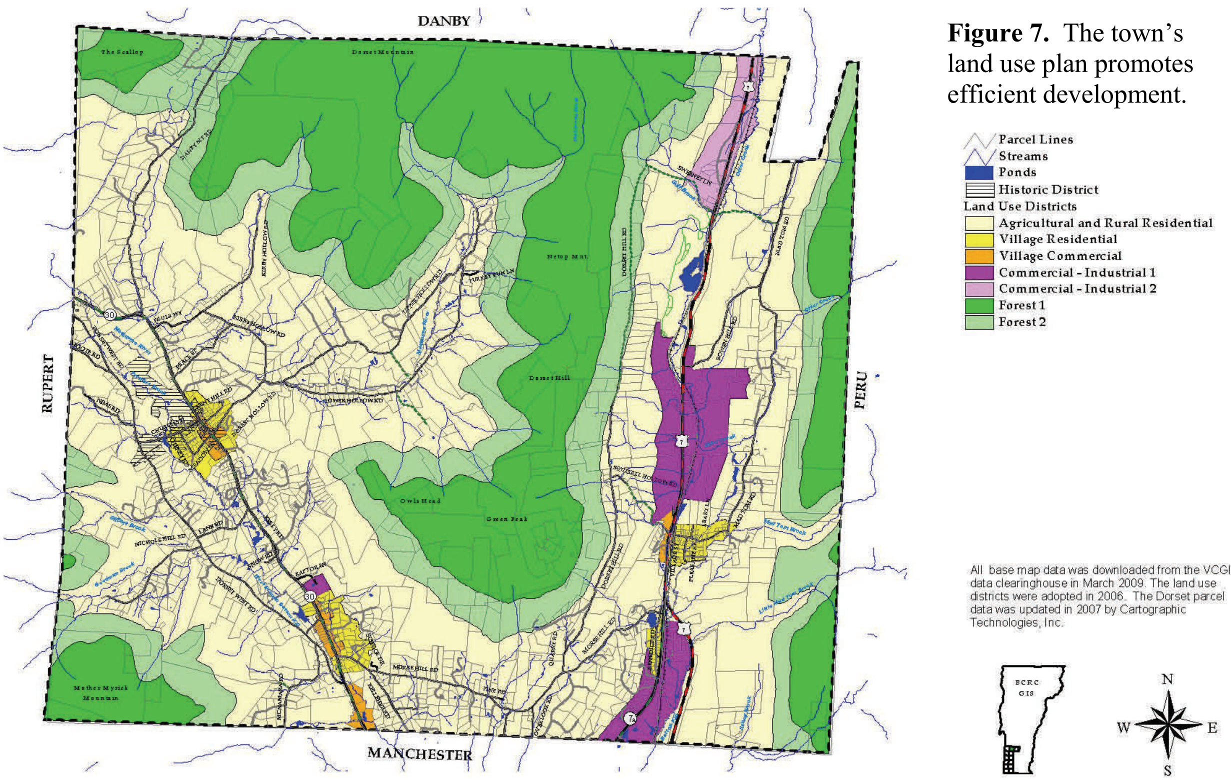


Figure 7. The town's land use plan promotes efficient development.

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).

When pursuing transportation efficiencies, businesses can consider encouragement of 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 are discussed in more detail in Section VII, but it should be noted here that incentives are available for purchase and installation of solar water heating systems, photovoltaic panels, biomass-based heating systems, and small-scale wind generation. 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.

<u>Conservation Strategies for Specific Types of Businesses</u>

Agriculture/Farms

Agriculture has a particularly important role to play in town-wide energy conservation efforts, as discussed in Section VII. 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:

- Equipment: Energy-saving projects may be eligible for custom 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

There are abundant opportunities for energy cost savings at agricultural operations; this barn is in nearby East Rupert.

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 numerous professional offices in Dorset, many of them quite small. With improved telecommunication facilities, it is likely that the number of professionals working from small offices in the area will increase, so considerable energy savings may be realized in this sector.

- 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

Dorset is home to small convenience and general stores that provide valuable services to residents and visitors in Dorset, South Dorset, and East Dorset.

- 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.

General stores provide convenient services for residents, and can benefit from a variety of energy conservation improvements.

- 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.

Lodging

A variety of lodging types exist in Dorset, ranging from historic inns and bed and breakfasts to roadside motels.

- Lighting Equipment, Controls & Design: Energy-efficient lighting choices include overhead and wall-wash lighting to 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, and even the number of scorched lamp shades. 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.

Restaurants

Dorset has a number of popular and successful restaurants, some stand-alone and some as part of an inn. Restaurants often use over twice as much energy as other comparably sized commercial buildings, but a number of opportunities exist to reduce energy consumption.

Dorset has a number of inns and restaurants in historic buildings.

- Commercial Kitchens: Food preparation can account for 35% 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 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

Dorset has a few small retail stores located in village commercial areas. Improving the stores’ appearance and comfort through efficiency measures also can

- 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.

HN Williams is a popular retail store in Dorset.

- LED Lighting: LEDs use up to 80% less energy than standard halogen bulbs. LEDs also last at least 10 times longer, have the same quality light you need 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. 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—and get a $25 to $50 rebate—to save up to $100 per year on electricity costs.

Industrial Uses

Dorset has a large amount of land near East Dorset planned for industrial use. Manufacturing and other industrial developments 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.

- 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: Refrigeration can account for nearly 50% of energy costs at food processing facilities. 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.

VI. TRANSPORTATION STRATEGIES

The amount of energy used for transportation in Vermont has grown more rapidly than energy use in any other sector over the past 25 years. 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.

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 a rural location.

Dorset is a predominantly rural community with two historic village centers. Most of the remote parts of town are forested, with no permanent homes or businesses, but houses are located along all of the maintained roads that traverse the town's scenic valleys and lower hillsides. Most residents travel to Manchester, Bennington, or Rutland to work and shop, although local stores, offices, churches, restaurants , and a library do provide some more accessible goods and services. The Dorset School and Long Trail School (a private school) provide educational services, although many of the town's students attend Burr and Burton Academy for secondary school.

Fortunately, although Dorset is a rural community with limited services for residents, it is quite close (for most parts of town, only five to ten miles along good state highways) from Manchester's commercial center. The much larger city of Rutland is located approximately 20 miles to the north along US Route 7. Nonetheless, the aggregate distance driven by Dorset residents is considerable (Table 3). For example, based on average commute times Dorset workers drive an aggregate of 16,000 miles and use 800 gallons of gasoline each weekday, just to get to work and home.

Without strong price incentives (i.e., higher gas taxes) to motivate conservation, other methods to reduce fuel consumption must be found. Of course, with a constricting supply and increasing demand, petroleum prices will continue to rise—and at an increasing rate—so price incentives will soon appear on their own, but strategies to help people adapt to that inevitability are important now. Transportation energy conservation strategies in Dorset can take several forms, including: increased availability of public transit services, improved bicycle and pedestrian facilities, expanded freight rail service for businesses and re-establishment of passenger rail service to the region, use of technologies that limit the need to drive (e.g., telecommunication infrastructure), deployment of alternative fuel vehicles and supporting infrastructure, and development of land uses within Dorset that provide more goods and services locally.

Public Transit

The only public transit service currently available to Dorset residents is "The Bus," a small bus operated by the Marble Valley Regional Transit District in Rutland. The bus stops at the East Dorset General Store four times (two times southbound and two times northbound) in the morning and four times in the afternoon. Although a very useful service for commuters who can get to the stop, it does not provide service to the west side of town or regular service throughout the day. The Green Mountain Community Network does provide "demand response" service to Dorset with its fleet of cars and vans, providing a valuable service, but one that is relatively costly and requires advance planning (and is, therefore, not particularly convenient). Without significant increases in Federal Transit Authority funding, it is unlikely that Dorset will see expanded access to local or regional bus services. Nonetheless, the town should actively participate in regional transportation planning, and if funding opportunities become available, should conduct the studies necessary to plan and implement new services. Residents also could form and support local volunteer driver and ride-sharing programs.

MVTI's "The Bus" connects Dorset with Manchester and Rutland, with four northbound and four southbound stops each day.

Bicycle and Pedestrian Facilities

Dorset's village streets, sidewalks, and lightly traveled rural roads are ideally suited for walking and bicycling, transportation alternatives that are both efficient and healthy. Of course, these alternatives are most practical, and likely to be employed by people, when distances between destinations are not great. It therefore makes a great deal of sense to encourage residential growth near existing and

Well-maintained shoulders like this one along state highways encourage bicycling.

planned commercial and service centers—principally around Dorset and East Dorset Villages. Maintaining and extending the existing sidewalk network, ensuring that adequate paved shoulders are provided and maintained on state highways and that town roads are kept in good repair all are strategies that will encourage more walking and bicycling trips.

The town could benefit from some new bicycle and pedestrian facilities as well. The abandoned Manchester-Dorset-Granville rail line potentially provides a direct and scenic connection between Dorset and Manchester; efforts to preserve the corridor and establish a multi-use pathway connecting the towns should be supported. Establishment of crosswalks on US 7 in East Dorset and VT 30 in Dorset should be supported as a way to promote pedestrian access and safety between residential and commercial centers. Finally, private businesses, schools, and municipal buildings should provide bicycle racks and other amenities for employees, customer, students, and the general public.

Rail

The state-owned Vermont Railway corridor runs through East and North Dorset. The rail line, part of Vermont's "western corridor" is now used for freight shipments, predominantly bulk shipments to facilities such as Haskins Propane facility in North Dorset. The nearest active passenger rail stations are in Rutland and Rensselaer, New York. A study currently underway would lay the groundwork for re-establishment of passenger rail service along the entire western corridor of the state, connecting Burlington, Middlebury, Rutland, Manchester, and Bennington to Amtrak's northeast network in Rensselaer. That effort should be supported, as should interim measures to provide direct bus service from Manchester and Bennington to the Amtrak station in Rensselaer. Physical upgrades to the rail line necessary to accommodate passenger trains also would improve the economic feasibility of expanded freight traffic on the line—providing significant opportunities for commercial and industrial cost and energy savings.

Alternative Fuel Vehicles

With the increasing cost and eventual decreasing availability of petroleum fuels, there will be a need to develop an infrastructure to support vehicles that operate on alternative types of fuel. The simplest of these vehicles are human-powered vehicles, such as bicycles discussed above, but this category also includes aerodynamic "velomobiles" and human-powered/electric hybrid bicycles and tricycles. These vehicles benefit from the same basic roadway infrastructure as discussed in the section on bicycles.

Electric and "plug-in" gas/electric hybrid vehicles will benefit from expanded charging infrastructure.

Gas/hybrid electric cars and trucks, including so-called "plug-in hybrids," and full electric vehicles, are coming on the market in increasing numbers. Full and plug-in hybrid electric vehicles will rely on charging stations that allow car batteries to be recharged while parked at workplaces, schools, or in commercial areas. The town should look for opportunities to participate in projects that supply grant funds to support development of this new electric-charging infrastructure—and should support development of efficient and sustainable renewable energy based generating facilities.

Telecommunications

An advanced telecommunications infrastructure is a transportation energy conservation strategy in that it enables people to avoid travel. If people are able to work at home, shop, attend meetings, classes, or special training sessions, and participate in public events "on-line," many miles of driving can be saved and people can engage in events that they may otherwise not have been able to access. A concern, however, is that these opportunities may work at cross-purposes with the town's efficient land use plan by enabling more small business development and other activities in remote rural areas. The town will have to consider all of these factors when developing new land use policies and plans.

VII. EMPHASIS ON LOCAL RESOURCES

A recurring theme throughout this plan is that the best way to conserve energy is to do things that inherently use less energy. Developing a strong economy that uses as many local resources and which develops local and regional markets for products reduces the amount of energy spent on shipping and keeps financial resources closer to home. Locally derived food, forest products, and energy (e.g., solar, small hydro, wind, and biomass) can each contribute to economic prosperity while saving large amounts of energy.

Local Food and Agriculture

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 Dorset, 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 Dorset's residents requires 58,860,411,000 Btu, or the equivalent of approximately 420,000 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 2,031, Dorset residents spend approximately $6.5 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.

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

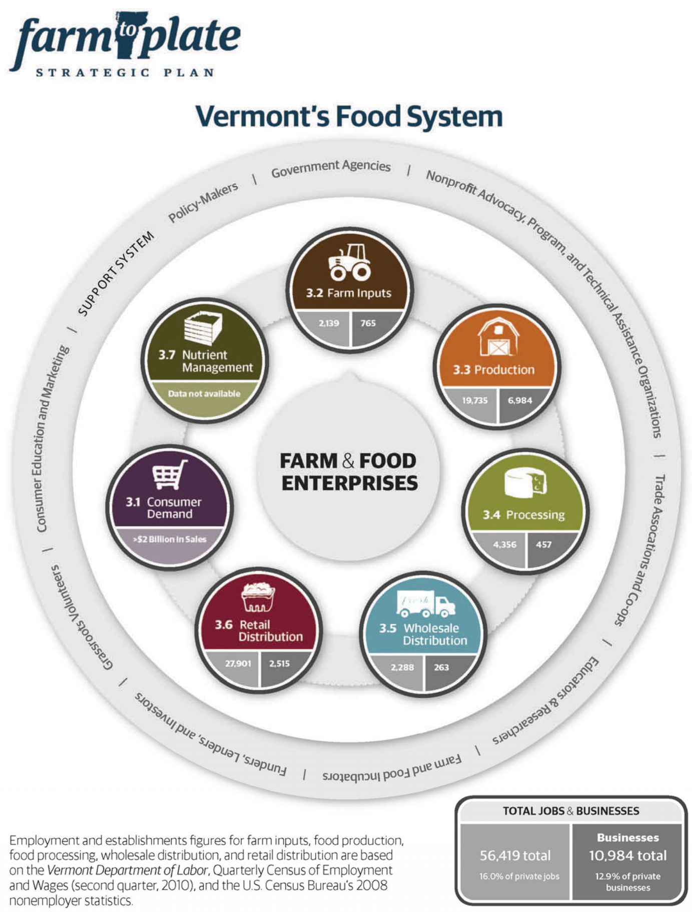


Figure 8. Food system diagram from the Vermont Farm to Plate Strategic Plan. Developing a similar plan for the Northshire area can lead to energy savings and growth in this economic sector.

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.

Dorset is located adjacent to the agriculturally productive Mettawee Valley and a number of small food producers—vegetables, fruit, livestock, and poultry—are located within the town. The popular Dorset Farmer's Market highlights this important aspect of community life and economic activity. By studying the entire food system (Figure 8) in the Northshire area—in cooperation with nearby towns and interested organizations—it would be possible to identify opportunities to coordinate and expand local production and consumption. For example, creating of a link between large institutional consumers (such as schools) and farmers—as with the Dorset Farm to School program—helps those small agricultural operations expand and encourage others to enter into farming. Because the cost of land, especially in the Dorset area, tends to restrict entry into farming for many people, support land trusts and creative use of public lands should be encouraged. Education on backyard gardening and food preparation also increase local food production and consumption.

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 of 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.

Local Renewable Energy Resources

The amount energy used in Dorset—as pointed out in previous sections—suggests that real economic benefits can be realized if a 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 (the amount of energy used to acquire it relative to the amount that is available for final use) and the extent to which use of the resource has negative impacts (such as diversion of land resources from other productive activities).

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 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 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 two pellet production facilities not far from Dorset and one business in Dorset that distributes pellets and sells pellet furnaces and oil-to-pellet conversion systems.

There is growing interest in biomass-based fuels for home, business, and institutional heating.

Biomass fuels are proving to be a cost-effective heating solution for many large institutions, especially schools and colleges. The typical biomass heating system uses chipped low-grade wood, either in a direct burn or gasification process (Figure 9). Local schools in Dorset should conduct an assessment of their long-term space heating needs and evaluate the cost-effectiveness of implementing a woodchip or wood pellet based system. The middle school and high school in Bennington both utilize biomass systems, reducing oil consumption by over 70 percent and saving tens of thousands of dollars in energy costs annually.

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.

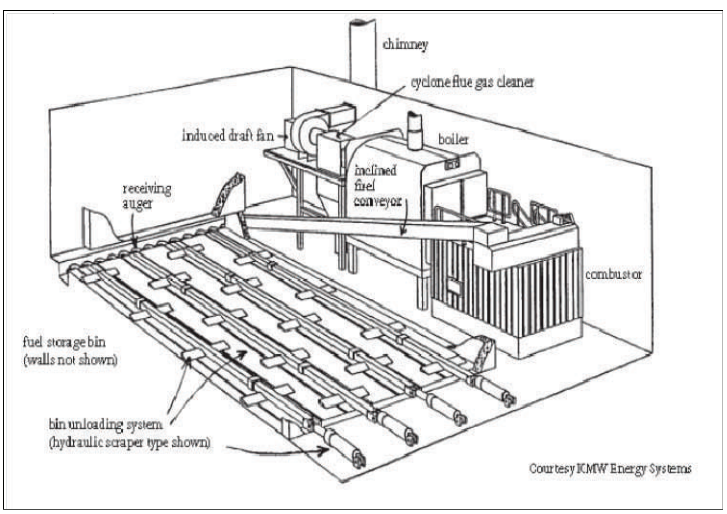


Figure 9. Schematic of a typical wood biomass heating system in use at many schools, hospitals, and other institutions around the northeast.

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 Dorset, but most agricultural and forest land are used 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 our area 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.

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, most of which are in Bennington and North Bennington, have the potential for producing at least 3 MW of electricity. Because of Dorset's location near the headwaters of river systems, the potential for large-scale local hydroelectric production is limited, but it is possible to install "micro-hydro" generators along many the smaller streams that flow out of the mountains that surround the town. 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 Dorset.

Commercial Wind Energy Potential

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 10). The Deerfield Wind facility 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

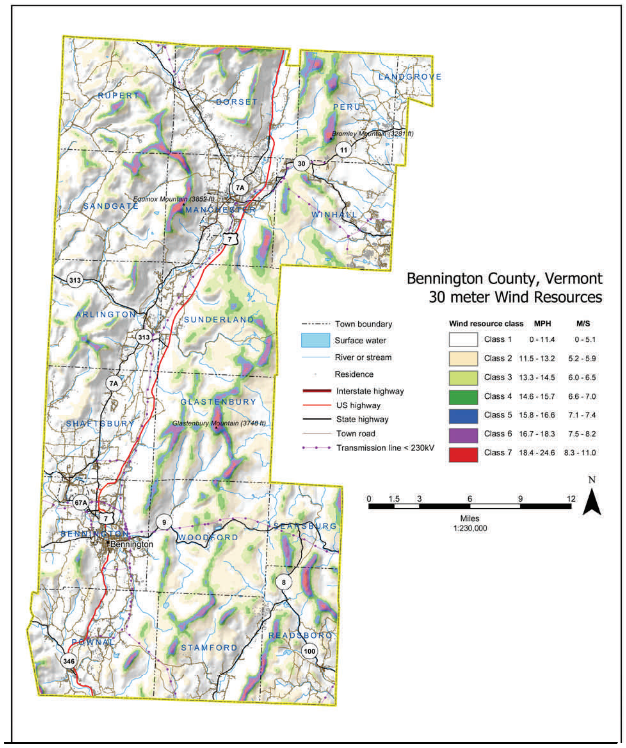


Figure 10. High elevation ridges in and around Dorset are physically capable of producing large amounts of energy from wind, but environmental and cultural concerns may make most sites non-viable.

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.

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.

Solar Energy Potential

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 mid-summer. 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. Because of its topography, it is unlikely that Dorset will see a large-scale solar generating facility sited in the town, but siting one or more smaller facilities, such as the 150 KW facility proposed at the former Bennington town landfill should be considered if appropriate locations are identified.

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 Dorset—and the tremendous outlay of financial resources that such energy use entails. 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 Dorset's economy amount to over 11 million dollars per year. Another 6.5 million dollars is spent on food that, for the most part, is imported to the region (with local dollars exported). Taken together, that 17.5 million dollars presents a host of economic 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, local economic benefits would exceed $1.5 million per year.

<u>Recommended Actions</u>

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.

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 publicize the Property Assessed Clean Energy (PACE) district it recently established 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.
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.
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 utilization of the public transportation system, carpooling, and school buses.
18. 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.
19. Continue to pursue energy efficiency upgrades at municipal and other publicly supported buildings.
20. Consider use of alternative energy systems or fuels for public buildings and equipment.
21. New municipal vehicle purchases should include considerations of energy efficiency.
22. Publicize the successful LED streetlight conversion and encourage business owners to make similar changes on their external lights.
23. The local schools should regularly participate in the School Energy Management Program reviews or energy audits, work with Efficiency Vermont to obtain incentives for weatherization and

efficiency improvements, and consider eventual conversion to biomass fuels for primary heating systems.

24. 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.

27. Support cost-effective and properly sited small hydroelectric, solar, and wind energy facilities after careful study and consideration of public concerns.